

On the Frontiers of Conservation



*Proceedings of the 10th Conference on
Research and Resource Management in Parks and on Public Lands*

Edited by David Harmon

The George Wright Society Biennial Conference

March 22-26, 1999

Asheville, North Carolina

Co-Sponsors:

U.S. National Park Service

U.S. Geological Survey Biological Resources Division

Supporter:

Eastern National

My father said to me,

*'If you take ONE STEP with all the knowledge you have,
there is usually enough light shining
to show you the NEXT STEP.'*

— MARDY MURIE

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HANCOCK, MICHIGAN
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Introduction

The 10th Conference on Research and Resource Management in Parks and on Public Lands took place March 21-26, 1999, at Asheville, North Carolina. These conferences, now held biennially, had their origins in a 1976 meeting on "Science in the National Parks." In 1982 the organization of the meetings was taken over by the George Wright Society (GWS) and the focus was expanded to include both cultural and natural resource subjects.

Over the last decade the conference has grown, both in attendance (just under 600 people came to Asheville) and stature. I began attending the GWS conferences in 1988, and have "worked them" as a GWS employee since 1990. One thing I have noticed is how a meeting such as this serves to "recharge the batteries" of people in the field. Researchers and resource managers working in protected areas have few opportunities to get together and share, not just information, but war stories from the front lines. I have come to feel that perhaps the most important product of the GWS conference is the sense of camaraderie it builds among the participants, along with a renewed sense of professionalism and commitment.

These proceedings are intended to be a record, admittedly a partial one, of what happened in Asheville. Because over 250 individual presentations were made, there could be no question of trying to get them all down in writing—even if such a thing were considered desirable! Still, we were able to include 87 papers here, and I think they represent a large cut of the sessions that took place. We are also glad to be able to present the two plenary addresses that were given, the other two plenary sessions having been panel discussions.

Our editorial philosophy with conference proceedings is to try to get them out quickly, recognizing that (for better or worse) many people regard such volumes as a snapshot whose colors fade quickly with time. Therefore, we do not referee papers (other than demanding that they meet reasonable standards of professional quality) and I, as editor, take a pretty light touch. Much of what I have done is simple copy-editing: regularizing punctuation, enforcing length limits, applying the GWS "house style," and so forth. The reader should therefore not expect to find a perfect evenness of tone throughout, as one would from a book meant to be read straight through. Still—having done just that—I was impressed by the consistently high quality of the contributions. We hope you will be too.

Our indebtedness to the many people who worked to make the conference a success is recorded (all too briefly) on the copyright notice page. Here, I would like to repeat our thanks to the underwriters. The 1999 conference was co-sponsored by the U.S. National Park Service and the U.S. Geological Survey-Biological Resources Division, with support from Eastern National. The GWS is grateful to these organizations for their long-standing financial and logistical support of these conferences. Without it, they could not go on. We also thank USNPS's Office of International Affairs and the U.S. office of the World Conservation Union (IUCN-US) for providing partial travel scholarships that allowed colleagues from Vietnam and the Philippines to attend.

David Harmon
Executive Director
The George Wright Society
November 1999

Aldo Leopold and Environmental Citizenship

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Aldo Leopold was active on the frontiers of conservation in the early 20th century and many now look to his insights, especially on the management of dynamic ecosystems and on the evolution of a land ethic, to guide us into the next millennium. Yet he died more than fifty years ago. He achieved this feat of being on the frontiers of two centuries by being extraordinarily open to discovery, insistent on reappraisal, and committed to innovation.

I am acutely conscious of speaking to an audience comprised mostly of park managers about a person who spent half his career in the U.S. Forest Service, and about speaking to people who probably identify more with their roles as professionals—especially at a conference like this—about the meanings of citizenship. Yet I have become convinced that the U.S. Forest Service and the National Park Service had more in common in their origins as Progressive Era professional conservation agencies than they had separating them, and that some reflection on the meanings of citizenship may be a healthy antidote to an excess of professionalism.

In the outpouring of books and articles in recent years on the meaning of citizenship, many of them lamenting the weakening of civic bonds in America, there has been scant attention to the role of citizenship with respect to the environment.¹ Even among environmentalists, who realize that citizen action has been a hallmark of the “new environmental movement” from the time of the first Earth Day (1970), there is little appreciation of the extent to which our citizenry has played a vital role in the shaping of American environmental policy ever since the origins of the nation.²

As we seek the historical roots of our quest for environmental quality and the means for sustaining it, it is worth pondering the roles and responsibilities of citizens and the relationship between the citizenry and the state—in short, how American democracy works. In this exploration, we may seek insights from Aldo Leopold, who was profoundly conscious of the American democratic tradition within which he was working and who thought hard throughout his career about the meanings and implications of environmental citizenship.

We have had in the United States a tradition of a limited or weak state. It may not seem that way today when people complain of a bloated federal bureaucracy, but relative to the strong central states in the democracies of Western Europe and certainly to authoritarian regimes, our government is decidedly limited and our citizens have always had a healthy skepticism about most everything that government tries to do. In this weak state we have traditionally had rather low legal expectations of our citizens. Citizens are expected to obey the law and pay taxes; even voting is optional. Yet we have had in America a concomitantly vibrant tradition of voluntary citizen action.

The foremost interpreter of the era of the American Revolution, Gordon Wood, has termed the phenomenon of revolutionary citizen action “the people out of doors.”³ He was likely not thinking environmentally, but rather portraying “people out of doors” as citizens acting voluntarily outside of the formal channels of government to shape the kind of community they wanted. When we look back at the controversies of the era, however, we see citizens acting often on environmental issues. Local groups organized, with some success, to prevent new dams from blocking the passage of salmon upstream, for example, seeking to protect their community’s customary right to fish against interference by new industrial mills.⁴

When we think of the origins of the nation, we tend to think of citizens struggling for liberty, for the right of the individual to pursue his or her own self-interest. This is a concept of American history that became cemented in our imaginations especially during the Cold War, when we were fighting the menace of international Commun-

nism and trying to picture America as being everything that the Soviet Union was not. Yet, historians returning to the original documents of the Revolutionary Era several decades ago began to see in them some ideas that were at first startling because they were so at odds with the usual interpretation. What they found were people who thought of themselves as citizens of a republic in which the greatest virtue was civic consciousness, a willingness to subordinate one's own self-interest to the good of the community. "Civic virtue," they called it, or "civic republicanism," referring to the participatory civic values of a republic like that of ancient Athens.⁵ We tend to celebrate America as a country grounded in individual rights, like the freedoms of speech and of the press and of assembly enshrined in the first article of the Bill of Rights. But a case can be made that these rights pertain to communities as well as to individuals; that they protect the opportunity for ordinary citizens to organize and communicate with each other outside of the formal channels of government to shape the environment of their communities or the policies of their governments.⁶

The complex of republican values so pervasive in revolutionary America was largely overwhelmed, scholars are agreed, by democratic egalitarianism, liberal individualism, and capitalist development in the early 19th century, ushering in the liberal democratic state we celebrate today. But the tradition of civic organizing has persisted in American history. It has not been mandated by law; it has been voluntary. The tendency of Americans to form voluntary groups—"associations," Alexis de Tocqueville called them⁷—could be used to sustain traditional community values; it could also be used to protect economic self-interest. This tradition of citizen action, especially in its "civic republican" strain, is the tradition out of which much of our American conservation movement grew. But it may also be the tradition from which several strands of what we may think of today as anti-environmentalism emerged—groups devoted to "wise use," property rights, and county supremacy.⁸ Citizens organize for a variety of purposes.

It must be noted that not everyone regards voluntary citizen action as key to the shaping of society or environmental policy. Many would argue that ours is a *representative* democracy, and that the shaping and administration of policy is the responsibility of elected representatives and executive agencies. Indeed, much of the administrative capacity of the modern American state was developed in the Progressive Era at the turn of the 20th century, in large part in response to environmental concerns. The U.S. Forest Service, in which Aldo Leopold began his career, has been regarded by scholars as the quintessential example of a progressive agency.⁹ And the National Park Service was cast in the same mold. Gifford Pinchot, the first chief of the Forest Service, sought to place technically trained experts—professional foresters like Leopold—in government, and let them establish specific policies and manage the resources. This was a model of governance that elevated the values of order, efficiency, and control, values that may be quite incompatible with democratic participation. Pinchot once said, "The first duty of the human race is to control the earth it lives upon," and I think Leopold himself once may have believed that.¹⁰ From the perspective of a later day, however, we may note that the progressive model, in elevating the virtues of professionalism and technical expertise, tended to crowd out the citizenry and also their elected representatives, the politicians.

Inasmuch as Aldo Leopold began his career as a professional in the employ of the modern administrative state, and is today regarded as something of a prophet of the new environmental consciousness, which elevates the responsibilities of citizenship, we may look to him for insights into the meanings of environmental citizenship—into the role of citizens in the modern state, the tension between the rights of individuals and the claims of the community, and the tension also between professional resource managers and citizen activists. We look first at what Leopold had to say about citizenship in *A Sand County Almanac*, the slender volume of nature sketches and philoso-

phical essays that represents the distillation of his mature thought, and then explore the evolution of his thinking during the course of his career.

As we page through *Sand County Almanac*, we meet our first citizen in the very first essay, "January Thaw":

The mouse is a sober citizen who knows that grass grows in order that mice may store it as underground haystacks, and that snow falls in order that mice may build subways from stack to stack: supply, demand, and transport all neatly organized.¹¹

The mouse is what kind of citizen?—an ordinary citizen who goes about his own business and pursues his own interests. We have many such in our communities.

Skipping perhaps a few citizens, we come to "Pines Above the Snow": "Each species of pine," Leopold tells us, "has its own constitution, which prescribes a term of office for needles appropriate to its way of life." He continues with his analogy between human constitutions and the regimen of various pine trees, the white pine retaining its needles for a year and a half, red and jack pines for two and a half years. "Incoming needles take office in June, and outgoing needles write farewell addresses in October."¹² These pines are going about their own business but they are also meeting the legal requirements of citizenship, acting according to their constitutions, even taking office in a perfunctory way.

Next we meet the thick-billed parrots of Chihuahua, who "wheel and spiral, loudly debating with each other the question . . . whether this new day which creeps slowly over the canyons is bluer and goldier than its predecessors, or less so."¹³ They are debating the criteria of the good life, which in Aristotelian thought is an activity of citizenship more fundamental even than that of developing legal constitutions. The vote being a draw, Leopold observes, they head to the high mesas for breakfast.

In "Clandeboye," the great prairie marsh of Manitoba, we find the grebe, a species of ancient evolutionary lineage impelled, Leopold believes, by "pride of continuity." His is the call that dominates and unifies the marshland chorus: "Perhaps, by some immemorial authority, he wields the baton for the whole biota."¹⁴ Here is the grebe as ethical citizen, as a leader directing the chorus of the marsh for the long-term betterment of the whole community.

Not until the more philosophical essays in the last section of the book do we meet *human* citizens. In "Conservation Esthetic" Leopold discusses the various components of the recreational process, beginning with the most basic motivation of trophy-seeking, common to hunters with both shotgun and field glass as well as to most conservationists and even professionals. He goes on to discuss other more highly evolved components of the recreational process, such as a feeling of isolation in nature or the perception of natural processes, and then reaches what to him is the ultimate component, a sense of husbandry. This component, he tells us, "is unknown to the outdoorsman who works for conservation with his vote rather than with his hands. It is realized only when some art of management is applied to land by some person of perception. That is to say, its enjoyment is reserved for landholders too poor to buy their sport, and land administrators with a sharp eye and an ecological mind." So, to Leopold, husbandry is the highest form of citizenship: actually working with one's hands, participating actively to build or maintain the land community. Yet the government, in substituting public for private management of recreational lands, he observes, "is unwittingly giving away to its field officers a large share of what it seeks to offer its citizens. We foresters and game managers might logically pay for, instead of being paid for, our job as husbandman of wild crops."¹⁵

Leopold expresses his concept of environmental citizenship most memorably in "The Land Ethic":

In short, a land ethic changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such.¹⁶

Here Leopold offers us a concept of citizenship in a community larger even than humankind: we are plain member and citizen of a community that embraces the land and all the plants and animals that are a part of it. The usual formula for conservation—"Obey the law, vote right, join some organizations, and practice what conservation is profitable on your own land; the government will do the rest"—is, he tells us, too easy. "It defines no right and wrong, assigns no obligation."¹⁷ Leopold's formula implies personal responsibility to participate actively as an ordinary citizen in maintaining or restoring the health of the biotic community.

This review of *Sand County Almanac* suggests that Leopold's mature concept of environmental citizenship, with its emphasis on obligation to the community, is similar in some respects to the concept of civic virtue in the republican ideology of the American Revolution, though he conceives the community much more broadly. But one would not necessarily expect to find these ideas early in his career, when he was working for the U. S. Forest Service, modeled on a different conception of the relationship between citizens and the state.

Aldo Leopold throughout his career was a consummate professional, extremely efficiency-oriented during his years in the Forest Service and fascinated by the intricacies of administrative procedures and standards.¹⁸ And yet we get a sense from one of his earliest publications that he was not wholly satisfied with the Forest Service model of governmental administration. Shortly after he had become supervisor of the Carson National Forest in New Mexico at age 25, he was stricken with an illness that nearly led to his death and required more than a year of recuperation. During this time he addressed a letter "to the forest officers of the Carson" reflecting on their responsibilities. The problem that concerned him was how to measure success in forest administration. Was success simply a matter of efficiently following prescribed policies and procedures, or was there something else? "My measure", Leopold wrote, "is the effect on the forest." Even at the start of his career he was concerned about the ends of administration, what was happening to the land, not only the procedures, or means.¹⁹

It was a preoccupation he would continue to pursue into the early 1920s, when he was chief of operations in charge of roads, trails, fire control, personnel, and finance on twenty million acres of national forests in the Southwest. In order to improve the efficiency of administration while focussing attention on "the effect on the forest," he developed an intricate system of tally sheets for a new system of forest inspection that would enable foresters to diagnose local problems and monitor the effectiveness of management solutions. Leopold regarded this elaborate system of inspection as one of his points of greatest pride during his career in the Southwest. And indeed, his lifelong fascination with tracking the dynamics of change and the efficacy of management for the total biotic system, begun during his inspection forays in the Southwest, would lead him in our own day to be acknowledged as the exemplar of the new philosophy of ecosystem management recently adopted by the Forest Service, the Park Service, and other land management agencies.²⁰

Clearly, Leopold was enlarging the responsibilities of professional land managers by extending the boundaries of the community of concern to include the entire biota—soils, waters, plants, and animals—as well as trees and scenery and the interests of the people who used them. But there was scant room for ordinary citizens in Leopold's model of public land management. Though he recognized the difficulty of determining the objectives of management—a problem that bedevils ecosystem management today—he concluded that these decisions should be made by "only the highest authority."²¹ Yet the essay in which he dealt most directly with what he called "standards of conservation" tails off in mid-sentence and remained unpublished, suggest-

ing that Leopold may have realized he was caught in an unresolved problem of authority: who decides the objectives and on what basis? A kind of "super-inspector" would crop up in his writing from time to time over the years, but I am not sure he was ever really comfortable with this type of authority.²²

Despite Leopold's commitment to professional expertise in resource management, he saw roles for citizens in related endeavors. Indeed, when his illness prevented him from resuming his post as a forest supervisor, he began developing a new line of activity in the Forest Service, game management, and in conjunction with this he traveled all across Arizona and New Mexico organizing game protective associations—citizen conservation organizations—in local communities and statewide. These associations of sportsmen, ranchers, and townspeople would work for non-political game wardens, predator control, and refuges. They were grassroots citizen-action groups in a long-standing American tradition.

Leopold addressed the subject of citizenship in a number of lectures early in his career, including one on "Home Gardens and Citizenship" to students at the University of New Mexico in 1917, just after the American entry into World War I. A home garden, he said, was one mark of a useful citizen. Nobility is won by soiling your hands with useful labor, by building something. Leopold was always one for building something. If your job doesn't allow enough play for creativity, he told the students, you can be creative by working the ground, whereupon he went into a soliloquy about how to raise spectacular tomatoes in your Albuquerque backyard. In a world threatened with food shortage, what right have we to hold idle some of the best agricultural lands in our back yards? he asked. Better to turn them into gardens and learn to be good citizens.²³

A year later he spoke to the women's club on "The Civic Life of Albuquerque." Having left the Forest Service to become secretary of the Albuquerque Chamber of Commerce, Leopold was now asking "What has the 20th-century American city contributed to human progress?" His answer was public spirit. He defined it as "year-round patriotism in action; . . . intelligent unselfishness in practice." He tried to trace the idea historically, contrasting Confucius, whom he saw as more interested in personal virtues and family ties than in obligations to others, with Socrates, who knew that citizens had a moral obligation to support and improve their government. But then he lost the thread, explaining that "it would require a better scholar than I am to even attempt to trace the idea of public spirit through the era of individualism and the political revolutions of the 18th and 19th centuries."²⁴

From this we realize that the concept of civic virtue, the republican ideology of the American Revolution, had been lost to consciousness by 1918. Leopold was assuming a revolutionary America dedicated to individualism; he had lost the thread of public spirit, though he sensed it must have been there somewhere. And in fact historians would not rediscover it until the late 1960s, twenty years after his death. But he went on to define the "modern idea"—modern as of 1918—of public spirit: "It means that a democratic community and its citizens have certain reciprocal rights and obligations." Not only rights, but obligations as well. "The man who cheerfully and habitually tries to meet this responsibility," he says, "we call public-spirited."

Leopold went on to offer a critical assessment of the public spirit of Albuquerque, confiding his dream that his own Chamber of Commerce might serve as the "common center" to organize the "democratic welter" of professional societies, women's groups, religious, political, labor, and other voluntary associations of citizens toward accomplishment of common goals for the betterment of Albuquerque. But he also admitted to some frustration—businessmen unwilling to welcome representation in the Chamber by labor and craft organizations, for example.

After little more than a year, Leopold left the Chamber of Commerce to rejoin the Forest Service. A few years later, still feeling the effects of his experience in the Chamber, he delivered a scathing "Criticism of the Booster Spirit" to an Albuquerque civic

society in which he excoriated "the philosophy of boost." Boost was premised on growth by unearned increment rather than investment in basic resources, he charged, using as an example the recent demand for a national park for New Mexico by boosters concerned solely with attracting tourists.²⁵ In his quest for fundamental improvement in the resource base, he began looking to enforced responsibility of landowners. In "Pioneers and Gullies," for example, he described numerous valleys of the Southwest torn out by erosion and he predicted, for the first time in print, that one day proper land use would be a responsibility of citizens: "The day will come when the ownership of land will carry with it the obligation to so use and protect it with respect to erosion that it is not a menace to other landowners and the public."²⁶

Leopold left the Southwest in 1924 to accept a job in Madison, Wisconsin, as director of the Forest Products Laboratory. Though the laboratory's focus on industrial products after the tree was cut proved ultimately frustrating for one so committed to the growing forest (he would leave after only four years), he did manage to extract from the experience a lesson for citizens. In his article "The Home Builder Conserves," he admonished people, before they castigated the "wasteful lumberman," to think about how their own arbitrary demands as consumers and home builders cause waste. The thinking citizen has power not only in his vote, but in his daily thoughts and actions, and especially in his habits as a buyer and user of wood. "Good citizenship is the only effective patriotism," he concluded, "and patriotism requires less and less of making the eagle scream, but more and more of making him think." This theme of the responsibility of the citizen as intelligent consumer is one Leopold would return to from time to time, most notably during World War II in "Land Use and Democracy."²⁷

Shortly after his move to Wisconsin, Leopold became involved with the state chapter of the Izaak Walton League of America, which was the most vibrant citizen conservation organization in the 1920s. He worked with the league to promote a non-partisan conservation commission and a forestry policy for Wisconsin. Still hewing to his professional orientation as a forester, however, he warned members to eschew the tendency to actually write policy: "It is a pretty safe rule to remember that while groups of men can insist on and criticize plans, only individuals can create them."²⁸ Leopold himself was a professional writer of policies, as he demonstrated both in the Forest Service and after he left in 1928 to conduct game surveys and recommend conservation policies in the Midwestern states, when he drafted an "American Game Policy" adopted by the American Game Conference in 1930, and when he helped write a "Twenty-Five Year Conservation Plan" for his home state of Iowa in 1931.

Leopold was tremendously impressed by the citizen commitment to conservation in Iowa, and genuinely proud of the plan for integration of all aspects of conservation—parks, forests, wildlife, fish, water quality, soil conservation—that the team of nationally recognized experts wrote. Iowa was clearly a leader among the states in conservation thought and practice in these years. But buried in Leopold's correspondence are intimations of foreboding. He warned his colleagues in Iowa that they needed to make a special effort to educate the public about what was in the plan, lest people buy into it without personally engaging with it. He was concerned especially about the protection-minded women so active in the parks movement who might become upset if they were suddenly to discover that the plan aimed to produce game to shoot. "There is grave danger," he said, "that the conservationists will blow it up before they even understand what it is."²⁹

In 1933, shortly after he accepted a newly created chair of game management at the University of Wisconsin, Leopold proposed to the dean of agriculture the development of a conservation plan for Wisconsin farms similar to the Iowa plan. The purpose, as in Iowa, would be to get all the government agencies working together to encourage farmers and other landowners to care for their lands in a more conservative way—or, as he put it, to "integrate economic with esthetic land use." But the means

would differ. In Iowa the plan was produced by imported experts who did not participate in its execution, an arrangement that clearly left Leopold uneasy, whereas in Wisconsin he proposed to "evolve" a plan "rather than to write one out-of-hand."³⁰

Leopold's emphasis on evolving a plan from the grassroots was prophetic—not only of the emerging emphasis on public involvement in resource planning in our own day but of the situation in Iowa at the time. By 1935 the Iowa conservation plan disintegrated, at least in Leopold's view. After Iowa merged all relevant agencies into a single department, as recommended in the 25-year plan, the new Iowa Conservation Commission bypassed the man whom to Leopold was the obvious director, and most of Leopold's friends in fish and game resigned or were fired. The issue apparently had to do with the Iowa commission's insistence on an immediate showing of quick results by government through public works rather than, as Leopold and his colleagues preferred, a long-term emphasis on building a new conservation consciousness in the citizenry, especially among land-owners.

In the wake of the Iowa debacle, Leopold commented to a friend that the only state conservation effort to survive was in Michigan, "strangely enough, by a process of internal disharmony. I am tempted to draw the conclusion that complete unanimity within a state [such as in Iowa] is a symptom of approaching dissolution."³² In other correspondence and articles in the 1930s he addressed the problem of factions within the conservation community, especially the shotgunners versus the field-glass hunters, arguing for tolerance, a capacity for self-criticism, and an institutional structure within which factions could argue out their conflicts. "It is a question of applying the democratic process to conservation," he concluded.³³

Leopold's thoughts on democracy and conservation were further stimulated by travel in Germany in 1935, where he observed an elaborate system of law, public administration, ethics, and customs that was "incredibly complete and internally harmonious." Though he could observe no real distinction between the government, acting hierarchically from the top down, and popular acceptance from below, he recognized that the German system, with its strong central governmental authority, was "manifestly a surrender of individualism to the community."³⁴ While he could admire it in Germany (before he understood the connection with the Nazi movement) he knew that it wouldn't work in America.

Leopold addressed the tension between the claims of the community and the rights of the individual in America in a number of essays in the 1930s in which he dealt with the role of government. How can we get conservation? he often asked. And his answer: we can legislate it, we can buy it, or we can build it. Government's initial efforts at conservation had been through laws prohibiting hunting, fishing, or cutting—a first step, but inadequate. The second step, augmented by the open money bags of the New Deal, was to buy land for conservation, but that could be carried only "as far as the tax-string on our leg will reach." The solution had to be found on private land.³⁵

By the time he wrote "Land Pathology" under the menacing clouds of the dust bowl in 1935, he saw only two possible forces that could effect change in private land use. One was the development of institutional mechanisms for protecting the public interest in private land—a quest he had been on for over a decade, especially after his new chair of game management was lodged in the University of Wisconsin's famed Department of Agricultural Economics with its institutional bent. The other was his new preoccupation with "the revival of land esthetics in rural culture." Out of these forces he hoped might eventually emerge what he was even then beginning to term a "land ethic."³⁶ After his friend Jay "Ding" Darling cautioned him that his search for institutional controls could lead to socialization of property,³⁷ Leopold seemed increasingly to emphasize development of a personal sense of obligation to the land community, a sense of husbandry.

During the 1930s Leopold searched for and experimented with various forms of citizen organization to encourage the practice of husbandry on private lands. One

venture, the Coon Valley Erosion Project near LaCrosse, Wisconsin, involved cooperation of local landowners with government agencies in a path-breaking demonstration of erosion control and integrated land use on a watershed scale. Other efforts functioned entirely outside the formal channels of government, including farmer-sportsman cooperatives he was instrumental in establishing at Riley and Faville Grove, Wisconsin, to encourage conservation of wildlife habitat and landscape beauty. He described these experiments in community conservation as *vertical* rather than *horizontal* planning, focusing a battery of minds simultaneously on one spot. "It may take a long time to cover the country spot by spot," he admitted, "but that is preferable to a smear."³⁸ He even proposed public-private cooperation in the inventorying of and planning for conservation of threatened species, with local conservationists or associations entrusted with custodianship of particular remnants.³⁹

As war clouds darkened the horizon and called into question his earlier admiration for Germany's tightly regimented system of resource administration, Leopold lectured to his wildlife ecology students about "Ecology and Politics," presenting the case for an evolutionary mandate for individualism. Individual deviations from societal norms in land management, like individual evolutionary variations, he suggested, might enable certain individuals to survive catastrophe even when most members of a species were eliminated.⁴⁰ This was an individualism not of economic self-interest but of creative experimentation, in the sense of solutions generated from the bottom up by individual citizens or communities rather than mandated by government on all alike. It was in this spirit that Leopold looked to the evolution of a land ethic.

American entry into World War II further defined the issue: "We must prove that democracy can use its land decently," Leopold argued in a seminal essay, "Land Use and Democracy." Here he called for conservation from the bottom up instead of from the top down. Vicarious conservation through government simply could not do the job alone, as he illustrated through the inability of national parks and other sanctuaries to protect wildlife:

It seems to me that sanctuaries are akin to monasticism in the dark ages. The world was so wicked it was better to have islands of decency than none at all. Hence decent citizens retired to monasteries and convents. Once established, these islands became an alibi for lack of private reform.

True conservation had to begin with "that combination of solicitude, foresight, and skill which we call husbandry," practiced by landowners on their own land. But citizens who do not own land had responsibilities in their roles as consumers as well. They could refuse to buy "exploitation milk" from cows pastured on steep slopes and insist on "honest boards" from properly managed forests. There was an indispensable role for government as "tester of fact vs. fiction" or guardian of standards, Leopold acknowledged, but farmers could scrutinize their own practices through courageous use of their self-governing Soil Conservation Districts, and there were opportunities also for self-scrutiny by industrial or citizen groups.⁴¹ More than half a century later, the Forest Stewardship Council's independent third-party certification of forest products and other examples of the movement for green production and consumption standards attest to the validity of Leopold's visionary argument.

Aldo Leopold's ideas about the roles of government and citizens in the shaping of environmental policy were tested in the last decade of his life as never before by his involvement in the traumatic deer debates of the 1940s in Wisconsin. After being nearly hunted to extirpation in the early decades of the century, the state's deer herd had increased to such an extent that by the early 1940s it needed to be reduced for the good of both deer and forest, and Leopold sought to work with the Conservation Department to build a case for an "any-deer" season, for killing does as well as bucks. But

the call for reduction stirred disbelief and resentment among both hunters and the general public, to whom conservation of deer was a good thing. In response, the Conservation Commission organized a Citizens' Deer Committee, appointing Aldo Leopold as chairman.⁴²

Leopold's committee had a cross-section of citizens, mostly from northern Wisconsin, most of them distrustful of the policy he was urging on the department. For the first meeting he prepared maps and charts to provide an historical review of deer irruptions nationwide. But he was upstaged by another member of the committee, Joyce Larkin, editor of the *Vilas County News Review*. She didn't think there were too many deer, and she arrived at the meeting armed with a printed booklet of history and local opinion about the deer situation in Vilas County. We don't know how Leopold reacted to Larkin that day, but we do know that he decided to take the committee and several newspaper reporters on a three-day tour of deer yards, to let them discuss what they were actually seeing on the ground. Joyce Larkin, among others, was impressed. She went back to Vilas, got the county board to accept Leopold's challenge to bring clashing interests together to look at the problems locally, and came to a subsequent meeting of the committee with a new report in favor of an any-deer season.⁴³

However successful Leopold proved at changing attitudes among the members of his Citizens' Deer Committee by letting them argue out their views with respect to conditions in particular locales, the deer problem proved too widespread and public attitudes too entrenched for him to make much headway in the state as a whole. A new newspaper, *Save Wisconsin's Deer*, ridiculed and castigated him in virtually every issue and offered fuel to those who opposed his reasoning. Yet he never gave up on his effort to educate the citizenry, individually and collectively. It is likely that the unremitting stress of dealing with the deer issue in the public arena during the 1940s helped send Leopold to an early grave. But he had been appointed to a six-year term on the Wisconsin Conservation Commission and he believed it was his responsibility as a citizen to serve.⁴⁴

During those years he took solace in the exercise of another type of citizenship that he had advocated since the days of his backyard garden in Albuquerque: he practiced husbandry as plain member and citizen of the land community at the sand farm his family called "the shack." He expressed this form of citizenship—citizenship as creative individualism—perhaps most poignantly in his essay, "Axe-in-Hand," which includes a definition of a conservationist that could as easily be read as his definition of a citizen:

I have read many definitions of what is a conservationist [citizen], and written not a few myself, but I suspect that the best one is written not with a pen, but with an axe. It is a matter of what a man thinks about while chopping, or while deciding what to chop. A conservationist [citizen] is one who is humbly aware that with each stroke he is writing his signature on the face of his land. Signatures of course differ, whether written with axe or pen, and this is as it should be.⁴⁵

[Ed. note: This is a revised version of a paper by the same title which is forthcoming in the *Transactions of the Wisconsin Academy of Sciences, Arts and Letters*.]

Endnotes

¹ See *A Nation of Spectators: How Civic Disengagement Weakens America and What We Can Do About It* (Final Report of the National Commission on Civic Renewal, 1998); and Robert D. Putnam, "Bowling Alone: America's Declining Social Capital," *Journal of Democracy* 6:1 (January 1995), 65-78. Much of the recent attention to citizenship in the United States has been stimulated by scholarly writing concerning the forging of civil society in new democracies around the world, especially since the fall of the Iron Curtain. See, for example, Andrew Arato, "Interpreting 1989," *Social Research* 60:3

(Fall 1993), 609-46; Michael Bernhard, "Civil Society after the First Transition: Dilemmas of Post-Communist Democratization in Poland and Beyond," *Communist and Post-Communist Studies* 29 (1996): 309-30; Shu-Yun Ma, "The Chinese Discourse on Civil Society," *The China Quarterly* 137 (1994); James Bohman, "Complexity, Pluralism, and the Constitutional State: On Habermas's *Faktizität und Geltung*," *Law & Society Review*, 28:4 (1994), 897-930; and Nancy Fraser, "Rethinking the Public Sphere: A Contribution to the Critique of Actually Existing Democracy," in *Justice Interruptus: Critical Reflections on the "Postsocialist" Condition* (New York: Routledge, 1997), 69-98.

² Susan L. Flader, "Citizenry and the State in the Shaping of Environmental Policy," *Environmental Review* 3:1 (January 1998), 8-24.

³ Gordon S. Wood, *The Creation of the American Republic, 1776-1787* (New York: W.W. Norton and Co., 1972), 319-28.

⁴ See, for example, Gary Kulik, "Dams, Fish, and Farmers: Defence of Public Rights in Eighteenth-Century Rhode Island," in *The Countryside in the Age of Capitalist Transformation*, ed. Steven Hahn and Jonathan Prude (Chapel Hill: University of North Carolina Press, 1985), 25-50.

⁵ See Robert E. Shalhope, "Republicanism and Early American Historiography," *William and Mary Quarterly* 39 (1982):334-56; Joyce Appleby, ed., "Special Issue: Republicanism in the History and Historiography of the United States," *American Quarterly* 37 (1985); Gordon S. Wood, *The Radicalism of the American Revolution* (New York: Alfred A. Knopf, 1992).

⁶ See Jack N. Rakove, "Parchment Barriers and the Politics of Rights," in *A Culture of Rights: The Bill of Rights in Philosophy, Politics, and Law—1791 and 1991*, ed. Michael J. Lacey and Knud Haakonssen (Cambridge: Cambridge University Press, 1992), 103; and William A. Galston, "Practical Philosophy and the Bill of Rights: Perspectives on Some Contemporary Issues," *ibid.*, 234.

⁷ Alexis de Tocqueville, *Democracy in America*, ed. Phillips Bradley (New York: Vintage, 1945), I:ch. 12, II:ch. 5.

⁸ See Philip D. Brick and R. McGreggor Cawley, eds., *A Wolf in the Garden: The Land Rights Movement and the New Environmental Debate* (Lanham, Md.: Rowman and Littlefield, 1996).

⁹ See Stephen Skowronek, *Building a New American State: The Expansion of National Administrative Capacities, 1877-1920* (New York: Cambridge University Press, 1982); and Samuel P. Hays, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920* (Cambridge: Harvard University Press, 1950).

¹⁰ Gifford Pinchot, *The Fight for Conservation* (Garden City, NY, 1910), IV:6. Compare Leopold: "It is no prediction, but merely an assertion that the idea of controlled environment contains colors and brushes wherewith society may some day paint a new and possibly a better picture of itself;" in "The Conservation Ethic," *Journal of Forestry* 31:6 (October 1933), 634-643.

¹¹ Aldo Leopold, *A Sand County Almanac and Sketches Here and There* (New York: Oxford University Press, 1949), 4.

¹² *Ibid.*, 87.

¹³ *Ibid.*, 138.

¹⁴ *Ibid.*, 161.

¹⁵ *Ibid.*, 166-67, 175.

¹⁶ *Ibid.*, 204.

¹⁷ *Ibid.*, 207-8.

¹⁸ For details of Leopold's biography see Curt Meine, *Aldo Leopold: His Life and Work* (Madison: University of Wisconsin Press, 1988), and Susan L. Flader, *Thinking Like a Mountain: Aldo Leopold and the Evolution of an Ecological Attitude toward Deer, Wolves, and Forests* (1974; Madison: University of Wisconsin Press, 1994).

¹⁹ "To the Forest Officers of the Carson," *The Carson Pine Gone* (July 1913), reprinted in *The River of the Mother of God and Other Essays by Aldo Leopold*, ed. Susan L. Flader and J. Baird Callicott (Madison: University of Wisconsin Press, 1991), 41-46 [hereafter cited as *River*].

²⁰ See Susan Flader, "Aldo Leopold and the Evolution of Ecosystem Management," in *Sustainable Ecological Systems: Implementing an Ecological Approach to Land Management*, ed. W. Wallace Covington and Leonard F. DeBano (USDA Forest Service General Technical Report RM-247, 1994), 15-19.

²¹ "Standards of Conservation" (handwritten ms., c. 1922), General Files—Aldo Leopold, Series 9/25/10-6, Box 16, University of Wisconsin Division of Archives [hereafter cited as LP 6B6 (Leopold Papers, Series 6, Box 16)], reprinted in *River*, 82-85.

²² See, for example, "Conservation Economics," *Journal of Forestry* 32:5 (May 1934), 537-544, reprinted in *River*, 201. For discussion of the problem of authority as related to the relationship between professionals and citizens see Terry L. Cooper, "Citizenship and Professionalism in Public Administration," *Public Administration Review* 44 (March 1984), 143-149; and J. Douglas Wellman and Terence J. Tipple, "Public Forestry and Direct Democracy," *The Environmental Professional* 12 (1990), 77-86.

²³ "Home Gardens and Citizenship," 23 April 1917, 7 pp. tps., LP 8B8.

²⁴ "The Civic Life of Albuquerque," 27 September 1918, 9 pp. tps., LP 8B8.

²⁵ "A Criticism of the Booster Spirit," 6 November 1923, 10 pp. tps speech to Ten Dons, LP 6B16, reprinted in *River*, 98-105. The national park reference may have been to a proposal by Secretary of the Interior Albert Fall for establishment of a park from a series of discontinuous segments of land near his home in south central New Mexico, part of which is now White Sands National Monument.

²⁶ "Pioneers and Gullies," *Sunset Magazine* 52:5 (May 1924), 15-16 and 91-95, reprinted in *River*, 106-113. Leopold's language on the obligation of landowners was similar to that in a speech he had written in December 1922 for the New Mexico Association for Science, "Erosion as a Menace to the Social and Economic Future of the Southwest." The speech was published many years later in *Journal of Forestry* 44:9 (September 1946), 627-33.

²⁷ "The Homebuilder Conserves," *American Forests and Forest Life* 34:413 (May 1928), 276-78 and 297, reprinted in *River*, 143-147; "Land-Use and Democracy," *Audubon Magazine* 44:5 (September-October 1942), 259-265, reprinted in *River*, 295-300.

²⁸ "Izaak [sic] Walton League and Its Relation to Forestry in Wisconsin," [n.d., c. 1925], 10 pp. tps., LP 6B16.

²⁹ Leopold to Claude V. Campbell, 15 October 1932, LP 3B5, and associated correspondence. See also Jacob L. Crane, Jr., and George Wheeler Olcott, *Report on the Iowa Twenty-five Year Conservation Plan* (Des Moines: Meredith, 1933).

³⁰ "A Conservation Plan for Wisconsin Farms," 23 October 1933, 6 pp. tps., LP 6B16.

³¹ See Leopold to William Schuenke, 10 July 1935; I.T. Bode to Leopold, n.d. [c. July 1935]; and Leopold to I.T. Bode, 19 July 1935, all in LP 3B5. See also Rebecca Conard, *Places of Quiet Beauty: Parks, Preserves, and Environmentalism* (Iowa City: University of Iowa Press, 1997), 120-136.

³² Leopold to P.S. Lovejoy, 18 July 1935, P.S. Lovejoy Papers, Michigan Historical Commission Archives, Lansing, RG63-12 B12F6.

³³ "A House Divided," *Wisconsin Sportsman* (October 1940), 5. See also "Game and Wild Life Conservation," *The Condor* 34:2 (March-April 1932), 103-106, reprinted in *River*, 164-68. For recent examples of local democratic participation in decisionmaking see Daniel Kemnis, *Community and the Politics of Place* (Norman: University of Oklahoma Press, 1991); and Mark Sagoff, "The View from Quincy Library: Civic Engagement in Environmental Problem-Solving" (Working Paper #16, The National Commission on Civic Renewal).

³⁴ "Notes on Game Administration in Germany," *American Wildlife* 25:6 (November-December 1936), 85, 92-93.

³⁵ See, for example, "The Conservation Ethic," *Journal of Forestry* 31:6 (October 1933), 634-43 [*River*, 181-92]; "Conservation Economics," *Journal of Forestry* 32:5 (May 1934), 537-44 [*River*, 193-202]; "Conservation in the World of Tomorrow," lecture notes 29 March 1937, 5 pp. tps., LP 6B14; and "The Farmer as a Conservationist," *American Forests* 45:6 (June 1939), 294-99, 316, 323 [*River*, 255-265].

³⁶ "Land Pathology," 15 April 1935, 8 pp. tps., LP 6B16, reprinted in *River*, 212-217. Leopold observed that mechanisms, economic and moral, to encourage conservation of landscape beauty on private lands might also help prevent the otherwise inevitable degradation of public parks: "Parks are over-crowded hospitals trying to cope with an epidemic of esthetic rickets; the remedy lies not in hospitals, but in daily dietaries."

³⁷ J.N. Darling to Leopold, 20 November 1935, LP 6B16.

³⁸ "Farmer-Sportsman Set-ups in the North Central Region," *Proceedings North American Wildlife Conference*, February 3-7, 1936 (Senate Committee Print, 74th Cong., 2d sess., 1936), 279-285. See also "Coon Valley: An Adventure in Cooperative Conservation," *American Forests* 41:5 (May 1935), 205-208 [*River*, 218-223]; "Helping Ourselves" (with Reuben Paulson), *Field and Stream* 39:4 (August 1934), 32-33, 56 [*River*, 203-208]; and "History of the Riley Game Cooperative, 1931-1939," *Journal of Wildlife Management* 4:3 (July 1940), 291-302. For recent examples of the

burgeoning movement in community conservation, see the special issue of the *Journal of Forestry* 96:3 (March 1998) on community forestry.

³⁹“Threatened Species: A Proposal to the Wildlife Conference for an Inventory of the Needs of Near-Extinct Birds and Animals,” *American Forests* 42:3 (March 1936), 116-119 [*River*, 230-234].

⁴⁰“Ecology and Politics,” WLE 118 Introductory Lecture, n.d. [c. 1941], 7 pp. tps., LP 6B16 [*River*, 281-89].

⁴¹“Land-Use and Democracy,” *Audubon Magazine* 44:5 (September-October 1942), 259-265 [*River*, 295-300].

⁴²See Flader, *Thinking Like a Mountain*, 168-260.

⁴³*Ibid.*, 183-193.

⁴⁴*Ibid.*, 194.

⁴⁵*Sand County Almanac*, 68.

The American Civil Rights Movement: Preserving the Legacy

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I am very flattered to be invited to speak with you this morning. For a simple teacher of history, it is gratifying to look out into an audience and find people who are choosing to listen to a lecture on history, in contrast to the undergraduates who have been conscripted to my classes by the university's history requirement. I hope I can justify your sense of anticipation.

I have just suggested that you are here by "choice," and I think this idea may be a good way to begin talking about the enterprise of historic preservation and historic site interpretation. Thinking about the concept of choice is helpful in two ways. First, as we're all aware, the public visits historic sites by choice, voluntarily, on family vacations, for reasons of intellectual curiosity. This is a familiar observation that I repeat simply to emphasize the point that historic sites are a potentially more powerful form of education than the university classroom. (I say that in complete sincerity because this is the primary reason I chose to become a public historian, not just a professor of history confining his teaching to the classroom and his research to a small academic audience.)

Choice is a helpful concept for a second reason: we who work with historic sites are continually making choices about what to preserve and how to interpret it.

The question I would like to pose this morning is: Are we being sufficiently self-conscious about our choices? Are we thinking enough about "why" we preserve? To turn to the topic of this plenary session: What do our choices in preserving the legacy of the civil rights movement tell us about the history we are teaching the public at these places?

Several years ago I set out to analyze the extent to which sites associated with the civil rights movement had been identified for the purposes of public education and heritage preservation. I looked specifically at the African American freedom struggle of the 1950s and 1960s. Clearly this struggle was underway well before the 1950s, and much has happened in the last thirty years. Clearly, too, the term "civil rights movement" can also be applied to the struggles of other groups in American society: other people of color, women, lesbians and gays. But it is the African American freedom struggle of the fifties and sixties that is currently finding its way into the public memory, especially since the opening in 1991 of the National Civil Rights Museum at the Lorraine Motel in Memphis.

And the trend continues: attention is being directed as never before to the material legacy of the civil rights movement through wide-ranging and imaginative efforts not only in the South but all across the country. There are significant public efforts to recognize the civil rights movement at all levels of government, from the National Park Service to state and municipal undertakings. These include new additions to the National Park System, the designation of National Historic Landmarks, nominations to the National Register of Historic Places, placement of state historical markers, and the creation of local preservation districts. Interpretive efforts include county and city funding of new museums (through adaptive use of historic structures as well as new construction), the publication of guides to African American heritage sites by state and local governments, and the erection of historical plaques. In addition to these public efforts, private non-profit organizations are also playing a significant role. Their work has ranged from commissioning memorial sculpture to establishing museums and research centers.

As impressive as these diverse efforts are for their recognition and interpretation of the civil rights legacy, what has *not* been commemorated is as revealing as what has been. I want to use the rest of my time this morning to identify three "problems of selectivity" in the commemoration and preservation of civil rights history.

The Challenge of Local Historic Resources

The first problem of selectivity is the challenge of local resources. Civil rights activism at the local level has tended to be ignored in preference for those dramatic events that attracted national and international headlines. Local activism is the one great chapter of civil rights history that really has not received its due in terms of commemoration—even though civil rights activity was most frequently a local undertaking.

To be sure, some efforts have been made. One can find a few examples, like the former home of civil rights activist Juanita J. Craft in Dallas, Texas, which has been adaptively re-used as a museum to civil rights history (1994). This type of site may well be one of the most significant for understanding the history of the civil rights movement. In Dallas and other cities, the homes of local activists—many of whom were women—were “action central.” They functioned as offices and meeting places, provided guest accommodations for visiting national leaders, and sometimes became targets for racist violence. Paying more attention to local resources such as these will help us remember that it was local activity, often organized by women, that desegregated American cities.

In general, preservation efforts have preferred the dramatic national event. Such headline-grabbing events as the *Brown v. Board of Education* court case, the Greensboro sit-ins, the Birmingham confrontations, and the Selma voting rights activity have all attracted elaborate preservation and interpretive efforts on the part of heritage agencies at the federal, state, and local levels. Nationally prominent figures have received similar notice. Dr. Martin Luther King, Jr., has been recognized, even lionized, through the preservation of his birthplace, his neighborhood, his assassination site, and his tomb. In addition, churches where Dr. King served as pastor (or simply delivered a speech) have been identified. Dramatic national events do matter, of course, and preservation efforts should recognize sites associated with these events. My point is simply that we are ignoring local activity.

The Challenge of “Young” Historic Resources

A second problem of selectivity is the challenge of “young” resources. Much of the movement’s material legacy is not yet recognized as significant because it is often vernacular architecture and its historic importance is relatively recent.

The material culture of the civil rights movement is, to a large extent, comprised of churches, homes, lunch counters, roadways, bus stations, bridges, parks, and other public spaces that served as local sites for community organizing, demonstration, and confrontation. Sometimes these places were buildings of architectural distinction and sites with long histories of their own. More often, though, they were examples of vernacular architecture of recent vintage. As a consequence, how—and even whether—to preserve them presents a unique set of challenges.

Sites associated with the process of organizing include schools and the homes of local leaders, as well as modern utilitarian buildings that would not normally attract the attention of historic preservationists. Sites of protest include places of public accommodation such as bus stations, lunch counters of national chain stores, and even bowling alleys. Sites of marches are associated with state capitols, city halls, roadways, bridges, parks, and other public spaces. Sites of incarceration include jails but also places that served as temporary prisons, such as livestock pens at state fairgrounds. While the most visible sites of the civil rights movement are monumental civic buildings and places such as college campuses and churches that tend to be well-maintained, the vernacular architecture associated with the movement is more vulnerable.

To my knowledge, there are no systematic efforts anywhere in the country simply to survey buildings or sites associated with the civil rights movement for the purposes of preservation.

The Challenge of "Dangerous" History

A third and final challenge is the problem of what we might call "dangerous" history. Where is Black Power? Where are the Black Panthers? Where is Malcolm X? At the moment, these seem to be chapters of the African American freedom struggle that are too difficult or too controversial to commemorate.

To be sure, some small efforts have been made to recognize the role of Black Power and black separatism. For example, the life and work of Malcolm X have received some commemoration. A marker has been placed at the site where his childhood home once stood in Omaha, Nebraska, and in Michigan a state historical marker in Lansing identifies another childhood home. Of course, parks, schools, mosques, and streets have been named for Malcolm X in several northern cities. And I understand that in my old home-town of Oakland, California, one can now take a Black Panther Party heritage walking-driving tour. But these efforts tend to be the exceptions that prove the rule: black separatism and black power are ignored in most heritage efforts.

The subject of "dangerous" history also raises the issue of white resistance. Should historic white resistance to the civil rights movement be identified in some fashion? From one perspective it is an appalling and fearsome question that perhaps should not even be asked. But from the perspective of using material culture to tell the full story of the civil rights movement, white resistance is as much a missing chapter as Black Power.

Conclusion

There are some quick observations about the problem of selectivity, which remains a problem despite the truly impressive and imaginative efforts underway all across the country. The point I would like to stress here is: absence is presence. We are remembering only parts of the civil rights story, and our "choices" not to remember some chapters of the story may be as revealing as what we are presenting—even celebrating—for public audiences.

It seems to me that Martin Luther King's legacy dominates how we are remembering the 1950s and 1960s, because Dr. King's philosophy fits the model for social change that the majority finds congenial. Non-violent means, the vocabulary of Christian love, and integrationist goals are easier for public agencies to commemorate than sites associated with violence, armed resistance, and racial separation.

Some of the selectivity in presenting civil rights history is rooted in the difficulties of assessing the movement after 1965 or so, when the story becomes more complicated: when the heroes, victims, and villains become harder to define; when violence seems to take on some utility; when we as a society lose consensus about the meaning of the movement and what the future should hold. It becomes easier to leave out black separatism and white backlash, for example, and to follow the story only through to the end of Dr. King's life in 1968.

The more general point is that history becomes controversial when it involves issues that are still relevant or that remain unresolved in a particular society. In the United States, race relations obviously remain an unresolved social and political issue, and as a consequence the unfinished agenda of the American civil rights movement gets reflected at historic sites and museums that take up historical subjects involving race. I think this helps us understand why heritage efforts find it easier to commemorate Martin Luther King than to interpret such subjects as black separatism or white racism. It is harder to put subjects such as these on text panels at museums—even though the timeliness of the issues might be the best argument for trying to locate them in broad context and historical perspective. Paradoxically, the contemporary relevance of historical issues makes the history challenging to interpret, just as it makes it urgent to take on the challenge.

Canada-U.S. Clean Air Partnerships for Protected Areas

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The U.S. Clean Air Act and the Regional Nature of Air Pollution

The Clean Air Act Amendments of 1977 established the Prevention of Significant Deterioration program to preserve and enhance air quality in the USA's national parks, designated wilderness areas, and refuges ("Class I areas"). The National Park Service (NPS), U.S. Fish and Wildlife Service, U.S. Forest Service, and other federal land managers (FLMs) were given affirmative responsibility in 158 national parks and wildernesses to protect resources that are sensitive to air pollution. In response the FLMs established air quality programs to monitor visibility, UV-B, acidification, and other air pollutants; study effects on water quality, soil, and vegetation; review new emission sources; and educate staff and visitors in air quality science, as well as air pollution causes, processes, and effects. The review provision authorizes an FLM to examine applications for state permits for new or expanding stationary air pollution sources. If the review shows that a new source would have adverse impacts on Class I areas, the permit could be denied. However, new sources come with advanced control technologies, and, after hundreds of application reviews, only one permit has been denied. Also, the major cause of air pollution problems in Class I areas is emissions from existing stationary and mobile sources. FLMs must therefore grapple with the problem of regional and multiple air pollution issues affecting numerous ecosystems and landscapes. Clean Air Act amendments in 1990 re-emphasized the regional nature of air pollution, when, for example, it established the Grand Canyon Visibility Transport Commission.

The Development of Clean Air Partnerships (CAPs)

In 1990, FLMs in the Sierra Nevada united to conduct monitoring, research, and permit and regulatory review. They knew that air pollution originating in the Central Valley, San Francisco, and Los Angeles areas was reducing visibility and damaging sensitive vegetation species. They believed that they could have a greater influence by working together, and in 1991 they organized the first CAP. At about this time, the superintendent of Colonial National Historical Park declared that air pollution was the park's principal management problem. Several sensitive plant species were displaying air pollution symptoms, its monuments and statuary were deteriorating, and its vistas were obscured. The park published the first air quality management plan in the U.S. National Park System (NPS 1991).

In 1991, Erik Hauge of NPS began to develop the agency's first regional air quality management plan, for Shenandoah and Great Smoky Mountain National Parks and the Blue Ridge Parkway (Hauge 1998). All had documented air quality problems such as visibility degradation, vegetation damage, and acidified ponds and streams. The Forest Service, with eight Class I wilderness areas in the southern Appalachians, asked to participate. They co-sponsored a contract to prepare an inter-agency southern Appalachian regional air quality management plan. In 1992 this effort was superseded by the Southern Appalachian Mountains Initiative, consisting of FLMs, the U.S. Environmental Protection Agency, state air regulators, industry, and non-governmental organizations.

There are now ten CAPs: 1) Arizona Federal and Tribal CAP, 2) California Desert CAP, 3) Idaho CAP, 4) Sierra Federal CAP, 5) Southern Appalachian Mountains Initiative, 6) Western Regional Air Partnership, 7) Yellowstone CAP, 8) Great Lakes CAP, 9) Northeast Regional Air Quality Committee, and 10) Pacific Northwest CAP (Figure 1). The last three straddle the Canada-USA border, and another may soon straddle the Mexico-USA border.

CAPs Defined

CAPs are associations of land-managing and air pollution-control organizations that deal with the adverse impacts of air pollution on the natural and cultural resources of protected areas on a regional basis. They recognize that air pollution is primarily a regional problem caused by a variety of existing sources. CAPs seek solutions to air pollution problems through consensus developed by communication, coordination, and cooperation. Some CAPs correspond to airsheds or regional ecosystems. Others deal with a single regulatory agency or correspond to several states and provinces. They all share costs and benefits of monitoring, research, permit and regulatory review, outreach, and other activities. A CAP provides a two-way communication channel for its partners to speak about and lobby on issues with a unified voice, and to learn about new scientific findings, policies, regulations, and agency activities that affect their region.

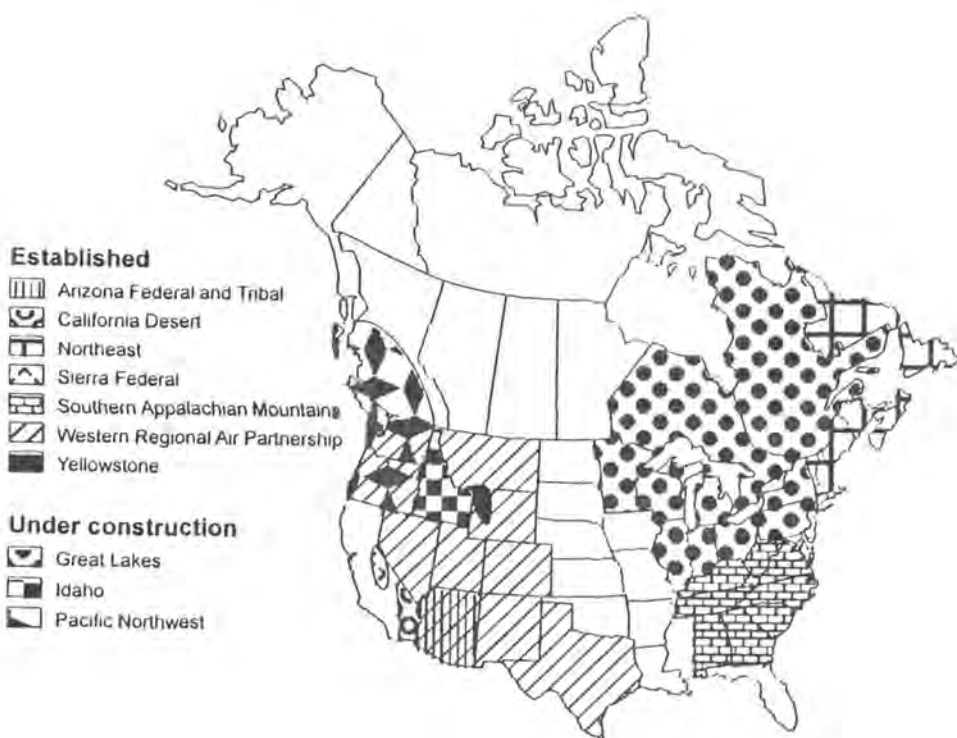


Figure 1. Clean air partnerships for protected areas in the USA and Canada.

The Canada–U.S. Air Quality Agreement

This 1991 agreement established the principle that the two countries are responsible for the effects of their air pollution upon each other. It committed them to consultation and reporting procedures, and provided mechanisms for public hearings and the resolution of disputes concerning transboundary air pollution (Environment Canada 1996). It sets caps and reduction schedules for sulphur dioxide and nitrogen oxide emissions (Environment Canada 1998). The agreement contains a section of

specific relevance to national parks. Section 4 recognizes "the importance of preventing significant air quality deterioration and protecting visibility, particularly for international parks, national, state and provincial parks, and designated wilderness areas" and for the two countries to "consult, as appropriate, concerning the implementation of the above."

Government-to-government consultation takes place under the aegis of an air quality committee, but the parks services themselves have no legal obligation to this process. However, the agreement provided a rationale to share experiences in protecting parks from air pollution, and fostered an effort to contribute to the spirit of the agreement. Informal discussions led in 1993 to the first International Air Issues Workshop at Roosevelt-Campobello International Park, New Brunswick, involving the NPS, Fish and Wildlife Service, Parks Canada, and Environment Canada. A second workshop took place at Waterton Lakes National Park in 1995 (Hauge and Welch 1995). It also included U.S. Forest Service, Environmental Protection Agency, state, provincial, and tribal representatives. The workshop produced a series of recommendations for binational and regional cooperation and information sharing. Prominent among these were support and suggestions for regional, binational clean air partnerships among protected area agencies.

Northeast Regional Air Quality Committee (NERAQC)

New England and Atlantic Canada are often called "the exhaust pipe of North America" because of the concentrations found there of pollutants carried from industrialized areas to the south and west. Stimulated by the signing of the binational air quality agreement, federal, state, and provincial agencies in Canada and the USA formed a CAP under the name of the Northeast Regional Air Quality Committee (Munro 1998). NERAQC was conceived of in 1991, went through several developmental stages, and was born in 1995 at its first full meeting. Its members include representatives from government agencies as well as specialized organizations such as the Appalachian Mountain Club. They recognize several common issues.

- Acid deposition, causing decreased fish stocks, and reduced forest, soil, and wildlife productivity.
- Long-range transport of ground-level ozone, triggering health alerts at Acadia National Park when ozone levels exceeded 120 parts per billion. Levels above the 82-parts-per-billion Canadian national acceptable standard have been measured in southern New Brunswick and southwest Nova Scotia.
- Air toxics, particularly mercury, showing up in fish, and the consequent health warnings in many states, New Brunswick, and Nova Scotia.
- Visibility, a major air quality-related value in the NPS.
- Prevention of significant deterioration of air quality.
- Local particulate sources from wood burning and traffic.

NERAQC depends upon each member agency to contribute funding to specific projects or provide in-kind services by staff. As of December 1998, NERAQC had funded an ozone monitor at Roosevelt-Campobello International Park, commissioned a background report on regional air issues, key pollution sources, and applicable legislation and regulations (Jacques Whitford 1996), exchanged information at its meetings and through a Web site on regional issues and studies, and reviewed and commented on proposed U.S. regional haze regulations. Work in progress includes the preparation of a public information brochure on air issues and protected areas, development of an air quality fact sheet template for all member parks to document their situation, and consideration of options to support the regional action plans on mercury and acid rain that were endorsed by the New England governors and eastern Canadian premiers in 1998. NERAQC is also interested in documenting air quality-related values, acid rain, mercury, ground-level ozone, and visibility issues.

NERAQC has also produced some intangible benefits. It has raised the profile of atmospheric sciences and issues in other agencies and political groups, as well as in member organizations, leading to greater support for some of the above activities. Through its semiannual meetings, NERAQC stimulates dialogue between agencies in both the USA and Canada, and keeps a number of organizations involved on issues impacting on natural resources. A memorandum of understanding took many people several years to revise, but it has been a valuable glue for the collaboration and dialogue in its development.

On the negative side, attendance at meetings by the states and provinces is low because of budgetary reductions, and field-level participation in Canada is low because of the lack of identified park positions to deal with air quality. For the same reasons there are few new air-related initiatives at the field level. However, there is a continuing interest in NERAQC and the biophysical impacts of air pollution on soils, water, vegetation, and wildlife, and many staff follow the progress of NERAQC through its minutes and an in-house newsletter. In the USA there is a lack of federal expertise in the region. It is mostly at the NPS Air Resources Division and the Fish and Wildlife Service Air Quality Branch in Denver. By contrast, in Canada the federal expertise is in a different department than Parks Canada, but is located at the regional level—a real asset.

Great Lakes Clean Air Partnership for Protected Areas (GL.CAP)

This partnership was established in June 1998 when Canadian and U.S. representatives of protected area and air agencies finalized the terms of the partnership. Any protected area can be a partner in the sense of staff participating in communications, attending meetings and collaborating in joint projects. Counting all national and provincial parks, biosphere reserves, designated wildernesses, wildlife refuges, forest reserves, tribal lands, and other protected areas corresponding to IUCN Categories I and II, along with U.S. Clean Air Act Class I and II lands, there are about 120-150 potential partners within the Great Lakes watershed. GL.CAP will communicate mainly through a listserver. Meetings will be open to all partners and invited specialists, and will generally take place annually. GL.CAP will be led by a secretariat consisting of Canadian and U.S. co-chairs, aided by two representatives from each country.

While protected area managers have little direct role to play as pollution controllers or regulators, GL.CAP may be able raise awareness among the public and foster cooperation between agencies. Much of the focus on air pollution has been on industrial and urban sources, and on human health effects. GL.CAP could play a role in identifying gaps monitoring ambient conditions in ecosystems, especially of ozone, and in research into ecosystem responses to air pollutants. GL.CAP has established that the major air pollutants affecting Great Lakes natural areas are nitrogen oxides, particulates, ozone, toxics (chiefly mercury, PCBs and dioxins), phosphates, and sulphur dioxide. Some of these link together, e.g. the role of nitrogen dioxides in producing ozone, or the role of sulphate aerosols in combining with other particulate matter to reduce visibility and lung function. Ozone and particulate monitoring are largely urban-centered, and there is not a strong basis for extrapolating these measures from existing stations to remote, rural areas.

However, as of this writing (March 1999) the partnership is not fully launched. Secretariat and Internet support has been jeopardized by the untimely death of one of its active members. Letters of announcement and invitation to all the region's protected area agencies have been stalled due to a personnel change and the illness of the partnership's co-chairs.

Pacific Northwest Clean Air Partnership (PNW.CAP)

Under the leadership of the NPS, PNW.CAP was established in October 1998 by federal, state, and university representatives from Canada and USA. There are al-

ready several state, provincial, and binational air issues partnerships in this area, particularly for visibility and regulatory issues, that include the U.S. FLMs. However, none of these bring an ecosystem science perspective to all air issues and to protected area management. Unlike NERAQC and GL.CAP, participants decided to set aside the creation and signing of a charter document, but did reach a consensus on certain elements that would guide the partnership.

- PNW.CAP would cover the Cascade Mountains and coastal areas of British Columbia, as well as Washington, Oregon, and, possibly, Idaho.
- It may define and enumerate air quality related values in the region.
- It could provide an information bridge to connect air science with air policy, particularly with respect to acid aerosols, ozone, and haze—a major air issue in Puget Sound and the Greater Vancouver Regional District, caused chiefly by vehicle exhaust exacerbated by ammonia from agricultural use of sewage sludge. Visibility is frequently impaired, a serious problem when scenic vistas are a major drawing card for tourists.
- PNW.CAP could develop a Web site to promote information exchange.

Parks Canada has not played a leading role in PNW.CAP because as yet there are no Canadian national parks in this zone. This may change when the Gulf Islands national park becomes a reality. Gwaii Haanas and Pacific Rim National Parks, outside the urbanized zone, could play a role as remote, clean-air protected sites for long-term monitoring and ecological effects research.

CAP Guidelines and Binational Prospects

Representatives from all CAPs and related federal services met in July 1998 at a binational workshop in Denver. They compared the successes and disappointments of CAPs and developed guidelines for existing and new CAPs. (These are available from John Bunyak in the NPS Air Resources Division). They include recommendations for writing the various elements of a CAP memorandum of understanding. The suggested elements include a mission statement, objectives, actions, performance indicators, membership and participation, organization and leadership, meeting organization, and funding. The guidelines contain recommendations for national and international leadership from national-level support coordinators. They recommend periodic all-CAP meetings to track their progress and activities.

The three binational CAPs did not happen spontaneously. They needed the persistence of key individuals working over several years through personal dialogue, scoping meetings, and structured workshops. They had to establish their value in competition with the many other serious issues and work loads facing protected area managers. They will thrive as long as there is vigorous leadership, but otherwise risk dissolution.

There is scope for two additional Canada-U.S. CAPs. One could focus on the Crown-of-the-Continent region centered on Waterton-Glacier International Peace Park World Heritage Site, where ecosystems, tourism, and agriculture jointly face air pollution and visibility deterioration from sour gas processing and wood residue burning. Another could be in the northern Great Plains, where nitrogen enrichment from agriculture may be affecting plant succession. Global warming could also have severe effects, through increased duration and intensity of drought, with implications for plant successions, soil sensitivity to wind erosion, and wetland habitat for migratory and summer-resident waterfowl.

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Sharing a World of Resources

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Background

Interpreters, resource managers, and other staff are creating places within their parks for discovery, reappraisal, and innovation through a recently forged partnership between the National Park Service (NPS) and the National Aeronautic and Space Administration (NASA) Goddard Space Flight Center (GSFC) in Greenbelt, Maryland. Using scientific resources generated by NASA, NPS staffs are helping visitors better understand and gain a global perspective of park resources.

Ten years ago the NPS' "Interpretive Challenge" addressed the need to explore opportunities for joint NPS-NASA research and projects. Two years ago the staff at GSFC contacted NPS because they recognized the need to share their resources and gain a broader audience. On April 23, 1997, the director of GSFC signed a memorandum of understanding with the acting director of the NPS that acknowledges the mutual interest of both agencies in the advancement of public literacy in science and mathematics through technology. These agencies will work together to provide appropriate educational materials to educational institutions and the American public. The NPS and GSFC will explore innovative ways to share staff and expertise through voluntary services and or interagency personnel agreements.

Before the memorandum of understanding was signed, the NPS and NASA were already working together. NPS's Denver Service Center uses NASA remote sensing technology to uncover archaeological resources. NPS researchers are working with (among others) scientists at NASA's Ames Research Center in California to use NASA technology to locate whaling ships sunk off of the Alaskan coast. To better understand glacial movement, NASA scientists created computer models of glaciers within Glacier National Park, Montana, and Glacier Bay National Park, Alaska. NASA satellite imagery allows schoolchildren, park staff, and GSFC scientists to study changes within the Chesapeake Bay watershed. These projects and the resulting research are not well-known within either agency, however.

Strengths in Partnership

The idea of having an NPS liaison to GSFC then came to fruition. The liaison will develop communications links between the NPS and GSFC to improve visitor services offered by both agencies. Promotion of the partnership focuses on strengths associated with each agency:

- GSFC is the home to the NASA Earth Science Enterprise, and one of the primary missions of GSFC is to study global Earth science and systems.
- The NPS is not only home to national treasures, but also some premier educational and public programs focused on local natural resource issues.

Current Status

The author is currently serving as the NPS liaison to NASA and GSFC. She is duty-stationed at GSFC, working within its Office of Public Affairs. During her one-year detail (from May 1998 through May 1999), she was the primary contact between the NPS and GSFC, coordinating resources between the two agencies. She

acts as a consultant to GSFC visitor center and education staff and provides interpretation training which will improve their interpretive skills and abilities. She provides benefits to the parks' visitor services and resource management programs by establishing links through the World Wide Web, providing access to field experts and a tremendous library of images, and connecting the outreach and education centers of the two agencies. The goals of the detail include:

- Developing a communication bridge that delivers NASA resources to the NPS and vice versa.
- "Institutionalizing" communication methods.
- Consulting on interpretive training for GSFC visitor center staff, volunteers, tour guides, speaker's bureau, education staff, and other interested groups.
- Coordinating development of education and public information materials, and suggesting means to distribute them within NASA, NPS, and related agencies or interested parties.
- Developing and implementing a pilot program with at least one NPS site that exemplifies strength in partnerships.
- Developing a World Wide Web site describing the partnership and highlighting useful resources of NPS and NASA.

Results

NPS staff members (from many divisions, not just interpretation!) are already utilizing some of the resources that the author has uncovered, including satellite-generated images and movies of Hurricanes Bonnie and Danielle, soil science data, and images taken by the Hubble space telescope. This information has been used to improve interpretive programs and exhibits. Internal NPS bulletin boards, newsgroups, and word of mouth have been the primary methods used to disseminate the information. The GSFC's staff is benefiting by discovering accessible and compatible research locations as well as interpretive training opportunities.

During the past year, there has been an increased dialogue between the earth science staff of GSFC and those in NPS's Geographic Information System (GIS) and resource management programs. In October 1998, three GSFC scientists spoke at a NPS GIS meeting. They explained their remote sensing projects and how the data from these projects may benefit park managers. An Earth Science Resources workshop was held on March 9, 1999. Sixteen NPS National Capital Region interpreters participated; four GSFC education specialists, along with the author, instructed. The interpreters worked on five hands-on NASA earth science activities. They discovered how these activities and materials could be used in their parks to help visitors and staffs gain a global perspective of their park resources.

A pilot program with a specific park site has not yet been developed. At least four different parks are working on establishing partnerships with NASA centers or NASA-sponsored projects. These proposed partnerships all include curriculum-based education programs and teacher workshops. Some of the topics under discussion include the Lewis and Clark Expedition bicentennial being coordinated at Fort Clatsop National Memorial, Oregon; the space observations taking place at Haleakala National Park, Hawaii; and classroom kits for the Rock Creek Park planetarium in Washington, D.C.

Craters of the Moon National Park, Idaho, collaborated successfully with NASA's Ames Research Center and its Johnson Space Center in Texas. In February 1999, a

teacher workshop on lunar sampling was held. Local teachers and park staff will now be able to help visitors not only better understand the park resource, but also establish connections with lunar resources. During the summer of 1999, in conjunction with the 75th anniversary of the park, three Apollo astronauts will visit. The astronauts studied geology at Craters of the Moon to prepare for their historic missions to the moon where they collected some of the lunar samples used during the teacher workshop.

Three GSFC public affairs staff members attended an interagency interpretation workshop held in October 1998. This was their first exposure to the principles of interpretation. As a result of their attendance, exhibits and newsletter articles now feature interpretive themes and provide opportunities for the reader to make meaningful connections to the featured project or mission.

A quality service training session was held for the GSFC visitor center volunteer staff in December 1998 using the principles of the NPS Interpretive Development Program. This is the first in a series of sessions designed to improve visitor service at GSFC. Future interpretive training programs are being discussed for the GSFC speaker's bureau and education specialists.

The interagency World Wide Web site (<http://www.nps.gov/interp/nasa>) went online at the end of February 1999. The site focuses on the details of the partnerships as well as links to resources available through each agency.

What Happens Next?

GSFC has secured one more year of funding for the liaison position. At the time of writing, the NPS Washington Office of Interpretation and Education is actively recruiting and will hire for that position sometime during spring 1999. Awareness has been the primary goal during this first year. The second year will focus on specific projects, which may include integrated training opportunities, colloquia featuring joint NPS-NASA research and education projects, and integrated education and outreach materials.

The Reality of Tomorrow

Robert H. Goddard, the namesake of NASA Goddard Space Flight Center, said "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow." Following the same thought as Dr. Goddard, it is difficult to say what is impossible, because through the NPS-NASA partnership we are making those dreams of the past twenty years a reality. By having a liaison working within the two agencies, collaborative efforts are becoming the norm, rather than an exciting discovery.

NASA and the NPS are actively sharing a world of resources. Current scientific resources, information, and images are being integrated into the parks' interpretive programs. Management, staff, and the public are all becoming better informed about their park sites as a part of a larger planetary system.

The Government Performance and Results Act Survey: Results from Selected Programs of the National Park Service

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Introduction

An integral part of the National Park Service (NPS) mission is working with co-operators "to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout the country and the world" (National Park Service 1997). In 1995, the NPS began to comply with the Government Performance and Results Act (GPRA) to develop a "performance management system" that will be beneficial to the programs and employees within the agency. GPRA seeks to make the federal government more accountable for its actions and expenditures. Performance management can best be achieved through the use and measurement of specific goals.

In the fall of 1998, the National Center for Recreation and Conservation and the National Center for Cultural Resources, Stewardship, and Partnerships set out to conduct a study to assess client satisfaction, in compliance with GPRA. Programs within these two centers conducted a study, in partnership with the West Virginia University, to measure community satisfaction in order to meet one of the goals of the 1997 NPS Strategic Plan: namely, that "80% of communities served [will be] satisfied with NPS partnership assistance in providing recreational and conservation benefits on lands and waters" (National Park Service 1997).

Included in this study were four programs within the National Center for Recreation and Conservation (NCRC) and two within the National Center for Cultural Resources, Stewardship, and Partnerships. This paper describes results from the four NCRC programs: Rivers, Trails, and Conservation Assistance (RTCA), National Heritage Areas (NHA), Federal Lands-to-Parks (FLP), and Wild and Scenic Rivers (WSR).

Study Design

The purpose of the study was to assess the level of satisfaction of specific co-operators who had received assistance or services from these NPS programs in 1998-99 fiscal year. For all programs, a questionnaire was developed with which to measure co-operators' overall satisfaction. More specific program services or types of assistance (e.g., fostering growth and development of the organization, assistance with publications) were assessed in an importance-performance matrix. This technique was used to better evaluate the current delivery of services in order to use feedback for areas that need it or reduce efforts when services were given too much attention. Respondents were asked to rate the level of importance and satisfaction with each program item on a 5-point Likert scale. A modified Dillman technique was used for the mail survey. The first mailing was conducted in the fall of 1998. Follow-up reminders and a second mailing were used to attain a satisfactory response rate (Dillman 1978). The RTCA response rate was 54% (91 of 168 surveys were returned); NHA, 55% (6 of 11); WSR, 75% (3 of 4); and FLP, 48% (43 of 90).

Findings: Overall Program Satisfaction

In the opinion of surveyed co-operators, three of the four programs (RTCA, WSR, and FLP) fared well relative to the goal set forth in the NPS Strategic Plan (i.e., a minimum of 80% of co-operators reporting being somewhat or very satisfied). Among these three programs, overall mean satisfaction scores ranged from 4.39 to 4.76, with the proportion of satisfied co-operators ranging from 89% to 100% (Table

1). Among the cooperators surveyed in the NHA program, overall mean satisfaction was 3.0, and only 40% reported being satisfied.

Similarly, in terms of the effect these programs are having on the achievement of project goals, cooperators with the RTCA, WSR, and FLP programs reported high mean satisfaction scores (4.67 to 4.8); however, only RTCA and WSR achieved an acceptable proportion of satisfied clients. For the FLP and NHA programs, only 68% and 50% of surveyed cooperators, respectively, reported being somewhat or very satisfied.

Table 1. Overall program satisfaction mean scores and percentage of satisfied cooperators for the RTCA, NHA, WSR and FLP programs.

Item	RTCA	NHA	WSR	FLP
1 Overall, how would you rate your level of satisfaction with the services and/or assistance provided by the [Program]?	4.76 (94%)	3.00 (40%)	4.67 (100%)	4.39 (89%)
2 What effect did the involvement of the [Program] have in achieving the goals of the project?	4.80 (97%)	3.67 (50%)	4.67 (100%)	4.67 (68%)
3 Overall, how would you rate your level of satisfaction with the outcome of the project?	N/A	N/A	N/A	4.33 (90%)
4 What effect did the involvement of the [Program] have in your decision to acquire the property for public parks, recreation, or conservation?	N/A	N/A	N/A	4.29 (79%)
Note: All Items were measured on a 5-point scale: the scale for items 1 and 3 ranged from <i>Very Dissatisfied</i> (1) to <i>Very Satisfied</i> (5); the scale for items 2 and 4 ranged from <i>Greatly Hindered</i> (1) to <i>Greatly Helped</i> (5).				
Note: A small proportion responded with <i>no opinion/undecided, not applicable, or too soon to tell</i> for the above items, and were excluded from the calculation of means scores.				

Findings: Importance-Performance of Program Services

Overall, and not surprisingly, responses to the various services provided by the four programs were overwhelmingly positive. Mean importance scores across all services provided by the four programs ranged from 3.85 for FLP to 4.3 for WSR. Similarly, mean overall satisfaction scores ranged from 2.8 for the NHA to 4.3 for the WSR. It is clear that NCRC-program cooperators concur with the array of services these programs have chosen to deliver, and are generally satisfied with how they have been delivered.

Between each program, stark differences exist in the priorities of respondents, and in their satisfaction with the delivery of program services or types of assistance. Within each program, interesting patterns emerge regarding the relative importance and satisfaction cooperators ascribe to various program elements.

Rivers, Trails, and Conservation Assistance. In general, a strong positive relationship was evident between importance and satisfaction scores (Figure 1). In other words, the items of highest importance to RTCA program cooperators are also items receiving the highest satisfaction scores. From a program delivery perspective, this is

a good indication that the program has a visceral understanding of which program elements are most important, and have made efforts to develop their capacity for excellence in these areas.

Elements of highest importance and satisfaction tended to relate to organizational development, while less important and less well-delivered were items related to the "nuts and bolts" of conservation work. Specifically, elements that fell in the "Keep Up the Good Work" category included: assistance with developing a vision, mission, and goals; ensuring support and involvement from relevant interest groups; fulfilling commitments made to the project; guidance in developing publications and graphic materials; and assuring support from the community.

Two items were rated highly important relative to other items, but did not receive high satisfaction ratings. Items in this "Concentrate Here" quadrant included: assistance with developing the capacity of the organization; and helping to secure possible funding sources. RTCA may want to consider either improving delivery in these two areas, or reducing cooperator expectations regarding RTCA's capacity to assist in these areas.

The most interesting finding was the fact that all seven items relating to provision of information were rated as "Low Priority" or "Possible Overkill." This suggests that, relative to the other program services offered by RTCA, providing information was seen as neither a high priority nor particularly well-delivered. It appears that RTCA cooperators may look to other sources of information while valuing the one-on-one assistance RTCA can provide them in developing the direction and capacity of their organizations. Other items that fall into this category include site evaluation and overcoming problems and crises.

The fact that only one item, provision of information about the experiences of other organizations, fell into the "Possible Overkill" quadrant, again suggests that the organization has done a good job at not devoting a disproportionate share of resources to low-priority items.

Federal Lands-to-Parks. As with RTCA, a fairly strong positive relationship was evident between importance and performance scores (Figure 2). This suggests that the program is doing a good job of developing excellence in areas important to its cooperators. Only three items fell into the "Concentrate Here" category, and only one in the "Possible Overkill" category.

In many ways, the FLP findings are in stark contrast to RTCA, suggesting a far different clientele with different service priorities. Unlike the RTCA respondents, FLP cooperators seem most interested in, and were most satisfied with, assistance they received regarding specific applications, agreements, and processes involved in the transfer of federal properties to public use. These items included: assistance with understanding procedures and requirements; providing information on land use, military base re-use, and points of contact; preparation of application materials; communicating stewardship requirements; development of third-party operating agreements; overcoming problems and crises; and fulfilling commitments made to the project.

Items in the "Concentrate Here" quadrant also related to the specifics of land transfer, including: promoting and supporting their proposal with other agencies, assistance with proposed changes in land use for the properties, and preparing deeds and transferring property. It appears that FLP cooperators expect the program to be both an advocate for the property transfer within the federal government and a source of technical legal help in accomplishing the transfer.

Also in contrast with RTCA was the finding of "Low Priority" for items relating to developing their organization or building public support for the project. These items included: identification and notification of available properties; developing justification for park and recreation uses of the property; building credibility for the project with other agencies or organizations; modifying or enhancing the property; alternative strategies; site evaluation, and planning for public use of the property.

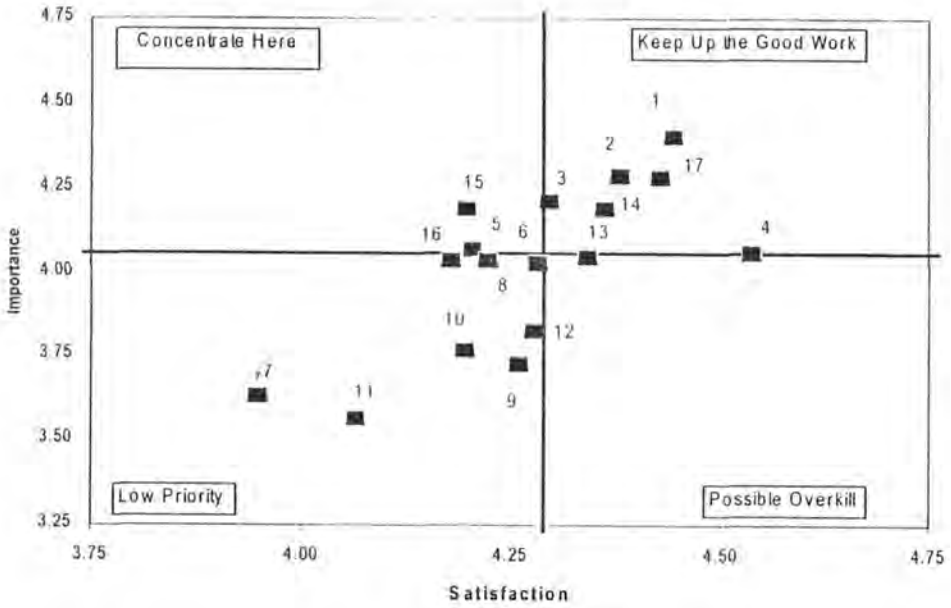


Figure 1. Importance-performance matrix for RTCA program.

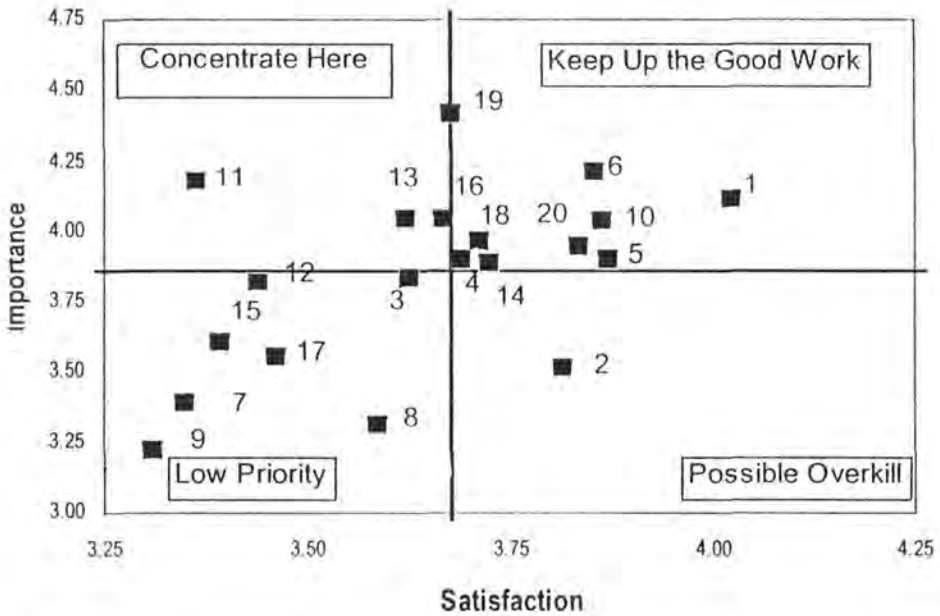


Figure 2. Importance-performance matrix for FLP program.

Lastly, assistance with developing the cooperator organization's vision, mission, and goals was well-delivered, but was not viewed as particularly important, and thus fell in the "Possible Overkill" category. It might be concluded that these groups have a well-defined and -focused mission—acquiring a specific piece of property—and can therefore look to the FLP program for direct assistance.

National Heritage Areas. In general, respondents indicated that the services provided by the NHA program were consistent with their organization's priorities (Figure 3). In fact, only the WSR program, with a sample size of only three, had a higher mean importance score. However, the NHA program produced the lowest mean satisfaction levels (2.8) among the four programs. Three of the twelve items fell below the 2.5 midpoint of the satisfaction scale.

Four of the twelve items fell into the "Keep Up the Good Work" category. Unlike RTCA and FLP, these items generally reflect the cooperators' interest in managing and sustaining their projects over the long term, and include fulfilling commitments made to the project, developing publications, provision of technical information about heritage area development, and involving other organizations that can be of assistance.

The three items in the "Concentrate Here" category also relate to long-term program management: helping the organization develop annual and long-range plans; provision of other federal programs that may assist their project, and securing other sources of funding. Worth noting is the high importance these cooperators placed on securing additional funding sources, and their high level of dissatisfaction with NHA in this regard.

Three items fell into the "Low Priority" category: provision of information about other organizations, fostering the non-financial growth and development of the organization, and overcoming unexpected problems. Only two items fell into the "Possible Overkill" category: administration of federal funds made available to their NHA, and site evaluation of resources.

Wild and Scenic Rivers. Because of the extremely small population size, the WSR results should be viewed with caution. Nonetheless, the findings are illuminating (Figure 4). We see no discernable connection among the four items in the "Keep up the Good Work" quadrant. These items include: overcoming unexpected problems, developing organizational capacity, securing other funding sources, and providing information on river conservation.

Unlike the other three program groups, WSR respondents place a high priority on resource evaluation. However, they were relatively less satisfied with assistance received in this area, resulting in its falling into the "Concentrate Here" category. Also in this category was provision of information on protection strategies.

Items that fell into the "Low Priority" quadrant include: developing vision, mission, and goals; building support within the community; providing interpretation and education; provision of protection strategies; perspectives on other organizations with similar projects, and; provision of information on trail development. Worth highlighting was the extremely low importance scores respondents place on information on trail development. In fact, this was the only item in any of the four program groups that fell below the 2.5 importance midpoint. It appears that this is a service that can be dropped or at least de-emphasized further.

Interestingly, four items fell into the "Possible Overkill" quadrant, more than for any of the four programs. These items included: assistance with facilitating of meetings, enlisting relevant interest groups, guidance on developing publications, and fulfilling commitments made to the project.

Discussion

With few exceptions, both importance and performance scores fell above the 2.5 midpoint, suggesting a high level of support for the services delivered by the four

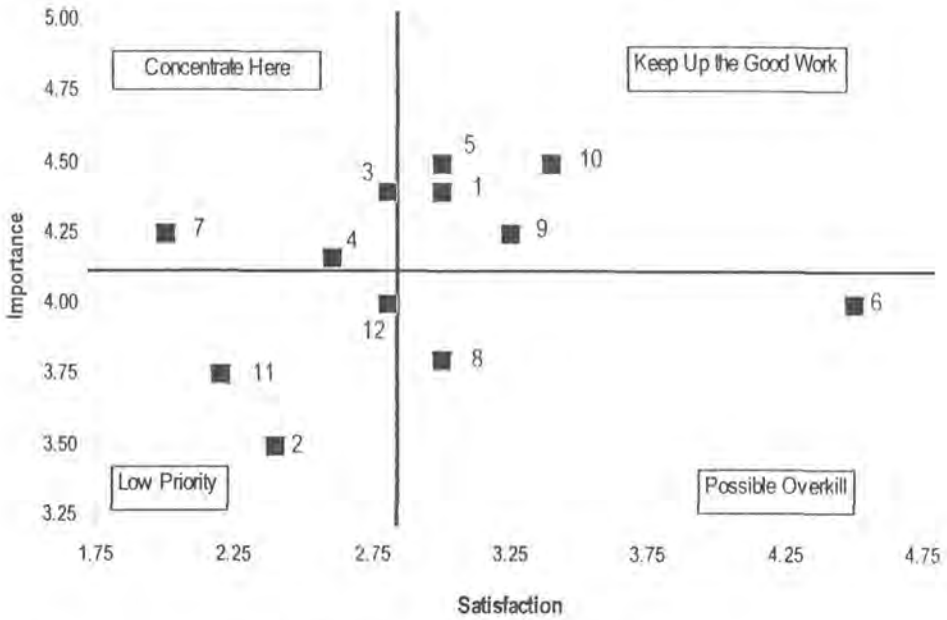


Figure 3. Importance-performance matrix for NHA program.

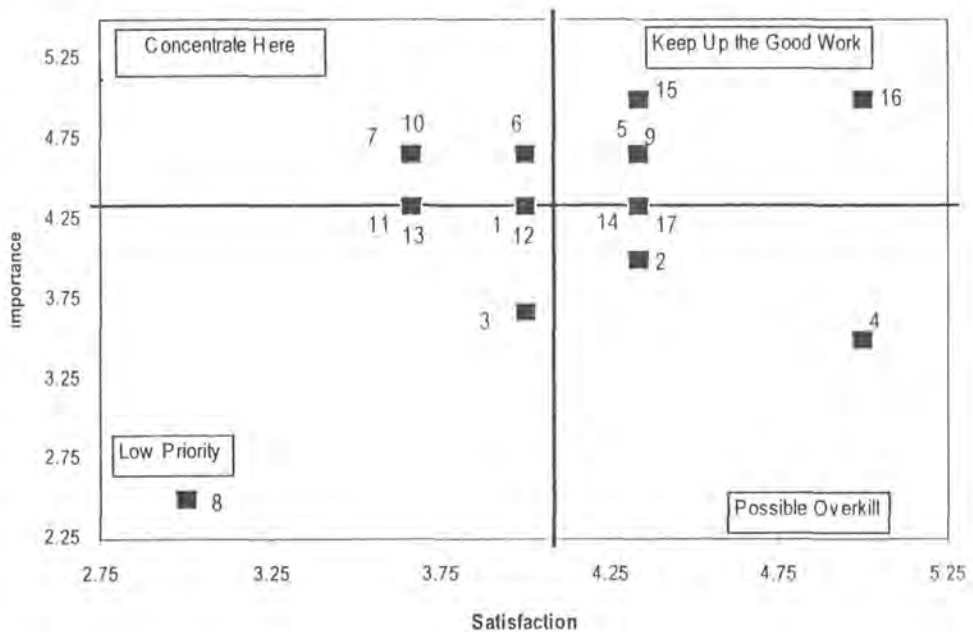


Figure 4. Importance-performance matrix for WSR program.

programs, and a high level of satisfaction. Program staff should be congratulated for having a very good sense of the program elements important to their constituents, and for developing a great capacity to deliver on these items. Overall, 23 items fell in the "Keep Up the Good Work" quadrant, while only 10 fell into the "Concentrate Here" quadrant.

Of the items held in common across the four programs, few response similarities emerged. For instance, while assistance with developing a vision and mission was viewed as important and well-delivered by RTCA participants, it was seen as a low priority or possible overkill by the two other programs that included it on their survey (FLP and WSR, respectively). This reflects the vastly different constituency needs and interests across the four programs, along with the ability of each program group to customize its services to the specific needs of its constituency.

Three of the four programs (RTCA, FLP, and NHA) viewed identification and evaluation of site resources as a low priority. Only WSR placed a relatively high value on its provision. Of the three programs that including assistance with obtaining funding as an item, two (RTCA and NHA) viewed the service as highly important, but were relatively dissatisfied with its delivery.

Thus, we can make two general recommendations: First, it appears that the NCRC programs should further de-emphasize site identification and evaluation as a program service. With the exception of the four WSR programs, this capacity is not highly valued by constituents.

Second, NCRC should place a greater focus on assisting constituents with securing funding for their programs. One way this could be accomplished would be to build technical capacity in the area of finance and funding within the NCRC. Alternatively, there are several organizations that focus on helping small nonprofits with issues related to fund-raising, grant-writing, and financing. Perhaps formal relationships could be developed with these organizations for the purpose of assisting NCRC cooperators with this vexing problem.

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A Consensus Approach to Management Planning: An Evaluation of Effectiveness for Riding Mountain National Park, Manitoba, Canada

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Background

Riding Mountain National Park comprises 2,976 sq km in western Manitoba in the geographic heartland of North America. Established in 1929, the park protects a representative part of the southern boreal plains and plateaux natural region in Canada. In an uncommon interface, three life zones overlap in the park: the aspen-oak, fescue grasslands, and mixed-wood. An essentially complete natural food chain is present in the park, including summit carnivores such as wolf, fox, and lynx. Black bear, elk, moose, deer and beaver populations are some of the most dense in Canada.

One of the most prominent features of the park is the striking degree of difference between the forested parkland and the adjacent agricultural land. Riding Mountain is one of the last large remnants of woodland that existed prior to European settlement in the 1800s, and once covered much of the western portion of the province and beyond. Satellite photos of the park area, showing this remarkable division, have become a popular way of illustrating landscape islandization (Noss 1995).

Aboriginal Peoples are known to have inhabited the park area for 6,000 years. During more recent times, the Ojibway and Nakota Peoples fished, traded furs, and hunted throughout the area. Their modern-day descendants are located in several First Nation communities around the park.

The park is a popular tourism destination in Manitoba. Wasagaming townsite is the most highly utilized area of the park. It provides developed visitor services and resort amenities such as restaurants and full-service campgrounds. Over 300 private cottages are located at Clear Lake.



Figure 1. Location of Riding Mountain National Park, Manitoba.

The Park Management Plan

A park management plan is the central document which guides Parks Canada in the protection, management, and operation of a national park. It outlines the appropriate mix of preservation, presentation, and visitor-use goals, and sets out the framework and priorities for achieving them. Management plans are required under the National Parks Act. They must be developed with the involvement of the Canadian public, and formally reviewed every five years. The review of the existing Riding Mountain plan was initiated in 1994 in response to this legislative requirement.

Situation Analysis

Several important trends and changes, both biologically and socially, had become apparent prior to the management plan review. These had a direct bearing on how the planning program took shape.

Increasing segregation between the park and adjacent lands. The park and adjacent lands are becoming increasingly isolated from one another, creating an islandization effect. Between 1957 and 1991, forest habitat in an area to the north of the park decreased from 51% to 16% (Walker 1998). Between 1976 and 1986, the area of tilled land close to the park increased by more than 20%, while nearby woodland areas declined by more than 45% (Trant 1992).

Intensification of land use outside the park. Between 1976 and 1986, in areas close to the park, pesticide and fertilizer use increased approximately 30%, and the proportion of land in pasture went from 23.7% to 28.6% (Trant 1992). In 1995, a major pulp and oriented strand board plant was licenced by the province of Manitoba to begin harvesting hardwood species in an area north of the park. About 1,000 cubic metres of hardwood were harvested in 1997.

Aboriginal issues. There was an emerging need for more cooperative management with First Nations. Issues included land claims and traditional use within the park, and equity in the park's hiring practices and workforce composition.

Amendments to the National Parks Act. Amendments to the National Parks Act in 1988 require that ecological integrity be the first consideration in management planning. This was a significant shift in Parks Canada's management focus. Prior to this amendment, the dynamics of each park in the larger ecosystem tended to be underplayed and management strategies inadequately addressed the linkages and interdependencies of species, including humans. Ecological integrity is defined as a condition where the structure and function of an ecosystem are unimpaired by human-caused stresses, and are likely to persist (Canadian Heritage 1994). Ecosystem-based management was subsequently adopted in Parks Canada policy as the most effective method of working toward ecological integrity (Canadian Heritage 1994).

Higher expectation of public involvement. In general, across Canada the public was demanding more meaningful input into decisions that directly affect them, their activities, or the place where they live. In Riding Mountain, inside-the-park stakeholders (e.g., cottage and business owners) and outside stakeholders (e.g., local land-owners and environmental groups) were demanding a greater role in the park's decision-making process.

Increased conflict between the park and stakeholders. Conflict between park administration and stakeholders had risen significantly. Disputes were common on many issues, including transboundary issues of water quality, flooding, and wildlife depredation, as well as internal issues such as facility appearances in the townsite. Working relationships with the province—considered a key stakeholder—were so strained that the provincial government did not recognize Riding Mountain's interest beyond the park boundaries. Much of the conflict stemmed from inadequate communications, and dissatisfaction with the limited involvement in management accorded to stakeholders.

Moving Ahead on Management Planning

A Parks Canada planning team was struck in 1993 to begin management planning. In the initial assessment, several key points became clear:

- Most of the priority park management plan issues were influenced to a large extent by non-Parks Canada interests, such as the provincial Department of Natural Resources;
- Resolution of these issues would require the involvement, support, and concurrence of key stakeholders (an important part of ecosystem-based management);
- Getting this support would require considerable exchange of information and relationship-building; and
- It would be impossible to develop a prescription-oriented plan that had stakeholder support within the two-year time frame of management planning; conflict resolution and understanding must first be pursued.

As a result of this assessment, a two-pronged vision for the planning program took shape. First, *the process would have to apply a broader management perspective that involved key stakeholders in developing the management plan.* This was a significant departure from more conventional planning programs where stakeholder involvement was often limited to commenting on drafts of plans prepared by Parks Canada. A conventional approach would not produce the kind of support from stakeholders that was needed to make progress on the issues.

Second, *the plan would have to provide direction for working collaboratively on the issues over the long term.* This differed from conventional plans that set out specific management prescriptions or ecological integrity targets. The plan would defer this level of detail until commitments from key stakeholders to working together toward mutually acceptable goals could first be reached.

The goal of the Riding Mountain planning program was subsequently identified as follows: “[A]chieve consensus between Parks Canada and key stakeholders on a management plan that sets out a long term plan of working together to develop park management goals and objectives, a strategy for resolving conflicts and issues between the park and its neighbours and users, and a framework for continuous communication, learning and problem-solving.”

Consensus-Based Planning

Riding Mountain proceeded to assess the viability of a consensus-based management plan, as defined in *Building Consensus for a Sustainable Future* (Canadian Round Tables 1993). A consensus planning process is one in which:

- All those who have a stake in the outcome aim to reach agreement;
- Participants work together in a self-defined process that maximizes their ability to resolve their differences; and
- Consensus is reached if all participants are willing to live with the total package.

A consensus process was particularly appealing for Riding Mountain because of its potential ability to provide a forum for communication, conflict resolution, and relationship-building, and to produce a more enduring plan that had the commitment of stakeholders.

Collaborative planning processes had been used previously in Canadian national parks. For example, Parks Canada was just beginning its involvement in the Banff-Bow Valley Task Force, which ultimately made recommendations to the Minister of Canadian Heritage on the management of the Banff ecosystem (Banff-Bow Valley Task Force 1996). In southern Alberta, stakeholders were leading the Crown of the Continent initiative in an attempt to encourage integrated land-use decisions around Waterton Lakes National Park (Zincan 1992). Model forest programs, with

similar objectives, have been established for five national parks. More recently, Zorn et al. (1999) identified guidelines for multi-stakeholder processes.

Elsewhere in Canada, British Columbia had used consensus processes to the greatest extent. The Commission on Resources and Environment (CORE) developed a publicly negotiated land-use strategy, using regional round tables representing a wide variety of sectors (British Columbia 1992).

Phase One: Preliminary assessment. Gauging public reaction to the program was a major first step. Public comments were solicited through newsletters, displays, and public information and town hall meetings in seven communities in and around the park. Public reaction to the proposed process was supportive.

Next, a consulting firm, Ecologistics Ltd., was retained to determine the feasibility of a consensus program. A part of the feasibility study consisted of interviews with over 40 representatives known to have an interest in the management of the park. Stakeholders were very supportive of a more collaborative approach to park management. The feasibility analysis concluded that a round table, consensus-based process was viable in achieving the goals for management planning for Riding Mountain (Ecologistics Ltd. 1994).

Phase Two: Plan development. The planning program formally began in October 1994 when stakeholders came together under an independent facilitator and chose a round table representation of 20 members (see Table 1). Eight meetings of the round table were held over eighteen months. The main steps in the process were: training in consensus-building and conflict resolution, identification of non-negotiables, developing a vision for the park and preparation of the draft, broad public review, and approval by the minister responsible for Parks Canada. Following the eight round table meetings, eight public meetings, and numerous draft plans, consensus was reached on a 38-page management plan (Riding Mountain National Park Round Table 1996). The plan is now serving as the primary strategy for park management. The process was not an easy one. Many of the participants describe it as difficult, stressful, frustrating, and time-consuming. This was expected given the wide range of interests and values on the round table, the complexity of the issues, and the many years of limited involvement of stakeholders in park management.

• Parks Canada	• Provincial & Municipal Governments
• Outfitters Association	• Cottage-Owners Association
• Environmental Nongovernmental Associations	• Manitoba Wildlife Federation
• Conservation District	• Land-Owners Association
• Park Cooperating Association	• Wasagaming Chamber of Commerce
• Tourism Associations	• First Nations
• Local School Division	

Table 1. Representation on the Riding Mountain Round Table.

The Effectiveness of the Consensus Program

The effectiveness of the consensus process is evaluated qualitatively, based on the question, "Did the process achieve the stated goals of management planning (setting out a long-term plan for Riding Mountain and stakeholders to work together in park management, reducing conflict, creating a continuous learning environment)?" The

evaluation considers the process's effectiveness in developing the plan, as well as how effective the plan has been since implementation.

Achieving the stated goals of management planning. The consensus plan set out a clear basis for key stakeholders such as the province to work cooperatively over the long term to address park and ecosystem issues. Implicit within that agreement was a recognition of the park's interests beyond its boundaries, a key objective of the park's involvement. The park is now able to cooperatively pursue its objectives in the broader ecosystem, something that had been previously unattainable.

The round table forum resulted in significantly improved working relationships among stakeholders and park administration. The forum built understanding of the complex nature of the issues and the underlying values which affect their resolution. The park's commitment to share decision-making in the consensus process was a strategically important gesture that reduced much conflict from the start.

In accordance with the plan, four sub-groups of the round table have been established and are providing advice and critical support in addressing park issues. The ecological integrity working group, for example, participated in the development of the ecosystem conservation plan, which focuses on issues such as water quality, wildlife, and human impacts. The cultural resources working group is participating in the development of the community plan for the townsite. Several specific issues, such as the provision of backcountry facilities, have been successfully addressed. Also in accordance with the plan, the round table has been meeting annually. It has met the challenge of maintaining momentum, through the addition of new members, perspectives and goals.

The role of the round table and the sub-groups has evolved from consensus-seeking to advising the park. This new role has increased the efficiency of cooperation. The opportunity to return to the consensus environment was critical in maintaining faith in the advisory process.

There is an overall sense with park staff that there is now a key opportunity to capitalize on the strong working relationship that exists, and increase the focus on detailed issues. The next phase of evaluation should measure success on these issues, and consultation maintained or revised accordingly.

Lessons Learned

- **A lack of prescription is a challenge.** The absence of clear, measurable targets for ecological integrity in the management plan departs from a basic principle of planning that says, "If you don't know where you are going, how will you know when you get there?" (Carroll 1939). Subsequent sub-planning programs of the management plan, such as the ecosystem conservation plan, were able to capitalize on the progress made during the consensus process, and began to set out important prescriptions (Riding Mountain National Park 1997).
- **Ensure that the method matches the problem.** Consensus processes are not appropriate for all planning situations. There are many other methods and levels of decision-making that should be considered, such as advisory committees or issue-specific consultation. The efforts that were spent in determining the appropriateness of a consensus process for Riding Mountain were critical.
- **Expensive, but worth it.** A consensus-based program requires a major commitment of time and money. The expense is proportionate to the product, however. Riding Mountain has advanced from a largely insular agency, to cooperative management. While much work remains, the park now has an important cornerstone of ecosystem-based management in place.
- **Momentum and renewal are required.** Over the longer term, there may be a tendency to fall back into sectoral management because of flagging energies and interest. Be realistic about what can be achieved in the cooperative environment, and creative in renewing commitment and re-inventing goals.

- **Consider your organization a key stakeholder.** Sharing decision-making is a profound change in the way business is done, and it affects the entire organization. Many park staff were uncomfortable with the abrupt change. In retrospect, staff were not sufficiently involved in the development of the plan. Communication and education are important.
- **Small victories are important.** Building consensus and managing cooperatively is a long and demanding process. It is important for representatives to be able to demonstrate to their constituents that the investments are productive. Quick action on specific issues can help maintain momentum.
- **True continuous learning reaps huge returns.** The learning and trust that are being built by the *ongoing, informal* exchange of the round table were unexpected and significant. Formal meetings are only a part of the learning equation. Informal exchanges, and increased familiarity with the people and the issues, have contributed markedly to resolving the issues.
- **The process is the product.** The term "process" is often negatively associated with a lack of results. On the contrary, the process can and should be a tangible product. In Riding Mountain, the process provided an opportunity for people to build trust, and learn about the complexity of the issues and the challenges in resolving them. Without that level of understanding, the management plan would have had little support from stakeholders.

Conclusion

The consensus process achieved its goals in that it produced a viable management plan and an effective working relationship with stakeholders for park management. The ability of Riding Mountain to work in an ecosystem management framework has significantly increased. Now, the park should capitalize on the new working relationship, and focus on addressing detailed issues, such as preservation of forest cover outside the park. The lack of prescriptive detail in the plan will make measurement of progress on park management issues difficult. The next phase of evaluation should measure success in resolving detailed issues to ensure that the consultative process continues to be productive.

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Achieving Diversity in Natural Resources

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Problem Statement

The National Park Service (NPS) has targeted the General Biology (401) occupational series for diversity recruitment and retention as part of its diversity goals under the Government Performance and Results Act (GPRA). While the NPS has provided opportunities for entry and advancement in natural resource careers, imbalances between genders and ethnicities still exist. In the 401 occupational series, the NPS is focused on general biology and does not account for other natural science and physical science series. Moreover, based on labor data from within the Pacific West Region, the gender and ethnic make-up of NPS employees in natural and physical science occupations does not mirror the level of diversity found in the national civilian labor force. Based on results of the 1990 U.S. Census, there is statistical evidence of availability of qualified applicants from underrepresented groups. This suggests institutional barriers to a more diverse workforce in the NPS.

In the past, hiring and promotion practices have tended to focus on candidates from within parks. Some patterns have developed: volunteers apply for seasonal positions, seasonal employees seek to be converted to permanent (career-conditional) status, and technicians are promoted to specialists (e.g., moving from 404 to another within the 400 occupational series). National parks are considered highly desirable work environments by many in environmental science disciplines. The demand for employment is high and the pool of interested candidates—many from volunteer and seasonal ranks—often abundant. For these reasons, proactive recruitment efforts may seem unnecessary to general a pool of qualified applicants, and selecting officials do not then consider seeking candidates from non-NPS, non-governmental sources (e.g., historically black colleges and universities).

Compounding the situation is an institutional lack of knowledge about non-NPS, non-governmental sources of qualified candidates. Without a history of recruitment from underrepresented groups, selecting officials are unaware of recruitment sources and how to increase their hiring options. Moreover, the recruitment and hiring process has a limited flexibility to direct efforts on selected pools of potential applicants.

The NPS has not, in the past, built strong ties with groups that are now identified as underrepresented in the NPS workforce. This is a problem common throughout most of the federal government. For example, as Mark Binker points out, "Hispanics make up more than 10 percent of the available U.S. labor force, but represent only 6.1 percent of workers in civilian federal jobs, according to the Merit Systems Protection Board. Only two federal agencies have met the government's 10.2 percent Hispanic employee target—the Justice Department and the Equal Employment Opportunity Commission" (Binker 1997).

Cultural and Sociological Barriers to a More Diverse NPS Workforce

Many groups of people underrepresented in the NPS workforce are not familiar with national parks and the NPS as a career opportunity. Through its Diversity Media Project, the NPS Pacific West Region has developed a database of media whose target audiences are women and minorities. Of the 130 or more publications and newspapers surveyed or researched, over 80% had little or no knowledge of or dealings with national parks (Kaarina Merikaarto, personal communication, 1999).

The NPS has sustained its own invisibility by its lack of outreach to underrepresented communities. In July 1998 the Pacific Great Basin Support Office hosted a forum, "Ethnic Impressions of the NPS," to open a dialogue between NPS and these communities. The panel presentations and dialogue revealed some informative per-

spectives of national parks. While some groups perceived opportunities for recreation and tourism, they also saw national park units as vehicles for recognition and remembrance for their history. There was not a strong connection between these communities and national parks due to economic barriers or a sense of disassociation with the "American culture" national parks represent. A need for inclusion recurred throughout the forum.

Another finding of the forum was that NPS employees see the agency as Eurocentric and without the resources—especially funding—to change. Few employees understood any relevance of diversity issues to their own work, a reflection of the detachment of the NPS and the people it serves. A low representation of diversity within the NPS—in the workforce and in the visitor experience—serves to reinforce the separation between national parks and the American public. Role models can offer a new direction to young people on the verge of choosing career paths. They can be found in obvious and subtle places alike: interpretive programs, displays, brochures and publications, rangers, volunteers, etc. Without equitable representation of the American population in the agency, the NPS is missing an opportunity to develop a diverse pool of future constituents, employees and park partners.

Invisibility of Natural Resource Careers

The most visible NPS careers tend to be away from resource management. The NPS does not define well career tracks in natural and physical science; these disciplines are often combined with other functions of park management such as interpretation (e.g., Muir Woods National Monument) or law enforcement (e.g., Cabrillo National Monument). Another result of this invisibility is the NPS's lack of career tracks in natural resources, an absence of clearly defined career ladders. If the NPS as an employer wants to recruit top-quality candidates, we must offer not merely entry-level opportunities but tangible career potential as well. Recruitment is merely one half of the equation. To retain quality employees, professional development must be available and accessible, by way of opportunities for training, promotion, and professional growth.

At the direction of the Department of the Interior, the NPS is currently targeting occupational series such as 401 (General Biology) in its diversity initiative. While agency statistics reflect a lack of diversity in such occupational series, they fail to recognize the full range of occupations within the 400 and 1300 series that comprise the natural and physical sciences. This reflects a broader lack of recognition throughout the NPS of the natural resources program and corresponds with an institutional neglect of resource management. (For more information on the history of natural resource management in the National Park Service, refer to Sellars 1997.)

Outreach, Recruitment, and Retention; Public Interest in the NPS Mission

To achieve a more diverse workforce tomorrow the seeds of change must be planted today in the communities that are currently underrepresented in the NPS workforce. We need to seek commonality, especially over the long term, and to develop priorities together. Over the long term, the NPS has to develop in young people two interests: in natural and physical science careers, and in the national parks as desirable places to work.

Community outreach can be facilitated through the media. The NPS can be presented in ways that link national parks to different cultures. The media can also prove a useful tool for recruitment through job advertisements, employee profiles, and national park interest stories, to name a few examples.

The NPS Workforce Diversity Agreement is the beginning of institutional change throughout the service towards greater diversity. For our part, the Pacific West Region has developed a Strategic Plan for Diversity, recruitment strategies for specific occupational series and for targeted candidate pools, and initiated an Education Strategy jointly with the Alaska Region. One outgrowth of the strategic plan for di-

iversity is the Diversity Outreach Program—Pilot Project. This multi-disciplinary team approach will foster enduring relationships with specific educational institutions that can help the Pacific West Region to achieve greater workforce diversity over the short and long term. Three outreach teams—Hispanic, Native American and Environmental Studies, and Special Populations—have been formed to educate public institutions and students about the NPS mission, and to forge a network of contacts for identifying and recruiting diverse candidates for employment.

Another effort in the education arena is the Alaska and Pacific West Region's joint education strategy. A workshop held in February 1999 emphasized the role of education to "connect people, parks, and natural and cultural resources" (National Park Service 1999). Diversity again was embraced as a key component of education, especially in life-long learning to reach all audiences.

Diversity is a state of mind. At the 1998 forum "Ethnic Impressions of the NPS," Victoria Hudson, a journalist with the Alameda Newspaper Group, made the point that Latinos like to use campgrounds for family outings, and, in their culture, this means large extended families. In response, the California Department of Parks and Recreation has redesigned some of its campgrounds to accommodate large family outings and to better appeal to Latino communities. Simple solutions—in this case, moving picnic tables closer together—can be the best ones to ostensibly complex problems.

The Pacific West Region's strategic plan for diversity addresses gender and ethnic under-representation in specific occupational series and promotes an NPS workforce diversity that more closely reflects the national civilian labor force. All superintendents have received a "tool box" of personnel authorities and procedures that can be used toward this end, and should be shared with all selecting officials in parks. For current vacancies, selecting officials can use any of the many available hiring authorities to their advantage to recruit diverse, qualified candidates. Where possible, they should use agency policies (e.g., affirmative action) to their advantage and, in the words of a former USDA Forest Service recruiter, "Select candidates without apology" (Drew 1998). The Pacific West Region has recently developed diversity recruitment strategies for the 025 and 401 series and for people with disabilities. These strategies are designed to give guidance to selecting officials in ways to diversify their workforce. One example is the Job Accommodation Network (JAN), a service arising from the President's Committee on Employment of People with Disabilities. JAN maintains a database of disabled college graduates seeking employment, and can provide lists of potential candidates sorted by skills and interests to recruiters. It also acts as a equipment clearinghouse for public accommodation. Another aid is the U.S. Office of Personnel Management's 10-Point Plan to Improve the Recruitment and Development of Hispanics in the OPM Workforce. More information is available on its web site.

The key to retaining good employees is to make the organization a place where people can and want to grow in their careers. It is important, for example, to clearly define career tracks within the agency and to make them accessible to qualified candidates. Mentoring programs can foster this accessibility and create role models for current and potential employees.

Specific to the NPS's natural resources programs are Servicewide efforts such as Resource Careers and the Natural Resources Initiative (NRI). Resource careers has fostered the professionalization of park resource managers to encourage and reward strong natural resource management programs. The NRI's program on "Fully Professional Staff" reiterates the need for a workforce with professional, technical, and leadership skills to make science-based, natural resource-focused decisions. If implemented, the NRI will offer recruitment, placement, and professional development opportunities for which diversity recruitment and retention strategies can also be applied.

The NRI also stresses the educational importance of natural resource programs. This initiative and others open avenues for the NPS to grow an interest in natural resource programs and careers in all communities. We need to spark interest in the natural and physical sciences of the national parks with the diverse communities of today that will be reflected in tomorrow's job applicants.

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The Banff-Bow Valley Study: Breaking The Public Policy Grid Lock

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Introduction

On October 7, 1996, the Honourable Sheila Copps, Minister of Canadian Heritage (and the minister responsible for Parks Canada), released the final report of the Banff-Bow Valley Study Task Force.

Banff, Canada's first national park, was created in 1885. In 1995, more than 5 million people entered the park. It has a complex array of infrastructure and activities. Two service centres, the town of Banff and the hamlet of Lake Louise contain approximately 7,600 and 1,500 residents, respectively. The four-lane Trans-Canada Highway and the main Canadian Pacific Rail line, the busiest east-west freight line in the country, bisect the park. The park is a 90-minute drive from the city of Calgary, which has a population of more than 800,000 people. More than 1,300 businesses are licenced to operate in the park and more than 1,800 leases are administered. Three large downhill ski areas and a variety of outdoor-experience companies operate in the park. The tourism industry is the main economic force, and is responsible for the more than \$873.1 million in visitor expenditures.

Lowry described the pressures on Banff National Park: "Most Americans are not quite prepared for what awaits them at Banff.... We found much more than hot springs and warm showers. Banff is a city of more than 7,000 residents, sprawling beneath and into the snow-capped peaks of the park. Add to this nearly 4 million visitors a year, and the result is intense congestion, pollution and traffic jams.... [I]t's like a cancer—it keeps growing" (1994, 96).

Since the park was created, the struggle of the forces of preservation and development has centred on the Bow Valley. The concentration of activities, growth in business development and infrastructure, and increase in visitation were resulting in increased rhetoric, polarized views of the future of the valley, and concern over the decision-making process. This, coupled with the concern over potential permanent damage to the ecosystem, caused the minister to commission the review.

The Development of a Public Policy Response

The minister set three overall objectives: develop a vision and goals for the Banff-Bow Valley; complete a comprehensive analysis of existing and future information needs; and provide direction on the management of human use and development. Five task force members, independent of government, were appointed to carry out the study. Five Parks Canada employees were seconded to form a supporting Secretariat. Two years were initially scheduled for their work, and a budget of \$1.9 million was provided to cover all costs.

Outcome

The results of the inquiry were many. The most public were a 432-page technical report titled *Banff-Bow Valley: At the Crossroads* and a 76-page summary report. Over 20 other reports and analyses were produced, covering such topic areas as governance, history, management of research, ecological indicators, human use, and public participation. Several analytical tools were developed or applied in an effort to understand the current conditions and trends in the valley. These included grizzly bear habitat effectiveness and security area models to simulate cumulative effects of development and use, the Stella II modeling tool to simulate future conditions, and demand economic impact models to understand the economic impact of Banff National Park on the local, regional, and national economies. Products of the public

involvement process included a report of the round table (containing consensus recommendations that went directly into the final report of the task force) and a more effective positioning of science in the public policy debate.

A less tangible outcome was the development, through the public involvement process, of a significantly improved understanding of issues, concerns and interests among the stakeholders concerned with Banff National Park and its environs. If nurtured properly, this may be the product of the greatest lasting value to Parks Canada.

This is the departure point for this paper. The following summarizes the extensive use of public involvement tools, in particular the Banff-Bow Valley round table and its unique characteristics. It also briefly examines the success achieved in bringing science and public policy together in a public forum.

Public Involvement

Borrowing from the British Columbia's CORE (Commission on Resources and Environment) process, Darling (1995) describes various methods of public participation as lying along a continuum (Figure 1) ranging from simple information-sharing (no participation) to shared decision-making (full participation). The task force used the full continuum of techniques. Not only was the public involvement program a major cornerstone of the study, it was perhaps the greatest success—with potentially the most lasting legacy—of the task force's work. The program had three essential elements, information-sharing, consultation, and public interest negotiation.

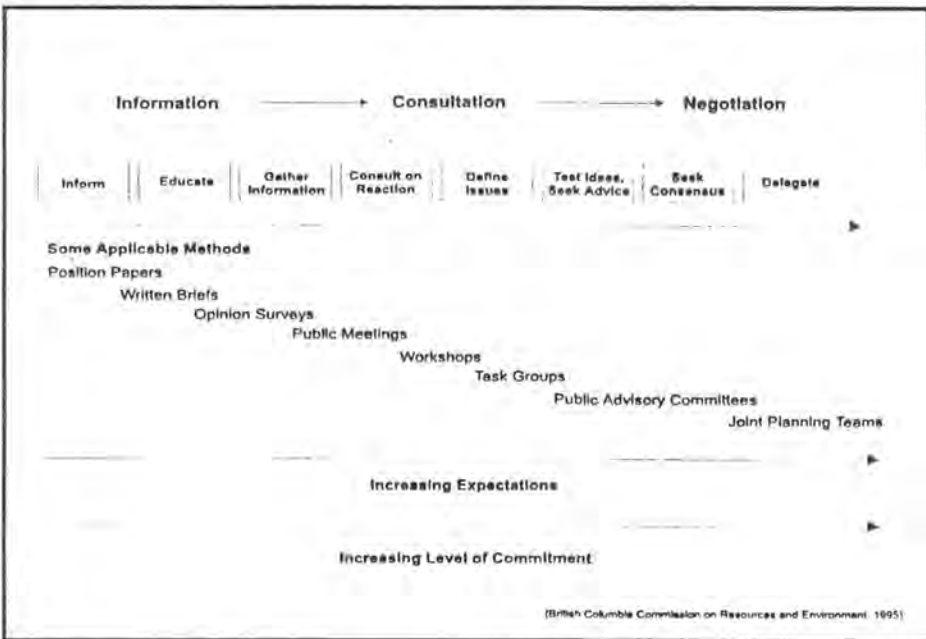


Figure 1. Public involvement continuum.

Information-Sharing

Continual sharing of information helped to build a sense of openness. A storefront office, operated in the town of Banff by the secretariat, reinforced to the public that the task force intended to be very available. Throughout the study, the public was encouraged to offer its views and opinions. This resulted in more than 1,200

submissions from both Canadians and non-Canadians. Newsletters and the Internet were used to provide regular status reports. Open houses and workshops elsewhere in Canada were conducted on a limited basis. As component projects were completed, the resulting reports were immediately made available to interested constituents. This ensured that the information playing field was kept level throughout the project. Finally, significant effort was given to maintaining close contact with local media, particularly the local newspapers.

Consultation

Direct consultation was the second component of the public involvement program. The task force invited interested groups and individuals to address it directly through deputations and one-on-one meetings. This afforded direct access for groups and individuals, and an opportunity for frank and informed exchange of ideas.

Stakeholders comprised a wide range of interests: the federal government, with specific and sometimes overlapping mandates; the community of large and small businesses, with their various interests; the environmental community, representing both local and national perspectives; park users, ranging from hikers to trail cyclists; day visitors, with a broad range of interests, including high-end shopping; the task force itself, with its specific mandate to produce a comprehensive report within a specified time; and the surrounding jurisdictions that are and will continue to be significantly affected by Banff National Park.

Engaging the local business community was a particular challenge. This community was not unlike other constituents in that it is not a homogeneous entity exhibiting a consistent approach to issues. Generally, members could be categorized as those who were vigorously opposed, the silent majority, and those wanting to get involved. The importance of this group and its economic and social impact on the local and regional economies meant it had a vital role to play in seeking solutions. Where the business community did participate, its impact on the process and the results was significant.

Public Interest Negotiations: The Round Table

The task force initially planned to use a conventional public involvement program: canvass opinion, analyse results, and recommend solutions. Feedback from the public showed that stakeholders were frustrated with this approach. It had been used extensively by Parks Canada with little apparent influence on decision-making. This led to perhaps the most important decision taken by the task force: to add an interest-based negotiation approach (i.e., a round table) to the public involvement program. Clearly an alternative approach to public involvement was needed to break the cycle of bitter and polarized debate, the lack of trust in the decision-making process, and the lack of predictability in the outcome of decisions. The round table was the highlight of the public involvement program and an outstanding example of meaningful participation in public policy decision-making. It shifted participants from an adversarial to a cooperative, problem-solving mind-set, and demonstrated that shared decision-making can work.

An environmental mediator was retained to help the task force develop the concept of a round table and to assess the appropriateness of the approach. The decision to proceed with the round table:

- Reinforced the task force's commitment to open and inclusive public involvement;
- Provided the task force with a consistent window on all of the interests in the valley and an opportunity to participate in an independently facilitated debate of the issues;

- Provided a unique situation wherein an expert panel participated as an equal partner in a shared decision-making process;
- Created clear expectations as to some of the content of the task force's final report; and
- Shifted significant shared decision-making levels to stakeholders.

The task force committed to include in its final report to the minister all round table recommendations that enjoyed full consensus. For the first time, valley constituents were given the opportunity to participate in a fully shared decision process. This removed some of the task force's flexibility because it was now accountable to the round table.

The round table was one of the most difficult aspects of the study to manage. Because there was little experience among valley constituents in such a shared decision-making process, the task force felt that it needed to provide leadership in the formative stages of the round table. A preliminary list of possible sectors of interest (Figure 2) was prepared. Opinion leaders in each of those sectors were contacted, the concept of the round table was explained, and their participation was solicited. They were also asked to recruit others within their area of interest and form a sector to sit at the table.

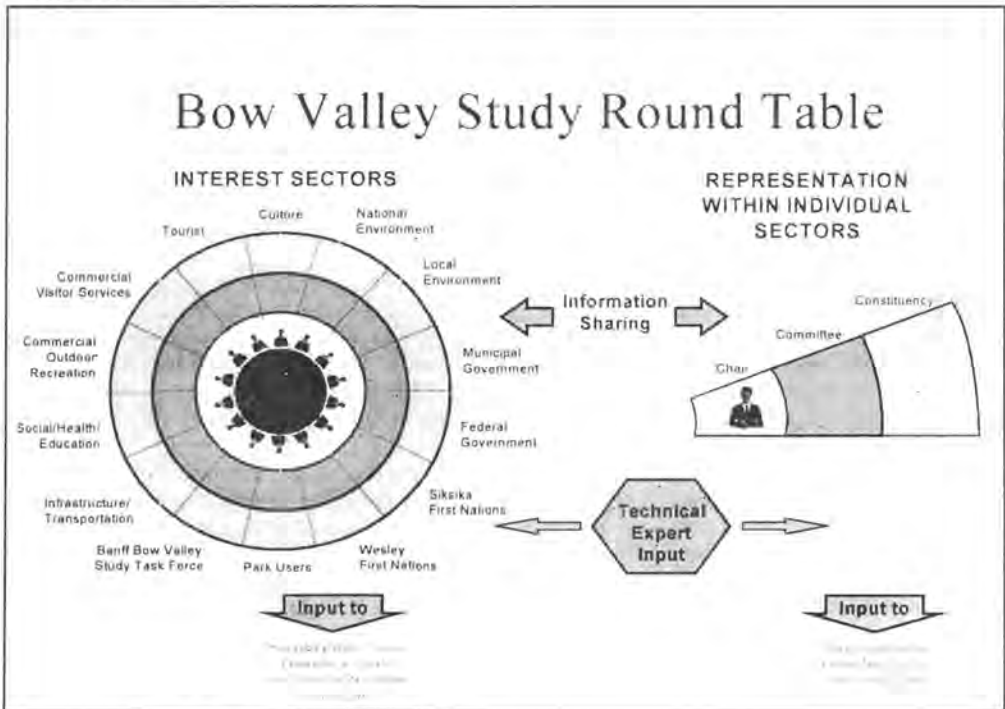


Figure 2. Banff-Bow Valley Round Table.

The independent mediator was indispensable due to the relative inexperience of participants in shared decision-making processes. The mediator was not from the area and had not engaged in any of the past debates on issues in the valley. Although retained under contract by the task force, the mediator reported to and took direction from the round table and, in the end, could be dismissed by the table. This brought a great deal of credibility to the process.

The Leader-Participant Paradox

The task force was forging for itself a role at the table that was both difficult and unique. It found itself in a leader-participant paradox. The task force was clearly in charge of the study; but it was also a client of the round table. It would receive and indeed adopt the consensus recommendations of the table. It was an equal participant having no more or less power of decision than any other member of the table. And yet it also had the role of expert advisor.

While this was a unique combination of roles for a round table setting, the task force was very successful in fulfilling each. Being an equal participant meant that, in a consensus-based forum, the task force was bound by the consensus of the group. As the client or final recipient of the round table's recommendations, the task force was always immediately available to provide clarification of its needs and expectations. Finally, as an expert advisor to the table, the task force could be held accountable for the comprehensiveness and accuracy of its scientific and technical information and advice. By responding to all of these challenges, the task force brought a high degree of rigour to the table's deliberations and enhanced immeasurably the quality of the final product.

In summary, the round table process provided constituents in the valley and Parks Canada with an example of an alternative approach to decision-making and public involvement. It provided a means whereby the task force was able to obtain and use the experience and expertise in the region. It also left a cadre of stakeholders experienced in the process of shared decision-making through open, disciplined, and civil debate. This will be valuable to Parks Canada now and in the future in helping to deal with the range of issues it faces. The overall contribution of the round table to the task force and to the future of Banff National Park justified fully the investment of resources and time by the participants and the task force, and met the need for a new approach to public consultation.

Role of Science in Decision-Making

The public process forced the task force to deal with one of the most thorny issues in the valley: the quality of scientific information and the role of science in decision-making. Any controversial decision-making process invites challenges to the scientific information used to support that decision. The task force took several steps to invite the public into the discussion of science and to engage them in the issue of quality assurance. As part of the *State of the Banff-Bow Valley* project (Pacas et al. 1996)—a comprehensive compilation of ecological, social, cultural, and economic information on the valley—interest sectors were invited to supply information as well as review and critique draft material. Wherever the quality of scientific information was questioned, critics were invited to explain the concerns and offer documented alternatives. This approach exposed unwarranted criticism, brought forward new information, and improved the quality of the final product. As a result, the *State of the Banff-Bow Valley* report provided a highly credible, level playing field of ecological and socio-economic information for the round table to use.

The task force used a scientific review committee (SRC) to conduct peer review of its work. In this case, round table sectors were invited to put forth names of accredited professionals in ecological, social, economic, and recreational fields for consideration in forming the SRC. This step assured a high degree of acceptance of the final committee. Scientists working on various ecological analyses presented and defended their findings to a joint sitting of the round table and the SRC. This afforded the round table the opportunity to participate in this review and to query the SRC as to the validity of the scientific information being presented. Combining external peer review with a public forum proved to be very useful for addressing scientific credibility.

These efforts, in combination, served to establish a common understanding and acceptance of the scientific information base. This allowed the round table to move

the discussion beyond the credibility of scientific information and on to the resolution of issues.

Conclusions

Three major conclusions can be drawn from the Banff-Bow Valley Study experience: (1) Effective public debate means using the full arsenal of public involvement techniques; (2) Public interest negotiation has an important place in public policy application; and (3) Combining independent peer review with a public participation forum can be effective in removing the debate over science.

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The Development of a Cooperative Climbing Management Plan at Stone Mountain State Park, North Carolina

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Introduction

In February 1997, the North Carolina Division of Parks and Recreation was approached by representatives of The Access Fund and the Carolina Climbers Coalition with a proposal to replace approximately 225 rock climbing anchors on the south face of Stone Mountain State Park in western North Carolina. Beginning in the 1960s, these anchors had been installed across 67 climbing routes by drilling and inserting expansion bolts into the rock face or by driving in pitons. Most of these anchors were over 20 years old, and many were home-made and of dubious reliability. This request coincided with the development by the division of a Systemwide climbing policy, and the resulting collaboration has led to a management policy and equipment replacement protocol that we feel can serve as a model for other land management agencies and climbing groups. This paper will briefly review: 1) climbing history and policy development in North Carolina's state parks; 2) the outcome of the Stone Mountain proposal; and 3) recommendations that we feel will prove useful to other agencies and user groups facing similar issues.

Climbing History and Policy Development

Technical rock climbing appeared in North Carolina in the 1940s, and the first routes on the nearly-700-foot-high granite dome at Stone Mountain were established in the early 1960s. The division recognized climbing as an accepted park activity under a little-utilized climbing policy in 1973, but it remained a lightly practiced sport through the 1970s, typified by crude equipment and limited technical knowledge. That began to change by around 1980, when the advent of reliable equipment, the growth of professional guide services, increased media exposure, and, most recently, the astounding proliferation of indoor climbing gyms combined to fuel an explosion in climbing's popularity (Attarian 1994). Estimates of active climbers in the United States today range from 250,000 to 500,000 (Kennedy 1991), and since the establishment of a voluntary registration system in the early 1990s, annual climbing numbers in the four North Carolina state parks that allow climbing are estimated conservatively at between 25,000 and 30,000. Approximately 25% of that use occurs at Stone Mountain.

Historically, it was the division's policy to take a completely hands-off approach to climbing management. This strategy was employed largely to escape legal liability by avoiding any direct management of such a clearly dangerous activity. The result was that climbers were free to do as they pleased, and there was virtually no staff presence in or knowledge of climbing areas. Consequently, climbing safety and resource damage went largely unaddressed, and climbing became one of the least regulated activities in the North Carolina state parks system.

However, by the early 1990s, park staff had begun to document greatly accelerated impacts to natural resources, including vegetation trampling and loss, erosion, wildlife disturbance, and damage resulting from the unregulated installation of permanent anchors. Safety and liability also became much more pressing issues. Since 1975, North Carolina state parks have averaged two climbing accidents per year requiring either rescue or evacuation. Since 1989, there have been three climbing fatalities and six fatal trip-and-fall accidents by non-climbers, including three such fatalities at Stone Mountain. As early as 1983, widely distributed climbing guide books were publishing warnings about suspected and confirmed dangerous anchors at Stone Mountain (Waddle 1983). In mid-1997, after a number of unpredictable an-

chor failures at other climbing areas, a nationwide warning was issued calling for the removal and replacement of a specific brand of expansion bolt, several examples of which were present at Stone Mountain (Leeper 1997).

In 1993, when the division embarked on the development of a new climbing policy, the resolution of liability and responsibility for permanent anchors was especially important, particularly at Stone Mountain, where climbers rely almost exclusively on permanent anchors for safety. It is important to note that in the USA today, there is probably no single more controversial recreational issue than the installation of permanent anchors. Land managers are increasingly reluctant, frequently with good reason, to continue the unregulated installation of anchors in areas that are, in many cases, nationally significant natural or cultural landmarks. And although the bonafide failure of modern climbing hardware is nearly unknown, numerous product liability lawsuits have been brought, largely unsuccessfully, by injured climbers. In this climate, anchor negotiations between many agencies and climbing groups have disintegrated into mean-spirited standoffs with neither side willing to concede any ground. Consequently, many agencies have completely banned anchor installations and closed entire climbing areas.

When we requested policy information from state and federal agencies across the country, we quickly discovered that there is a wide range of agency involvement. Generally, the national tendency is toward policies that place responsibility for anchor installation, maintenance, and liability exclusively on the climbing community. However, a number of states have developed memoranda of agreement or other simple cooperative programs that specify the conditions under which climbing groups may voluntarily replace fixed anchors. Others have developed technical review committees and permit programs staffed by volunteer climbers who scrutinize every individual route and anchor proposal.

We opted for what we considered to be a sensible middle ground stressing cooperation and education over intervention and regulation. We decided early in the process that if we were to avoid the confrontational quagmire that has engulfed many agencies, then seeking legal counsel and involving the climbing community from the beginning were essential steps. This led to a series of discussions and meetings in which both sides acknowledged that resource protection would take precedence over recreation, and agreed to a policy that would, among other things: 1) limit climbing to designated areas with the understanding that the division could further limit access in the event of a documented need for resource protection or visitor safety; 2) establish a written protocol and record-keeping system whereby existing anchors could be replaced by the climbing community on a voluntary basis; and 3) develop a sign system warning visitors about the presence of dangerous cliffs and notifying all climbers that any decisions regarding the placement, use, and maintenance of permanent anchors rest solely with the climbing community, not North Carolina state parks. Although this policy causes the division to more closely monitor climbing issues than has previously been the case, it still keeps the division at arm's length from the direct management and responsibility of permanent anchors. Aside from record-keeping, the division does not and will not under any circumstances supply, install, inspect, or certify the reliability of any anchor (see North Carolina Division of Parks and Recreation 1997).

Is this a perfect system in terms of liability? Frankly, no. However, complete insulation from liability is elusive, especially in states like North Carolina that do not have "recreational user" statutes granting state agencies and their employees complete immunity from injuries sustained within state parks (see Taladay 1994). However, it is the opinion of legal counsel for both the division and the coalition that identifying credible, highly skilled technical advisers, responding affirmatively to warnings about unsafe conditions, and warning visitors that they climb at their own risk were the most reasonable and prudent methods by which to minimize liability for both parties. It must also be noted that in the handful of injury cases that have

reached trial, the courts have consistently recognized climbing's inherent dangers and have just as consistently refused to hold land-owners liable (Taladay 1994).

Completion of the Stone Mountain Proposal

The division's climbing policy was adopted in August 1997, clearing the way for the Stone Mountain proposal to proceed. This project represented the first comprehensive anchor survey and replacement at Stone Mountain in over 20 years and was preceded by extensive consultations between division staff and representatives of the Carolina Climbers Coalition and The Access Fund. Anchor replacements began in December 1997, with a total of 59 routes eventually being retrofitted with approximately 250 new anchors. The coalition also installed seven new multi-anchor stations at various locations across the mountain to facilitate emergency escapes and technical rescues. All work was performed on a voluntary basis, with the coalition assuming complete responsibility for selecting and procuring all of the replacement anchor hardware.

The mountain's existing bolts and pitons were inventoried and, where deemed appropriate by coalition volunteers, were removed and replaced. Prior to this project, the permanent anchors on Stone Mountain's south face covered a wide variety of ages, styles, and reliability. Most were 1/4-inch or 3/8-inch diameter expansion bolts, and included home-made equipment, ordinary construction-grade hardware, and bent, missing, or cracked bolts and hangers. On those routes where anchors were replaced, the old anchors were either pried out, unscrewed and removed, or chopped off using a cold chisel. In many cases, the old hardware proved surprisingly resistant to removal; There were, however, numerous instances where old anchors broke off, cracked, or were removed with little exertion. Where possible, the old anchor holes were redrilled and used for the new anchors. In all other instances, the external hardware was removed and the hole was filled with a mixture of water-based ceramic tile grout and sand. The salvaged hardware was later incorporated by the coalition into an educational display and donated to the park.

All replacement anchors were stainless steel, 1/2-inch diameter Petzl Long Life bolts coupled to stainless steel Petzl hangers. The anchor shafts are approximately 2" long and, unlike many of the old anchors, they are a stronger product designed specifically for use in rock climbing. All belay and rappel stations were equipped with two Petzl bolts that had been coupled to Fixe ("fix-ee") stainless steel hangers equipped with permanently attached 3/8-inch diameter stainless steel rings. The rings have a tested strength of 10,000 pounds and, in addition to adding strength to the belay stations, are intended to facilitate rope retrievals and alleviate the trend toward home-made chain hangers and abandoned webbing slings tied to the anchor stations. All anchors were installed without the use of adhesive or caulk in or around the anchor hole.

The consistent use of stainless steel and the absence of moving parts, such as cap screws and threaded bolts, renders these anchors much less susceptible to corrosion and vandalism than older-style anchors. Given the quality of the rock surface at Stone Mountain and the high quality of these anchors, coalition volunteers believe that this system will have a useful life of perhaps 50 years. Through the use of standardized anchors, published route maps (see Kelley 1997), and publicity in the climbing press (Attarian and Carus 1998; Ellis 1998), we believe that climber cooperation and resource protection will be enhanced at Stone Mountain.

Lessons Learned and Recommendations

The Stone Mountain project represents the first time that the North Carolina state parks system has approved a cooperative project to systematically standardize and monitor the climbing hardware in a climbing area. This project's development and implementation were not, however, easily or quickly accomplished. Getting climbers and administrators to agree on anything is a lot like trying to herd cats, and several

times over the course of eleven months of negotiations, we very nearly failed. But having succeeded, we believe that this project proves that management agencies and climbers can, in fact, reach common ground on controversial recreation and resource protection issues. In a time when park bashing is much in vogue, particularly by narrow-minded critics who believe themselves to be exempt from any sort of regulation, it is important to note that this project succeeded in no small measure because the coalition's representatives were unfailingly courteous and patient. The division gained an acceptable level of legal and resource protection, the climbers got continued access and a safer venue, and in the end, everyone got what they wanted. Ask yourself: how often does this happen in resource management? I'll tell you how often: hardly ever, that's how often.

In closing, then, here are several recommendations on how to successfully avoid confrontations and authoritarian decisions (see also Ellis 1998):

- Cultivate a cordial, long-term relationship with the climbing community that acknowledges their recreational needs while emphasizing the park's need for resource protection. If climbers expect a place at the table, then they must be made to understand that no park's resources are unlimited.
- Identify skilled, experienced technical climbing advisers with a track record for environmental awareness. Credible climbing organizations with representatives across the country include The Access Fund, the American Mountain Guides Association, the American Alpine Club, and Outward Bound of America.
- Get a lawyer and do your homework, particularly regarding liability.
- Understand fully the realities of the climbing impacts in your park or preserve. Few things work better than a compelling, air-tight case. Nothing, however, will sap your credibility as thoroughly as authoritarian decisions that are based on perceptions instead of data.
- Have faith. Like most projects involving complex issues, this will likely be neither easy nor quick. But once established, it can pay great dividends. The Stone Mountain model has transferred easily to our other climbing parks, with a second park having been retrofitted in October 1998. A third project is scheduled for April and May of 1999, and the last park is scheduled for refitting in 2000.

Finally, we agree with Attarian (1994) that long-term cooperation between land managers and climbers is essential in order to successfully accommodate both sides. Climber education, cooperation, and self-regulation are important, practical options that can be employed to address safety and resource management issues. Unless warranted by clearly pivotal issues of resource protection or visitor safety that cannot be resolved through negotiation and education, then management decisions that impose severe or arbitrary restrictions or regulations should be considered only as a last resort.

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Identification and Management of Visitor Impact Problems within Protected Areas in Costa Rica and Belize

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Introduction

Nature-based travel and tourism are increasing in popularity, with increasing numbers of tourists from developed countries visiting developing-country protected areas (Ceballos-Lascurain 1996). Visitor activities within protected areas contribute to natural resource impacts and may result in such social or experiential impacts as crowding and conflict. For example, hiking and camping may result in trail or site proliferation and degradation. Wildlife viewing may result in disturbance and displacement from critical habitats, or the creation of "nuisance" animals through feeding. Snorkeling, diving, and motorboat use may contribute to coral reef damage and water pollution. Inappropriate visitor behaviors, such as littering, graffiti, vandalism, and illegal collection of flora and fauna, may also occur (Liddle 1997; Hammit and Cole 1998; Marion and Farrell 1998).

A variety of strategies and actions are available for protected area managers to mitigate these impacts, including reducing use of the entire protected area or of problem areas, modifying the location or timing of use, modifying the type of use and visitor behavior, modifying visitor expectations, increasing the physical resistance of the resource, and maintaining or rehabilitating the resource (Table 1).

This paper presents case study research from eight protected areas in Belize and Costa Rica designed to characterize the types of visitor impacts that are occurring, evaluate these impacts within the broader context of protected area management, and compare actual or potential impact management strategies.

Study Area

The protected areas in these case studies represent one of three stages of development and visitation. *Undiscovered* protected areas have limited visitation, lack extensive visitor facility development, and are minimally staffed. The Community Baboon Sanctuary in Belize protects 3,000 ha of howler monkey habitat based on voluntary agreements with local landowners from eight villages (Mahler and Watkins 1997). The sanctuary has a small visitor center staffed by two employees, one of which guides tourist groups, maintains trails, and manages the sanctuary. Braulio Carrillo National Park in Costa Rica is the country's largest, protecting 46,000 ha of rainforests, mountains, and waterfalls (Universidad de Costa Rica 1994). However, facilities are limited to a small visitor center and a few trails, and visitation, largely by residents, is essentially restricted to a few paved roads.

Newly discovered protected areas include Altun Ha and the Hol Chan Marine Reserve in Belize and Tortuguero National Park in Costa Rica. Characteristics include recent, rapid increases in visitation that currently exceed levels of facility development and management capabilities. Altun Ha is Belize's most accessible Mayan ruin, located only 50 km north of Belize City. Visitation, 18,200 tourists in 1997, has tripled since 1992 (BTB 1997). Several busloads of tourists often arrive simultaneously, with as many as 200 per group, overwhelming the manager who is the only permanent staff. The Hol Chan Marine Reserve protects the second largest barrier reef in the world, attracting 41,622 annual visitors in 1997, an increase from 33,630 in 1992 (BTB 1997). In spite of such visitation, only one ranger patrols the reserve. Tortuguero National Park has fewer annual visitors (18,946 in 1997), but a vast majority of that visitation is concentrated into the months of July and August, when tourists arrive to witness sea turtles laying eggs. Tourist groups must be accompanied by guides, who are certified annually, and purchase daily permits for each tour group.

The Monteverde Cloud Forest Reserve, Manuel Antonio National Park and Volcan

Table 1. Strategies and tactics for managing visitor-related natural resource and experiential impacts (adapted from Cole et al. 1987)

I. Reduce use of the entire area

- Limit number of visitors in the entire area
- Limit length of stay in the entire area
- Encourage use of other areas
- Require certain skills and/or equipment
- Charge a flat visitor fee
- Make access more difficult throughout the entire area

II. Reduce use of problem areas

- Inform potential visitors of the disadvantages of problem areas and/or advantages of alternative areas
- Discourage or prohibit use of problem areas
- Limit number of visitors in problem areas
- Encourage or require a length-of-stay limit in problem areas
- Make access to problem areas more difficult and/or improve access to alternative areas
- Eliminate facilities or attractions in problem areas and/or improve facilities or attractions in alternative areas
- Encourage off-trail travel
- Establish differential skill and/or equipment requirements
- Charge differential visitor fees

III. Modify location of use within problem areas

- Discourage or prohibit camping and/or stock use at certain campsites and/or locations
- Encourage or permit camping and/or stock use only at certain campsites and/or locations
- Locate facilities at durable sites
- Concentrate use at sites through facility design and/or information
- Discourage or prohibit off-trail travel
- Segregate different types of visitors

IV. Modify timing of use

- Encourage use outside of peak use periods
- Discourage or prohibit use when impact potential is high
- Charge fees during periods of high use and/or high-impact potential

V. Modify type of use and visitor behavior

- Discourage or prohibit particularly damaging practices and/or equipment
- Encourage or require certain behavior, skills and/or equipment
- Teach a wilderness ethic
- Encourage or require a party size and/or stock limit
- Discourage or prohibit stock, pets, or overnight use
- Encourage or require the use of guides

VI. Modify visitor expectations

- Inform visitors about appropriate uses and conditions they may encounter
- Require the use of guides

VII. Increase physical resistance of the resource

- Harden the site using gravel, boardwalks, or by providing other resistant surfaces
- Provide facilities that shield the site from impacts

VII. Maintain or rehabilitate the resource

- Remove problems
- Maintain or rehabilitate impacted locations

Poas National Park in Costa Rica represent *established* protected areas. Characteristics include extensive visitor facility development, interpretation and education programs, and intensive staffing and management. Monteverde is privately owned and protects 10,522 ha of cloudforest. Visitation is approximately 50,000, though the trip requires a lengthy ride up a windy, mountainous graveled road (MCFR, unpublished data 1998). Guides are trained by the reserve and are fluent in English and Spanish. Manuel Antonio is one of the more popular Costa Rican parks with 114,922 annual visitors in 1997 (ACPC, unpublished data 1997). Visitors come to see coastal forests, wildlife and beaches, and participate in hiking, sunbathing, and surfing. Volcan Poas National Park is the most heavily visited (215,930 annual visitors), accessible (55 km from San Jose) and developed (visitor center, souvenir shop, and auditorium) Costa Rican National Park (ACCVC, unpublished data 1997). This park protects 5,600 ha of volcanic craters and dwarf cloudforest.

Methods

Visits of one or two days were made to each protected area during August 1998. Research methods included interviews, resource condition assessments, and observations. Ten semi-structured interviews were conducted with managing agency and protected area representatives to provide background information on visitor impacts, identify management contexts, and consider the applicability of visitor impact management strategies. Interviewees also described the relative success of impact management strategies using the list presented in Table 1. We assessed resource conditions on trails and recreation sites using condition class and photographic systems, multi-indicator site condition assessment, and point sampling and problem assessment methods for trails (methods are further described in Leung and Marion 1999; Cole 1983; Cole 1989; Marion 1991). Observations were also recorded of wildlife and other impacts that were difficult to characterize due to the short duration of site visits.

Results and Discussion

Visitor impacts and management contexts: undiscovered protected areas. Undiscovered protected areas have the luxury of low visitation and therefore may be considered to experience minimal visitor impacts. However, the amount of use is only one factor contributing to resource impacts (Cole 1987; Kuss et al. 1990). For example, studies have indicated that trail location and design are more important determinants of certain trail impacts (Cole 1983; Leung and Marion 1996). We recorded excessive trail erosion, exposed roots on trails, multiple trails, and muddy soil on trails at both protected areas. Visitor and guide behaviors also contributed to impacts. For example, we observed a tour guide and tourists feeding howler monkeys and inducing their calling at the Community Baboon Sanctuary.

Although neither protected area actively manages visitor activities, certain design elements and maintenance actions may be helping to prevent resource impacts. For example, the Community Baboon Sanctuary has concentrated visitor use on one short trail system, though the resident troop of howler monkeys may be adversely affected by the constant, heavy visitor contact. Similarly, Braulio Carrillo trail maintenance staff have reinforced some of the trails with gravel and other resource-shielding materials. Constraints hindering efforts to manage visitor impacts include severely limited funding and staff, insufficient attention from managing agencies, and internal strife between protected area managers and agency administration.

Newly discovered protected areas. Managers of newly discovered protected areas face the greatest management challenges. These areas typically lack sufficient funding and attention from managing agencies since they are less popular. Furthermore, their rapidly escalating use often exceeds facility and staffing capacities, and inadequate resource protection measures increase their vulnerability to visitor-related impacts.

Many resource impacts may be avoided or minimized if visitors use low-impact practices. However, visitor information and education efforts are minimal. For example,

our observations suggested that coral reef damage at Hol Chan Marine Reserve can be largely attributed to inexperienced and uninformed snorkelers and divers. We witnessed individuals standing on or inadvertently bumping into coral, and stirring up sediments. Tour group leaders are currently required to deliver minimum-impact messages to tour groups, though compliance is not assured. Similarly, at Altun Ha visitors have created numerous steep and sometimes eroding trails to access the tops of ruin buildings. According to the manager, some visitors also collect artifacts, vandalize the ruins, litter, and camp illegally. *In his opinion, the inability of park staff to provide visitor information may cause some tourists to lack respect for the ruins.*

Law enforcement is needed for those tour guides and visitors who knowingly break the rules. Staff in both protected areas are too few in number and lack the authority to effectively control visitor and tour operator activities and behaviors. For example, the manager at Altun Ha cannot write tickets or otherwise enforce rule violations. Similarly, tour guides visiting Hol Chan apparently know where the ranger is patrolling, and therefore can easily avoid those areas.

Newly discovered protected areas also often lack the site facilities necessary to shield or harden locations that receive intensive visitor use. Visitor facilities at Hol Chan were limited to the provision of buoys, to eliminate substrate damage from repeated anchoring. Use of visitor-created paths at Altun Ha has been somewhat reduced by the recent path construction on some ruins.

Established protected areas. Established protected areas have the greatest access to financial, technical, and other planning and management resources. These areas typically receive substantial grants and they often have management plans and trained natural resource management and maintenance staff. Therefore, managers can more effectively minimize visitor-related impacts. For example, the use of trail reinforcement and hardening materials has resulted in minimal occurrences of excessive trail width, erosion and exposed roots. We also recorded very few impacts at recreation sites for similar reasons. According to an interview subject, established protected areas are able to invest in facility development and maintenance programs because tourism is self-sustaining, generating revenue to pay for visitor impact management. They also are able to invest in environmental education programs for local residents and visitors, and in guide training and certification programs. Surprisingly, little printed information such as pamphlets or brochures are available. Management problems are typically related to higher volumes of use, such as visitor safety, crime, and crowding and conflict. Littering, illegal hunting and fishing, flora and fauna collection, and vandalism also occur. Managers also reported instances of inappropriate or uninformed behaviors, such as wildlife feeding and disturbance.

Management Strategies

Effective visitor-impact management requires managers to identify the types of impact occurring, interpret their significance within the overall management context, and understand underlying causes and influential factors in order to select appropriate management strategies.

First, consider crowding and conflict. One option is to limit the number of visitors to the protected area (Strategy I in Table 1). This "carrying capacity" approach has been adopted at Manuel Antonio, Monteverde, and Volcan Poas based on administrative capacities, such as number of staff. However, reducing use of problem areas (Strategy II) is a more effective means of addressing experiential impacts since they typically occur in specific locations within protected areas. For example, Monteverde currently limits the numbers of tour groups and tour group sizes for each trail (Strategies II and V).

Another option available to managers is to construct additional facilities or alter zoning strategies to better accommodate use (Strategy II). However, some protected areas are constrained by terrain features, or by funding, thus precluding facility development. Also, adding facilities to accommodate additional use may be undesirable. Modifying the location (Strategy III), timing (Strategy IV), or type (Strategy V) of use and

visitor behavior are other effective strategies. For example, at Tortuguero managers have restricted visitors to a small portion of the sea turtle nesting beach and to two-hour time periods. Visitors must also be accompanied by trained and certified guides. Additionally, Volcan Poas and Monteverde have sought to modify expectations by telling visitors about crowded conditions and likely waiting times (Strategy VI).

Second, consider wildlife feeding and disturbance. One option is to discourage or prohibit use of critical wildlife habitat areas (Strategy II). For example, most protected areas have designated specific resource protection zones, prohibiting tourism use. Alternatively, use could be restricted to certain time periods, as in the Tortuguero example (Strategy IV). Alternatively, modifying visitor and tour guide behaviors (Strategy V) permits wildlife observation while simultaneously addressing inappropriate behaviors as the primary cause of impact. It is therefore critical that guides exemplify and encourage appropriate behaviors for tourists. For example, the guide at the Community Baboon Sanctuary supplied tourists with cashew fruit to feed the howlers and even taught the group to imitate the howler call, setting a poor example for visitors. Providing incentives or enacting penalties help to encourage tourist and tour guide compliance with rules and regulations.

Third, consider such inappropriate visitor behaviors as littering, vandalism, graffiti, and artifact collection. These impacts are also best managed by changing visitor behaviors (Strategy V). For example, Volcan Poas and Monteverde have developed extensive interpretation programs and rely on well-trained guides and local naturalist volunteers to answer visitor questions and monitor visitor behavior. However, the effectiveness of interpretive information and materials is sometimes low. Signs posted at Altun Ha requesting that visitors carry out their litter have not prevented littering. Placement of additional trash receptacles and a greater staff presence may be required. Another feasible alternative is to remove the problems, as through Volcan Poas and Monteverde's recycling programs (Strategy VIII).

Fourth, consider trail or site proliferation. One of the best options is to concentrate and channel use (Strategy III). For example, trail proliferation had been a serious problem at Manuel Antonio until rope borders were installed along the main access trail, effectively containing visitor traffic. Other potential management actions include prohibiting off-trail and off-site travel, or modifying visitor behaviors (Strategies III and V). For example, use of established trails at Altun Ha could be encouraged by marking their location to make sure that visitors are aware that they exist. Undesired trails could then be closed and rehabilitated (Strategy VIII).

Fifth, consider trail and site degradation. One of the most desirable options is modifying the location of use (Strategy III). For example, trails and sites at Manuel Antonio are located on sand, which is highly durable and resistant to impact, thereby minimizing maintenance costs. Alternatively, poorly located sites and trails can be relocated. However, choosing alternate site or trail locations may not be possible (e.g., in attraction feature areas). Therefore, increasing the resistance of the resource is another option, commonly applied in the more developed protected areas (Strategy VII). All of the protected areas have used site and trail shielding and strengthening materials to varying degrees, including cement lattice blocks, poured cement treads, gravel, and rot-resistant wood planking. Shielding materials enhance resource protection, and provide visitor convenience and safety. Some degree of maintenance and rehabilitation typically also needs to occur (Strategy VIII). Sites and trails in advanced stages of degradation may even need to be closed. For example, campsites at Manuel Antonio were closed after large areas experienced a complete loss of vegetation.

Conclusion

This study investigated visitor impacts and their management for eight protected areas in Costa Rica and Belize using interviews, condition assessments and observations. The areas selected represented a broad spectrum of environmental characteristics, visitation, development, access, and management intensity. Impacts occurring in undiscovered

protected areas included trail degradation and wildlife feeding. Newly discovered protected areas experienced trail degradation, wildlife feeding and harassment, and coral damage. Social or experiential impacts occurred in established protected areas. Other impacts reported by managers included littering, vandalism, graffiti, and illegal collection of flora and fauna. Inappropriate or uninformed visitor and tour guide behaviors contributed to a variety of impacts, though potential strategies to minimize these impacts, such as teaching minimum-impact practices, are not commonly employed. Managers tended to favor more restrictive management strategies such as limiting use and requiring the use of guides.

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Understanding the Visitors' Experience at Fort Sumter National Monument

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Conceptual Background

Visitor satisfaction, a central concept in tourism research and management, has been defined as a positive evaluation of a tourism experience. Previous research has demonstrated that, in general, visitor satisfaction is a function of both expectations related to certain important attributes and evaluative judgements about destination visits and travel to destination settings (Driver and Tocher 1970; Crompton 1979; Dunn and Iso-Ahola 1991). A major shortcoming of much of this research is the failure to generate information on how tour visitors evaluate specific destination facility, service and program attributes. Previous research has emphasized visitor ratings of an overall tour experience. However, measures of overall satisfaction tend to be inadequate indicators of the extent to which tourists enjoy their visits (Ingham 1986; Mannell and Iso-Ahola 1987). Such measures lack specificity with regard to visitor evaluations of tourism facility, service, and program attributes. From a managerial perspective, identifying the specific conditions leading to a positive or negative evaluation (i.e., satisfaction or dissatisfaction) is more useful.

During the destination engagement, tourists perceive certain conditions pertaining to specific facility, service, and program attributes, as well as problems or conflicts. It is during this stage of the tourism engagement that a visitor has the opportunity to make evaluative judgments (Iso-Ahola 1989). The visitor goes through an evaluative process by comparing expected, preferred, and perceived conditions (related to specific facility, service, and program attributes and perceived conflict). The outcome of this process is a satisfaction response (Manning 1986). The response has two primary components—a behavior response and an attitudinal response. The behavioral response focuses on future visitation, which may include displacement, substitution, and adaptation. The attitudinal response is more evaluative and focuses on visitation satisfaction; that is, overall satisfaction as well as satisfaction with specific attributes.

Methods

All initial sampling of Fort Sumter tourists occurred while on the boat to the island. Tourists were briefly intercepted to obtain their permission to participate in a mail-survey study. The on-site sampling was conducted by NPS personnel and volunteers during the first three weeks of August 1995. Nearly 500 visitors were intercepted during their tours and asked to volunteer their participation in the study. After completing a half-page interview form, a systematic, random sample of 393 visitors was mailed a ten-page, return-addressed, postage-paid mail questionnaire by researchers at Clemson University. Information obtained through the mail questionnaire included: visitor characteristics; past experience; reasons for visit; expectations, preferences, perceptions, and satisfaction of specific facility, service, and program attributes; conditions encountered during visit and conflicts experienced; and visitor support or opposition for proposed changes. Of the 393 individuals to whom questionnaires were mailed, 261 returned completed surveys—a 66% response rate. A four-step modified Dillman (1978) mailing procedure was used to obtain the response rate.

Results and Discussion

Tourist profile. The majority of survey respondents were male (58%). The average age of tourists was 44.5 years, with the largest percentage in the 41-to-60-year range. About 16% were senior citizens over 60 years of age. Almost all (98%) respondents were white. Two-thirds reported that they were employed full-time, and

about 15% were retired. Most respondents were employed in executive (20%), administrative (14%), clerical/sales (15%), and other business (11%) positions. The tourists were highly educated, with approximately 78% having some level of college education. Accordingly, incomes were also fairly high. Over a quarter of visitors had household annual incomes of over \$75,000 and 62% had incomes of \$50,000 or more. About 75% of visitors to the fort stayed overnight in the local area of Charleston-Mt. Pleasant, South Carolina. Over three-fourths of them came as a family group, with 14% having children under six years of age and 30% having children 6-11 years of age. At the other extreme, nearly a quarter of family-group members were 60 or more years of age.

Information sources about tours. Information concerning a tour, the destination, and proper use of site resources are a necessary component of heritage and coastal tourism management. The source of the information that tourists receive and the importance of various information sources is significant to tourism personnel, for information outlets can be an important tool for tourism management. In light of this, visitors were asked to indicate the importance of various sources in providing information about Fort Sumter. The information sources important to at least 50% of Fort Sumter tourists were: guidebook (75% identifying it as important), rack cards found in welcome centers and hotel lobbies (61.0%), tour guides (53.2%), and friends and relatives (49.2%). Magazines were also fairly important as an information source (42.9%).

Reasons for visiting Fort Sumter. Visitors are motivated to visit heritage tour sites for various reasons. These reasons are commonly related to the anticipations and expectations of visitors concerning destination visits. An indication of the importance of reasons for touring a site, and a hint of the anticipations and expectations of visitors for the destination can be an important insight for the development of heritage-tourism management plans.

Two reasons for visiting were rated extremely important by about 40% of visitors: to visit a site of cultural-historical significance, and to learn more about American history (Table 1). If the "very important" and "extremely important" categories are combined, four reasons were rated very-to-extremely important by more than 80%: to visit a site of cultural-historical significance (90.2%), to see historic objects (88.6%), to visit a Civil War site (88.4%), and to learn more about American history (87.4%). Thus, history-based reasons are the most important. Reasons somewhat important to at least one-third of respondents included: to learn more about Low Country culture and daily life in the past, to view Charleston Harbor, and to ride on a boat. Two items were clearly not important, perhaps because they did not apply to the participants in this survey: to attend a school field trip and to complete a course requirement.

Factors affecting arrival at Fort Sumter. Travel to, arrival at, and accessibility of coastal historic sites are an important element of heritage tours and tourism management. Not being able to locate the destination or getting temporarily lost reaching the tour site are frustrating experiences for visitors. Thus, the quality of directional highway signs, the availability of parking, the walking distance to the site, and information and interpretive services become important components of heritage tour management, even before the visitor ever arrives.

Table 2 reports visitor reaction to the quality of some these factors. Elements of most concern (rated poor-to-fair) were: availability of shelter from the weather before boarding boat (44.6%), directional signs from interstate highways to local streets (29.7%), and directional signs from local streets to parking areas (23.0%). However, only the first item received any considerable proportion of visitors rating it as "poor" (16.6%). For example, over 70% of visitors rated the directional highway signs as good-to-excellent. Parking and walking distances seemed to be no problem at all.

Table 1. Reasons for visiting Fort Sumter (n = 186)

<i>Reasons</i>	Not important (%)	Somewhat important (%)	Very important (%)	Extremely important (%)	Uncertain (%)
To visit a site of cultural and historical significance	0.5	8.8	47.9	42.3	0.5
To see historic objects	0	11.4	49.7	38.9	0
To view Charleston Harbor	6.8	36.8	44.3	12.1	0
To take or accompany the family on an outing	12.6	17.9	42.6	23.2	3.7
To ride on a boat	33.5	36.7	24.5	4.8	0.5
To visit a Civil War site	0.6	11.0	51.8	36.6	0
To visit a national park site	13.1	28.8	44.5	13.1	0.5
To learn more about American military history	2.1	21.5	42.9	33.5	0
To learn more about Low Country culture and daily life in the past	13.6	38.2	33.0	13.1	2.1
To learn more about American history	0	12.6	46.0	41.4	0
To complete a course requirement	85.2	3.7	3.1	8.0	0
To attend a school field trip	86.5	1.3	2.6	0.6	9.0

Table 2. Quality of factors related to reaching the Fort Sumter general area (n = 180)

<i>Factors</i>	<i>Percentage of respondents selecting each factor (%)</i>			
	Poor	Fair	Good	Excellent
Directional highway signs from interstates to local streets	7.4	22.3	56.0	14.3
Directional highway signs from local streets to parking areas	6.3	17.0	58.0	18.7
Availability of parking at tour boat terminal	8.7	8.7	44.0	38.6
Walking distance from car to the ticket area	1.1	8.3	58.9	31.7
Walking distance from the ticket area to the boat	1.1	6.9	51.3	40.7
Availability of shelter from the weather before boarding boat	16.6	28.0	34.8	20.6
Availability of interpretive services at the ticketing area (park brochures, information bulletins, maps, etc.)	2.2	13.8	55.8	28.2

Services and conditions concerning the boat tour. Visitors were asked to indicate their level of enjoyment of some selected services and conditions connected with their boat tour to Fort Sumter (Table 3). Those aspects enjoyed very much were: learning the geography of the harbor (78.9%), the boat ride to and from the Fort (74.6%), and the boat's audio tape about the history of Charleston Harbor and Fort Sumter (67.9%). About a third of visitors indicated they enjoyed very much the first mate's interpretation on the boat tour, and getting on and off the boat. The number of visitors (i.e., crowding) on the boat was not enjoyed by 5.4% of visitors, and 5.2% did not enjoy getting on and off the boat. Several items were not applicable or items for which visitors had no opinion.

Table 3 . Services and conditions on boat tour to Fort Sumter (n = 188)

<i>Conditions</i>	<i>Effect on experience (%)</i>				
	Did not enjoy	Enjoyed somewhat	Enjoyed very much	No opinion	Not applicable
The boat ride to Fort Sumter and back	0	22.8	74.6	2.1	0.5
Learning the geography of the harbor	0	15.8	78.9	3.7	1.6
The boat's audio tape about the history of Charleston Harbor and Fort Sumter	4.3	23.0	67.9	2.1	2.7
The first mate's interpretation services on the tour boat	1.6	28.5	34.9	16.2	18.8
The food on the boat	4.8	10.0	4.3	33.0	47.9
The number of visitors on the boat	5.4	24.9	23.2	38.4	8.1
The number of organized tour groups (school groups, etc.) on the boat	0.5	2.7	4.8	41.2	50.8
Getting on and off the boat	5.2	33.5	35.6	23.6	2.1

Conditions affecting Fort Sumter visits. The conditions of the facilities, services, and programs at Fort Sumter can affect the experience of tour visitors. Historical resource managers need to know the influence of various site conditions on the enjoyment of visitors to better manage both site resources and heritage tour visits. Visitors were asked to indicate how some specific site conditions affected the enjoyment of their tour to Fort Sumter.

Table 4 lists the conditions evaluated and their effect on tourist enjoyment. Six conditions were enjoyed very much by 80% or more of visitors: the view from Battery Huger (86.4%), the walking tour at Fort Sumter (84.5%), the organization or layout of the museum (81.4%), having park rangers available to answer questions (81.4%), reading information provided by the outdoor exhibits (80.9%), and the display of flags on top of Battery Huger (79.2%). The viewing of museum exhibits at

Fort Sumter was “enjoyed somewhat” by 90.7% of visitors. No condition was indicated as not being enjoyed by very many respondents, except “having [only] one hour to spend at the Fort” (28.0%).

Table 4. Effect of conditions at Fort Sumter on respondents’ visit (n = 191)

<i>Conditions</i>	<i>Effect on Fort Sumter visit (%)</i>				
	Did not enjoy	Enjoyed somewhat	Enjoyed very much	No opinion	Not applicable
Having park rangers available to answer questions	1.0	13.4	81.4	2.6	1.6
Having ranger-led talks	3.2	12.8	70.7	6.4	6.9
Reading information provided by the outdoor exhibits	0.5	16.5	80.9	2.1	0
The museum shop selection of books on Civil War and Charleston history	2.6	33.7	49.7	10.4	3.6
The park brochures and information handouts	1.0	25.7	66.5	4.7	2.1
The number of organized tour groups (school groups, etc.) at the fort	0.5	4.8	3.2	39.7	51.8
The number of other visitors at the fort	2.1	20.3	25.7	43.9	8.0
Viewing the museum exhibits	7.3	90.7	1.0	1.0	0
The organization or layout of the museum	0.5	14.0	81.4	3.1	1.0
Viewing the silent video in the museum	2.1	15.8	36.3	19.5	26.3
Walking around at Fort Sumter	3.6	11.4	84.5	0.5	0
Climbing to the top of Battery Huger	2.6	19.0	72.7	3.6	2.1
The view from Battery Huger	0.5	9.9	86.4	1.6	1.6
Having one hour to spend at the fort	28.0	21.5	47.8	2.7	0
Having to wait to use the restroom	5.8	2.6	5.3	33.9	52.4
The number of stairs or steps at the fort	6.5	16.2	16.2	55.2	5.9
The display of mounted and unmounted cannon	1.5	19.1	75.3	4.1	0
The display of flags on top of Battery Huger	1.5	11.5	79.2	6.3	1.5

Management actions at Fort Sumter. An important component of tourism site management is the implementation of management actions and the public's degree of support of or opposition to them. Table 5 contains some possible management actions and the degree of visitor agreement with them. Four actions strongly favored by a significant portion of tourists were: providing a ferry system to and from Fort Sumter that allows visitors more flexibility in their length of stay (55.0%), continuing departures of tour boats from both marina sites (52.8%), having more time to spend at the fort (48.2%), and having park rangers available on the tour boat to present a history talk and to answer questions (45.5%). About 30% of visitors also strongly favored having exhibits and other information at the boat ticketing-loading areas. The management actions receiving the least degree of support (i.e., strongly disagreed with) were: moving the Fort Sumter museum exhibits to the boat ticketing-loading areas (46.0%), providing tour boat services only from the city of Charleston (40.3%), and providing tour boat services only from Patriot's Point in Mt. Pleasant (39.7%). A good proportion of visitors were neutral concerning two of the management actions: limiting the size of organized groups (42.0%) and increasing the number of visitors to Fort Sumter (38.8%). Thus, visitors were fairly undecided on visitation capacities, as an additional 15% indicated they didn't know concerning the above two items.

Quality of the Fort Sumter tour. Heritage tour managers are interested in the quality of the physical and historical resources they manage, and the quality of tourism and educational visits. Visitors were asked to indicate an overall quality rating for their tour, and, secondly, to list various attributes as to why they felt the way they did about the overall quality of their tour. This second portion of the question was an open-ended response, meaning respondents were asked to volunteer if there "was anything in particular that made you feel this way?" about the tour.

Overall quality of the Fort Sumter tour. Nearly one-quarter (26.6%) indicated their tour was excellent, while another one-half (49.5%) said the visit was very good. Thus, over three-quarters of visitors rated their tour very high in quality. Of the remaining visitors, 18.8% had a good visit and 3.6% had a fair tour. Only 1.5% indicated they had a poor or unacceptable tour to the fort.

Attributes underlying the quality ratings. The open-ended responses to this question were categorized into some common content or attribute domains and the number of positive and negative respondents for each attribute tallied. Because most of the visitors had a high-quality tour to Fort Sumter, most of the open-ended comments were of a positive nature. The positive attributes mentioned most often as influencing the quality of tours were: the service of park rangers (57 respondents), the interpretation program (27), the history of the site (19), and the maintenance of the site (19). Fourteen (14) respondents cited the boat ride as a positive attribute. While most of the comments were positive, visitors did mention some negative aspects to their visits. The two negative aspects cited most often were the tour time being too short (18 respondents) and the weather being too hot (16 people).

Summary and Conclusions

- The results best describe late-summer visitors to Fort Sumter.
- About 15% more visitors depart from Patriot's Point than from Charleston Marina.
- Nearly 8 of every 10 visitors to the fort are first-time visitors.
- Visitors have little past experience with the fort over the last five years.
- The quality of visits are rated very good or excellent. Hot weather and the short length of Fort Sumter tours are the only negative aspects.
- Highway directional signs and shelter from the weather before boarding the boat need some attention by management.
- Nearly 30% of visitors want more than a one-hour tour of Fort Sumter.
- Visitors want more flexibility in the ferry system and length of stay at the fort.

Table 5. Support for possible management actions at Fort Sumter (n = 189)

<i>Management Actions</i>	<i>Degree of support (%)</i>					
	Strongly disagree	Somewhat disagree	Neutral	Somewhat favor	Strongly favor	Don't know
Having more time to spend at Fort Sumter	1.5	6.8	26.2	17.3	48.2	0
Having exhibits to view at the boat ticketing-loading areas	1.6	4.8	22.2	38.6	31.2	1.6
Having park rangers available on the tour boat to present a history talk and to answer questions	3.2	2.6	19.6	28.6	45.5	0.5
Providing tour boat services only from the city of Charleston	40.3	14.2	23.0	2.6	2.1	17.8
Providing tour boat services only from Patriot's Point in Mount Pleasant	39.7	18.0	24.3	1.6	2.1	14.3
Continuing departures of tour boats from both sites (Charleston and Mount Pleasant)	0.5	0.5	15.7	21.6	52.8	8.9
Providing a ferry system to and from Fort Sumter that allows visitors more flexibility in their length of stay at the fort	2.6	3.2	11.6	26.5	55.0	1.1
Moving the Fort Sumter museum exhibits to the boat ticketing/loading areas	46.0	28.5	13.8	3.2	3.2	5.3
Limiting the size of organized groups to Fort Sumter	5.4	6.4	42.0	19.1	11.7	15.4
Increasing the number of visitors allowed to Fort Sumter	13.8	20.7	38.8	6.9	3.8	16.0
Providing additional information about the park through exhibits, brochures, or other means at the boat ticketing-loading areas	0	5.3	26.8	37.4	26.8	3.7

- The major reasons for visiting are related to Civil War history.
- Guidebooks, rack cards in information centers, and friends and relatives are the main sources of tour information.
- Fort Sumter is not the primary destination of most summer visitors.
- Three out of every four visitors to Fort Sumter stay overnight in the Charleston–Mt. Pleasant area.
- Most visitors are family groups; another one-quarter are senior citizens.
- The average visitor is about 45 years of age, nearly all are white, and two of every three are employed full-time. Most are highly educated professionals, with over three-fourths having some college education. Incomes are high by national standards, with over 60% having household incomes of \$50,000 or more.
- Fort Sumter functions as a regional destination, as over 60% of the visitors come from North and South Carolina and surrounding states in the southeastern USA.

Acknowledgment

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The NPS Visitor Survey Card: First-Year Survey and Implications for Park Management

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Customer Service in the National Park Service

The National Park Service (NPS) Organic Act of 1916 requires the secretary of the interior to manage national parks to provide for public enjoyment, while ensuring that the parks are left "unimpaired for the enjoyment of future generations." Leaders such as Stephen Mather and Horace Albright worked to keep this mission statement at the forefront of the agency's efforts. As a result, a tradition of willingness to serve the public is firmly engrained in the agency culture. Customer satisfaction is of extreme importance to the NPS.

The NPS and customer evaluation. An accurate understanding of the relationship between people and parks is critical to both protecting resources unimpaired and providing for public enjoyment. Towards this end, an NPS social science research program was established in 1996. This program includes a Social Science Plan for furthering social science in the NPS (Machlis 1996). The plan contains a number of research projects which include the measurement of customer service. The Visitor Services Project (VSP) conducts visitor surveys and customer service evaluations for the NPS. Parks, park clusters, and field areas also contract for visitor studies. NPS technical assistance programs are developing evaluation instruments for use with their client organizations and communities. In addition, the NPS has carefully monitored visitor satisfaction with the Recreational Fee Demonstration Program. Results from these types of research projects are being used by NPS managers to improve visitor services, protect resources, and make the agency more efficient and cost-effective.

In 1993, Congress passed the Government Performance and Results Act (GPRA) which directs federal agencies to join the "performance management revolution." For the past several years, the NPS has been working to implement GPRA, to make it "fit" the agency and mission, and to make it useful. As mandated by GPRA, the NPS has developed Servicewide standards for a broad range of key performance measures, including both annual and long-range goals. One of these goals involves the annual measurement of visitor satisfaction in units of the National Park System.

The Visitor Survey Card Project

A standardized GPRA survey. In 1995, the University of Idaho Cooperative Park Studies Unit (CPSU) developed a pilot visitor satisfaction survey for potential use by the NPS and the U.S. Fish and Wildlife Service (USFWS). A research effort was conducted to investigate outstanding private-sector customer satisfaction programs. This information was used to develop a standardized visitor satisfaction survey which was successfully tested in a number of parks and refuges.

In 1997, the NPS assigned the Social Science Program the task of developing a standard GPRA survey that could be used annually by all NPS units to measure visitor satisfaction. Knowledge gained from the 1995 pilot survey was used to develop the visitor survey card (VSC)—a GPRA-based customer evaluation system for the NPS modeled after "the best in business." The project is being conducted by the CPSU, under the direction of Gary Machlis, visiting chief social scientist of the NPS. The author coordinated the project.

The overall objectives were to develop a visitor service evaluation system that is efficient and cost-effective to implement; is appropriate for use in all NPS units, allows for comparison at various NPS organizational levels, is timely for managers, is scientifically sound, and provides useful information to managers, both for meeting GPRA reporting requirements and improving visitor services.

The VSC is similar to mail-back customer satisfaction surveys successfully used in major U.S. corporations. The card addresses 12 indicators of visitor satisfaction, allowing visitors to rate the quality of park facilities, visitor services, and recreational opportunities. Visitors rate the services using a five-point scale ("very good," "good," "average," "poor," and "very poor"). For GPRA reporting purposes, the card includes an overall quality question used as the primary measure of visitor satisfaction.

Survey methodology. The VSC studies are based on a systematic survey of park visitors. Four hundred survey cards are distributed to a random sample of visitors in each park during a 30-day study period. Visitors at selected locations which are representative of the general visitor population are sampled. For each survey, park staff select an interval sampling plan based on the previous year's visitation. Park staff are trained to carefully hand out survey cards according to an approved set of survey instructions and guidelines.

The VSC surveys have several limitations. The results do not necessarily apply to visitors during other times of the year, or park visitors who did not visit the location. Visitor groups that do not include an English-speaking person may be underrepresented. Caution is advised when interpreting any data with a sample size of less than 30, as the results may be unreliable.

Survey administration. After a 45-day collection period, all returned survey cards are electronically scanned, and the data coded and analyzed. A standard VSC data report is generated and delivered to each park approximately three months after the completion of their survey. At the end of the year, reports at the NPS cluster, region, and Systemwide levels are generated and delivered to the agency.

Results

Response rate. The average response rate for the 1998 VSC Project was 24%.

Individual park results. Each park report contains three categories of data: park facilities, visitor services, and recreational opportunities. Within these categories are graphs for each of the 12 indicators evaluated by park visitors. Responses for indicators within each service category are averaged into a combined graph for the category. Table 1 gives results from the 1998 VSC survey at Grand Canyon National Park, showing the percentage of visitors satisfied with the 12 service indicators. Satisfaction scores for such visitor services as assistance from park employees and ranger programs show evidence of excellent visitor service at Grand Canyon National Park, while restrooms received the lowest rating.

Servicewide quality goal. The 1998 Servicewide GPRA goal for visitor satisfaction states that "77% of park visitors are [to be] satisfied with appropriate park facilities, services, and recreational opportunities." For GPRA reporting purposes, each report contains a rating of the park's overall quality of facilities, services, and recreational opportunities. A visitor is "satisfied" if their response is either "very good" or "good." Based on evaluations by park visitors, there is strong evidence of excellent customer service in the National Park System. Of the 281 parks which completed a 1998 VSC survey, 275 (98%) met the goal.

Cluster results. In addition, survey results are summarized at the NPS cluster level. In 1998, overall satisfaction scores for the clusters evaluated (some NPS regions include a single cluster or do not have a cluster designation, and so were excluded) ranged from 90% (Pacific Island cluster) to 96% (Allegheny, Appalachian, Chesapeake, and Gulf Coast clusters).

Region results. Survey results are also summarized at the NPS region level. Overall satisfaction scores ranged for the regions were (from high to low): Midwest (96%), Southeast (96%), Intermountain (95%), Northeast (95%), Alaska (94%), National Capital (93%), and Pacific West (93%). These high scores are another indication of excellent visitor service across the National Park System.

Table 1. Percentage of visitors satisfied, Grand Canyon National Park, 1998 (n=92 respondents)

<i>Service indicators</i>	<i>% satisfied</i>
Sightseeing	99
Assistance from park employees	95
Ranger programs	94
Outdoor recreation	94
Walkways, trails, and roads	89
Campgrounds and/or picnic areas	88
Learning about nature, history, or culture	88
Visitor center	88
Exhibits (indoor or outdoor)	83
Park map or brochure	83
Commercial services in the park	80
Restrooms	66

Systemwide Results

Service indicators. Finally, survey results are summarized at the Systemwide level by combining and averaging visitor responses. Table 2 shows the percentage of visitors satisfied with each of the 12 service indicators. Satisfaction scores for direct employee services, such as assistance from park employees and ranger programs, demonstrate evidence of the agency's willingness to serve the public. Satisfaction scores for park facilities such as campgrounds, picnic areas, and restrooms, although high, show room for improvement. Commercial services in the park received the lowest visitor satisfaction rating.

Table 2. Percentage of visitors satisfied, National Park System, 1998 (n=281 parks; 22,913 respondents)

<i>Service indicators</i>	<i>% satisfied</i>
Assistance from park employees	96
Sightseeing	95
Learning about nature, history, or culture	93
Park map	93
Ranger programs	93
Visitor center	93
Exhibits	91
Outdoor recreation	91
Walkways, trails, and roads	91
Campgrounds and/or picnic areas	83
Restrooms	81
Commercial services in the park	74

Service categories. Visitor responses for indicators within each service category are also combined and averaged at the Systemwide level. Ninety-three percent of the visitors were satisfied with recreational opportunities, 91% with visitor services, and 89% with park facilities. In future years, these baseline numbers will provide an opportunity to monitor service quality and demonstrate improvements in the provision of visitor services.

Overall quality. The respondents rated the overall quality of facilities, services, and recreational opportunities at the park they visited. Ninety-five percent of these respondents were "satisfied" with the overall quality of services provided. This high level of visitor satisfaction is strong evidence of a successful effort by NPS employees to provide for the public enjoyment.

Technical Audit

At the end of 1998, the CPSU conducted a technical audit of the project. The purpose was to document how closely park units were able to follow survey instructions, guidelines, and methods. The audit examined VSC surveys conducted at 30 randomly selected NPS sites. The findings suggest that park staffs effectively used the instructions and administrative materials to plan and conduct their survey.

Survey Response Rate and Non-Response Bias

The project's research and development effort included an investigation to determine a typical survey response rate for similar mail-back customer service cards. Of the firms contacted, typical response rates for similar mail-back customer service cards without financial incentive ranged from 10 to 30 percent. A review of the customer satisfaction literature confirmed this range to be reasonable (Varva 1997; Hayes 1997). The 24% average response rate for the 1998 VSC Project is comparable to the best in private-sector customer service evaluations and is acceptable for general performance measurement.

Although non-response bias is a potential problem in the VSC project, a number of steps were taken to deal with it. Non-response bias is a function of many factors within a survey—not just the final response rate (Dillman 1978). These include the *survey instrument*, *survey methodology*, and the *final response rate*. The VSC project carefully addressed each of these factors to reduce the potential for non-response bias in survey results. In addition, a test was conducted to identify non-response bias within the VSC survey results.

To test for non-response bias, the CPSU compared survey results from three VSC studies with the results from three 1998 VSP studies. These VSP studies contained the same overall satisfaction question included on the VSC for GPRA measurement. The average response rate for these three VSP studies was 76%. These VSP studies were conducted at the same park, season, and survey locations as the VSC studies. Table 3 shows the percentage of visitors satisfied overall from these three parks for both the VSP and VSC studies. This comparison identifies similar results for the two types of studies. The comparison suggests that non-response bias is not a significant factor within the 1998 VSC results.

Feedback from the NPS

In an effort to improve the VSC survey, each park staff had an opportunity to evaluate the 1998 survey and reporting process. An evaluation card was provided for each participating park unit. Fifty-six percent of the parks completing a VSC survey returned an evaluation card. Figures 1 and 2 show the results. The evaluation results suggest that park staffs found the VSC instructions and guidelines easy to use (Figure 1). The results also suggest that park staffs were satisfied with the quality of services provided by the VSC staff (Figure 2).

Table 3. Comparison of overall satisfaction, VSP and VSC survey results, 1998

	<i>Visitor Services Project</i>		<i>Visitor Survey Card Project</i>	
	% satisfied	N size	% satisfied	N size
Acadia NP	96	996	95	86
Chattahoochee River NRA	80	658	85	107
Jean Lafitte NHP&Pres	95	528	95	79
Average	90		92	

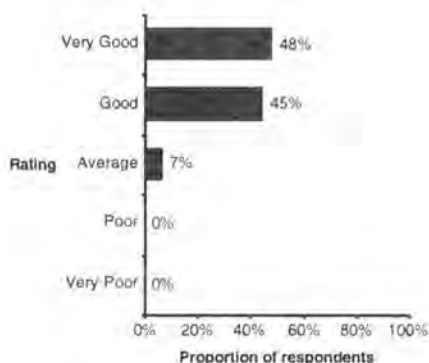
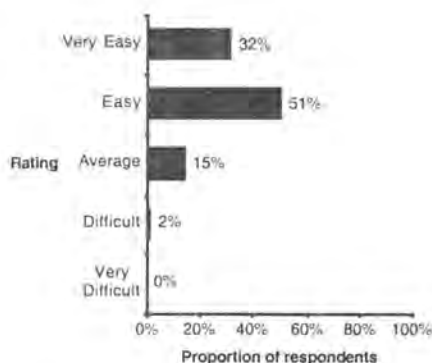


Figure 1 (left). VSC evaluation: Ease of use (n=156)

Figure 2 (right). VSC evaluation: Quality of services (n=156)

Using the VSC Survey Results

GPRAs purposes. As part of the GPRAs process, the NPS has developed a hierarchy of mission statements and goals to guide the performance management process. This planning framework provides the structure for measuring park performance across the System. At the park level, long-term and annual goals are the tools for performance evaluation. The goals for visitor satisfaction state the desired future condition of the visitor’s experience at units within the National Park System.

For planning purposes, a long-term goal is five years in duration. Thus, the long-term visitor satisfaction goal establishes the agency’s vision for the year 2002. This long-term goal functions as a stairway to increasing visitor satisfaction in all parks within the System. Annual goals act as steps towards achieving the long-term goal. Annual goals are tiered, with steady incremental increases towards achievement of the long-term goal.

The NPS plan is to use the 1998 VSC survey results, along with other important GPRAs measurements, in the agency’s resource allocation process (dollars and staffing). At the Systemwide level, the NPS will need to show Congress why more funding is necessary and justify it with a record of previous success. At the park level, managers will use their GPRAs performance record to justify requests for additional resources. In 1999, the annual goal for visitor satisfaction will be increased to estab-

lish a reasonable Systemwide standard. In future years, the annual and long-term goals will be used as a tool to increase the level of visitor service in all units of the National Park System.

The 1999 VSC Survey

In 1999, a VSC survey will be conducted in 321 units of the National Park System. These surveys will be done during the months of February through September. A number of improvements have been made, including:

- An extended (8-month) survey schedule, providing greater flexibility in survey month assignment;
- Additional guidelines for card distribution in survey locations with dispersed visitation (e.g., campgrounds and picnic areas);
- Additional suggestions for improving card distribution in low-use survey areas;
- Additional suggested techniques for increasing visitor response;
- An improved version of the survey card; and
- A Spanish-language version of the survey card.

In addition, a VSC database is being created to allow comparison of the study results in future years. The database will provide the NPS and other clients with comparative data relating to visitor satisfaction, and will allow trends to be monitored over time.

Conclusion

The 1998 VSC survey results provide the NPS with useful information for managers, other staff members, and the public on customer satisfaction. The results also allow the agency to monitor customer service in accordance with the National Performance Review. In addition, survey results provide the NPS with the ability to transfer the useable knowledge gained from the evaluations into improved customer service at the local, regional, and national levels.

While the NPS is providing excellent customer service, there are still opportunities for improvement. The survey results show that visitors rate certain service indicators lower than others. Although the majority of parks have high customer service ratings, an effort is needed to bring all of them to this high level of visitor service. Finally, there is the long-term challenge of maintaining a consistently high level of visitor service in all units from year to year.

In future years, additional benefits will be realized as VSC survey results accumulate. Baseline data at the individual park, cluster, region, and Systemwide levels can be compared with each new year's survey results. In addition, annual and long-term goal performance will continue to be monitored at all parks. And perhaps most importantly, continuous measurement of customer service performance will become a part of the agency culture.

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Acadia National Park Historic Hiking Trail System: Planning for Management and Maintenance

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Introduction

Acadia National Park, located on the Maine coast in the northeastern United States, contains some of the most beautiful and heavily used hiking trails in the country. Covering a large percentage of Mount Desert Island, most of the trails pre-date the 1916 establishment of the park. The system includes Native American trails, early roads, and paths constructed by local village improvement associations (VIAs) near the turn of the century. Additional trails were built by the Civilian Conservation Corps (CCC) and other government works programs in the 1930s, when the island-wide system reached its peak size of 250 linear miles. A product of human design and construction, the system contains a wide variety of skillfully built features, including stone steps, stone paving, stone retaining walls, iron ladders, wooden bridges, and stone cairns (Figure 1).

While the system has withstood nearly 100 years of heavy usage, some trails have fallen into disrepair, with many no longer marked and maintained. A renewed interest in trails from the community and enhanced funding from the Friends of Acadia (a non-profit independent park support group), National Park Service Fee Demonstration Program, and National Park Service Cultural Resources Preservation Program has led to a drive to rehabilitate the existing trails and consider re-opening some abandoned trails. In an effort to foster this interest and develop new and innovative ways of preserving and maintaining this important resource, a four-year planning project is underway for trail management and maintenance. Goals include documentation of the system's history and development of treatment and maintenance recommendations for both the historic system and individual trail features. The Olmsted Center for Landscape Preservation, a National Park Service technical assistance center with expertise in the preservation of cultural landscapes, has been a partner with Acadia National Park in this process and has taken the lead in the implementation of the majority of this project.

This project has been broken into five phases, described below.

Phase One: Inventory and Duplication of Historical Documentation

A large amount of historical documentation relevant to the trail system can be found in local repositories on Mount Desert Island and in both private and public off-island collections. The construction of VIA and CCC trails is documented in various logs, journals, and maps. Many historic photographs portraying the character and workmanship of trails at or near the time of construction are available. This material is helpful in documenting trail history, identifying character-defining features, and developing trail management guidelines.

When the project group first convened, several community members expressed concern that some of these one-of-a-kind resources were in dire need of archival conservation. Although not normally part of a planning project like this, it was determined that preservation of this material was of utmost importance and would be included as the initial phase of the project. The materials were inventoried, stabilized, and duplicated on microfilm and large-format negatives. Master copies were deposited in the archives of Acadia National Park to allow for ease in future duplication. The originals, along with additional copies, were returned to the repositories, allowing the materials to be more easily accessed and better preserved for future use. The cost of archival duplication was recouped in research time saved during Phase Two of the project.



Figure 1. A footbridge over Duck Brook indicates the influence of the picturesque style on the early development of the trail system, ca. 1870. Photographer unknown. Courtesy Acadia National Park Archives.

The assistance of the following repositories was invaluable during this initial phase: Acadia National Park Archives, Bar Harbor, Maine; Appalachian Mountain Club Library, Boston, Massachusetts; Bar Harbor Historical Society, Bar Harbor, Maine; Bar Harbor Village Improvement Association, Bar Harbor, Maine; Friends of Acadia, Bar Harbor, Maine; Jesup Memorial Library, Bar Harbor, Maine; Maine Historic Preservation Commission, Augusta, Maine; Maine State Archives, Augusta, Maine; National Archives, Waltham, Massachusetts; New York Public Library, New York, New York; Northeast Harbor Library, Northeast Harbor, Maine; Northeast Harbor Village Improvement Society, Northeast Harbor, Maine; Seal Harbor Library, Seal Harbor, Maine; and Seal Harbor Village Improvement Society, Seal Harbor, Maine.

Phase Two: Cultural Landscape Report, Volume I—History, Existing Conditions, and Preliminary Analysis

Phase Two included the completion of the first volume of the trails cultural landscape report (Coffin 1999). This illustrated history of the trail system was prepared using primary and secondary source materials and oral histories. The historical narrative describes significant events, groups, and individuals related to the development of individual trails and examines the system in the context of regional and national recreation trends. A description of each trail identifies the trail makers, their objectives for trail building, construction techniques used, and character-defining features. The report includes historic and contemporary photographs and approximately 50 maps dating from the late 1800s to the present, illustrating the configuration of the trail system during specific historic periods.

To document existing conditions, a database of trails was developed based on the available historical documentation and current management records. The database includes all trails that are part of the historic system, both those currently in use and those no longer marked or maintained. A current trails map was produced by combining information from historical maps with modern Geographic Information System, Global Positioning System, and AutoCAD technologies. Existing conditions that are described in the narrative document focus primarily on spatial organization, associated structures, vegetation, views and vistas, and small-scale features, including steps, ladders, rungs, bridges, signs, cairns, benches, plaques, walls, and drainage systems. A preliminary analysis of the significance and integrity of the system also was included.

Phase Three: National Register Nomination

In Phase Three, the topics of significance and integrity were given a more in-depth discussion through development of the National Register nomination for the trail system (Stakely, Coffin, and Weinbaum 1999) and the concurrent development of the multiple property documentation for historic resources within the park (Meier and Terzis 1999). This documentation establishes the trail system's period of significance as 1890-1942, the era most of the trail construction took place under the different VIA and government work programs. The system was determined to be significant under the National Register criterion A, representing broad patterns of history, for its association with the local VIAs, and criterion C, indicating a significant type, period, or method of construction, for its association with the rustic design style used by the National Park Service between 1916-1958. Although minor alterations have been made to the trail system over its lifetime, such as in the loss of some trails through new construction, rerouting, or lack of maintenance, overall the system was determined to have a moderate to high remaining degree of integrity in location, design, setting, feeling, association, materials, and workmanship (Figures 2 and 3).

The trail system extends across the park boundaries and covers much of Mount Desert Island. However, due to management concerns, only those trails or segments of trails located within the park are listed in this nomination. This includes trails that



Figure 2. View of the Schiff Path soon after construction, ca. 1916.
Photographer unknown. Courtesy Acadia National Park Archives.



Figure 3. View of the Schiff Path, 1998. The high degree of remaining integrity is evident when comparing this view with the above view. Photographer unknown. Courtesy Acadia National Park Archives.

are currently marked and maintained as well as extant abandoned trails. Because of the large number of trails, each containing numerous individual features, the trails were grouped as a system for the nomination process rather than nominating each trail individually. Some trails may warrant individual distinction for their high level of construction, but the majority of trails follow what has been called the "Acadia Style" of design. This includes precedents from both rustic and picturesque design styles, like the use of native stone (Figure 4) and wood in construction, while incorporating some modern trail features new to Acadia, like split-log bog walks and trailhead signage.

Phase Four: Cultural Landscape Report, Volume II—Treatment Alternatives and Maintenance Recommendations

Phase Four includes the development of treatment alternatives and maintenance recommendations for the trail system. The goal of these guidelines is to ensure preservation of the historic character of this resource while meeting the demands of high visitor usage. Development of this document has been influenced by the input of many interested individuals. A working group convened twice during the summer of 1997 to discuss both current and historic construction and maintenance techniques for Acadia's hiking trails. Individuals with expertise in trail design and maintenance offered perspectives on what methods of trail work would be both effective and appropriate. Differences in opinion helped to articulate what characteristics are essential to Acadia's trails. From these discussions, prototype guidelines were developed for selected trails. These preliminary guidelines served as the foundation for developing rehabilitation guidelines for the entire trail system.

For rehabilitation and maintenance, the included trails have been divided into two categories. The first consists of trails that are more highly constructed. They warrant special attention to the preservation of their constructed features. Trails in this category include endowed or memorial paths built during the VIA period and some significant CCC trails. The second category represents "Acadia Style" trails. These trails are not as highly built but still contain characteristics representative of VIA and CCC craftsmanship. Recommendations for this group places emphasis on maintaining the overall character of the system without sacrificing the individual character of the trail and its features. Preferred rehabilitation methods are presented for constructed trail features under each of these two categories. Implementation of these methods during continued maintenance, rehabilitation, and new construction will ensure that the historic character of the system is preserved.

Phase Five: Trails Management Plan

The entire historic trail system, including trails not currently maintained, will be systematically analyzed to determine the appropriate management strategy. This trail-by-trail analysis may result in closure of some currently maintained trails if they are determined to be unsafe to visitors, a duplicate route, or in conflict with environmental values or other protected resources. Additionally, some abandoned trails or new trails may be opened where they form loops or village connectors, have high historic significance, or provide a desirable visitor experience.

Conclusion

Upon completion of this project, management at Acadia National Park will have a better understanding of the resource they are entrusted to preserve and maintain. By examining and defining approaches to critical issues like the maintenance for currently used trails, reopening of abandoned trails, or creation of new ones, the park will be able to maintain the trail system in a way that preserves its integrity while providing for increased visitor usage. This initial planning also makes integration with the management of other park resources an easier task by making the impact on other resources a primary consideration when undertaking any action on the trails.



Figure 4. Stone staircase on the Emery Path, ca. 1916. Photographer unknown.
Courtesy Acadia National Park Archives.

The key to the success of this project is the cooperation of many interested parties involved in the planning process. Input by professional staff from Acadia National Park and the Olmsted Center, the Friends of Acadia, local historical groups, and private individuals has been invaluable during all phases. This cooperative effort will continue to be vital as park management begins to implement procedures and guidelines developed during this process, undoubtedly increasing the funding and labor requirements needed for protection of this historic resource.

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Mountain Biking and Soil Erosion: User Preference of Factors of Erosion and Management Techniques

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Introduction

Recreational carrying capacity is "the level of recreational use an area can withstand while providing a sustained quality of recreation" (Wagar 1964). Within this definition there are four sub-capacities that must be identified by recreation resource managers in order to better manage recreation environments. These are physical capacity, ecological capacity, social capacity, and facility capacity (Shelby and Heberlein 1986). There are few studies that have specifically focused on the social carrying capacity for mountain biking; however, there is a need to incorporate more social research into management decisions. At present, resource managers often face a difficult task of managing the physical environment, in addition to the diverse range of user groups that function in that space. Therefore, there remains a need for more research that focuses upon the specific needs, preferences, and experiences of different user types. Studies need to focus upon specific user groups and user-group interaction, in order to provide managers with data that can be applied in the field.

This study focuses on the trail and management preferences of mountain bikers. Mountain biking is a relatively recent use-type addition to recreation environments. Ford (1989), Hain (1986), Pettit and Ponte (1987), and Seney (1990) have questioned the ecological and physical impacts of this new user group. However, at present, it is debatable whether social carrying capacity is effectively applied in mountain bike recreation environments.

Literature Review

In one of the few comprehensive studies of mountain biker preferences of recreational settings and experiences, Cessford (1995) surveyed different users and their level of experience in New Zealand concerning preferred landscape factors, trail types, trail conditions, downhill and uphill preferences, and social encounters. Primary findings showed that there was a relationship between biker preference and level of experience. For example, novice bikers preferred smooth, open, or clear trails, and had low preference for obstacles and carrying bikes on sections not feasible for biking. The same question posed to expert riders showed preference for rougher tracks, and more tolerance for carrying bikes across terrain not suitable for biking. Cessford also concluded a number of other preferences for recreational settings. For example, novice bikers' reasons for recreational biking were exercise and personal fitness, whereas expert bikers sought "speed," "excitement," "technical challenge," and training for competition. All groups (novice, intermediate, and expert) stated that they preferred native forest settings to plantation pine forests, open farmland, or human-made surfaces. Novice bikers were also more tolerant of gravel roads and wide, smooth trails, whereas more experienced riders preferred tight, narrow, rough, and uneven trails.

Sprung (1997) discussed attitudes of other trail users towards mountain bikers. Other users perceived that mountain bikers did not have much concern for the environment. This perception was attributed to the speed at which bikes travel and the association of the term "mountain bike" with other forms of wheeled transport. However, a national study has shown that mountain bikers, and their associations, do stress substantial concern for the environment. Mountain bikers generally accepted the need for limits of acceptable change, and organized much of their lives

and recreation activity around environmental issues (Hollenhorst et al. 1996). Hollenhorst and his co-authors also stated that bikers formed a "tightly knit community" of individuals. Trail preferences included single-track forest trails instead of gravel, physically and technically challenging trails, and multiple-use trails that allowed hikers, equestrians, and others to share the recreation environment. The study appeared to be oriented towards promoting the use of wildland recreation environments by mountain bikes. It seemed to dispel perceptions that bikers are anti-environment in order to attempt to shape future management policy. Hollenhorst and his co-authors concluded, surprisingly, that bikers reported dissatisfaction with policy that designated trails solely for mountain bike use, and that bikers formed a unique recreation community that needed to be managed accordingly. One major limitation of this study, which the authors stated as a unique benefit, was the study population. Bikers were only sampled from the International Mountain Biking Association (IMBA). Membership in an active professional organization suggests some form of environmental and opinion orientation of an individual. Findings suggested that the sample did not adequately represent the more generic mountain biker population. For example, the reported average age of the typical biker was 38 years. The "tightly knit community" of environmentally aware individuals reported may just be due to the respondents' common interest of being a member of IMBA.

A survey of 393 bikers in southwestern Virginia studied the relationships between experience, commitment, and attitudes towards the management of mountain biking (Ramthun 1997). An initial hypothesis stated that bikers with more experience and commitment would have different trail preferences than beginners. This was supported, although no specific trail preferences were stated. It was also found that as bikers became more committed to the sport, there was a need for more trails to be opened for mountain bike use and more designated trails for bikers only.

Present literature on the user profile of mountain bikers is limited relative to the amount and concentration of mountain bike use in many areas of the United States. The research that has been done appears to be narrow in scope, or has not addressed some specific issues concerning recreation resource management. This study seeks to add to social research concerning the user profile of a mountain biker. In particular, it seeks to address some questions that resource managers face at present. For example: How does a resource manager choose techniques that reduce soil erosion and protect the environment, but still cater for the preferences of the user at the same time? How does a resource manager design a trail in order to maximize mountain biker enjoyment while minimizing environmental damage? Is there evidence to suggest that a resource manager should have different management strategies, in accordance with the profile of the user? These questions, and others, will be addressed in the following survey results and discussion.

Methods

A pilot user survey was designed and tested. The primary objective was to gather data from mountain bikers concerning issues about the following four objectives:

1. To identify the mountain biker by age, sex, and place of residence, and their commitment and use levels on the trails they ride;
2. To identify biker environmental concern and perception of other trail users;
3. To identify the influence of trail conditions on mountain biker experiences; and
4. To test whether any biker parameters could be used as predictors of trail preferences and environmental concern.

The survey was pilot-tested in November 1997. Surveys were e-mailed to 32 mountain bikers from one e-mail list in the United Kingdom to test wording and select 5- or 7-point Likert type rating scales for some questions. A final survey was devised from the recommendations and results of the pilot survey.

The 17-question revised survey was then sent to 700 randomly selected mountain bikers on e-mail discussion lists administered at <http://www.cycling.org>, on April 3, 1998. The response rate from this initial mailing was 42%. A first reminder was sent on April 20, and the cumulative response rate increased to 51%. A final reminder was sent on April 27, and the final survey response rate totaled 58% ($n = 406$). Results were collated in Excel 97, and SAS v6.12 was used for statistical analysis. All reported significant differences were calculated at an alpha level of 0.05, unless otherwise stated, and Least Significant Difference (LSD) was used as a method for means separation analysis. The selection of 5- or 7-point Likert type rating scales, for specific variables, is reported in the results section.

Results and Discussion: Influence of Trail Conditions on Mountain Biker Experiences

Erosion factors. Trail conditions resulting from soil erosion were rated on a 7-point Likert type scale according to their effect on the quality of biking experiences (1 = detracts greatly from experience; 7 = adds greatly to experience). In general, the presence of roots, rocks, and gullies added to biking experience. Roots ($\bar{x} = 5.24$) and rocks ($\bar{x} = 5.29$) (Figure 1) added to the biking experience significantly more than all other resultant factors of soil erosion. The presence of surface water did not affect experience positively nor negatively ($\bar{x} = 4.01$). The only erosion factor that detracted from biker experience was the presence of mud ($\bar{x} = 3.6$). The presence of mud had a significantly smaller effect on experience than all other resultant factors of erosion. Additional conditions written in as open-ended responses by bikers included "drops/drop offs" ($\bar{x} = 6.3$), sand ($\bar{x} = 2.2$), smooth trails ($\bar{x} = 7.0$), dust or dry soil conditions ($\bar{x} = 6.0$), erosion holes ($\bar{x} = 2.0$), and all-terrain vehicle ruts ($\bar{x} = 1.0$).

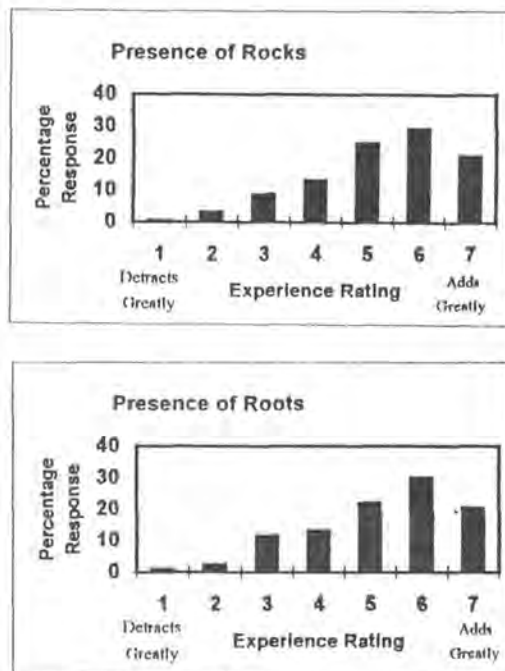


Figure 1. Trail erosion: The effect of roots and rocks on biker experiences
In Parks and on Public Lands • The 1999 GWS Biennial Conference

Design. Design factors were also rated on a 7-point Likert type scale (1 = detracts greatly from experience; 7 = adds greatly to experience). Mountain bikers preferred a mix of steep ($\bar{x} = 5.68$) and gentle slopes ($\bar{x} = 5.64$), and, in general, the presence of turns ($\bar{x} = 6.34$), bumps or jumps ($\bar{x} = 5.81$) (Figure 2), and obstacles ($\bar{x} = 5.70$) added to experiences. No design factors detracted from the quality of biker experiences, with the exception of wide trails which only detracted slightly ($\bar{x} = 3.76$). The presence of turns was the most important trail design factor, adding significantly more to the experience than any other design factor.

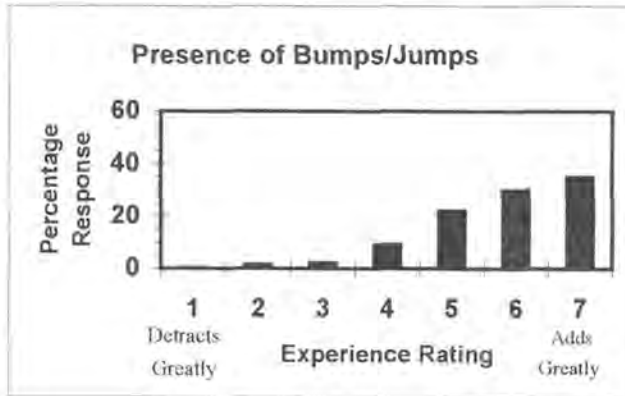


Figure 2. Trail design: The effect of bumps/jumps on biker experience

Some trail erosion and design conditions may even make mountain biking unfeasible, and therefore need to be managed or avoided. Eighty percent of mountain bikers indicated that there were conditions that made biking unfeasible. The most common condition was mud or clay (30%), followed by wet trails (20%). Fifty percent of the conditions that made biking unfeasible related to improper or poor trail drainage.

The remaining 20% of bikers who found no conditions unfeasible appeared to be “die-hard” or less-experienced bikers. Conditions such as two-foot-deep mud will make biking unfeasible. Those identifying no unfeasible conditions perhaps refused to admit that there were conditions in which they would not try to bike even though their experience would probably be very limited in those conditions, or perhaps those bikers were answering the question specific to their past experience.

Erosion Management. Many of the trail erosion and design conditions detracting from experiences of mountain bikers, particularly those making biking unfeasible, can be effectively reduced by recreation management techniques. Biker preference for several trail-erosion management techniques was rated on a 5 point Likert type scale (1 = Low preference; 5 = High preference). Mountain bikers preferred water bars ($\bar{x} = 3.81$) (Figure 3) significantly more than all other listed management techniques. Wooden steps ($\bar{x} = 2.55$) and flexible plastic water strips ($\bar{x} = 2.83$) were least preferred, of which, wooden steps were significantly less preferred than all other management techniques. Gravel ($\bar{x} = 3.21$) and the use of rock steps ($\bar{x} = 2.92$) garnered slightly more preference. Comments indicated that mountain bikers did not prefer plastic strips because they looked unnatural in the wildland environment. Few

comments were obtained concerning the poor preference for wooden steps; however, this might be attributed to the difficulty in traversing such obstacles at speeds on a mountain bike, as noted by Hain (1986).

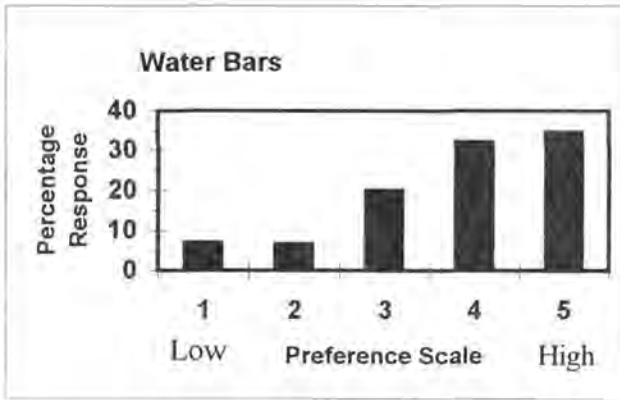


Figure 3. Erosion management : Preference for water bars

Conclusions

The mountain biker is another wildland recreation user-type with specific characteristics and trail environmental preferences. As a group, mountain bikers have well-defined parameters, such as age, skill, commitment, and trail preferences. Therefore, recreation resource managers should incorporate these parameters into the decisions that they must make concerning the management of the recreation resource. However, it is sometimes not safe to assume or generalize about a population, based upon summary statistics. This study has shown that there is no one all-encompassing biker preference profile that resource managers can apply to the management of all mountain bike recreation environments.

The way in which soil erosion is managed is also a major consideration for resource managers. Preference ratings indicate that resource managers need to evaluate several aspects of different trail management techniques, instead of choosing the best at controlling erosion, or the more readily available technique in a given area. Water bars were more preferred than wooden steps, rock steps, flexible plastic water strips, and gravel, in terms of their effect on biker experiences, and thus should be implemented wherever feasible. However, it is acknowledged that other factors, such as cost and time, also affect management decisions. The same pattern also holds true for trail design. Bikers, in general, enjoy the challenge of obstacles on the trail, such as bumps and jumps, gullies, roots, rocks, and surface water. Many of these obstacles are present due to erosion. Therefore, one must ask the question: should resource managers minimize erosion when mountain bikers state that most trail erosion factors add to the biking experiences? Also, should erosion management be instigated at the inception of a new trail system? or, should erosion management differ in its intensity over time? Once a trail system is designed and opened for mountain bike use, should managers allow some degree of erosion to occur until a point is reached where the trail conditions suit the biker, and then instigate more intense erosion management? There appears to be an equilibrium point at which the social and ecological capacity for mountain biking meet. One cannot exist without a reduction in the other. One cannot minimize erosion but still provide favored biking experiences, and one cannot maximize biking experiences but reduce erosion to a minimum, because of the

"erosion"-related preferences of mountain bikers. This is not to say that allowing erosion is correct management, or even desired from an environmental standpoint.

A more logical solution to this paradox is to locate and design mountain bike trails in areas that are resistant to trail erosion but which still provide the trail factors preferred by the majority of bikers. If, within a resource area, there are several soil types and textures, a resource manager might direct trail location to areas with textures that are more sandy and soil types that are shallow. This type of design would reduce erosion and pollution of the environment because of a more durable soil texture, and a shallow soil would create less potential for a large amount of soil loss than on a thicker soil. Shallow soils would also provide experience-enhancing obstacles, such as rocks, after a relatively small amount of soil erosion, compared with a large amount of soil having to erode on a deeper soil for unconsolidated rock material (saprolite) to be exposed.

The mountain biker is a relatively recent addition to the recreation spectrum and future research needs to allocate as much study to this user group as it does to other recreational use types. It is still unclear how some recreation resource environments should ideally be managed for mountain bike use. A balanced information base will aid resource managers and allow them to make more informed decisions in our wildland areas concerning appropriate carrying capacities and levels of acceptable change.

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Inventory and Monitoring Program Along the Appalachian Trail

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Objectives

The Appalachian Trail (AT) provides an example of an inventory and monitoring program along a lengthy, linear land corridor through multiple jurisdictions utilizing minimal staff. In 1988 the AT became the first national trail to establish an inventory and monitoring program, and it may still be the only trail to have such a program. The primary purpose of conducting AT natural heritage inventories in the 14 states through which the trail passes is to identify and record occurrences of rare, threatened, and endangered plant and animal species and exemplary natural communities found along the trail corridor. After completing each inventory, a monitoring program can be established. The AT inventory and monitoring program is also designed to guide future land management decisions and to educate the trail community about the ecological significance of trail lands (Figure 1).

History of the AT

At approximately 2,150 miles, the AT is the longest unit within the National Park System. The trail passes through 14 states, 6 National Park Service (NPS) areas, 7 national forests, and many state parks and forests. In total, it passes through more than 75 jurisdictions. As originally envisioned by forester Benton MacKaye in 1921, the AT connects the scenic high ridges of the Eastern Seaboard in one continuous public footpath from Springer Mountain, Georgia, to Mount Katahdin, Maine. Work on the AT commenced in 1922 and was completed in 1937.

In 1968 the AT became one of the original trails included under the National Trails System Act. Unlike most of the other 19 national scenic and historic trails, considerable land has been purchased to protect the AT corridor. Since 1978 the NPS has purchased approximately 105,000 acres to protect the AT. This land is in addition to the 165,000 acres of the AT corridor that were present in 1978, most of it in existing national and state parks and forests. The trail corridor is generally 1,000 feet in width, though in some locations it extends over one mile in width. Currently, about 99% of the trail corridor is public land, and the remaining 1% is to be purchased by 2000.

Ecological Significance

Although the AT was created to provide recreational and scenic opportunities for hikers, the trail is becoming known as an important habitat for significant and rare natural resources. The AT corridor protects many rare, threatened, and endangered plant and animal species and natural communities found only in the higher elevations of the eastern United States. Many of these species are endemic to the Appalachian Mountains. With over 1,600 rare plant and animal occurrences identified to date, it is possible that the AT corridor contains among the most occurrences of threatened, endangered, and rare species within any unit of the National Park System.

The southern and central Appalachians are among the most biologically diverse areas within the United States. On maps produced by the World Wildlife Fund (1997), the Appalachian-Blue Ridge ecoregion, which includes the southern and central Appalachians, is in the second highest category (out of 10) in the number of vascular plant and animal (mostly vertebrate) species found within the continental United States. With regard to species endemism, the Appalachian-Blue Ridge ecoregion is also in the second highest category (out of 11) in number of species.

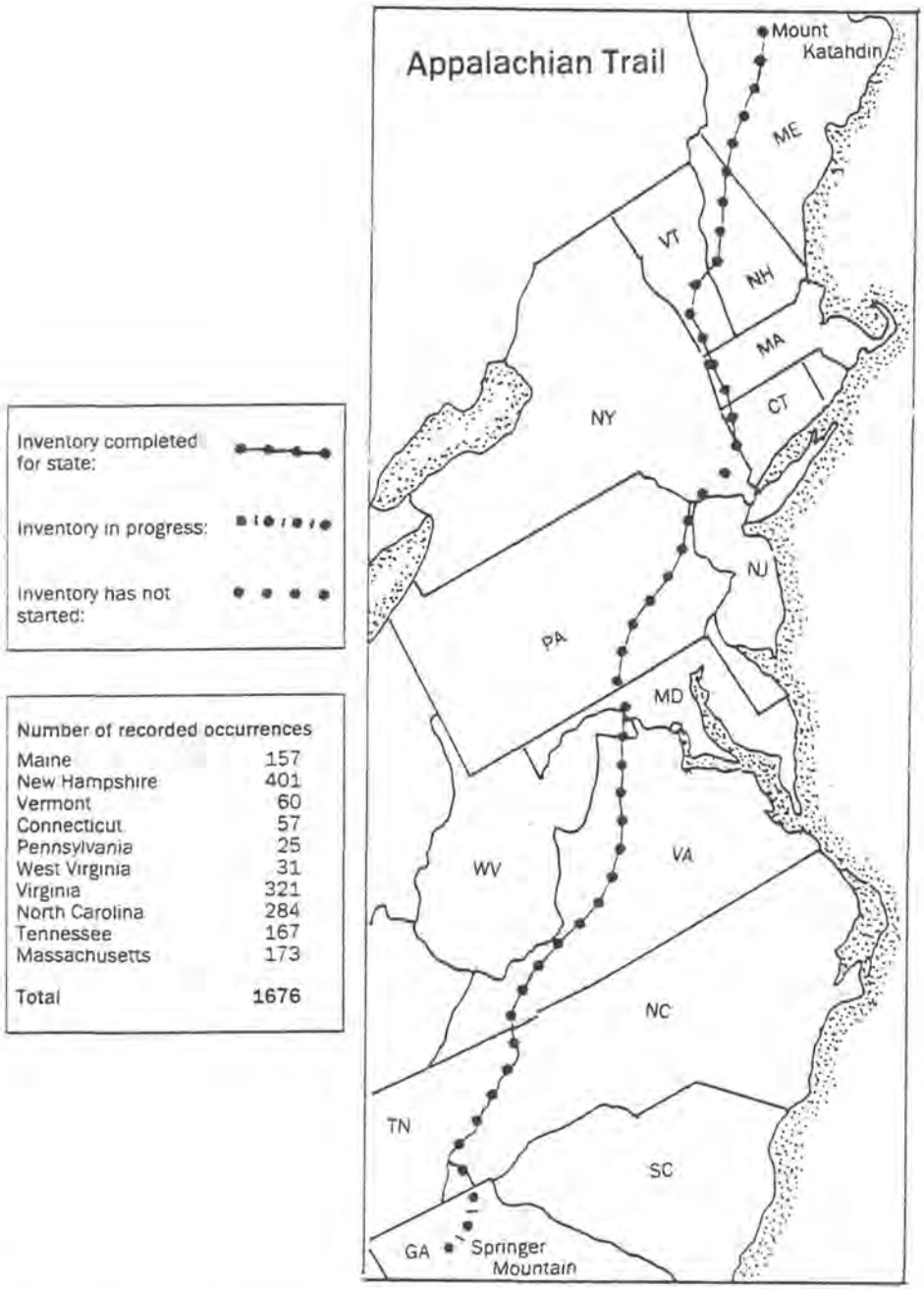


Figure 1. Current status of Appalachian Trail natural heritage inventories

Partnerships and Cooperative Agreements

Management of the AT is accomplished via a system of agreements between the Appalachian Trail Conference (ATC), its trail clubs, NPS, the U.S. Forest Service (USFS), and state land management agencies. The ATC is a private, non-profit organization to which the NPS has delegated the responsibility of maintaining and managing the AT corridor. The NPS retains ultimate responsibility for the administration and protection of the trail, including environmental compliance, threatened and endangered species, law enforcement, and the authority to acquire lands through which the trail passes.

The inventory and monitoring program for the AT was established in 1988 by Paul Brewster, a USFS resource specialist assigned to the NPS's Appalachian Trail Park Office (ATPO), and was further developed by Don Owen of the NPS. The program is administered jointly by the ATPO and the ATC. The ATPO has a staff of seven, including one natural resource specialist who manages the inventory and monitoring program. The ATC has regional offices along the trail, three of which have a staff person assigned to use a small portion of their time to help coordinate natural heritage inventories and monitoring in their regions. Other partners in the AT inventory and monitoring program are the federal or state land-owners through which the trail passes, the local AT clubs, and the state natural heritage programs, which often conduct the actual inventories. A cooperative agreement or a contract defines each party's role.

Conducting the Inventories

At the time the inventory and monitoring program for the AT was being established, it was felt that inventorying rare, threatened, and endangered species was the most immediate need. Due to the trail's length, it was also thought that the most manageable way to proceed would be to conduct the inventory state-by-state. In addition to breaking the inventory into more manageable segments, each state has its own natural heritage program that is a repository for information on all recorded species in the state, including distribution, habitat, present status, and land ownership. Though each state has its own natural heritage program, there is consistency among the states, since they all use a standardized system of field survey methods and data storage that were developed by The Nature Conservancy in the 1970s.

In most of the AT states, the state natural heritage office has agreed to conduct the state AT inventories utilizing their own staff, with funding provided by AT partners. Some natural heritage offices have supplemented their own staff by hiring contract botanists and zoologists to complete specific parts of an inventory. In a few states where the state natural heritage office was unable to conduct an AT inventory, the ATC has contracted directly with independent scientists.

Due to time and fiscal limitations, not all groups of plants and animals have been included in the state AT inventories. In each state, all rare vascular plants have been inventoried, and in a few, some groups of rare non-vascular plants were identified. The recommendations of the state natural heritage offices have been important in deciding which animal groups to inventory. The animal groups most frequently inventoried have been birds, reptiles, and amphibians.

inventory. All endangered and threatened species; USFS PETS (proposed, endangered, threatened, and sensitive) species; and watch list species are included in the AT inventories.

Preparing a landscape analysis and work plan is the first step in conducting an AT natural heritage inventory. The landscape analysis identifies which locations are most likely to contain extant populations of previously recorded or new occurrences of rare, threatened, and endangered species and exemplary natural communities. In addition to doing an element search of the natural heritage database, information is gathered from historical records, such as surveyor notes and fire records; scientific literature; aerial photographs; satellite imagery; herbarium and museum specimen collec-

tions; consultations with experts on the flora and fauna of the region; and interviews with people familiar with the area. The work plan is developed from the landscape analysis, and it usually consists of a map-based summary of high- and low-probability sites slated for field survey, a list of the existing and potential species of concern to be surveyed for, and a brief summary of the procedures to be followed in the field.

In the field survey phase of each state AT natural heritage inventory, the research team attempts to verify existing records of element occurrences on the ground, while searching for previously unrecorded occurrences. Populations of rare species are described and habitat characteristics are noted. The boundary of each rare species occurrence is mapped, as is the boundary of each natural heritage site. (A site includes all rare species occurrences at a single location.) The large majority of the trail length is surveyed at least once in the field season, and in many cases on several occasions, to increase the probability of locating ephemeral species. The state AT natural heritage inventories have taken 1-3 field seasons to complete, depending primarily on the length of the AT in each state.

While conducting the field surveys, researchers note any natural or unnatural disturbances or threats that may endanger the survival of rare species populations. Among the most common threats recorded during the AT natural heritage inventories are: competition from invasive exotic plants, competition from other native plants, trampling by hikers and trail maintenance crews, and defoliation of canopy tree species by gypsy moth and hemlock woolly adelgid infestations.

Also while in the field, researchers begin assessing the options for managing the threats that have been identified. Common recommendations for dealing with threats to rare species have included: monitoring for presence and health, conducting additional survey work, control of exotic species, acquiring additional lands or interest in lands, relocating the trail, consultation with the state natural heritage program and the ATPO prior to any relocation of the trail, educating trail maintenance crews to exercise caution around occurrences, and using signs to educate trail users. Some of these recommendations require actions by land managing agencies, but many, such as monitoring and careful trail maintenance, can be performed by local trail clubs. A few recommended actions, particularly relocations of the trail, take place during the time of the inventory fieldwork, in order to immediately eliminate continued impacts to a rare species occurrence.

Written documentation of the AT natural heritage inventories in each state has included an interim draft, a final draft, and a final report delivered to the ATPO, the ATC, and to other federal and state land-owners along the trail in that state. The state AT inventory reports have varied from about 100 pages to 600 pages. After discussing methodology, the final inventory report contains individual site reports, which consist of: 1) a table of exemplary natural communities and element occurrences, with their global and state rarity and legal status (Figure 2); 2) site descriptions, including rare species, common species, and habitat; 3) threats to the rare species and communities; 4) recommended management actions; and 5) a series of topographic maps which identify the natural heritage site boundary and the boundaries of the individual rare element occurrences and exemplary natural communities.

Results

The first statewide AT natural heritage inventory to be completed was that of Pennsylvania in 1990. Other states—about one per year—followed, and at the present time, inventories have been completed for 10 of the 14 AT states. One inventory (Georgia) will be completed in 1999, and the remaining three (New York, New Jersey, and Maryland) should be completed in 2000 (Table 1).

Inventory results have shown that trail lands provide much critical habitat for sensitive species. Thus far, 429 natural heritage sites, containing 1,676 occurrences of rare, threatened, or endangered plant or animal species or exemplary natural communities, have been identified. The total number of natural heritage sites has varied

PINK MOUNTAIN

SIZE: ca. 1,586

BIODIVERSITY RANK: B4

NATURAL HERITAGE RESOURCE SUMMARY TABLE

SCIENTIFIC NAME	COMMON NAME	GLOBAL RARITY RANK	STATE RARITY RANK	USFWS STATUS	VA LEGAL STATUS	ELEMENT OCCURRENCE RANK
Plants:						
CINNA LATIFOLIA	SLENDER WOOD REEDGRASS	G5	S2	--	--	D
DIPHYLLEIA CYMOSA (1)	UMBRELLA-LEAF	G4	S2S3	--	--	D
DIPHYLLEIA CYMOSA (2)	UMBRELLA-LEAF	G4	S2S3	--	--	C
DIPHYLLEIA CYMOSA (3)	UMBRELLA-LEAF	G4	S2S3	--	--	C
HYPERICUM MITCHELLIANUM	BLUE RIDGE ST. JOHN'S-WORT	G3	S1S2	--	--	D
ILEX COLLINA	LONG-STALKED HOLLY	G3	S2	3C	LE	E
PRENANTHES ROANENSIS	MOUNTAIN RATTLE-SNAKE ROOT	G3	S2	3C	--	C
Animal:						
GLAUCOMYS SABRINUS FUSCUS	VIRGINIA NORTHERN FLYING SQUIRREL	G5T2	S1	LE	LE	D
Community:						
SUBMESOTROPHIC FOREST						B

Figure 2. An example of a resource summary table for rare plants and animals and exemplary natural communities found within a natural heritage site report. "G1" and "S1" species are rarest (five occurrences or fewer globally or statewide), "G3" and "S3" species are moderately rare, and "G5" and "S5" species are very common. "LE" refers to a listed endangered species.

from 8 in West Virginia to 74 in Virginia, and the total number of occurrences has varied from 25 in Pennsylvania to 401 in New Hampshire. Virginia and North Carolina also have a large number of rare species occurrences, partly due to greater habitat diversity across a wider range in elevation found in these states. One plant, the federally endangered small whorled pogonia, is found at several locations along the AT, including the only population of the orchid in Connecticut. Among the rarest animals found along the trail are several species of Shenandoah salamanders.

Funding

Support for the AT inventories has come from the NPS operating budget, the NPS challenge cost-share program, the USFS, the National Forest Foundation, the National Fish and Wildlife Foundation, state resource agencies, and private foundations and corporations. The total cost for the inventories conducted to date is \$247,250 on an acreage of 254,158 acres, or an average of only about \$1.00 per acre surveyed. Inventory cost has varied from \$4,000 for West Virginia to \$59,750 for Virginia, reflecting the amount of acreage surveyed and the year in which the inventory was conducted.

<i>State</i>	<i>Acreage</i>	<i>Miles</i>	<i># of sites</i>	<i># of occurrences</i>	<i>Cost</i>	<i>Status of inventory</i>
PA	30,000	229.8	15	25	\$13,500	Completed 1990
NH	23,000	157.7	59	401	\$9,900	Completed 1991
VT	22,500	145.5	33	60	\$8,400	Completed 1991
CT	6,000	46.7	27	57	\$4,500	Completed 1992
NC	27,500	234.0	66	284	\$27,000	Completed 1993
VA	60,000	543.2	74	321	\$59,750	Completed 1994
TN	10,800	73.2	58	167	\$17,000	Completed 1996
WV	2,100	29.4	8	31	\$4,000	Completed 1997
ME	40,300	274.6	46	157	\$44,100	Completed 1998
MA	12,500	89.0	43	173	\$19,500	Completed 1999
GA	7,166	75.6	In progress	In progress	\$19,600	Begun June 1998
NY	12,292	90.9	—	—	\$25,000	Begun May 1999
NJ	—	73.0	—	—	—	Begun May 1999
MD	—	40.0	—	—	—	Planned for 2000

Table 1. Summary of Appalachian Trail natural heritage inventory and monitoring program, by state

Site Monitoring

Once a statewide AT inventory is completed, a monitoring program for the trail in that state can begin. The primary goals of the natural heritage site monitoring program are to discern the size and health of the rare species and to identify any threats to them. Because of AT staff limitations, and because of the success of utilizing volunteers in other roles along the AT, a decision was made to accomplish the monitoring program through volunteers. Most natural heritage volunteers are selected from local trail clubs based on their interest in observing plants and animals, though some are also environmental professionals. Of the total 429 sites identified in 10 of the AT states, only about 100 of the highest priority sites have been identified for monitoring, based primarily on the rarity of the species and the threat to its presence. Approximately 100 volunteer natural heritage monitors have been trained and are active along the AT.

Workshops

At least one workshop is held in each state to train volunteers in identifying the species to be monitored and in procedures for monitoring. The ATPO and the ATC regional offices organize each workshop. The primary instructor is usually from the

state's natural heritage office or is the contracting biologist for the AT inventory. Also invited are natural resource managers from national parks and forests and state land agencies in the region. Over the course of the six-hour workshop, volunteers are introduced to the concepts of biodiversity and rare species protection, briefed on the AT natural heritage inventory program, shown identifying characteristics of the species or communities to be monitored (through slides and herbarium specimens), and instructed on how to complete monitoring forms. During the afternoon portion of the workshop, volunteers practice species identification and monitoring under the guidance of professionals.

A monitoring packet supplied to each volunteer consists of general information on the AT inventory and monitoring program, a specific site report from the inventory, drawings or photos of the species and community occurrences, topographic maps showing the location of the occurrence(s), and blank monitoring report forms. Volunteers are encouraged to take photos of their site and species. The monitoring reports are critical to determining if a natural heritage site needs more active management to preserve its rare elements.

A Look Ahead

Once the 14 state AT inventories are completed, the ATPO will devote more time to prioritizing and implementing additional management recommendations from the inventories, particularly on its own lands.

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The Suitability of Bus Drivers for Monitoring Large Mammal Abundance

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Introduction

Providing wildlife and scenic viewing opportunities to the growing number of visitors to Denali National Park and Preserve has resulted in increased vehicular traffic along the park road since 1973 (Fortier and Olson 1996). A number of studies (Tracy 1977; Singer and Beattie 1986; Looney 1992; Taylor 1997) have measured large mammal abundance and behavior along the park road corridor, but these studies were generally not designed to be readily compared (but, see Burson et al. 1998). To fill this void, a long-term monitoring program was needed to evaluate trends in large mammal abundance along the park road and to aid in assessing the effects of increased traffic on these populations.

Denali National Park has a concessionaire-run bus system that transports visitors to observe wildlife and scenery. The bus drivers often have long-term interest and experience observing wildlife along the park road (e.g., Looney 1992; Taylor 1997). We conducted a study that compared wildlife data recorded by selected bus drivers and by National Park Service (NPS) biologists during June, July, and August over the period 1995-1997 to determine if data collected by bus drivers were suitable to be used for long-term monitoring of large mammals along the park road.

All wildlife monitoring programs first need well-defined objectives. Ideal programs also require within- and among-year consistency (Silsbee and Peterson 1993; Shampine 1993). There should be no observer bias, all observers should be interchangeable, and the same observers and protocol should be used throughout the study. The only thing that should vary is the object of study itself—in our case, the number of large mammals observed from the park road. However, there are always constraints such as time, personnel turnover, and budget limitations. It was within these constraints that a program to monitor large mammals along the park road in Denali National Park was developed and is reported here.

Study Area

Denali National Park and Preserve is located between Anchorage and Fairbanks in the interior of Alaska. The climate of the 24,000-sq-km park is subarctic; only June, July, and August have an average maximum temperature $>17^{\circ}\text{C}$ and an average minimum temperature $>0^{\circ}\text{C}$ (NPS unpublished data). Mean annual rainfall was 35.3 cm during 1995-1997 with a mean of 19.6 cm during June-August (NPS unpublished data). Depending on the time of year, daylight varies from over 20 hours to about 4 hours.

There is one road into the park that traverses a valley between the Alaska Range on the south and the Outer Range on the north. This valley varies in elevation from about 475-1,000 m and in width from 1-10 km. The park road, completed in the 1930s, crosses five braided rivers and many smaller streams between Alaska Highway 3 in the east and the private inholding town of Kantishna 147 km to the west near the base of the 6,158-m Mt. McKinley (Denali). The road transects spruce-dominated (*Picea* spp.) forests, birch- and willow-dominated (*Betula* and *Salix* spp.) shrub tundra, and higher-elevation tundra of *Dryas* species and other short-stature plants. Snow usually covers the road from October to April or May. The road is paved the first 24 km; the remaining 123 km is gravel.

Methods

Selected bus drivers and two NPS biologists recorded observations of caribou, grizzly bear, Dall sheep and moose within 400 m of the park road during one-way

trips between park headquarters (5.6 km from the start of the road) and Eielson Visitor Center (105.6 km). After an orientation to procedures and the data form, bus drivers recorded observations during their regularly scheduled trips. Their primary obligation was driving the bus; however, they usually had help from passengers searching for wildlife. The buses' maximum speed was 56 km/hr, though their actual speed was usually slower. When wildlife was spotted, drivers recorded the time and location of the sighting, the species, and the number of individuals. NPS methods were similar to those of Tracy (1977) and Singer and Beattie (1987). Two biologists drove between park headquarters and Eielson Visitor Center in a pickup truck travelling 40-48 km/hr. When wildlife was observed, the biologists stopped and recorded the time and location of the sighting, the species, and the number of individuals.

We used data from three bus drivers each year, and to eliminate biases from unequal sampling we paired bus driver and NPS trips by date. If more than one bus trip per day was recorded, we randomly selected one driver's data to be analyzed. To assess the suitability of bus driver data, we compared the annual mean number of individuals per trip of each species observed by bus drivers and NPS biologists. Because the moose data appeared inconsistent between the two techniques, we used the non-parametric Wilcoxon 2-sample test (SAS Institute 1988) to determine if the mean number of moose observed per trip by bus drivers and biologists differed. We also compared the proportion of trips when at least one individual of each species was observed by bus drivers and by biologists. We used chi-square analysis (SAS Institute 1988) to test if the proportion of trips when moose were observed differed between the two techniques.

Results

Bus drivers and NPS biologists each completed 116 trips (29 in 1995, 46 in 1996, and 40 in 1997). The two techniques had similar relative changes in annual abundance of caribou, grizzly bear, and Dall sheep over the three years (i.e., both techniques showed an increase, then decrease, in caribou abundance from 1995-1997) (Figure 1). However, bus drivers recorded a lower mean number of individual caribou, grizzly bear, and Dall sheep each year than did NPS biologists (Table 1). Although the mean annual number of moose observed per trip by bus drivers and NPS biologists appears dissimilar, there was no statistical difference (1995: $Z = -0.472$, $n = 29$, $P = 0.637$; 1996: $Z = 0.420$, $n = 46$, $P = 0.675$; 1997: $Z = -1.100$, $n = 40$, $P = 0.271$).

	Caribou						Bear					
	Bus			NPS			Bus			NPS		
	mean	se	range	mean	se	range	mean	se	range	mean	se	range
1995	3.9	0.7	0-15	6.4	1.2	0-29	1.5	0.4	0-6	2.8	0.5	0-9
1996	6	0.9	0-32	12	1.8	1-52	1.9	0.3	0-7	3.2	0.5	0-10
1997	3.2	0.5	0-16	11	1.7	0-46	2.2	0.3	0-8	3.1	0.3	0-7

	Sheep						Moose					
	Bus			NPS			Bus			NPS		
	mean	se	range	mean	se	range	mean	se	range	mean	se	range
1995	0.8	0.45	0-10	4.8	1.5	0-28	0.9	0.25	0-5	0.6	0.2	0-3
1996	3.5	0.52	0-63	6.9	1	0-44	0.4	0.06	0-3	0.7	0.1	0-5
1997	1.7	0.84	0-27	5.6	1.9	0-62	1.3	0.35	0-10	0.9	0.3	0-8

Table 1. Mean number, standard error, and range (by trip) of individuals observed by technique, Denali National Park, June-August 1995-1997

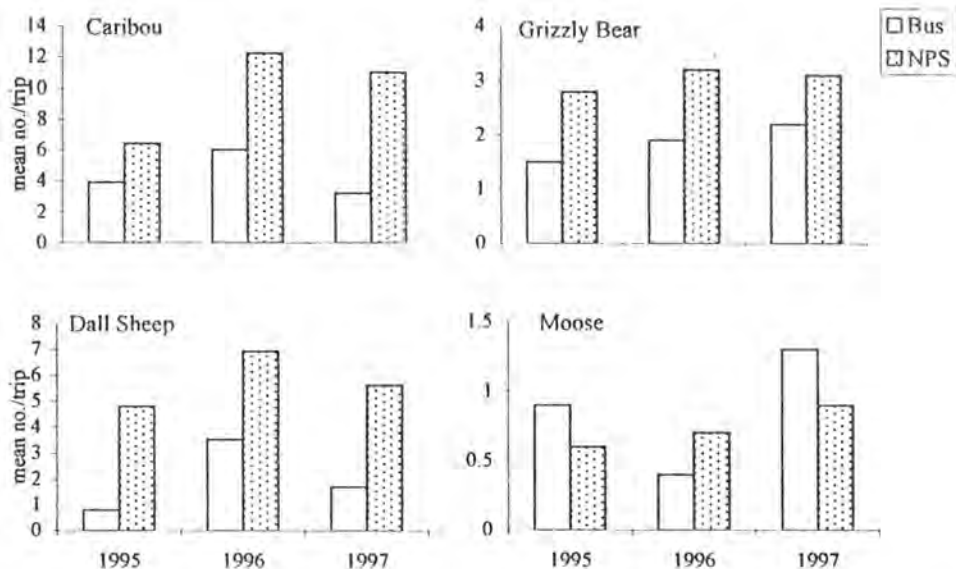


Figure 1. Annual mean number of individuals observed per trip by bus drivers and NPS biologists by species and year, Denali National Park, June-August 1995-1997

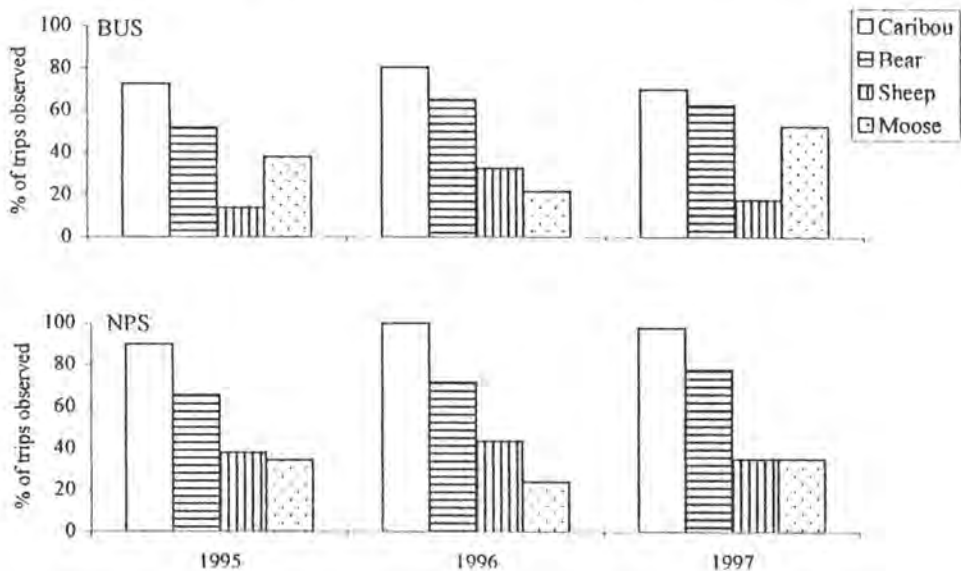


Figure 2. Proportion of trips each species was seen, Denali National Park, June-August 1995-1997

The consistent agreement in the trends of abundance was also apparent in the proportion of trips when at least one individual of each species was observed (Figure 2). Although bus drivers had a lower proportion of trips when caribou, bears, and sheep were observed than did biologists, the trends of the proportions were consistent across years. There was no statistical difference between techniques in the proportion of trips when moose were observed ($\chi^2 = 2.081, 2 \text{ df}, P = 0.312$).

Discussion

In our comparison between park road bus drivers and NPS biologists, the observed abundance of animals varied by year and technique. Although Singer and Beattie (1986) found no difference in wildlife visibility from buses and pickup trucks, biologists, not bus drivers, observed from the buses. During each year of our study, bus drivers recorded fewer caribou, grizzly bear, and Dall sheep than did NPS biologists. However, documenting changes in abundance, rather than accurate population estimates, is frequently sufficient for a long-term monitoring program. Daily movements of animals, number of observers, the influence of weather on animal behavior and visibility, height and speed of the vehicle and chance all influence the number of individuals seen along the park road. Given this inherent inaccuracy, the two techniques exhibited remarkable agreement of the changes in the abundance and the proportion of trips each species was observed. We therefore conclude that wildlife data collected by bus drivers is suitable to monitor caribou, grizzly bear, Dall sheep, and moose abundance along the park road in Denali National Park.

A benefit of this type of long-term monitoring program is its cost-effectiveness. Using three bus drivers to collect wildlife data with an NPS biologist to administer the program reduced the cost more than 70% for Denali National Park compared with having two NPS biologists collect the data. A savings of this magnitude could mean the difference between having a long-term wildlife monitoring program and doing without.

Non-biologists could also be trained to monitor wildlife in other national parks and public lands if they regularly visit the study area (e.g., transportation system drivers, law enforcement officers, maintenance workers, delivery drivers, and volunteers). Recruiting participants is easier and the data more reliable if the data collection procedure is quick and easy to understand. However, scientific rigor must be maintained (Silsbee and Peterson 1993). We recommend developing a simple, inclusive data form and comprehensively training all participants in proper data collection procedures. We also recommend frequently checking completed data forms for accuracy and integrity throughout the sampling period (Shampine 1993). We encourage providing equipment that enhances the precision and accuracy of the data as much as possible (e.g., using laser range-finders for determining distances instead of using visual estimates). Uniform sampling over the entire study period and stratifying by time of day also reduces biases.

The use of non-biologists can extend research and monitoring studies within limited budgets. The Christmas Bird Count of the National Audubon Society, the Hawk Mountain Sanctuary migration monitoring (Bildstein 1998), and the Breeding Bird Survey (Peterjohn et al. 1994) are other examples of the successful use of data collected by non-biologists for long-term monitoring programs.

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How Do We Discover What We Don't Know in the Smokies?

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Great Smoky Mountains National Park was established out of 500,000 acres of private land as a gift from the states of North Carolina and Tennessee. It has been the most heavily visited of America's 54 national parks since it commenced operation in 1934. In 1999, some 10 million visitors came to the park. This particular national park was literally snatched in the nick of time from the timber companies and encompasses over 100,000 acres of uncut forests, including 19 national champion trees. On a clear day one can distinguish real mountains out there—16 peaks over 6,000 feet, representing most of the major life zones in the East.

Most importantly for our focus here today, the park possesses a number of species groups with regional, national, or global significance in terms of diversity. And we have yet to find out what we need to know about them. The park has as many tree species as there are in all of Europe; ore salamander species, in more genera, than anywhere else; and many groups of invertebrates. Scientists believe multi-cellular life in the park could be as high as 100,000 species (we have only documented the presence of 10%). All this diversity has been a factor in designating the park as an international biosphere reserve and a World Heritage site.

Some of the problems and unwanted changes that concern us today are:

- Exotic species, including 30 pest plants, nine serious forest insect and disease problems, and non-native trout and hogs.
- Pollution—mostly air pollution. Some of the highest depositions of nitrate and sulfate in North America have been recorded in Great Smoky Mountains. Ozone 24-hour accumulation is higher in mid-elevations of the park than in regional metropolitan areas.
- Habitat loss and fragmentation.
- Boundary urbanization, as well as reservoir impoundments from earlier decades.
- Loss of habitat in the park due to wildland fire suppression and early park development.
- Poaching. It's not just game animals, but moss, American ginseng, salamanders, butterflies, and who knows what else.

We know how to minimize unwanted changes: we can conduct traditional resource management. But we believe that we have been arrogant in the past by assuming that what we know is all we need to know about park resources.

It is most efficient, with limited funding and scarce personnel time, to detect problems early and prevent unwanted changes. If we were to have to "fix" changes after serious damage, we are in no way prepared to do that. In order to be ready, we have to be able to detect changes. Long-term ecological monitoring can increase a park's probability of doing that—sometimes even after just a few years.

An example: in 1987, the park learned that a heretofore-unknown fungus was infecting butternuts, a medium-sized native tree closely related to the black walnut. We instituted a limited, quick monitoring project solely to see if the fungus was slowly killing butternuts in the park, as the U.S. Forest Service (USFS) suspected. The trees were tagged and re-assessed every three years, and by 1993 we had three data points. By this time, the species had declined so much that it had been designated as a candidate for a federal listing as a threatened and endangered species. We shared our data—which showed a steady loss of trees correlated with fungal cankers—with the USFS forest health program. The chief of the USFS convened a meeting in Washington to see what could be done to keep the butternut from declining to the point of federal listing. Smokies data proved to be the oldest such data set around, and was a

major contributing factor to the USFS chief's ban on cutting butternuts in all Eastern national forests.

Unfortunately, some of the unwanted changes now occurring in the Smokies are of such a magnitude that we believe we are losing species before we can even catalogue them. Over the years we have completed natural resource inventories sporadically, as soft funding becomes available. At that rate, in the Smokies we figure it will take us 150-200 years to complete all of them. Over the past few years we have discovered a great deal of interest in the scientific and education communities in pursuing an all-taxa biodiversity inventory (ATBI), initially in the Smokies but eventually elsewhere in the country as well. An ATBI is an intensive inventory of all biological groups conducted over a relatively short period of time. This strategy has been developed and championed by Professor Dan Janzen of the University of Pennsylvania.

My point during this short time frame is to emphasize that we cannot hope to know enough to protect the Smokies (or other natural resource reserves) by touting them as "vacationlands" for America. As an agency, we need to transition from management based on recreational and scenic values to focusing on heritage values. We need the public to value their parks as special places, where the most exciting thing going on in them is the study of natural processes and the collection of important information about all species known in this country.

The parks should be a *sentinel system for the continent* for all natural and unnatural changes. By investing in more natural resources inventory and long-term monitoring activity in the parks, we will attract science and education partners in unprecedented numbers. The public will finally appreciate us for what we are—and we can prevent and reverse the trends that threaten our parks' resources.

Is Great Smoky Mountains National Park Acting as a Population Source for Wood Thrushes?

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"How cool and assuaging the thrush's note after the fever of the day! I doubt if they have anything so richly wild in Europe. So long a civilization must have banished it. It will only be heard in America, perchance, while our star is in the ascendant."

— Henry David Thoreau, 1852 [1962]

Even in 1852 Thoreau observed that habitat destruction and fragmentation (due to civilization) could have detrimental effects on the populations of wild birds. Certainly the American star has been in the ascendant for the 145 years since these words were written. And indeed there has been growing concern in recent years for the populations of neotropical migratory landbirds in general, and the wood thrush (*Hylocichla mustelina*) in particular. The Breeding Bird Survey (BBS), the annual nationwide survey of breeding birds begun by the United States Fish and Wildlife Service in 1965, represents the best data set available to assess continent-wide trends in the populations of bird species. By the late 1980s, the BBS data suggested that populations of neotropical migrants were experiencing broad-scale declines (Robbins et al. 1989). In particular, wood thrush populations were shown to be experiencing a global decline.

Complicating the analysis of long-term census data is the fact that local populations of neotropical migrants represent elements of metapopulations with sources and sinks (Pulliam 1988; Brawn and Robinson 1996). Wilcove (1985) identified a relationship between forest patch size and predation on artificial nests. He found that a higher percentage of nests were depredated in smaller fragments and in more suburban landscapes. Robinson, Thompson et al. (1995) demonstrated that the nesting success of neotropical migrants in forest fragments in the Midwest is probably insufficient to maintain the breeding populations in many fragments. In a study specific to wood thrush nests, Hoover et al. (1995) found a positive relationship between forest patch size and nesting success. These studies suggest that the populations of neotropical migrants should be thought of as metapopulations consisting of sources and sinks.

Higher rates of nest predation are not the only threat to wood thrush populations on the breeding grounds. Nest parasitism by the brown-headed cowbird (*Molothrus ater*) is an additional factor contributing to the failure of populations to sustain themselves. May and Robinson (1985) clearly showed how high rates of nest parasitism by a generalist brood parasite can have severe impacts on the populations of some of its host species. The conversion of forests to farmlands and the increased use of mechanized harvesting that leaves more waste grain available to cowbirds throughout the winter have allowed the population of cowbirds to increase markedly in this century (Terborgh 1989; Robinson, Rothstein et al. 1995). Brood parasitism by cowbirds can significantly reduce the number of host young that are fledged. Cowbird chicks generally hatch before host chicks and demand resources from the host parents. In addition, cowbirds may remove a host egg near the time of laying their own (Robinson, Rothstein et al. 1995). These behaviors can reduce the number of host fledglings per successful nest, especially when nests are parasitized multiple times. For example, Robinson (1992) found nearly four times more cowbird eggs than wood thrush eggs in 15 wood thrush nests in forest patches in central Illinois. The result was only one wood thrush fledged from the 15 nests, and four out of five

fledgling broods being fed by wood thrush consisted entirely of cowbird young. One nest actually contained 12 cowbird eggs!

There is a strong geographic trend in cowbird parasitism on wood thrush nests. Hoover and Brittingham (1993), using nest records from the Cornell Laboratory of Ornithology, found that a higher proportion of wood thrush nests was parasitized and more cowbird eggs were laid in parasitized nests in the Midwest than in the Mid-Atlantic and Northeastern regions of the USA. The rate of parasitism was positively correlated with the number of cowbirds detected on BBS routes and negatively correlated with the number of wood thrush detected. Other studies in Midwestern forest patches have found the rate of parasitism to be negatively correlated with the degree to which the surrounding landscape was forested (Robinson, Thompson et al. 1995; Donovan et al. 1995). Even within the largest forests remaining in Illinois, Trine (1996) found high rates of nest parasitism and a high incidence of multiple parasitism on wood thrush nests.

In contrast, the Eastern USA has the lowest rates of parasitism (Hoover and Brittingham 1993). Some small, isolated forest patches have been shown to experience consistently low rates of cowbird parasitism on wood thrush nests (e.g. Roth and Johnson 1993). In fact, in a Maryland woodlot, Link and Hahn (1996) ranked wood thrush as the host species least likely to be parasitized based on Bayesian estimation.

In light of the trends in the BBS data for wood thrush and the work by Robinson, Thompson et al. (1995) and Hoover et al. (1995), it seems reasonable to expect that the heavily forested landscape of the southern Appalachian mountains may act as an important population source area. Great Smoky Mountains National Park, a nearly completely contiguous tract of forest approximately 200,000 hectares in size, may represent the ideal place to expect nesting success for wood thrush to be high. Indeed, this is where Wilcove (1985) found the lowest rates of predation on artificial nests.

Wilcove (1988) also revisited areas in the park that had been censused by Fawver in 1947-1948 (also see Kendeigh and Fawver 1981). He concluded that the distribution and abundance of neotropical migrants had not significantly declined within the park. This indicated that the park might act as a refuge for populations of birds sensitive to habitat fragmentation.

The goal of our study was to evaluate whether Great Smoky Mountains National Park is acting as a population source for the wood thrush. To address this, we designed the study to estimate the seasonal fecundity of wood thrushes. This estimate of seasonal fecundity allowed us to investigate the population dynamics and evaluate the source or sink status of the park.

Study Area and Methods

Great Smoky Mountains National Park is located in the southeastern USA, straddling the border of North Carolina and Tennessee. It encompasses a wide range in elevation, from just over 300 m to over 2,000 m. Since its establishment as a national park in the 1930s, all logging has been prohibited and forest fires have been controlled. This has resulted in the park being a nearly contiguous forest with a broad range of habitat types.

We conducted intensive searches in a number of locations, mostly on the Tennessee side of the park. Once a nest was found we returned to it about every third day to monitor its progress until it failed or the chicks fledged. Nest checks were conducted quickly so as not to cause unnecessary disturbance to the nest or nest-site. Often, nests were only observed from a distance to see if they were still active. Chicks were considered to have fledged if they survived ten days after hatching because when wood thrush chicks reach this age, they often jump out of the nest if disturbed. Chicks normally fledge at about 12-15 days (Roth et al. 1996). We calculated daily nest survival rates after Mayfield (1975). We estimated seasonal fecundity with the model developed by Pease and Grzybowski (1995). We combined adult and juvenile

survival rates from the literature for a simple Leslie (1945) matrix model to determine the source or sink status of the park.

Results

We located and monitored 426 wood thrush nests between 1992 and 1997. A total of 229 nests failed during the 5,516 nest-days, resulting in a daily survival rate of 0.958. Only seven nests were parasitized by brown-headed cowbirds.

The estimate of seasonal fecundity was 2.76 fledglings per breeding female. We used 62% as our estimate of adult annual survival and 31% as our estimate of juvenile survival. The Leslie matrix predicted that a seasonal fecundity of 2.58 would be required to maintain the wood thrush population in the park. Therefore these models suggests Great Smoky Mountains National Park is acting as a population source for wood thrushes.

Discussion

Despite the fact that the observed daily nest survival rates were not very high (see also Farnsworth and Simons in press), the estimate of seasonal fecundity in Great Smoky Mountains National Park (2.76 fledglings per female) was considerably higher than the productivity measured by Trine (1996) in Illinois (0.3 to 2.1). This was most likely due to the much higher incidence of brood parasitism by cowbirds in Illinois. The estimates of seasonal fecundity in the park were much more similar to those of Roth et al. (1996) in Delaware (2.62 fledglings per female), where cowbird parasitism is also low.

The best available data for return rates of adults come from the long-term study in Delaware by Roth et al. (1996). Survival rates based on return rates are necessarily biased because they do not include emigration. In particular, return rates appear to be sensitive to the nesting success of the previous year (Trine 1996; Roth and Johnson 1993). Roth et al. (1996) corrected for these biases by reporting the return rates of birds which had used the site for three, four, and five years. These ranged from 64-75%, leading Roth et al. (1996) to estimate survival rates of adult wood thrushes to be between 70% and 75%. Therefore we believe our estimate of 62% is conservative.

Unfortunately, no reliable data exist for the annual survival rates for juveniles. For a hypothetical neotropical migrant, Temple and Cary (1988) estimated juvenile survival to be half that of adults and used 62% adult survival and 31% juvenile survival. Under these assumptions, the park should act as a population source. However, if survival rates are lower for adults (~50%) and juveniles (~25%) then not even Great Smoky Mountains National Park can act as a population source. Survival rates as low as this could not have existed during the evolution of the wood thrush unless nest survival rates were extremely high. The large national park probably provides one of the best areas in which to study the likely "natural" predation rate on wood thrush nests.

Our work in the park suggests that large forests in forested landscapes can indeed serve as good places to maintain populations of neotropical migrants and probably serve as significant population source areas. However, this was not due to significantly higher survival rates of nests. Perhaps surprisingly, daily survival rates were not as high as would be expected based on the extensive work by Robinson, Thompson et al. (1995) and Hoover et al. (1995). In these studies, wood thrush nest survival rates were higher in larger forests, but the largest forests in these studies were not as large as Great Smoky Mountains National Park. Our results indicate that the nest survival rates in the park are not as high as those for the largest forest fragments studied elsewhere. For example, Hoover et al. (1995) reported daily survival rates for nests in the large forests greater than 0.98, considerably higher than what we observed in the park (<0.96). This may be due to a greater diversity or abundance of nest predators in the park. However, the daily nest survival rates observed in the park

do not appear to prevent the Smokies from acting as a population source. The re-nesting ability of wood thrushes is probably sufficient to overcome this presumably natural predation pressure.

Another strong conclusion of this study is that brood parasitism by the brown-headed cowbird is not currently affecting productivity of wood thrushes in Great Smoky Mountains National Park. A very small percentage of nests were parasitized (<2%), and each of these only contained one cowbird egg. In large forests in Illinois, Trine (1996) concluded that cowbird parasitism and nest predation contributed about equally to low seasonal fecundity. This was mostly due to the high incidence of multiple parasitism. Our study found that in the virtual absence of brood parasitism, wood thrush populations should be able to sustain themselves even when nest predation rates are moderately high.

Almost all of the brood parasitism observed was in Cosby campground (six out of the seven parasitized nests). This suggests that even within a large forested landscape, the presence of a heavily used campground may provide cowbirds with access to nests of forest-interior species. At present the level of parasitism is too low to affect the seasonal fecundity of wood thrushes. If this rate of parasitism were to substantially increase, the combined effect of parasitism and the existing moderately high nest predation could prevent wood thrushes from fledging enough young to maintain the current populations.

The large size of Great Smoky Mountains National Park should contribute to its role as a significant source for wood thrushes. The extensive nesting habitat in the park has the potential to produce thousands of birds to maintain sink populations in other areas. Future work should attempt to quantify the amount and occupancy of available habitat in order to estimate the size of the breeding population within the park. Perhaps large protected areas can help prevent civilization from banishing the richly wild song of the wood thrush.

Acknowledgments

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Nutrient Loads Traced to Interbasin Groundwater Transport at Buffalo National River, Arkansas

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Probably everyone has looked at a spring and wondered where the water comes from. When water quality monitoring indicates that a spring is polluted, however, knowing the source of its water becomes more than a mere curiosity. Water quality studies at Buffalo National River have shown that springs, and streams influenced by springs, typically have the highest concentrations of nutrients and are significant contributors to the nutrient load of the national river during base-flow conditions.

Many units of the National Park Service (NPS) are located in karst regions, or areas of soluble bedrock that are characterized by natural underground plumbing. Water resource assessments can be especially challenging in these terrains. Protection and management of karst watersheds is often made difficult because their limits are not known. Although obvious in many geologic settings—as one simply follows topographic divides—watershed boundaries of karst aquifers typically are not governed by surface terrain.

Buffalo National River is located in the Ozark Plateaus of northern Arkansas, one of the USA's largest karst regions. The term karst refers to a landscape modified by chemical and physical erosion of soluble strata, and is characterized by losing streams, sinkholes, caves, springs, and underground drainage. Two-thirds of the Buffalo River's 857,607-acre watershed has soluble limestone and dolomite exposed at the surface (Scott and Hofer 1995). The study area (Figure 1) covers approximately 57,000 acres and contains numerous springs and caves, including a commercially operated tour cave (Mystic Caverns) and the longest cave in Arkansas (Fitton Cave). The study area is characteristic of the national river's broader karst environment, and an understanding of groundwater processes here can be applied to other karst basins which contribute flow to the Buffalo River.

Of national significance, the Buffalo River is one of the country's few remaining undammed rivers over 150 miles in length. A clearwater stream, biologically productive and diverse, it is a scenic attraction drawing over one million visitors each year. Congress mandated that the NPS protect the "free-flowing" nature of this stream and its attendant water quality. This edict is extremely challenging given that the NPS owns only 11% of the river's watershed. With upstream land use and development dominated by agricultural and silvicultural activities, nonpoint source pollution is a major concern.

The state of Arkansas also recognizes the significance of this riverine resource and has designated it an Extraordinary Resource Water, thereby mandating no reduction of water quality. To assess state and congressional protection mandates, Buffalo National River launched a water quality monitoring program in 1985 under the guidance of NPS's Water Resource Division. The Arkansas Department of Environmental Quality (ADEQ) provides laboratory analysis as part of this program and assists with numerous water resource studies. As an unbiased earth science agency, the U.S. Geological Survey (USGS) is providing geologic mapping and participates in developing a hydrogeologic framework of the area (Hudson 1998).

Water quality monitoring determined that Mill Creek contributes as much as 96% of the nitrate load in the Buffalo River below their confluence (Maner and Mott 1991). This percentage is highest during periods of low base flow (base flow in this

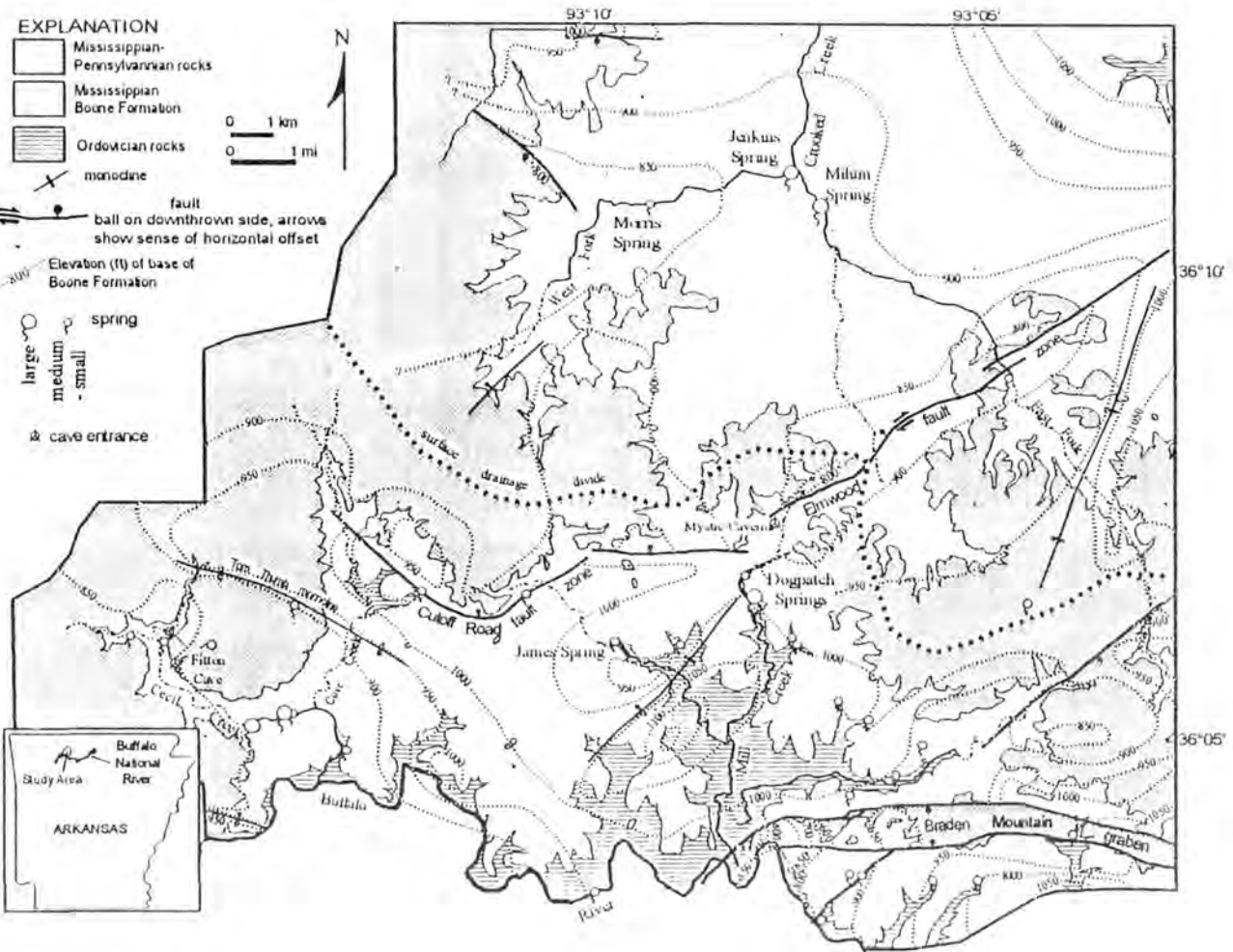


Figure 1. The study area and relative aspects of its hydrology and geology

paper refers to stream flow dominated by groundwater input as opposed to surface runoff), such as might be observed in late summer. Subsequent investigations showed that elevated nutrient (nitrate and phosphate) concentrations affect aquatic communities in both Mill Creek and the Buffalo River (Mathis 1991; Bryant 1997). A synoptic study over the length of Mill Creek showed that these nutrients originate from two springs (Upper and Lower Dogpatch) at the head of this tributary (Maner and Mott 1991).

Field observations suggested that the Dogpatch Springs discharged a relatively high volume of water considering their position near the head of the Mill Creek topographic basin. Discharge was measured once each season throughout a range of base flow conditions to estimate the yearly average where Crooked Creek and Mill Creek exit the study area. Average yearly base-flow for Mill Creek (23.6 cubic feet per second) was divided by its topographic watershed area (21.3 square miles; Sullivan 1974) to yield a discharge/area ratio of 1.1 cfs/sq mi (Figure 2). Similar measurements for the adjoining Crooked Creek basin yielded a discharge/area ratio of 0.65 cfs/sq mi. The discrepancy between these ratios provided the first quantitative evidence that flow in Mill Creek is augmented by groundwater transferred from the Crooked Creek basin via a subsurface drainage network.

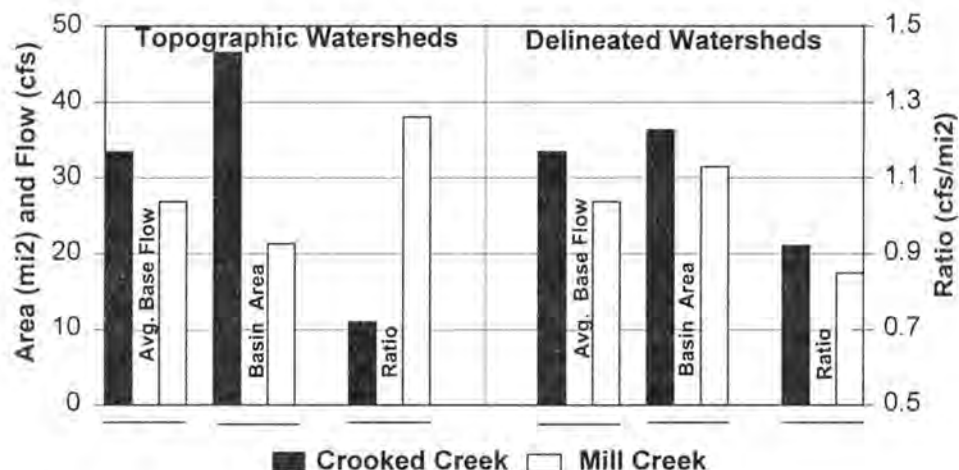


Figure 2. Average base flow and basin size comparisons for topographic and delineated basins with respective discharge/area ratios

The overall goal of this study was to form a conceptual model of groundwater flow and contaminant transport within the Buffalo River's karst aquifers. To achieve this goal the following studies were conducted: detailed geologic mapping, karst inventories, groundwater basin delineations, and discharge and water quality measurements. Geologic mapping was conducted by the USGS under a cooperative program with NPS's Geologic Resources Division. Karst inventories and basin delineations were conducted by the Ozark Underground Laboratory and funded by NPS's Water Resources Division. Discharge and water quality measurements were col-

high frequency of springs near this contact is attributed to the less permeable nature of Everton Formation sandstones and dolomites, which variably underlie the 400-ft-thick more permeable (secondary porosity) limestone of the Boone Formation. Thirty-six percent of the remaining springs lie near faults and monoclines (Figure 3; Hudson 1998). Three springs issuing from the middle of the Boone Formation are associated with a major chert horizon that is most prominent in the Crooked Creek portion of the study area.

Structure contours show the elevation of the base of the Boone Formation in map view (Figure 1). Large springs within the Buffalo River basin in the southern part of the study area are spatially associated with structural lows, suggesting that these lows may develop extensive karst networks and preferentially gather groundwater from surrounding regions. In the southwest part of the study area, for example, large springs along Cecil Creek, as well as Fitton Cave, all lie within a broad structural trough bounded on the north by the Tom Thumb monocline. A second example is the location of Upper and Lower Dogpatch springs which emit near the base of the Boone Formation just south of a large low caused by downdrop of the intersecting Elmwood and Cutoff Road fault zones. Given the present topography, the Dogpatch springs occupy the lowest point where groundwater could exit from the corner of this downdropped structural block, thus providing an element of structural control over the location of these large springs.

Trending toward the Dogpatch springs is the northeast-striking Elmwood fault zone which contains an array of en echelon faults and associated fractures. This zone is the only major structure that traverses both the Crooked Creek and Mill Creek basins. A concentration of karst features, including Mystic Caverns, that corresponds with the fault zone suggests that fractures associated with the zone have enhanced solutional processes. Based on these observations, this zone of solutionally enlarged fractures may preferentially drain groundwater within the Crooked Creek watershed and allow it to flow southwest across the watershed boundary to discharge at the Dogpatch springs.

A total of 12 dye traces were conducted to delineate groundwater recharge areas and test the interbasin flow hypothesis developed from the preliminary karst hydrologic inventories and geologic mapping. Paths of the various dye traces (Figure 4) along with intervening surface topography were used to delineate that 10.2 sq mi of the Crooked Creek topographic basin supplies groundwater to the Dogpatch Springs. The total area of the Dogpatch Springs' groundwater basin is thus 13.8 sq mi, or almost four times larger than their topographic watershed (3.6 sq mi). Adding this additional area (10.2 sq mi) to the Mill Creek topographic basin, and subtracting this same area from the Crooked Creek topographic basin, resulted in discharge/area ratios for the delineated basins of 0.75 and 0.82 cfs/sq mi, respectively (Figure 2). These numbers are bracketed within accepted measurement errors, substantiating the accuracy of the karst aquifer delineations.

The shape of the topographic and delineated basins relative to the Elmwood fault zone provides an indication of its influence on surface runoff and groundwater recharge. This fault zone appears to influence the shape of the surface basin, probably as a result of decreased erosional resistance within this fractured lineament (Figure 4). However, the shape of the groundwater basin appears to be independent of this structure as indicated by several dye introductions into this zone along its northeastward trend. The location and elevation of the delineated recharge divide, intermittent and perennial streams, and springs within the study area were used to simulate groundwater gradients within the Boone Formation. The southward gradient toward the Dogpatch springs (0.008) is about twice as steep as the northward gradient (0.004) toward Jenkins Spring, and is consistent with the regional potentiometric surface (Pugh 1998). These results indicate interbasin transfer is mostly independent of interbasin structures, and is principally a function of hydraulic gradient. However,

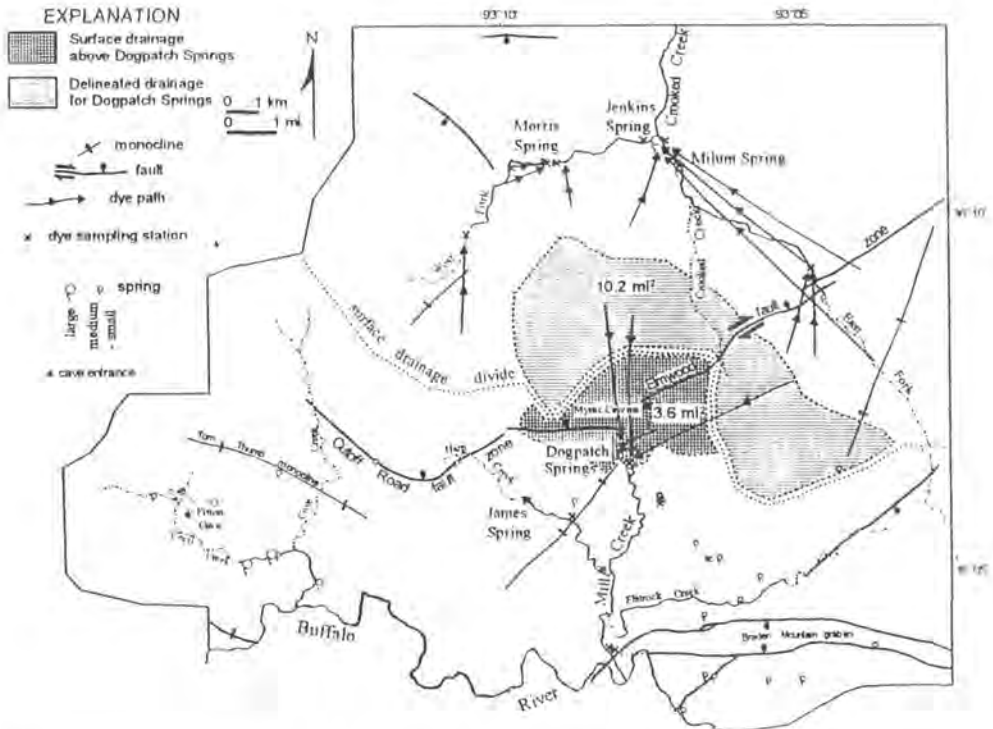


Figure 4. Dye trace paths and topographic and delineated watersheds

the location of springs and the size of their recharge areas appear to be controlled by combined elements of groundwater gradient, stratigraphy, and structure.

Land use in the Crooked Creek basin is dominated by agriculture, whereas the Mill Creek basin is predominantly forested. Agricultural land uses within the Crooked Creek basin include confined poultry operations, dairies, hay production, and beef cattle operations. Other groundwater concerns arise from subdivisions served by on-site septic systems, service stations, illegal dumping in sinkholes and losing streams, and highways upon which hazardous materials are transported. The above concerns are heightened by the fact that karst groundwater transport is rapid and provides little chance for attenuation of contaminants. As an example, dye introduced into a sinkhole filled with cattle carcasses moved over two miles from the Crooked Creek basin to the Dogpatch Springs at the head of Mill Creek in less than five days.

The sewage treatment plant associated with the defunct Dogpatch Amusement Park and Dogpatch apartments discharges below the Dogpatch Springs. Before this study started, however, raw sewage was observed spilling from a lift station into the ephemeral portion of Mill Creek just above the Dogpatch Springs. Contaminants from this sewage system could complicate interpretation of water quality compari-

sons between the Mill Creek and Crooked Creek delineated basins because of its proximity to the Dogpatch Springs. Recent permit enforcement and monitoring by ADEQ shows the sewage system is now compliant and that the problems which caused the spills have been alleviated. Chronic leakage from this aging system is also possible, but water quality results from this study did not implicate exfiltration.

Four base-flow water samples were collected and analyzed for a suite of water quality parameters during 1998 and 1999 at major springs within the Crooked Creek and Mill Creek basins, and at a reference spring (Luallen Spring) within a nearby forested basin (Figure 5). In comparing spring water quality it was noted that James Spring was not a recovery point for any of the dye traces from the Crooked Creek topographic basin, Upper Dogpatch Spring received dye from one trace, and Lower Dogpatch Spring received dye from two traces. The highest nutrient concentrations were recorded at springs within the Crooked Creek topographic basin, as would be expected given the more intensive agricultural land use there. Nutrient concentrations within the Crooked Creek springs, however, were closely mirrored by those Mill Creek springs which received dye from the Crooked Creek topographic basin (Upper and Lower Dogpatch). James Spring was significantly lower in nitrates than either the Crooked Creek or the Crooked Creek-influenced springs, and the reference spring was significantly lower than all sites for both nitrate and phosphate. Average fecal coliform bacteria concentrations showed similar relationships.

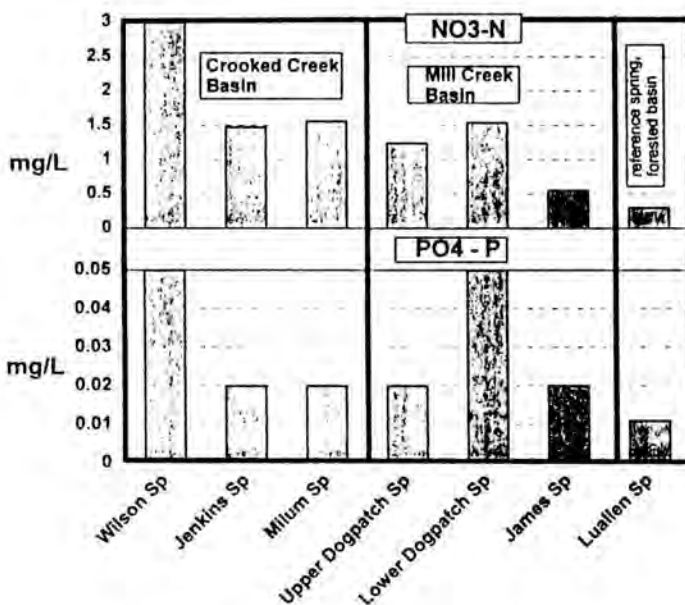


Figure 5. Average nitrate and phosphate concentrations at major springs in the Crooked Creek and Mill Creek basins, and at a reference spring

During summer, high water clarity, low discharge (and therefore low dilution), slow velocities, and warm temperatures make the Buffalo River susceptible to enhanced algal and cyanobacterial production caused by elevated nutrient levels. For perspective, the average nitrate concentration in the Buffalo River is 0.06 mg/L, whereas the average nitrate concentration at Lower Dogpatch Spring is 1.52 mg/L, twenty-five times greater (Mott 1997). Dissolved reactive phosphorus averages were

five times greater for this spring than for the river. Because nitrogen and phosphorus are limiting nutrients, raising their concentrations increases primary productivity. Increased aquatic plant production alters stream communities at various trophic levels, skewing them toward pollution-tolerant species or toward benefiting functional groups (filter feeders, scrapers or grazers, and herbivorous fish) (Mathis 1992; Bryant 1997; Petersen 1998). To park visitors, increased productivity means green water (phytoplankton), green slime (*Spyrogyra* and other filamentous green algae), and a general reduction in aesthetic appeal.

This study yielded the following conclusions: (1) base flow discharge/area ratios can be used to screen areas for interbasin transfer; (2) detailed geologic mapping and karst inventories, combined with dye tracing, can elucidate physical properties of aquifers which influence interbasin transfer and are therefore critical scientific, managerial, and interpretive tools in karst settings; (3) areas of interbasin transfer can be significant both in their size and in their influence on water quality and aquatic communities, and must be accurately delineated for effective water resource management; and (4) hazardous materials derived from spills, dumps, or leaks can be rapidly transported long distances via karst groundwater systems.

Based on these conclusions, the primary author recommends the following: (1) the current moratorium on liquid waste management systems placed on the Buffalo River watershed should be expanded to include areas outside the topographic basin which yield water to springs within the Buffalo River basin; (2) nonpoint source cost-share programs should receive special emphasis in sensitive karst basins, especially where these basins harbor nationally significant water resources; (3) a dye trace designed to detect exfiltration from the Dogpatch sewer system should be conducted to determine if leakage from this aging system is occurring; and (4) spring inventories should be conducted to collect background water quality data, to screen for interbasin transfer, and to locate springs for immediate assessment or response in the event of a hazardous material release.

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Missing Link in Ecosystem Management: The Role of Geology

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Introduction

Concern with modern humans' effects on the natural world is driving many to reconsider their approaches to land management. Several federal agencies, including the National Park Service, advocate an ecosystem approach. Ecosystem management is holistic, and it requires an understanding of the physical frameworks within which ecosystems function, including the geology.

Many of the effects people have on ecosystems come about indirectly through changes to the physical environment and processes. Ecosystem functions depend upon many physical parameters. Geologic structure, chemistry, processes, and stability affect both landforms and natural vegetation, and thus may determine indirectly an area's susceptibility to fire and rate of spread. Rates of erosion, shoreline change, sand dune growth or loss, glacial movement, soil development, and water infiltration influence ecosystems physically and chemically. *Encroaching development, imported earthen materials, and subsurface disturbances* (such as water wells, mineral development, and waste disposal wells) can alter geologic processes. These changes may accelerate erosion rates, alter groundwater flows, and expose chemically or physically unstable strata.

This paper presents some ways geology can help to foster sound ecosystem management. It explores roles geology plays in ecosystems under three broad headings: 1) the significance of geologic materials and landforms; 2) the importance of geologic processes, their relative histories, and whether or not processes can be considered continuous or sporadic; and 3) geochemical influences.

Ecosystem Responses to Geologic Materials and Landforms

Rocks vary in chemical composition, hardness, porosity, and cohesion, and affect ecosystems in many ways. Rock properties influence soil nutrient levels, erosion rates, groundwater availability and quality, the degree to which structures must be engineered, and the risk of geohazards. Physical and chemical conditions change when a site is disturbed, and may need to be restored to ensure either natural revegetation of the site or to ensure that seeding and planting efforts are successful.

Geologic processes are at work shaping the mountains, lakes, prairies, valleys, ridges, and other features that geologists call landforms. Specific landforms can provide clues to specific geologic processes. Landform stability or lack thereof determines if the local geology functions ecologically as a relative constant or as a variable, depending upon the life spans of particular species, their life histories, and their modes of dispersal.

Landforms exist and influence ecosystems at a range of scales, both directly and indirectly. Mountains make their own weather and climates. A rain shadow extends about 300 km east of the Rocky mountains, leading to a different prairie ecosystem than further east. Stream hydraulics sort bed particles into pools and riffles. The riffles function by aerating the stream water and providing pebbles for fish spawning beds, and the pools function as fish feeding, resting, and hiding habitat.

Groundwater is the water moving through porous or fractured rock and sediments. Available water, rock material and its porosity, sequence of rock formation bedding, and geologic structure are the primary controls over groundwater. Groundwater feeds springs and maintains stream flows and lake volumes into the summer and drought periods. One must understand how the natural geology affects aquifers, springs, riparian areas, the availability of potable water, and fisheries before one can fully understand how human impacts on the geology may affect these resources or may facilitate other geologic changes that will affect them.

Geologic Processes and the Biosphere

A geologic process is a progression of events in geologic time. Within a given process, geologic events are singular occurrences within the progression. For example, faulting is a process of movement on a plane involving a sequence of events. First, stress builds in the rock. Next, failure occurs in the rock at one point. Then, failure propagates along the fault. An example of an event in the faulting process is an earthquake or aftershock. A consequence of the faulting process over geologic time may be mountain-building.

Resource managers, interpreters, and administrators need to be aware of the implications of both progressive geologic change and geologic events for particular ecosystems. The earth's surface is changing and will continue to change long into the future. Ecosystems will change in response. Some changes will be rapid, but others will occur so slowly that managers may not perceive them.

A challenge in appreciating the relevance of geology is that geologists often work with very long relative time scales, whereas life-science specialists deal with much shorter time scales. But one must remember that the geologic time scale is actually made up of many shorter time scales and that the earth's geology is very dynamic and undergoing constant change. Some massive geologic changes are seen in a day's time, such as the debris flows in Shenandoah National Park in 1995. Others can be seen in our lifetime, such as the lava dome growing in the crater of the Mount St. Helens volcano. There are changes that we will never see, but they are occurring and will occur. Managers must be aware of what is changing and how fast the changes are occurring. Rapid geologic processes and events may function as variables in ecosystems. Slow, continuous geologic changes may be treated as constants in some ecosystem studies.

Predicting ecosystem stability or change must be done knowing an ecosystem's history, not just its present state. About 10,000 years ago, the earth was entering the present interglacial period and life started returning to glaciated North America. Significant changes also were occurring in unglaciated North America as it entered the interglacial period (Pielou 1991).

To better understand geologic processes and the significance of geologic time to ecosystems, one may compare and contrast various processes in terms of the durations and frequencies of events. Ecosystems are not disrupted if conditions change slowly, although with time, populations tend eventually to segregate and create islands of species and subspecies, shaping the course of evolution. Rapid geologic changes tend to be ecologically disruptive. Thus, in one group, we can put the processes that are continuous over more than 10,000 years, allowing stable ecosystems to develop. In a second group, we can put the processes that occur in single or episodic events completed in less than 10,000 years, and promote changing ecosystems. Of course, divisions shorter or longer than 10,000 years between what is considered constant and variable may be more appropriate in specific instances. Also, not every disruptive process causes ecological harm. Disruption by flooding is necessary to maintain riparian ecosystem functions and adaptations. Human actions that block or alter physical processes and events tend to alter ecosystems. Managers need to be aware of these physical processes and ecosystem dependencies.

Geologic processes lasting more than 10,000 years: Relative ecosystem constants. The continents are on great distinguishable plates of the Earth's crust. They move relative to each other on the order of centimeters a year. Over millions of years they have come together and separated. This geologic process placed the North American plate in the temperate climate zone.

Uplift of the Earth's surface into plateaus and mountains is a slow process, done through the mechanism of faulting and folding. Faulting occurs in rapid, periodic, relatively small movements. The result is that uplift and erosional lowering drive climatic and ecosystem changes.

Weathering, the physical and chemical breakdown of rock into smaller and smaller units, is the process that makes rock material available for soil formation. Soil is the growth medium for vegetation and harbors microorganisms, fundamental components

of ecosystems.

Continuous geologic change may be interpreted as a relative constant in ecosystem dynamics, but it is one of the driving forces of biotic evolution. Geology has produced a mosaic of habitats, some different and others alike, but physically isolated from one another. When apart, plants and animals evolve along different lines. This explains the great genetic differences in the composition of native ecosystems between continents, even those with similar climates.

Geologic barriers and distance separated many ecosystems in the past, but human actions today augment movement of biota among spatially and geologically isolated habitats (e.g., dispersal of exotic species). Invasions of some exotic organisms have led to the extinction of natives or have disrupted the stability of entire ecosystems. The movement of genotypes beyond natural barriers is significant biologically in the long term, on an evolutionary scale of time, considering that the long-range dispersal of many organisms was prevented for millions of years by geologic barriers before humans arrived.

Geologic processes lasting less than 10,000 years: Relative ecosystem variables.

Rapid geologic processes and events are the most likely to require immediate attention by managers. These include volcanism, earthquakes, landslides, lava flows, and the sudden collapse of caves with a thin roof (sink holes) in limestone. Human interference may catalyze some geologic events. Resource managers need to be aware of geologic processes and to consult with experts when planning and implementing resource and development projects. Landslides can occur on even moderate slopes—given sufficient water, even a 3-degree slope of clay or shale might fail.

Earthquakes, well-known for bringing death and destruction, are caused by fracturing of the rocks of the Earth's crust (faulting). Evidence for faulting is very common in mountains and hills. Even though less common and evident in prairies and plains, it may still be found there. Faulting near Yellowstone Park in 1959 and the resultant landslide dammed the Madison River and changed a riverine ecosystem to a lake ecosystem. Some of the largest earthquakes are caused by a portion of one of the Earth's crustal plates pushing suddenly under another. These giant earthquakes occur along the "ring of fire" all around the Pacific Ocean, and they can produce tsunami waves that cross the entire ocean, affecting life and property on distant coasts.

Volcanism is characterized by events in which mantle rocks erupt from the Earth's surface under pressure. Volcanoes are common in the western United States. Fresh basalt deposits frequently have such a rough and sharp rock surface that large animals cannot cross them. It takes many years of weathering for rock to break down enough for vegetation and animals to use it as fully developed habitat. The nature of volcanic eruptions depends upon the temperature, pressure, and composition of the lava. Basalt lava, which formed the Hawaiian Islands and the plateau region east of the Cascade Range, emerges and spreads out as a thick liquid. But the volcanic peaks of the Cascade Range formed from more silica- and water-rich kinds of rocks, including andesite and dacite, that are more viscous. These volcanoes tend to produce violent pyroclastic explosions of superheated steam, volcanic ash, cinders, and even volcanic boulders. The eruption of Mount St. Helens is the most recent example.

Geochemical Criteria Dictate Survival and Health of Biota

Knowing the nutrient requirements of an organism, and the chemistry of soil and rock, may help in determining why a plant or animal is present, or why it has disappeared or is in decline.

Only 22 elements are actually essential to life, and each is essential at a particular level. If an element is in short supply, it is said to be "limiting" or "deficient." There is generally an optimal level, typically measured in plant growth tests as a peak or plateau. Then, if the level increases to much higher levels, it begins to become toxic. An excess of selenium in rock and soil may lead to "blind staggers in some large mammals such as mountain goats and pronghorn antelope" (Robbins 1992). A selenium deficiency can

result in "white muscle disease."

In the natural world, plants—and, to a lesser extent, animals—are limited to the amounts of elements available to them in their individual locality. Understanding geologic conditions will help to discern which minerals are at, below, or above the required nutrient levels or known toxic levels. Also, knowledge about the geologic formations is key to knowing which processes will likely continue or change these amounts. Knowledge of geologic conditions and processes can help with other resource management issues. For example, knowledge of the buffering capacity provided by a local geologic formation will help biologists and physical scientists deduce the level of threat posed by acid deposition.

The transport of nutrient elements by various processes affects ecosystems in many ways. Nutrient elements can be recycled through ecosystem organisms many times. They are eventually lost by gas exchange or leaching, and then transported away. The transport may be via natural geologic processes or by those augmented by human actions. Therefore, in managing ecosystems, it is useful to know the nature and magnitude of both the transport processes and the human influences. Some of the important geologic processes include suspended transport by streams, solution transport in surface or groundwater, wind transport of suspended dust, and glacial transport in moving ice. Loss of essential elements may be accelerated by human activities such as agriculture, logging, and road construction. Human activity may also transport elements into, rather than from, ecosystems. Natural systems may be significantly disrupted by influxes of nutrients via agricultural runoff or disturbance of the local geology.

Conclusions

The National Park Service is adopting a systematic approach to natural resources management by seeking to understand park ecosystems. By focusing more upon how biotic and abiotic components interact, it can develop a more complete scientific base with which to support its resource decisions.

Geology influences many aspects of natural environments. Geologic structures and bedding are controlling factors in surface and groundwater flow. Landforms have a significant effect on weather and climate. Geologic processes, whether slow or fast, usually change environmental conditions and habitat. Rocks provide the structural base of landforms, the parent material of soils, and the source of the elements required by all biota. The ecosystems of each park exist within the context of its geology, among other factors.

Understanding the geology of national parks can help protect these magnificent natural treasures from unintended harmful actions. Knowledge of the geology may facilitate understanding the risk levels associated with geologic hazards. Geohazards (avalanches, landslides, earthquakes, and others) may be serious threats to park visitors and employees. Knowing the geology, terrain, and associated natural processes can help in planning to avert events such as costly human-induced landslides from road construction. Awareness of how ecosystems depend upon disturbance can be valuable in maintaining disturbance regimes.

Knowledge of past and current local geology and its dynamic relationships with other abiotic and biotic factors opens a window both into comprehending impacts to ecosystems, and ways to help mitigate these impacts. Consideration of geologic controls and constraints can increase success and lower costs of restoration and revegetation. A solid grasp of geologic conditions and processes can help parks to determine parameters for inventory and monitoring in order to identify ecological trends and to prepare for the future. Scientists today are studying geological processes to further the understanding of global warming. Geology deserves a key role in ecosystem management.

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Geological Science: Where Does it Fit in Ecosystem Management?

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Introduction

The geosciences traditionally have not been integrated into land management or ecosystem planning. This is, in part, because traditional approaches to land management perceived the landscape as a web of biological processes playing out on an inert geological stage as opposed to perceiving the landscape as a collection of processes—biological, geological, and social—that are interrelated and interdependent. Through the last two decades, the focus of land management has slowly been shifting from the former approach to the latter. This changing philosophy brings a need to devote increased attention to the geosciences, and especially to the interactions between the geological and biological systems.

Understanding geological processes is necessary for the fundamental reason that the geology defines the physical conditions of the landscape on which the biological and social systems operate. To manage successfully for conservation of species and habitats, a land manager must understand the spatial and temporal behavior of the geological system *and* be cognizant of the interactions between the geological, biological, and social systems. For instance, the geology is a major determinant of the topography, the water and soil chemistry, the fertility of soils, the stability of hillsides, and the flow styles of surface- and groundwater. These factors, in turn, determine where and when biological processes occur such as the timing of species reproduction, the distribution of habitats, and the design of cities. Likewise, biological processes affect geological processes. For instance, biological activity contributes to soil formation and soil fertility, controls hillside erosion, traps blowing sand to form sand dunes, stabilizes drainages, and attenuates floods.

This paper describes the changing role of geosciences in land management and ecosystem planning. Examples of geoscience management are drawn predominantly from the National Park Service, since the NPS manages lands containing some of the most dramatic geological features in the country and is the agency with which the author is most experienced.

The Neglected Science

Despite the fact that geology is often the defining factor in the distribution and sustainability of habitats, land managers are clearly more comfortable managing the biological system than its physical counterpart. I attribute this low comfort level to the following: 1) the common perception that geological processes occur at such slow rates and at such massive scales that human activities cannot easily affect them, 2) the perception that the biological and geological environments operate independently of one another, and 3) the lack of geological expertise in the resource management ranks, stemming from the historic roles of resource managers and geologists. These three points are addressed below.

An incorrect perception: geological processes occur so slowly and at such massive scales that human activities cannot easily affect them. Geological processes occur over a variety of temporal and spatial scales. At one end of the temporal spectrum lie the processes that occur over millions of years, such as the rising of a mountain range or the widening of a rift. At the other end lie the processes that occur virtually instantaneously (and often catastrophically), such as floods, landslides, and earthquakes. Between these extremes are processes that are not easily pinpointed in time but are rapid enough that we can easily observe changes in geological features as they occur. Often, they occur continuously or in repetitive cycles. Examples of these are shoreline movement, river transport of sediment, soil formation, and cave development.

Spatially, geological processes are as diverse as they are temporally. The absorption of chemical elements to sediment particles may be the key process in determining groundwater chemistries. This process occurs at the microscopic level. In contrast, the geothermal activity at Yellowstone or Lassen Volcanic national parks is related to the convergence of tectonic plates at a global scale.

An incorrect perception: the biological and geological environments operate independently of one another. Therefore, the management of species does not require an understanding of the geological environment. The geological resources of a park—the soils, the caves, the fossils, the stream network, the springs, the volcanoes, the gullies—provide the precise set of physical conditions required to sustain the biological system. Interference with geological processes and alteration of geological features inevitably affect habitat conditions. For example, the channelization of the Virgin River in Zion National Park caused the channel to incise, lowering the groundwater table and reducing the habitat of floodplain-obligate species (based on the author's riparian survey in the summer of 1998; Steen 1999). In Jean Lafitte National Historical Park and Preserve, externally triggered land subsidence is raising the water level in the park, inundating the swamp forest and reducing habitat for forest-dependant species (Sauier 1994). Likewise, a manipulation of the biological system can trigger changes in the geological system that can re-affect the biological system. For example, when beavers are trapped to increase the density of hydrophytic shrub species, the river morphology and sediment transport capacity changes resulting in a redistribution of the types of fish species that predominate.

Lack of geological expertise in the NPS. The lack of geological expertise in the resource management ranks stems from the historic roles of resource managers and geologists. Early resource managers in the national parks were wildlife rangers whose major functions were to promote game populations and maintain the parks aesthetically (Sellars 1997). They were not concerned with conserving the ecological health of the parks; indeed, they often interfered with such natural processes as predator-prey relationships, fire, and floods in order to minimize the inconvenience to and maximize the enjoyment of visitors. Despite the fact that resource management issues have grown increasingly complex, requiring the attention of both geologists and biologists, the initial assumption that resource managers should be biologists still stands.

In addition, geologists were often (and still are) regarded as mineral explorationists concerned with locating and extracting mineral resources, not as conservationists (Higgins, personal communication, 1999; Kerbo, personal communication, 1999). Despite the fact that the geology often defines landscape behavior, geologists are not generally considered qualified to manage land resources.

The History of Geology and Ecosystem Management

John Wesley Powell may have been the first geologist to publicly attempt ecosystem planning from a geological basis when, after exploring the desert Southwest, he suggested to the U.S. Geological Survey that large-scale development in the region was inappropriate given the scarcity of water and encouraged regional planning based on water occurrences. (It is worth noting that Powell resigned from the Survey shortly thereafter over this and other issues!). During the late 19th and into the early 20th century, a few land classification programs were initiated by the Department of Interior and Army Corps of Engineers, mainly for the purpose of classifying lands for entry (Nelson, personal communication, 1999). The Natural Resource Conservation Service's soil survey program was (and still is) a comprehensive attempt to plan land uses on a landscape scale using geological variables (e.g., soil types, bedrock types, drainage characteristics, and gradient).

Within NPS, it was during George Wright's leadership that the concept of ecosystem management was first expressed. Wright questioned the agency's utilitarian and recreational approach to land management and encouraged managers to view

landscapes in ecological terms (Sellars 1997). Despite this pioneering attitude, Wright regarded the landscape as a biological system and did not expand his focus to include geological processes. The influential Leopold and National Academy of Sciences reports of 1963 both articulated that parks were complex ecological systems requiring scientific attention by trained biologists, but did not explicitly acknowledge the role of the geological processes in ecosystems (Sellars 1997). In 1995, as part of the NPS reorganization, the agency created the Geologic Resources Division in the Natural Resources Program Center, presumably as a result of an increasing awareness that geology merits more attention by park managers.

In the last several years, there has been renewed interest in the geological community to apply geological information to landscape assessments. In a field that has been dubbed "geo-ecology," researchers are realizing the interdependencies between the physical and biological environments, and that geology can provide critical information to ecosystem planning efforts. This is evidenced by the fact that the Geological Society of America offered sessions in geo-ecology at their 1996, 1997, and 1998 annual meetings. The advent of the Geographic Information System (GIS) is also playing a significant role in integrating geology in ecosystem management. GIS provides the tools to conduct landscape assessments that effectively integrate biological and geological data sets in both space and time. As GIS data sets are developed and the technology becomes more affordable, integrated landscape assessments may become not only the accepted but the expected approach to large-scale land management.

Opportunities for Integrating Geology into Land Management

The efficacy of ecosystem management can be significantly improved with the integration of geology. This section offers scenarios in which geology can be used to enhance the quality of landscape-scale management. This list is not inclusive as the potential of using the physical sciences to manage habitats and conserve species is considerable.

Watershed assessments. Perhaps the most common example of an integrated approach is that used by watershed scientists in assessing watershed behaviors and characteristics. Watershed scientists, often motivated by a desire to preserve aquatic species and habitats, have realized that the conservation of riparian zones depends on the maintenance of the physical processes and conditions that operate in the watershed (Meehan and Bjorn 1991; Schlosser and Karr 1978). Hence, watershed assessments usually involve, at a minimum, investigating the surface and bedrock geology, near-surface geochemistry, and hydrologic regime in addition to investigating such landscape ecological factors as connectivity, habitat patch sizes, and species distributions. Notable examples of integrated watershed assessments are the Kickapoo Valley Watershed Conservation Project in southwestern Wisconsin (Smith, *in press*; Hewitt, personal communication, 1998) and the South Florida Ecosystem Project (USGS 1999).

Habitat conservation. The geology dictates, to a large extent, the physical landscape characteristics, which, in turn, dictate the biological landscape characteristics. Understanding the physical requirements of specific species and where those physical requirements are met (in space and time) on the landscape facilitates the identification and, hence, the protection of species' habitats. The identification of potential locations of hanging gardens, a rare habitat endemic to the Colorado Plateau region, is an example of habitat identification using physical landscape features. In the late 1980s researchers studied known hanging garden sites in order to understand the physical requirements for successful survival (May 1997; May, personal communication, 1998). They concluded that the occurrences of hanging gardens are highly dependent on the bedrock geology and hydrology of a site, and used this information to develop a system for identifying probable locations of additional hanging garden locations.

Fire planning. Geological investigations are fundamental to fire management planning. Geology provides the tools for determining fire histories, including fire recurrence intervals and fire styles. It also sheds light on historic (pre-settlement) watershed responses to fire, information that is integral in predicting watershed responses to future fires and planning appropriate mitigations (see Despain 1998; Renkin and Despain 1992; Meyer 1998).

Cave and karst protection. Caves are formed and continually modified by a combination of specific geological processes, including the solution of bedrock by groundwater. In order to insure that caves (including all their unique features and species) and cave processes are protected for perpetuity, managers must protect the sources of the water that feed the cave. Specifically, the quantity, quality, and timing of water flows entering the cave should remain unchanged. Geology provides the tools to delineate source water areas, and to measure changes in the quantity, quality, and timing of flows. Additionally, geology provides the tools to distinguish natural change in these parameters from anthropogenically induced changes.

Mineral materials planning on a landscape scale. A major management issue facing virtually all land managers today is the need to acquire mineral materials for road and facility construction without significantly damaging the ecosystem that they are mandated to protect. Geological assessments provide managers with information about the types and occurrences of mineral materials and the potential for sediment erosion and transport (see Lake Chelan National Recreation Area 1996). In addition, geologists can assist managers in siting facilities to minimize the potential for damage from geological processes (e.g., floods, rockfalls, volcanoes, earthquakes, clay swelling, and landslides) and minimize the amount of mineral materials required and the magnitude of disturbance in the long run.

Management of regulated rivers. Very few of the major watercourses in this country remain wild; most are regulated by dams or through irrigation diversions. The regulation of rivers has resulted in modification to the natural hydrological regime. Specifically, regulation has altered the quantity and timing of water and sediment flows, with the result that the shape of the channel is changed either through aggradation or degradation and the physical conditions of the riparian zone are permanently modified. Species that evolved in concert with the pre-disturbance physical conditions of the river system are often unable to survive in the regulated environment. Geologists can assist managers in assessing the physical and biological changes that have occurred in a river system, in distinguishing natural change from induced change, and in recommending mitigation strategies to re-create conditions favorable to threatened species.

Land management zoning. Ideally, general management plans for land management units should delineate zones based on natural resource values and characteristics. As stated above, geology often dictates the fundamental characteristics of a landscape, from topography and spatial heterogeneity of habitats to hillslope stability and physical vulnerability to disturbance. Because of this, it makes sense to use geology as one of the primary factors in delineating the management zones. For instance, streams that flow through lithologies that yield deep silty soils may be able to withstand a greater intensity and magnitude of disturbance than rivers that flow through sandy lithologies. A road constructed on hillslopes prone to erosion may be the source of considerably more nonpoint source pollution than the same road constructed on more stable lithologies.

Restoration planning. A land manager faced with multiple disturbances on the landscape must develop a scheme for determining restoration priorities. Geology is a useful parameter for this type of decision-making. By determining the characteristics and behavior of the rock formations (e.g., erosive potential, geochemical composition, ability to re-form soil and heal the scar without interference) the land manager can determine which disturbed sites pose the largest threat to resources and prioritize them accordingly.

Conclusion

The geosciences traditionally have not been accepted as a discipline relevant to natural resource management. The recent movement toward ecosystem management is forcing land managers to consider the physical characteristics of the landscape in addition to the biological characteristics, and, more importantly, to consider how the physical and biological systems interact. The advent of GIS has facilitated this shift by providing managers with the tools to simultaneously analyze physical and biological parameters over large areas and time periods. This paper provides multiple examples of the utility of geological investigations in managing ecosystems in an effort to convince readers that geology is just as much a part of ecosystem management as biology and deserves an equivalent seat at the "land management table."

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Places of Discovery: Paleontology, Research, and Natural Areas

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Introduction

It is a privilege to be here at the George Wright Society meetings again, discussing paleontology. I was especially taken by the theme of this year's conference, "On the Frontiers of Conservation." If there is any discipline that seems to be on the frontier, it is paleontology—not only spatially, but temporally. Visiting the frontiers is what we do in paleontology: we go out to wildernesses of unvisited times that are entombed in the earth's sediments, and bring back strange species and unusual ecosystems for everyone to look at here in the recent.

As this is a general audience filled with a variety of specialists, there are only two general objectives to be accomplished in this paper. The first is targeted at those conservation biologists and managers who *don't* always consider the fossil record and evolutionary biology during planning and thought processes: a suggestion to include consideration of long-term paleoenvironmental changes in your efforts. The second is aimed at managers of fossil resources and others that *do* realize the significance of the fossil record—and whether they know it or not, there are over 120 areas just within the National Park System with significant fossil deposits, a large increase from previous estimates (Vincent Santucci, personal communication, 1999; Chure and Fremd 1987). For these people, a framework is described within which to query and document paleontological resources, that has applications outside of the discipline.

There is a dichotomy to conservation and fossil resources. Normally, paleontological workers are concerned with what we can do to understand, protect, and study the fossil record—and assume that the value of these data are generally well-understood to workers attempting to understand, protect, and study modern ecosystems. Unfortunately, very few conservation biologists appear to consult the paleontological literature germane to their spatio-temporal area. The other side of the issue therefore concerns what the fossil record can do to help us appreciate and protect natural areas and recent ecosystems.

What Can the Fossil Record Do for Modern Ecosystem Studies?

Most of us are familiar with concepts such as "the tree of life" and other metaphors designed to illustrate the history of organisms (see Figure 1). In these depictions, the trunk and branches may represent species, genera, or other taxonomic hierarchies, or may suggest the evolution and intertwined nature of evolving ecosystems. Recent life exists only at the very top of this "tree," and all of our modern cultural accessories and associations of organisms that we cherish are in the "plane of the recent." In fact, it may be a more valid metaphor to suggest it is somewhat like looking at the sliced tip of a very thick and long rope on end, seeing only patterns of the fibers on the two dimensional plane. By looking at only the very last stage in a long sequence such as a tree or a rope, one completely misses its essence. Simply, the reason ecosystems look the way they do has got less to do with the way they are now than with events rooted in previous adaptations and interactions. Many of the structures and systems we observe today (both at the organismal, population, and ecosystem level), in this plane of the recent, may not make sense when studied *in situ*. They become comprehensible (often with an "aha!") when their history is analyzed.

Some definitions: A reasonable description of paleontological activity and fossils usually contains two parts: any evidence of past life, found in a geological context. By "the recent", most paleontologists mean anything less than about 10,000 years old or so. Fossils can be and are found in "the recent", therefore, and some of the most important clues to bring us up to the present state of ecosystems are found preserved in a geological context only a few hundred years old.

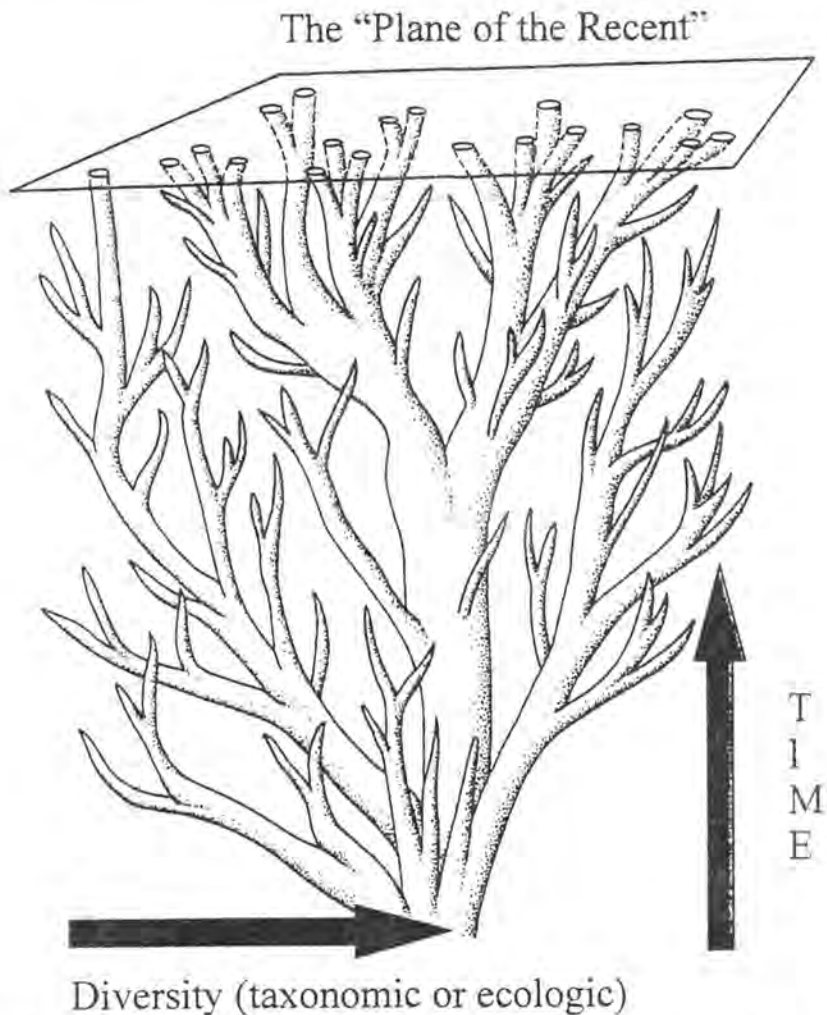


Figure 1. Recent ecosystems exist at the thin slice at the top of the figure. Modified from Weller 1969.

One way to perceive the dimensional differences between paleontological and recent temporal events is to consider time by relative orders of magnitude. Thus, if we use a year as a unit, 10^1 years is a decade, and so forth (see Figure 2).

One observation that can be made from this is that we simply don't live anywhere near long enough to see anything major happening (except the almost instant decimation of species diversity at our own hand—a phenomenon unprecedented in Earth's history). For example, much of our discussion seems to be analyzing ecosystems and species from solely a recent perspective. Yet, a major extinction event took place only 10,000 years ago (among North American mammals, for example, three-fourths of the "large bodied" fauna went extinct). It takes an enormously long time to recover from that kind of stress, and as a result of these and other relatively recent extinctions, modern populations of plants and animals are probably in a state of "dynamic disequilibrium."

Recent

10^1 = Tens of years: lifespan of many large organisms, agencies, us....

• (This is the temporal framework of most analyses, observations, study)

10^2 = Hundreds of years: old-growth forests, successional stages....

10^3 = Thousands of years: earliest New World hominids, climate fluctuations...

Paleontological

10^4 = Tens of thousands of years: major extinctions, faunal interchanges....

10^5 = Hundreds of thousands of years = major cycles in climate, etc....

10^6 = Millions of years: faunal speciation, adaptive zone turnovers....

10^7 = Tens of millions of years: "deep time," extinction cycles....

• (This is the temporal range-zone of many paleontological analyses)

Figure 2. Time scales of biological processes by orders of magnitude.

One hundred fifty years ago, Alfred Russel Wallace wrote: "We live in a zoologically impoverished world, from which all the hugest, and fiercest, and strangest forms have but recently disappeared...." That assertion is even more obvious today to a paleontologist. In many cases, the disappearances have left us with a hundreds of *biological anachronisms*. A couple of examples may serve to illustrate this concept.

For many years, biologists puzzled over the running speeds of North American pronghorn, which seemed to be capable of both astonishing bursts of speed and prolonged endurance runs at high speed. The question from an adaptationist perspective is why these animals evolved these capabilities—there seems to be an absence of a strong selective pressure, most likely from a predator, to be reflected in the animals' behavior and morphology. It wasn't until paleontologists reported the presence in North America of a Pleistocene cheetah-like cat (Martin et al. 1977; Van Valkenburg et al. 1990) that what is seen in the pronghorn's speed was the shadow of an predator that coevolved with it. Whenever I see pronghorn today running across my property in Oregon, I think of how I just missed seeing—by a paltry 10^3 years—a wonderfully fast creature that probably pursued these beasts.

Similarly, in a what I consider one of the best-titled papers to appear in the decade, two workers investigated peculiar adaptations seen in a number of neotropical fruits: "Neotropical Anachronisms: The Fruits the Gomphotheres Ate" (Janzen and Martin 1982). In brief, a botanically puzzling situation of large endocarps and extremely durable tissue systems in many of the seed structures seemed to be adapted to ... nothing. Without understanding the nature of what these plants were coevolving with, one cannot understand why the reproductive strategies appear as they do today. It turns out that the fossil record, previously not marshaled until this paper to solve the problem, suggests that a gomphothere (an large, extinct proboscidean or elephant-like creature) was probably the primary seed dispersal mechanism for these taxa, and in that light the fruits make perfect sense.

Without regard to the fossil record, how can we know that some of the ecosystems we are looking at aren't filled with similar, if less dramatic, anachronisms? I would suggest that a careful examination of the pertinent fossil record may offer a great deal to workers today attempting to understand much of modern ecology. Knowledge of the fossil record prompts many of us to look at recent ecosystems and ask, not so much "What's there?" but "What's missing that used to be there?" As indeed many plants and animals were part of a linked system, one would expect a pattern of ecological "creative tension" to permeate the survivors of an extinction as

massive as the most recent. Condors, for example, are anachronisms that may or may not forge links with other evolving species—sadly for us, that process happens on a time scale far beyond our personal perceptions on the “plane of the recent.”

Paleontologists off looking at the vistas of time aren't necessarily gathering information because it will help tropical ecologists. Conversely, a great deal of work that is being done in tropical ecology to conserve remaining ancient forests and endangered habitats isn't being done with the knowledge that it will be of great use to us in reconstructing a 44-million-year-old cloud forest in Oregon. Paleontologists read that literature and learn a great deal from it, however; after all, the key to the past is the present, and vice versa. Thus, when we are working on ancient deposits that contain terrific mudflows and examples of stupendous volcanoes causing tremendous ecological flux and resets ... then we have available to us a well-documented example of what organisms were doing during this period of time to get to where we are today. The trick is to be mindful of each other's efforts. Recent organisms are dynamic in space, but frozen in time; whereas the columns of life in the fossil record are frozen in space, but dynamic in deep time.

What We Can Do to Improve Our Work with the Fossil Record

An example of being “on the frontiers” of space *and* time can be found in the John Day Basin. This is an area (see Figure 3) with hundreds of fossil localities scattered across much of central Oregon, on lands managed by a variety of public and private entities. The fossil resources of the area are managed cooperatively as described at a previous George Wright meeting (Fremd 1992), and illustrate a classic example of how political boundaries have next to nothing to do with paleontological deposits, even in areas designated *because* of their fossil resources.

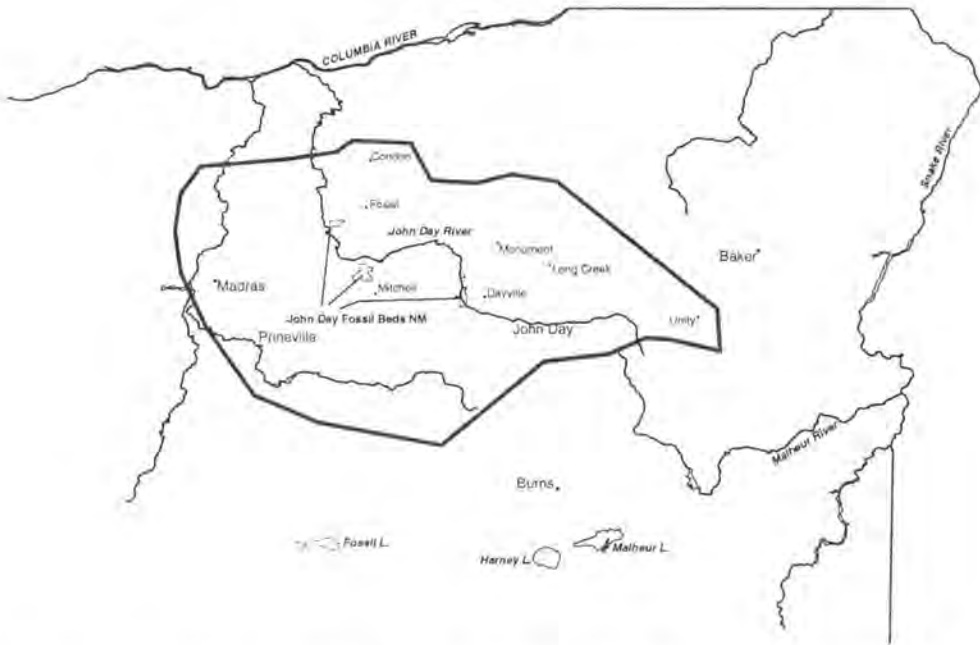


Figure 3. Location of the John Day “basin” and John Day Fossil Beds National Monument

The John Day Basin is *stratigraphically* significant, because the composite strata are over 5,000 m thick, the section is remarkably detailed, intra-basin "gaps" are minimal, the sequences are volcanoclastic, abundant biotite and sanidine tuffs permit extremely accurate dating, and the depositional environments are varied. The area is *paleobiologically* significant (Fremd 1994) because the composite strata contain these attributes:

- Fossils with very high, sometimes exceptional, preservation quality
- Floral and fauna that are often associated
- Spatially varied paleocommunities
- Unusually high taxonomic diversity
- Very long evolutionary continuity
- Paleoclimate "surges" that are detected
- Excellent fossil soils that permit paleobiogeochemistry

Places like this are globally rare. The National Park Service, through John Day Fossil Beds National Monument, is indeed fortunate to be the lead agency administering the fossil resources of this area and serving as the designated curatorial facility. When the national monument was established, it was not clear that the above characteristics listed above were true; many of the seminal discoveries leading to these realizations only occurred after the park was established.

Thus, an area such as this is ideal for examining the major processes and events described above: the very kinds of things that only a long, coherent record of the past can provide us. Features such as: speciation and extinction, major global climate changes, "mode and tempo" of evolution, paleocommunity changes, immigration and dispersal, and how modern ecosystems "got here."

These kinds of major issues can only be addressed, however, if the data collection efforts aren't biased and the research teams are "in synch." The problem is that existing museum and project data are inadequate for analyses of long processes, both here and in other fossiliferous basins (see Fremd 1996). These data often suffer from severe collecting biases, including workers seeking mere "exhibit" pieces; retrieving only certain taxonomic categories (e.g., just mammals) or only potentially new species or "charismatic megafauna"; and limiting collecting to data only from "classic" localities.

Imprecise data storage and temporal "blurring" of stratigraphic and ecological features (see Fremd and Wang 1995) is also a problem. The latter results in what could have been discretely collected intervals or habitats intermixed in the museum research collections. This results from: insufficient, imprecise, or undiscerning stratigraphy; poor recording of locality and paleoecology data, or non-recognition of paleohabitats; a lack of knowledge about relative ages of samples; and "lumping" of discrete assemblages.

Thus, *what we often settle for* as scientists and managers of paleontological resources is unrefined data collection that blurs paleoenvironmental processes. This results from imprecise resource management planning, reacting to and issuing permits for "specimen collecting" in the parks without a cohesive research design, and accommodating specialists who have little interest in pursuing long-term goals but are merely seeking a quick publication or two. *What we need* are data retrieval and analyses that can match the resolution preserved in the strata. In this way, rather than a blurred "hodge-podge" of fossils and rocks from a large spatio-temporal interval, we have an ability to curate a precise series of paleocommunities, often only separated by millimeters of strata. This kind of approach is rarely taken on by other institutions, which more typically jealously guard their "territory" from what are perceived as competitors rather than collaborators. Land management agencies such as the NPS are ideally situated for offering this sort of symbiotic relationship between research benefactors.

As an example of this, the national monument's detailed biostratigraphy projects led to what I call a "CIS": a *Chronologic Information System*, sort of a "GIS system on steroids." This provides an ability to add n -dimensional attributes of paleoecological systems to three-dimensional spatial data, critical for analyzing time, coefficients of variation in sedimentation, rates of evolution in a lineage, and so forth (other components include specimen, locality, literature, and taxonomic databases). There are three key components to this system that emerged from the research plan:

1. To minimize the effects of poor locality and stratigraphic data, establish a new, high-precision stratigraphic framework for global, as well as regional, correlations. This includes collaborative efforts on high-precision radiometric dating; paleomagnetic polarity analyses; stratigraphic descriptions and section measurements; paleosol analyses with point counts, SEM, and XRD analyses; and more.
2. All new and existing assemblages, including important types, and all possible taxa of specimens, are placed into this new framework. This work also provides resource protection through cyclic prospecting, wherein all scientifically significant specimens that are threatened from erosion, vandalism, or theft are retrieved and placed into dedicated museum storage (Fremd 1995; Foss and Fremd 1998).
3. Close examination is made of overlooked areas and less-fossiliferous intervals. Some of our most important strides have been made by working the periphery of the basin and the intervening sections of strata that contain the "keystone" intervals, if not the most glamorous fossils, of the depositional sequences (Bestland et al. 1994, 1995).

It is my experience that the only way to reach such goals is for the NPS to develop specific paleontological research planning (Fremd 1998). The NPS can develop a *coordinated, "partnership" program with depth and continuity—one that is sufficiently funded and maintains a long-term commitment to increasing the knowledge of a particular basin or strata*. In this way, cohesive studies can lead to better management of fossil resources, and better understanding of the development and processes inherent in recent ecosystems.

Note: This paper has been adapted directly from the "notes" windows of a Microsoft PowerPoint talk (consisting of 30 slides) that was presented at the conference. Due to space and print-quality limitations, most of the concepts in this "proceedings" version aren't linked to any accompanying graphic. Readers desiring the associated graphics may contact the author.

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Integrating Human Dimensions with Ecosystem Management at Canadian National Parks in Ontario

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Introduction

It is clear that considerable human dimensions information (Ewert 1996; Cannon 1994; Super et al. 1994) will be needed if protected areas are going to be successful in using ecosystem management to ensure conservation needs are adequately considered while contributing to a more sustainable society in their immediate surroundings. Their role for *in situ* conservation and as loci of change towards a less exploitive human society, as well as many other values (Rolston 1985), make protected areas of a significant part of our collective future. Ultimately, the land-use goal both locally and at larger scales might be "secure high-quality viable protected areas" forming "the core of a hierarchically connected network including satellite natural areas, linkages, and compatible surrounding land (and water) uses. This network would be designed as part of a planned land-use mosaic and, along with contributions from agricultural, forestry, and human settlement lands, would ensure *in situ* biodiversity conservation" (Stephenson 1994).

A report to a previous George Wright Society conference (Stephenson 1995) outlined how the existing natural resources programs at Ontario national parks (St. Lawrence Islands, Pt. Pelee, Pukaskwa, Georgian Bay Islands, Bruce Peninsula, Fathom Five Marine) were assessed in light of the implications of Grumbine's (1994) characteristics of protected areas ecosystem management. Obvious adjustments to existing programs were made to establish a sense of spatial hierarchy, ecosystem boundaries, and better conservation biology data over a greater ecosystem scale. Meanwhile, the pursuit of ecological integrity indicators was supported by the 1989 amendments to the Canadian National Parks Act (Government of Canada 1989), which places integrity over use, and Parks Canada's *Guiding Principles and Operational Policies* (Canadian Heritage 1994), which direct that an ecosystem management approach be developed. A variety of protected areas ecosystem management initiatives took place in Ontario national parks over a four-year period (1992-1996) and a set of common program components became evident, many of which need effective communication to be successful (Stephenson and Zorn 1997).

These components (Table 1) were compared with Grumbine's characteristics to ensure each was adequately represented and to identify component relationships within the context of an ecosystem management process. The result in Ontario was an ecosystem management program framework to informally replace the Natural Resource Management Process, the national guideline providing a conservation program framework (Government of Canada 1992). It dates from the late 1970s and, despite some revisions, the updating did not reflect the revised National Parks Act, Parks Canada's policy, or the protected area management implications of such new fields of science as conservation biology and landscape ecology. In February 1999, at a Canadian national parks ecosystem management forum, there was a consensus to prepare a new conservation program framework and to incorporate elements of the ecosystem management process used in Ontario's national parks.

The approach has been to set a minimum number of critical, but not necessarily technical, considerations that should be evident during implementation of each component in order to establish progress indicators. An open-ended discussion with staff responsible for ecosystem management delivery and their community (agency, interest, municipal, or private) partners—a discussion which tailors the assessment to local circumstances—is also held. Each national park has a different history, shifting

land-use patterns, existing staff and programs, current partners, suite of ecosystem stressors, and regional institutional arrangements (e.g. biosphere reserve, official plan, forestry agreement) that must be taken into account.

The style of ecosystem management program we encourage has some fundamental characteristics. The program is bottom-up, flexible enough to be refined, inclusive, not totally fact-based or linear, dependent upon mature partner relationships, seeks a role in surrounding land-use decision-making fora, encourages understanding and appreciation of the concepts involved by both partners, and imparts knowledge and shifts organizational culture.

<ul style="list-style-type: none"> • Ecosystem conservation plan • Area of cooperation • Stakeholder analysis* • Partnership group guidelines* • Information network* • Communication strategy* 	<ul style="list-style-type: none"> • Greater park ecosystem • Inventory analysis • Scientific research program • Ecological indicator selection • Ecological monitoring program
<p><i>* Items related to human dimensions information</i></p>	

Table 1. Ecosystem management components

The assessment is conducted every two years and will result in a strategic ecosystem management program direction for up to three years. Detailed scientific design and implementation concerns are addressed in the parks' annual business planning and scheduled project-level peer reviews and audits. This ecosystem management process is also intended to evolve as progress occurs. Fundamentally, this evolution is to allow the national parks to lead "on-the-ground" change towards the synthesis of the compositional (protected area) and functionalist (use area) concepts recently described by Callicott et al. (1999).

This evolutionary capability is not great for the technical components. For example, an inventory may grow in content or spatial scope, but it still remains an inventory. Those components where human dimensions information is needed—the stakeholder analysis, partnership group guidelines, information network, and communication strategy (Table 2)—must evolve, however. The goal of these components is some form of mature "overarching" partnership with community interests based on common values, understanding, experience, and achievement. The majority of today's national park partnerships are topic- or issue-based, short-term, sometimes confrontational, and often the result of fundamental misunderstandings. The difference is like that between dating and marriage. But, we are not sure how to characterize the ideal partnership and must keep in mind the frequent failure of these types of complex relationships. Considering the distance to this goal, we chose to describe these four components as achievable results that take a step toward our goal and upon which more advanced steps can be designed, then tested.

Defining Human Dimensions Information Needs

In order to achieve these four components of the ecosystem management process, a start must be made on human dimensions information-gathering. We chose to take a program rather than project approach. Keeping our component objectives in mind, we began reviewing the available literature with two purposes in mind:

1. What are the aspects of human dimensions and how might they be applied to our protected area ecosystem management approach? We asked these questions in order to decide what human dimensions studies might be priorities, since little new funding or staff time would be available.

<i>Stakeholder Analysis</i>	Based on the area of cooperation, it involves the <i>mutual</i> understanding of prospective partner groups and the local community, their associated values, interests, objectives (mandate, supporting legislation), and available staff and resources.
<i>Partnership Group Guidelines</i>	<ul style="list-style-type: none"> • Effective sustainable partnerships are in part characterized by: • A predetermined decision-making framework • A role in relation to the greater park ecosystem decision-making framework • Common interests and values that lead to specific objectives • A commitment to shared benefits • Consolidated information and communication mechanisms
<i>Information Network</i>	<p>This is a critical partnership, addressing issues such as:</p> <ul style="list-style-type: none"> • Data storage and access • Information use and analysis • Cost contributions <p>Shared knowledge is fundamental to successful ecosystem management.</p>
<i>Communication Strategy</i>	A communication strategy is a formal plan that identifies appropriate messages, media, and audiences for disseminating ecosystem management information. It is a means through which public support is gained, the community is informed, people are educated, and partners exchange ideas.

Table 2. Components requiring human dimensions-related information

2. What is the philosophy or rationale behind these studies? Do case studies demonstrate benefits? How, in general, are the studies conducted? We asked these questions in order to provide park staff with a broad understanding, acknowledgment of need, and a sense of how much commitment would be necessary in order to begin the work.

When we had a reasonable idea of the minimum program of human dimensions needed and an improved level of park staff knowledge, we conducted informal but documented discussions with key park staff at each park to see if a general consensus could be reached. The ability of staff to answer the questions helped define the priorities at each national park. Eleven general types of studies were identified (Table 3) as most likely to facilitate the "social" components of the ecosystem management process to lead to improved consideration of greater ecosystem conservation needs.

It is relatively clear how the minimum set of human dimensions studies can contribute to stakeholder analysis, partnership group guidelines and the information network. Additional analyses (Peine 1998; Cordell 1998) and case studies are becoming available in the literature that can help protected area managers select, design, and use human dimensions information in their ecosystem management programs. There is no substitute for a reasonable understanding of the literature. Even if you can bring social scientists in to help, the responsibility for success lies in the exchange of information and ideas between the protected area and its community partners.

The most important contribution of human dimensions information is to the communication strategy. It represents a synthesis of what protected area staff and their conservation partners know and wish to have happen, why it should occur, and how they wish to convince citizens and governments. As achievements occur, the direction and scope of this plan may change, but it must continue to inform the partners, inform the community, then re-inform the partners for monitoring and adaptation. Ultimately, the human dimensions information program, and the ecosystem

1. <i>Economic impact park visitors have on the local economy</i>	Knowing the type and value of expenditures visitors make within the national park and the greater park ecosystem. Increases appreciation of the role of tourism.
2. <i>Economic impact of the national park on the local economy</i>	Knowing the type and value of expenditures the national park makes within the greater park ecosystem compared with outside. Helps define the parks role as a local employer.
3. <i>Development modeling in the greater park ecosystem</i>	Adding quantitative economic information on the contribution of conservation and such activities as traditional use, recreation, outfitting, and nature observation to regional development models. Provides decision-makers with a greater range of alternative futures and helps ensure adequate consideration of conservation needs.
4. <i>Governance mechanisms</i>	<ul style="list-style-type: none"> • Review of official plan: A partner-based review of the use of conservation information in decision-making. Identifies areas for improvement and a role for conservation-oriented, park-sponsored partnerships. • Land-use participation workshops: A partner-organized activity to define and bring conservation needs to decision-making fora of the region. Provides citizen understanding and participation. • Stewardship workshops: This partner-organized activity brings private land-owners and groups them into the conservation initiative activities. Provides essential support (especially in southern Ontario, with four of the five national parks are mostly privately owned).
5. <i>Conservation land-use and awareness study</i>	This knowledge, primarily about individuals who are influential in decision-making, is gathered with the help of partners. Provides a baseline, a way to select and target relevant conservation messages, and a mechanism to measure the success of community-oriented education.
6. <i>Partnership formation and linking</i>	This process allows for re-shaping and improving existing partnerships and combining them as much as possible. Given the institutional constraints of the region, a single conservation coalition could be established.
7. <i>Regional demographic change study</i>	This partner-fostered analysis puts the future of the local community into focus. Anticipates opportunities and challenges that will arise, leading to better decision-making.
8. <i>Land-use study</i>	Baseline and input into conservation analysis intended to affect governance (i.e., the official plan). This partner product can be invaluable for land-use planning.
9. <i>Issue-specific surveys</i>	Often all issues cannot be addressed in the more general surveys (e.g., items 5, 7, 8) or certain issues may be driving community attitudes. Partner energies may need to be focused on selected issues.
10. <i>User and infrastructure impact analysis</i>	<ul style="list-style-type: none"> • The park: This analysis of protected area activities demand should define the extent that the protected area can provide for them, given physical and mandated constraints. This sets park limits and defines its recreation role. • The greater park ecosystem: A similar analysis puts provision of these user demands into a regional context. This will influence tourism strategies and so forth.
11. <i>Human dimensions of ecosystem management assessment</i>	This provides critical review of quality, progress, and deficiencies in consultation with both partners and users. Sets direction and can generate significant support.

Table 3. General types of studies in human dimensions of ecosystem management

management process it is embedded within, should become not just something that belongs to the protected area, but something that is shared within the community.

Current Status

This part of the paper is dominated by a brief description of some of the human dimensions information-related initiatives that we anticipate will go furthest toward building understanding in the participants. This foundation will in turn, lead to better use of this information in our ecosystem management programs. A cursory mention of Parks Canada's general organizational response to the need for human dimensions information is also appropriate.

Parks Canada has undergone several parent-department transfers over the past five years that led to "separate" agency status as of April 1, 1999. This did not facilitate a shift in organizational culture conducive to ecosystem management. Currently, the plan to separate Parks Canada slightly from mainstream federal government as an agency with a large cost-recovery requirement has also distracted from this type of awareness. While we can hope these disruptions will settle out with time, it has not been a good period to introduce new natural conservation concepts. In Ontario, we prepared a business case (i.e., funding request) as a result of our human dimensions information program design. We requested very modest capital funding to conduct in-house training, implement selected pilot projects, and work with community interests to develop practical applications for the information and analysis. No funds were made available.

The impetus behind human dimensions information-gathering as part of ecosystem management is the effort of individual national park staff (supported by Parks Canada's Ontario Service Centre) using the flexibility built into work planning. Some noteworthy initiatives over the past three years are not park-specific but reflect general shifts in thinking or individual pilot projects that can be adapted for use elsewhere:

- There has been a realization that the local community (individuals, organizations, governments) is a primary audience. Our current attention to visitors (there is some overlap, of course) means that local communication is often limited to school-aged children and tourist or "Chamber of Commerce" groups. This realization creates a broad acceptance of the style of the relationship and the need for better human dimensions information.
- Reflecting the above, all of Ontario's national parks plan to revise or have started revising their interpretive themes and messages. These now incorporate ideas such as: what is ecosystem management? what characterizes a more sustainable future? what is the role of protected areas singly and collectively? what does this mean for land-use and values or attitudes about conservation? and so on. The content is being tailored to each park, and advocacy of conservation in general within the greater ecosystem is substantially strengthened.
- Ontario's national parks have indicated interest in a generic sense-of-place initiative that involves knowledge of community attitudes in order to better identify content and to segment the local audience in order to create greater conservation awareness. Ideally, these studies will be done in cooperation with community partners.
- Two inexpensive economic analyses have been done for all of Ontario's national parks. These cover (1) local expenditures by the park and (2) local expenditures by visitors (expenditure questions had been dropped from the three-year cycle of visitor surveys some years ago for cost savings). These allow each park to demonstrate and improve its direct economic contributions as well as to cooperatively develop effective ways to enhance visitor expenditures.
- The national parks have all provided support to land trust-type initiatives by local interests, resulting in two formal trusts and a variety of "friends" groups

- that (for example) address local watersheds. This tangibly enhances shared values and creates new avenues for protected area staff to reach the community.
- Parks Canada supports (primarily in principle) the biosphere reserve model which emphasizes human dimensions information in relationship-building. We are a major partner in the Niagara Escarpment Biosphere Reserve and promote potential international biosphere reserve benefits in the Thousand Islands region, southern Georgian Bay, and the Lake Superior watershed, all of which have active bioregional groups.
 - Parks Canada's policy requires suites of science-based ecological integrity indicators, but it is necessary to develop and implement these so that the protected area is in context of its greater ecosystem. This has required improved contacts and cooperation, particularly with other land management agencies. Sharing has occurred with other database partners (versus owners) and cooperative regional-scale GIS databases are established at all Ontario national parks.
 - As a spin-off of developing scientific indicators and ways to communicate them, the desire for selected, complementary economic indicators, such as per capita income, is being pursued at several national parks.
 - In 1998, nationally sponsored marketing training (position, client analyses, target messaging) took place in Ontario national parks. At the request of staff, only half of the course addressed visitor groups, while the other half used conservation examples from communities within the greater ecosystems. For example, analyses were conducted on the "cottage country" culture around one park, while another considered the implications an ecosystem dominated by the forest industry.
 - Due to general government cutbacks, the traditional Canadian national park barrier between natural resources management and interpretive staff may be eroding further. The idea that interpretation must make a priority of communicating ecosystem management influenced park restructuring. In three out of five of Ontario's national parks interpretive and ecosystem staff are now combined, with a potential for greater synergy than previously.

Other representative activities dominated by human dimensions aspects are more park-focused. Some of these are outlined in Table 4.

Conclusion

Many protected areas have no ecosystem management framework or policy, do not formally recognize the need for human dimensions information, or simply do not have the capability to fund a systematic research-based initiative. Nonetheless, it should still be evident that building a broader, more effective community relationship in the region around protected areas is a minimum requirement for successful long-term natural conservation and a more sustainable future. When Ontario national parks began exploring ecosystem management, related communications and human dimensions information needs were not even informally recognized and still have not been funded.

In fact, our greatest achievement has been education directed, first of all, at staff and management understanding (resulting, we hope, in support), and then at current or prospective partners. Key staff in each park have now committed themselves to all or some of these ideas. They find ways within the flexibility of their budgets and work plans to implement particularly attractive ideas, and often contribute their own time. The examples in Table 4, while not all successful, are catalyzing similar or improved variations on the human dimensions information theme at other parks.

Even partial successes transfer understanding to community partners and Parks Canada management. The results are already visible in more sophisticated community partnerships and in the gradual acknowledgment of this approach by Parks Can-

<p><i>Pt. Pelee National Park</i></p>	<ul style="list-style-type: none"> • The park regularly culls its white-tailed deer population. Systematic communication takes place with hunter, naturalist, and concerned citizen groups on the need, methods (e.g., contraception alternatives), and success. An attitude survey was undertaken to help direct our management communications. • At Point Pelee the need for conservation interests to participate in land-use decision-making has resulted in park representatives on the regional Stewardship Council, the Natural Habitats Strategy Committee, and the Carolinian Canada (i.e., all of southwestern Ontario) Coalition. Further, the park was a key sponsor of an International Countryside Commission (University of Waterloo 1997) project where outside conservation experts were invited to assess regional needs and make recommendations to the local government.
<p><i>Pukaskwa National Park</i></p>	<ul style="list-style-type: none"> • A protected areas attitude and values survey of influential people for the Lake Superior basin was conducted (reported on, in part, in Cantrill and Potter 1997). Pukaskwa intends to use the list of respondents in its region to form a group of citizens willing to be regularly surveyed as a way of assessing the impact of its conservation messages in the greater ecosystem. • At this park the greater ecosystem had been described using a largely human dimensions approach (Skibicki 1994). • At Pukaskwa, credible, consistent, and persistent communication by staff on conservation needs, combined with a spatial vision for the region, has resulted in considerable local conservation success in negotiating adjacent forest industry leases and discussion on how to use provincial lands (Michels et al. 1998). • Pukaskwa has partnered with the provincial government and academics in Canada and the United States to develop predictive modeling capabilities for regional development around protected areas. They are collecting information such as recreation or subsistence economic contributions to extend considerations beyond the traditional forestry and mining industries.
<p><i>Bruce Peninsula-Fathom Five national parks</i></p>	<ul style="list-style-type: none"> • Bruce Peninsula-Fathom Five Marine is sponsoring a graduate student to work with the ecotourism industry to provide conservation and Niagara Escarpment Biosphere Reserve messages to natural-experience operators and their clients. • The parks and their combined advisory board, established in 1987, are working to keep the group relevant and influential as a northern-end subcommittee of the Niagara Escarpment Biosphere Reserve. This evolution will broaden the scope of the advisory board from the park to the region as a whole.
<p><i>Georgian Bay Islands National Park</i></p>	<ul style="list-style-type: none"> • At Georgian Bay Islands, the staff have had success by preparing regional conservation-vision "core and connector" maps and by sponsoring a community working group of local municipal planners, citizens, seasonal cottage residents, and biosphere reserve interests.
<p><i>St. Lawrence Islands National Park</i></p>	<ul style="list-style-type: none"> • St. Lawrence Islands will continue to nurture biosphere reserve capabilities in the Thousand Islands region via a graduate student who will work with staff and citizen groups to gauge interest and propose strategies to advance the concept. • Similarly, the park is a prominent participant on the environmental round table convened its federal Member of Parliament. The results could be communicated to an influential audience. • Algonquin Provincial Park (Ontario) and the Adirondack Park (New York), the two largest protected areas in northeastern North America, are connected by a land bridge of Precambrian rock, running 150-km north to south, which forms the Thousand Islands region. St. Lawrence Islands National Park has been a principle advocate of the Algonquin-to-Adirondacks conservation linkage, a citizen-driven local land-use approach. The park has centered its ecosystem management program around its contribution to conserving this continental-scale landscape function.

Table 4. Park-specific examples related to human dimensions

ada as an organization. We have begun to scratch the surface, but much more needs to be done to create and drive a conservation-based ecosystem management approach to land-use decision-making around protected areas. The authors encourage all protected area professionals to start building this foundation to a sustainable future now, regardless of the obstacles.

Acknowledgments

While the opinions expressed in this paper are those of the authors, we would like to recognize our immediate supervisors who have been flexible enough to allow us some time to work on the future rather than labour exclusively on today's crises. Obviously, all the Ontario national parks staff who have listened to our ideas, found some to which they could relate, and then tested them, deserve our thanks. Finally, we wish to thank Heather Paleczny, a university student on a work term, who did most of the manuscript preparation.

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A Review of Science and Ecosystem Management in the U.S. National Parks

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Introduction

Science relates to managing resources by providing information so that managers can:

- Know resources (by conducting complete inventories);
- Protect resources (by conducting research into threats);
- Guide resource utilization (by conducting long-term monitoring); and
- Restore damaged resources (by conducting research into system function).

Review

I want to start this review in 1980 and continue it beyond today and into the future. In 1980, a "threats to the parks" survey was conducted. It identified 4,300 threats to park resources. Today, we know that the 1980 survey barely scratched the surface of the problem. One of the realizations of conducting the case studies that we did for our book *Science and Ecosystem Management in the National Parks* was that the more people you have working on a situation, the better you know that situation. In 1980, there were not many resource people in the National Park Service (NPS).

Another significant event of 1980 was the legislation that created Channel Islands National Park. A requirement placed in that legislation was that NPS would report every two years to Congress on the status of the resources of the park. This forced NPS to initiate a long-term ecosystem monitoring program for marine and terrestrial systems. The development of this system was headed by Gary Davis, and in 1983 I was privileged to come and help.

In 1986, a task force, headed by Boyd Evison, was gathered to advise NPS on the development of a nationwide inventory and monitoring program. Davis played a significant role in that task force, and the monitoring program at Channel Islands was relied on heavily in developing the national program. The national program was initiated in the late 1980s and was operational by 1991.

Davis and I conducted the review of case studies which eventually led to the publication of *Science and Ecosystem Management in the National Parks*, as part of the initiation of the national inventory and monitoring program. We needed a way to tell reluctant managers that the inventory and monitoring program would be beneficial.

In addition to the issue of not having enough information from inventories and from monitoring programs, the book deals with the following:

- Ecosystem integrity and ecological and aesthetic degradation (fire in the Sierra Nevada, wolf and moose populations on Isle Royale, saguaro cactus dynamics and urban encroachment on Saguaro National Park)
- Polluted air (Grand Canyon National Park)
- Altered water quality and quantity (water rights for the Devil's Hole pupfish, karst hydrogeology at Mammoth Cave)
- Resource consumption (cutthroat trout at Yellowstone Lake)
- Visitor impacts (backcountry use in the Sierra national parks, river use management at Ozark National Scenic Riverways)
- Alien species invasions (alien species in Hawaii national parks)
- Rare species maintenance (rare plant monitoring at Indiana Dunes National Lakeshore)

We put this list together in 1990-91. Some of the lessons learned are today looked on as, "So what?" Ten years ago, however, they were news to most park managers. It reflects how far and fast we have come. The lessons we learned by reviewing these case studies are as follows:

1. National parks are not the static entities they once were portrayed to be. Every program that has tried to preserve a certain look in a park has had to eventually admit that it can't be done. Systems are continually changing through all scales of space and time. Management practices must learn to deal with it.
2. Absence of information leads to false conceptual models and costly mistakes. Management based on belief alone led to practices of fire suppression, killing of top predators, and instability of protected ecosystems.
3. As are all natural areas, NPS areas are heavily influenced by transboundary forces; nature is not impressed with lines that humans draw on a map.
4. Long-term data sets are scientifically and politically powerful. Verifiable information can help solve use-versus-protection dilemmas better than consensus-based opinions. Sustained research reveals secrets that short-term studies never do, therefore, NPS areas need active long-term studies to understand ecosystems. Long-term monitoring can be cost-effective in protecting resources because it allows you to catch problems early; however, not all long-term studies can be readily applied to short-term management issues.
5. Research, monitoring, and resource management must be a cooperative effort—it can take years to recover from an encounter with a “mad scientist.” The relationship between researchers and park staff is crucial. Supervision of research should be done jointly by the superintendent and research supervisor. Each park's research and resource management program should be related to a university peer group or the larger research community.

Information Management

In the past two decades, the amount that we collectively know has increased exponentially, yet we still hear the same answer to almost every question: “We need more information to understand that.” This is the paradox: we have more information now than ever—in fact more than we can handle—and yet we still lament the fact that we don't have all the information we need for any specific question. Actually, today we know more about what we don't know than ever before. In fact, we seem to be getting a good dose of that old truism: “The more you know, the more you know you don't know.” In other words, the more you know about any subject, the more you understand that it is more complex than you have ever thought it was. Managing resources is proving this truism—in spades.

Just when we got people in the field collecting data in inventory and monitoring programs, we see that collecting data is only about half the job. The other half is data and information management. As we develop more and more information, and there are more and more groups interested in having that information, information management becomes a bottleneck, or the small portion of an hourglass.

What's needed? A delivery system. Today we have as few if not fewer people to do this job than we had scientists 20 years ago. We need machines, engineers, operators, mechanics—just like Federal Express needs in its package delivery system. We need to translate science data and jargon into a story that many different groups will be able to relate to.

Multiple-use Management

A shift is taking place in our mass or social consciousness from strict independence to interdependence and cooperation. From a preservation-utilization dichotomy to balanced, integrated management. A shift in which we increase the numbers of people making a decision; that is, a shift from authoritarian decision-making to collaborative, participative decision-making. This means lots more meetings with lots more folks: federal and state agencies, watershed associations, friends groups, Audubon, The Nature Conservancy, the Sierra Club, and so on.

Your future: an increased need for information and sharing that information, an increased need to cooperate with many others, and an increased need for new governance systems and new ways of doing business.

The Importance of Inventory and Monitoring Data Sets in Resolving Ecosystem Management Problems at Mammoth Cave National Park

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Introduction

In the early 1930s, George Wright clearly laid out four steps leading to the development of a wildlife management plan. First, reconstruct a predisturbance picture of the area; next, outline disturbance history; then conduct an intensive inventory; and finally, develop a management plan to restore predisturbance conditions (Wright et al. 1932). Though he didn't discuss monitoring specifically, it is implied, since this is how progress toward restoration is gauged. Nearly seventy years later, Wright's ideas are increasingly important as disturbance histories grow longer, new species are discovered, and predisturbance research technologies develop. The long-term focus of staff and resources required to capture and analyze these conditions led to the development of the NPS's inventory and monitoring program. At Mammoth Cave National Park, we are contributing to these efforts by building a framework of data sets that reflect current and historical conditions. These data sets will describe ecosystem disturbances and will help set and realize restoration goals.

The Mammoth Cave region is a karst landscape (characterized by subterranean drainage), with one historical and three functioning ecosystems. These are the river ecosystem, with sinking streams and base-level rivers; the cave ecosystem, containing aquatic and terrestrial components; and the forest-woodland ecosystem with riparian and upland communities. Historically, prairie or barrens covered large portions of the karst (sinkhole) plain located south of the park. Soon after settlement in the late 1700s, these grasslands were largely converted to agriculture (Figure 1).

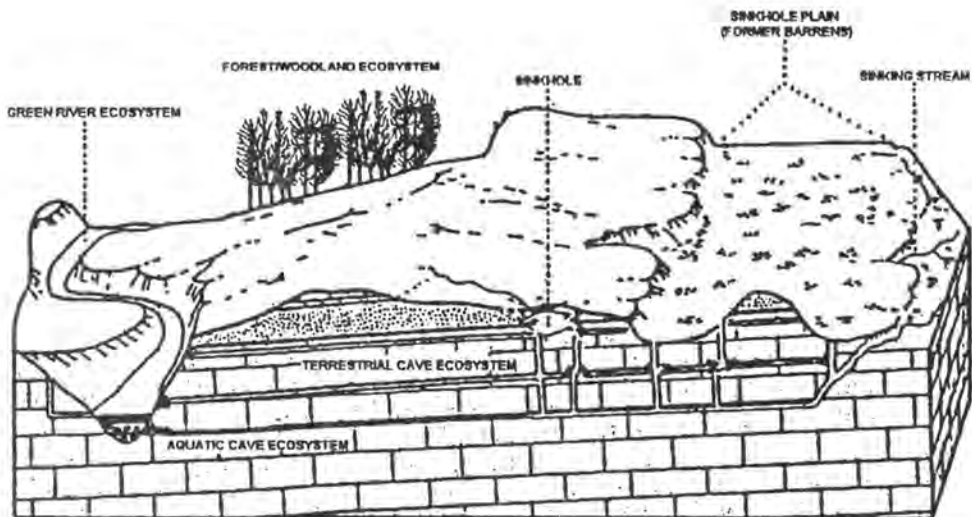


Figure 1. Ecosystems of Mammoth Cave National Park (modified from White et al. 1970)

Functionally, since sinking streams and cave streams are tributaries of base-level rivers via springs, they are all part of the river continuum, with the important distinction that the middle section is underground. These distinct but connected aquatic ecosystems are energetically supported by inwashed organic debris from the forest-woodland and former barrens ecosystems. Food transport is usually down-gradient, but natural back-flooding from the river through springs into the lower cave streams is also important. As base-level rivers lower their channels, cave streams follow and leave dry upper levels. These passages become habitat for the terrestrial cave ecosystem which is also dependent upon the forest and former barrens ecosystem for its food base. The import of food is mostly accomplished by cave crickets, bats, and packrats, which feed outside and use caves for refuge, where their guano accumulates. Clearly, all of the component ecosystems within the karst landscape are functionally connected and must be managed holistically in order to realize our restoration goals. When disturbances occur, long-term data sets that define the ecosystem are needed to detect changes. The following cases at Mammoth Cave National Park illustrate ongoing efforts to establish a network of inventory and monitoring data sets and protocols to help resolve ecosystem management problems.

Case 1: River Impoundment

Lock and Dam Six on the Green River retards its flow for sixteen miles, as well as seven miles of the Nolin River, within the park. Habitats for six species of freshwater mussels, federally listed as endangered, are seriously degraded through this reduction of natural flow velocity and resultant siltation. The Green and Nolin rivers also possess one of the most diverse fish and invertebrate faunas in North America—82 species and 51 species of mussels alone, respectively. These populations are severely affected by the impoundment as well (Cicerello and Hannan 1990, 1991; Schuster et al. 1996). Mussel surveys conducted in 1987, 1988, and 1989 determined that only eight taxa (represented by 16 specimens) were found at impounded sites, compared with 34 taxa (represented by 1,652 specimens) at transitional sites, and 41 taxa (represented by 1,552 specimens) at free-flowing sites (Figure 2). These inventory and monitoring data sets are being used in cooperative efforts with the U. S. Army Corps of Engineers and the U. S. Fish and Wildlife Service (USFWS) to effect removal of the dam.

Case 2: Groundwater Contamination

Beginning in the early 1970s, dye tracing of groundwater flow routes revealed that groundwater recharge areas for Mammoth Cave National Park extend well beyond its boundaries (Figure 3). This groundwater is subject to pollution from inadequate sewage treatment, sinkhole dumps, agrichemicals and manure, routine runoff from transportation corridors, and spills (Quinlan and Ray 1981). Sinking streams and sinkholes in the recharge area feed habitats occupied by cave stream communities within the Mammoth Cave system, and constitute a major threat to biota, including the federally endangered Kentucky cave shrimp (Poulson 1990). These threats instigated development of Mammoth Cave's water quality monitoring program (Meiman 1990) and cave aquatic biological monitoring program (Pearson and Jones 1998) which were designed to establish baseline data on water quality and cave aquatic communities, and to determine if a correlation exists between ecosystem health and land use in the recharge area.

Initial results of the first three years of the water quality monitoring program not only show a correlation between water quality and agricultural activities, but also identify flood pulses as the primary transport mechanism for non-point source agricultural waste. To detect long-term trends, monthly monitoring at ten sites will continue on the "off five year, on two year" schedule established by the national water quality assessment program of the U.S. Geological Survey (Olson et al. 1993). A da-

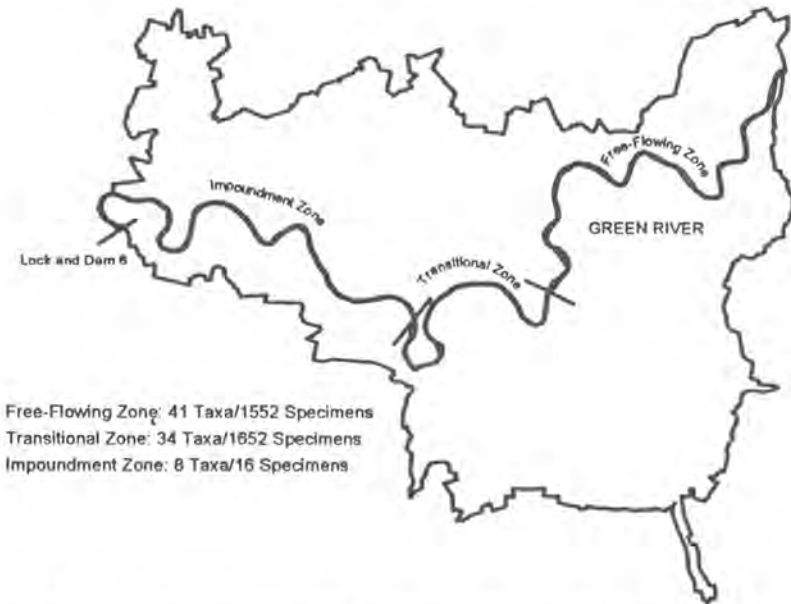


Figure 2. Mussel data summarized by zones upriver from Lock and Dam 6 (based on 1987-89 Cicerello survey of Green River within Mammoth Cave N.P.)

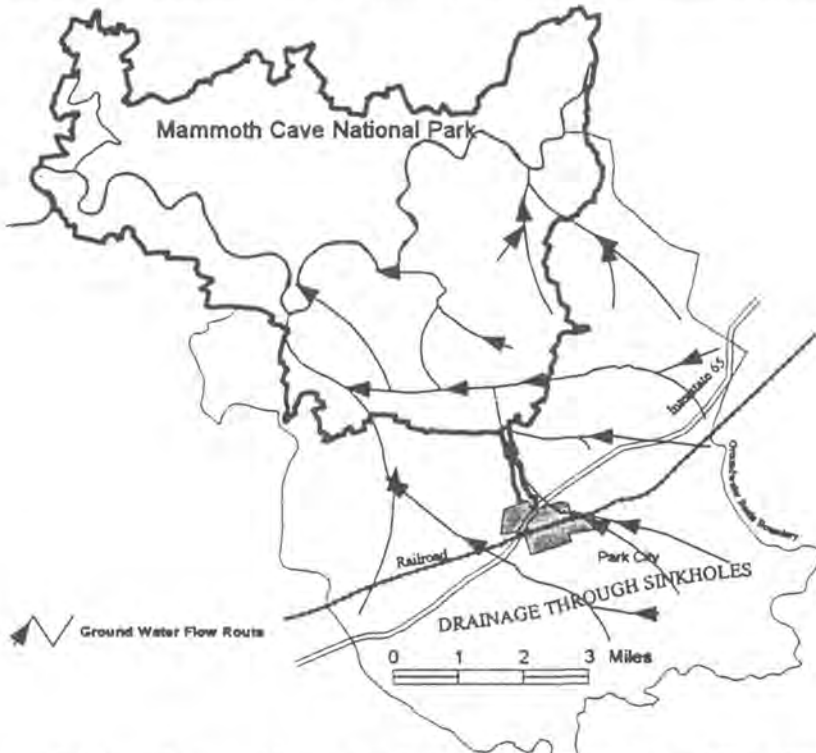


Figure 3. Groundwater recharge area (modified from Quinlan and Ray 1981) in Parks and on Public Lands • The 1999 GWS Biennial Conference

tabase with more than 40 parameters has been developed by the park hydrologist to document trends in the condition of this important resource.

For cave aquatic communities, an index of biological integrity was developed and compared with water quality indicators to provide additional information on ecosystem impacts. Based upon the diversity, density, and recruitment of key aquatic species, eleven metrics were developed and tested on ten subterranean stream sites during the period 1993-1995 (Pearson and Jones 1998). Although long-term data are needed to define natural variability and trends in these communities, the index successfully ranked the most and the least affected sites according to documented water quality impacts.

Data from dye tracing and monitoring programs have provided justifications for: 1) installing a regional sewage treatment system and containment structures for livestock manure; 2) development of a sinkhole map to respond to hazardous spills along Interstate 65 (Fry and Meiman 1994); and 3) plans for installation of retention basins along the interstate highway to filter routine runoff and catch spills. As well, sinkhole dumps that drain into cave shrimp habitat are being cleaned up (Olson et al. 1999).

Case 3: Cave Microclimate Disturbance

Near the historic entrance to Mammoth Cave, biological communities are adversely affected by human disturbance, such as entrance passage excavations, which have altered airflow and therefore the cave microclimate. This portion of Mammoth Cave was rich in wildlife only 150 years ago, and was possibly the world's largest roost for hibernating bats (Silliman 1851; Olson 1996; Tuttle 1997). Today, two of the former winter-resident bat species are listed as endangered, and a paleontological inventory is being used to reconstruct pre-disturbance winter microclimatic conditions at old hibernation roosts (Toomey et al. 1998). Data from the examination of bat remains (bones, mummies, guano, and ceiling stains), combined with the knowledge of narrow, species-specific hibernation temperature ranges, helps reconstruct the historical cave microclimate conditions for management prescriptions. Installation of a USFWS-approved bat gate, developed by the American Cave Conservation Association, was a significant step toward restoring wildlife habitat in the historic section of Mammoth Cave, and Plexiglas baffling attached to the gate has greatly restored pre-disturbance microclimatic conditions (Figure 4).

In 1994, Mammoth Cave initiated cave atmospheric and biological community monitoring programs (Fry and Meiman 1995; Poulson et al. 1997) prior to construction of airlocks at artificial cave entrances. The purpose of the airlocks was to mitigate the unnatural influx of winter air, which was causing below-normal temperatures and relative humidity. Seven monitoring stations were established to study airflow patterns and determine the effectiveness of the airlocks. The resulting cave atmospheric monitoring data sets have shown the desired stabilization of cave temperatures and humidity in most of the affected areas, and the biological community data sets also indicate positive effects from the entrance airlocks.

Case 4: Habitat Degradation

Suppression of fire in woodland and prairie ecosystems has resulted in the loss of open habitat for hundreds of plant species. Archeological inventory of park caves has revealed that rattlesnake master (*Eryngium yuccifolium*) and false foxglove (*Gerardia* spp.), which were used by prehistoric Indians for fiber and torch materials respectively, were once much more common than they are today (Watson 1969, 1974). Habitat for Eggert's sunflower (*Helianthus eggertii*) has also been marginalized to the extent that this species is now listed as threatened by USFWS. With more than 1,000 species of flowering plants, including 84 species of trees, the diversity within plant communities is high. Many of these species are dependent on very small remnant areas of specialized habitat, such as the disappearing barrens and glades. During the

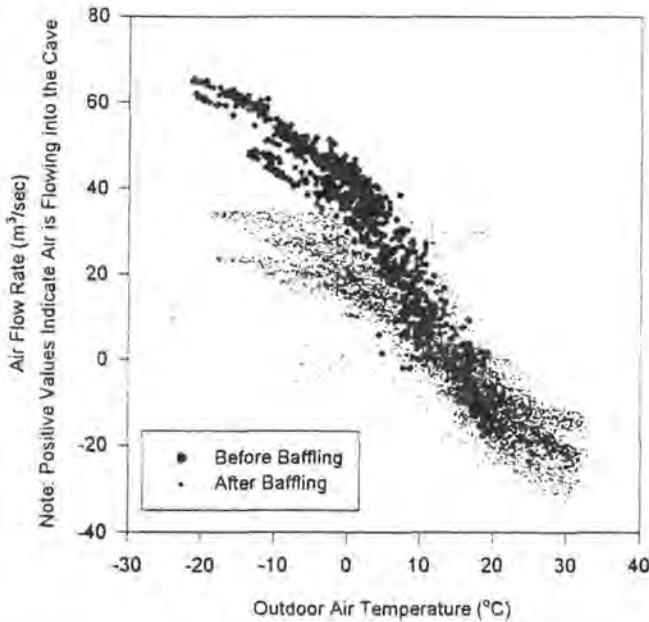


Figure 4. Effects of Plexiglas baffling in historic section of Mammoth Cave (source: Jernigan 1998)

period 1993-1995, a botanical inventory was conducted to augment the park's vascular plant checklist and help identify those species and habitats in danger (Seymour 1996). More than 250 previously unreported species were added to the park's 866 known taxa, an increase of approximately 30% (Figure 5). This data set also provides plant locations and attributes (such as habitat type, frequency, and flowering) for over 5,000 survey records, which were entered into the park's Geographic Information System (GIS) by the park inventory and monitoring data manager.

Due to the size of the park (53,000 acres), and the outstanding balance of vegetation inventory and monitoring work to be done, a GIS-based habitat model was developed by the park ecologist and GIS specialist (Olson and Franz 1998). Upland forest, woodland, and glade communities differentiate along moisture gradients which are largely determined by bedrock geology, slope, and aspect. As an example, natural cedar glades in the park are easily differentiated from successional cedar stands by their habitat which consists of limestone slopes facing south to southwest. Using GIS tools, bedrock geology, slope, and aspect were combined digitally to produce nine habitat classes. There is good agreement between the habitat model and Seymour's field observations, and a previously unknown but particularly rich glade community was predicted by the model. Due to the botanical inventory data sets, we realize the negative effects of fire suppression. Armed with this information and the predictive capability of the habitat model, we are developing a fire management plan to restore barrens, glade, and open-woodland communities.

Conclusion

The inventory and monitoring projects described above are being used to build Mammoth Cave National Park's long-term ecological monitoring (LTEM) program. Selected in 1993 as the prototype site for the cave-karst biogeographic category, the

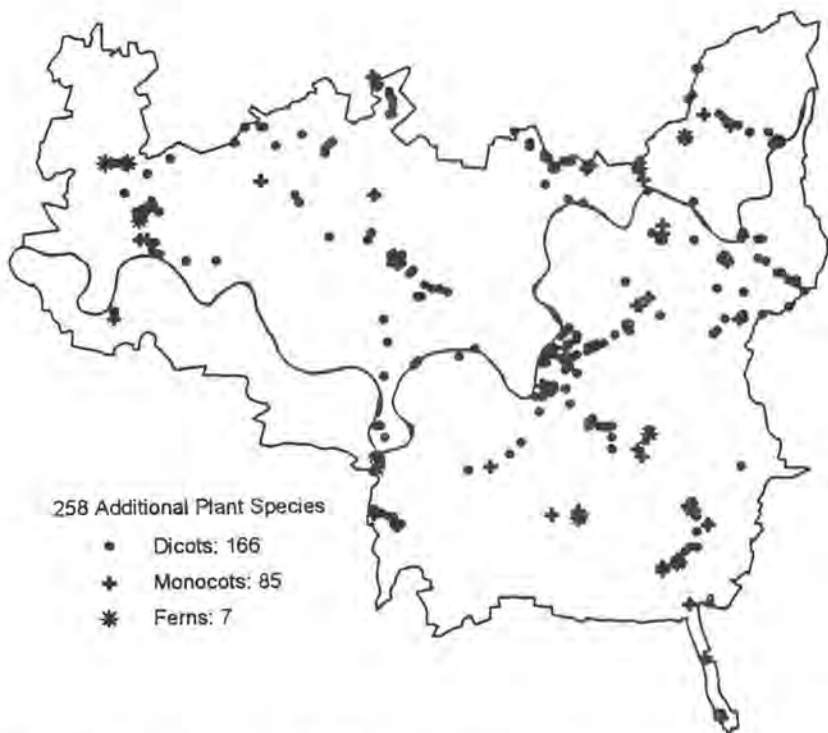


Figure 5. Mapped locations of additions to vascular plant species based on 1993-1995 Seymour survey (source: Seymour 1996)

park is ready to integrate its existing data sets and protocols into a comprehensive design. The significance of karst landscapes is not widely recognized, but 20% of the Earth's land surface and 25% of the continental United States is karst. As well, approximately 60 NPS units have karst resources (Olson et al. 1993). Our LTEM program will integrate data from all component ecosystems within the karst landscape; this holistic approach is necessary because cave ecosystems are vitally connected to their surface counterparts. Following George Wright's lead, presettlement conditions and disturbance history will be incorporated through ongoing historical research, paleontological studies, and archaeological inventories into our ecological restoration plans. The data sets generated through each of these efforts in the natural and cultural resources are the foundation for management plans to restore predisturbance conditions in all of the distorted ecological situations described above. This landscape-level approach will insure relevance and applicability to all cave and karst resources within the National Park System and beyond.

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Counting Sand Grains in a Sandstorm: The Evolving *Lessingia germanorum* Monitoring Program in the Presidio, Golden Gate National Recreation Area

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The Presidio of San Francisco is a 1,480-acre former Army base on the northwest tip of the San Francisco Peninsula. Since 1994, the Presidio has been part of Golden Gate National Recreation Area (GGNRA). Much of the area is underlain by sand dunes of late Pleistocene to contemporary origin. Several remnant native dune communities persist, providing habitat for five rare plants, including the San Francisco lessingia (*Lessingia germanorum* Asteraceae), which is a federally listed endangered species. The vegetation management program has evolved from a single Park Service "gardener" to a multifaceted program centered around community partnerships, including those with local schools and thousands of volunteers. As the program has grown, the direction of rare plant management has changed from simple protection of remnant populations to relatively large-scale enhancement through habitat restoration, monitoring, and research. Working more from the base of community partnerships than from a traditional relationship between NPS and the U.S. Geological Survey Biological Resources Division, several projects have been initiated to monitor the populations and habitats of lessingia. This paper will critically evaluate these projects as well as highlight the challenges and opportunities that have emerged from working through community partnerships.

From the 1970s until 1994, the California Native Plant Society and GGNRA identified remnant areas of natural vegetation in the Presidio and began implementing occasional weeding programs. Work focused on removing direct threats to rare plants, with primary attention given to including the four remaining populations of the then-proposed, and now-listed, San Francisco lessingia. A late summer-blooming annual, endemic to the San Francisco dune complex and occurring in only five populations, lessingia occurs in open dunes and gaps in dune scrub. Individuals vary greatly in biomass and seed production, ranging from 14 to over 37,000 seeds per plant (Pogge 1998).

In 1994, the Presidio was handed over to the GGNRA, and Sharon Farrell was hired as a "gardener" to manage twelve species of rare plants. Initial efforts involved installation of protective fencing and signage, and weeding. There was, however, debate about the strategy that would be employed for long-term lessingia management. Specifically, the question was whether to weed the native shrubs that had recruited into the lessingia range, or instead allow succession to occur and attempt to expand suitable adjacent habitat for lessingia to move into. At the time, the local California Native Plant Society representative believed that lessingia occurred in open dune blowouts and not with native scrub species, and therefore supported weeding within existing populations, but little was known about the population biology or ecology of lessingia to provide clear direction for a management strategy. Also, there was a clear need to track the size and range of the lessingia population over time. In an attempt to address these issues, monitoring programs were begun.

The lessingia monitoring goals fall into three categories: determining habitat associations, assessing management effectiveness, and tracking population size and range. The first two goals were not clearly distinguished at the time, and projects to address these goals reflect a lack of clarity in developing specific monitoring objectives with measurable outcomes. The goals for the monitoring program were summarized in a 1994 report: "to measure long term effectiveness of management efforts," "to document what other vegetation lessingia co-occurs with," and "to provide information on the rate of lessingia expansion into areas opened up by non-native plant removal."

The development of monitoring protocols to address these goals was further hindered by the fact that in 1994 there was a very limited tool box of monitoring methods thought to be available for vegetation sampling in the park. Direction from the Biological Resources Division of NPS provided that the only approved methods for collecting quantitative data on plants at the time were line-point transects and brush-density belt transects, as had been developed for long-term vegetation monitoring at Channel Islands National Park.

Based on these prescriptions, the first attempt at monitoring involved censusing all species within what were to be permanent 30-m belt transects. This was abandoned on Day Two because of the time it was taking. The other apparently available option, line-point transects, also would not work to address these monitoring goals due to the small size and sparse distribution of *lessingia* and many of its associates in the open sand habitat. Line-point transects were later to be utilized at reference sites to determine appropriate plants for dune scrub restoration, but it was clear that the one-method-fits-all approach would not meet the needs of *lessingia* management.

Breaking from pre-approved protocols, in late 1994 a protocol was developed utilizing point-frames on a fixed grid in each *lessingia* site. This involved placing a permanent grid on 5-m squares over the existing *lessingia* population and the adjacent area thought to be suitable for potential expansion of *lessingia*. At each corner of the 5-m grid system, a 0.25-sq-m frame with evenly spaced cross-hatched strings was laid down, and at each of the 16 corners where strings crossed, a pin was dropped and the presence of either the plant species touched or bare sand was recorded. This time-consuming but seemingly useful method was carried out in 1994 and 1995.

Due to lack of managerial and research-division time and expertise, and the absence of a pre-defined analytical method, the data for the first two years were not analyzed. In 1996 a small contract was provided for a third year of data collection and evaluation of the monitoring protocol (Wayne 1996). The contractor was Lisa Wayne, a student finishing her Master's in plant ecology at San Francisco State University. She determined that the project was not yielding information appropriate to addressing the initial goals. The reasons for this were the following: (1) using a point method for a sparsely distributed species resulted in mostly data points with a "0" value, thus lowering the sample size for analyses below that which yielded significant results; (2) evaluating the effectiveness of specific management treatments was not possible because a variety of treatments had occurred in sample areas and had not been precisely documented; and (3) evaluating management effectiveness was not possible because there was no control area without management treatment. Thus, after three years this method was also scrapped.

Two positive results came from the ultimately unsuccessful point-frame monitoring. First, this experience of working with local plant ecologists who are comfortable with the community-based program (i.e., working with volunteers, interns, and staff) and familiar with local ecology has proven to be a very successful model. Second, the community volunteers, interns, and staff who participated in the project became more familiar with the resource, promoting advocacy, public education, dialogue about management strategies, and the qualitative monitoring of *lessingia* and its management.

Qualitative monitoring to address all of these goals had been done since 1994 via photomonitoring from permanent photopoints and by documenting observations and work performed at each rare plant site. These observations and work records have come from all field managers, whether they be staff, interns, contractors, or volunteers. Documentation of this sort eventually became such a useful tool that a GGNRA restoration database was designed, wherein all qualitative observations and work performed, including photomonitoring and quantitative monitoring data, are entered into a Microsoft Access database. This database is now utilized throughout the park to track progress and develop plans.

Ultimately, it was the qualitative monitoring, combined with simple censuses and range maps of *lessingia*, that addressed the initial monitoring goals and directed management efforts. What the managers and stewards were finding was that *lessingia* was indeed moving into adjacent areas after weeding opened up sandy soil, and also that *lessingia* was persisting in gaps between native shrubs.

In 1995, the opportunity to take on a major management action based on these conclusions became available. A city sewer replacement project that impacted *lessingia* habitat in the Lobos Creek Dunes made funds available for the removal of nine acres of weedy vegetation and the re-creation of a natural dune community. The plan dictated that the site would be managed for *lessingia* and all of its habitat associates, including shrub species. The site was planted and seeded in distinct zones representing hypothesized successional seres. *Lessingia* was seeded with other dune annuals in the "annual" zone. In the "sub-shrub" zone, low-growing perennial shrubs were planted and the dune annual mix was seeded. Finally, in the "scrub" zone, a dune scrub assemblage was planted that was made up of species found in dense, taller remnant dune scrub areas. Throughout this project, the GGNRA has worked closely with its cooperative association, the Golden Gate National Parks Association (GGNPA), which handles the administration and funding for the project.

Meanwhile, in order to take on this project, enhance the other natural areas of the park, and develop a community of committed stewards, Sharon Farrell and counterparts at the GGNRA and GGNPA were building a model program of volunteer ecological restoration, now called the Presidio Park Stewards Program. Through the program, volunteers from conservation and community corps, local middle and high schools, and universities; from corporate, fraternity, and other groups; and individuals from local communities were coming out to learn and work on a daily basis. Interns paid only a minimal stipend became the program staff, and got involved in all aspects of vegetation management, from weeding to plant propagation to site planning and monitoring.

In order to again address the goals of determining the relationship between *lessingia* and its native habitat associates, and determining the success of management actions, a monitoring protocol was developed for the re-creation project (Lynn and Albert 1999). A small contract was provided to a local ecological design consultant to co-develop a sampling design. The contract funds were only able to provide for a sampling design, however, and once again the specific measurable objectives and associated analytical methods were not developed until an additional contract was procured in the spring of 1999, after two years of data collection. The initial design seems to have been robust enough so that the first two years of data will be able to be used in subsequent analyses. The objectives are: (1) to track the biodiversity in the project area, as measured by native species richness and evenness; and (2) to determine the trend in *lessingia* cover both in the site as a whole and within each planting and seeding zone. For this project, the site is stratified by planting and seeding zone. Within each zone, ocular estimates of cover class for each native species are made within randomly placed 2-m x 0.5-m quadrats. Descriptive results from the first two years indicate that none of the 79 planted and seeded species have dropped out, and that *lessingia* has increased in cover both within seeded and unseeded zones.

As mentioned above, a critical element of the monitoring program has been the assessment of *lessingia* range and population size. To assess changes in *lessingia* range, each year *lessingia* populations have been mapped using a GIS system. In 1998 a standard ArcView layout was developed by a volunteer for all GGNRA rare plant mapping.

From 1994 to 1997, the *lessingia* population sizes were determined through censuses using staff and volunteer groups. Meter tapes were laid out in belts 3 m wide, placed side-by-side across the population, and individual belts were censused. This method had the benefit of providing many community members direct contact with the resource in a useful way. Populations were either steady or rising through this

period and ranged from 2,000 to 18,000 individuals at all sites except the Lobos Creek Dunes, two years into its re-creation project, where the population was counted at nearly 300,000. These censuses, however, became problematic in being very time-consuming and in that it was difficult to ensure accuracy. The result was a pseudo-census where the populations were essentially being estimated rather than fully censused, but without any way to estimate variation and error.

In 1998 money was available to provide small contracts for both another graduate student who had participated in volunteer programs and the aforementioned ecological design consultant. They collaborated on the development of sampling protocols to estimate *Lessingia* population size (Bode 1998). The project involved developing a sampling design and testing for the relative efficiency of two quadrat shapes. It was determined that a bipartite quadrat, with two 0.25-m x 1-m segments separated by a 1-m divider, was more efficient than one continuous 0.25-m x 2-m quadrat. Two populations were estimated by this method in 1998, and beginning in 1999 all populations will be sampled. In 1998 both the sampled and censused populations skyrocketed further still, with the total population estimate reaching over 1,700,000.

Conclusions

In summary, the management of the endangered San Francisco *Lessingia* has been an unquestionable success, with a current population range more than three times that in 1994, a hundredfold increase in population size, and a committed and knowledgeable team of staff and volunteers who actively steward all populations. The monitoring projects, however, have had mixed success, though there have been many lessons learned. The most important problems encountered have been:

- 1) A failure to develop specific measurable objectives, and the analyses that will address them, from the beginning of projects;
- 2) Limitations on "approved" NPS vegetation sampling methods; and
- 3) Trade-offs for resource managers between volunteer management and project development.

The development of monitoring projects within a community-based program has had many benefits as well. The most important of these are that:

- 1) Vastly more management and monitoring has been enabled through over 50,000 volunteer hours annually;
- 2) The involvement of many people in qualitative monitoring increased knowledge of the resources and addressed management goals more quickly than quantitative monitoring projects;
- 3) Advocacy for the park and the resources as well as public education have flourished; and
- 4) Contracting with local ecologists familiar with the area and the program has been more successful than working with the Biological Resources Division.

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Optimal Use of Beaches and the Preservation of Endangered Species in the Greek Islands

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Introduction

Tourism is one of the major income sources for Greece. During the last decade, the Greek government and the European Union financed an attempt at tourism development in over two hundred islands. Balancing the irreversible commitment to economic investment and the preservation of endangered species is a subject which has stimulated much debate in Greek society.

Special attention has been paid to the preservation of the Mediterranean sea turtle (*Caretta caretta*). This very rare animal, which once thrived all over the Mediterranean basin, is currently restricted to a handful of Ionian and Aegean islands. The standard governmental policy on preservation of endangered species in Greece is to offer tax incentives in some ecologically sensitive zones. Nongovernmental organizations (NGOs) have long suggested that a tax incentive policy is not enough to solve the problem.

In 1996, the World Wide Fund for Nature (WWF) proposed the acquisition of some beaches to save threatened species. However, this policy was found unacceptable by the residents of the islands. The local communities claimed that tourism and turtle populations could coexist on the same beach. They argued that sea turtles need part of the beach for less than three weeks each year to lay their eggs. Thus, rotational use of the beaches could bring about ecological and economic optimality.

The following section sets out an economic model to analyze the different policies suggested by WWF and the local Greek communities. The model incorporates the notion of irreversibility in species preservation by noting the obvious fact that species extinction is an irreversible event. Relaxing the basic assumption of Davis (1981), land conversion is considered to be not completely irreversible. A rotation mechanism that would leave a percentage of the beaches empty for a period and thus preserve the endangered species is possible. The aim is to examine the hypothesis that a rotation mechanism in the use of the beaches can be more effective than a permanent restriction on land use.

In the last section of the paper, the conditions for optimal strategies of species preservation management are analyzed. Additional policy implications can also be drawn for the wildlife management of different species. Finally, the conclusions of the optimizing model are contrasted to empirically known facts.

The Basic Model

Consider the problem facing the social planner who must allocate beaches over time between tourism and natural habitat use. Assume the existence of two economic goods in a Greek island: a private good, G , an aggregate of the wealth stemming from tourism and a public good, S , the population of sea turtles. The problem requires the use of a social welfare function. The welfare maximization problem is defined in a finite horizon $t = T$, and under the assumption that the intertemporal utility function depends on G and S . The social welfare function is defined over the utilities of k individuals. This is formally represented as

$$\max W = \sum_t V(U_1, U_2, \dots, U_k) dt \quad (1)$$

subject to

$$G_t = a L_k G_{t-1} \quad (2)$$

$$S_t = bL_s S_{t-1} \quad (3)$$

$$L_t + L_g \leq L \quad (4)$$

$$L_t > 0, L_g > 0, G > 0, S > 0, \quad (5)$$

where W is a measure of the discounted social welfare. L represents total area of beaches suitable for both tourism and conservation. L_g is the land devoted to tourism development. L_s is land devoted to the conservation of endangered species. Crucial for this model is the assumption that G and Q are not directly related. However, G and S are related in an indirect way, as they both require the use of land for production. Their individual production functions are given by equations (2) and (3). The development of wealth arising from tourism depends on the use of land and the wealth of the previous period, as reinvestment is a crucial production factor for the tourist industry. Similarly, the development of the population of endangered species depends on the land use and the population of the previous period. The linear structure of equations (2) and (3) serves the simplicity of the model.

Assuming an interior solution, the Lagrangian maximization problem as a discrete time problem defined by (1)-(5) is as follows:

$$\max LR = V(U_1, U_2, \dots, U_k) + \lambda_{1t} \sum_t [G_t - aL_g G_{t-1}] + \lambda_{2t} \sum_t [S_t - bL_s S_{t-1}] + \lambda_{3t} \sum_t [-L_s - L_g + L] + \lambda_{4t} \sum_t [G_t - \sum_t G_t] + \lambda_{5t} \sum_t [aL_g G_{t-1} - G_t] \quad (6)$$

The variables $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ and λ_5 are nonnegative multipliers or shadow prices of the respective constraints in time t . The first-order conditions for the problem maximization are:

$$dLR/dG_t = \sum_t V_i U_{g_t} - \lambda_{4t} = 0 \quad (7)$$

$$dLR/dG_t = \lambda_{4t} - \lambda_{5t} = 0 \quad (8)$$

$$dLR/dS_t = \sum_t V_i U_{s_t} - \lambda_{2t} + \lambda_{2t-1} S_t = 0 \quad (9)$$

$$dLR/dL_g = a \lambda_{1t} G_{t-1} - \lambda_{3t} = 0 \quad (10)$$

$$dLR/dL_s = a \lambda_{2t} S_{t-1} - \lambda_{3t} = 0 \quad (11)$$

$$\text{and } \lambda_1, \lambda_2, \lambda_3, \lambda_4 \text{ and } \lambda_5 \geq 0. \quad (12)$$

Equations (7), (8), (10) and (11) can have straightforward interpretations. Equations (7) and (8) simply state that the marginal values of the benefits that come from tourism should be equal to the shadow prices of the respective constraints on the development of tourism. Similarly, equations (10) and (11) require that the marginal cost of using land for tourism or conservation of endangered species should be equal to the marginal utility produced by L_g and L_s . Particular attention should be paid to the interpretation of the remaining condition. Rewriting condition (9) as

$$\lambda_{2t} = \sum_t V_i U_{s_t} + \lambda_{2t-1} S_t \quad (13)$$

it becomes clear that the sum of the marginal utilities of the individuals and the changes in species population should be equal to the marginal price of changing the growth rate of the population. Thus, the value of the marginal product of any additional unit of land for the conservation of the beaches should equal the marginal cost of losing this land for the development of tourism. This conclusion, combined with the ability to revert land, has particular implications for the optimal management

of the endangered species and the way that the government should decide to legislate the use of beaches.

Let us assume irreversible habitat conversion due to investment commitment on the area devoted to tourist activities. Under this condition, equation (13) may not be satisfied. The inability to reconvert land from tourism development to species habitat limits the ability of the social planner to increase the sum of individual utilities. The social planner can increase the public utility only by increasing land conversion to development, but not in the opposite direction. Apparently, strict zoning policy will lead to gradual reduction of species habitats and increase the probability of species extinction.

Irreversible habitat conversion is not always the case. Rotational use of beaches is possible, provided that tourist development does not involve investment of some particular kind of infrastructure. Knowledge of the biological cycle of species is also essential for rotational use of land. This assumption implies that the land input for both uses may increase. Most importantly, tourism and development will compete over a smaller quantity of land. The social planner has the chance to create economic development which can be characterized by sensitivity and respect towards nature. The achievement of this goal demands integration of economic and ecological scientific wisdom.

Summary and Policy Conclusions

Welfare maximization models can capture only a small part of the real world. The power of policy implication that comes from simplified versions of reality should not be overestimated. However, the above analysis indicates that policy makers should not restrict their efforts to drawing frontiers between economic development and conservation policy. Zoning under irreversible habitat conversion may lead to gradual minimization of land available for species conservation.

The Greek government should perhaps consider the seasonal nature of tourism, as well as the fact that sea turtles demand a maximum of thirty days of beach use for reproduction. Acquisition of beaches for conservation reasons is a standard international policy of NGOs, but raises constitutional questions in Greece (whose constitution defines all beaches as public land) and is not an acceptable policy for some local governments. Tourist development which is friendly to the endangered species may be the solution to this problem. A careful study by economists and marine biologists may determine the boundaries of development as well as the obligations of the human populations on the islands. Such a plan could reconcile NGOs and the local governments to set a common aim and work in the same direction.

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Marine Protected Areas in the Gulf of Maine: Providing a Framework for an Ecosystem Approach to Management

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Introduction

In response to the increasing decline of marine resources, managers and planners are abandoning the traditional species-by-species approach to regulation, where policies are fragmented by administrative lines, and are instead embracing the emerging paradigm of ecosystem management. Ecosystem management has been proposed as an improved framework for protecting resources over the long term and achieving sustainable development. While the theory behind ecosystem management is well-developed, little attention has been given to aspects of implementation.

Marine protected areas (MPAs) are one management tool that facilitate the protection and sustainable use of marine ecosystems. As individual sites, MPAs can protect critical habitats and provide a focal point for tourism, research, and education. However, a coherent network or system of MPAs can provide a framework for an ecosystem approach to management that will address many of the complex environmental problems associated with the marine environment more effectively than traditional regulatory models. The feasibility of establishing an MPAs network is examined for the Gulf of Maine ecosystem, where existing coastal and offshore protected areas have been mapped and cataloged through a GIS database. Through spatial and statistical analysis, a better understanding can be formed about the way in which existing and future sites can be effectively coordinated in the Gulf of Maine.

Value of an MPAs Network

As single designations, MPAs protect critical natural resources and provide focal points for sustainable development. When linked or coordinated, they may offer a means to implement and test the principles of ecosystem management. MPAs have historically been established on an *ad hoc* basis with little regard for the spatial and ecological dynamics of the marine environment (Ray 1996). Yet, a coherent network or system of MPAs may offer an effective means of protecting transboundary resources by better addressing issues contributing to the decline of the marine ecosystems, such as overfishing and loss of habitat (Ballantine 1991). A network can be defined as multiple protected areas founded on ecological principles and coordinated for the purposes of sharing knowledge and improving management strategies, and for collaborating to achieve commonly held conservation goals. To form a network, protected areas must have some common basis for being linked. That is, they must be consistent in their type, overall management objectives, and specific regulations.

Through careful planning and regional coordination, an MPAs network focused on entire marine ecosystems may offer ecological and human benefits not gained through traditional haphazard or reactive approaches to marine protection. First, by accounting for habitat linkages, biogeographic processes, and the constant flow of resources through the system, a network approach can more effectively achieve commonly held conservation and management goals (Brunckhorst and Bridgewater 1995). Second, by coordinating across jurisdictions, scientific, educational, and management-oriented information can be more easily transmitted from one area to the next. Finally, transboundary collaboration can reduce duplicative efforts and leverage limited human resources to provide a more efficient approach to managing marine ecosystems.

Gulf of Maine: From Theory to Practice

The concept of an MPAs network was applied to the Gulf of Maine ecosystem in an effort to better understand how a systematic approach to establishing MPAs can

take place. As a well-defined marine ecosystem with high biodiversity and multiple protected areas, the Gulf of Maine acts as an ideal case study to examine and test the theory of networking MPAs.

The gulf is a 36,000-sq-mi basin stretching from the tip of Cape Cod in Massachusetts to the Bay of Fundy in Nova Scotia (Figure 1). This water body is 70% enclosed by New England and Canadian land masses, and is often referred to as a "sea within a sea" because its waters are separated from the Atlantic Ocean by the submerged plateaus of Georges Bank and Browns Bank and are isolated by temperature and salinity differences from the rest of the Atlantic (Waterman 1995). The Gulf of Maine is distinguished by a counterclockwise water current, called a "gyre," creating an intricately linked ecological system in which a negative impact in one area can affect another location hundreds of miles away. The ecosystem is thus constantly in flux and, as a result, habitats are often connected through the movements of valuable species and other organisms (Townsend 1992).

GIS Database

A GIS database of existing coastal and offshore protected areas, conservation zones, and restricted fishing areas in the Gulf of Maine was produced to examine the range and scope of regulated areas from an ecosystem perspective. By providing a centralized database, users can begin to understand commonalities and differences among sites, observe where protection measures overlap or leave gaps, and make conclusions about the level of resource protection across jurisdictional boundaries. An informational system providing the location and extent of existing resource protection will aid decision-makers in designating future sites that contribute to a network of protected areas in the Gulf of Maine. Through the use of the GIS database, we were able to statistically and graphically portray patterns of consistency in protection throughout the ecosystem. With this knowledge, we can better understand how a network using existing and future sites can be accomplished.

Study Area

The study area was expanded beyond the Gulf of Maine proper to include important offshore fishing closures on George's Bank. Water portions extend north from Cape Cod to the Bay of Fundy, and east to include George's Bank, Brown's Bank and the western peninsula of Nova Scotia up to Halifax. The study area also includes lands adjacent to or touching salt water. Jurisdictions lying within the study area include Massachusetts, New Hampshire, Maine, New Brunswick, Nova Scotia, U.S. federal offshore areas, and Canadian offshore areas.

Data Collection

Due to the broad scope of what constitutes an MPA and the diversity of protection levels within the study area, information was collected for a wide range of areas. Data were gathered and mapped for state and provincial parks, national parks, offshore fishing closures, marine sanctuaries, and other regulated sites seeking to protect discrete areas in the coastal and marine environment. In addition to mapping protected area boundaries, the following attributes were catalogued for each site: name, type of designation, jurisdiction, location, size, year established, legislation, ownership, IUCN management category, and site-specific regulations.

Results and Analysis

General observations. Within the study area, 167 protected areas were identified and mapped. As expected, the results indicate a sharp distinction between coastal and offshore protection. While only 48 of the total identified sites are offshore, on average, these sites are substantially larger in acreage. Among offshore sites, federal fishing closures constitute both the greatest number of sites and the largest amount of

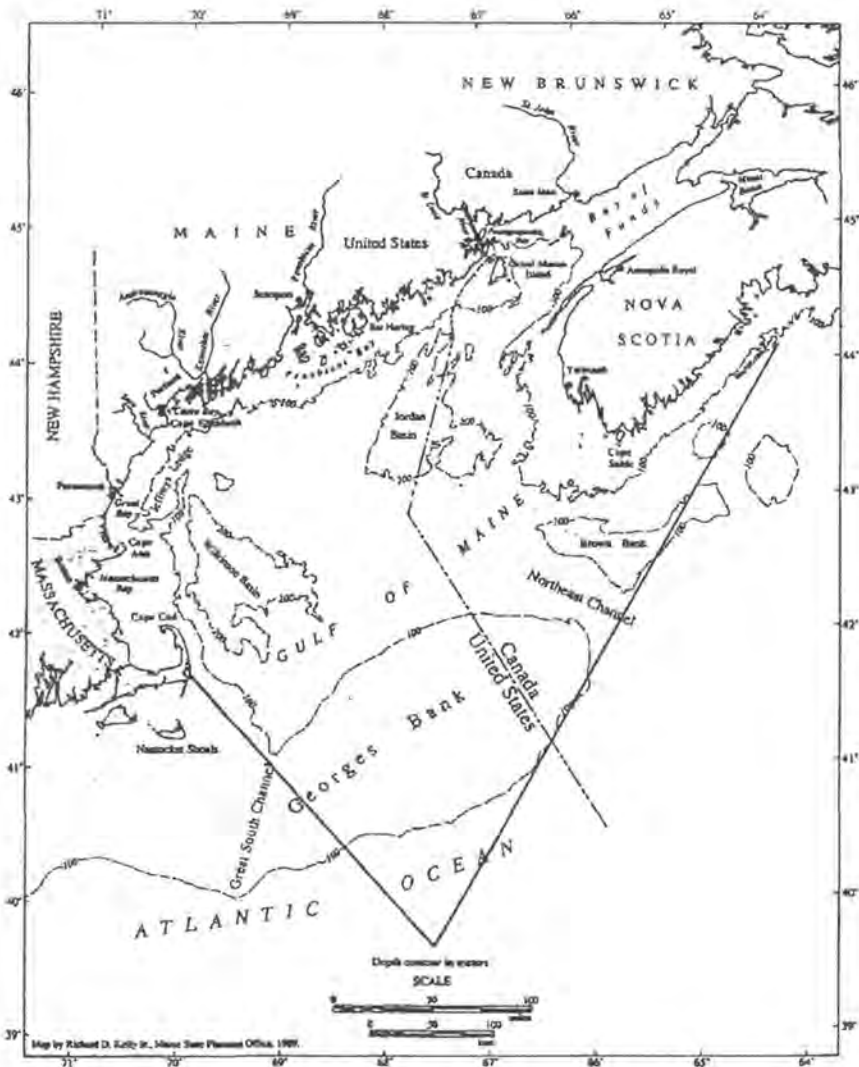


Figure 1: Gulf of Maine Marine Protected Areas Project Study Area

protected acres. Among onshore sites, state and provincial parks represent the greatest number of sites, yet federal parks account for the largest number of protected acres (Table 1).

Management objective. The following IUCN categories were used to assess the general management objective for each site (IUCN 1994)

- I: Strict protection
- II: Ecosystem conservation and recreation
- III: Conservation of natural features

- IV: Conservation through active management
- V: Landscape/Seascape conservation and recreation
- VI: Sustainable use of natural ecosystems

There were no IUCN Categories I or VI found within the study area, indicating a more limited range of management objectives. Ninety-five percent of the offshore sites were assigned to Category IV. In contrast, the majority of onshore sites follow management categories II and V (Figure 2). The variation between onshore and offshore IUCN categories indicates an important distinction with regard to level of protection. Offshore sites are primarily associated with species-based protection, such as fish spawning areas, while onshore sites focus more on habitat or landscape protection, as demonstrated by areas of environmental concern and national parks.

MPA Types	# Sites	Acreage	% Total Acreage in Gulf of Maine
Onshore			
National Wildlife Refuges	10	44,770.22	0.149%
Federal/National Parks	9	96,075.43	0.321%
State Areas of Critical Environmental Concern	10	64,833.20	0.216%
State/Provincial Parks	57	30,213.32	0.101%
State Wildlife Management Areas	11	7,548.60	0.025%
State Wildlife Sanctuaries	4	161.00	0.001%
State Public Reserved Lands	3	2,600.00	0.009%
Canadian Eastern Habitat Joint Venture sites	5	522.00	0.002%
Canadian Wildlife Service sites	10	15,068.80	0.050%
<i>Total Onshore</i>	<i>119</i>	<i>261,792.57</i>	<i>0.874%</i>
Offshore			
National Marine Sanctuaries	1	538,880.00	1.798%
Federal Fishing Closures	18	23,967,939.80	79.981%
National Estuarine Research Reserves	2	6,880.00	0.023%
Right Whale Critical Habitats	4	3,082,856.96	10.288%
State Ocean Sanctuaries	4	674,231.01	2.250%
State Fishing Restrictions	4	760,654.18	2.538%
State Complimentary Harbor Porpoise Closures	2	672,447.00	2.244%
State Marine Conservation Areas	13	1,215.21	0.004%
<i>Total Offshore</i>	<i>48</i>	<i>29,705,104.16</i>	<i>99.126%</i>
<i>Total, Gulf of Maine</i>	<i>167</i>	<i>29,966,896.73</i>	<i>100.000%</i>

Table 1. Onshore and offshore MPA types in the Gulf of Maine

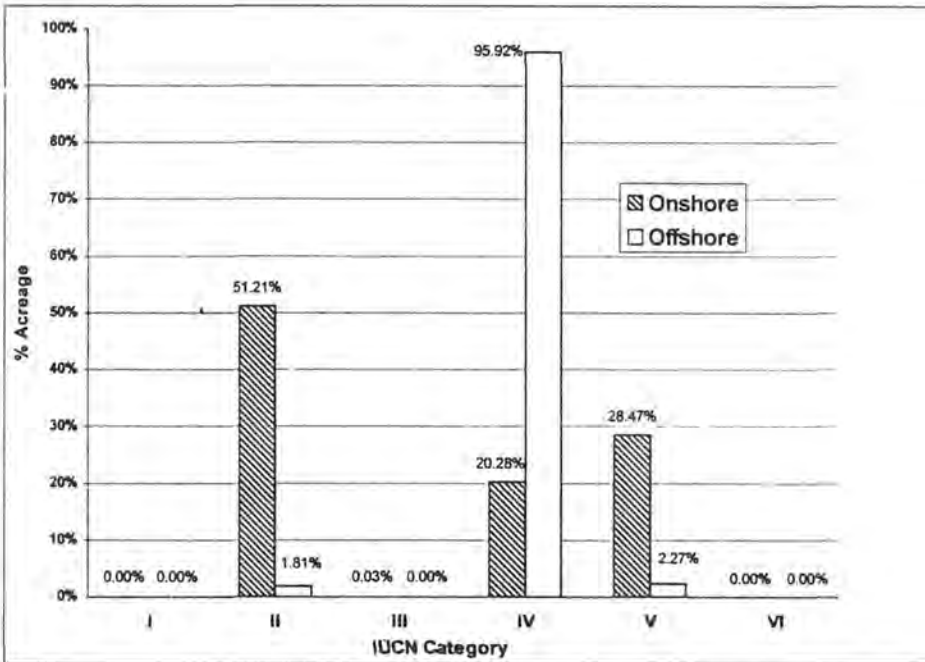


Figure 2. IUCN management categories for onshore and offshore MPAs

Regulations. A wide spectrum of specific regulations was catalogued for all sites. Onshore sites contain a variety of regulations focused on habitat protection, which address activities such as hunting, development, and human access. In contrast, offshore sites are more homogenous in their regulatory scope and are primarily concerned with seasonal commercial fishing closures and restrictions.

Time. Legislation affects the time period during which sites are established. As a result, more offshore sites have been designated in the past decade due to an increasing legislative focus on the marine environment. In the U.S., the majority of coastal areas were designated before the 1970s, reflecting legislation addressing terrestrial concerns. The majority of offshore sites were designated in the 1990s, reflecting recent amendments to the Magnuson Act, which call for an increase in fishery management through the establishment of commercial fishing closures.

Consistency Model

To effectively establish a network of MPAs in the Gulf of Maine, or in any other marine ecosystem, multiple sites must be consistent in their general goals and orientation. Commonalities between sites will enhance conservation measures and facilitate collaboration across multiple jurisdictions. When attempting to protect the same type of habitat or species throughout an ecological system, it is intuitive to establish sites possessing common attributes. That is not to say that sites need to be replicated across an ecosystem, but there must be some basis for coordination. To determine

the feasibility of creating a network in the Gulf of Maine, consistency among MPAs was examined based on the following criteria:

- **Type.** Sites should have the same general goal (e.g., fish protection vs. whale protection).
- **Objective.** Sites should have the same general management objective as indicated by the IUCN category.
- **Regulation.** Sites should have a common set of regulations (e.g., fishing restrictions, dumping, human access closures, etc.).
- **Spatial redundancy.** Sites should not overlap spatially, particularly across type.

The consistency criteria were applied to both right whale protected areas and federal fishing closures in the Gulf of Maine. These case studies reveal insight into the relationships between sites of the same type and indicate the feasibility of networking different areas throughout the ecosystem.

There are five federal sites (two in Canada and three in the U.S.), comprising over 2.6 million acres, designated to protect right whales during different feeding periods within the study area. While these sites attempt to protect the same species, they vary significantly in their objectives and regulations. With respect to IUCN management categories, four of the areas are designated as Category IV—Conservation through active management, while one site, the Stellwagen Bank National Marine Sanctuary, is designated as Category II—Ecosystem conservation/recreation. In other words, 85% of the total acreage for whale protection is consistent in terms of management objective. Regulations within these right whale protected areas vary widely. For example, the Canadian areas have only voluntary restrictions, the U.S. federal fishing-restricted areas deal exclusively with net type, and the Stellwagen Bank sanctuary restricts development and dumping. Overall, 68% of the total acreage designated for right whale protection is consistent for regulations in the USA, while only 17% is consistent in Canada (Figure 3). Spatial redundancy is also an issue for whale designations, where over 44,000 acres overlap seasonally between the Stellwagen Bank sanctuary and the Cape Cod Bay critical habitat closures. Establishing and coordinating a network of whale protected areas will be further complicated by the diversity of government agencies involved in management. Of the five sites dedicated to whale protection, the following three agencies are responsible for their management: the Canadian Department of Fisheries and Oceans, the U.S. National Marine Fisheries Service, and the U.S. National Marine Sanctuary Program.

Federal fishing closures were also examined through the consistency criteria. In response to the sudden decline of groundfish stocks (Vaughn 1993), managers have designated approximately 23.9 million acres of fishing closures and restricted areas in the Gulf of Maine. While all of these areas are designated IUCN Category IV, they are inconsistent with respect to specific regulations. For example, only 18% of the total acreage devoted to protecting commercial fisheries is closed year round, while approximately 80% is closed during different seasons. In addition, significant spatial redundancy occurs between federal fishing closures, particularly in the western part of the gulf. Approximately 2.45 million acres overlap between seasonal and year-round closures alone. Despite some variation, federal fishing protected areas are fairly consistent in their attributes such that opportunities exist for networking across jurisdictional boundaries. Although not captured in the consistency model, these areas have been created on a reactionary, *ad hoc* basis in response to the sudden decline of commercial fish stocks. Such an approach to protected area establishment will make it extremely difficult to proactively link and coordinate different sites, even of the same type.

Spatial redundancy is the most commonly violated criteria in the consistency model and was found to be prevalent for large, offshore protected areas. Overlap occurs both within the same type of site (i.e., among whales or fish-related sites) as de-

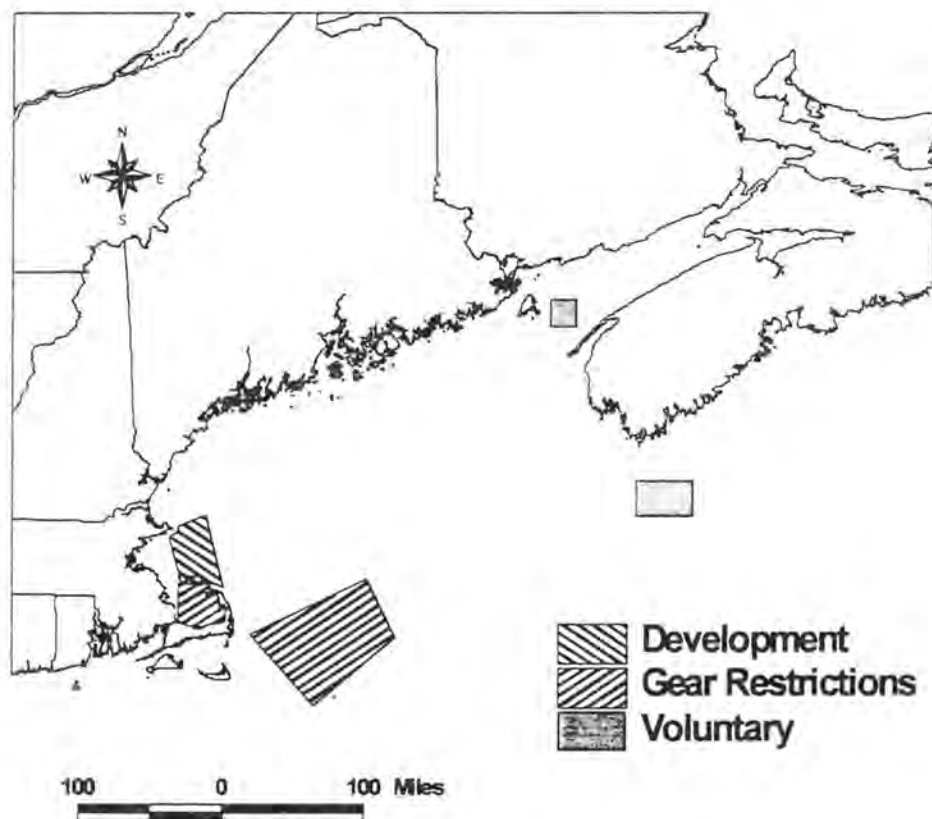


Figure 3. Regulations in whale protected areas, Gulf of Maine

scribed above and between different types of sites (i.e., whales on top of fish-related sites). For example, 4.2 million acres overlap between federally protected areas for whales and fish. In Massachusetts Bay, the boundaries of state and federal fishing closures, state ocean sanctuaries, and areas of critical environmental concern all overlap. Two or more sites sharing the same space indicate a lack of coordination and superfluous use of scarce financial resources. Spatial redundancy, particularly between different types of sites, is the expression of an *ad hoc* or reactive approach to marine management. Multiple regulations covering the same area is not only an inefficient way to manage natural resources, but makes it difficult for marine users, such as commercial harvesters, to interpret and follow the rules. In the case of Massachusetts Bay, each site is managed by a separate organization with different, and sometimes conflicting, management goals. The designation of a single site managed by one agency and a clearly defined set of goals would be a far more efficient approach to marine management, and one which would require both fewer resources and overall protected acres.

Conclusion

Using Geographic Information Systems (GIS) to examine protected areas on an ecosystem level enables managers and marine users to conceptualize the entire system. The GIS database created for the Gulf of Maine provides a tool with which to

spatially and statistically analyze how one area relates to others in the region. It can reveal insights into the patterns that emerge when looking at management objectives, regulations, and spatial relationships across the entire ecosystem. Most importantly, the GIS database can help to ensure future sites are consistent with the attributes of existing areas and are coordinated to protect habitats that are linked throughout the ecological system. In this sense, the database can facilitate a proactive approach to marine management, as opposed to the *ad hoc* method used in the past.

While the GIS database for the Gulf of Maine demonstrates the presence of a potential MPAs network, as yet the database is incomplete. Future mapping must also be done for local community and nongovernmental areas. In addition, research is needed to understand how such a GIS system can be effectively incorporated into the decision-making process and how a diversity of interests can have access to the data. If stakeholders can use the GIS database to better understand the present and plan for the future, the overall goal of sustainably managing Gulf of Maine resources will be more readily attained.

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Impacts of Vessel Groundings to the Natural Resources in Biscayne National Park, 1995-1997

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Seagrass is considered to be one of the most productive ecosystems in the world (Fonseca 1994; Thayer et al. 1997). Seagrass beds are extremely important, creating shelter from predators and acting as a nursery ground for commercial and recreationally important fish and invertebrates. Seagrass also stabilizes sediment, reduces wave energy, and filters nutrients from the water column (Thayer et al. 1975; Zieman 1976, 1982; Fonseca and Fisher 1986; Fonseca and Cahalan 1992). The loss of seagrass can have effects on these ecological values that are undesirable and often difficult to reverse (Fonseca 1994; Thayer et al. 1997).

Damage caused by boats has been recognized as a serious hazard to seagrass communities (Zieman 1976; Durako 1992; Fonseca 1994; Sargent, 1995). Estimates of recovery to areas damaged by motor boats indicate that scars, with little sediment loss, can take two to five years to fully restore (Zieman 1976) while more extensive damage may take decades to recover (Durako et al. 1992). These estimates are only for sites in which no further damage is occurring (Zieman 1976; Durako et al. 1992). In order for seagrass to recover naturally, damaged areas must remain free of additional scarring, and, in some cases, scarred seagrass beds may never recover.

Sargent (1995) observed that 9.1% of Florida's seagrass has been at least lightly scarred by boat propellers. As the population in Florida increases, so does the threat to seagrass from vessel damage. Sargent (1995) noted that between 1970 and 1990 the population in Florida doubled, but the number of vessel registrations tripled. Miami-Dade County has the second-highest moderate-to-severe scarring in the state, and much of this is concentrated in south Biscayne Bay, or Biscayne National Park.

The National Park Service's mandate is to protect a park's unique natural and cultural resources while providing for the enjoyment of visitors. In Biscayne National Park, providing for the enjoyment of visitors and protecting the resources for future generations can sometimes come into conflict. This is most noticeably seen in the area of vessel use within the shallow waters of the park. Recognizing the threat to the ecosystem from vessel groundings, in 1995 the park created a proactive management program to bring about an overall reduction in vessel groundings. The goal of this program is to minimize the physical damage to natural resources caused by vessel groundings and to develop more effective strategies, including education, law enforcement, and resource management, for the prevention of future incidents (Biscayne National Park 1996).

In 1996 an increased effort was made to assess damage from vessel groundings to determine the overall damage to the resources of the park. This effort has continued through 1998. The data collected has been used in part to assist in educating boaters, to gain restitution monies for restoration of damaged seagrass shoals through criminal and civil cases, and to justify the installation of more aids to navigation in the park.

Study Area

Biscayne National Park, which encompasses Biscayne Bay and the offshore coral reefs to a depth of 60 ft, extends from Key Biscayne to just north of Key Largo. The park is approximately 180,000 acres, of which only about 5% is terrestrial. The terrestrial habitats include the mangrove shoreline and a narrow chain of islands extending north from Key Largo. Coral reefs and the associated seagrass communities dominate the marine habitat to the east of the keys. The depths vary from an average of 30 ft to coral that breaks the surface. To the west of the islands is Biscayne Bay

which has an average depth of 10 ft. Biscayne Bay is approximately 90,000 acres with about 60-70% covered in seagrass. In many areas of the park, the seagrass is exposed at low tide, creating shallow-water shoals which are vulnerable to damage from boats. The dominant species of seagrass in the park are *Thalassia testudinum*, *Syringodium filiforme*, and *Halodule wrightii*.

Methods

Grounding sites were marked by visitor protection and resource management staff or tow company operators at our request (see Biscayne National Park 1996 for grounding protocols used in response to grounded vessels). Assessments of the damage were completed by park biologists as soon as possible after the grounding incident. The majority of assessments occurred after the vessels were removed from the shoal, but some occurred with the vessel still present. If the biologist could not positively attribute damage to the vessel, the site was not assessed. A meter tape was used to determine the length, width, and depth of the propeller scars, holes, or trenches. Grounding track length was measured from the point where the vessel first hit bottom to the point where it came to a stop. The type of damage was classified into three categories. Level 3 is defined as damaging the grass but leaving the rhizomes unimpacted. Level 3 damage includes cut grass blades or seagrass covered with sediment. Level 2 is defined as removing seagrass, damaging the rhizomes, or excavating a trench or hole to less than 0.30 meters deep. Level 1 is defined as excavating seagrass and sediment to a depth greater than 0.30 meters. A single grounding incident could have any combination of the damage levels. Notes were made on pages of Mylar film while underwater; these rough drawings and measurements were then transferred to a grounding form from which technical reports were generated.

Results

One hundred and seventy-seven groundings were reported in 1997 (Table 1). Approximately one third of the vessels were sailboats. This number is down from the total reported groundings in 1996, but the total extent of damage (in sq m) created by the vessels in 1997 was greater than in 1996 (Table 2). The total extent of damage to seagrass in 1997, including all levels of damage, was 8,354 sq m. The average extent of damage per power boat increased in 1997 from 52 to 112 sq m, but the average extent of damage from sail boats decreased from 14 to 13 sq m (Table 2).

In 1996, the highest percentage of vessels running aground was in the 20-29 ft size class (52%, Table 3). In 1997, this proportion decreased to 38% (Table 3). Although there was a decrease, over the past three years the largest number of grounded vessels has consistently been in the 20-29 ft size class (Figure 1). The average extent of damage to the seagrass increased with the size of the vessel (Figure 2). The average extent of damage by vessels in the 1-19 ft size class was approximately 6 sq m, but this number increases to over 300 sq m for vessels over 60 ft in length.

Discussion

Vessel groundings are a serious threat to the health of the marine ecosystems in Biscayne National Park. Between 1995 and 1997, 521 vessel groundings were reported in seagrass or coral, but this is considered to be only 20% of all the groundings which occur in the park. Most vessels do not get stuck, and therefore the groundings go unreported. The park has, on average, over 100 reported groundings a year. Ziemann (1976) and Durako et al. (1992) found that propeller scars regularly took more than five years to recover. Their studies only took into account scarring that removed a minimum amount of sediment. Scarring and blowouts in Biscayne National Park regularly exceed a depth of 0.30 m and have been measured to depths of 1.5 m. Additionally, damage from motor boats is recurring and does not allow for undisturbed natural recovery. Studies in the park (Battle 1998) have shown that holes less than 0.30 m deep can be completely filled in, and some holes deeper than

0.30 m partially filled in, after two years. These numbers appear to vary greatly depending upon the width of the holes, the strength of the currents in the area, the sediment size, and other vessels not re-damaging the sites. The numbers do not take into account the time it takes for seagrass to recolonize the area.

Vessel Groundings	1995	1996	1997
Seagrass Vessel Groundings Reported	120	217	177
Seagrass Vessel Groundings Assessed	19	109	106
Coral Vessel Groundings Reported	1	2	4
Coral Vessel Groundings Assessed	1	1	2

Table 1. Total number of reported and assessed seagrass and coral groundings, 1995-1997

Seagrass Damage	1995	1996	1997
Total Damage, All Levels (sq m)	2,249	4,082	8,354
Total Damage, Level 1 (cu m)	63	362	280
Total Damage, Level 1 (sq m)	91	518	584
Total Damage, Level 2 and 3 (sq m)	2,158	3,483	7,770
Average Damage per Vessel (sq m)	118	37	79
Average Damage per Sail Boat (sq m)	0	14	13
Average Damage per Power Boat (sq m)	131	52	112

Table 2. Total extent of seagrass damage for vessel groundings, 1995-1997

Size Class	1995 (n=116)	1996 (n=198)	1997 (n=166)
1-19.99 ft.	7%	11%	3%
20.00-29.99 ft	41%	52%	38%
30.00-39.99 ft	38%	15%	36%
40.00-49.99 ft	11%	17%	16%
50.00-59.99 ft	3%	2%	4%
60.00 ft and above	0%	3%	3%

Table 3. Percentage of seagrass groundings within each size class of vessel, 1995-1997

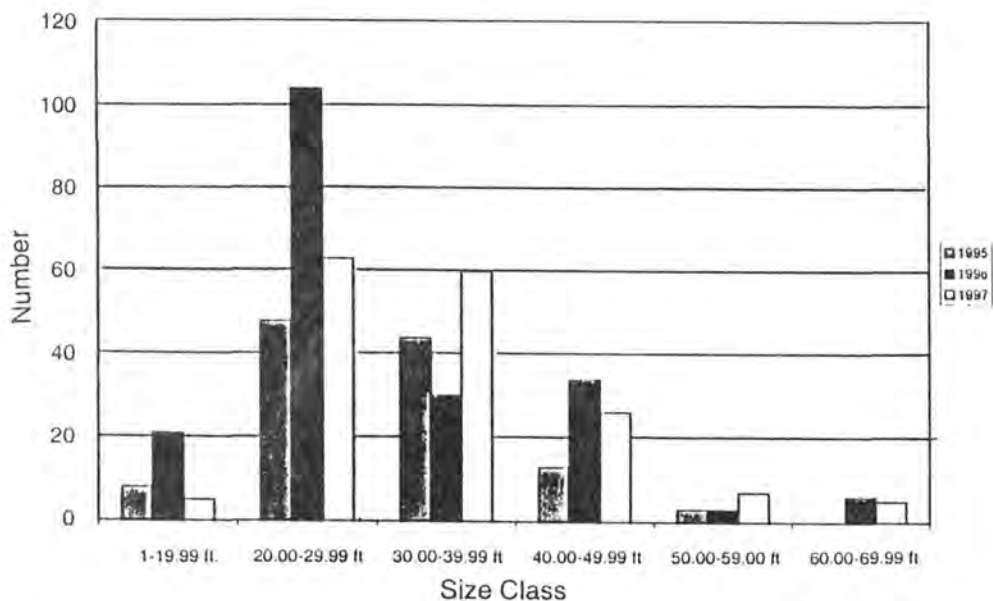


Figure 1. Number of seagrass vessel groundings per size class, 1995-1997

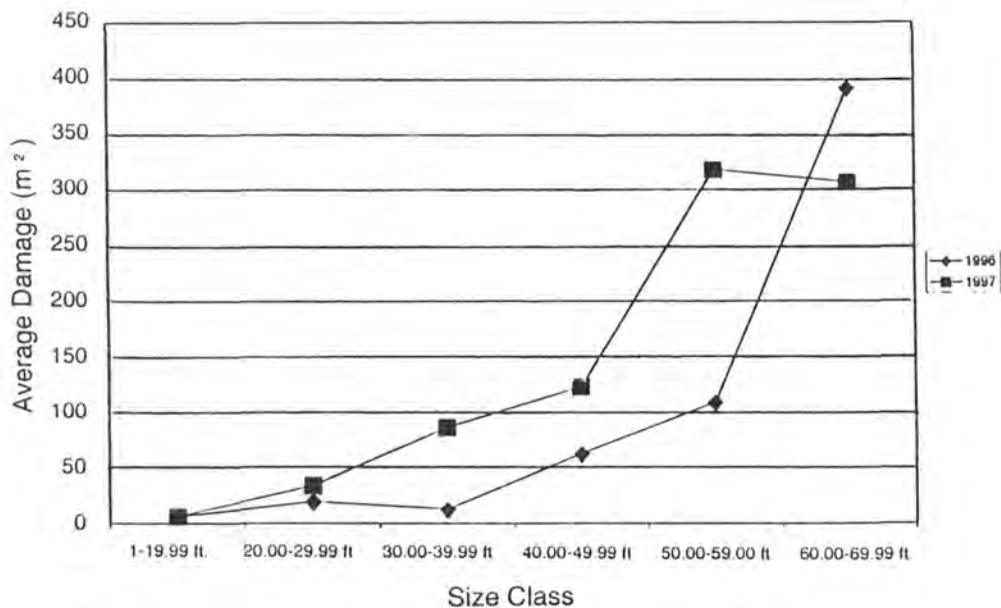


Figure 2. Average extent of damage per vessel size class, 1995-1997

The number of groundings in 1997 was down from 1996 (Table 1). The data for reported groundings in the park is dependent on factors including paperwork or notification from the commercial tow companies. By the author's personal observations, the decrease in the numbers between 1997 and 1996 appears not to have been due to an actual decrease in the number of groundings, but rather reflects a decrease in submitted reports. Although the number of reported grounded vessel decreased in 1997, the total extent of damage increased (Table 2). This was in most part due to two incidents in which the vessels, a 50-ft power boat and a 65-ft tug pulling a 100-ft barge, each damaged over 1,000 sq m of seagrass. The total extent of damage to seagrass averages approximately 1 to 2 acres per year. If we consider this to be 20% of the actual extent, we could estimate that 10-20 acres of seagrass are being damaged each year. These numbers do not reflect the actual overall damage to the seagrass community. The numbers represent the measured extent of damage, but long scars which bisect a shoal can cause negative impacts to the whole shoal.

Individual grounding incidents are independent of other grounding incidents. It is possible for a vessel of any size to run aground and create damage ranging from zero to more than 1,000 sq m (all damage levels combined). In 1997 the average total extent of damage for vessels over 60 ft in length was 306 sq m, whereas a single 29-ft vessel did 429 sq m of damage. It is more likely, however, for a larger vessel to create more damage (Figure 2). Vessel size is not the only factor to influence the amount of damage a vessel creates when it runs aground. The boater's attitude, shoal size, change in water depth, vessel speed, and sediment types all play a role in the amount of damage caused by a grounded vessel. If boat operators did not attempt to "power off" or if they trimmed up their motors, they created less damage. Sediment type, fine or coarse, can also influence the amount of damage created. Fine sediments allow the propellers to more easily penetrate and excavate the seagrass. The author has observed that vessels which grounded on fine sediment shoals were more likely to have the hull of the vessel penetrate the top layer of soils, as well as the propellers.

Coral groundings. The number of reported coral groundings has been increasing each year. In 1995, only one coral vessel grounding was reported; in 1997, four were (Table 1). Vessels impact the coral quite frequently but because the vessels do not get stuck, as in seagrass groundings, the groundings go unreported. Beginning in 1995, the commercial tow companies became familiar with the park's seagrass grounding protocols and their requirement for reporting grounded vessels to the park. Seagrass groundings are very straightforward to determine, whereas coral groundings can be more difficult. This is especially true when a vessel strikes the coral but continues its forward motion from the original location of impact. Biscayne has continued to work with the tow companies stressing the importance of reporting coral groundings as well as seagrass groundings. The tow companies contracts, in 1998, were amended to read that "anytime a vessel comes in contact with the bottom the tow companies must report it to the park." Nine coral vessel groundings were reported in 1998.

Occasionally Biscayne will have vessels over 100 ft in length run aground on the coral reef. Between 1995 and 1998 the park had two such incidents. On 4 November 1996, a 480-ft tanker, *Igloo Moon*, carrying 6,500 metric tons of Butadiene liquid, ran aground in the park. Over 2,600 sq m of patch reef was impacted. The final assessment has not been completed at this time and the case is still pending. On 20 July 1998, a 110-ft tug pulling a 354-ft barge, carrying 12,000 tons of sugar, allegedly ran aground in the park. The damage to the reef included cable scrapings, fractured framework, shattered live coral, and a "blowout" hole. The final assessment has not been completed at this time and the case is still pending.

Aids to navigation. Biscayne has been working closely with the United States Coast Guard in an effort to improve the aids to navigation in the park. A plan was developed in 1997 to install "danger shoal" markers around two of the most heavily impacted shoals in order to reduce the number of groundings. In May 1998, nine

new danger shoal markers were placed around these two shoals. In the first six months after placement (June through December) the number of vessels running aground increased at one of the shoals and decreased at the other, compared with the same period in 1997. This increase in vessel groundings could be a result of boaters who confused the markers for channel markers. As the newness of the markers wears off, we can hope that there will be fewer groundings.

Education. Education is a very important part of any vessel grounding management program. Various projects were completed to educate boaters on groundings. Grounding stickers were developed by park staff and paid for by a vessel owner as restitution for grounding damage. These stickers, which explain how to keep from running aground, were handed out, along with a boating safety checklist, to visitors. During 1998, the park offered a "Boating in Biscayne" class which included a discussion on groundings and tips on how to navigate around the park. Throughout 1997 and 1998, park staff attended many off-site functions to explain the park's grounding program and the problem that exists. Ideas have been presented for a grounding Internet site and for seagrass-grounding pamphlets. Biscayne also attend the 1999 Miami Boat Show. The park had a booth, staffed by Biscayne employees, that was dedicated to the grounding problem.

Restoration. In early 1999, Biscayne National Park was given its first large settlement for a vessel grounding incident. In a plea agreement with the vessel's owner, the park was compensated over \$100,000 for damage to seagrass. The money from this case and future civil cases will be used to actively restore the damage caused by vessel groundings. This restoration will include refilling holes and trenches and replanting seagrass. On a smaller scale, the park will be using the restitution money (gained from criminal grounding cases) to restore "orphan" grounding sites. The park has also completed emergency restoration to coral grounding sites, and is currently researching techniques for coral restoration to be used in future grounding incidents.

Conclusion

Biscayne National Park's ecosystems are being heavily impacted by groundings. Vessels of all sizes can cause extensive damage during grounding incidents. This type of degradation to seagrass, coral, and mangrove communities can contribute to a reduction in fisheries, water clarity, and water quality throughout the entire park. In an effort to try and reduce the number of grounding incidents and amount of damage each vessel causes, Biscayne National Park staff will continue to promote and improve the grounding program.

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I&M&M(angement): Getting from Inventory and Monitoring to Management—Cabrillo National Monument's Evolving Intertidal Tale

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Introduction

The fundamental purpose of National Park Service (NPS) inventory and monitoring (I & M) efforts is to help park management understand the nature and status of natural resources in a park area, and to elicit strategies to preserve them. Developing and implementing the steps necessary for resource preservation require significant contributions of park and non-park staff and fiscal resources. These changes can affect the park's short- and long-term plans as well as visitors' experiences in the park.

When impacts of an I&M program are this broad, support from two players is particularly important: the superintendent and the I&M investigator. Without the superintendent's support of an I&M program, the study leader may not even have the opportunity to begin a project, much less influence changes in resource management practices. Without the support of the investigator to translate what has been learned and to develop management recommendations, the importance and meaning of the monitoring may be lost, relegated to an office shelf.

The following is a case study describing big changes made to resource management in a small park, highlighting the key roles of the investigator and the park superintendent. Discussions with other natural resource managers have convinced me that it is difficult to develop any substantive program without support from the top—particularly if this program requires the coordinated participation of several park divisions and a significant portion of the work week. Conversely, when dedicated individuals have clearly stated support from their leaders, great things can happen. That is why I have chosen to trace the role of leadership in progressing from inventory and monitoring of the rocky intertidal region to its management.

Background

Lying within the city limits of San Diego is the rocky intertidal zone of Cabrillo National Monument, considered one of the richest examples of this ecosystem remaining in southern California (Engle and Davis 1996). Over 250 species of marine plants and invertebrates make their home within this narrow strip of rocky coast about three-quarters of a mile long (Zedler 1976). Among the more active residents are immature opaleye and wooly sculpin, California spiny lobsters, kelp and hermit crabs, California sea hares, two-spotted octopus, and ghost shrimp. The calmer set includes knobby seastars, abalone, California mussels, anemones, barnacles, giant keyhole limpets, feather-boa kelp, and dead man's fingers (an alga).

Many of these plants and animals are beautiful or tasty or both and have widely varying abilities to survive handling, evade capture, and reproduce. People have been drawn to and extracting from this rich resource since long before the establishment of Cabrillo National Monument in 1913. Native Americans came to the rocky intertidal areas to harvest lobster, abalone, and other nutritious food (Shipek 1991). European-Americans relaxed and played here back in the days of long, black, woolen swimsuits.

Today, approximately 100,000 visitors crowd into this narrow shelf each year. Impacts have not gone unnoticed. Long ago, black abalone were very abundant in the rocky intertidal but they have not been seen at Cabrillo in ten years of twice-yearly searches. Many San Diego residents have reported noticing declines or even local extirpation of species. Until recently the park had no empirical data to support these observations, much less trace their origins or begin to formulate solutions.

The Inventory

In 1976, NPS hired Joy Zedler of San Diego State University to conduct an inventory of the rocky intertidal area at Cabrillo. Among her conclusions were an observation and a recommendation: this fragile resource was being measurably affected by

visitors, and park management needed to begin monitoring in order to detect these and other impacts. Without a long-term monitoring program, the park had been forced to make largely uninformed management decisions. Additionally, in the absence of baseline data, park staff would be unable to assess environmental impacts in the event of oil or other hazardous spills.

The Monitoring Study

In 1990, Gary E. Davis, then a research marine biologist with the NPS Cooperative Parks Studies Unit and adjunct research associate at the University of California-Davis, and John M. Engle, director of the Channel Islands Research Program at the Tatman Foundation and research associate at the University of California-Santa Barbara, designed and implemented a monitoring study of the rocky intertidal zone at the national monument. The study ran from 1990 until 1995, and was paid for by Cabrillo National Monument Foundation, the park's cooperating association. Davis and Engle borrowed and customized many of the intertidal sampling techniques already developed and tested at Channel Islands National Park, an I&M prototype park. The techniques employed were simple and efficient so other parks could eventually implement a long-term monitoring program independently.

For our study, the rocky intertidal study area was divided into three use zones (Figure 1), each about 330 meters long, to parallel the different intensities of visitor use. Visitation was heaviest at the entrance to the intertidal area (Zone I), but only about 10% of these visitors ventured to the southern tip of the Point Loma Peninsula (Zone III).

Thirteen taxa (species or species groups) were monitored in those six years. These taxa were selected according to several criteria, including their ability to indicate the overall health of the intertidal ecosystem and their vulnerability to particular sources of stress: trampling, pollution, or poaching. Ninety-nine permanent plots were sampled twice each year, with an equal number of replicates in each of the three use zones.

During each sampling session, Davis and Engle involved park staff in the sampling, trained them in the techniques, and discussed the goals, methods, and utility of the monitoring. Handing the monitoring off to Cabrillo staff was always part of the plan. Once six years of sampling had been completed and the results formulated into a report, we found ourselves at a crossroads faced by many parks: will the park staff understand and utilize the study results, or will the study gather dust?

Critical Step Number One

Part A—Gary Davis came back. Rather than drop the report off and run along to the other 495 projects he has going, Davis and park staff set aside a day that would prove to be a turning point for rocky intertidal management at Cabrillo. First, all park staff and volunteers were invited to gather in the park auditorium to listen to Davis's presentation. The impact of this meeting was strengthened by the following:

Part B—Davis "spoke English." He discussed the monitoring program using a medical analogy, with the rocky intertidal zone as the patient. Monitoring was the equivalent of regular checkups; those who conducted the sampling were doctors and nurses. The apparent health of the taxa being monitored were the vital signs of that patient. All park staff members have a role in caring for that patient. This "interpretive" device made the study results and our respective roles much easier to understand than otherwise would have been the case. This greatly facilitated the post-lecture meeting.

Part C—Davis generated enthusiasm. If he had not been able to get park staff to care about these results, this report might have languished like so many others. Although many of the results of the study were sobering (seven of the thirteen taxa had declined or were found to be absent), Davis emphasized what we could do to improve the situation—to save the patient. There was hope. After his talk, we re-assembled in the park library.

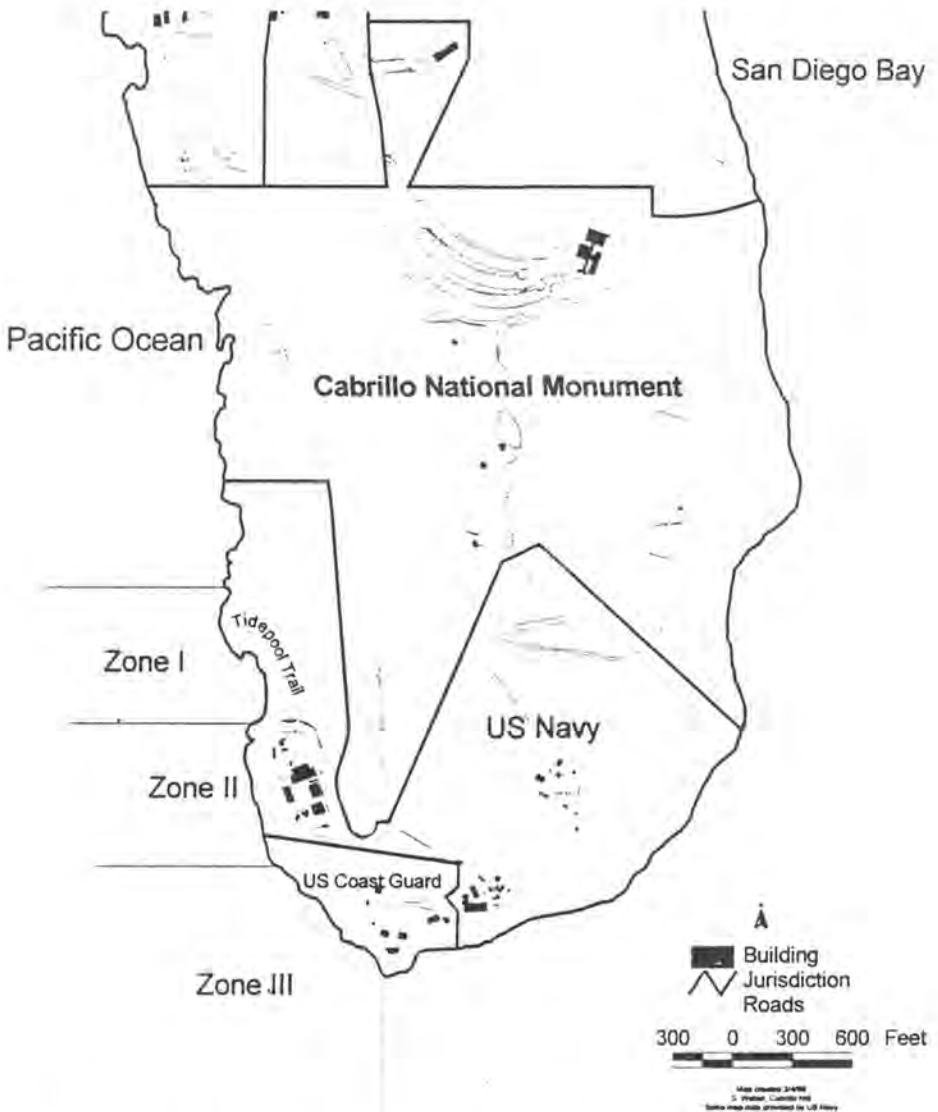


Figure 1. Cabrillo National Monument rocky intertidal monitoring zones

Adeptly mediated by Davis, the park staff brainstormed solutions on huge pads of paper. Everyone had an opportunity to pitch in, asking questions and offering ideas. Once we had generated a healthy list of ideas to protect the rocky intertidal area and enlist public support, we received instant feedback on the merits and feasibility of different ideas—since Davis was still there, holding the felt-tip pen.

Next, we formed a Tidepool Committee. This created a body responsible for coordinating some of the tasks listed on the "big list" once Davis was gone. The interpretation, resource management and visitor protection, and natural resource science divisions worked closely to attack the problem in concert. Each worked from a different angle, like different health care professionals (e.g., internist, nutritionist, and physical therapist) taking care of the patient in different ways, but with the same overall goal—to restore the patient to health.

Critical Step Number Two

The park superintendent bought into the whole program. From Davis's presentation on the state of the rocky intertidal and the staff meeting which followed it, Superintendent Terry DiMattio drafted the "Tidepool Protection, Education, and Restoration Plan." This 11-step plan named specific divisions and staff members who were to implement specific tasks by target dates. This changed the intangible ideas and goals to tasks and timelines for which staff members were held accountable.

Next, the superintendent made it clear that this plan was a high priority for the park. He let division chiefs know that they needed to allow their employees to spend the time necessary to achieve the goals that were spelled out in that document. If this meant that some other projects would be completed later than forecast, so be it.

One of the more controversial steps in the plan was closing Zone III, the most remote and least visited area of the tidepool zone, to the public. Its temporary closure was recommended to allow for resource recuperation, and to establish a scientific control, strengthening the experimental design of the monitoring program. The scientific information provided by Engle and Davis's study provided us with the solid base from which we could propose such a bold step. Months before the proposed closure date, the superintendent and park staff disseminated the closure plans as widely as possible using press releases, interviews, letters and phone calls. Zone III was closed to the public on 9 November 1996.

To gauge the public's reaction to the closure, DiMattio worked with Larry Beck of San Diego State University (SDSU), Davis, and regional and local park staff to design and implement a tidepool visitor survey. This questionnaire, carried out by SDSU students, was designed to learn about basic demographics of tidepool visitors and their use of, experience in, and appreciation for the tidepools, as well as their feelings about the closure of Zone III. By June 1997 we had a complete report on visitors to the rocky intertidal zone, their values and their perspectives. Ninety-nine percent of the 321 respondents supported our decision to close Zone III. In fact, they preferred a zone closure method to any other alternatives offered, including guided tours or a reservation system.

Behind the scenes, the superintendent had been working proactively for some time to strengthen the park's ability to develop an I&M program. Two decisions he made advanced this goal dramatically. One was creating a natural resource science division and appointing its acting chief—a year before receipt of Engle and Davis's report. This division was given its own budget, and its now-permanent chief reports directly to the superintendent. This division's primary responsibility is to develop and implement an inventory and monitoring program for the park's marine and terrestrial systems. This includes acquiring and maintaining the skills, equipment, infrastructure and volunteer help to monitor the rocky intertidal zone indefinitely.

The second important step toward long-term rocky intertidal management was the request for a natural resource specialist (marine biologist) for the new natural resource science division. The superintendent ranked this position request at number one for the park, above even that of a museum curator—a very unusual move for a "cultural" park. The request was granted.

Bonus Step

Whom to recruit for the marine biologist position? While most park staff members were dealing with the day-to-day realities of implementing the new tidepool protec-

tion, education, and restoration plan, Davis and DiMattio were hatching plans for that position. Davis had been talking to Paul Dayton, a renowned intertidal ecologist at Scripps Institution of Oceanography, to explore the possibility of recruiting one of his graduate students to apply for this position.

The potential benefits to the park were impressive: a first-rate, well-educated employee with experience in marine systems; a graduate student whose dissertation might answer some of the questions the rocky intertidal monitoring work generated; affiliation with the prestigious Scripps Institution of Oceanography; and the association of Dayton with Cabrillo's marine resource management program. Among the benefits to Scripps: funding for a graduate student; affiliation with the National Park Service; access to the rocky intertidal area as a living laboratory, a uniquely protected and rich resource; a very tangible, real-world value to its research; and work experience for the graduate student.

It worked. Now the park has a natural resource science division, funding, and an affiliation with Scripps. Our marine biologist is taking over the rocky intertidal monitoring program and will investigate the causes of the observed species declines for her dissertation research. With the combination of her expertise and that of Scripps's faculty, she is helping park staff, volunteers, and visitors understand the complex marine system we are trying to preserve, unimpaired, for the future generations.

Conclusion

The evolving intertidal tale of Cabrillo National Monument may be a unique set of events stemming from an unusual partnership between a dedicated researcher and a park superintendent. However, this sort of partnership does not have to be uncommon. This example shows that surprising things can happen if resource managers and superintendents prioritize natural resource preservation, back that up with full-time positions and budget allocations, and allow themselves to consider what fiscal and personnel resources are necessary to sustainably manage park resources for the long term—not just what they think they could get. The message is: think big and for the long term; consider all the possibilities; foster novel partnerships; encourage employee involvement; stay positive; and keep at it.

If anyone had told me ten years ago, when I first worked as a GS-4 fee collector and weed-puller, that this "cultural" park would hire a marine biologist before they would hire a museum curator, I would have laughed, had them sit down, and taken their temperature. Now I just feel lucky to be involved, proud of the work everyone has done and continues to do, and excited about the future of Inventory & Monitoring & Management at Cabrillo National Monument.

Acknowledgments

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The Role of the National Park Service in the Northwest Forest Plan

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Introduction

The Clinton Administration inherited the Northwest timber issue in 1993, and a commitment to resolve it was high on the president's list. To end the legal impasse, remove the injunctions from the region's federal forest lands, and move the region forward, the president asked his Administration and federal professionals to create a science-based forest management plan built on five goals: (1) adhere to the nation's laws, (2) protect and enhance the environment, (3) provide a sustainable timber economy, (4) support the region's people and communities during the economic transition, and (5) ensure that federal agencies work together.

The challenge to the administration was to develop a plan that achieved each of these goals while recognizing that difficult trade-offs would have to be made to address often-conflicting interests. Agency coordination was implemented in June 1993 by the administration. The administration proposed and Congress secured federal appropriations to start the economic assistance program by December 1993. On 13 April 1994 the federal forest management plan was completed, incorporating nearly 110,000 public comments.

Protect and Enhance the Environment

Of the five goals that serve as the backbone of the Northwest Forest Plan, goals 2 and 5 have the most significant implications for the National Park Service (NPS). Goal 2, "protect and enhance the environment," could serve to be very beneficial in assisting NPS in meeting its congressional mandates and portions of its strategic plan, as well as further protecting individual national park units within the Northwest region. The concept of ecosystem management recognizes that forests are complex networks of biological systems connected to and dependent on each other, and that people are an integral part of those ecosystems. The Northwest Forest Plan is one of the first large scale attempts to define and operate ecosystem management across an entire region.

The plan covers the range of the northern spotted owl, which includes western Washington and Oregon plus northern California. The 24.4 million acres of federal forest lands in this region are allocated into seven categories (Table 1) created to maintain and restore 80% of the remaining late-successional and old-growth forests, as well as water quality and fish and wildlife habitat, and to allow a sustainable timber harvest of 1.1 billion board-foot per year. This plan includes 17 national forests, nine Bureau of Land Management (BLM) districts, 13 national park units, 26 national fish and wildlife refuges, and one Department of Defense unit (Fort Lewis, Washington).

An aquatic conservation strategy was implemented to restore and maintain the health of watersheds, providing direction for analysis, restoration, and monitoring. The region is divided up into 12 physiological provinces to focus on how land management activities will address the unique ecological attributes of each subregion. For example, the old-growth rainforests of the Olympic Peninsula province in Washington have different management requirements than do the less-dense and drier forests of the Klamath Basin province in southern Oregon and northern California. The provinces allow the Northwest Forest Plan's standards and guidelines to be adapted to fit unique, local conditions.

<i>Category</i>	<i>Description</i>	<i>Acreage</i>	<i>%</i>
<i>Congressionally reserved areas</i>	Areas reserved by Congress (national parks, wilderness areas, wild and scenic rivers, Department of Defense lands).	7,320,600	30
<i>Late-successional reserves</i>	These reserves will maintain a functional, interactive, late-successional and old-growth forest ecosystem.	7,430,800	30
<i>Adaptive management areas</i>	These areas are designed to develop and test new management approaches to integrate and achieve ecological, economic, and other social and community objectives.	1,521,800	6
<i>Managed late-successional areas</i>	These lands are either (1) mapped managed pair areas for northern spotted owls or (2) unmapped protection buffers for certain rare and endemic species.	102,200	1
<i>Administratively withdrawn areas</i>	These areas are identified in land management plans as campgrounds, recreational or scenic visual areas, backcountry, and other areas not scheduled for timber harvest.	1,477,100	6
<i>Riparian reserves</i>	These are (1) areas along streams, (2) wetlands, ponds, or lakes, or (3) unstable or potentially unstable areas where the conservation of aquatic and riparian-dependent terrestrial resources receives primary emphasis.	2,627,500	11
<i>Matrix</i>	This is the federal land outside the six categories set forth above. It is the area where most timber harvest and other silvicultural activities will be conducted.	3,975,300	16

Table 1. Land allocation categories under the Northwest Forest Plan

Ensure that Federal Agencies Work Together

Goal 5 directs government agencies to work cooperatively rather than separately. This cooperation is difficult because agencies have different mandates, responsibilities and cultures that sometimes overlap or conflict. Such agencies as the U.S. Forest Service (USFS) and BLM share similar missions—to manage federal lands for resources, recreation, and environmental protection; regulatory agencies like the National Marine Fisheries Service and U.S. Fish and Wildlife Service (USFWS) are responsible primarily for conserving species under the Endangered Species Act, the Migratory Bird Treaty, and several other laws.

To coordinate and focus the plan's implementation, the federal agencies are working together in new interagency groups that do not take decision authority away from individual agencies but require them to coordinate with each other and the public. In this effort, agencies have developed region-wide means to coordinate activities, improve communication, share information, and eliminate duplication. Advisory committees were established to ensure that federal decision-makers receive in-

put from local, state, and tribal governments and the public. The committees are focused on building coordination, communication, and trust among the seven departments and 16 agency programs implementing the Northwest Forest Plan.

The Interagency Steering Committee (ISC), based in Washington D.C., establishes policies for the plan, and resolves regional issues that are brought before them. The Regional Interagency Executive Committee (RIEC) serves as the senior regional coordinating and implementing body. Advising the RIEC is the Intergovernmental Advisory Committee (IAC), which ensures a forum for local, state, and tribal governments.

Each of the 12 provinces has a Provincial Interagency Executive Committee (PIEC), of federal agency managers who oversee the public programs within their province. Advising the PIECs are the Provincial Advisory Committees (PACs), made up of community, business, and environmental, local, state and tribal representatives.

The Regional Ecosystem Office (REO) provides independent recommendations and scientific, technical, and other staff support to the RIEC. Staff members of the REO are on loan from federal agencies participating in implementing the Northwest Forest Plan.

Government agencies are working together—the daily activities of the REO are an example of interagency cooperation. Such coordination is saving staff and financial resources, creating trust among the agencies, leading to better and more unified positions and helping manage the inevitable conflicts. Successful partnerships require people to look beyond their own mission and values to develop mutually agreed-upon solutions. Working things out takes considerable patience and time, but in the end more people feel better about the decisions and the mix of resources being managed.

The Northwest Forest Plan is designed to be adaptable and flexible. It allows people to consider and incorporate new information, scientific results, and on-the-ground experience to meet the plan's objectives. Over the next few decades, the plan, if carefully implemented, will generate more old-growth habitat and provide environmentally sound, sustainable timber production for the entire region. Most important, the plan can prevent a return to the gridlock and frustration of the past. It is a starting point for the people, communities, and forests of the Pacific Northwest and northern California, a blueprint for a new way of managing the region's natural resources for the continued benefit of everyone. In the long-term, the plan will increase the ecological integrity of the lands surrounding national park units within the region. This improved condition could pay dividends in terms of enhanced wildlife habitat and viewsheds on lands outside park boundaries.

Why are National Parks Included in the Northwest Forest Plan?

The Northwest Forest Plan focuses primarily on land management activities on USFS and BLM lands. Both the secretary of interior and the secretary of agriculture signed the record of decision amending 17 USFS and 7 BLM planning documents to create, for the first time, a common management approach to the lands they administer throughout an entire ecological region. In setting forth on this mission to develop a strategy for management of federal old-growth and late-successional forests, the president charged us to use an ecosystem management approach. In this vein, the planning area for this strategy was defined as the federally administered lands within the range of the northern spotted owl. The preferred alternative provided for a functional and interconnected old-growth forest ecosystem. All relevant federal agencies were involved at an early point in the planning process. National parks are federal forested lands and are therefore included in the Northwest Forest Plan. Since national park lands fall within the first category of Table 1, congressionally reserved areas, they are included as part of the total land base, the "federal forested lands." The Northwest Forest Plan does not alter any of the congressional mandates for national park lands or change their management. The plan's standards and guidelines

only apply to the USFS and the BLM lands and their management activities. Inclusion of national park lands in the Northwest Forest Plan "does not adopt new management direction for those lands" (USFS and BLM 1994a, 16).

National park units play a significant role in the Northwest Forest Plan by providing large blocks of pristine habitat and stable environments for many species. The national parks serve as islands of biological diversity, but are surrounded by highly managed, fragmented landscapes where most of the old-growth forest component has been harvested and no longer exists. When mapping the biological conservation strategy, planners started with the best large blocks of habitat and areas already identified for conservation. These were the national parks and wilderness units. Additional federal forested lands (of which most had been logged) were added around the parks and wilderness lands to create a large conservation reserve strategy (i.e., late-successional reserves) across the entire region. The national parks serve as functional (often low-elevation) old-growth habitat providing the only remnant habitat for old-growth-associated threatened and endangered species in their provinces. Of the 13 NPS units found within the range of the northern spotted owl (Table 2), 11 host populations of the bird and the remaining two (Fort Clatsop National Memorial and Lava Beds National Monument) host populations and habitats for salmon species and bats. At least six national park units host populations of the marbled murrelet.

<i>National Park System Area</i>	<i>Attributes</i>
North Cascades National Park	federal forest, northern spotted owl habitat, headwaters
Olympic National Park	federal forest, northern spotted owl & marbled murrelet habitat, headwaters
Mount Rainier National Park	federal forest, northern spotted owl & marbled murrelet habitat, headwaters
San Juan National Historic Site	federal forest, marbled murrelet habitat, headwaters
Fort Clatsop National Memorial	federal forest, headwaters
Crater Lake National Park	federal forest, northern spotted owl habitat, headwaters
Oregon Caves National Monument	federal forest, northern spotted owl habitat, headwaters
Lava Beds National Monument	federal land, bat habitat
Redwood National & State Parks	federal forest, northern spotted owl & marbled murrelet habitat, headwaters
Whiskeytown National Recreation Area	federal forest, northern spotted owl habitat, headwaters
Point Reyes National Seashore	federal forest, northern spotted owl habitat, headwaters
Golden Gate National Recreation Area	federal forest, northern spotted owl habitat, headwaters
Muir Woods National Monument	federal forest, northern spotted owl habitat, headwaters
<i>Note:</i> "headwaters" designation is for park units that have stream headwaters that contribute to the conservation of sensitive fish species.	

Table 2. National park units included in the Northwest Forest Plan

Olympic National Park has a large population of northern spotted owls, and without its status as a national park, some biologists speculate that the species would

have been extirpated from the Olympic Peninsula years ago. On the very southern range of the northern spotted owl, Point Reyes National Seashore, Muir Woods National Monument, and Golden Gate National Recreation Area host 53 known owl sites, with 33 pairs known to be nesting and a combined known population of 81 owls. These Marin County parks provide the highest density of northern spotted owls known to exist anywhere in the world. These are just a few examples showing the important role national parks play in the Northwest Forest Plan.

National Parks contain approximately 9% of the land base of the 24.4 million acres of the Northwest Forest Plan. To put this into perspective, consider Table 3.

<i>Agency</i>	<i>Acres</i>	<i>%</i>
USFS	19,417,700	79
BLM	2,711,200	11
NPS	2,157,400*	9
USFWS and Department of Defense	168,900	1
Total federal forested land	24,455,200	100

*Adjusted total NPS acres = 2,224,849. The difference in the acreage numbers is the inclusion of Golden Gate National Recreation Area's Marin County unit and Lava Beds National Monument—two locations which serve as habitat for threatened species previously unknown to exist in these locales and not included in the original planning team's calculations.

Table 3. Northwest Forest Plan land allocations, by agency

Benefits of NPS Involvement in the Northwest Forest Plan

NPS benefits in a number of ways by being involved in the Northwest Forest Plan:

- Serving on the IAC and PACs, and being represented on the REO, provides an unparalleled opportunity to promote both the ideals of NPS and its mission, and to garner information from and cooperate with other federal agency regional administrators, state and county officials, and tribal leadership.
- For years, NPS has been trying to express its concerns over the management of adjacent lands, particularly those controlled by USFS and BLM. The Northwest Forest Plan speaks to these concerns by requiring all 17 national forests and nine BLM resource areas to take an ecosystem approach.
- Unique funding opportunities, including congressional appropriations, arise from time to time that occur because of the REO's existence.
- The plan includes an aquatic and watershed conservation strategy and regional monitoring programs that can benefit the parks.

Conclusion

The Northwest Forest Plan is the best conservation measure for federal forested lands in the Pacific Northwest since the region's national Forests and BLM lands were established. This will have a positive influence on the national parks west of the Cascades and those parks in the southern range of the northern spotted owl through the next century. Furthermore, the national parks and the NPS will benefit in the following four areas:

1. Improved forest health on neighboring federal forested lands;
2. Opportunities to further educate other agencies about NPS's needs, concerns, and perspectives;

3. Connections between neighboring and participating agencies; and
4. Dialogue with neighboring agencies with an interagency perspective.

Continued NPS support and enthusiasm for the Northwest Forest Plan is critical to its success. As we enter the fifth year of this 100-year plan, it is important that we recognize not only the long-term benefits for the national parks, but the improved health of all the federal forested land within the range of the northern spotted owl. The Northwest Forest Plan provides those of us in NPS with a unprecedented opportunity to participate in one of the largest ecosystem management plans in the USA.

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National Parks and Gateway Communities: Three Case Studies

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Introduction

During the past 20 years, a great deal of attention has been devoted to the relationship between parks and their neighboring lands. In 1980, the *State of the Parks Report* identified a wide range of threats to park resources that originated in whole or in part from sources outside of park boundaries. Concerns about potential adverse impacts of adjacent land uses were again documented in a 1994 study by the General Accounting Office, which reported that 85% of National Park Service (NPS) areas identified significant threats from outside their borders (General Accounting Office 1994). At least half of those requesting funds for new General Management Plans (GMPs) in 1999 identified rapid changes in adjacent land uses as a major factor in their need for new planning direction.

The perception of the adjacent lands problem and potential solutions has been evolving. In 1991, the *Vail Agenda* (NPS 1992) focused on the need to improve cooperation with adjacent communities to reduce adverse impacts on park resources from adjacent land uses, and to encourage the provision of visitor services outside of park boundaries. Specific recommendations from the Vail Symposium focused on both threats and opportunities involving gateway communities: NPS was encouraged to provide technical and planning assistance to gateway communities, encourage private-sector visitor services outside of parks, and assist local governments in planning for sustainable economic development. This paper is one response another recommendation from Vail: that "demonstration projects should be monitored, evaluated, and expanded to other areas of the Service."

Pilot Projects

In 1994, three parks were chosen as pilot projects for collaborative planning efforts with gateway communities. Specifically, the initiative aimed to link park GMPs with cooperative planning for gateway communities. Proposals were invited from NPS regional offices, and the directorate selected three pilot projects: (1) Mount Rainier National Park and the communities of Ashford-Elbe and Greenwater in Washington state; (2) Sitka National Historical Park and the city and borough of Sitka in Alaska; and (3) Grand Canyon National Park and the Tusayan area in Arizona.

To evaluate the experience with these three projects, key participants were interviewed during the summer of 1998. Approximately 10 individuals from the parks and communities in each of the three areas were contacted by telephone. Additional information was gathered from park GMPs and community comprehensive plans, press releases and newspaper articles, Internet Web sites, and other literature reviews.

Although the goals for the three projects were similar, differences in emphasis are noteworthy. At Mount Rainier the stated purpose of the project included improvement of community relations and support from NPS for comprehensive planning underway in the communities. For Sitka, the project was intended to improve management of visitor services in order to protect resources in the community as well as the park. At Grand Canyon, provision of visitor services outside of the park in the gateway area of Tusayan was a clearly defined intent of the GMP.

At Mount Rainier, the communities of Elbe and Ashford have a combined population of approximately 1,500 at the primary entrance to a park that hosts 1.5 million visitors each year. The economy of these communities depends heavily on park-related tourism. In contrast, the community of Sitka is a major tourist destination in itself, where the park encompasses only 107 acres. Sitka National Historical Park is a

park within a community, with the city and borough of Sitka encompassing 1.9 million acres. The community outside of the park contains many important cultural and historic sites. Local economic activity has traditionally been supported by timber and fishing, but tourism, largely from cruise ships, delivers more than 250,000 visitors during a very short season.

The South Rim of Grand Canyon is becoming increasingly overwhelmed, with visitation approaching 5 million per year. The gateway area of Tusayan has developed—with little evidence of planning—to provide a range of services, including buses, helicopters, recreation vehicles, shops, motels, an IMAX theater, and other “attractions” in a narrow strip leading to the park entrance. Tusayan is an unincorporated area with approximately 550 residents, while the park and concession staff living at the South Rim of Grand Canyon National Park exceeds 1,600.

While the Tusayan “community” appears to be primarily focused on increasing commercial activity and limiting governmental intervention, the Sitka community and the gateways to Mount Rainier appear to have greater concern about conserving their current character and environmental qualities.

Project Actions

The project for Mount Rainier focused on assisting the gateway communities in efforts to define their own vision for the future. NPS’s Rivers, Trails and Conservation Assistance program, in cooperation with the Sonoran Institute, conducted workshops in the gateway communities during the very early stages of a new GMP for the park. This linkage between the RTCA program and park planning is not typical of NPS experience in other areas, where there has been a substantial gap between NPS’s internal and “external” programs. Although the linkage between technical assistance to the communities and the park plan was reported to be unclear, the intent was to explore where park and community goals might overlap. An underlying goal for the Mount Rainier effort was reported to be mitigation of a long history of distrust—or at least poor communication. More obvious goals related to the potential of the gateway communities to become staging areas for transportation systems serving the park.

At Sitka, the initiative for cooperative planning came in large part from the community, which was seeking to mitigate problems associated with visitor circulation and distribution. The Sitka gateway initiative was a formal and highly publicized project, with a memorandum of understanding signed by the park and community outlining the planning process. The Sitka Assembly established a team to work with the NPS on the gateway initiative. On the NPS side, a project team of landscape architects, architects, and a planner organized a design workshop and produced a series of recommendations for cooperative efforts. The report from the design workshop contained a range of ideas that could be cooperatively implemented rather than a plan that was adopted by NPS. For example, signage improvements have been made to direct visitor distribution in the park and the community, and a private shuttle service has been established to take visitors to key sites in the community and the park.

The adopted GMP for Grand Canyon (NPS 1995) envisions a major change in the location of visitor services outside of the park. These include a major parking facility, up to 500 new housing units, and a community services center. Unlike the cooperative planning efforts at Sitka and Mount Rainier, which focused on the existing communities, the Grand Canyon experience involved the creation of an entirely new master-planned gateway to be developed outside of Tusayan. A complex and controversial Environmental Impact Statement regarding exchanges of U.S. Forest Service (USFS) lands has been the focus of discussion about the future of the South Rim. The proposed development of a new destination and center for visitor services and employee housing would incorporate state-of-the-art sustainability features. But it

would compete with the businesses that currently exist in Tusayan, and has been opposed by their owners.

Lessons Learned

At Mount Rainier, the perceived problems with communication between the park and community were reported to have persisted in spite of the efforts of the gateway project. Community representatives complained that the park was not listening to them. Park staff report that attempts to cooperate are not reciprocated. Local residents also reported their sense that the planning initiatives were focused on park needs rather than community interests. Uncertainty about policy direction and funding support also were reported to be obstacles to more effective cooperation. Misunderstandings about the purpose and goals for the gateway initiatives also were reported. The community workshops were generally rated as useful in getting the communities together and defining a vision, but there was disappointment in the level of commitment to follow-up evidenced to date.

These reported limits of success of the gateway initiative at Mount Rainier were tempered by the observation that commitments to cooperative planning can be found in the park's GMP and the Upper Nisqually Community Plan. The results at Mount Rainier may not be evident for several years: "the jury is still out" was a consistent theme of those who were evaluating the success of the project. But the amount of progress needs to be considered from a starting point that was characterized by a high level of difficulty in communication and distrust.

At Sitka, the physical integration of the park and community make communication inevitable, and there is a much more obvious mutual interest in resolution of many issues. A commitment by the superintendent to participate in community functions and events reflects a history of positive interactions across park boundaries. A visually attractive product of the design workshop also received glowing reviews from participants. The workshop process was valuable, but moreover the technical design assistance provided to the community was especially well-received. In spite of the general feeling reported that the initiative was successful, the final outcomes remain to be seen. At Sitka, the issues being addressed may not have been as controversial as those in other areas, and implementation of the major recommendations will depend on action by the community.

Planning for Grand Canyon reflects an effort to address complex, controversial park management issues on a regional and long-term scale. Transportation, water conservation, employee facilities, and tourist services are being addressed comprehensively. The park planning effort has required a major commitment of staff and work on an interagency basis with the USFS. The initiative at Grand Canyon might be considered an attempt to create a new gateway community rather than plan cooperatively for one that exists. Accordingly, there is an obvious conflict between competing interests that creates limits on the potential for cooperative efforts.

Summary and Conclusions

These three pilot projects are part of a growing body of experience that is available to NPS managers. This includes a report from two workshops on parks and their neighbors held in 1996 at Gettysburg and Zion; a guide designed for communities by the Rivers, Trails, and Conservation Assistance program, *Building Gateway Partnerships*; and a book collecting experiences from throughout the nation, *Balancing Nature and Commerce in Gateway Communities* (Howe, McMahon, and Propst 1997). Major lessons learned from these three cases include:

Clearly define goals and expected outcomes. Collaboration and partnerships are often identified as important goals for park managers. However, these are means, not ends. Both park managers and community representatives are often not clear on what they want to accomplish by cooperating or partnering. This uncertainty can be reduced or eliminated by clearly articulating the desired conditions for resources and

visitors and community residents. The most frequently cited impediment to collaborative planning was community confusion regarding NPS objectives.

Clarify authorities and expectations. Park managers are often uncertain about their authorities to operate beyond park boundaries. Parks and their neighbors also may be uncertain about how "cooperative" planning might suggest intrusions of authority: by the park into local planning or by the locals into the NPS domain. There may be no single answer to these questions, but they need to be answered for each project.

Secure and maintain commitment. For a collaborative effort to succeed, there must be genuine interest from both the park and the community in: 1) addressing transboundary issues; and 2) involving public participation in the process. A common perception is that it takes more time, money, and energy than there is to spare, so what are the advantages? To this end, lack of sufficient interest from both the park and the gateway communities was mentioned as a key problem in the Mount Rainier project. The Sitka pilot suffered similarly in that the project lacked adequate support from key community participants. Joint planning will not succeed without interest from both parties to look outside their boundaries and work together to address issues of mutual concern.

This crucial step of securing interest, let alone making the commitment to sustain the interest, is often ignored or under-emphasized. Some parks and communities note the need for additional staff and funds specifically targeted for collaborative planning. However, others, including Rocky Mountain National Park, have taken the initiative by re-allocating available resources and staff to focus on these issues.

Focus on human dimensions. Efforts to clearly define the human dimensions of problems are often overlooked. Participants perceived that project planning often focused on alternatives and end-products without first defining the problems. By failing to understand and clearly address the fundamental problems in their full complexity, solutions were elaborated that addressed the symptoms rather than the problems. Rather than striving to identify the primary problems, participants in both the Sitka and Mount Rainier projects noted that many hours and days were spent revisiting the same peripheral issues.

Often, data collection in the initial phases of a project focuses on natural and physical factors, without giving sufficient weight to the human side of the problem. Social mapping is an inventory technique which is useful for understanding the social aspects of resource management: Who has a stake in park-related issues? what are their perspectives and objectives? how do they expect to affect decisions? what assets might they contribute to a project? how strong are the local organizations? and, in what way do they interact with other participants?

Measure and reward success. Collaborative planning with gateway communities requires efforts towards long-term and sustainable partnerships. The emphasis in all government agencies on measurable outcomes and results presents special challenges for those seeking to establish, improve, and sustain positive relationships with gateway communities. Where outcomes may not be evident for many years, some interim indicators for successful gateway projects may need to be developed. Awards and recognition by NPS leadership or interested organizations provide another set of incentives to encourage effective partnerships with gateway communities.

The NPS cannot successfully implement its mission of resource conservation and visitor satisfaction without engaging adjacent communities in the planning and management process. Public participation from diverse factions of the community is essential. Together, park managers and community members need to determine how, and to what degree, they will carry out the decision-making process. The experiences at Mount Rainier, Sitka, and Grand Canyon help highlight that the human community is part of the solution, not the problem, as the protection of park resources is inextricably linked to the quality of life in surrounding communities.

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Completing Canyonlands: Establishing Boundaries That Make Sense

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There never really was any doubt that the red rock landscape of southeastern Utah was of national park quality. Before the National Park Service (NPS) had reached its 20th birthday, there was already a serious proposal and accompanying boundary map, sketching out a national park for this region. Like so many of today's parks, the question was not whether this landscape was of national park caliber; rather, one of the key questions back then—one which remains with us today—is, where do we draw the line? Given the context of topography, sociopolitical considerations, and natural and cultural resource concerns, where do we find that invisible but critical division between lands that will be preserved by NPS and the lands that fall to the other side of this line?

The path to the agreement on the boundaries of today's Canyonlands National Park, just west of Moab, Utah, was as twisting and turning as the landscape itself. And, after nearly three-quarters of this century, the question still dogs us: What boundaries make sense for Canyonlands National Park?

Once called the Great American Desert, the basin at the confluence of the Green and Colorado Rivers was first proposed as a 4.5 million-acre national monument by Secretary of the Interior Harold Ickes in 1936. Extending 200 miles from the Colorado's western border to Arizona, the lands encompassed about 8% of Utah. It would cover a land area over twice the size of Yellowstone National Park. Because it crossed the route of the Spanish priest who first explored the region for the Old World, it was to be called the Escalante National Monument.

Viewing the proposal as promoting tourist developments throughout the region, the congressional delegation and the Utah Planning Board heartily endorsed the concept, with the latter recommending that such a designation should be left in the hands of the local people (Richardson 1965).

NPS held a public meeting in May 1936 to assess local sentiment toward the proposal. While only 87 people turned out for the meeting, most of the residents feared that the vast withdrawal of grazing lands would damage the market for cattle and sheep. Thus, after further discussions over time, NPS agreed in February 1938 to reduce the proposed monument to 2,450 square miles, forming a string between three and 50 miles wide from the Arizona border to two points north of the confluence of the Colorado and Green Rivers. NPS continued to argue that scenery and recreation were the most important economic assets of the state (Richardson 1965).

While many went on record to support the scaled-down monument, others argued there were other economic possibilities besides tourism to be considered and that the monument could preclude several potential power sites along the Colorado and Green Rivers whose potential output could total over a million horsepower. By the early 1940s, the issue boiled down to accepting a monument where recreational use was subordinate to economic development—a position that the NPS could not accept—or a monument in which preservation of the resources was emphasized—a position which the state could not accept. No compromise could be found to adequately bridge this polarization. As the country became embroiled in World War II, the matter of the monument was temporarily set aside, as no agreement could be reached.

New life was breathed into the park concept when, prodded by a local citizens' initiative and the efforts of the nearby Arches National Park superintendent, Bates Wilson, the NPS commissioned a field investigation in 1959 to document the wild areas surrounding the confluence, and the nearby Maze and Needles areas of this rugged landscape. In 1960, on a surveying trip to the canyon country, park planner Leo Diederich stood at the overlook at Grand View Point staring down on the Needles district and its surrounding basin below, a portion of which would become part of the

park, and asked, "Why stop at Needles? There's the park—the entire erosion basin" (Negri 1998).

The year 1959 was to be significant to the future parklands in a political way. That was the year that Frank Moss, a Democrat, entered the U.S. Senate representing Utah. He was placed on the Senate Interior Committee, having considerable interest in national parks.

Senator Moss was a quick and passionate proponent of a Canyonlands National Park. On a Senate committee flight to see the California redwoods, Moss asked the pilot to alter the course so the committee members could see the canyonland country. The pilot flew low and the committee members were most impressed by the red rock landscape that was spread out before them. According to Moss, it was at that moment that the committee became convinced of the worthiness of a park for this area (Moss, personal communication 1998).

With the Kennedy administration and Stewart Udall serving as secretary of the Interior pushing for an aggressive enlargement of the National Park System, the stage was set. After a tour of the region in July 1961, Udall joined Utah's congressional delegation and its governor, Republican George Clyde, for a river trip down the Colorado, after which Udall publicly declared his support for a new Canyonlands National Park of 1,000,000 acres (Howard 1998).

Senator Moss introduced a Canyonlands National Park bill, covering an area of about 1,000,000 acres in 1961. Once again, the size of the park became a hot issue. Governor Clyde and Utah's senior senator, Republican Wallace Bennett, thought the proposal was far too expansive and would forbid grazing and stymie mineral development in the region. They called for a 11,000-acre national park divided into three small segments—the Island in the Sky, the Needles, and the Maze—all as separate units of the National Park System.

To investigate the speculation about mineral development, Senator Moss requested the Bureau of Mines to conduct a study of the mineral deposits in the region. The study revealed that there were only marginal chances of uranium deposits found in commercial quantities, but that sizable potash deposits did exist there. As a result of the study, the Senator revised his proposed park boundaries so that the potash deposit would remain on state-administered lands. He also allowed in the bill some features of multiple-use that would be phased out over time.

A Canyonlands National Park bill was passed by Congress and signed by President Johnson on September 12, 1964. The newly-established park would have 257,000 acres, a compromise between the two senators' visions for the region. The park had straight-line boundaries, entirely following section lines, cutting across large canyons with no difference in scenic quality between those lands inside and outside the boundary. Bighorn sheep move between portions of basins inside and outside the park, and stream and storm runoff in the basin flow across the boundaries as well. Though these areas are integral parts of the park experience, they do not have the protection of national park status.

However, the legislation did not settle the park boundary issue. In less than a decade, more legislation was being sponsored to re-visit the appropriate boundaries for the park. Spurring this effort was the growing awareness of the tremendous recreation potential and demand for these services in the canyon country, as well as concern for the protecting its spectacular scenery and unprotected archeological resources. While the area's isolation had been the most important factor in resource preservation, anticipated tourism promotional campaigns and improved road access threatened to remove this protection.

With more NPS studies conducted in the mid-1960s, legislation was approved in 1971 to add three areas to Canyonlands National Park. First, a detached unit known as Horseshoe Canyon was added to protect the five major panels of Fremont culture pictographs that were present in a portion of this 400-foot canyon. Second, a section to the north of the park was added to provide essential access and circulation roads for

the park. The lands were also important to preclude encroachments and undesirable developments at the park's north end. And third, the upper portion of Lavender Canyon was included and a critical section of Upper Salt Creek on the park's eastern boundary. These additions brought the acreage to 337,570 acres.

Just as every decade since the 1930s had generated boundary proposals for this park, the 1980s were no exception. A general proposal to enlarge the park surfaced in 1982 in response to a plan that would bury nuclear waste on the park's boundary (Butcher 1982; Means 1982). A more studied proposal surfaced in 1988, with the publishing of the National Park and Conservation Association's *Park Boundaries: Where We Draw the Line* (National Parks and Conservation Association 1988).

The NPCA study found park boundary inadequacies in more than 175 units of the National Park System. It concluded that 69% of the boundaries of primarily natural areas and 41% of the primarily cultural areas of the park system needed adjustment for four major reasons: "1) to include resources pertinent to the theme of the park; 2) to protect resources within boundaries and related resources outside boundaries from adjacent activities; 3) to preserve the integrity of the view from within the park (viewshed); and 4) to improve park management." More than 40% of the parks need boundary adjustments just to preserve pertinent resources, according to the report.

In investigating Canyonlands National Park, the report recommended 554,000 acres be added to complete the park. This proposal included 100,000 acres of the Labyrinth Canyon of the Green River flowing into the park, 34,000 additional acres to complete protection of Horseshoe Canyon which would attach the unit to the park, and 420,000 acres to include the Canyonlands basin, rim to rim, as was originally envisioned by Senator Moss. This unit also included much of the land on the park's west side, to be transferred from Glen Canyon National Recreation Area to Canyonlands National Park. All other lands involved would be those administered by the Bureau of Land Management (BLM).

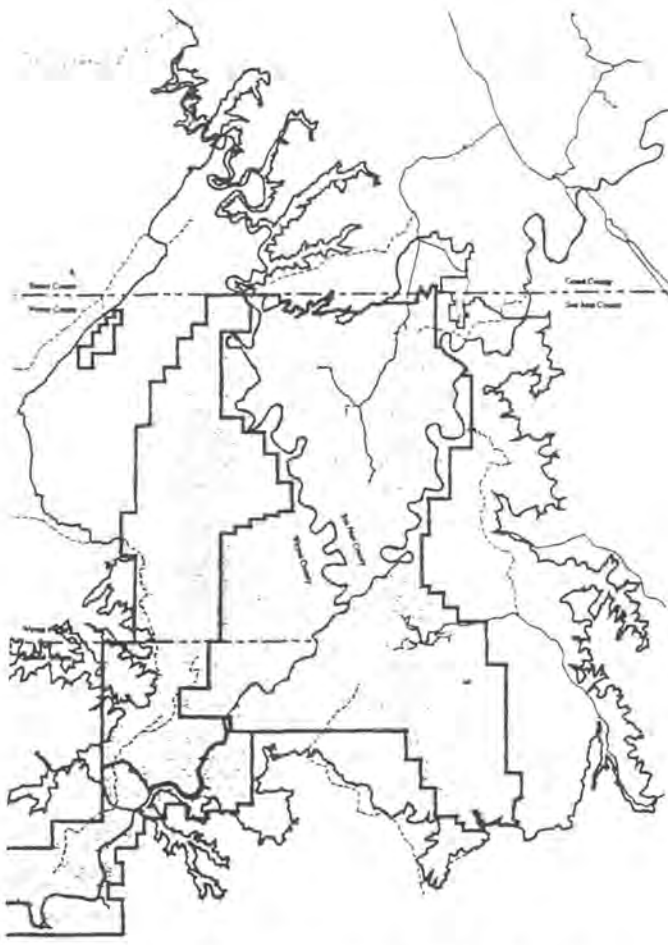
Although the proposal sought to encompass watersheds more completely, many of the boundary lines were still drawn along straight sectional lines. With Congress in no mood to discuss park enlargements at the time, most of the recommendations in this report, along with those for Canyonlands, have gone unheeded.







Recently, NPCA has taken this earlier proposal, refined it, and has begun a campaign to complete the park along the lines envisioned in the early 1960s (Figure 1). However, while the general principle of establishing the park to preserve the entire erosional basin remains unchanged from earlier conceptions of the park, this proposal would draw boundaries congruent with actual topographical lines. In this manner, entire watersheds would be included in the park as well as the viewsheds. Additional benefits include: uniform land management policies rather than jurisdictions split between BLM and NPS, improved law enforcement and visitor contact on lands incorporated into the park, and enhanced resource protection.

Under this proposal, the park's northern boundary would be established by the Green River's entrance into Labyrinth Canyon and along the Colorado River just below Moab. The southern extremity of the park would end at the northern point of Lake Powell. The entire erosional basin, rim to rim, would comprise the heart of the park. Adjacent lands to be added to the park are currently managed by BLM and Glen Canyon National Recreation Area. No private lands would be included.

Changing boundaries often creates other management issues, and this will be true with Canyonlands. One key issue is what happens to adjacent BLM wilderness study areas and wilderness proposals put forth by citizens which would only be partially included into the enlarged park. Environmentalists would like to see these areas included in park boundary bill to be included in the legislation. However, wilderness designation in Utah has always been very controversial, and it is unclear whether such inclusion would substantially weaken support for the bill.

Other issues that will need to be addressed are common with park designation: cattle and mineral leases, which roads remain open to four-wheel drive vehicles, and



-  existing park service boundary
-  proposed park boundary
-  existing NPS boundary
-  proposed Canyonlands NP boundary
-  paved road
-  unpaved road

Boundary Map Canyonlands National Park

Emery, Wayne, Grand, San Juan, & Garfield Counties, Utah

United States Department of the Interior - National Park Service

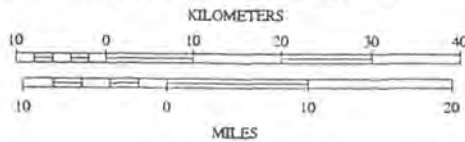


Figure 1. Current and proposed new boundaries of Canyonlands National Park in Parks and on Public Lands • The 1999 GWS Biennial Conference

off-road vehicle policy. Fortunately, both cattle and mineral leases are minimal in the areas being considered. The only private lands within the new park boundaries, the Dugout Ranch, has recently been bought by The Nature Conservancy, and would remain a private inholding.

The vision of a Canyonlands National Park that protects the entire erosional basin of this spectacular country has been studied and discussed for the better part of this century. As the century comes to a close, a proposal to finish the park is before us once again. Perhaps this time we will finish the park, with topographical lines forming the boundaries that, for the first time in this park, make sense—from an ecological, managerial, hydrologic, and aesthetic standpoint.

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Transboundary Cooperation Between Internationally Adjoining Protected Areas

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Introduction

Every conservation professional is painfully aware of the fact that politically drawn boundaries of protected areas rarely coincide with ecological boundaries. This conference session on "Rethinking Park Boundaries: Planning Across Boundaries" illustrates the fact that cooperation across and outside protected area boundaries is a fact of life for protected area managers. Similarly, all are fully cognizant of just how difficult this transboundary cooperation can be, as multiple stakeholders, administrative entities, and land-owners are brought into planning and land-use decisions. When these protected area boundaries are between different countries, however, the difficulties are multiplied, as the high-profile issues of national security and sovereignty, military or guerrilla activity, customs and immigration issues, illegal transborder activities, and differing languages, cultures, and governments—not to mention the hundreds of administrative details commensurate with international transboundary relations—come into play. Considering all these impediments, one might doubt that much international cooperation could occur at all. Nevertheless, it does occur and is occurring, at least in most of the places around the world where protected areas adjoin across international boundaries.

Identifying Internationally Adjoining Protected Areas

One evidence of ecosystems divided by international political boundaries is the many situations around the world where protected natural areas meet or nearly meet across international boundaries. Considerable attention has been focused recently on so-called "transboundary protected areas," also referred to as "transfrontier nature reserves," "transborder protected areas," "border parks" or even "international peace parks." Whatever the name, the hope expressed is the same: that cooperation between protected areas across international boundaries will both improve the quality of ecosystem-based conservation and encourage warmer relations between neighbors. In many cases, though, these names describe the hopes better than the actualities, as the only thing truly "transboundary" may be the ecosystem. In some situations, the use of terms such as "transboundary" or "transfrontier" when describing protected areas on international borders may raise specters of threats to sovereign ownership of national territory. Due to these political sensitivities, in this paper they are being referred to simply as "internationally adjoining protected areas." Whatever these entities are called, however, in most cases they represent internationally divided ecosystems that require some level of international cooperation for optimal management.

The goals of this research project are to determine what cooperation is occurring between these protected areas that adjoin across international boundaries and to examine what factors contribute to or inhibit this cooperation. Before this could be undertaken, however, a comprehensive list of these sites needed to be compiled. This task proved more complicated than expected, ultimately involving over two years of effort on the part of the author and the assistance of countless protected area experts and professionals. The starting point was a list of "Border Parks" compiled by Thorsell and Harrison in 1988, which revealed 70 cases of protected areas on international boundaries (Thorsell 1990). This list was amended with other regional lists from various sources and from the many individuals at Duke University working with protected areas around the world. Protected area professionals attending the IUCN World Conservation Congress in Montreal in October 1996 were also interviewed. This draft list was then verified with the protected areas database and Geographic Information System biodiversity map library at the World Conservation

Monitoring Centre (WCMC) in Cambridge, United Kingdom. It was then taken to the headquarters of IUCN-The World Conservation Union in Switzerland and reviewed by the regional vice chairs of the steering committee of IUCN's World Commission on Protected Areas and by the IUCN protected areas unit. Further recommendations resulted from extensive international correspondence through fax, mail, and electronic mail with hundreds of protected area managers and professionals around the world. Finally, the list was finally updated in 1998 with information received from responses to a global survey mailed, with the assistance of IUCN, to the managers of the adjoining protected areas. Even so, this list is obviously a constantly changing "work-in-progress."

Two criteria were used in deciding which protected areas should be included in the list. The first was that at least two areas in a cluster of adjacent areas should actually or nearly adjoin across international boundaries. Internal boundaries within countries were not included. Secondly, the two internationally adjoining areas must qualify as protected areas by the 1994 IUCN definition: "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means," and they must be assigned one of the six IUCN protected area management categories (IUCN 1994). In order to qualify as an official protected area, a site must be so designated by its host government and must be at least 1,000 ha in size. This means that many complexes of smaller sites were omitted. In the many situations where a protected area exists on an international boundary, but no protected area exists in the adjoining country, protection has been proposed on the other side or even is in the process of establishment. These complexes did not qualify for inclusion on this list, so a second list of potential sites was also compiled. This second list included those that were referred as possible candidates, but did not meet the criteria or could not be verified in the WCMC database.

A Snapshot of Internationally Adjoining Protected Areas

The final global list of adjoining protected areas (Zbicz, in press) contains 136 conglomerates of two or more internationally adjoining protected areas, often providing contiguous habitat for species. (Zbicz and Green 1997). These conglomerates include at least two protected areas that adjoin across international frontiers and often other adjacent sites within the two countries, meaning that different clusters contain up to 13 individual protected areas. Altogether, 488 individual protected areas are included, 415 of which have been assigned IUCN categories. Twenty-seven of these clusters, also referred to as "transfrontier protected areas complexes," contain protected areas in three different countries. The 136 complexes involve 98 different countries, or almost half of the world's 224 countries and dependent territories. The list of potential adjoining protected areas contains an additional 85 complexes.

As can be seen from Table 1, Europe, with 45, has the greatest number of adjoining protected area complexes, or 36% of the total. Africa follows with 34, for 25%. Both of these totals reflect the large number of boundaries on those continents. North America contains only eight adjoining protected area complexes, or 6% of the global total, but these exist along only two borders. The five complexes between Canada and the USA involve thirty protected areas, while the three between Mexico and the USA include twelve.

Defining Transboundary Cooperation

The next phase of the research, describing the extent and nature of transboundary cooperation between adjoining protected areas, was done by means of an international mail survey sent to the managers of these sites. Of the 136 complexes, 129 qualified for the study. The unit of analysis most appropriate for a study of cooperation is a pair of neighbors. These complexes contain 179 different pairs, or "dyads" of adjoining protected areas. Out of these 179 pairs, responses were received from

147. In some cases responses were received from both sides, and in other cases from only one side. These responses represent 82% of the dyads and 91% of the complexes qualifying for the study.

<i>Regions</i>	<i>Adjoining Protected Area Complexes</i>	<i>Protected Areas</i>	<i>Proposed Complexes</i>	<i>Complexes with 3 Countries</i>
North America	8	42	4	0
Central and South America	24	93	15	6
Europe	45	154	26	6
Africa	34	123	12	9
Asia	25	76	12	3
TOTAL	136	488	69	27

Table 1. Internationally adjoining protected area complexes by regions, 1998

A series of questions on the survey asked how often different cooperative activities occur between these adjoining protected areas, with possible answers including "Always," "Usually," "Sometimes," or "Never." These questions were combined with others (concerning the number of annual meetings and communications and the number of issues on which the protected areas cooperate) to define six levels of transboundary cooperation between adjoining protected areas. The six levels range from "No Cooperation" to "Full Cooperation." Each level (described in Table 2) incorporates the requirements for the levels below it, thus reflecting increasing cooperation. Although not quite proving that transboundary cooperation actually proceeds through sequential phases, these six levels can be useful for gauging the status of cooperation between any given pair of internationally adjoining protected areas and looking forward to what potential cooperation may yet be achieved. Even though this template was designed for cooperation between protected areas that adjoin across international boundaries, it might also be adaptable for use by protected areas adjoining within a country, or for measuring protected area cooperation with other neighbors, as addressed in this session.

An astute observer might notice that even at "Full Cooperation" joint management does not always or even usually occur, although it is expected to occur at least sometimes. One might suggest that in a real "Transboundary Protected Area" or an "International Park" regular joint management would be a requirement. However, where international boundaries are involved, concerns over territorial sovereignty make joint management rare. This conference session on "Planning Across Boundaries" has recognized that, in many cases, the highest that may be achieved is joint planning. In fact, joint management may not be absolutely necessary for ecosystem-based management and effective biodiversity conservation to occur. Most of the responding protected area managers, however, do believe that some level of transboundary cooperation is necessary. In 89% of the pairs, at least one respondent answered that better transfrontier cooperation would improve the management of that protected area.

<p>Level 0: No Cooperation. Staff from the two protected areas (PAs) never communicate or meet. They never share information or cooperate on any specific issues. Many actually wrote in "No Communication" on the questionnaire.</p>
<p>Level 1: Communication. Some two-way communication occurs between the protected areas. They meet and communicate at least once a year and sometimes share information. They sometimes will notify each other of actions which may affect the other PA.</p>
<p>Level 2: Consultation. This level corresponds to the international legal definition of notification, where notification of actions affecting the adjoining PA usually occurs. Notification of emergencies also occurs. Communication is more frequent (at least three times per year) and the two sides claim to usually share information. Cooperation occurs on at least two different activities.</p>
<p>Level 3: Collaboration. At this level communication is frequent (at least bimonthly), and meetings occur at least three times per year. The two PAs actively cooperate on at least four activities, sometimes coordinating their planning and consulting with the other PA before taking an action.</p>
<p>Level 4: Coordination of Planning. The two PAs not only communicate often, but actually coordinate actions in some areas, especially planning. They work together on at least five activities, sometimes holding regularly scheduled meetings and usually notifying each other in case of emergency. Not only do the PAs usually coordinate their planning, they sometimes plan jointly, often planning for the two as a single ecological unit.</p>
<p>Level 5: Full Cooperation. This level requires that planning for the two protected areas be fully integrated, and, if appropriate, ecosystem-based, with implied joint decision-making and common goals. Joint planning usually occurs, and, if the two share an ecosystem, this planning usually treats the two protected areas as a whole. Joint management sometimes occurs, and a joint committee exists for advising on transboundary cooperation, which occurs on at least six activities.</p>

Table 2. Levels of transboundary cooperation

The Extent of Transboundary Cooperation Between Adjoining Protected Areas

The survey responses were used to identify the appropriate cooperation level for each pair of adjoining protected areas. The distribution reveals a wide range of cooperation, from none to full. The largest number of pairs, 57, are cooperating at Level 1, with some communication and exchange of information taking place. This represents 38.7% of the total. Although an encouraging first step, this is likely inadequate to most effectively manage an internationally divided ecosystem. Even so, Level 1 is better than the total lack of transboundary cooperation reported by 26 (17.7%) of the adjoining protected area pairs. Full cooperation reportedly is occurring in 11 of the dyads (7.5%), which might be considered role models for transboundary cooperation between adjoining protected areas. Similar numbers of pairs fall into Levels, 2, 3 and 4. Perhaps the greatest hurdles for adjoining protected areas to overcome are moving from "No Cooperation" to "Communication" and on to "Consultation." The greatest difficulty appears to be moving from the level of communicating (Level 1) to actually consulting with one another (Level 2). This is not surprising since consulting across international boundaries actually begins to open a country up to expectations and criticisms of the neighboring country. But once this level is reached,

perhaps cooperation between neighbors increases more easily, and they progress more quickly on to higher levels.

Although fewer in number, most of the internationally adjoining pairs of protected areas in North America appear to be cooperating at high levels. The eight complexes in North America contain 16 different dyads. Four of these are at "Full Cooperation," the highest number at this level of any region. Five dyads are at Level 4, "Coordination of Planning." Only Europe, with eight out of its 54 dyads at Level 4, has more. Only one dyad in North America claims to not be cooperating at all (at least as of mid-1998), but this dyad involves a newly designated protected area and transboundary cooperation is planned, but not yet occurring.

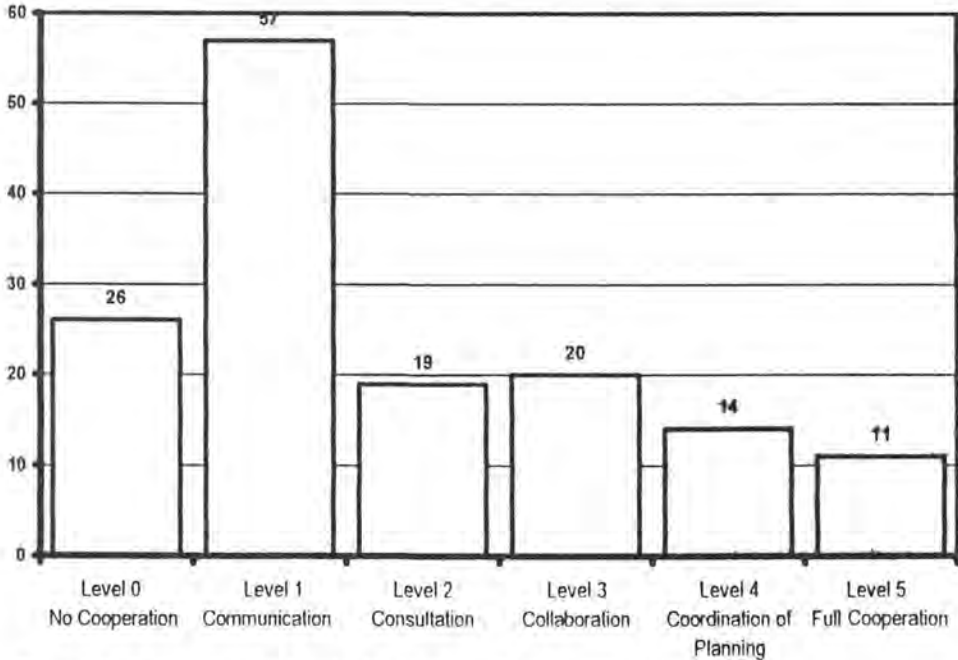


Figure 1. Dyads at each level of transboundary cooperation

	<i>Level 0</i>	<i>Level 1</i>	<i>Level 2</i>	<i>Level 3</i>	<i>Level 4</i>	<i>Level 5</i>	<i>Total</i>
N. America	1	2	2	2	5	4	16
Cent. & S. America	5	17	1	0	0	1	24
Europe	4	18	7	11	8	3	51
Africa	8	14	7	6	1	2	38
Asia	8	6	2	1	0	1	18
Total	26	57	19	20	14	11	146
% of total	17.7%	38.7%	12.9%	13.6%	9.5%	7.5%	100%

Table 3. Responding dyads at each level of transboundary cooperation (for explanation of levels, see Table 2).

Summary

Around the world 136 complexes exist where protected areas adjoin across international boundaries—evidences of internationally divided ecosystems. These complexes involve 488 individual protected areas and 179 pairs of neighbors. A recent survey reveals that some degree of cooperation is indeed occurring in 82% of those 147 dyads that responded. When cooperation is broken down into six increasing levels, 38.7% of the responding pairs of adjoining protected areas are cooperating at Level 1, where communication and some sharing of information occurs, but little else, while a total of 43% are cooperating above Level 1. Eleven of the dyads are cooperating at the highest level, serving as models of successful transboundary cooperation between adjoining protected areas. The purpose behind enumerating levels of cooperation and identifying the level for each dyad of adjoining protected areas was to be able to examine what factors contribute or inhibit transboundary cooperation. This analysis is well underway, and final results should be available soon, hopefully providing further assistance in the optimal management of adjoining protected areas and internationally divided ecosystems.

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Brucellosis in the Greater Yellowstone Area: Environmental Organizations' Perspectives on Maintaining Wild Bison in Yellowstone National Park

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The wild character of Yellowstone National Park derives from its dynamic natural processes and a National Park Service (NPS) philosophy which calls for minimal human interference inside the park. Yellowstone is truly unique, in part because it is so large that natural processes can be seen in all the resulting diversity and wildness. More than 90% of the park's 2.2 million acres has been proposed as wilderness; and three of the park's ten roadless areas exceed 400,000 acres (NPS 1972).

The park is home to vast migratory wildlife herds, including the largest migratory herd in the lower 48 states. It encompasses an intact geothermal system, one of only two left in the world, with over 60% of the world's surface geothermal features. It is still home to new discoveries, for its renowned hot springs contain resilient microorganisms that flourish where other life cannot, leading recently to major advances in the bioengineering and pharmaceutical industries.

Despite this wonderland of nature, we are at risk of losing the wildness we associate with Yellowstone. Nowhere is this danger more evident than in the current controversy over management of the nation's last pure and free-roaming bison herd. Since 1968, when the NPS in Yellowstone first allowed bison to roam throughout the park, the herd grew to about 3,500 animals in 1997, when almost 1,100 bison were shot or sent to slaughter by the state of Montana and NPS because Montana fears the bison will transmit brucellosis to cattle outside the park (NPS 1998, 330). Montana's approach, defined by the state's livestock industry, has caused a crisis in wildlife management, one which threatens to unravel the wildlife management policies within Yellowstone and other national parks.

Over the past year, the federal agencies, including the Animal and Plant Health Inspection Service (APHIS), NPS, and the U. S. Forest Service (USFS), have adopted a policy, developed by APHIS, which would allow low-risk bison (calves, bulls, yearlings and post-parturient cows) to move onto public lands outside the park. Yet the State of Montana has refused to accept this policy (McMillion 1997; NPS 1998, 369-372; Simpson 1999). The federal agencies should be commended for this policy. The state's rejection of this approach, however, results in the continued killing of bison that pose virtually no threat of transmission of brucellosis. The state of Montana continues to slaughter bison in winter even when no cattle are present on public or private lands (Radovich 1999).

The state Department of Livestock (DOL) is in control of migrating wild bison in Montana, instead of its Department of Fish, Wildlife, and Parks. The DOL does not have any statutory responsibility or expertise to manage for healthy wildlife herds. Its expertise is domestic livestock, and it treats the wild bison migrating from the park as a disease vector which must be eliminated no matter the cost to the wildlife in the park or on the public's lands.

At the same time, Montana has adopted a statute to allow the selling of live bison that exit the park. This very significant provision to allow the commercialization of Yellowstone wildlife, held in public trust, was adopted without public notice or public hearing in 1997. These animals are the most genetically pure bison left in America and would be an enormously valuable commercial resource for private bison ranchers. Yet the precedent-setting policy of capturing wild animals that migrate from Yellowstone for sale to the highest bidder undermines the overall concept of a sanctuary which a national park provides.

NPS appears to also be weakening its ability to protect migrating wildlife in a national park with the following practices:

- The NPS has endorsed a population range for bison within the park that sets a maximum limit far below that established through scientific analysis (Alternative 7 of the Draft Environmental Impact Statement; NPS 1998). This population limit is based on politics, not science.
- NPS managers built and operate a bison capture facility within park borders for the express purpose of prohibiting bison movements outside the park (NPS 1997; NPS 1998, Appendix A). The agency has implemented this action even though it acknowledges in numerous documents filed as part of litigation with the Greater Yellowstone Coalition and others that bison are not harming park resources, and that the NPS does not believe brucellosis is detrimental to park bison.

Until recently, cattle have been given priority over wildlife use on national forest lands outside the park, resulting in the hazing and killing of bison in order to accommodate cattle. That changed in 1999 when USFS, to its credit, implemented a policy of having the start-up dates for grazing allotments adjacent to the park depend on when bison leave the area, rather than driving bison off those lands in order to accommodate cattle (USFS 1999).

The livestock industry seems intent upon halting natural regulation inside the park. During the recent public comment period of the environmental analysis process for the long-term plan to manage Yellowstone bison, organized livestock groups and the U.S. Animal Health Association, the national organization of professional livestock veterinarians, supported the establishment of eight capture facilities within the park in order to conduct an aggressive, multi-year test-and-slaughter program on Yellowstone bison. There is virtually no allowance for bison to move outside the park under their preferred alternative (NPS et al. 1999). Livestock producers also supported immediate vaccination of bison, even though there is no vaccine that has been approved as safe and effective according to the protocol adopted by the Greater Yellowstone Interagency Brucellosis Committee.

Should we be allowing the western livestock industry to gain control over how wild animals are managed in and around Yellowstone and the national forests? Do we turn our backs upon the concepts of wildlife management which have shaped the national parks and many of the successes of wildlife management in this century?

Free-roaming bison in Yellowstone represent a tremendous conservation success story, a story we should be celebrating, rather than worrying about whether or not the last free-roaming herd will be rounded up, tested, culled, and domesticated. These bison are unique. They are of special importance as the last remnant of the indigenous wild herds of North America, containing, as noted in a 1998 National Research Council report, "lineages that go back without interruption to the aboriginal stocks in the area." The report notes that the Yellowstone population is the "only extant bison population that has not been derived solely from stocks held in captivity at some point in their history.... [I]f any current population is likely to contain unique alleles from the original bison ... it is the YNP herd" (National Research Council 1998, 116). These bison herds are a symbol of what this country's first national park has preserved for us and what Americans want passed on to their children and grandchildren. When we see Yellowstone bison, we see what's left of the 30 to 60 million wild buffalo that once inhabited most of the country.

What's most important, though, is that we can still see wild bison roaming. We know that Yellowstone is not a zoo, not another theme park. And it certainly isn't a stockyard. The understanding of truly wild bison herds and all that the concept implies is critical to the visitor experience.

Unfortunately, not everyone shares the goal of keeping Yellowstone wild. Some challenge the natural regulation policy, a policy that has evolved into one of minimal human intervention. For some critics, there seems to be a visceral objection to not controlling nature: the idea of minimal human intervention challenges their fundamental belief that nature should be controlled, whether it means taking timber out of our national forests, damming our rivers, or conducting capture and test-and-slaughter operations on wild bison deep within the national park.

But there are also challenges associated with people's perceptions of wild animals, and the lines are becoming increasingly blurred by game farms, feed lots, and wildlife management practices at other state and national parks and refuges. This blurring has been exacerbated by the fact that the people now given authority over wild bison in the Greater Yellowstone Area of Montana are the livestock industry, who capture, corral, test, vaccinate, and feed animals for their livelihoods. While that may be accepted practice for domestic animals, it's not what we have come to expect in Yellowstone or for wild animals. Yet for some, there is no distinction. They do not distinguish between wild animals and livestock, or between a national park and a ranch or stockyard.

We have a lot to lose. In survey after survey, visitors to the park have ranked wildlife viewing as their primary activity. Consistently, over 90% of visitors engage in this activity in the park (NPS 1998, 152). Visitors who come to Yellowstone see natural events that no longer exist in most of the country. The park's role is not about capturing a vignette of yesterday; it's about saying this dominance by nature still can exist today, in this small part of the world. It's about knowing that these natural processes go on, day after day, season after season, year after year, knowing that change is taking place—but change less marked by humans and human manipulations than we may see anywhere else.

A 1995 national public opinion survey on the National Park System found that 88% of respondents said providing an important experience for future generations was the most important park value. Seventy percent said the parks should be managed for future generations over more short-term management strategies. Preserving wildlife habitat was also ranked very high, with 87% calling such protection "very important" and 82% saying efforts to preserve natural ecosystems were also "very important." Just over 70% agreed that wildlife in the national parks don't receive adequate protection, calling the failure a serious threat (DeRuiter and Haas 1995).

Protected areas such as national parks fill an important role as ecological baselines in helping us understand the effects of human use and development elsewhere. Ecological baselines are essential for reconciling arguments about the maintenance of biological diversity, the natural state of biotic communities and ecosystems, and the range of variation that will be observed in them in the absence (or minimization) of human intervention. Such baselines are needed to facilitate our understanding of how to manage wildlife communities and ecosystems successfully by offering something with which we can compare and judge other management approaches, and to help resolve uncertainty.

The authors of the National Research Council report *Brucellosis in the Greater Yellowstone Area* described Yellowstone and a few other large parks as the controls for the national and global human experiment, and stated that retaining the ecological integrity of the park requires setting limits and not intruding where nature can manage without human intervention (National Research Council 1998, 118). Decisions to intervene, they said, should be supported by clear and compelling evidence and a consensus of experts that they are necessary. We maintain such evidence and consensus are absent on the issue of bison management, and that intervention should be severely restricted.

The park still provides a rare, unparalleled opportunity for comparison with other more manipulated environments if internal interference is minimized and natural changes in the system are allowed to proceed unimpeded. Human use does not

need to be excluded for an area to serve as an ecological baseline, but it does need to be minimized. Surrounding national forests function as a key component of the ecosystem, extending from the core of the park to private lands outside the forests, thus underscoring the ability of the park to successfully serve as an ecological baseline.

This tremendous ecological value was reiterated by scientists who have conducted research in Yellowstone. In 1997, eleven scientists, led by Mark Boyce of the University of Wisconsin-Stevens Point, endorsed a letter sent to President Bill Clinton (15 July 1997) objecting to the decision by NPS to arbitrarily cap the number of bison within the park. They believed the decision undermined the agency's policy of allowing natural ecological processes to prevail in national parks with minimal human intervention. Scientists, they said, recognized the value of the park's natural regulation management policy because parks are ecological baselines. They noted that since the reintroduction of wolves into Yellowstone, all of the ecological components are in place to permit Yellowstone to function relatively unimpeded by human influence. Fluctuation in bison abundance may be fundamental to the natural functioning of the Yellowstone ecosystem. The scientists protested the potentially drastic consequences to ecological management resulting from imposing population limits inside the park. They called instead for programs to minimize contact between livestock and both bison and elk during periods when the risk of transmission is greatest.

Intervention is not necessary to protect the livestock industry and can only undermine the park's value as an ecological benchmark. Data do not support the contention that failure to capture, test-and-slaughter, or vaccinate bison has resulted or will result in transmission of brucellosis to cattle. Transmission from wild bison has never been documented in Yellowstone or Grand Teton national parks in the absence of such measures, and other actions are available to minimize the perceived risk without intervening so dramatically in the park's natural processes in this way. The National Research Council report maintains that serious issues of ecological and evolutionary consequences, such as those related to vaccine delivery, probably are best not worked out in Yellowstone, the crown jewel of the U.S. National Park System (National Research Council 1998, 113).

If Yellowstone National Park's role as an ecological baseline can't be maintained, then there is little hope of maintaining it elsewhere. It is because of these concerns that the Greater Yellowstone Coalition and the National Parks and Conservation Association played key roles in developing the *Citizens' Plan to Save Yellowstone Buffalo* in July 1998, as part of the Draft Environmental Impact Statement (DEIS) process (Greater Yellowstone Coalition 1998). The plan, which was endorsed by over 20 local, regional, and national groups representing over 5 million Americans, manages bison as wild animals, minimizes human intervention in wildlife dynamics in Yellowstone National Park, and accommodates bison on winter range outside the park. It also provides reasonable and cost-effective measures that protect private property and livestock interests. The plan received over 47,500 letters of support during the recent DEIS process, out of over 67,000 comments received. The proposal to reintroduce wolves into Yellowstone is the only other national park issue which received more public comments. The citizens' plan proposes to:

- Maintain wild, free-roaming bison in Yellowstone National Park.
- Create special management areas outside the park where bison can survive harsh winters, managed by wildlife professionals.
- Develop ecologically sound bison population ranges for the park and the special management areas, and maintain minimum viable herd sizes below which the herd would not be reduced.
- Apply the traditional wildlife management tools of relocating bison to public lands and Indian reservations, and implement a regulated harvest.

- Emphasize acquisition of key winter range from willing sellers through purchase or conservation easement, and create incentives that would encourage land-owners to modify livestock operations to increase winter foraging opportunities for bison outside the park.
- Recommend mandatory vaccination of cattle within and immediately adjacent to the special management areas.
- Establish a voluntary program to compensate land-owners for damage to fences and other permanent structures cause by natural bison migrations.
- Allow vaccination of bison within the special management areas, but only with a vaccine that is safe and effective and can be administered in a non-intrusive manner, and in conjunction with a plan to address the existence of the disease in elk.

We believe that the strategies in the citizens' plan will maintain wild, free-roaming bison while protecting the interests of the livestock industry. Bison typify what's at stake for wild Yellowstone and wild animals. We must treat them with the respect they deserve if we are to preserve Yellowstone as a natural wonderland for future generations.

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Restoring Fishing Bridge Campground: The Challenges of "Undevelopment" in America's Oldest National Park

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Introduction

Yellowstone National Park occupies more than 2.2 million acres (889,561 ha), largely in the northwestern corner of Wyoming. In the first decades after the park's establishment in 1872, visitor facilities were near the park's major scenic attractions. One of the largest developments sprung up on the northwestern shore of Yellowstone Lake (Figure 1). The Fishing Bridge development, named for the historic road bridge over the Yellowstone River where it exits the lake, eventually included a visitor center, 285 tourist cabins, a cafeteria, general store, service station and auto-repair shop, employee housing, a 360-site concessioner-operated recreational vehicle park, and a 310-site campground run by the National Park Service (NPS) (Consolo-Murphy and Kaeding 1998).

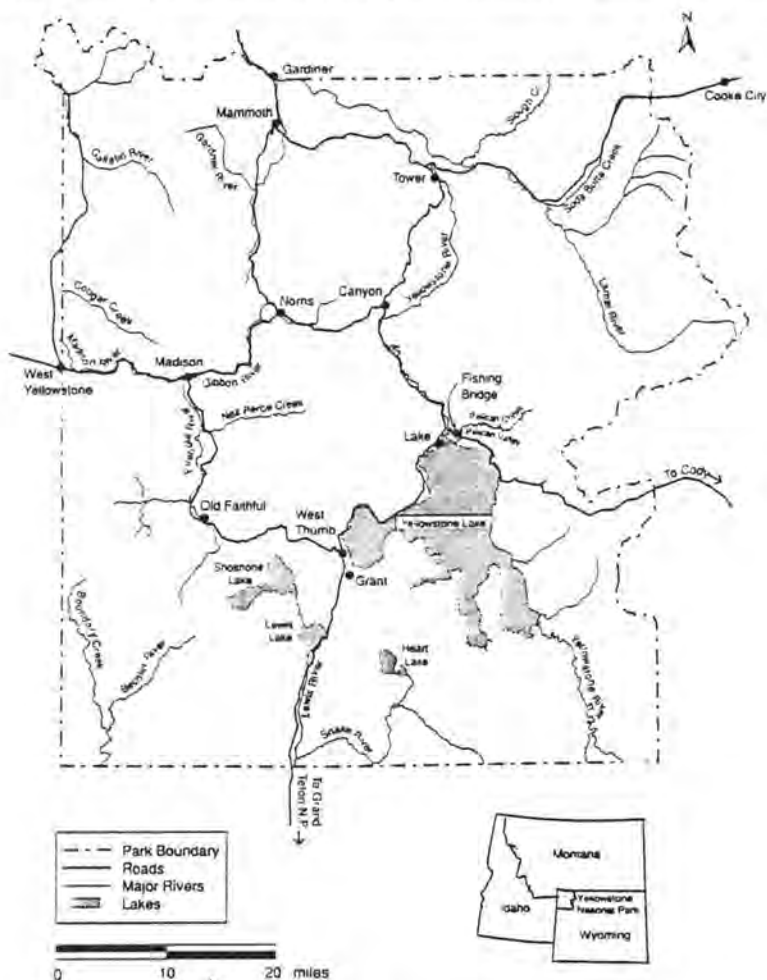


Figure 1. Yellowstone National Park

In 1972, Yellowstone's master plan outlined general goals for the park that included removing facilities at Fishing Bridge due to their proximity to habitat for the population of threatened grizzly bears (*Ursus arctos*) (NPS 1973). Subsequent research demonstrated that bears—especially adult females, the most critical segment of the population (Knight and Eberhardt 1984)—were adversely affected in several ways by roads and developments (Mattson et al. 1987). Although not all bears made less-than-expected use of areas near developments, the seasonal habitat loss associated with the avoidance of human facilities and the disruption of foraging activities was estimated as sufficient to support four or five adult female bears during a period in which biologists believed there were only about 50 females in the population (Mattson et al. 1987).

By the mid-1980s, Yellowstone staff and NPS planners stationed at the Denver Service Center had begun to complete a development concept plan (DCP) and Environmental Impact Statement (EIS) for the Fishing Bridge area (NPS 1988). Controversy surrounding the proposed removal of long-popular visitor facilities resulted in a compromise decision, made in 1988, to the original suggestion of complete area restoration (Consolo-Murphy and Kaeding 1998). The tourist cabins were gradually relocated or razed, and the gates to the NPS campground finally swung shut in September 1989.

Restoring the Campground

Closing a campground—12% of all the campsites offered in Yellowstone (NPS 1994)—was a major change in the park's development landscape. The action was hailed as a victory for wildlife, but other constituents viewed it as an assault on visitor access and extracted a promise from park managers that lost campsites would be replaced elsewhere if justified by public demand (Consolo-Murphy and Kaeding 1998). By 1991, the senior author and others were deep into planning for these follow-up facilities. Concern was high among the Greater Yellowstone Ecosystem's land and wildlife managers for the continually thorny issue of grizzly bear management. Despite signs of an upturn in the grizzly bear population (USFWS 1993; Eberhardt et al. 1994), citizens opposed to the potential "delisting" of the grizzly population and U.S. Fish and Wildlife Service (USFWS) biologists, with whom the park was required to consult regarding effects of developments and other management actions, continued to express concern over the effective loss of habitat.

At the heart of the matter for many critics inside and outside Yellowstone was a series of unfulfilled commitments written into the Fishing Bridge DCP/EIS. Fishing Bridge campground, though closed, retained its infrastructure and internal roads; administrative buildings such as the former campground ranger's quarters were in continued use. True restoration of habitat for grizzlies or other species languished, even prompting some park staff to suggest that re-opening the campground would be preferable to constructing additional replacement campsites in other park locations.

In the midst of planning for what became known as the "Fishing Bridge campsite replacement" (NPS 1994), park biologists began searching for ways to accomplish more of the actions outlined in the Fishing Bridge DCP. A major problem with campground rehabilitation was the cost, estimated to be at least \$725,000 (NPS 1994). As was typical for major unfunded development-related projects, the park had submitted a funding request on the standard NPS form 10-238. However, by 1991, the Fishing Bridge campground restoration effort ranked too low among hundreds of NPS line-item construction projects to warrant funding. Motivated by a desire to make on-the-ground habitat gains for bears as well as the need to reassure the USFWS of our agency's credibility, we suggested that, rather than wait indefinitely for funding, Yellowstone staff begin its own rehabilitation efforts. With the park's own substantial staff and maintenance equipment, couldn't we accomplish at least a significant portion of site restoration?

After some initial resistance to the idea, park managers agreed and momentum began to build. A "Fishing Bridge campground rehab day" was selected, and the chief ranger promised to send at least one staff representative from each of the park's 14 subdistricts.

On September 25, 1991, approximately 40 employees, representing each of six organizational divisions, responded to the call and arrived with work clothes and gloves. Their task was to take out whatever structures could be removed by hand—bumper logs, fire grates, picnic tables, signs, campsite markers, lights, and comfort station fixtures and pipes. The results of that day were small compared to the heavy-duty work that lay ahead; however, a significant message was conveyed to park staff and the public that Yellowstone was dedicated to accomplishing campground reclamation, even if it had to be done piece by piece.

Rehabilitation and revegetation of the campground continued systematically, using various park staff. The district resource management coordinator (co-author of this paper) provided oversight, enlisted volunteer groups for hand-work, and documented progress in park newsletters and annual reports. Maintenance crews operating heavy equipment removed large structures and road material. Landscape architects supervised revegetation and landscaping efforts.

In 1992 and 1993, crews removed the Mission-66 era restroom buildings using an excavator-hoe with a "thumb" attachment that took apart the rest rooms and removed the concrete foundations. The excavator was also used to salvage barrier boulders that had lined the roads of the nine campground loops; rocks were taken elsewhere to demarcate pullouts and parking spots. Four log comfort station buildings of historic significance were relocated for adaptive uses within the park.

From 1992 through 1997, maintenance staff used heavy equipment such as graders, front-end loaders, and dump trucks to scrape and remove asphalt and road material, working on several loops each year (no work was done in 1996). Approximately 4,500 cubic yards of asphalt, road material, and soil was moved to a maintenance yard; some of the material was recycled for local road patching. Crews then recontoured the old campground roads to more natural conditions.

The revegetation crew began in 1992, working immediately behind the asphalt removal crew. Workers hand-planted several hundred smaller seedlings and used a tree spade to plant 200 larger saplings. Native species used were lodgepole pine (*Pinus contorta*), Englemann spruce (*Picea englemannii*), subalpine fir (*Abies bifolia*), and whitebark pine (*Pinus albicaulis*). The crews revegetated the forest floor with grass "plugs" from adjacent vegetated sites and dispersed more than 20 pounds of previously collected native grass and forb seeds throughout the reclamation area. They spread nearly 1,000 cubic yards of wood mulch and placed rocks and tree snags throughout the site to provide plant cover and protection, and to assist in moisture retention. Revegetation was completed in 1997.

Finally, volunteers from the Youth Conservation Corps, Student Conservation Association, local church groups, and concession employees were brought in to add finishing touches on the project site by removing small asphalt pieces and hand-raking the ground to remove tracks left by the heavy equipment. The sense of accomplishment and pride was widespread among park staff and the many cooperators who assisted in campground restoration.

Identifying Institutional Barriers to Change

We find it valuable to review the institutional barriers we encountered to restoring Fishing Bridge Campground. First, the high cost of removing and restoring long-developed areas had been a deterrent. It was apparent that the park had fallen into a long-standing pattern of awaiting potential manna from Washington, D.C., to fund a project of this scale. But the reality was that line-item NPS construction dollars were most likely to be spent on development projects, not "undevelopment." The agency's planning, design, and construction staff were oriented primarily to DCPs and other efforts to build park facilities, not remove them. And although there have been some well-publicized discussions about relocating visitor services and administrative functions outside congested areas, such as at Yosemite Valley and the Grand Canyon's South Rim, such proposals have been at least as contentious as Yellowstone's Fishing Bridge debates.

Also, Yellowstone was hampered by organizational confusion about just who should be in charge of restoration. Resource staff were comparatively removed from construction and development projects, and could probably be characterized as intrinsically skeptical about, if not downright opposed to, such efforts. If involved in planning efforts, resource specialists were likely to be assigned to evaluate impacts as part of required environmental assessments; they were not necessarily invited to participate in proposing alternative development or management actions.

Staff knowledge and commitment were also factors. Yellowstone resource specialists had little training or expertise in disturbed-site restoration, skills not previously associated with their positions. The park's landscape architects were assigned responsibility for mitigating and monitoring new construction impacts, had established a native plant nursery, and ensured that topsoil was stored for revegetation efforts. But their workload did not allow them to tackle the major backlog of restoration projects identified by resource specialists as benefiting wildlife, wetlands, or other resources. Neither the maintenance nor the resource divisions had the equipment or training needed to design and implement restoration of disturbed sites to natural contours and vegetative conditions.

Last, Yellowstone's organizational and budgeting patterns contributed to a sentiment among staff that the job was too big for them to accomplish. Large construction projects traditionally required special funding and work was often contracted to private architectural, engineering, and construction companies. No entity among Yellowstone's divisions felt responsible for, or empowered to undertake, site restoration, even had they possessed the necessary training and funds.

Making Progress

By 1999, natural and cultural resource professionals in Yellowstone had commonly been assigned to road and facility planning teams. While viewing the added duties as a burden (and generally less appealing than field or lab work), resource specialists were able to offer mitigation measures for impacts associated with road improvements, new employee housing units, and even placement of satellite dishes in historic districts.

Inspired by the visible progress made at Fishing Bridge, staff sought and discovered other ways to accomplish disturbed-site restoration. In 1992, Yellowstone entered into a cooperative effort with the state of Montana to restore an old coal mine adit in northern Yellowstone. In 1993, another partnership with the state of Wyoming's abandoned mine lands reclamation program provided funding for rehabilitation of an 11.5-acre gravel quarry that had been eroding into a cutthroat trout spawning stream, and restoration of another 5.0-acre pit and 5-mile access road in the south-central part of the park. In 1994, the park began another project designed to restore grizzly bear habitat—the removal and reclamation of the abandoned Turbid Lake Road east of Fishing Bridge. A reclamation specialist from Redwoods National Park conducted a site survey and offered recommendations for treatment. A \$22,500 donation from Canon USA, Inc., allowed us to begin work on the road corridor in 1997. Using funds from the NPS fee demonstration program, along with existing park staff and equipment, reclamation should be completed in a few years.

Fortunately, we believe that Yellowstone staff now operate under a new paradigm in which they perceive not only that disturbed sites *should* be rehabilitated, but that they *can* be—often without the massive influx of dollars associated with typical line-item construction projects.

Additional Discussion

In 1996, the NPS' National Leadership Council established new direction for the agency's line-item construction program. Using a revised system to prioritize funding requests, they ranked removal of visitor facilities in the Giant Forest at Sequoia-Kings Canyon National Park as the top project. But project proposals with natural resource protection objectives were limited in that year's array of 10-238s (Miller 1996). We

suggest that many natural resource programs are still encumbered by the agency's long-standing patterns of separating development and construction projects from their program objectives. We urge resource managers to heed Miller's advice about working with facility managers to design projects (Miller 1996).

In the 1980s, the NPS sponsored a series of training programs for natural resource specialists. The senior author, who was a graduate of the second such class, perceived during the intensive professional development program that revegetation and disturbed-site restoration lacked "ownership" and were not clearly aligned with natural resource programs at national, regional, or park levels. We hope this is changing as more parks express a program need, establish professional resource management positions, and obtain added expertise. Professional organizations such as the Society for Restoration Ecology can offer educational assistance and training to park personnel in any division. Also, NPS's geologic resources division (GRD) can provide parks with technical assistance and, since 1998, some project funding from its abandoned mining lands program, in addition to fee demonstration monies. As part of the NPS director's natural resource initiative, the GRD has asked for an increased budget of \$1 million annually, which would be awarded competitively beginning in fiscal year 2000 for disturbed-site reclamation projects (D. Steensen, NPS GRD, personal communication). This proposal, if approved, will substantially improve the organization and funding support available for addressing a backlog of site restoration needs in Yellowstone and across the National Park System.

Still, the task is daunting. Yellowstone staff have identified more than 150 sites in the park that need reclamation. Yet, by strengthening our interdisciplinary efforts to plan, fund, and execute many more "undevelopment" projects, Yellowstone hopes to restore more acres of wetlands, natural contours, vegetation, and plant and animal habitats; to improve aesthetics; and to remove safety hazards to humans and wildlife in America's oldest national park.

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Ecological Restoration of a Wilderness and Cultural Landscape, Bandelier National Monument, New Mexico

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Summary

In 1990, a program was conceived to actively restore the wilderness and cultural landscape of Bandelier National Monument, located in north-central New Mexico. Initial efforts were directed at documentation of baseline conditions, including vegetative cover and soil erosion rates in degraded piñon and one-seed juniper woodlands. Development and testing of restoration methodologies began with small-scale evaluations of overstory thinning, slash mulching, and supplemental seeding techniques. Encouraging results from small-scale trials led to testing of overstory thinning and slash mulching techniques at a functional (100-acre) watershed scale. With validation of restoration methodologies at multiple scales, the park successfully obtained funding to implement large-scale restoration efforts. Implementation is being delayed however, pending environmental impact statement (EIS) review of the proposed restoration actions on wilderness, cultural, and natural values.

Program Review

In 1916, Bandelier National Monument was established to protect the "relics of a vanished people" whose cultural remains—i.e., "certain prehistoric aboriginal ruins"—were considered to be "of unusual ethnologic, scientific, and educational interest." Subsequently, in 1976, a large portion of the park was designated as wilderness owing to the rugged and remote nature of its backcountry. Therein was sown a unique management dilemma: the tools for cultural resource protection now had to be compatible with a wilderness philosophy. Moreover, even a management founded on ecological considerations could sometimes find itself at odds with a nature defined more by aesthetics than by process.

Piñon (*Pinus edulis* Engelm.) and one-seed juniper (*Juniperus monosperma* (Engelm.) Sarg.) woodlands occupy some 10,000 acres within Bandelier National Monument. Domestic livestock grazing, beginning in the late 1600s and intensifying with the arrival of the railroad in 1880, transformed fire-dependent grassland and savanna communities into woodlands choked with young tree growth. Overgrazing reduced standing herbaceous biomass and continuity of fine-grass fuels, effectively preventing fire from propagating in these systems (Gottfried et al. 1995). As the soil-stabilizing, grassy ground cover was supplanted by increasing densities of trees, highly erodible soils were exposed to physical processes. Bandelier, a mountain wilderness and cultural landscape of abandoned pre-historic settlements, was established to preserve the unique ancestral remains of Puebloan Indian peoples. The largest proportion of archeological sites in the monument occur within piñon-juniper communities, and of these, over 80% have sustained erosional damage. Rapid soil loss in degraded piñon-juniper communities is unsustainable and threatens the integrity of thousands of pre-historic cultural sites. On the basis of soil erosion bridge and sediment catchment data, soil loss within degraded piñon-juniper communities at Bandelier is conservatively estimated at 2.5 cm per decade; an unsustainable rate given shallow soils with average depths of 1.0 to 12.0 cm (Davenport 1997; Davenport et al. 1996; Wilcox and Breshears 1995).

Without prompt management action to stabilize soils, we predict wholesale loss of soils and cultural resources within the next 100 years. Approximately 8,000 acres of woodland at Bandelier are in critical condition, relative to soil loss and threats to cultural resources, and could benefit from proposed management restoration actions.

Beginning in 1990, Bandelier began to document baseline conditions within

woodland communities in an attempt to quantify the erosion issue. At the same time, an evaluation of locally native plant materials with potential for use in soil stabilization efforts was initiated in cooperation with the Soil Conservation Service. A two-year revegetation study, designed to evaluate techniques for establishment of grass from seed in degraded woodland areas, was started in 1992 (Chong 1993; 1994). In 1993, instruments were installed in a 1-ha experimental watershed, yielding high-resolution measurements of precipitation, runoff, and sediment transport that could be used to model the hydrologic dynamics of degraded woodland systems (Wilcox, Newman, et al. 1996; Wilcox, Pitlick et al. 1996). In 1994, development and testing of restoration methodologies that altered woodland structure were begun, with evaluations of overstory thinning, slash mulching, and supplemental seeding techniques (Jacobs and Gatewood 1998; Loflin 1998). By 1996, the measured herbaceous response to structural restoration treatment was encouraging enough to prompt evaluation of the overstory thinning and slash mulching method at a functional 100-acre watershed scale. Results from these large-scale studies, at two years post-treatment, continue to validate the herbaceous response of small-scale tests across greater a heterogeneity of pre-treatment conditions. By 1998, confident a feasible restoration approach had been identified and anxious to stem additional losses of soil and cultural materials, the park obtained agency funding to begin implementation of restoration efforts covering thousands of acres. Subsequently, heightened concerns about the potential impacts of large-scale restoration on wilderness values prompted National Park Service management to postpone the project until a wilderness plan and associated EIS could be completed. Preparation of a wilderness plan and EIS which clearly articulates the role of research and management, and defines an acceptable balance between wilderness values and ecosystem processes, is in progress.

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Ecological Restoration and Park Development as Interpretative and Public Education Tools in the Urban-Suburban Matrix: Furstenberg Nature Park, Ann Arbor, Michigan

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Historical and Biophysical Context for Furstenberg Park

Historical preface. In June 1829, J. W. Wing recorded the following near Ann Arbor, Michigan: "The scene was beautiful beyond description. The timber consisted of large oak trees standing several rods apart and the intermediate space between them was covered with bright green grass and beautiful flowers. The whole country had been burnt over every fall or spring, I presume, for centuries, and everything destroyed except these giants of the forest. It did appear as if one-half of the vegetation was flowers. The most of them were about eighteen inches high and when moved by the wind the effect was wonderful. I have never seen in any of our large cities a park that was its equal."

Regional context. Furstenberg Park is located in southeast Michigan, approximately 30 miles from the Detroit Metropolitan area. The park is positioned in Ann Arbor at roughly the halfway point along the Huron River's 125-mile journey to Lake Erie. The city, which lies upon glacial terrain along the mid-section of the Huron River, falls between the river's upper stream-and-lake-pocketed reaches and the low-land marshes and forests of the lake plain.

Historically this steeper, central section of the Huron River was biologically diverse, with large spawning runs. John Allen, one of Ann Arbor's first European settlers, arrived during 1824 and staked his claim along the Huron, calling the river "the most beautiful I have beheld, and abounding with the most valuable fish." The deep clay-loam soils in the area were some of the most productive in the region, and hence, within four years of Allen's arrival, dozens of mills and dams were built and the land began to be cleared for farming and settlement. These activities changed the landscape in dramatic ways. Fish and other aquatic species dwindled, boxed in by 94 dams and lake-level controls, warmed by stormwater runoff, with eggs and food buried by silts and tainted by pollutants. Now, where hundreds of fish once lived, approximately 35 species remain. The diversity of ecosystems that co-existed with Wyandotte and other Indian tribes also declined as the population grew.

Recent site history. At Furstenberg Park, woodlands were cut and nearby dams straightened and slowed the river, and for many years the site was used for grazing and other agricultural purposes. Roads were built and expanded, and institutional and residential development embraced most of the surrounding landscape. Then, in 1960, the approximately 39-acre tract was donated to the city and set aside for conservation purposes.

Local urban context. Furstenberg Park lies within the heart of Ann Arbor and is part of the North Campus drainage basin. It is surrounded by University of Michigan, Ann Arbor city, and residential land. Immediately adjacent to the site is Huron High School, one of three major high schools in Ann Arbor. The University of Michigan's Nichols Arboretum lies across the river, and Gallup Park (perhaps the city's premier recreation-attractor) is just downstream. A three-mile bike trail links Gallup Park to the downtown and the city fringe. Figure 1 shows Furstenberg Park (the mitten-shaped peninsula in the center of the photo) with downtown Ann Arbor in the background.

Site conditions and park planning context. Furstenberg Park is part of an old floodplain; however, dams now control the river to plus-or-minus two feet. Park soils are river-laid sand, gravel, and loam, making them quite droughty at times. The old



Figure 1. Huron River, Gallup park, Furstenberg Park, and the surrounding Ann Arbor, Michigan, context (ca. 1991). Photo by Peter Pollack.

river's edge provides the most significant topographic relief (approximately five to eight feet) with the remainder of the site being nearly level. Vegetation types range from dry to mesic (with native overstory species including black, white, red and bur oaks; pignut and shagbark hickory; green and white ash; and black walnut).

From aerial photographs and oral histories, the project team concluded that the "old field" on site had been grazed until about 1947, the property lying vacant since that time. Many exotic plants established themselves within the park during that time and, by 1990, with the exception of small areas within the oak-hickory woodland and emergent wetland, the park was dominated by honeysuckle, buckthorn, oriental bittersweet, Russian sage, and other early-succession trees, shrubs, vines, and herbs.

In 1990, the Ann Arbor Parks and Recreation Department let a request for proposals and Pollack Design Associates (for whom the lead author worked between 1990-1993) was selected to prepare a park master plan. As project manager, the lead author helped guide the project through conceptual planning to development of an illustrative master plan, detail designs, and construction documents, then through Phase One implementation (walking the contractors through one-and-a-half years of construction work, including initial prairie and oak-hickory woodland restoration). During 1994-1996, the Parks and Recreation Department completed Phase Two design and construction work, including the boardwalk linking Gallup and Furstenberg parks.

Park Planning and Design Intentions

The intent of the Parks and Recreation Department was to create "a more natural park" than nearby Gallup Park (composed chiefly of turfgrass to the water's edge).

Within Furstenberg Park, the city envisioned group picnic shelters, a playground, an active play space, trails for walking and jogging, river access for fishing and viewing, and a pedestrian connection to Gallup Park.

Pollack Design Associates' approach was to use no "typical" solutions nor carry preconceptions as to what this park must be. Rather, the design team sought first to discover what the land and interested residents had to say. This was done through a detailed site inventory, analysis, and evaluation (PDA 1991), and via a participatory park planning process.

Site Inventory, Analysis and Evaluation

The purpose of the inventory was to search for relationships between existing features and the landscape's functions and dynamics. The following paragraphs highlight the major issues considered.

The land: Site structure and function. What is here? How is the existing system functioning? How will the place change over time? How will the park's program relate to and alter existing ecosystem structure and functions? What type of changes are desired or acceptable and why? How does one retain the capacity of land to provide habitats for humans and wildlife? Can surfacewater runoff be effectively held or filtered through the soil? How can the park's character be retained and ecosystems effectively restored or created?

The people: Desired activities. Who is the public? Who is really concerned about this place and what do these people want and need? How are public needs and wants best served? And, what is the best process for answering these questions? At Furstenberg Park, the client and consultant had the first say in addressing these questions. After the biophysical analysis of the park revealed remnant "prairie" and "oak opening" species, it was agreed that ecological restoration should play an important role in the park design. In addition, citizens who came to the public meetings or followed up directly with the city and design consultant influenced the process greatly. These folks wanted the park to retain its "natural" and "wilderness-like" characteristics. The assumed position of the "silent majority" (the desire for direct access to Furstenberg for picnicking and recreation) was advocated by several members of the design team and consented to by neighbors and environmental advocates, with guaranteed "limits" on the size of the parking area and "controlled pedestrian access" within the park.

Furstenberg Park's Natural and Cultural Potential

In Ann Arbor, riverfront land within the city is thought of as a continuous, complementary natural and recreational system (Pollack 1995). The community's conservation ethic, the qualities of the land and river, the recreational resources of adjacent parks, and a participatory design and decision-making process determined that Furstenberg should primarily be a place for nature study and the interpretation of conserved, restored, and constructed ecosystems.

Nowhere else in the city could one experience so conveniently core and ecotone habitats ranging from flowing river to still lagoon, oak-hickory woods to prairie, and cat-tail marsh to sedge meadow. Proximity to educational institutions and active recreation areas made this location ideal for interpretation, allowing a variety of visitors to experience a diverse and constantly evolving landscape (Pollack 1995).

Long-Term Vision and Master Planning Attitude

Through the process of client, consultant, and community dialogue via meetings, workshops, field reviews and discussions, the following idea emerged: Furstenberg Park should be a complement to the open, active, human-made, water-dominated Gallup Park. Indeed, the self-enclosed, dynamic, and natural character of Furstenberg Park must shine through!

For the designers (landscape architects, working in close collaboration with biologists and interested community members), the notion was that the two adjacent parks

would mutually complete each other. Gallup Park's focus was active land-and-water recreation. At Furstenberg, ecological restoration and management was to be melded with more reflective recreation, interpretation and education; the park (vegetation, soil, water, and land) was envisioned as an ecological system, with a primary focus on how this place was to be seen, used and experienced by people. A sensitively placed trail and boardwalk was envisioned to link the two parks. In sum, Furstenberg Nature Park was to conserve the land as a functioning habitat, buffer and filter, as well as providing conservation-based recreation, interpretation and education.

Design Characteristics and Project Importance

The nature of the land and its resources are evident upon entering the site, with a constructed prairie surrounded by the school bus access loop, and a constructed wetland basin holding and filtering stormwater from roads and parking. In the distance, restored prairie, oak savanna, oak-hickory woods, and riparian vegetation are discernible (Figure 2).



Figure 2. Restored prairie vegetation showing the diversity of seeded native species (1996).

Access to each ecosystem is fitted to its specific character: the openness of the prairie and oak savanna is matched by the walk's long, sweeping, and controlled lines; the density of the woods is expressed by short, informal curves, with the path carefully aligned between trees; river access points are understated to keep on-the-river experiences "wilderness-like," and the boardwalk moves lightly but directly over wetlands to minimize impacts. Furnishings and conveniences, by design, are also specific to each setting, varying to reinforce unique places within the park (Pollack 1995).

Furstenberg Park is an example of design that helped unite ecological and socio-cultural factors. The master plan envisioned a long-range management plan, providing a framework for restoration and enabling the public to see and participate in the site's evolution. Interpretive opportunities encourage discovery and foster an understanding of the restoration process, and ultimately help transform the perceived and physical landscape. Community work-sessions are treated as restoration and management workshops where invasive plants are identified and appropriate controls practiced. A natural areas stewardship program makes the park a community laboratory for environmental history, education, and research (Figure 3). Since 1993, parks staff and community members have contributed hundreds of hours to restore and manage the representative ecosystems within the park (Figure 4).

Evaluation Criteria for Ecological Restoration in Urban and Suburban Parks

Critical issues that need to be considered when communities, park personnel, and designers consider restoring ecosystems in urban or suburban areas include a range of social, political and environmental concerns. Criteria related to effectively restoring ecological structure, function, and dynamics—from institutional, biophysical, and technical standpoints—include institutional capacity of the community, educational and interpretive value for community members, and ecological integrity (appropriate structure, function, and viability) through time.

In the case of Furstenberg Park, Ann Arbor's ability and commitment to manage the park's restored ecosystems over time (its institutional capacity) seems more than adequate. For other urban and suburban communities with a smaller population base and parks department, institutional capacity may be less certain. Maser (1997) discusses how institutional capacity can be realized by increasing community literacy about the environment and by actively involving citizens in project planning, design, and implementation.

The educational and interpretive value of restored and created park ecosystems include their power to connect individuals and human communities with the larger bioregion, as suggested by many landscape architects and land planners, including Lyle (1984), Hough (1990), McHarg (1992), Jones (1995), Lewis (1997), Tamminga (1997), and Thayer (1997). In short, such landscapes motivate people to learn and know more about the places they call home.

In like manner, ecological integrity denotes the provision of connections to the larger landscape, the capacity of restored and created ecosystems to rebound from future stresses, and the maintenance of viable ecological structure and function over the long term (see Forman and Godron 1986; Munn 1993; Forman 1995; Dramstad et al. 1996; Pickett et al. 1997). The ability to evaluate success in meeting these criteria requires active monitoring, ideally instituted as part of the park planning and design process.

The Importance of Ecosystem Monitoring

According to Galatowitsch (1998), ecological designs cannot be considered successful without appraisal of the biological changes occurring on site since implementation. Correspondingly, restorationists need to answer the following question: should current restoration management practices be continued or modified? "The best way to answer this question is by monitoring the changes that happen during restoration" (Masters 1997, 279). In short, restorationists need a monitoring program with clear objectives and answerable questions. In addition, they need to explicitly state what "restoration success" means, determine the indicators of ecosystem change, and describe how these changes will be measured (Masters 1997).

One way to monitor ecosystem restoration is to measure floristic changes using quantitative sampling in sufficient numbers and intervals "to achieve a representative amount of plant frequency and coverage data" (Masters 1997, 283). Floristic quality assessments can be undertaken to measure intact structure, composition, and



Figure 3. Interpreter with community residents in the constructed wetland basin.



Figure 4. Volunteers celebrate with a group photo of their work—a more intact prairie and a pile of hand-pulled knapweed (a highly invasive non-native plant).

processes (Swink and Wilhelm 1994; Herman et al. 1996; Masters 1997). Such efforts have been initiated at Furstenberg Park, helping address questions such as: Are non-native shrub patches increasing or decreasing in the prairie? Are specified rare species increasing or decreasing? What is the effect of burning (and other management tools) on exotic woodland species? What species have been successfully reseeded into prairie and woodland ecosystems? How do specific management regimes change vegetation in restored areas?

The floristic quality index (FQI) for natural areas is the method Ann Arbor currently uses to quantify the botanical, or floristic, quality of parks and natural areas. Within the 70 or so natural areas inventoried in Ann Arbor, FQIs range from a low of 11.5 to a high of 73.6. Furstenberg Park's FQI is 70.0 (Walters 1997), making it third-highest in the city and "botanically important" from a state-wide perspective (Herman et al. 1996).

In addition to monitoring and research plots, Furstenberg Park contains about 50 photomonitoring points to track changes over time. These photopoints are important because laypersons understand pictures better than hard data. Nevertheless, effectively communicating both types of findings to the public is essential.

Summary: Project Success, Research Value, and Lessons Learned

During the past five years, biologists have documented a surprising increase in plant diversity at Furstenberg Park (a major measure of the success of the city's restoration efforts). As of December 1997, the park contained 433 total plant species, 308 of them native, including three species which are "state-threatened" or of "special concern" (Walters 1997). Longer-term monitoring is required to determine how floristic quality in the park changes over time.

As a result of ecosystem restoration and creation at Furstenberg Park, many issues have arisen. At times, prairie-woodland burning and other management procedures have raised questions. Because of this, restoration success and the role of community participation in promoting restoration/management acceptance demand further research—and, this story of hope and vision (Bernard and Young 1997), needs to be reassessed and written about in future years.

When planners, designers, biologists, and land managers undertake ecological restoration within public parks, it is important to remember that the effort is a long-term process. Restoration requires persistent work every year, until exotics are pushed back into a minor role within each ecosystem. Restorationists must plan accordingly, and not bite off more than they can effectively manage. They must know the site and its human and ecological contexts, set clear goals, and proceed carefully. Likewise, they need to dedicate sufficient resources to the work and prioritize efforts where they will do the most good. Establishing a monitoring program is critical, as is the task of regularly assessing how objectives are being met, then making changes as needed. Finally, two suggestions: We need to learn from our mistakes. And, to listen to the land and learn from it too!

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Restoring the Gray Wolf to Olympic National Park: Background Information and Current Status

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Europeans settled the Olympic Peninsula of Washington state in the late 1800s. Accounts from early settlers report wolves as "numerous or very abundant" on the peninsula at that time. However, wolves were greatly reduced through trapping and hunting by 1915. The last fully documented wolf was shot on the peninsula in 1920; however, reports of scattered wolves continued into the early 1930s.

Olympic National Park park was formed in 1938, and at that time wolves were probably extirpated. However, with the possible exception of the fisher, the remaining species assemblage in the park is intact.

Proposals to restore wolves to the Olympic Peninsula have been raised several times in the intervening years. In fact, Adolph Murie first proposed it in 1935. In 1981, a National Park Service (NPS) advisory board task force chaired by Durward Allen proposed that the NPS explore the possibility of wolf restoration to two parks: Yellowstone and Olympic (Allen et al. 1981, 24). U.S. Representative Norm Dicks and the nongovernmental organization Defenders of Wildlife raised the current initiative in early 1997. This paper covers the progress that has been made to date.

The Olympic Peninsula is over 13,740 sq km in extent. Olympic National Park lies in the heart of the peninsula (Figure 1), and the core area of the park (without its coastal strip) encompasses 3,626 sq km. The park is primarily bordered by Olympic National Forest, Washington Department of Natural Resources lands, and the Quinault Indian Reservation. In total, there are 6,158 sq km of federal and 7,888 sq km of public lands on the peninsula.

Elevations within the park range from sea level to almost 8,000 ft at the peak of Mount Olympus. Eleven major drainages radiate from the Olympic Mountains. Coniferous forests dominate the park landscapes below 5,000 ft. On the west side of the park, the valley floors are broad and U-shaped, and lower elevations contain Sitka spruce-western hemlock forests. On the east side, valleys are narrower and steeper and contain more xeric vegetation. Meadows occur above 5,000 ft in the alpine and subalpine zones. Although the park is centered on Mount Olympus and adjacent peaks, the distribution of alpine and subalpine habitats is skewed towards the eastern side of the park, whereas low-elevation coniferous forests are more prevalent on the western and northern drainages.

The primary prey species for wolves on the peninsula were, and would be again, Columbian black-tailed deer and Roosevelt elk.

Congress allocated \$350,000 towards wolf restoration in the Olympics in the 1998 fiscal year budget. Of that, \$300,000 went to the U.S. Fish and Wildlife Service (USFWS) for initiating the process. Since the start of the initiative, the park has been working closely with the USFWS, U.S. Forest Service, Washington Department of Fish and Wildlife, and several local tribes. All entities realized that if wolves were restored to the park, the wolves would not recognize administrative boundaries.

The funding was spent on two tasks: preliminary prey-base research and a wolf restoration feasibility study. Results from the prey-base research will be covered in other papers (Jenkins et al. 1999). The feasibility study was contracted to a group of researchers at the University of Idaho in April 1998. Their task was to compile existing data and assess the feasibility of restoring wolves to the park, given current conditions.

The feasibility study was due for completion in September 1998. All agencies took the position that they would take no stand on wolf restoration until the feasibility study was completed and released. The agencies wanted the feasibility

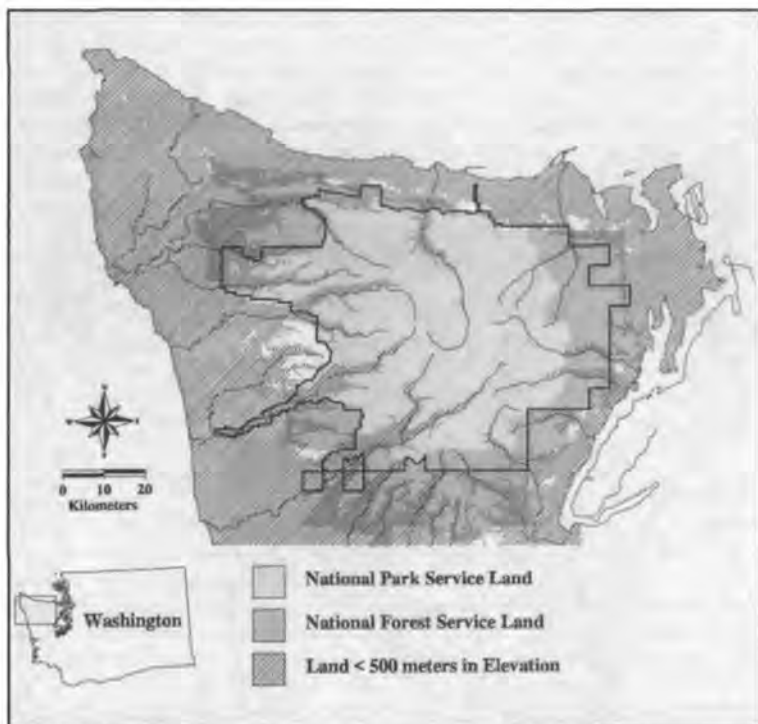


Figure 1. Location of Olympic National Park, Olympic National Forest, and the wolf restoration primary analysis area (PAA) on the Olympic Peninsula

study to be a first, objective look at the situation. The study results were to be used to make a decision on whether to further pursue the proposal. The thought was that if the study concluded that wolf restoration was not feasible, we would save the time and expense associated with undergoing the National Environmental Policy Act (NEPA) process. If the report concluded that it was biologically feasible to restore wolves, then the information compiled would be folded into an Environmental Impact Statement, and could jump-start the NEPA process. Also, the document would serve as an information platform to base the NEPA scoping process.

The contractors ran into several problems, and the final report (Ratti et al. 1999) was not received until 3 February 1999, and not released by the USFWS until 5 March 1999. The document, over 350 pages long, is available for reading on a USFWS web site (<http://www.r1.fws.gov>). Some highlights will be presented below.

The report's first step was to determine how much suitable wolf habitat was left on the Olympic Peninsula. In that effort, they defined suitable wolf habitat as areas with roads <0.6 km/sq km and human density <5 people/sq km (Ratti et al. 1999), based on wolf-human-road relationships derived in other studies (Mladenoff et al. 1995). From that analysis, they estimated that there was 4,455 sq km of suitable wolf habitat on the Olympic Peninsula (or about 27% of the peninsula). They subsequently used this block of suitable habitat as their primary analysis area (PAA). Ninety-eight percent of the PAA is public land: with 78% in the park and 19% in Olympic National Forest (Figure 1). All national forest lands identified in the PAA

are designated as either wilderness or late-successional reserve. The remaining lands on the peninsula were excluded because the road densities there are too high (Figure 2) (Ratti et al. 1999).

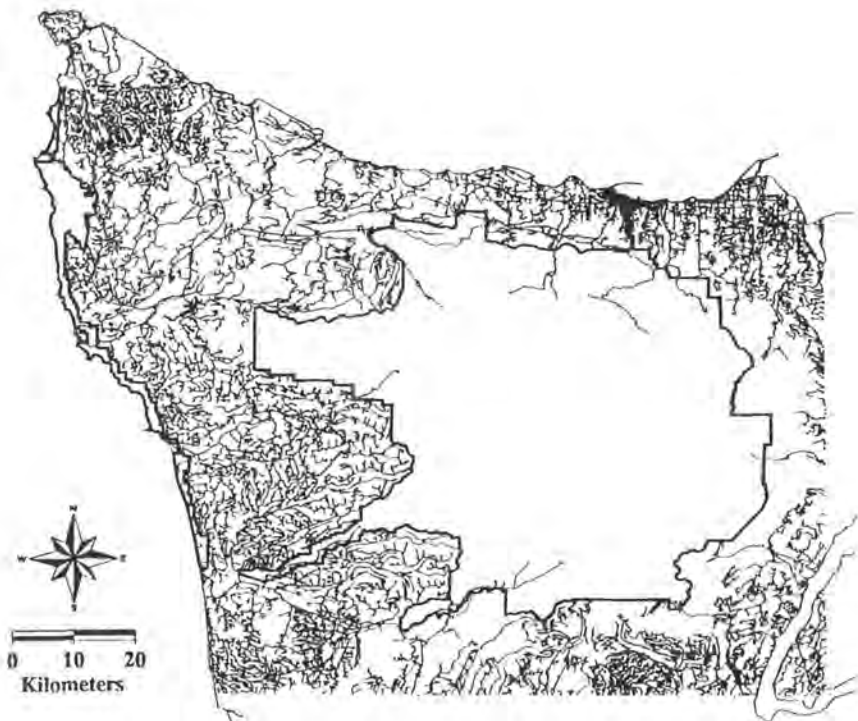


Figure 2. Distribution of roads adjacent to Olympic National Park

The report then defined suitable year-round wolf habitat as those areas where elevations are <500 m (essentially, elk and deer winter range). After the high-elevation areas were excluded, their estimate of available year-round habitat was reduced to 787 sq km, of which 592 sq km, or 75%, is in the park. The authors next went on to predict the number of wolves that could be supported on the peninsula, based on the number of deer and elk that inhabited the winter range in the PAA. Using data provided by the NPS, the state, and local tribes, they estimated that there were 4,409 elk in the PAA; of those, 4,248 were in the park as year-round residents, primarily in the western and northern drainages. They also estimated that 2,485 deer resided in the PAA, of which 1,917 were year-round park residents. Using those prey numbers, they did a simple model (Fuller 1989) on a drainage-by-drainage basis. If the area supported <2 wolves it was excluded from further analysis. They ended up estimating that 56 wolves would survive in park, all in the western and northern drainages. From their analysis, no wolves were expected to solely occupy areas outside the park.

The researchers also examined wolf population stability and viability. The results of those investigations were unclear. The environment on the Olympic Peninsula is stable and not prone to stochastic factors, which has favorable implications for population stability. However, the restored wolf population would be isolated, and less than the 100 individuals generally thought of as being required for genetic viability

over the long term. Consequently, they labeled the potential wolf population in the park as "marginally viable" and stated it would need to be monitored for genetic problems, and perhaps occasionally augmented (Ratti et al. 1999).

Predator-prey relations were modeled to assess potential wolf impacts on prey populations. Because they predicted that virtually all the wolves would inhabit the park, they restricted their analysis to the park. Due to a lack of data on other predators, weather influences, prey demography and density-dependence, they used a simple one-predator, two-prey model. The model predicted a 16-17% elk decline and 13-16% deer decline in the park, or an equilibrium of approximately 59 wolves, 1,608-1,668 deer, and 3,531-3,563 elk (compared with current figures of 0 wolves, 1,979 deer, and 4,248 elk). They concluded that the herbivore decline was not enough to affect the herbivore-vegetation equilibrium that exists in the park (Ratti et al. 1999).

The authors of the report also identified several challenges that they thought would be associated with any wolf recovery process on the Olympic Peninsula. The primary challenge was a perceived conflict between wolf predation and elk hunting. Although the elk population is stable within the Park (Jenkins et al. 1999), elk numbers outside the park are about half what they were ten years ago. Consequently, there have been controversial reductions in sport hunting opportunities. In addition, elk allocation between sport and tribal hunters is also a contentious issue. Many parties are uncomfortable with the thought that another predator will be added to the system. However, because the authors determined that suitable wolf habitat would be basically restricted to the park, the report predicted that wolf restoration would not significantly affect elk and deer populations, or hunting opportunities, outside the park. They did acknowledge that once the park is fully occupied by wolves, wolves will try to disperse outside the park, and thus may produce localized impacts. However, those were not predicted to be significant from a population standpoint, but may have local implications in elk herds with restricted ranges and low population numbers (Ratti et al. 1999).

In wolf recovery efforts elsewhere, livestock depredation has been a big issue. However, Ratti et al. (1999) predicted that depredation would not be significant on the Olympic Peninsula. This is because livestock numbers are low: <5% lands on the peninsula are agricultural, and most of the agricultural lands are not in or near the PAA. However, they did recognize that depredation would occur occasionally, and would be a source of conflict when it occurs.

The feasibility study was hampered by several data gaps. The most notable was in the digital road (GIS) data. There were significant omissions of roads in a key section of the peninsula, and the digital layers did not reflect road closures. We know that many of the logging roads are closed, and suspect that when accurate data on closures is added, the result will be an increase in available wolf habitat, and the predicted size of the wolf population. The analysis was also hampered by a lack of data on prey, especially on deer in the park. In fact, prior to prey-base studies funded by the wolf restoration project, there had been no work done on deer in the park. We also have no data on predation rates in the park. It is unknown to what extent wolf predation will be additive to that of other predators (cougar, coyotes, black bear).

In addition to the funds administered by the USFWS, \$50,000 was allocated in 1998 to the Olympic Natural Resources Center (ONRC), a research institute in Forks, Washington, affiliated with the U.S. Forest Service and the University of Washington. ONRC was directed to use its funds for public outreach and polling. The appropriation language associated with the funding stated that Congress wanted the studies to include

...a detailed assessment of the potential interaction between the wolves and the people who live, work, or recreate in the park, national forest, and surrounding lands. The Committee is interested in both a scientific analysis

of the frequency and impact of potential wolf-human interactions, and a review of the opinions and attitudes regarding wolf introduction of those who live in the immediate area and would be most likely to have direct contact with wolves. The EIS should also address any potential impacts that wolf introduction may have on hunting on the Olympic Peninsula.... The committee also notes that it does not intend to support wolf introduction unless it is clearly demonstrated in the EIS that such introduction has the support of a majority of the people who live or work in the immediate introduction area, and whose families, livestock, and pets would be most likely to encounter the wolves if introduced.

ONRC stated out that it would "carry out the intent of Congress by designing and implementing a process which will provide information regarding opinions and attitudes of those described in the appropriation language." Although ONRC initially was a part of the interagency team working on wolf restoration, with its administrator expressing support for the proposal, ONRC soon ceased attending the interagency meetings. ONRC ended up doing no public outreach or polling on the wolf restoration issue. Instead, it held three "electronic town hall meetings," all of which were held before the feasibility study was released. In its process, ONRC interviewed 24 people from the four counties surrounding the park. From those interviews, it developed 70 questions or statements that were then put to people to vote on, using a six-point sliding scale ranging from agreement to disagreement. The votes were registered on electronic devices, like remote television controls, and the results shown almost immediately on big screen for all to see. At each meeting, only the first 100 people through the door got to vote (ONRC 1999).

There were several critical limitations with this process. Firstly, a wide cross-section of the public was not interviewed in the question development phase; 11 of the 24 people interviewed were from the small community of Forks. Secondly, the questions asked in the meetings were taken directly from people's statements. There was no attempt to make them factually correct or unbiased. Consequently, the process further perpetuated inaccurate information. Some examples of questions asked are: "The greatest value of Olympic National Park is as a World Heritage Site, preserving and restoring an ecosystem, protected from human influence," and "The Park Service is making it increasingly hard for people to use Olympic National Park." Only after these statements were voted on was the public asked to vote on wolf restoration. One question was so poorly worded and inflammatory that the participants demanded it be thrown out.

Perhaps the most problematic aspect of this process was that the respondents were not randomly selected, and consequently the results are not a true poll; i.e., they do not reflect the opinion of the residents of the areas around the park. Instead, they reflect the opinions of those who showed up for the meetings. The demographics of the respondents clearly reflect the biased sample (69% male, 56% older than 50, 74% having resided on the peninsula for over 20 years). Consequently, it was not surprising that the end result was that 66-90% of those who voted at the three meetings were opposed to wolf restoration in the park. In contrast, two prior, non-biased polls have shown that the majority of peninsula residents favor wolf restoration (OPA 1999; Rooney 1995).

Yet before the feasibility study was released, U.S. Senator Slade Gordon stated publicly that he will block any further funding for wolf restoration in the park. In that statement, he cited the results of the town hall meetings. In light of Senator Gordon's position, Representative Dicks has stated that he will not pursue further funding for wolf restoration until there is a change in the support for the proposal in the Senate. In the meantime, the park will continue to try to fill in data gaps critical to the wolf recovery process, and, if and when funding becomes available, we will proceed with the proposal.

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Ecological Restoration in Parks and Protected Areas: Facing up to Scientific Understanding and Social Demands

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Introduction

Management of parks and protected areas requires a blend of biological and human considerations in a temporally dynamic environment. Ecosystems change over time through natural succession, visitors' expectations change from one generation to another, and management issues are transformed with the demographics of local communities. Seemingly, the only constant is change. However, the underlying management goal remains the same: to respect the intrinsic human values associated with parks and to preserve natural and cultural resources.

In many parks, the sustainability of unique biological resources is of special concern, particularly when threatened by human activities. The decline of old-growth forests dominated by ponderosa pine (*Pinus ponderosa*) in the western United States is one such example. Noss et al. (1995) estimated that approximately 70% of the old-growth ponderosa pine ecosystems in Idaho have been lost or degraded due to fire suppression or high-grade logging. This can pose a significant dilemma for park managers where ponderosa pine is in decline. Where feasible, managers may choose to "restore" the ecosystem to more sustainable conditions to prevent potential resource losses.

Within this context, the process of ecosystem restoration is complex. Management activities will not only affect biological resources, but community values, politics, economics, and people. As a result, park managers must consider the concerns of the public as well as the biological resource when implementing restoration. The purpose of this paper is to suggest a process that combines both the human and biological dimensions for ecosystem restoration. We discuss the successful implementation of this process using a case study of Ponderosa State Park in Idaho.

Ponderosa State Park

Ponderosa State Park consists of 1,700 acres (688 ha) adjacent to Payette Lake in central Idaho (Figure 1). It was established in 1912 to protect unique biological resources, including virgin mixed-conifer forests that are between 200 and 400 years old. Daytime visitor use has increased steadily over the last six years from around 60,000 in 1991 to more than 145,000 in 1992. The town of McCall, Idaho (population 3,000) is located adjacent to the park.

Historic Forest Trends within Ponderosa State Park

The mixed-conifer forests in the park have undergone significant structural and compositional changes over the past 75-100 years, primarily as a result of fire exclusion. At the turn of the century, much of the park was covered by open, old-growth forests dominated by large ponderosa pine and western larch (*Larix occidentalis*). These forests developed under the influence of frequent, low-intensity surface fires (5-to-25-year mean intervals) that favored pine and larch over more susceptible species such as grand fir (*Abies grandis*) and Douglas-fir (*Pseudotsuga menziesii*) (Crane and Fischer 1986; Sloan 1998). Frequent burning maintained open forests by periodically reducing under-

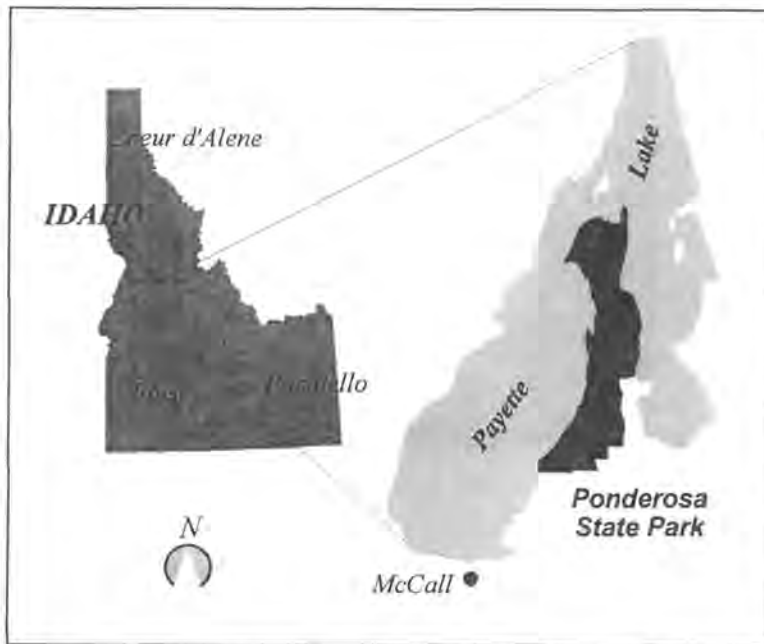


Figure 1. Location of Ponderosa State Park in central Idaho, USA.

story tree densities, consuming dead and down woody debris, and promoting herbaceous ground cover (Covington et al. 1994). Most of the standing volume was distributed among large trees that could survive the fires.

With the onset of fire exclusion around the turn of the century, frequent surface fires were eliminated as an ecological influence in the park. In the absence of fire, grand fir and Douglas-fir have increased dramatically at the expense of ponderosa pine and larch (Figure 2). In addition, tree densities, fuel loading (including ladder fuels), and large tree mortality have increased (Figure 3). These changes are not unique to the park, but are characteristic of more widespread conditions throughout the western United States (see Covington et al. 1994 and Agee 1993 for a more detailed review). Potential consequences include an increased risk of high-intensity wildfires, increased susceptibility to insect and disease epidemics, reduction in herbaceous vegetation, and a loss of old-growth habitat and species diversity (Covington et al. 1994; Morgan 1994).

Restoration Resource Management Process

In response to forest changes in the park, Ponderosa developed a management strategy designed to restore forest sustainability and reduce wildfire risk. During the summer of 1993, the park began the process of implementing a resource plan emphasizing ecosystem restoration. Prior to this period, the primary focus was on visitor use and recreation management. In order to accomplish this change, Ponderosa adopted a ten-step restoration management process that incorporated both human and biological dimensions. The following is a brief description of this process in relation to management in the park.

Step 1: Clearly state the purpose of restoration management. Park managers must strive to maintain a balance between social demands and natural ecological processes.

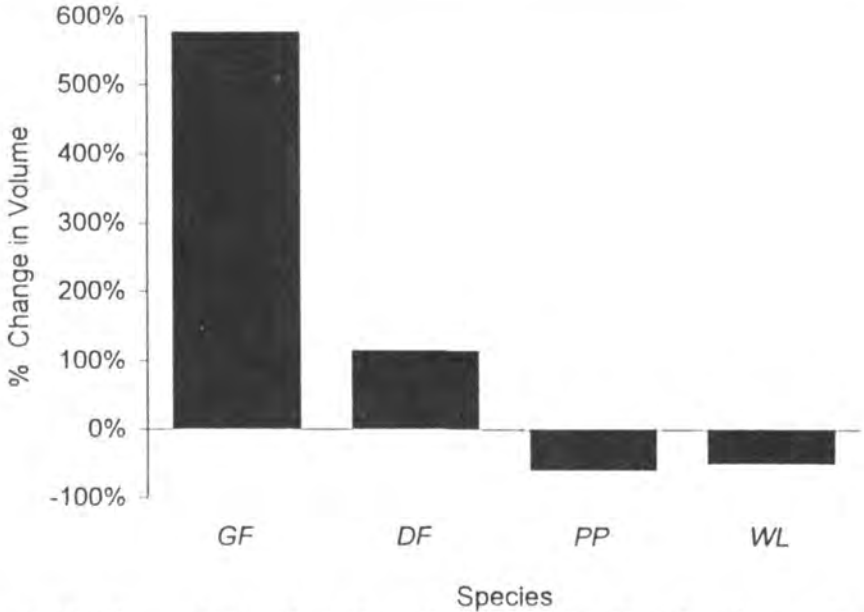


Figure 2. Net changes in standing volume (board feet) for selected conifer species in Ponderosa State Park between 1920 to 1995. Species codes are: GF = grand fir; DF = Douglas-fir; PP = ponderosa pine; WL = western larch.



Figure 3. Typical structure and composition of mixed conifer forests in Ponderosa State Park resulting from fire suppression. Note the large, old-growth ponderosa pine in the overstory and the dense thickets of young grand fir and Douglas-fir underneath.

The goal of restoration is to return important biological characteristics of altered ecosystems in order to maintain unique natural communities and biological diversity. The primary objectives in Ponderosa were to restore ponderosa pine structure and composition to presettlement conditions to make them more resistant and resilient to natural and human-caused stresses.

Step 2: Gain support and assistance of federal, state and local resource agencies. Resource management activities in Ponderosa directly or indirectly influence nearby lands managed by local, federal, and private agencies. Working proactively with all affected agencies allowed park staff to gain valuable input and helped form the scientific and political foundation of the restoration plan. Moreover, it fostered a sense of local ownership in the project, eliminated any unnecessary surprises (e.g., smoke pollution), and provided a future framework to implement resource-based ecological management across jurisdictional boundaries.

Step 3: Select potential restoration areas. Restoration sites were selected based on the expected ecological response, the potential influence on surrounding areas, and the feasibility of treatment. Meadow Marsh was chosen as a pilot study area to implement and evaluate initial restoration prescriptions. The area had not burned this century and was representative of other areas in the park altered by fire exclusion. It was also strategically located to maximize the influence of fuels reduction on surrounding stands and provide an opportunity for the public to observe and evaluate restoration without being too visually obtrusive.

Step 4: Evaluate desired results in relation to a "no action" policy. Understanding potential consequences of restoration is important to evaluate and justify management. For example, reintroducing fire to unnaturally dense, stressed forests might actually increase mortality to the large ponderosa pine or result in an escaped fire. However, under a "no action" alternative, ponderosa pine will likely drop out as succession advances or be decimated by high-intensity wildfire. The implications of each scenario must be weighed in relation to all park resources.

Step 5: Public involvement to gain input and support. The public involvement process should seek agreement or understanding among opposing interests. It also provides an opportunity to create community partnerships. Ponderosa developed a public involvement program to communicate the background of the issue, describe the decision-making process, solicit input, assess the level of controversy, and facilitate information exchange with the public. Gaining the long-term trust and support of the public requires formal and informal relationships over many years and multiple issues.

Step 6: Develop prescriptions for restoration. A variety of management techniques were evaluated for the Meadow Marsh restoration. Park staff felt strongly that to restore process and function to the forest, fire needed to be a part of the prescription. It was concluded that a combination of silviculture and prescribed fire offered the best flexibility for meeting the objectives. Understory thinning was used to initially reduce ladder fuels and tree densities and to facilitate safer prescribed burning. Grand fir and Douglas-fir <20 inches dbh (diameter at breast height), which developed following fire exclusion, were thinned mechanically while the ground was covered with snow to prevent soil impacts. Prescribed fires were then used to restore ecological processes such as nutrient cycling, soil chemistry, and herbaceous development, and to maintain species composition and structure.

Step 7: Prepare project plan. A comprehensive project plan that clearly documents all phases of the management process has several important functions. It promotes effective organization and communication, and provides managers and the public with an important mechanism to ensure that accountability and standards are met. The plan will also serve as an important baseline reference for future projects.

Step 8: Develop and implement an environmental education and interpretation strategy. The park considers interpretation and environmental education to be impor-

tant tools to complement resource management. The purpose is to provide the public with a better understanding of the biological resources and management objectives in the park. It should explain to the public how and why management practices are being used to implement park management objectives.

Step 9: Adhere to management prescriptions. Perhaps one of the most important management principles is to adhere to your prescriptions and to implement the project under appropriate conditions. A well-planned, scientifically based prescription is only as effective as the extent and quality of its implementation. Management activities implemented under the inappropriate conditions may not have the desired effects, and could possibly harm park resources. Adhering to documented prescriptions also bolsters the credibility of the park manager with the public. Restoration in Ponderosa began on schedule in December 1994 and closely followed the thinning and prescribed burning prescriptions (Figure 4).

Step 10: Initiate project monitoring and evaluation. Monitoring is necessary to determine whether management objectives have been achieved, and to refine management prescriptions for future projects. A series of permanent monitoring plots and transects encompassing a range of site conditions and treatments were established throughout the park in 1995. Key ecological variables are being measured and will be used to compare data on forest composition, structure, mortality, fuel dynamics, and insects and diseases. Preliminary post-treatment data from the Meadow Marsh study area indicate that key structural and compositional characteristics were restored to pre-European conditions (Figures 4 and 5). Post-fire monitoring data revealed that fuel loading was significantly reduced, mortality of large trees (>20 inches dbh) was less than 10%, understory tree density was reduced by 50%, and herbaceous cover increased by 50%.



Figure 4. Profile of forest restoration in the Meadow Marsh study area: a) pre-prescribed burning following mechanical understory thinning; b) ponderosa pine with open stand structure and reduced fuel load one year after burning; c) herbaceous understory response two years after burning.

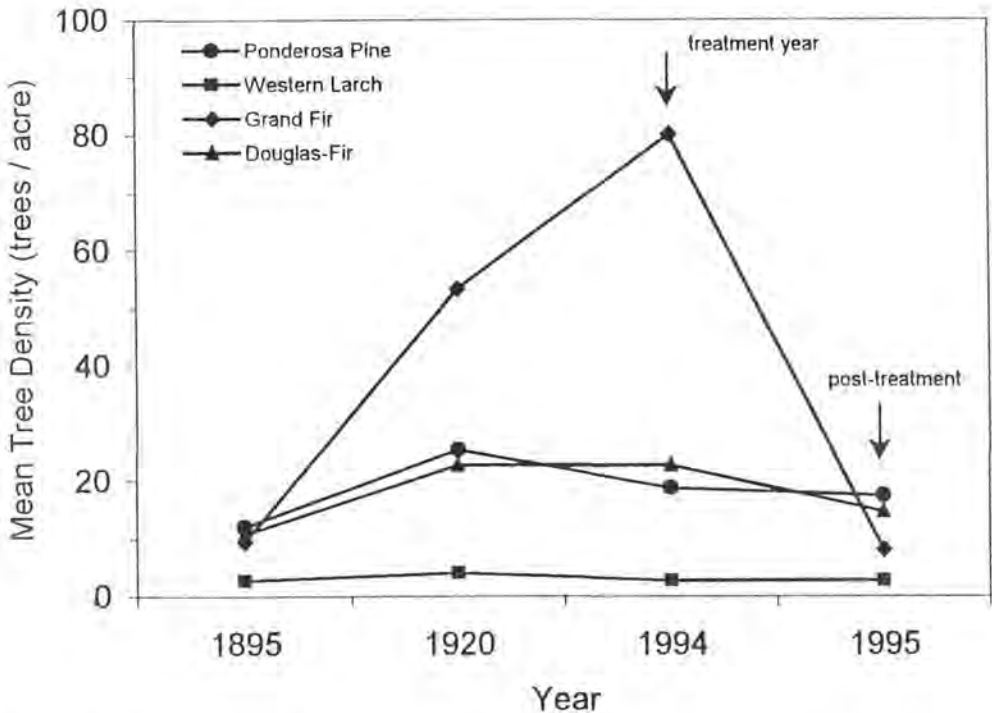


Figure 5. Comparison of tree density (trees per acre) by species in the Meadow Marsh study area at four different points in time: 1895 (settlement begins), 1920 (management begins), 1994 (pre-restoration), and 1995 (post-restoration). Note: tree density only reflects the number of trees per unit area, not their size distribution.

Conclusion

The process outlined in this paper provided a template for park managers to successfully implement forest restoration in Ponderosa State Park. Initial management activities in Meadow Marsh restored forest structure and composition to conditions that prevailed before fire suppression, making them more resistant and resilient to natural disturbances. Fuel loading and fire hazard were reduced, lowering the potential risk of wildfires to park visitors, park infrastructure, and the urban interface. Monitoring data validated the management prescriptions and provided useful data to refine techniques for future restoration. Park employees were able to successfully engage the public and enlist support for ecological restoration, and interpretation and education developed a sense of enthusiasm and ownership for park resources and management. A management framework has been established for the continued use of fire in the future. State park managers must continue their commitment to training personnel in the development and implementation of restoration to meet management challenges.

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Plant Community Re-Establishment in Former High-Elevation Campsites in Yosemite National Park

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Introduction

Yosemite National Park wilderness covers 2,756 sq km of the Sierra Nevada and averages 120,000 visitor use-nights per year. Managers are charged with protecting and restoring natural processes while still allowing acceptable levels of visitor use. This challenge presses management to constantly evaluate and monitor conditions of wilderness lake basins. The following descriptive and exploratory research examines the rates of plant community re-establishment at former campsites adjacent to Budd, Lower Cathedral, and Elizabeth lakes.

Background

Yosemite has over 100 subalpine lakes (ranging in elevation from 2,500 m to 3,200 m) carved out by glaciers and surrounded by coarse morainal soils. This study examines three subalpine lake basins which are in the Tuolumne River drainage at elevations between 2,800 m and 3,100 m. These lakes receive approximately 1.0 m of precipitation, most of which comes in the form of snow during the winter months.

Yosemite's wilderness impacts monitoring system documented that subalpine lake basins account for over half of Yosemite's 5,000 wilderness campsites (Sydóriak 1989). Campsites in lake basins close to the road generally receive the most use and consequently show the most loss of herbaceous vegetation. Budd and Elizabeth lakes were closed to camping in the late 1970s but still receive sporadic overnight use.

In the early 1980s, wilderness managers qualitatively noted that, even in closed areas, re-establishment of herbaceous vegetation was happening at an extremely slow rate. In 1987, NPS resource managers began attempting to revegetate former wilderness campsites at Budd, Elizabeth, and Lower Cathedral lakes.

In 1987, Barbara Moritsch established eight permanent study sites centered on former campsites at these lakes (Moritsch 1992). She evaluated treatments that could potentially expedite plant establishment on denuded and degraded former campsites. She found that transplanting did not change plant cover and only slightly increased species diversity. Soil scarification increased percent cover and species richness on some sites, but the evidence was statistically inconclusive due to a small sample size. Three species, *Calamagrotis breweri*, *Carex rossi*, and *Juncus parryi*, showed potential for transplanting and nursery propagation.

Vegetation disappearance in relationship to use levels has been well-documented (Liddle 1997; Cole and Fichtler 1983; Frissell 1973). Many previous wilderness studies have been one to three years in duration, but this is too short to evaluate plant re-establishment (Cole 1985). This study utilizes data sets collected from the same Moritsch sites in the summer of 1990 and again in the summer of 1998.

Objectives

The objectives of this study were twofold: explore the factors that contribute to plant re-establishment on high-elevation campsites at the lakes, and make recommendations for future monitoring programs.

Site Description

Soil compaction at these lakes is not a major impediment to plant establishment because the soils range from decomposed granites to sandy loams and the main mechanism of compaction is human feet. In normal snow years, the growing season lasts from mid-June until mid-September and there are 50 to 100 frost-free days (Elford 1970). In June and early July, moisture is supplied by the melting snow pack.

From mid-July through September, most available moisture comes from afternoon thundershowers. At similar sites in Kings Canyon National Park, potential evapotranspiration exceeded precipitation from June through September (Burke 1982).

From 1990 to 1998, the mean monthly precipitation totals at a Tuolumne weather station, 7 km away, were: July, 3.0 cm; August, 1.2 cm; September, 2.0 cm. These precipitation averages are very similar to the 30-year averages. During two summers, 1990 and 1998, 200% of the average summer precipitation fell, and during one summer, 1993, no precipitation fell. The summer precipitation from 1990 to 1998 was a normal sample of Sierra Nevada summer conditions.

Because most growth happens in July and August, and the eight-year average precipitation for those months was only 4.2 cm, plants could not produce large amounts of new vegetative matter. Micro-topography above a site, such as small drainages or impermeable granite slabs, may double the amount of moisture that some sites receive from a single thundershower.

Percent vegetative cover in 1990 averaged 5.1% and was composed entirely of native perennials. Most of the individual plants were from 1-5 cm high and occupied an area the size of a credit card. The average site had a 31-sq-m barren core that had less than 1% vegetative cover. Areas lacking vegetation were either covered with conifer litter or were simply bare mineral soil. *Carex rossi* and *Juncus parryi* were the most prevalent species. Eight other species had more than 1% cover on at least one site, and the total species richness for all eight sites was 25 species.

Methods

This study replicated Moritsch's (1993) data collection methods, but analyzed the data differently. Moritsch established eight permanent 10 m-by-10 m plots at former campsites. These plots were then divided into 100 quadrats, each 1 m square. The quadrats in each plot were grouped into three strata: barren core (BC), moderately trampled (MT), and peripheral control (PC). Barren core areas had little to no vegetation and no litter or duff. Moderately trampled areas had noticeably less vegetation and litter than surrounding areas. Peripheral control areas appeared to have experienced little reduction in vegetation, litter or duff. Stratification was necessary because mean values of percent cover for the whole campsite do not provide a realistic picture of the effects of concentrated use on vegetation (Stohlgren 1982). The plots were deliberately positioned to include barren core, moderately trampled, and peripheral control areas.

At each plot, approximately ten quadrats were sampled from each of the three strata. Each stratum was evaluated as one unit rather than as ten separate quadrats because the quadrats were not independent. Moritsch (1992) visually estimated the percent cover within each quadrat of: each species, bare mineral soil, and plant litter. Moritsch was present during sampling in 1990 and again in 1998 to ensure consistency of methods.

This study tested whether the percent cover in 1990, moisture, or use was correlated with increase in percent cover or increase in species richness from 1990 to 1998. To test for the influences of 1990 percent cover, regression was performed comparing it with change in percent cover and change in species diversity.

Moisture. To test for the influence of moisture, the eight sites were divided into three distinct moisture classes (defined as follows) and analyzed using one-way ANOVA to test for differences in change in percent cover:

- *Dry sites:* Flat knolls, 2+ m above lake level, that receive no runoff from adjacent areas.
- *Varied-moisture sites:* Sites on slopes with natural indentations that capture some up-slope runoff, or sites within 1 m of lake level.

- *Wet sites:* Sites onto which the natural topography funnels water. These sites receive at least twice as much growing-season water as do the flat sites.

Use levels. Although all studied sites have been officially closed to camping for 15+ years, six of the eight are still being influenced by human use. Budd and Elizabeth lakes each received between 10 and 30 over night parties and around 500 day-use visitors each summer during the 1990s. These numbers are inferred from ranger patrols, which occur approximately 15 times in a 100-day season. Ranger reports were used to outline three use levels defined below. Regression was performed comparing use levels with change in percent cover and change in species diversity.

- *Moderately used:* Sites where NPS rangers break up new fire rings several times each summer.
- *Seldom used:* Sites that often receive day use and may receive one or two parties of overnight use each summer.
- *Rarely used:* Sites which presently receive no use because they are too uneven, rocky or otherwise unattractive for camping or day use.

Results and Discussion

This study indicated that several factors are positively correlated with changes in percent cover. Percent cover in 1990 was an excellent indicator of change in percent cover from 1990-1998 ($r^2 = 0.95$; $p = 0.0001$) (Figure 1). Moisture, influenced by topography, was a strong indicator of change in percent cover ($r^2 = 0.87$; $p = 0.0007$). Wet sites had significantly greater increases in percent cover than either varied-moisture sites or dry sites. This was shown in a least significant difference (LSD) test and ANOVA ($p = 0.0007$; $f = 44.53$). Use levels were not correlated with change in percent cover ($r^2 = 0.15$; $p = 0.33$).

Sites with higher 1990 percent cover had more roots that could extract more nutrients and water from the soil. Using these resources, the existing plants both produced seed and spread vegetatively. Because of the minute stature of the plants, they did not compete with each other for light or nutrients.

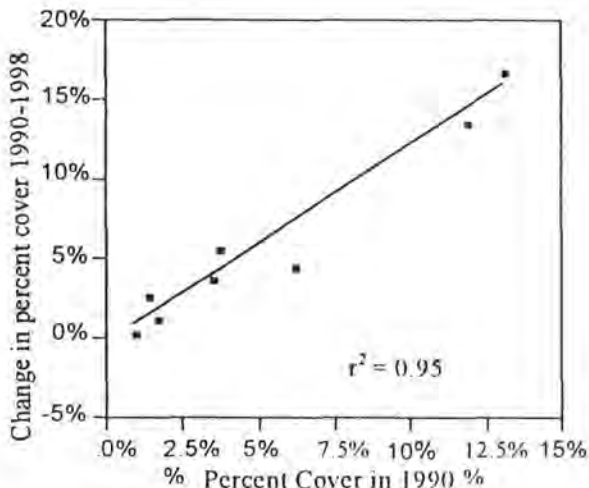


Figure 1. Change in percent cover from 1990-1998 vs. percent cover in 1990

Moisture, which is influenced by topography, was correlated to increases in percent cover. The perennial species that grow in the subalpine environment can survive extremely dry summers. However, new plant establishment and vegetative spread happen only at a certain minimum growing-season moisture threshold. Topography that funnels moisture to certain sites allows them to meet their moisture threshold for plant cover spread during more summers. Sites that are close to lake level may maintain moisture levels above the threshold even during years with few thundershowers.

Resource managers were surprised that use levels did not correlate to percent cover increase ($r^2 = 0.15$; $p = 0.33$). Although use levels are estimates, use of the study sites appeared to vary between 0 and 5 nights per year (NPS 1997). Resource managers know that use does retard plant establishment, but a stronger correlation may exist at higher use levels.

Species diversity on all sites increased from 24 to 33 species, and the mean single site increase was 2.5 species. Moisture is the strongest indicator of change in species diversity ($r^2 = 0.91$; $p = 0.0003$). Wet sites and varied-moisture sites gained significantly more species than dry sites. The ANOVA suggests that there were significant differences in the change in species diversity between the moisture classes ($f = 24.55$; $p = 0.0026$), and this was supported by the LSD test (Figure 2).

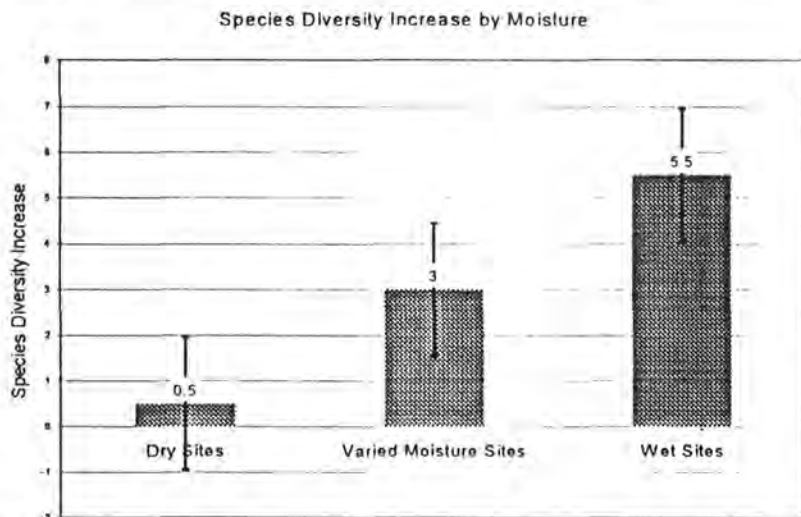


Figure 2. Number of new species by moisture class.

Species diversity increase was also correlated to 1990 percent cover ($r^2 = 0.81$; $p = 0.0023$). Species diversity increase was not correlated to use levels ($r^2 = 0.21$; $p = 0.26$).

Species diversity increase was correlated to moisture, which suggests that a wider variety of plants can survive on the wetter sites. Likewise, the sites with 1990 percent higher cover were more hospitable to new species establishment.

Variation between strata. On the two wet sites, the strata responded just as resource managers had expected. After a decade of reduced use, the percent cover levels on the BC and MT strata were approaching the PC levels. The drainages feeding into these sites imported a diverse seed bank and moisture and, as a result, growth is now vigorous on all strata.

On the dry sites and varied-moisture sites, plants are re-establishing but are still well below the natural levels. The PC strata grew the most, increasing their percent

cover by 2.82%. The BC strata grew the least, increasing their percent cover by only 1.38% (Figure 3).

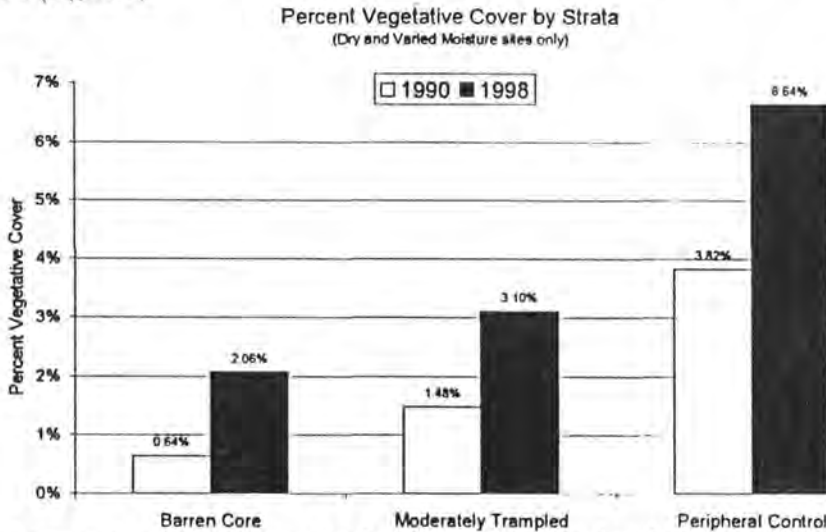


Figure 3. Actual growth on the three strata in dry and varied-moisture sites.

These trends are due to: sporadic use, which affects the barren core the most; seeding plants, which are more abundant in the PC; and a more diverse microtopography in the PC. Because the BC increased by only 1.38% in the last eight years, full recovery may be decades longer than in areas with higher initial percent cover.

Also of interest was the fact that increase in species richness was highly correlated with increase in percent cover ($r^2 = 0.84$; $p = 0.001$) (Figure 4). This has implications for both future research and management prescriptions.

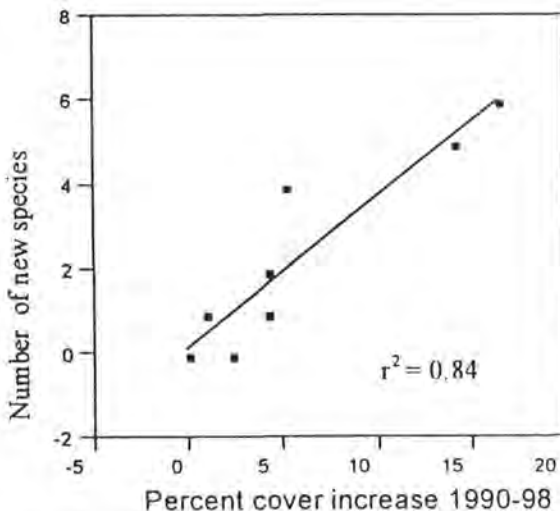


Figure 4. Species diversity increase by percent cover increase 1990-1998.

Management Implications for Future Research

- Measuring percent cover may be a more cost-effective way of monitoring plant community health than keying plants to species, since species diversity and percent cover were correlated in this study.
- A quantifiable measure of soil moisture would have allowed this study to more strongly state the role of moisture as a limiting factor.
- Overnight and day use of the monitored sites must be quantifiably measured on a regular basis so that acceptable use levels can be established.
- A larger sample size is desirable even if that means measuring fewer parameters.

Conclusions

This study examined rates of plant re-establishment in high-elevation campsites. It found that percent cover increase and species diversity increase were both highly correlated to 1990 percent cover and to moisture levels. Neither was closely correlated to use levels. On the dry and varied-moisture sites, the PC strata grew the most and the BC strata the least. While the wet sites approached full recovery in a decade, dry sites and varied-moisture sites recovered at a much slower rate. Plant re-establishment is correlated to existing percent cover. In severely denuded areas (less than 1% cover) plant re-establishment takes several times longer than it takes in moderately denuded areas. As park managers, we must be aware of all of these factors when deciding how to manage visitor use and monitor high-elevation areas.

Acknowledgments

The Yosemite Fund and the National Park Service financially supported this study. Barbara Moritsch played a crucial role initiating the plots and helped out in 1998. Sue Fritzsche provided encouragement, advice, and allowed us sufficient work time to complete this paper. Victoria Hartman, Paul Amstutz, and Robert Fiegenger helped with data collection and entry. Sue Beatty and Gram Roy proofread the manuscripts and kept us honest with the statistics.

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The National Park Service I&M Program: Current Status and New Initiatives

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In fiscal year 1991, the National Park Service (NPS) initiated a program designed to implement natural resource inventory and monitoring (I&M) throughout the agency. To accomplish this mission, the Servicewide program was structured around two major goals: 1) to ensure that all natural resource park units possess at least the basic complement of data sets needed to support managerial decision-making and resource protection, and 2) to acquire the knowledge and expertise NPS will need in the future to design and implement comprehensive, cost-effective monitoring programs at various spatial and temporal scales. This paper provides a summary of the current status of the NPS effort to accomplish these two programmatic goals as well as information about new initiatives that will be implemented over the next few years.

Level 1 Resource Inventories

The Servicewide program will complete a set of 12 basic (Level 1) natural resource data sets for each of the approximately 260 natural resource park units. The Level 1 data sets include a variety of biotic and abiotic ecosystem components as well as cartographic data sets needed to implement geographic information systems (GIS). The current status of each inventory is summarized as follows.

Bibliographic databases. A major focus of the Servicewide inventory effort is to maximize the utilization of existing information. For that reason, the first major inventory effort focused upon constructing bibliographic databases for each natural resource park. The databases include information on previous studies and investigations that have been completed in the park. Park bibliographies have been completed in a common format, using Procite software to ensure compatibility with other efforts underway within NPS. Bibliographies have now been completed for 256 parks and a national archival and maintenance facility is being established at the Columbia Cascades Support Office in Seattle.

Base cartographic data sets. A key feature of the Servicewide I&M program is to make inventory information accessible through park GIS. To facilitate that goal, the program has provided funding to acquire standard U.S. Geological Survey (USGS) base cartographic data sets for use in park GIS. Cartographic data sets being acquired through this effort include DEMs, DLGs, and DOQs. Thus far, data sets have been acquired for approximately 200 parks. Funding has been cost-shared with the USGS and the A-16 data acquisition process.

Water quality baseline. The I&M program entered into a cooperative effort with the NPS water resources division to produce baseline water quality assessment reports for each natural resource park unit. These reports summarize existing information stored in Environmental Protection Agency (EPA) national databases, principally STORET, and provide each park with water quality summary statistics, trend information, and insights into potential data deficiencies and situations needing management attention. To date, baseline water quality assessment reports have been completed for 145 parks. Assessment reports should be completed for all natural resource parks by the end of fiscal year 2000. In fiscal year 1998, the I&M program began funding additional field inventories to complete Level I data sets for parks having deficiencies.

Vegetation mapping. In 1994, NPS entered into a cooperative effort with the USGS Biological Resources Division (BRD) to complete a vegetation map for each natural resource park unit. The inventory is being conducted through a national contract awarded to a consortium of firms including the Environmental Systems Research Institute (ESRI) and The Nature Conservancy. Through this contact, NPS has developed standards and protocols for the classification system, field sampling meth-

odologies, and procedures to assess map accuracy. The classification system and mapping protocols were tested in several pilot park units. Production mapping has now been initiated or completed in more than 20 parks.

In addition to the vegetation mapping inventory contracted through ESRI, the I&M program also funds vegetation mapping efforts for Alaskan parks. This effort is being managed by NPS's Alaskan Field Office in Anchorage because vegetation mapping in Alaska is being conducted using satellite imagery, whereas the ESRI effort uses aerial photography technology. This is the fifth year of funding for the Alaskan effort, and the project is acquiring satellite imagery as well as conducting mapping in several parks.

Soils mapping. In 1995, NPS began cooperative efforts with the Natural Resources Conservation Service (NRCS) to initiate soils mapping in a number of units throughout the National Park System. Pecos National Historical Park in New Mexico served as a pilot project and helped investigators refine procedures for assessing park needs for soils information. To date, soils mapping projects have been initiated or completed in 32 park units. A soils scientist is being hired to initiate and manage soils mapping projects at the national level. The position will be shared with the NPS Geologic Resources Division in Denver. In addition, the soil scientist will also work with NRCS state soil scientists to digitize those park soils maps that were completed since 1980 but have not yet been digitized. Perhaps as many as 75-80 park soils maps fall into that category.

Geological mapping. In fiscal year 1998, the first phase of a pilot project ultimately intended to inventory the geologic resources of parks was conducted. The pilot project was carried out under the direction of a group of NPS, USGS, and state geologists and was designed to provide parks with four products: 1) a bibliography of geological literature and maps, 2) an evaluation of park geological resources and issues, 3) an assessment of geological map coverage and production of digital products, and 4) a geological assessment report. Ten Colorado parks were included in the pilot project. In fiscal year 1999, the pilot will be expanded to include parks in Utah and, perhaps, North Carolina.

Biological inventories. A goal of the I&M program is to document the occurrence of at least 90% of the species of vascular plants and vertebrates found in parks. The program began funding field inventories for avian and herpetological species in fiscal year 1998, since those species were given high priority by park resource managers. In fiscal year 1998, approximately \$1.4 million was spent on avian inventories in 20 parks and herpetological inventories in 13 parks. These inventories will continue each year until they have been completed in all natural resource parks.

Unfunded inventories. The Level I inventory also includes other resource categories which have not yet been funded, principally air quality-related values and basic climatic information (meteorology, precipitation, etc.). These inventories have not been initiated primarily because of funding limitations and the fact that they received lower priority rankings from park resource managers. However, inventories for these resources will be started as funding permits.

Prototype Monitoring Programs

The tremendous variability in park ecological conditions, sizes, and management capabilities represent significant problems for any attempt to implement ecological monitoring throughout NPS. To deal with this ecological and managerial diversity, the I&M program assigned each of the 260 natural resource park units to one of 10 major NPS biomes and then selected one park to represent a "prototype" or experimental monitoring program for that particular biome. Three programs were selected as "cluster" programs, i.e., a grouping of 4-6 small units, each lacking the staff and expertise needed to conduct a monitoring program on its own.

The prototype programs vary widely with respect to how the structure and function of the park ecosystems are monitored. In all instances, the programs are de-

signed to provide ecological information that will be useful in addressing questions beyond today's issues. Protocols and expertise developed by the prototype programs will be shared with sister parks occurring within similar ecological and managerial settings. Prototype programs also serve as training centers for natural resource management personnel throughout NPS. Seven prototype monitoring programs have been initiated:

Channel Islands National Park (Pacific Coast Biome). Channel Islands has served as a prototype monitoring program since 1992. The monitoring strategy at Channel Islands is based on the assumption that organisms integrate the effects of a vast array of ecological factors, including predation, competition, and other environmental factors that are expressed in changes in population abundance, distribution, and growth and mortality rates. A conceptual model of the park's ecosystems was used to identify 15 mutually exclusive system components for monitoring. Monitoring protocols being implemented at Channel Islands and the other prototype parks are listed in Table 1. The Channel Islands monitoring program is fully "operational," i.e., the monitoring activities and associated information management are being carried out by members of the park's natural resource management staff.

Channel Islands National Park <ul style="list-style-type: none"> • kelp forest • terrestrial vegetation • terrestrial invertebrates • terrestrial vertebrates • seabirds • land birds • weather • pinnipeds 	Shenandoah National Park <ul style="list-style-type: none"> • forest vegetation • rare plants • meadow vegetation • aquatic macroinvertebrates • stream fishes • amphibians • land birds • white-tailed deer • black bear 				
Great Smoky Mountains National Park <ul style="list-style-type: none"> • aquatic macroinvertebrates • brook trout • stream fishes • rare plants • white-tailed deer • black bear 	Denali National Park & Preserve <ul style="list-style-type: none"> • weather • glaciers • hydrology • terrestrial vegetation • small mammals • large ungulates 				
Prairie Cluster <ul style="list-style-type: none"> • prairie vegetation communities • invasive plants • rare plants • aquatic macroinvertebrates • butterflies • grassland birds • black-tailed prairie dogs • adjacent land use 	Caribbean Park Cluster <ul style="list-style-type: none"> • coral reefs • reef fishes • marine water quality • sea turtles 				
<table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td> Cape Cod National Seashore <ul style="list-style-type: none"> • shoreline change • contaminants • pond water quality • hydrology • estuarine nutrients </td> <td> <ul style="list-style-type: none"> • meteorology • terrestrial vegetation • aquatic invertebrates • freshwater fishes • amphibians </td> <td> <ul style="list-style-type: none"> • waterbirds • land birds • white-tailed deer </td> </tr> </tbody> </table>			Cape Cod National Seashore <ul style="list-style-type: none"> • shoreline change • contaminants • pond water quality • hydrology • estuarine nutrients 	<ul style="list-style-type: none"> • meteorology • terrestrial vegetation • aquatic invertebrates • freshwater fishes • amphibians 	<ul style="list-style-type: none"> • waterbirds • land birds • white-tailed deer
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Table 1. Examples of protocols being developed by prototype monitoring programs (listings may not be inclusive in all cases).

Shenandoah National Park (Deciduous Forest Biome). The prototype monitoring program at Shenandoah focuses on four major components: ecosystem dynamics, population dynamics, watershed process monitoring and modeling, and landscape change monitoring. The park's monitoring began in the mid-1980s when managers needed to have a better understanding of how invasions by the alien gypsy moth were affecting the park's forest communities. Since that time, the program has been expanded to include a number of other ecological parameters. Shenandoah's monitoring program is fully operational.

Great Smoky Mountains National Park (Deciduous Forest Biome). Great Smoky Mountains also entered the prototype monitoring program in 1992. Long-term monitoring in very large parks presents a special problem related to spatial scale. The monitoring program at the Great Smoky Mountains attempts to deal with these difficulties by structuring the program around a hierarchy of five spatial scales: landscape, ecosystems, watersheds, communities, and individual species. Within these spatial levels, 13 key ecosystem processes, as well as components identified in the park's resource management plan, are being monitored. (Table 1). The monitoring program at Great Smoky Mountains is fully operational.

Denali National Park (Arctic-Subarctic Biome). Denali National Park and Preserve was selected as a prototype monitoring program in 1992 to evaluate a watershed approach to monitoring in large Alaskan parks. For purposes of monitoring, the park has been divided into five major watersheds which represent the major terrestrial habitats, aquatic systems, and climatic regimes within the park. Ecosystems based upon prevalent vegetation, from lowest to highest elevation, have been identified for study within each watershed. Protocol development is still in the research and development phase. Thus, most of the funding and support is currently provided by the BRD under a cooperative arrangement.

Great Plains Cluster (Prairies-Grasslands Biome). The first of three "cluster" prototype monitoring programs was initiated in 1994, and is structured around six small prairie park units in the midwestern USA. Wilson's Creek National Battlefield in southwestern Missouri serves as the lead park for the cluster. Monitoring protocols relate to three high-priority management issues: (1) to what extent are small remnant and restored prairie ecosystems sustainable through restoration and management? (2) what are the external land-use and watershed impacts on small prairie preserves? and (3) what are the impacts of fragmentation on the biological diversity of small prairie parks? The monitoring program is still in the initial protocol design and development phase and thus funded and staffed primarily by BRD. The program is expected to become fully operational in fiscal year 2001.

Caribbean-South Florida Cluster (Tropical-Subtropical Biome). A second cluster monitoring program, initiated in 1996, focuses on a group of three park units in the Caribbean and south Florida. Virgin Islands National Park serves as the lead park. The program, currently funded and staffed primarily by BRD, expands upon existing and prior monitoring efforts in the parks to integrate all monitoring activities into a systematic, comprehensive program. The major focus is on monitoring coral reefs, marine fish communities, terrestrial forests, exotic species, and vertebrate populations.

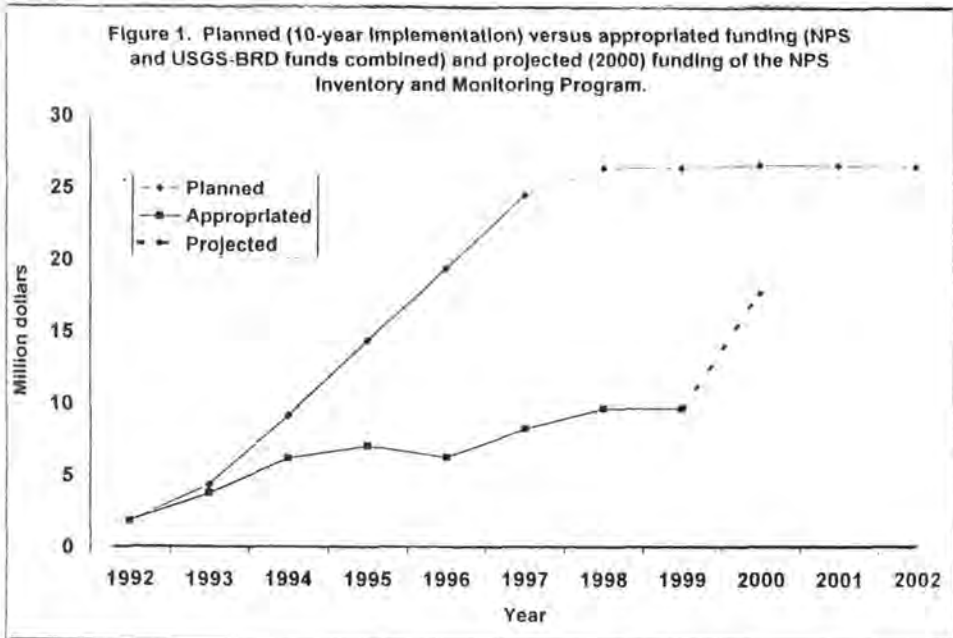
Cape Cod National Seashore (Atlantic-Gulf Coast Biome). The monitoring program at Cape Cod also started in 1996. The program, funded and staffed principally by BRD, focuses on five major coastal ecosystem components: (1) shoreline margins; (2) barrier islands, spits, and dunes; (3) estuaries; (4) kettle ponds and freshwater habitats; and (5) maritime forests. Monitoring protocols associated with each ecosystem component address management questions specifically related to Cape Cod and other coastal parks.

Unfunded prototype monitoring programs. Four other monitoring programs—Olympic, North Cascades, and Mammoth Cave national parks and the Northern Colorado Plateau Cluster—have been selected for participation in the pro-

prototype monitoring network. Those programs will be implemented as funding becomes available. The implementation sequence will be based upon a joint decision by BRD and NPS.

New Initiatives

Program funding. Total funding for the Servicewide I&M program in fiscal year 1999 is approximately \$9.8 million. This includes \$5.8 million administered by the Washington Office, \$2.1 million of which has been permanently transferred to base accounts of prototype programs to support operational monitoring, and \$2.0 million being provided by BRD for vegetation mapping, research and development at prototype monitoring programs, and development of protocols for threatened and endangered species. While significant, this level of funding is substantially less than what was envisioned when the I&M Program was initiated in fiscal year 1991 (Figure 1).



Because funding is less than planned, implementation of the program has been much slower than anticipated. For example, under planned funding levels, projections were that Level I inventories for all natural resource parks, plus implementation of the 11 prototype monitoring programs, could have been accomplished in a period of 10 years. However, under current funding levels, 15-18 years may be needed to complete the Level I inventories, *assuming no additional prototype monitoring parks are funded*. With funding available from BRD, approximately 30 years will be needed to map vegetation in all natural resource parks.

Funding for the I&M program will likely increase if the NPS director's natural resource initiative is supported by Congress. For example, the president's budget for fiscal year 2000, the first year of the natural resource initiative, includes an \$8 million increase for the I&M Program. If received, approximately \$5.5 million of that increase would be devoted to accelerating inventories of vascular plants and vertebrates in parks. These inventories would be funded and administered through regions, taking advantage of opportunities to expand partnerships with local universities and other Federal agencies. Additional portions of the increase would be used to fund the four prototype monitoring programs currently in the research and development phase, support one new position in each region to coordinate biological inventories, and to accelerate abiotic inventories.

Information management. In addition to assisting parks in the acquisition of basic resource information, another important objective of the I&M program is to provide leadership in the development of tools and methods parks can use to manage the information in a professional manner. Previously, the program had developed a series of protocols parks can use to formulate data management plans, catalogue data sets, and manage data. More recent efforts are focused on the development of standardized databases and systems.

Alternative systems for managing species and related information are being evaluated. One prototype system, called NPSPECIES, has been developed. NPSPECIES is structured similarly to the NPFLORA database developed for NPS by the University of California-Davis several years ago, but offers advantages over NPFLORA. A system for managing species information developed in British Columbia is also being investigated.

In addition, the I&M program is also investigating ways to standardize data formats and directory structure for spatial data layers. The GIS "data browser," developed by the Alaska Region, and the AQUIMS decision support system, developed by NPS's air resources division, are two of the systems being evaluated.

Monitoring Natural Resources in National Parks: Determining What and How to Monitor

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Knowing the condition of natural resources in national parks is fundamental to the National Park Service's (NPS's) ability to protect and manage parks. National park managers across the country are confronted with increasingly complex and challenging issues, and managers are increasingly being asked to provide scientifically credible data to defend management actions. Many of the threats to park resources, such as invasive species and air and water pollution, come from outside its boundaries, requiring an ecosystem approach to understand and manage the park's natural resources. A long-term ecosystem monitoring program is necessary to enable managers to make better-informed management decisions, to provide an early warning of abnormal conditions in time to develop effective mitigation measures, to convince other agencies and individuals to make decisions benefiting parks, to satisfy certain legal mandates, and to provide reference data for relatively pristine sites for comparison with data collected outside of parks by other agencies. The overall purpose of monitoring is to develop broadly based, scientifically sound information on the current status and long-term trends in the composition, structure, and function of the park ecosystem, and to determine how well current management practices are sustaining park resources. Use of monitoring information will increase confidence in decisions and improve the ability to manage park resources.

NPS policy and recent legislation (Title II of the National Parks Omnibus Management Act of 1998) requires that park managers know the condition of natural resources under their stewardship and monitor long-term trends in those resources in order to fulfill the NPS mission of conserving parks unimpaired. In Title II, Congress directed the secretary of the interior to "undertake a program of inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources. The monitoring program shall be developed in cooperation with other Federal monitoring and information collection efforts to ensure a cost-effective approach." Parks without a long-term monitoring program are now beginning to design sampling schemes to address park issues. It is well-recognized that it is not possible, nor desirable, to monitor all aspects of a park's natural resources. One of the key challenges in designing a monitoring program is "to select for measurement those attributes whose values (or trends) best reflect the status and dynamics of the larger system" (Noon et al. 1998). The monitoring program should address not only today's resource problems, but also the need for information to anticipate and define future resource problems. What are some of the things a park should consider during the difficult process of selecting specific indicators and protocols to be included in their monitoring program?

To be effective, a monitoring program must: (1) be relevant to current management issues as well as anticipate future issues based on current and potential threats to park resources; (2) be scientifically credible; (3) produce data of known quality that is accessible to managers and researchers and provided in a timely manner; and (4) have an explicit link to management decision-making. There is no cookbook approach for designing a long-term monitoring program in all parks, but guidelines for developing a park monitoring program can be found in NPS-75 guidelines (NPS 1995), Silsbee and Peterson (1991), Peterson et al. (1995), Davis (1993, 1997), and Noon et al. (1998). Other publications that may be useful in planning a park monitoring program are Elzinga et al. (1998), Goldsmith (1991), and Thompson et al. (1998). Each of these documents stresses the importance of setting specific goals and objectives for the monitoring program, and developing a conceptual model that de-

scribes the important components of the ecosystem and the interactions among them. Once the program's goals and objectives have been set, and a conceptual model developed, the next steps are to select indicators and protocols for measuring specific components.

Indicators: What to Monitor

Noon et al. (1998) clarified some of the terminology used in environmental monitoring as they defined the term "indicator": "An attribute is simply some aspect of the environment which is measurable. When an attribute is measured it takes on a (usually) numeric value. Since the exact value of an attribute is seldom known with certainty, and may change through time, it is properly considered a variable. If the value of this attribute is indicative of environmental conditions that extend beyond its own measurement, it can be considered an indicator. Not all indicators are equally informative—one of the key challenges to a monitoring program is to select for measurement those attributes whose values (or trends) best reflect the status and dynamics of the larger system." Indicator selection is not a trivial matter. The Environmental Protection Agency (EPA), U.S. Forest Service (USFS), and other agencies have spent tens of millions of dollars developing and testing various indicators for monitoring ecosystems, and still there is little consensus on which indicators are best or how best to quantify them.

In their review of EPA's Environmental Monitoring and Assessment Program (EMAP), the National Research Council (NRC 1995) discussed the relative merits of retrospective monitoring (EMAP's basic monitoring approach) versus predictive or stressor-oriented monitoring. Retrospective, or effects-oriented, monitoring seeks to find effects by detecting changes in the status or condition of some organism, population, or community. This includes most of the monitoring in national parks, such as measuring changes in foliage condition of trees, size or trends in animal populations, or diversity of aquatic macroinvertebrates in streams, and it takes advantage of the fact that biological indicators integrate conditions over time. In contrast, predictive, or stressor-oriented, monitoring seeks to detect the cause of an undesirable effect (a stressor) before the effect occurs or becomes serious. Stressor-oriented monitoring will increase the probability of detecting meaningful ecological changes, but it is necessary to know the cause-effect relationship so that if the cause can be detected early, the effect can be predicted before it occurs. Examples of predictive monitoring include monitoring animal tissues for presence of carcinogens, and using a canary to monitor toxic gas levels in a mine. Predictive monitoring is not commonly used in national parks because our knowledge of ecosystem processes is still poor and cause-effect relationships have often not been established. The National Research Council concluded that in cases where the cost of failing to detect an effect early is high, predictive monitoring and modeling are preferred over retrospective monitoring. They concluded that traditional retrospective monitoring was inappropriate for environmental threats such as acid precipitation, exotic species effects, ozone depletion, and biological extinctions, because of the large time lag required for mitigation, and recommended that EPA investigate new indicators for monitoring these threats.

Many criteria have been recommended for selecting indicators to monitor park resources, and these are mentioned in the documents listed above. Another good set of indicator-selection criteria came out of an April 1998 workshop for Lake Mead National Recreation Area. Twelve desirable characteristics of indicators are that they (1) have dynamics that parallel those of the ecosystem or component of interest; (2) are sensitive enough to provide an early warning of change; (3) have low natural variability; (4) provide continuous assessment over a wide range of stress; (5) have dynamics that are easily attributed to either natural cycles or anthropogenic stressors; (6) are distributed over a wide geographical area or are very numerous; (7) cover those species which are either harvested, endemic, alien, or otherwise of special interest, or have protected status; (8) can be accurately and precisely estimated; (9)

have costs of measurement that are not prohibitive; (10) have monitoring results that can be interpreted and explained; (11) are low-impact to measure; and (12) have measurable results that are repeatable with different personnel.

Protocols: How to Monitor

Any successful long-term monitoring program must survive turnovers in personnel (as people change jobs or retire) and technology. In almost all cases, measurements over time will be taken by different people. Therefore, sampling protocols (1) must be fully documented, with enough detail that different people can take measurements in exactly the same way; (2) must include quality control and quality assurance measures, so that it can be demonstrated that any changes are actually occurring in nature, and not simply a result of measurements being taken by different people or in slightly different ways; and (3) should not rely on the latest instrumentation or technology that may change in a few years, such that measurements cannot be repeated. Protocol development requires a research effort. Sampling protocols must be field-tested, and experiments must be conducted to determine when and how often a site should be sampled. It has been estimated that the federal government spends \$640 million per year to monitor the environment. The EPA, USFS, and Natural Resource Conservation Service (NRCS) alone have spent tens of millions of dollars developing and testing indicators and sampling protocols. NPS, whenever possible, should take advantage of these efforts by other agencies by using well-tested, standardized sampling protocols developed by other agencies if they meet park objectives. If other agencies are using well-established protocols to sample certain components outside of park boundaries, it makes not only fiscal and political sense to use them (or at least adapt them to specific park needs), but also allows the park to put its monitoring data in context by making comparisons with areas outside the park. Many biological data sets require 10 years or more of data before trends can be clearly established. Use of standardized protocols that are in use by others outside the park adds a spatial dimension to the monitoring program that may allow the park to see problems much earlier, and therefore to act much sooner than if only the temporal component is available.

Information on various sampling protocols being used or developed by the prototype monitoring parks of the NPS national inventory and monitoring program are available through a protocol database at <http://aqsun.aqd.nps.gov:82/sfancy>. Parks should also be aware of several well-established and tested protocols developed by the EPA, USFS, and U.S. Geological Survey (USGS). For example, EPA's EMAP surface waters group has funded development of a set of standardized protocols for sampling various components of lakes, including water quality parameters, fish, benthic invertebrates, and waterbirds. These protocols can be downloaded from EPA's Web site at <http://www.epa.gov/emap/html/publs/docs/surfwatr/97fldman.htm>. The USGS national water quality assessment (NAWQA) program has developed widely used protocols for monitoring stream fish, benthic invertebrates, and stream habitat; these are available through their Web site at http://www.rvares.er.usgs.gov/nawqa/protocols/doc_list.html.

The Forest Health Monitoring (FHM) program has developed indicators and protocols for monitoring forest ecosystems that are very pertinent to many park issues. FHM protocols are used by most of the major federal land management agencies, including BLM, NRCS, U.S. Fish and Wildlife Service, and the Department of Defense, as well as most state forestry agencies and 19 universities. The mission of FHM is to "develop and implement a cooperative multi-agency program to monitor, assess, and report on the status, changes, and trends in forest ecosystem health and sustainability in the United States." FHM uses an ecosystem approach to monitor and report on a broad set of ecological indicators as described below. Recent changes to the FHM protocols to sample understory diversity, exotic plant species, down woody debris, and fuel loading may be particularly interesting to parks. To

meet national and regional monitoring needs, FHM plots are systematically placed about 17 miles apart in forested areas. However, any number of plots could be placed randomly or systematically in a national park to meet specific monitoring needs, and several agencies around the country have intensified the FHM grid to meet local needs.

The FHM program has selected the following indicators to monitor forest ecosystem condition:

- *Crown condition*: crown diameter, live crown ratio, crown density, crown dieback, foliage transparency, crown vigor.
- *Tree damage*: presence of decay, disease, breakage, discoloration.
- *Tree growth*: dbh (diameter at breast height) of saplings and trees.
- *Tree mortality*: dbh of trees that have died since last plot visit.
- *Tree regeneration*: seedling and sapling counts by species.
- *Ozone damage*: percentage of damaged foliage on indicator plant species.
- *Lichens*: abundance as bioindicator of changes in air quality, climate, and forest structure.
- *Soils*: soil erosion, soil nutrients (carbon storage, N, P, Ca, Mg, K).
- *Vegetation diversity and structure*: nested plots; number and density by species, height; percent ground cover; presence and density of exotic species.
- *Down woody debris*: number and volume of dead tree parts.
- *Fuel loading*: percent cover and depth of grass, shrubs, slash and litter for fuel models.

Additional information on the FHM program, as well as other relevant programs and protocols in the USA and Canada, are available on the Web at <http://aqsun.aqd.nps.gov:82/sfancy>.

Conclusion

There is no cookbook approach for designing a long-term monitoring program that will work for all parks. However, all parks have the common problem of specifying the goals and objectives of monitoring, developing a conceptual model of the various ecosystem components and their interactions, selecting a manageable set of ecological indicators from the huge list of potential ones, and determining the specific sampling protocols that will be used to determine trends in those indicators. Park monitoring programs must be relevant to current and potential management issues, must be scientifically credible, and must have an explicit link to management decision-making if they are to be effective. Wherever possible, parks should adopt indicators and sampling protocols that are consistent with those used by other agencies on adjacent lands; this adds a spatial component to the park's data, which often makes it easier to interpret results and to identify problems or trends earlier.

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Using Analytical Tools for Decision-Making and Program Planning in Natural Resources: Breaking the Fear Barrier

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Planning and Program Development: Stuck on Hold?

Natural resource management has become increasingly complex during the past two decades due to the multiplicity of management objectives that must be considered to address public interest, legislative requirements, and environmental compliance. "Ecosystem management" is the paradigm most commonly cited as the appropriate template for resource management by public agencies. Indeed, this single concept has provided a vehicle for a transition from predominantly commodity-dominated and output-based management on federal lands. The critical tenet of ecosystem management—and the one that drives its inherent complexity—is the need to address social, economic, and biological interactions at *multiple* spatial and temporal scales.

Although increased complexity of decision-making in natural resources is common knowledge, the basic decision-making *process* of most agencies has changed little. The most common approach is sometimes termed BOGSAT (Bunch of Guys [and Gals] Sitting Around a Table), which refers to a relatively unstructured discussion of objectives and priorities, normally without much quantitative documentation or tracking of how decisions are derived. Although the National Park Service, U.S. Forest Service, and other agencies use formal and often structured frameworks (including standard software) for project statements and management alternatives, actual decisions are typically made without quantitative input or analysis. This is generally true even when there are hundreds of individual projects and alternatives being considered simultaneously, a situation that is not atypical for a national park or national forest.

Some group-interaction techniques (e.g., nominal group technique, Delphi process) have been used to assist decision-making and assessments in natural resource agencies, although these techniques are typically focused on components of a larger issue. Formal decision support systems (DSSs) are more recent developments, and despite the fact that a number of them are designed specifically to aid resource managers, very few of these systems are routinely used. Resistance to using a DSSs in a group setting is likely due to: (1) fear of losing individual input or control; (2) an aversion to, or inadequate understanding of, computer-oriented techniques; and (3) lack of interest or training in group dynamics. Unfortunately, failure to use a consistent and formal process leaves the decision-making group open to criticism (and litigation) for lack of objectivity and quantification. Long-term strategic planning for resource management, inventory and monitoring (I&M), and project implementation (tactical planning) is more important today than ever before. An analytical decision-making framework is needed to quantify and document decisions, thereby improving the credibility of agencies in the public eye.

An Analytical Framework for Making Decisions and Setting Priorities

The analytic hierarchy process (AHP) (Saaty 1980; Saaty 1990) is a decision-making framework that uses a hierarchical structure to decompose a problem, paired comparisons to quantify value judgments (items at each hierarchy level are ranked with respect to importance or preference or likelihood), and matrix multiplication to convert level-specific, local priorities into global decision priorities (aggregation). This technique has been applied to a wide variety of decision problems, including resource management and monitoring plans in national parks (Peterson et al. 1994;

Schmoldt et al. 1994). A number of other forestry and natural resource applications of AHP have been reported, including a framework for participatory decision-making (Schmoldt et al. 1995). The AHP can also be used in group settings by obtaining group agreement on paired comparisons (e.g., Peterson et al. 1994) or by geometric averaging of judgments (Saaty 1980; Schmoldt and Peterson 1999; Schmoldt et al. 1999).

Ratio-scale ranking of list items is a key feature of the AHP. Normalized, principal right eigenvectors are used to estimate priorities from ratio-scale judgments. Matrix multiplication integrates values derived at different hierarchy levels (e.g., criteria and objectives) to obtain a prioritized list of decision alternatives (see Schmoldt et al. 1994 for details). Because individual judgments are made in a pairwise fashion and collective judgments can be mutually inconsistent, the AHP also permits inconsistency estimation.

This approach can be easily extended to decision-making in resource management, and is helpful for both long-term (strategic) and implementation (tactical) planning levels. For example, the AHP has been used to develop priorities for I&M activities as a component of the resource management plan at Olympic National Park. (Peterson et al. 1994) (Table 1). In this case, a diverse group of park managers provided input to pairwise comparisons of eight park I&M activities, resulting in both an ordinal list of priorities and a numerical ranking of their relative priority for different management emphases. In addition, the AHP was integrated with a simple, linear optimization model that allocated funds and personnel based on project priorities, funding, and personnel availability.

I&M project	Objective importance assigned by park staff		All objectives ranked equally		Management decision-making has highest priority	
	Priority	Ranking	Priority	Ranking	Priority	Ranking
Air quality	0.137	5	0.130	6	0.099	7
Anadromous fish	0.128	6	0.143	4	0.145	3
Avalanche monitoring	0.069	8	0.057	8	0.111	6
Elwha River	0.148	1	0.163	1	0.168	2
IPM program	0.095	7	0.077	7	0.042	8
Mountain goat impacts	0.141	3	0.135	5	0.197	1
Sensitive wildlife	0.143	2	0.149	2	0.134	4
Water quality	0.140	4	0.146	3	0.122	5

Table 1. Priority ratings and rankings for I&M projects at Olympic National Park under different management objective priorities (from Peterson et al. 1994).

The mathematical components and calculations of the AHP can be challenging for resource managers as well as scientists. However, several commercial software implementations of the AHP shield the user from those details, so that a technical *understanding* of the computational aspects is not necessarily required for effective *application*. Our experience with using the AHP in group settings (e.g., Schmoldt and Peterson 1999) is that acceptance of the AHP approach quickly follows initial hesitancy and a brief learning period. Implementing AHP decision-making interactively in a group setting, for example by projecting a computer display that shows decisions and scores instantly, helps to engage participants and facilitate rapid decisions. Most par-

ticipants find that this rapid feedback improves their understanding of the decision-making process and speeds up the process by keeping discussions focused. Some participants even remark that applying AHP interactively in a group setting is fun.

During the past decade, there has been a proliferation of workshops associated with planning and decision-making in federal agencies. However, the personal experiences of many workshop participants are that such meetings are often unfocused and unproductive, wasting both time and money, and producing relatively sterile results. Although the AHP has most often been applied in small-group settings, it is also effective in facilitating the conduct of workshops that include decision-making as a component of their objectives (Schmoltdt et al. 1999).

Developing an Inventory and Monitoring Program: A Dynamic Workshop

Focused workshops are an effective means for eliciting information as a basis for strategic planning. This is particularly true for national parks and national forests that need to develop or update I&M programs. No individual park or forest can be expected to have the necessary expertise to develop a comprehensive plan (e.g., Peterson et al. 1995). Therefore, an expanded group of experts is generally needed to collaborate on identification of critical concepts, methodologies, and implementation priorities.

Workshops will succeed only if (1) the workshop host has clearly stated the objectives (Silsbee and Peterson 1991, 1993), (2) the workshop process is highly structured, and (3) there are specific products resulting from the workshop. It is normally helpful to present workshop participants with a "straw man" structure as a framework for discussion and potential revisions. In the case of an I&M program, the straw man can be a summary of key scientific and managerial questions and responses, sample project statements, or a programmatic plan developed by someone else. The straw man may eventually be completely revised in the course of the workshop, but its presence is extremely helpful in reducing unfocused discussion. In addition, smaller work groups designated prior to the workshop can convene separately to address specific issues, typically according to general resource categories (e.g., aquatic biota, and cultural resources). Any introductory information and plenary sessions should be relatively brief and directly relevant to the objectives of the workshop.

The principal tasks within each work group should be as follows.

Brainstorm the key issues. Key issues typically include specific taxa or processes to be monitored. These issues can be taken directly from the workshop straw man, modified from the straw man, or developed as new concepts. Key issues should be simple and concise, and participants should avoid combining multiple or related ideas within the same item. The intent of brainstorming is to generate lots of ideas quickly with relatively little discussion. Because this process involves idea generation rather than judgment, work group participants should be able to reach consensus about the most important subset of key issues without formal procedures. While we suggest brainstorming for idea generation, there are other methods, e.g. the nominal group technique (Van de Ven and Delbecq 1971), that can also be used to generate a list.

Discuss the key issues. Each key issue should be further refined to develop a clear and unambiguous statement of the issue and a thorough explanation of its rationale. It is helpful to record these discussion points on a standard I&M component template which contains (1) critical I&M and scientific issues relevant to the I&M component, (2) stressors and related factors, (3) specific taxa or processes to be measured, (4) location of I&M activities, and (5) justification and other information critical to successfully implementing the component. Information from the component template can be transferred directly to project statements within the I&M program plan or other document.

Rank the key issues. The AHP is used to prioritize and rank the individual key issues within the list generated by each work group. As described above, this is con-

ducted by all work group members (who make pairwise comparisons of the issues), with final scores calculated for the entire group. Individual rankings should generally be compiled privately by each person to avoid the possibility of biases. It is recommended that rankings be developed for both importance and feasibility (or practicality), because these different criteria may have very different implications for program development. By having AHP software available at the workshop, all the raw data for pairwise comparisons can be entered, and final rankings quickly calculated and reported to workshop participants.

An example of the brainstorm-discuss-rank process is shown in Figure 1 for monitoring aquatic biota. There is no "right" or "wrong" in this process, only the expert judgment of work group participants. Straightforward "step-down" charts (Figure 2) provide an effective visual summary of workshop output and the framework for an I&M program within a resource category. The AHP can then be used to collectively analyze work group outputs in developing global priorities for the overall I&M program.

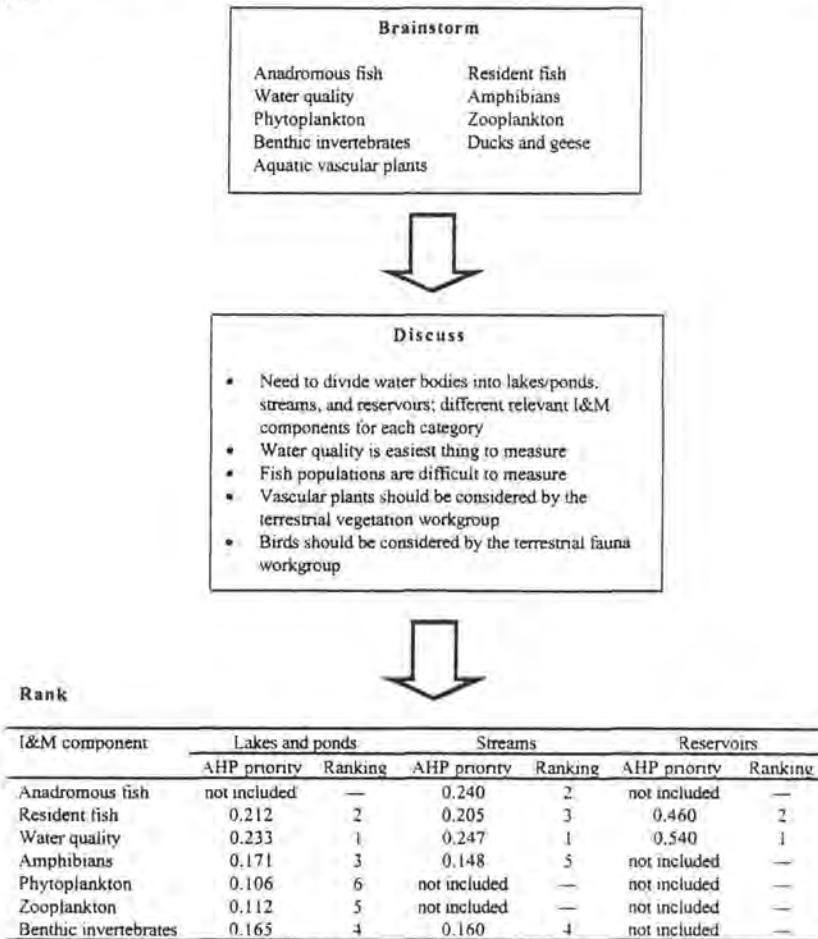


Figure 1. An example of the brainstorm-discuss-rank process for monitoring aquatic biota. This type of information is typically recorded on a flip chart or laptop computers during the workshop. Adapted from workshop output for the North Cascades National Park Service Complex.

Resource categories can be compared at the next highest level in the I&M hierarchy, as shown in the right-most portion of Figure 3. This allows disparate resource categories such as aquatic resources, atmospheric resources, and vegetation to be compared objectively and quantitatively. At an even higher level, monitoring objectives are considered (Figure 3). Priority weights assigned to the two types of monitoring objectives (management and scientific understanding) are distributed to specific objectives. In turn, those weights are further distributed among the resource categories. Pairwise comparisons are made between elements within each level that are connected to a common element in the level above. This may seem like a cumbersome task, however, we have found that it can be accomplished quickly and efficiently by natural resource staff members who are familiar with the operation of the AHP (Peterson et al. 1994). These global rankings can be performed after the completion of the formal workshop.

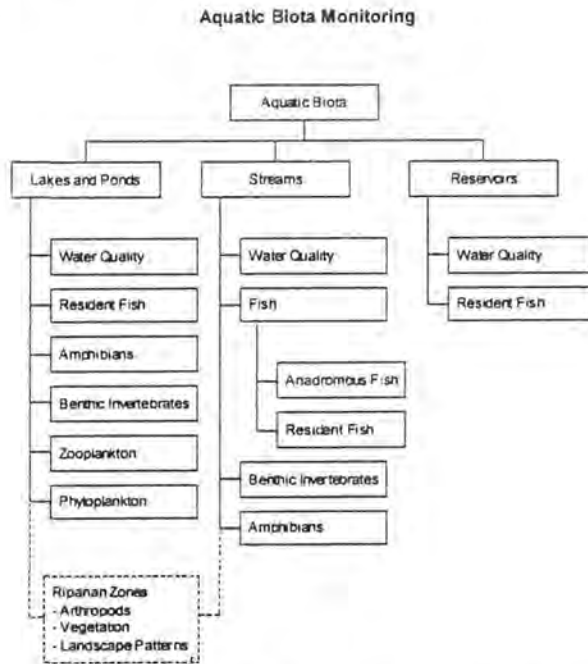


Figure 2. A conceptual framework for monitoring aquatic biota, based on information in Figure 1. Adapted from workshop output for the North Cascades National Park Service Complex. The dashed-line box at the bottom identifies possible linkages to other I&M issues.

While there are many ingredients to a successful workshop, these are the most critical:

- Clearly describe workshop objectives and distribute them and other relevant materials to participants *before* the workshop.
- Limit attendance to no more than 50 people for effective group dynamics; a maximum of six people per work group will greatly facilitate decision-making. A combination of scientists and resource managers works best, and substantial participation by personnel from the host agency ensures local ownership of work-

shop output. Resource managers generally are more amenable to using AHP and less argumentative than scientists.

- Allow movement of individuals between work groups to allow for sharing of expertise and developing linkages between related topics.
- Develop a clearly defined product from the workshop output (Davis 1989, Schmoldt and Peterson 1999). This product will typically be an I&M plan that is collated and edited by the host agency. A draft plan should be developed by resource management staff and be made available for review by workshop participants (posting the plan on a Web site is highly effective). Post-meeting follow-up will ensure that attendees know that something tangible resulted from their hard work, and they will be more likely to participate in future, similar efforts.

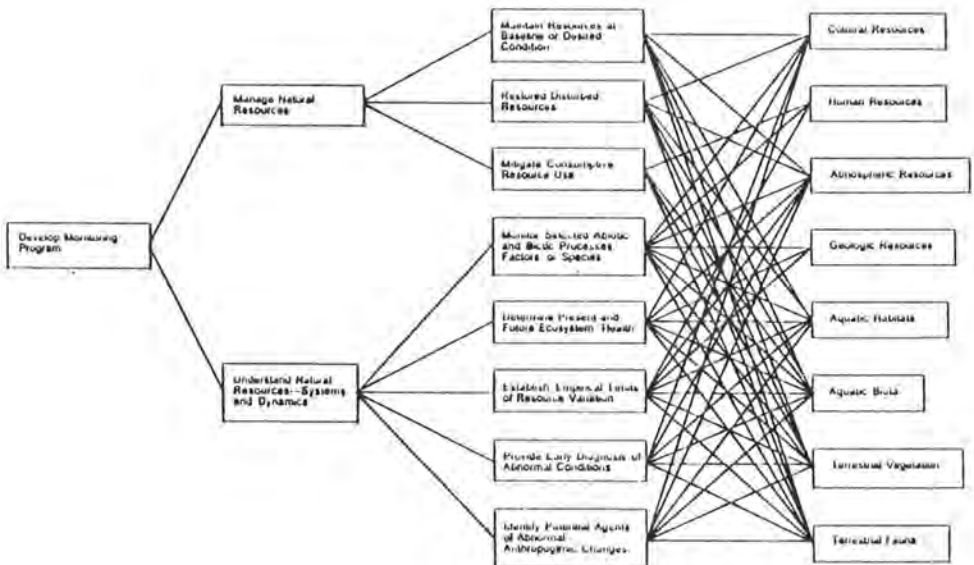


Figure 3. Using the judgments and priorities developed in Figures 1 and 2, it is possible to create a more global perspective of I&M program planning by adding a level of monitoring objectives (of two types: management and scientific) and a level containing resource categories (items within each of these levels are also prioritized).

A highly structured workshop can elicit a large amount of expert knowledge in a short amount of time. We have found that two days is sufficient to produce the template of entire I&M plans and similar documents. Economic efficiency is an important benefit

of the workshop, because each extra day can cost the host agency several thousand dollars for salaries, travel, and facilities, in addition to potential frustration of participants. More protracted meetings produce rapidly diminishing returns for attendees' time.

Analytical Decision Making for Resource Management: Another New Paradigm?

Science-based resource management generally is acknowledged as one of the important developments of the past decade. It is now time for the decision-making process in public agencies to match this increasing level of sophistication. Quantitative and analytically based procedures are needed to ensure not only good decisions, but greater accountability within agencies and with the general public (e.g., Schmoldt and Rauscher 1996; Rauscher 1999). Agencies must document decisions more effectively and go beyond compiling information (i.e., the scientific data) on which decisions are based.

How do we make this paradigm shift in decision-making? There must be commitment of public agencies at the national and local levels to do a better job of documenting the decision-making process. Agencies need resource management staff with a higher level of skills in quantitative applications, as well as the sociological and psychological components of decision-making. A policy of aggressive evaluation and application of potentially beneficial new technologies is critical. Coordinators for I&M planning, who possess analytical and science management skills, are a valuable asset for land management agencies. Finally, good coordination and working relationships with local scientific organizations will ensure that the AHP and other analytically based approaches can be customized for specific management applications.

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Channel Islands National Park Inventory and Monitoring Program Data Management Web Site Demonstration and Teaching Model

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The Channel Islands National Park inventory and monitoring (I&M) program is a long-term monitoring system developed to achieve the objectives of resource inventory and increased ecological understanding upon which to base future resource management decisions. This ecological monitoring program was designed to provide park managers with regular assessments of ecosystem health by determining limits of natural variation, diagnosing abnormal conditions, identifying potential agents of change, and prescribing remedial treatments.

The resource management division at Channel Islands manages the park I&M prototype kelp forest, tidepool, seabird, land bird, land vegetation, terrestrial vertebrates, beach debris, beach lagoon, and weather program databases. The data are organized in an integrated structure to facilitate analysis of the programs (Figure 1).

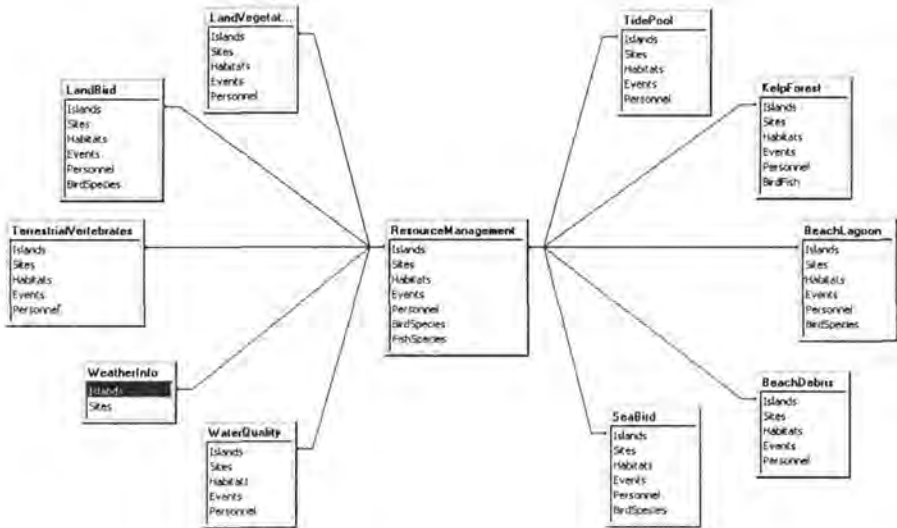


Figure 1. Integrated database relationships

Channel Islands has created a Web site which describes the I&M program. The purpose is to share information and lessons the I&M staff have learned throughout the process of designing, reviewing, and updating monitoring protocols, preparing a database management plan, integrating databases, creating data entry forms with error checking, developing metadata, and automating annual reports. The Web site is designed to be graphical and to provide templates and examples that will assist other resource managers in the process of developing monitoring programs. Components of the information management section on the Web site are: a description of the process to integrate data across monitoring protocols, a graphical depiction of the relationships between databases, a sample program database with associated Access queries, data entry forms, automated reports, a description of the metadata system

with examples from the data set catalogue, and a pilot project to create a species database using marine fish species that will be compatible both with the Channel Islands I&M integrated data system and the NPS nationwide NPSPECIES database.

A link to the recently completed data management plan which describes the program data management history, goals, status, procedures, and protocols will be provided. Download of the plan will also be available. Updated sections of the data management plan sections on the Web site include the executive summary, background, purpose, goals and vision, history, current status, and data management philosophy. A link will be provided to the data handling protocols section of the plan, and the help forest monitoring program sampling and data handling protocols handbook will be on the Web site. These handbooks provide a good example of a detailed step-by-step procedures manual.

The data management system section of the Web site provides graphic representations of the database integrated structure (Figure 1) and defines the basic steps to create a data management system. The basic steps to create a data management system are as follows (not in order): inventory, evaluate, and clean up historical data sets; establish quality control for all new data and its management; optimize computer resources associated with data management; provide data security and accessibility; create a data management structure that provides for data integration; and provide for needs of users and assist users in the use of the system.

A subset of the vegetation database will be available to use on-line and may also be downloaded. A data relationships graphic (Figure 2) will demonstrate the structure of the database. Important aspects of the database of use to resource managers include data entry forms with incorporated error-checking (pick-lists, ranges), numerous queries to examine the data, automated reports, and charts (Figure 3) that do statistics on the data and are ready to be incorporated into annual reports.

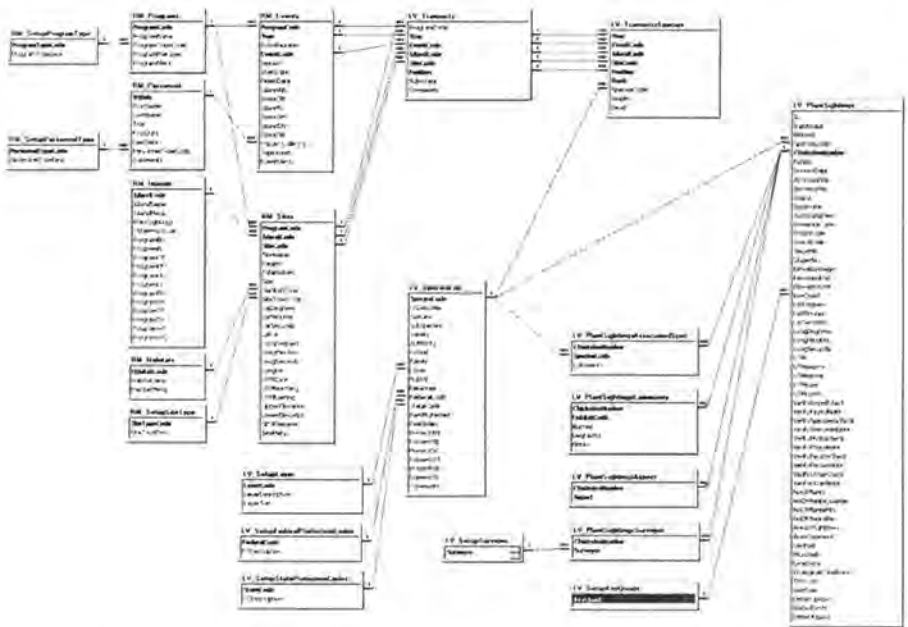


Figure 2. Vegetation database relationships

*Average Relative Frequency - Native vs. Exotic
Boxthorn Scrub on Santa Barbara Island*

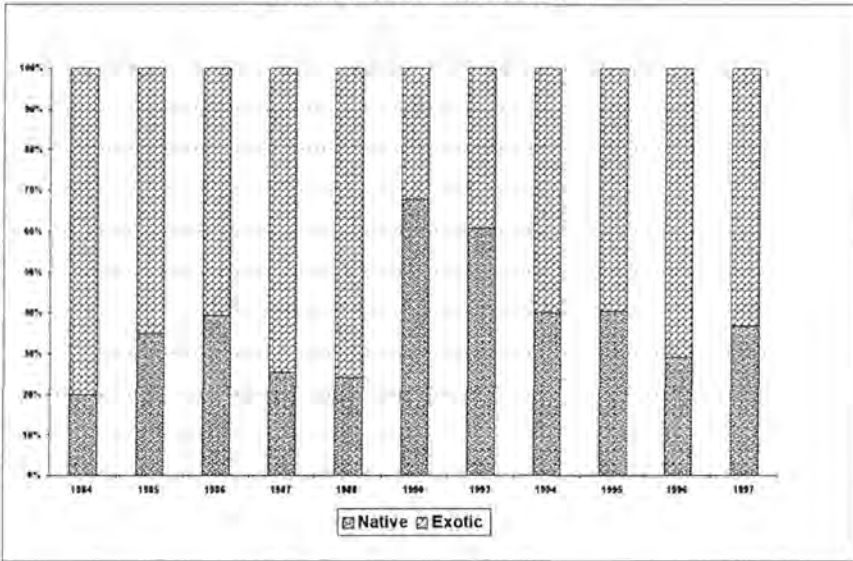


Figure 3. Sample chart

A pilot marine fish species list database will be available online and to download. The intent of this database is to contain all park species and be shared by all programs. The fields are as follows: species code, NOAA Code, USDA Code, taxon, common name, kingdom, phylum/division/subphylum, class/subclass, order, family, genus, trivial name, community, comments/synonyms/status, and program code. The database will be set up to upload to the nationwide NPSPECIES database and a link to that database will be provided (password required; creation of the nationwide species database is in process). An example of a vegetation database table data catalogue entry (Figure 4) will be provided and a link to that database will be available (password required).

The on-line data set catalogue is a one-page document providing basic information about each database. Each table in the Channel Islands database will be one record in the data set catalogue. These records will provide the basic Channel Islands non-spatial metadata. Additional metadata is recorded in the database tables and will be available as trip reports linked to the tables. Trip reports provide descriptions of essential details about each sampling event. The last section of the Web site includes information management and GIS annual reports.

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 1901 Spinnaker Drive
 Ventura, CA 93001
 Phone 805-658-5700
 FAX 805-658-5799

CATDATE: 11/19/98
 ACCESS: PUBLIC
 PARK CODE: CHIS
 ADMIN. INFO: Pacific Great Basin Cluster

TITLE: Terrestrial Vegetation Transects
KEYWORDS: Vegetation, monitoring, inventory, chaparral, coastal sage scrub, transects
SUBJECT: Botany **VERSION:** active **PROJ_ID:** CHISLVTrans
DESCRIPTION: annual sampling of 100 pts. along 30m long transects, record species presence at each pt., to calculate % veg. cover, avg. rel. freq. of each species and substrate on each transect and in each community.
DOCUMENTS: annual reports 1984-1996
 Plant Community research studies
 Natural Resources Study by Santa Barbara Museum of Natural History, 1979
REL. DATA: TransectSpecies table
 SpeciesList table
STATUS: ACTIVE **BEGIN DATE:** 1984 **END DATE:** present
DATE NOTES: gaps 1989, 1991, 1992 **UPDATE FREQ:** annual
LOCATION: Santa Barbara, Santa Rosa, San Miguel, Santa Cruz, and Anacapa Islands

PLACES IN

SPATIAL DATA:		UTM ZONE: 11		
Longitude	Latitude	UTM Easting	UTM Northing	
Centroid Coordinates:	-119.91241	33.98632	230952	3764269
Bounding Rectangle:				
Northwest:	-120.4702	34.24928	180394	3795051
Southeast:	-119.0066	33.44786	313485	3702546

Figure 5. Transect table vegetation data catalog entry example

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<http://aqsun.aqd.nps.gov/CHISDATA/chis.htm>
- NPS I&M data set catalogue:*
<http://165.83.36.151/>
- Report describing Channel Island I&M program:*
<http://www.nature.nps.gov/nrid/im/chis/chis.htm>

Metadata Implementation in the National Park Service Midwest Region

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Introduction

Throughout the National Park Service (NPS), resource managers and other park personnel are increasingly turning to geographic information systems (GIS) to meet their information management needs. To exploit the potential of these systems, NPS has made significant investments to acquire and develop vast amounts of geographic data and related databases. This information plays an important role in the protection and management of cultural and natural resources and is widely used for park planning.

The lack of documentation (metadata) to describe the quality and content of GIS data is a common problem compromising the validity, usefulness, and long-term value of the data. To address the need for developing appropriate metadata, the Midwest Region of NPS, in conjunction with staff at the University of Wisconsin-Madison and with the financial support of the Federal Geographic Data Committee (FGDC), has launched the NPS Midwest Region geospatial metadata education initiative to implement systematic procedures for metadata development at the parks in the Midwest Region. This initiative is designed to empower parks with the necessary knowledge and tools to produce metadata that are fully compliant with the standards outlined by the FGDC (1997). Federal agencies are mandated by Executive Order 12906 to document all geospatial data (Nebert 1996). Metadata safeguards the value of NPS GIS resources for many years to come (Robinson 1996).

In addition to serving as an important organizational tool for GIS data, the completed metadata also allow NPS to participate in the FGDC national spatial data infrastructure (NSDI). This online network allows public access to metadata records from NPS and all other participating organizations. These records allow users to search for existing data and determine the suitability of different data sets for their needs. Considering the significant expense associated with developing new geographic data, it is important to determine if appropriate data already exist in order to prevent duplication of effort and the waste of scarce financial resources. The NSDI is linked to the NPS GIS clearinghouse (www.nps.gov/gis) where the public can directly access GIS data and metadata free of charge. Currently, only a fraction of NPS park units are represented on this clearinghouse. Through this initiative, however, all parks in the Midwest Region with GIS resources will have the opportunity to participate in the NSDI, allowing the public greater and easier access to NPS GIS data, as directed by OMB Circular A-130 (Nebert 1996).

Methods

Although the process of metadata creation is relatively simple, an organizational commitment at all levels is necessary for its successful implementation (Hart and Phillips 1998). This commitment necessitates an understanding of the importance of metadata for protecting the value of GIS resources. While GIS staff at the national, regional, and park levels generally appreciate the importance of metadata, this importance must be communicated and emphasized to all other park staff who might use GIS resources and to park managers who supervise the activities and priorities of GIS park support staff. The most important criterion for selecting parks to participate in this initiative was their level of organizational commitment.

Once an organizational commitment to metadata is established, all GIS data at a park are inventoried. The inventory of GIS data is then prioritized for documentation based on its frequency of use and overall importance to park management. With a prioritized inventory in place, metadata training for the park GIS staff can begin. All Midwest NPS units with GIS functionality are using software from Environmental

Systems Research Institute, primarily ARC/INFO and ArcView. For those park units using the more robust ARC/INFO, metadata training is provided on-site at the park by a trained GIS specialist with extensive metadata experience. For those park units using ArcView, GIS staff are invited to a three-day training session at the NPS Midwest GIS Support Office in Madison, Wisconsin. In both cases, the training stresses the importance of the FGDC metadata standards and includes the documentation of data from the parks.

Metadata production requires additional software that is used in conjunction with the primary GIS software. Many options for metadata software exist. The criteria used to select the most appropriate metadata software included ease of use, cost, and the extent to which the metadata software is 'intelligent', i.e. able to extract information such as projection and attribute information automatically from the data. For parks using ARC/INFO, the Midwest Region is supporting the use of the data dictionary developed by Gerry Daumiller at the Montana State Library (Daumiller 1999). For ArcView, parks are using the metadata collector tool developed by the National Oceanographic and Atmospheric Administration's Coastal Services Center (NOAA 1999). Both of these metadata software packages are easy to learn, are available free of charge, and facilitate the production of 'intelligent' metadata. They both prompt the user for information through simple fill-in-the-blank forms, and produce metadata that are fully compliant with FGDC standards.

Both data dictionary and the metadata collector tool can output FGDC compliant metadata text files. These files are then validated through the use of a metadata parser (MP) developed by Peter Schweitzer (Schweitzer 1999). MP is a free software utility that checks the formatting and completeness of each metadata record and outputs HTML and SGML files appropriate for publication on the NPS GIS on-line clearinghouse. These files are also essential for allowing sophisticated search functions through the FGDC NSDI (Flewelling and Egenhofer 1999).

Results

The preliminary results of the NPS Midwest Region geospatial metadata education initiative are promising. Thus far, two group training sessions for ArcView users from eleven NPS units have provided them with a conceptual understanding of metadata, as well as the practical skills to generate metadata for their respective park units. In addition, a metadata specialist has provided on-site training for ARC/INFO users at Cuyahoga Valley National Recreational Area and St. Croix National Scenic Riverway. Future plans include on-site training at an additional four NPS units that use ARC/INFO. Altogether, seventeen NPS units in the Midwest region will receive direct metadata training.

While still in its early stages, results can be quantified based on the number of GIS data sets that are fully documented and posted to the NPS clearinghouse. After the initial training, the park GIS staff at Cuyahoga Valley documented eleven baseline GIS coverages, validated the documentation using MP, and posted the metadata and data to the NPS clearinghouse. Similarly, fifteen coverages were fully documented at St. Croix immediately following initial training. The results will continue to be assessed as more park staff are trained and as the long-term impact of the training is monitored. The on-line clearinghouse is a quick and easy way to assess progress within the parks, since all metadata records are publicly viewable on the clearinghouse.

Discussion

The NPS Midwest Region geospatial metadata education initiative is proving that metadata implementation in an organization does not have to be a difficult process. Indeed, this initiative has shown that fully compliant FGDC metadata can be produced quickly and easily. However, successful implementation of metadata procedures is far from automatic. Although the initial results of this initiative are

promising, they have also underscored some of the obstacles to successful implementation.

First, it is important to determine who needs to create and maintain metadata. At least one trained staff person should be available to maintain the GIS metadata. This should preferably be the same person who is responsible for the development and use of GIS resources (Robinson 1996). Parks lacking such an individual would have a very difficult time keeping the metadata current.

Second, the time required for proper documentation of GIS data and the already heavy workload experienced by many GIS specialists in the NPS present major hurdles to implementation. The metadata training itself requires several days. In addition, many park GIS staff find themselves with a tremendous backlog of data that needs to be documented. Getting caught up with all existing data can be an enormous task in an already packed schedule. Some data sets are likely to be without any documentation or any information about their lineage, particularly if there has been any staff turnover. Such data will likely be useless since no information is available to describe its content or quality. Under such circumstances, complete metadata for all GIS data can seem like an impossible goal.

To address the problem of a metadata backlog, a thorough prioritized inventory of all existing GIS data is crucial. With such an inventory, a reasonable schedule can be developed to allow for a gradual shift toward complete documentation. Once achieved, regular maintenance of existing metadata requires a minimal time investment. Although the current metadata initiative in the NPS Midwest Region is using these inventory and scheduling procedures, its long-term success or failure is still uncertain.

While an inventory and schedule are vitally important, the ultimate success of metadata implementation in the NPS Midwest Region hinges on the incentives offered to the individual park GIS specialist for completing metadata development. Clearly, the 1994 federal mandate to produce metadata has not been sufficient thus far in promoting the creation of metadata. There is no question that a park GIS program will enjoy many long-term benefits of metadata development, especially in the case of staff turnover. However, the individual park GIS specialist must be provided with adequate incentives in order for metadata implementation to succeed.

One such incentive is that metadata distinguishes the varying utility of different GIS data sets and provides the GIS specialist with direction for the use of the data. Metadata also aids the GIS specialist by facilitating public requests for data and general data-sharing. Nonetheless, the incentives for the GIS specialist might be insufficient in light of the added workload of having to catch up with the backlog of needed metadata. Additional incentives may be necessary to ensure the success of efforts to develop metadata.

Conclusions and Recommendations

The goals of the metadata initiative in the NPS Midwest Region include greater protection and organization of GIS resources through documentation, the provision of easier public access to NPS GIS data, and compliance with federal regulations. Although the initial results of the initiative are achieving these goals, long-term success is still questionable. The following suggestions will help to promote both the long-term as well as the immediate success of such an initiative.

A straightforward training approach with user-friendly software tools is important for successful implementation. The ease of using both the data dictionary and the metadata collector tool is the basis for much of the early success in implementing metadata procedures in the NPS Midwest Region. In addition, it is useful to begin the process in parks with highly competent and motivated GIS staff, so their successes and experiences can serve as examples for other parks with fewer resources. Lastly, since launching a metadata effort can be a major investment of time, it is essential that the GIS data first be inventoried and prioritized. Failing to do so will greatly reduce the

likelihood that the overall implementation effort will succeed. A reasonable implementation schedule can transform a gargantuan task into a series of easily achievable goals.

Aside from these technical aspects of implementation, the development of a series of incentives that encourage park GIS specialists to promote metadata might be the most important factor for the long-term success of metadata implementation. The direct benefits of metadata to the GIS specialist are often too limited and too intangible relative to the work required, particularly while the backlog of metadata is being completed. Therefore, additional incentives are necessary.

Directly linking a park's future GIS funding to the output and maintenance of metadata would serve as one incentive to encourage participation. Such a system, however, would require coordination between national, regional, and park GIS staff. Another way to help prioritize metadata within the job description of park GIS specialists is to ensure that park superintendents or other supervisors understand the vital importance of metadata for protecting a park's GIS investment.

Other more positive incentives could also help promote metadata implementation. Simply providing recognition from the regional or national GIS coordinators could provide the needed incentive for GIS staff to participate. Publicizing metadata accomplishments within the NPS through letters, messages, and certificates would help show the GIS specialists that their efforts are both worthwhile and appreciated. This information could also be included in the existing quarterly on-line NPS GIS newsletter. Regardless of the means chosen, it is imperative that the individuals responsible for creating metadata be offered adequate incentives so that they will feel compelled to promote GIS metadata in the future.

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Monitoring Change in Protected Areas: Problems of Scope, Scale, and Power

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Introduction

Scientific research conducted in support of natural resource management has among its goals detection of changes in the condition of resources, signaling the need for management actions and indicating the kinds and amounts of intervention needed to protect those resources. Monitoring—repeated measures of some quantity believed to indicate the condition of a resource—has gained currency as a means of detecting change. In addition, it often fortuitously reveals appropriate prescriptions for mitigation, adaptation, or remedy.

Monitoring programs will work as intended only if properly designed. For example, when a biotic community or one of its components is of interest, we must ensure that the variable or variables being measured adequately reflect the condition of the resource of concern. If effects of change on entire ecosystems are of concern, we must ensure that the variables being measured respond to the significant forces driving the system. In instances where the state of measured variables fluctuates wildly over short periods, long-term changes are likely to be difficult to detect. Owing to these and other considerations, variables considered ideal and often measured in monitoring programs tend to either: (1) directly measure changes in the status of the resource or resources of concern, or (2) integrate the effects of multiple driving forces on entire ecosystems or biotic communities. On this basis, we might distinguish *direct monitoring* and *integrative monitoring*. Detecting annual change in the population of an endangered species would be an example of direct monitoring of a resource of concern, and measuring periodic changes in growth of dominant trees in a forest ecosystem might be an example of an integrative variable intended to reflect the availability of water, sunlight and nutrients, and the effects of diseases, pollutants, herbivory, etc. that might affect the general condition of an ecosystem and its component species.

The qualities that lend integrity to both direct and integrative resource monitoring programs can also lead to frustration. Tracking changes in populations of an endangered species may alert us to a problem while telling us nothing about the causes of change, and measuring incremental increases in the diameter of tree trunks may consume years before any significant change is detected, and decades may be required to produce statistically valid proof of change. Even when we are finally able to say that the condition of a direct or integrative variable was significantly different statistically in one decade rather than in another, we have the perplexing problem of evaluating the biological significance of this finding.

Some basic qualities of design seem to influence the effectiveness of all kinds of monitoring programs:

Scope. Increasing scope in this context simply means measuring a greater number of variables. In the case of direct monitoring of resources, it is obvious that having more information about the resource of concern is likely to provide useful information. In the example of direct monitoring, tracking annual reproductive success and patterns of mortality in a population of an endangered species could tell us far more about the condition and future prospects of this resource than changes in population size alone. By increasing the scope of integrative investigations we can potentially find variables that respond more directly to driving forces than the one originally chosen, and better distinguish among putative driving forces. If were to measure tree growth as an integrative variable, for example, the interpretive value of our monitoring would be much improved if we knew that temperature and rainfall

patterns, air quality, abundance of herbivores, or the occurrence of disease were changing simultaneously.

Scale. Sampling ecologically similar sites with similar methods over a wide area—the southeastern United States, for example—can also add greatly to the value of a monitoring program. When we do this, differences in directions, rates, and patterns of change add another dimension to our investigations. Anomalous changes at one or two sites might indicate local effects; consistent changes across all sites might suggest broad regional, or even global effects; and patterns of clustered change might indicate effects attributable to known driving forces. For example, changes at a single site might be attributed to effects of air pollutants from a nearby emission source, changes over a subregion might be related through known patterns of prevailing winds to diffuse sources of pollution, and changes affecting all sites might be related to global phenomena such as climate change. Using hypothetical data, Figures 1 and 2 show the advantages of scope and scale in interpreting monitoring results.

Power. Statistical practice provides the means to calculate the power of an experimental design, and to optimize designs to most efficiently produce the kinds of information needed. Many authors have urged the use of power analysis in monitoring designs (e.g., Gerrodette 1987; Fairweather 1991). Factors that go into power calculations include the degree of statistical certainty one desires, the number of replicate measures that can be made of each quantity, and the magnitude of the difference one detects or needs to be able to detect—the “effect size.” Stated simply, effect size is important because most statistical treatments work better and better represent reality when the differences between sample means are relatively large. If a measured variable (e.g., rate of growth measured as change in the diameter of tree trunks) varies only ± 0.2 mm or 2% among samples after a decade, extremely large sample sizes may be needed to achieve statistical significance, and even if statistically significant, one might question the biological significance of so small a difference. More importantly, determining appropriate effect sizes involves judgment on the part of knowledgeable scientists who for example, must determine in advance whether a 2% or a 20% change in the rate of tree growth is significant biologically. The question may be particularly difficult with some animal populations, the abundance of which may increase and decrease by orders of magnitude over the course of a season, and vary by many times from year to year.

These subjects are covered in general in the work by Cohen (1977) and are applied to problems in biological monitoring by Hayek (1994b). The problem of inadequate statistical power was discussed by Reed and Blaustein (1995). They pointed out instances in which monitoring programs were designed with inadequate power to detect the population declines they were intended to track. Despite criticism of their methodology (Hayes and Steidl 1997), consequences for management could be important when decision-making relies on the results of monitoring programs that may in fact be incapable of detecting significant changes in the condition of resources. A somewhat different concern was expressed by Toft and Shea (1983) and supported, with reservations, by Rotenberry and Wiens (1985). Together, these authors argued that too much emphasis on statistical certainty (i.e., avoiding acceptance of a false hypothesis) carries with it the risk of unnecessarily nullifying a valid, but inadequately demonstrated, relationship. Accepting a null hypothesis that there is no difference in a variable measured among monitoring sites or time periods may convey the false impression that we have proven that no difference exists, when in fact we have only failed to reject the null hypothesis with the data at hand, and at the confidence and effect levels chosen. In environmental monitoring, differences are often subtle or complex, control of variables is at best indirect, and the statistical conventions appropriate for accepting or rejecting hypotheses tested by well-controlled experiments may not serve us well.

Instances in which statistical power analysis have been applied to monitoring data are sobering. Some studies of freshwater benthic invertebrates (Bartsch et al. 1998),

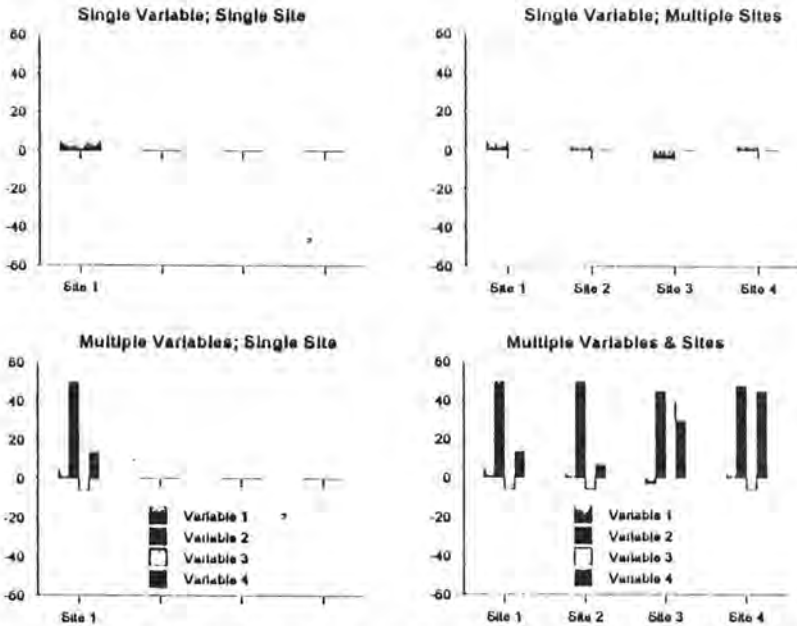


Figure 1. Hypothetical data showing the additional interpretive value when scope and scale are increased.

Figures on the left show that measurement of additional variables, as in the lower figure, detects a negative change which would be unknown if only one variable were measured, as in the upper figure. Figures on the right illustrate the additional information available when scale is increased, indicating that some variables show opposite or anomalous trends in different sites.

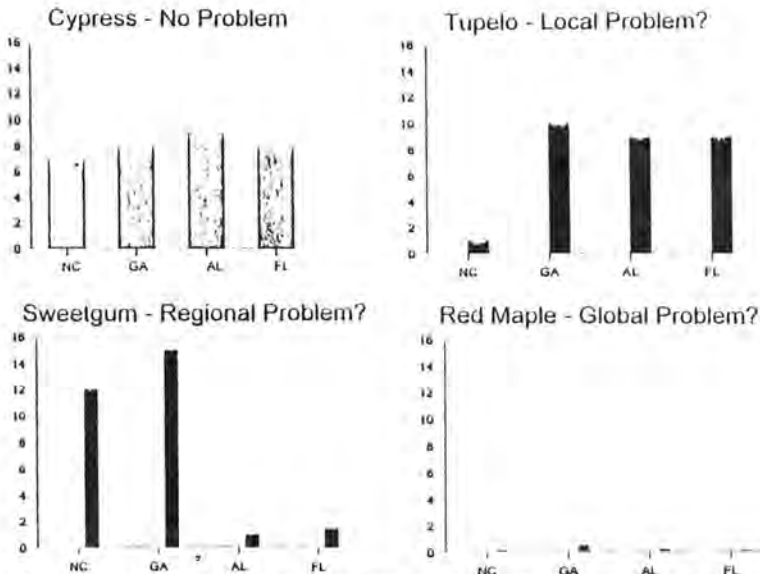


Figure 2. Possible interpretation of hypothetical data on growth rate of trees in mm per year. Cypress trees show similar trends across four states, suggesting no unexpected changes across the sites. Tupelo shows an anomaly at one site, suggesting a local effect, whereas the effect on sweetgum appears to be regional. The fourth species, red maple, shows lower growth than expected at all sites, indicating a possible broad-scale effect.

butterflies (Van Strien et al. 1997), and reef fishes (DeMartini et al. 1996) have observed that available sampling intensities had insufficient power to detect change in the rarer or more variable species, and that only changes of relative large magnitude would be detectable.

Case Studies: Florida and Caribbean Coral Reefs, and Amphibians in the Smokies

The Florida Caribbean Science Center (FCSC) is involved in development of two monitoring programs in national parks that represent greatly differing approaches to the problem of monitoring in protected areas. In monitoring coral reef ecosystems in Florida and the U.S. Virgin Islands, we have concentrated on integrative monitoring, whereas our approach to monitoring amphibian populations in the Great Smoky Mountains National Park has been direct monitoring of populations of concern.

Florida and Caribbean coral reefs. Coral reef ecosystems of South Florida and the Caribbean region occur in a region nearly 2,500 km in longitude (almost as great as the distance between Washington, D.C., and Denver) and 1,100 km in latitude. Despite this great geographic expanse, generally hospitable seas and strong oceanic currents carry planktonic forms of marine life throughout the region (Roberts 1997), and faunal composition shows relatively little change as one travels throughout the region. Coral reefs have extremely high secondary productivity and biological diversity, and have been compared with tropical rain forests in their complexity and level of biological development. Coral reef ecosystems are often vulnerable because of their location in regions where exploitation of natural resources for subsistence is important (see Coblenz 1997).

Coral reefs may be highly vulnerable to local effects (Rogers 1992), and also changes occurring on regional or global scales. For example, increased atmospheric CO₂ could lower calcification rates, with far-reaching effects on reef structure (Pennisi 1998). They are sensitive to changes in temperature and increased ultraviolet radiation, sometimes responding to these changes by "bleaching," accompanied by a cessation of reproduction and decreased growth (e.g., Szmant and Gassman 1990).

Since 1995, the FCSC has been developing, in cooperation with the National Park Service, a prototype coral reef monitoring program to design and test monitoring protocols for coral reef ecosystems in the Virgin Islands and Dry Tortugas national parks and Buck Island Reef National Monument. A pioneering effort by Rogers et al. (1994) summarized accepted methods of coral reef monitoring, which at that time mostly relied on arduous and expensive underwater surveys conducted by experienced diver-biologists. These have proven to be unsuited for routine implementation by management personnel, or in providing enough information to understand causes of change. As a result, the focus of current work is developing new methods that meet these difficult requirements.

Scope. In our approach to integrative monitoring of coral reef ecosystems, the single most important variable measured—percent cover of live coral—is somewhat analogous to the hypothetical example involving measurement of growth in tree trunks. Results reflect the general condition of the keystone organisms in the ecosystem and probably the overall condition of the coral reef communities surveyed. The effects of catastrophic change are readily apparent, as these may drastically change the structure of reefs. On the negative side, in the absence of severe insults, this variable normally displays incremental change only over long time periods, and the data produced are few and do not support detailed analyses.

Our attempts to develop methods in which data can be collected by non-scientists have also increased the potential scope of our surveys. Underwater surveys conducted directly by diver-biologists are being replaced by underwater videography. Using a digital video camera, a diver swims along a transect at a fixed height and makes a record of the ocean floor. Data can be retrieved and live coral coverage calculated in the laboratory. The videotapes are permanent records, and

more detailed examinations can potentially be used to measure other variables or serve as an archival resource.

Our approach to monitoring coral reef fishes emphasizes counts of groupers (genus *Epinephelus*) and snappers (family Lutjanidae), the most important predatory species (and, coincidentally, those that are commercially exploited). This monitoring is believed to be integrative in that these top predators depend on populations of numerous prey species and are regarded as suitable surrogates for fish populations in general. It also is direct because it measures the status of exploited populations of concern. However integrative they may be, populations of these species may relate poorly to biological diversity within the broader community, and they tell us almost nothing about the status of the hundreds of species of fishes and invertebrate animals found in the vicinity of reefs. Future improvements to our monitoring program must include more representative sampling.

Scale. Rogers (1992) pointed out that environmental effects on coral reef ecosystem are extremely variable over the dimension of space, even measured on a relatively small scale. Storms, for example, may have devastating effects on reef ecosystems with windward exposures, whereas less-exposed reefs nearby may be affected little; depth and species composition also affected vulnerability to damage from particular storms. Even if local variations are taken into account, restriction of surveys to a few sites in relatively close proximity severely limits the power to detect and understand the influence of driving forces that are regional or global in scale. Future plans call for sampling much more geographically dispersed sites so that driving forces operating over small and large scales can be isolated and the contributions of each to observed changes in biological diversity statistically described.

Power. Other advances in our coral reef monitoring program seek to ensure that transects are representative, randomly placed, and can be faithfully replicated over the long period the program needs to run (Rogers 1999). These are all factors that will improve statistical adequacy, but the effect on power is still unknown. Increased scope may include measurement of variables that respond more directly than does coral cover to stresses on the ecosystem, and also may increase the chance of detecting changes of biological significance.

Amphibian monitoring in the Smokies. Ken Dodd of FCSC is working on development of a monitoring program for amphibians in the Great Smoky Mountains National Park. The park has 42 known species of amphibians, which occupy habitats ranging from river bottoms to mountain tops. Some species never leave the water, while others may never enter it. Some have long larval periods spent in aquatic habitats, while the eggs of others hatch out miniature terrestrial adults. Some have great abundance over a wide range of habitats, while others are so rare or elusive that they may not be seen for years or decades. This complexity makes developing a comprehensive monitoring program an extremely difficult goal. Do we try to monitor changes in population status of all 42 species? Or should we try to monitor a representative subset, and if so, what is representative? Would tracking the population status of the semiaquatic seal salamander (*Desmognathus monticola*) tell us anything about the population status of the wholly aquatic hellbender (*Cryptobranchus alleganiensis*), let alone about that of the terrestrial pigmy salamander (*Desmognathus wrighti*), a close relative of *D. monticola*? Should we emphasize easily sampled species, or those that may be less abundant, can be detected only with difficulty, and are perhaps more vulnerable to the effects of environmental change?

Our approach attempt to deal with this by applying a variety of sampling methods in a variety of representative habitats. Sampling time is divided between aquatic and terrestrial habitats, and for each there are lower- and higher-altitude components. Aquatic habitats are divided into ponds and streams, and streams in turn are divided into low- and high-gradient reaches. Each of these may be sampled by any of a variety of standard methods. For example, terrestrial sampling involves active (time-

constrained searches) and semi-passive (searching under artificially installed cover objects). Other sampling focuses on designated species or assemblages of concern to park management, or seeks to reveal the effect of prescribed burning on amphibian communities. Thus, effort is apportioned not only among major types of habitats, but also among common and widespread species, and those that are rare or considered to be of management concern.

Scope. Measuring the occurrence and relative abundance of up to 42 species obviously produces abundant data and the scope for numerous comparisons. Initial efforts will overwhelmingly emphasize indices of population size, but in many instances data will also be collected on other aspects of ecology. For example, both larvae and adults of some species may be monitored, providing indirect indications of reproductive effort and success as well as population status. In our amphibian program, time-constrained searches of transects or plots and records of amphibians found under cover boards also permit us to record community-level statistics. Species richness, evenness, and species diversity are examples of statistics that tell us something about the community, based on numbers of species and individuals recorded in surveys (see Hayek 1994a). If sufficiently robust, these community-level statistics may serve as integrating variables.

Scale. As with our coral reef surveys, our amphibian surveys are now restricted to sites in relatively close proximity—that is, within a single large national park. We may be able to compare differences from sites with different altitudes, slope exposures, or dominant plant communities, but regional or geographic differences are not obvious. Other programs examining amphibian population trends in other sites may provide some useful comparisons, but, with different targets and methodologies, the various programs probably produce relatively little data useful for regional or national comparisons. There is an active proposal to link existing U.S. Geological Survey amphibian monitoring programs and add many strategically located sites in order to establish a true national monitoring network.

Power. The power of our amphibian monitoring program to detect changes in abundance will tend to differ among species, depending on such factors as initial abundance, natural variability within populations, and sampling efficiency. Initial indications are that effect size may be large for those species whose populations are capable of changing rapidly and dramatically in response to environmental conditions. Although normal fluctuations in numbers are probably large for some species, with careful design and application of statistical power analysis techniques, biologically significant long-term changes should be detectable.

Conclusions

1. To be most effective, a monitoring program should measure as many relevant variables as possible; ideally it should include a combination of direct and integrative measures.
2. A monitoring program limited to one national park or other protected area is less likely to achieve both broad and park-specific objectives than one with widely dispersed sites. This is true even from the perspective of a single park because changes at one locality are more easily detected and better understood when compared with changes observed elsewhere.
3. Determining critical effect sizes is important before the design of monitoring programs is begun, and should be based on biological knowledge and realistic assessments of levels of change that are cause for management concern. Calculations of statistical power should then be used to make critical decisions regarding program design, and to inform scientists and resource managers of the capabilities and limitations of monitoring programs in use.

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Status of Butternut, *Juglans cinerea*, on Lands Administered by the National Park Service and a Proposal for a Servicewide Management Strategy

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In 1993, George Washington Memorial Parkway hired a botanist to conduct the first comprehensive inventory of vascular plants for Turkey Run Park, a roughly 200-acre natural area (administered by the parkway) which lies along the palisades of the Potomac River in Virginia near Washington, D.C. Included in that final inventory was butternut, *Juglans cinerea*, a small tree native to the United States. A casual remark by the National Park Service (NPS) regional chief of natural resource management about including it on the inventory triggered a greater interest among the parkway staff in a species that had been of little concern previously (Fleming 1993). The staff had a general lack of knowledge about the tree and an even greater ignorance about the disease that will likely erase it from the landscape within the lifetime of this generation. Approximately 100 units of the National Park System, including the many smaller developed parks and cultural sites such as battlefields and historic homes, are located within the native range of butternut trees. Although there are exceptional employees within NPS who are aware of the issue of butternut decline, the lack of knowledge exhibited by the parkway staff is more typical. This lack of knowledge inhibits the ability of NPS to effectively participate in strategies to conserve this species.

The native range of butternut extends from southern New Brunswick and Maine through the Upper Peninsula of Michigan to eastern South Dakota, southward into northern Arkansas and the mountains of Alabama and Georgia (Collingwood 1937). It is primarily an eastern tree, commonly found near the forest edge, near watercourses and in clearings, or occasionally in the understory. Although the native range of butternut is extensive, the trees tend to be locally patchy, and generally forest stands may contain only "an occasional butternut tree" (Rink 1990). Butternut is never a dominant species of the forest.

Butternut trees are a deciduous hardwood, most closely related to black walnut, *Juglans nigra*. Butternut is distinguished from black walnut most readily by its shorter height (butternut rarely grows more than fifty feet tall); the terminal leaflet of the pinnately compound leaf, which is present in butternut while absent in black walnut; and the fruit, which is noticeably oblong, while that of the black walnut is round. Butternut wood is used for some furniture-making and, more commonly, for decorative purposes such as veneers. The nuts are edible and have a distinctive flavor. The nuts were also used as a dye during colonial times (Preston 1989) and for dyeing Confederate uniforms during the Civil War (Schlarbaum 1997). Butternut trees seldom live as long as 75 years (Rink 1990).

Butternut has declined dramatically throughout its range, due primarily to a fungal canker, *Sirococcus clavignenti-junglandacearum*. It is estimated that in the southern states 80% of the population on all lands has been lost since the 1970s (Schlarbaum 1999).

Sirococcus cankers arise on all aboveground parts of the trees ... and affected trees usually have multiple cankers. Single cankers may girdle twigs or small branches, but large limbs and trunks succumb only as the result of the girdling effect of multiple coalescing cankers. During lesion formation, the inner, healthy bark is degraded to a dark brown mush. Liquid oozes through small openings to the bark surface and spews out as shiny black spots. Conidia (the asexual spores that are the fruiting bodies of the fungus) have been trapped at distances up to 45 meters from diseased trees, but

most are deposited close to their sources" (Sinclair, Lyon, and Johnson 1987).

The fungus is thought to be spread primarily by rain splash, and possibly by insects. (USFS 1995).

Although efforts to better understand the disease and its effects on the trees have been documented for many years, NPS has not conducted a Servicewide census nor is there clear knowledge of the rate of infection of the trees on NPS lands. The U.S. Forest Service's (USFS's) North Central and Southern Area Research Stations, in conjunction with the University of Tennessee, the University of Minnesota, and Great Smoky Mountains National Park, have led the research and conservation efforts with regard to butternut canker. No strategies to curb infection have been identified. Butternut is not federally listed and is not known to be listed as threatened or endangered by states. At most it can be considered as a species of concern.

If NPS is to provide effective measures to protect this natural resource, it needs to better identify the population size and assess the health of its butternut trees. In addition, parks can benefit from reviewing and adopting management strategies. Ultimately, NPS can only provide training and guidance; implementation of effective protection strategies is the responsibility of each park unit.

In 1998 and 1999, I surveyed a group of parks that either list butternut as present in the NPS vascular plant inventory (NPFLORA) or are located within the native range. To date, I have received 19 responses (Table 1). Of those parks responding, 14 parks reported at least one butternut in the park, and most of these parks had a high level of confidence in their identifications. Most parks indicated they had personnel who are able to identify butternut trees, although there was less confidence indicated in their ability to recognize signs of the canker. The survey resulted in a conservative estimate of hundreds of butternut trees currently growing on lands administered by NPS. This represents a significant population and an important repository of genetic information that is entrusted to the agency.

Seven of the fourteen parks with butternut also indicated that the canker is present, and six of these parks indicated that 10% or greater of their population is probably affected and may be dying. Only two parks with butternut reported no signs of canker. Ten parks either did not respond or did not know if canker is present. Great Smoky Mountains has documented an 80% mortality rate (Johnson 1999).

These results give a clear indication of the severity of the problem on lands administered by NPS—and also indicate that we have more to learn. Few parks conduct forest health surveys beyond assessing specific major threats, such as gypsy moth infestations. The decline of butternut trees on NPS lands is significant not only in itself, but as an indication of the repercussions of not engaging in survey methods to monitor forest health established by USFS and other agencies.

Many authorities have considered measures to address research, surveys, forest health, and management strategies for butternut trees. It is not the purpose of this paper to suggest that imposition of mandatory measures be adopted regarding inventory and protection of butternut trees. The purpose is, however, to identify some current and potential measures that can be adjusted and adopted by individual park units to better understand the butternut trees under their care and to actively engage in strategies to better protect them. Both the parks responding to the survey and authorities on butternut recommend a number of measures to take to protect the trees. In response to a question on the survey suggesting a moratorium on removing any healthy butternut trees, most parks responded they could see no problems with adopting such a moratorium. Many parks requested information on the status of the tree and disease. Most responded that they were willing to participate in studies to identify resistant disease-strains.

Park	Butternut Present?	Total Population	Canker Present?	% Affected	Type of landscape
Abraham Lincoln Birthplace NHS (KY)	no	0	NA	NA	developed / landscaped
Big South Fork NR & RA (KY, TN)	yes	>50	Yes	50-100%	natural
Blue Ridge Parkway (VA, NC)	yes	5-50	Yes	<10% ?	natural
Catoctin Mountain Park (MD)	yes	5-50	Yes	10-50%	natural
Chesapeake & Ohio Canal NHP (DC, MD)	yes	1-5	Unknown	Unknown	natural
Fort Washington (DC, MD)	yes	1-5	No	Unknown	natural
George Washington Memorial Parkway (DC, MD, VA)	yes	5-50	Yes	50-100%	natural
Great Smoky Mountains NP (NC, TN)	yes	>50	Unknown	NA	natural
Harpers Ferry NHP (MD, VA, WV)	yes	Unknown	Unknown	Unknown	natural
King Mountain NMP (NC)	no	0	NA	NA	natural
Little River / Russell Cave NM (AL)	no	0	NA	NA	natural
Mammoth Cave NP (KY)	yes	5-50	Yes	50-100%	natural
Manassas Battlefield (VA)	yes	1-5	Unknown	Unknown	natural
Marsh-Billings-Rockefeller NHP (VT)	yes	>50	Yes	10-50%	small vegetated areas
Obed WSR (TN)	no	>50	Yes	50-100%	natural
Prince William Forest Park (VA)	yes	>50	Unknown	Unknown	natural
Rock Creek Park (DC)	yes	5-50	Unknown	Unknown	natural
Shiloh NMP (TN)	no	0	NA	NA	small vegetated areas
Stones River NB (TN)	yes	1-5	No	0	natural

Table 1. Butternut survey responses. NA = not applicable.

The following measures are strongly recommended. With regard to surveys:

- A standard protocol should be adopted for both inventory and monitoring to allow for comparison of data between parks and among agencies and institutions involved in butternut study and conservation. Great Smoky Mountains, the U.S. Geological Survey Biological Resources Division, and research stations all have developed initial protocol models. A core set of tree and site characteristics should be identified, although parks may choose to add additional parameters.
- Files should be maintained in both park and regional-office databases on all reported butternut trees. This information should also be forwarded in a uniform manner to the appropriate USFS regional offices.

With regard to protection strategies:

- All location data should be considered confidential in the same manner as are natural heritage and federal threatened and endangered species data. Maps showing exact locations should not be in files or publications generally accessible to the public, nor posted on Internet files.
- All actions that could adversely affect any individual butternut tree or the general population should be subject to National Environmental Policy Act compliance that will specifically identify alternatives to adverse impacts. All reasonable alternatives that eliminate any adverse impacts should be included.
- A moratorium should be adopted prohibiting removal of any live butternut trees, even those with 20% or greater crown dieback, except for situations involving public health and safety. All decisions, as mentioned above, should be subject to compliance. Even diseased trees should be left since there are signs that some trees can survive for years with cankers that do not completely girdle the tree. These trees may be important as repositories of germplasm as the population continues to decline (Ostry 1995).

With regard to park and public education:

- NPS's mandate for using the resources under its stewardship as educational examples of broader ecological lessons is well-established. Natural resource managers should work with park interpreters and other educators to design and implement appropriate programs and materials to increase the public's understanding of the plight of butternut trees and to use this specific disease as an example of broader ecological issues of forest health and altered processes, as may be determined to be appropriate by the local parks.
- All field and management staff should be trained to identify butternut trees, determine tree health, and implement protection strategies.

Some additional policies and measures for consideration:

- NPS units should cooperate with National Plant Material Centers and other appropriate agencies and institutions to assure conservation of the germplasm. Great Smoky Mountains cooperates in supplying some nuts for butternut plantations administered by USFS or their cooperating universities. Butternut seeds, by nature, are appropriate for only short-term seed storage, but future research may result in the ability to preserve genetic material through successive growing of seedlings, grafting, backcross breeding (Leffel 1996), or other mechanisms.
- In some parks, public trails come close to butternut trees, and information about butternut can be included in guided walks to educate visitors about the tree. Other parks may have so few trees, or they may be so endangered by disease or potential poaching, that staff may choose to grow trees from nuts produced by

butternuts in the park, planted in areas specifically for educational purposes. These plantings should follow NPS guidelines and most current information for butternut propagation.

- Parks should conduct comprehensive forest health training in conjunction with USFS and other agencies and institutions.
- Butternut frequently grows at the forest edge, therefore it is frequently found along roadways and at the edge of managed landscapes. Mechanical barriers such as trunk collars should be placed to prevent "accidental" adverse impacts from management practices such as mowing, "weed-whackers," and other landscape and facility maintenance practices. Accidental injury or removal of trees has been identified as a problem in some parks.

In summary, butternut trees on lands administered by NPS are experiencing the same decline that has been documented on other public and private lands. NPS, as a first step, needs to implement an aggressive internal education program so that employees can identify individual trees and assess their health. There are a variety of strategies currently available to assist in protecting existing trees, as well as to conserve the continued viability of the population. Each park must adopt those measures which, in its estimation, will best protect its trees. In general, this program might be looked upon as an opportunity to examine the current ability of NPS to conduct forest health monitoring beyond such special concerns as gypsy moth infestations. Protection of this species speaks to the heart of the purpose for which Congress created the National Park Service in 1916: "to conserve the scenery and the natural and historic objects" of the parks "by such means as will leave them unimpaired for the enjoyment of future generations" (National Park Service Organic Act, 16 USC 1).

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Reinterpreting the Cultural Landscape of Chalmette Battlefield: Landscape Management Strategies for Parks with Multiple Layers of History

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Introduction

Sites which contain multiple layers of material history often do not conform to the established methodology for analyzing cultural landscapes. Such landscapes may contain historic resources—buildings, roads, vegetation—from multiple eras which are only loosely related developmentally. As a result, these landscapes may exhibit multiple and overlapping periods of significance. The degree of historical integrity the landscape retains from its primary period of significance may be weak, suggesting that conventional restoration is unfeasible or ill-advised. This does not preclude the possibility, however, of an ecologically informed and creative landscape rehabilitation, which draws inspiration from historic documentation while addressing contemporary interpretive and management concerns. A cultural landscape report prepared for the Chalmette Battlefield and National Cemetery Site during 1998-1999 provides interesting insights into such a rehabilitation and some innovative management strategies that could easily be adapted to other sites with multiple layers of history.

Site Context and History

Chalmette Battlefield and National Cemetery Site is administered by the National Park Service as a management unit of Jean Lafitte National Historical Park and Preserve. The park is located in St. Bernard Parish, Louisiana, approximately six miles southeast of downtown New Orleans in a highly industrialized corridor along the east bank of the Mississippi River (Figure 1). The property is bounded to the south by a broadly concave arc of the river and by its adjacent levee, which is maintained and administered by the Army Corps of Engineers. To the north, an approximately 200-foot-wide strip, containing highway, railroad, and utility rights-of-way, separates the park from the St. Bernard Highway (Louisiana State Highway 46). The mammoth refinery and waste site of the former Kaiser Aluminum and Chemical Corporation bounds the park to the east; Chalmette Slip, a ship docking and storage facility, bounds the park to the west. A service road along the landward toe of the levee provides cross-park access between the neighboring industrial properties. A 1.5-acre sewage treatment facility, owned by St. Bernard Parish, stands as a conspicuous in-holding at the southern end of the battlefield.

The 142.9-acre park includes the commemorative battlefield and the adjacent Chalmette National Cemetery, a designed landscape which occupies a portion of the former battlefield (see Figure 1). The battlefield property serves to commemorate the Battle of New Orleans and to interpret the strategy of this decisive American victory during the War of 1812. The cemetery was established in 1864 for the interment of Union soldiers killed during the Civil War in Louisiana. The 17.3-acre cemetery is set apart from the battlefield within a brick-walled enclosure along the park's eastern edge.

Both the battlefield and cemetery occupy land that belonged to the historic Chalmette and Rodriguez plantations. It was on these two properties that the primary action of the Battle of New Orleans—the last engagement of the War of 1812—was fought, on 8 January 1815. During the battle, British troops advanced westward across the fields of Chalmette Plantation, attacking the American troops entrenched behind a canal on the eastern boundary of the neighboring Rodriguez Plantation (Figure 2). The two-hour battle was an impressive victory for General Andrew Jackson and his outnumbered troops over British forces seeking to capture New Orleans

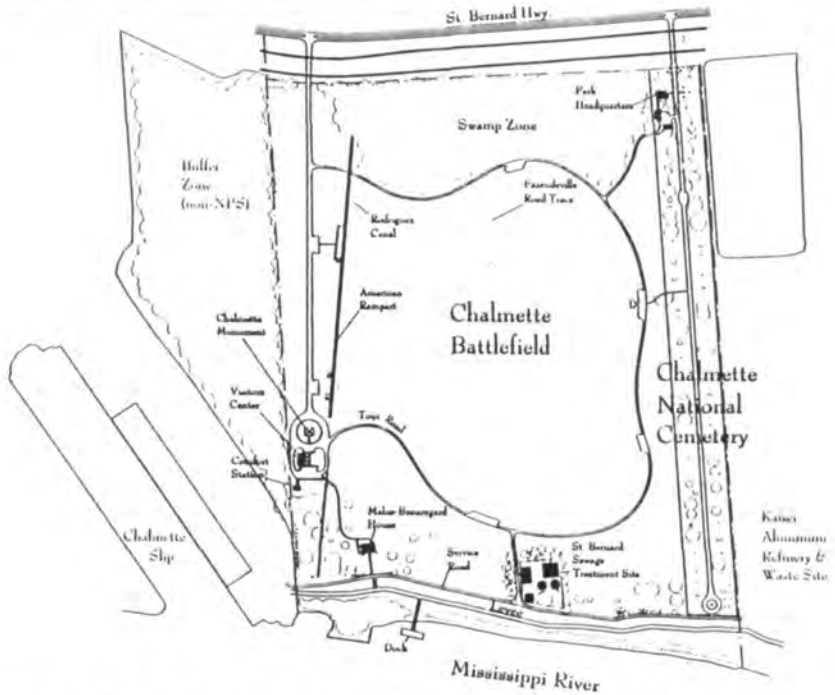


Figure 1. Chalmette Battlefield and National Cemetery: Existing conditions and site context

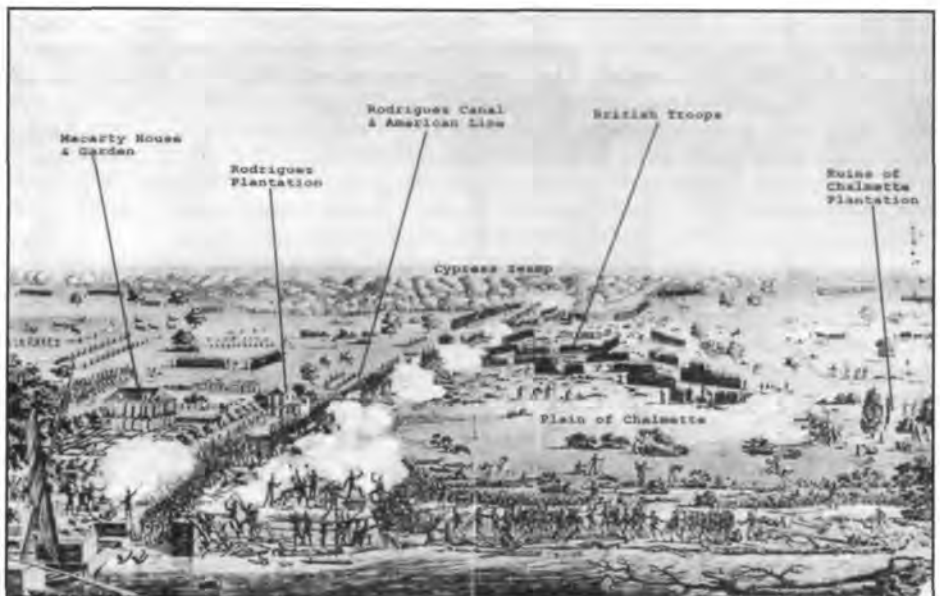


Figure 2. Hyacinthe Laclotte's engraving of the Battle of New Orleans: The American troops positioned along the Rodriguez Canal and the British forces attacking across the fields of Chalmette Plantation (annotations by author)

from the east. The victory solidified American claims to the Louisiana Purchase and bolstered Jackson's popularity, helping to catapult him to national prominence.

The commemorative battlefield contains a number of features associated with the Battle of New Orleans: the Rodriguez Canal, which served as the line of entrenchment for Jackson's troops; the partially reconstructed American rampart and artillery batteries; the site of the British attack and advance batteries; the Rodriguez Plantation archeological site; Chalmette Monument, erected in 1855 to commemorate the American victory; and Spotts Marker, erected in the 1890s to memorialize First Lieutenant Samuel Spotts's role in the battle. However, the battlefield also contains significant features not connected with the battle, notably the Malus-Beauregard House, an architecturally noteworthy summer residence built in 1833, and archaeological resources related to post-battle land use and subdivision. For example, a trace of Fazendeville Road, a remnant of the free black subdivision of Fazendeville that existed on site from the late nineteenth century until 1964, remains within park boundaries. The interpretation of these non-battle-related features has proven problematic to the park's primary mission of interpreting the battlefield landscape, yet these features hold historical, cultural, and ethnographical significance in their own right. The cultural landscape report was developed, in part, to address this issue.

Project Description—The Cultural Landscape Report

A cultural landscape report is a research document that (1) records the existing and historic conditions of a cultural landscape; (2) analyzes the integrity and historical significance of that landscape against established National Register criteria; and (3) provides treatment recommendations for managing the cultural landscape in light of historical documentation and contemporary management concerns. For the Chalmette site, the overall goal of historical research was to trace the history and evolution of the various land parcels that compose the contemporary park. Significant periods of change in the landscape were documented, including investigation of the site's pre-battlefield landscape (plantation agriculture to 1815); the battlefield scene (1814-1815); Chalmette's post-battle history of subdivision and private ownership (1815-1964); and the battlefield's long history of private and public commemoration (1840-present). The historical research findings were compared with the park's existing landscape in order to assess what resources remained from both the battle-era landscape and from latter cultural overlays. Treatment recommendations were then devised to suggest how the park's landscape resources could most effectively be treated and interpreted in the future.

Problems and Management Issues

The battlefield's natural setting has been dramatically altered by surrounding industrialization, which has erased the formerly rural, agricultural context. In addition, progressive reinforcements of the levee have severed the landscape from its connection with the river. The presence of a highway and railroad to the north of the park has further altered the distinctive spatial character of the former battlefield land. Strategically open view lines, across the once sweeping Chalmette Plain and along the curve of the river, have been blocked by industrial infrastructure or wooded buffer zones to the east and west of the park. The cypress swamp, which spatially defined the northern extent of the battlefield and played a critical role in Jackson's battle strategy, was lost to timbering in the nineteenth century. Consequently, the woodland swamp zone that exists today does not contain cypress trees and only loosely approximates, for interpretive purposes, the original swamp. The levee has blocked views of the Mississippi River to the south.

Because of the relatively small size of the site, the battlefield setting is noticeably interrupted by the presence of non-contributing park-era infrastructure, especially the visitor tour road, which circumscribes a portion of the central battlefield, and the complex of the visitor center, comfort station, and parking area. The tour road intro-

duces automobiles into the battlefield setting and hinders understanding of the rectilinear land patterns that prevailed at the time of the battle. The visitor center, parking area, and comfort station are clustered in unfortunate proximity to the Chalmette Monument and Rodriguez archeological site. Though not owned by the park, the St. Bernard sewage treatment plant also intrudes into the battlefield landscape. The Malus-Beauregard House, a post-battle era construction, poses yet another interpretive challenge to the park; its anachronistic presence at the southern end of the battlefield confounds a clear understanding of the historic scene.

Summary of Findings

Given the highly industrialized context of its surroundings, Chalmette's landscape is not readily legible to the uninformed visitor; and it bears only the loosest resemblance to the landscape that existed at the time of the Battle of New Orleans. Furthermore, the site's connection to the Mississippi River and to a broader regional context—information critical for understanding the site's early development as an agricultural landscape, its evolution to post-agricultural land uses, and its present condition as a relic landscape within a highly industrialized corridor—remains largely uninterpreted. The landscape treatments proposed were thus devised with multiple purposes in mind: to preserve the park's significant cultural resources; to provide a fuller and richer interpretation of the site's landscape features, context, and multiple layers of history; and to address such contemporary planning and management concerns as boundary buffering, vegetation management, and visitor-use patterns.

A carefully selected program of rehabilitation was determined to be the most viable treatment approach for the commemorative battlefield. The urgent need for site buffering, a shift in visitor-use patterns, and the tightened economies of site management required landscape treatments that addressed such contemporary problems, yet enhanced the park's interpretive aims. In fact, primary and secondary interpretive themes were strengthened by revising visitor circulation patterns and by defining separate spatial zones, or "character areas," in which differential interpretation could occur. Treatment recommendations also propose the removal or relocation of the park-era infrastructure that compromises the spatial integrity and understanding of the historic battlefield landscape. The riverfront was treated as a separate management zone because of its spatial isolation from the battlefield and its individual interpretive potential. Treatment recommendations suggest how the riverfront might be more fully incorporated into the park's interpretive program and the visitor experience.

Because of its developmental history, designed layout, and independent spatial integrity, Chalmette National Cemetery stands apart from the battlefield as a distinct designed landscape. Consequently, separate treatment recommendations propose a rehabilitation of the cemetery's allées and planting patterns, based on historic documentation and photographs (Figure 3). Such improvements will further distinguish the cemetery from the commemorative battlefield and will provide much needed buffering from the Kaiser Aluminum property to the east.

Management Strategies for Parks with Multiple Layers of History—Lessons from Chalmette

- Define separate interpretive zones or "character areas" to highlight secondary interpretive themes. Re-establishing historic circulation and vegetation patterns helps visitors to better understand the development and significance of a landscape on an experiential level, even if such features are not explicitly interpreted. For example, rehabilitating the historic planting patterns in the national cemetery will enhance its distinct spatial character and developmental identity, while buffering the site from the surrounding industrial development. Resources which are anomalous or anachronistic to a park's primary interpretive theme are

best placed within an interpretive and landscape context of their own, not ignored or glossed over for ease of interpretation. Simplifying a site's history for interpretive purposes does not do justice to the complexity of a cultural landscape. Furthermore, it denies the public a broader understanding of the site's historical development. Visitors may take away a false impression if such anomalies are not expressly interpreted. For example, the Malus-Beauregard House is often misinterpreted as a plantation house, and despite the park's efforts to the contrary, some visitors probably take away the impression that it was one of the battle-era plantations. Re-establishing a landscape setting for the house and restoring the riverfront approach will further distinguish the house from the battlefield.



Figure 3. Chalmette National Cemetery, ca. 1960, showing the former allées of tree plantings and the Kaiser Aluminum waste site to the east

- Use mowing patterns, natural successional processes, or selective planting to establish distinct interpretive zones. Employing natural succession to simulate a landscape's historic spatial arrangement can reduce maintenance costs and time. For example, releasing an additional area of the "swamp zone" from active mowing in order to sweep across the tour road would provide buffering along Chalmette's entrance sequence, would create spatial and experiential variety for park visitors, and would complete the line of the swamp as seen from the southern end of the battlefield. Differential mowing patterns can be used to highlight hidden archeological features or historic circulation routes, a technique that is inexpensive to implement and easily reversible, e.g., mowing swaths through the battlefield to represent battle-era ditch lines, or perhaps Fazendeville Road.
- Plant ecologically sustainable native vegetation to simulate the texture, color, pattern, or appearance of historic vegetation or field patterns, such as by using a rowed planting of a coarse-textured, native clump-forming grass to simulate the appearance and pattern of sugarcane fields at Chalmette.

- Re-establish historic arrival sequences, circulation patterns, and spatial arrangements. Mid-twentieth century park development often altered or eliminated earlier circulation patterns and spatial arrangements in order to accommodate increasing automotive tourism. In many cases, these changes were implemented with little regard to the integrity of prevailing land patterns and, as a result, continue to hinder the visitor's understanding of the park's cultural landscape. For instance, the tour road at Chalmette runs counter to the rectilinear field patterns that existed at the time of the battle. Parks should encourage visitors to approach landscape features in the manner in which they would have been accessed historically.
- Especially in a small park, develop interpretive programs that place the site in a larger regional context. Encroaching industrialization and suburbanization are jarring realities for many parks, yet many choose to ignore these contextual changes in their interpretive program, even though such changes are part of the regional and developmental context. Provide waysides or open-air interpretive pavilions that allow visitors to experience the historic site from a new perspective or spatial framework. Such interpretive sites need not be complex, expensive, or visually obtrusive, and can include historic photographs or documentation that reveals the landscape as it would have appeared in the historic period. As an example, Hyacinthe Laclotte's painting of the Battle of New Orleans (see Figure 2) could be effectively used to interpret the battlefield scene from atop the levee.
- Remove or relocate non-contributing park-era infrastructure, such as visitor centers, comfort stations, picnic areas, tour roads, etc., so as to minimally interfere with the spatial and experiential understanding of key historic landscape patterns. Infrastructure which must intrude into the spatial core of a historic landscape should be minimized so as to not interfere with historic circulation patterns, spatial arrangements, or archaeological resources.
- Preserve—and, ideally, enhance—existing buffer zones along park boundaries. Many parks are engulfed by suburban, commercial, and industrial development. The use of vegetative plantings to create visual buffering at both the micro- and macro-scale from within a park can be a relatively inexpensive and effective alternative when additional land acquisition is not feasible. Think about internal sight lines and how vegetation can be used to screen distant undesirable views, or to create distinct interpretive zones within the park. For example, planting trees to the rear of the Malus-Beauregard House will help to screen it from the battlefield, setting this post-battle-era feature apart in its own character area. Also, replanting the historic cemetery allees will provide micro-scale buffering from the Kaiser Aluminum plant to the east of the park (see Figure 3).
- Use landscape materials to interpret hidden archeological or ethnographic resources. Using a simple footprint marking of contemporary brick or stone pavers to interpret a vanished historic building or structure renders an invisible feature visible, and makes a cultural landscape more legible to the visitor, especially when combined with period historic documents, such as photographs, paintings, or maps, that depict the vanished resource. The Rodriguez archeological site is presently unmarked, but could easily be interpreted using this technique.
- Lastly, concentrate on the quality of the visitor's experience while moving through the park. Is the visitor brought into contact with all the historically important features or aspects of the landscape? If a certain landscape feature or zone played into the historic events that occurred on site, is the visitor encouraged to explore these features? Provide access to the park's various ecological zones. A site's cultural history is never divorced from its ecology. A riverfront interpretive site at Chalmette would provide better site orientation to visitors arriving by riverboat, would encourage visitors who arrive by car to visit the riverfront, and would emphasize the river's importance to the battlefield scene and the site's later development.

Ethnographic Landscapes in Alaska: Preservation and Conservation Redefined

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It is a bit awkward to attempt to speak to the title of this presentation: "Ethnographic Landscapes in Alaska: Preservation and Conservation Redefined." While writing the initial proposal after arriving in Alaska a month earlier, I thought that by the time of the conference I would certainly be able to outline the approach of the cultural landscapes program toward the ethnographic landscapes of Alaska within the various National Park Service (NPS) units. In general, ethnographic landscapes are one of the four types of landscapes with which the cultural landscapes program is particularly interested—the others being historic designed landscapes, vernacular landscapes, and historic sites. Ethnographic landscapes are, in general, exceedingly difficult to define—both as abstractions, and as bounded entities in physical space (Birnbaum 1994, 1-2; Schoepfle et al. 1998, 2.1.1).

Now, some six months later, the complexity, scale, and the unique character of these landscapes is overwhelming. Retitling this presentation to something a bit more humble seems in order—perhaps simply, "Thoughts on the ethnographic landscapes in Alaska." With that disclaimer, I would like to make a few observations on Alaskan cultural landscapes, and then a few comments on the challenges of documenting and preserving ethnographic landscapes in Alaska, particularly within the framework of subsistence.

As a native Virginian who has spent a decade living and traveling throughout the American West, I can tell you with great certainty that Alaska is remarkably unique from the Lower 48 in many ways. As a historical landscape architect and ethnohistorian, I have found—even in my limited time there—that the landscape is exceedingly difficult to read in terms of cultural resources. In terms of cultural landscape methodology, historical landscape architects seek to discern the physical and spatial evolution of landscapes based on historical forces such as agrarianism, urbanism, and industrialism, among others. In the cultural landscapes in which the NPS has a legal interest in Alaska, only the latter applies—and that tenuously—in the various sporadic mining ventures and fish canneries. (One exception to the "sporadic" character of the mining landscapes in terms of sheer scale—as well as historical significance—would be the Kennecott National Historic Landmark in Wrangell-St. Elias National Park and Preserve.)

Added to the lack of familiar perspectives through which to view these landscapes is the sheer scale and immensity of the land in proportion to the human imprint. Revealing the cultural dimensions of landscape in Alaska becomes a radically different venture whereby subtler, less obvious human patterns and connections must be discerned.

One inherent difficulty is due to the distinctly Euro-American perspective through which much of Alaska has been viewed for the last century; namely, the wilderness paradigm. In a late-19th-century travel classic, John Muir's *Travels in Alaska*, the intrepid naturalist detailed his rapture with the Inside Passage of the southeast panhandle in 1879: "To the lover of pure wildness Alaska is one of the most wonderful countries in the world. No excursion that I know of may be made into any other American wilderness where so marvelous an abundance of noble, new-born scenery is so charmingly brought to view..." (Muir 1998 [1915], 13; emphasis added).

Muir's fascination with Glacier Bay was due to a fusion of his belief in the "glacial gospel" espoused by Louis Agassiz with the philosophic legacy of Transcendentalism, which held that humankind, in its denigration of the natural world, severed connections with the Divine, thereby losing their Edenic legacy. In the ideological

footsteps of Agassiz, Muir extolled this "noble, newborn scenery" as evidence that validated the glacial origins theory, in itself a scientific creation myth. By the reckoning of many, Muir was credited with the "discovery" of Glacier Bay. This, of course, was news to the Tlingit Indians who guided him through the different glacial bays, and whose presence in the area predated the most recent glacial period (roughly several hundred centuries) by at least a millennium, if not as much as 7,000 years.

The sharp contrast between the world views of Muir and the Tlingits illustrate the persistent dilemma of ethnocentric bias in defining the cultural landscape: the landscape that the Hoonah Tlingits harvested and cultivated with their fishing, hunting, and wild plant gathering was a Garden of Eden, a "Hoonah Breadbasket"; what Muir saw through the lens of the glacial origins and Transcendentalism was likewise a place of origin, but, significantly, without people: a wilderness, pristine, free of human corruptive influence, and in need of protection. When Glacier Bay National Monument was established in 1925, largely due to lobbying by the ecologist William Cooper and the Ecological Society of America, its enabling legislation completely ignored the aboriginal land claims of the Tlingit. Instead, Glacier Bay was to be an "outdoor laboratory" wherein the study of dynamic ecology—the model of plant succession—would be captured in a reborn landscape without human "interference" and preserved as a national "monument." Glacier Bay National Park and Preserve currently encompasses over 3.2 million acres of—depending on your perspective—glacial wilderness (2,770,000 acres or 85% of the federal holdings) or the various clan homelands of the Hoonah Tlingit (Catton 1997, 6-22).

In 1980, a century after Muir's encounter with the Tlingits, the Alaska National Interest Lands Conservation Act (ANILCA) was signed into law. Affecting 104 million acres, 28% of the state in an area roughly the size of California, ANILCA constituted, in the words of historian Roderick Nash, the "single greatest act of wilderness preservation in world history." In one stroke of the presidential pen, ANILCA created six new national parks and enlarged an existing one (Mount McKinley—now Denali), established two new national monuments, enlarged two others, and set aside two new national preserves. This "act of wilderness preservation" single-handedly doubled the number of acres in the entire National Park System, and by adding an additional fifty-six million acres to the National Wilderness Preservation System, more than tripled its size (Nash 1982, 272).

Even more striking, perhaps, ANILCA initiated an entirely new policy with respect to Indian land rights: in this case, those of the Native Alaskans, in particular the Inupiat and Inuit (northern and southern Eskimo) and the different groups of interior Athapaskans. Notably excluded are the coastal Athapaskans, which included the Tlingit. In the Lower 48 states, the creation of national parks signaled the eviction of any remaining Indian inhabitants (or others) by extinguishing their land claims; additionally, national park policies for resource protection and public access excluded any subsistence activities by instituting a ban on humans as hunters and gatherers. In ANILCA parks, the land rights of a pre-existing traditional culture were recognized as legal, in particular, those related to hunting and gathering activities in a "traditional use of their subsistence resources" (Nash 1982, 272-273; for a comprehensive history of ANILCA, see Williss 1985).

Despite an enduring and highly political controversy over the subsistence issue ever since, ANILCA reoriented planning and resource management in those national parks in Alaska to the importance of ethnographic research, ultimately impacting, to one degree or another, the non-ANILCA parks in Alaska as well as the rest of NPS. The dynamics of documenting and studying cultural landscapes in which the assessment of change over time is not limited to physical artifacts, but which includes the daily ecological demarcation and use of that landscape in a subsistence framework, are mind-boggling, at a minimum.

In the ANILCA parks, then, the enabling legislation mandated a form of cultural conservation—in this case, native subsistence culture. Thus charged with cultural conservation—which is, in itself, an ethnographic rather than ethnocentric perspective—we have a legal obligation to preserve and protect the full array of resources people use to define and sustain their cultures. First and foremost in the consideration of the ethnographic landscape, we must allow an alternative conception of history from that which has dominated Euro-American thought, namely “traditional histories” by which communities construct their past in their own terms. In traditional histories, communities validate their own stories as authoritative cultural history, whether based on myth, symbol, or event. For traditional cultures, landscapes are the physical and spiritual residence of an embedded history indivisible from the idea of place; in this context, environmental features assume a whole new dimension of meaning within a larger symbolic and cultural matrix (Downer et al. 1994, 56-65).

Documenting ethnographic landscapes through the medium of traditional histories, or “conserving history” as some have so eloquently stated, inevitably “shift[s] attention past sites and structures to the dynamic nature of the past and history-making” (Hufford 1994, 6). In doing so, we will continually be redefining the dimensions and types of “historic places” and their significance in terms of the National Register, to which the NPS cultural landscape program is tied. Although the mechanism for this is already in place in the designation of “traditional cultural properties,” I suspect that the study of Alaskan ethnographic landscapes will push the envelope in this category (Parker and King n.d.).

Given the “inhabited wilderness” of the ANILCA parks and the *de facto* historical legitimacy of ethnographic landscapes in parks such as Glacier Bay in which subsistence rights are not legally recognized traditional cultural ties to the landscape, we have some very compelling work ahead of us (Catton 1997). Whether as historical landscape architects, historians, or anthropologists, we are compelled to view these landscapes within the Braudelian *long durée*, or “long view.” ANILCA essentially redefined preservation and conservation in Alaska in legal terms; in the more practical application on the daily level, the situation is much less clear. We are in uncharted territory.

Essentially, we must strip off the wilderness goggles in order to understand the physical and spiritual dimensions of landscape through the traditional histories of the Alaska Natives. In most cases, these histories are contained within traditional oratory, narratives that unfold customary subsistence lifestyles and recount cultural origins in mythic time. In understanding this phenomenon—the legitimization of cultural authority other than the wilderness precept—we will uncover a delicate tracery of historic human use and modification of the landscape. The extant physical artifacts which signal these cultural landscapes range from the subtle, almost imperceptible prehistoric cairns along the North Slope as the boundaries of caribou drive lines to the nearly invisible trails and trap-lines emanating, web-like, from winter settlements and seasonal harvesting camps, and the more recent remains of salmon canneries on the once Tlingit-dominated salmon streams in the panhandle.

Attempting to historically reconstruct millennia-old interactions of people and environment in a symbiotic transformation is the penultimate ethnographic challenge. Nevertheless, even embarking upon this mission shatters the wilderness paradigm in these landscapes, damning here, if not for all time, the 1963 Leopold report recommendation that “the biotic associations within each park be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white man [so that] a national park should represent a vignette of primitive America” (Leopold et al. 1963). By ignoring or obfuscating the cultural impress of native peoples upon the lands and resources contained within national parks, this ethnocentric policy failed miserably to recognize the human as a quintessential factor in so-called natural park landscapes, thereby portraying these places with critical absences in their history.

What we have here, then, is the opportunity to develop a vision of landscape "before the wilderness," a landscape which, in fact, was a garden (Blackburn and Anderson 1993). This is no small task. While Alaska has been described as the last great battleground for conservationists—meaning, the last wilderness frontier—it likewise provides us with a chance to acknowledge and recontextualize the historical human presence in the landscape as one which, indeed inhabited the wilderness. Given the daunting task of inventorying these landscapes within the context of the National Register, it is a virtual certainty that, just as ANILCA transformed the management of national parks by including subsistence as a priority use, the study of ethnographic landscapes in Alaska will transform everything it touches. The arcane segregation of resource management into "cultural" and "natural"—much like the myth of wilderness—is no longer viable. If we are going to redefine park units in terms of cultural landscapes, we must present comprehensive portraits of ever-evolving cultural patterns of habitation and environmental cultivation within an ecological context in order for park managers to have the information they need to make sustainable decisions. As cultural landscape specialists, our interdisciplinary methodologies will need to be resilient and our stamina great. Wish us luck!

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Rethinking the Cultural Landscape: A Study of Thomas's Wharf on the Eastern Shore of Virginia

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There are landscapes where the history is deposited in layers, from prehistoric to historic activities. Significance is derived from the fact that fragments of these many periods and histories can be read on the landscape; a palimpsest. One such landscape is a seaside property on the Eastern Shore of Virginia, owned by the Nature Conservancy's Virginia Coast Reserve. A management and preservation plan was developed for this property, known locally as Woodland Farm and Thomas's Wharf, according to the method established by the National Park Service (NPS). The method includes four steps: A cultural landscape is identified through (1) historical research and (2) inventory and documentation of existing conditions; evaluated through (3) a site analysis and assessment of significance and integrity; and finally, (4) preserved through recommendations for future management. A significant issue was raised during the process: does National Register significance begin to address the landscape as a palimpsest, a record of past people and activities that are significant to the local area and community?

Farms on the Eastern Shore of Virginia typically comprised several hundred acres and a wharf for water access and travel. Bayside land adjacent to waterways was quickly patented and settled by the mid-17th century (Whitelaw 1951). A shift in this steady settlement pattern came in 1633 when the first land was patented on the seaside. The continued settlement of land with access to water gave rise to a very dispersed population, with few organized towns. With a water- and agriculturally based economy, the people of the Eastern Shore focused little on the physical structure of local towns as trade centers. Centers of business were the private wharves that were built on waters adjacent to patented lands.

Characteristics, or features, of a landscape are specific to the place and the people who settled that place. The peninsula that constitutes the Eastern Shore is bounded by the Chesapeake Bay to the west and the Atlantic Ocean to the east. Water greatly influences the way people live and work. Because of little need for overland travel due to the ease of water transportation, the Eastern Shore was made up of a rural and dispersed population. Dense communities formed along the railroad line in the late nineteenth century, radically changing the way local farmers marketed, sold, and transported their goods. Focus eventually shifted inward, from the water to the center of the peninsula. With change came significant changes in the landscape. Landscapes near and of the water, once very numerous, were abandoned as associated activities such as commercial fishing and shipping began to disappear. Thomas's Wharf is a good example of what remains of these traditional landscapes on the Eastern Shore.

First patented in 1647, Woodlands is a seaside farm with one of the few deep-water access ports on the Matchipongo River. The significance of its port, Thomas's Wharf, is one that spans many periods. One period alone does not stand out as the most important. What does stand out is the evolution of the landscape, land use, and activities that occurred at and on this isolated bit of upland. Remnants of each of those periods, spanning Native American settlement, the establishment of the shipping and seafood industries, and traditional farming, can be found in this one place.

Thomas's Wharf is representative of the continuum of history and culture on the Eastern Shore of Virginia and should be recognized as significant for this reason. First, it is recognized as a significant settlement site of the Machipungo Indian tribe. Most histories written about Virginia's Eastern Shore make mention of the large seaside villages of Native Americans. Both Woodlands Farm and the adjacent property of Brownsville were significant sites during this era.

Second, extensive shipping took place along the Matchipongo River for hundreds of years, and it occurred at Thomas's Wharf. The first recorded shipping expedition of sweet potatoes to New York City in 1827 was the work of a small company that had ties to Thomas's Wharf. John T. Wilson, partner in the company, was living at Woodlands at that time, thus hinting at a very active wharf. Steamboats also frequented Thomas's Wharf during the 1880s and 1890s, making regular stops once or twice a week during the busy growing season to take goods to the mainland of Virginia or to northern ports. Finally, illegal shipments of liquor were common during Prohibition. One such shipment was raided in 1930 at Thomas's Wharf. Will Stevens, farmer and landowner of the wharf, was arrested with several local and out-of-town men for transporting and storing illegal, foreign liquor. Not only was it a shock to the local community, the liquor raid was news for the whole Eastern Shore and Virginia Tidewater.

Traditional activities on the Shore included fishing and farming, both of which continue today. Local watermen depend greatly on having suitable and ready access to the water. From about 1903 to 1909, the Battle Point Fish and Oyster Company was operated by James A. Marian and his brother-in-law, Will Stevens. Built out at Thomas's Wharf to support the fishing activity was a wharf, oyster house, and a dwelling with outbuildings. After the close of the fish company, Will Stevens and his wife Malissa continued to live and farm at Thomas's Wharf. Living in a two-story frame dwelling with several outbuildings placed along the edge of the cultivated field, they worked the land until 1955, when Thomas's Wharf was sold to the commercial fishing company of Standard Products.

Finally, the one element of the physical location of Thomas's Wharf that resulted in consistent use throughout history was its deepwater access. Bathymetric readings have shown the depth of the channel at the point of the wharf to be 66 feet, and it has been consistently the same depth since the first recorded reading in the late nineteenth century. Access is certainly the outstanding attribute of this landscape that influenced the layers of history and culture deposited at Thomas's Wharf.

Today, Thomas's Wharf is a landscape of ruins. The few structures remaining are in the process of decomposing, while others have been carried away by the sea. Those defining features that do remain are subtle hints of past activities and movement that provide the site with a high level of integrity: the traces of old roads through the marsh, fence posts defining edges of usable space, piers rising from the marsh, a lone utility pole, brick scatters, wood shingled roofs resting on the ground, a concrete walk leading to concrete steps, early spring daffodils, and rose bushes. The upland that comprises Thomas's Wharf has changed slowly over time. Pioneer species have taken over the edges of upland, creating a wall of vegetation encompassing the cultivated field. Successive vegetation now grows where once there was a house, a foundation pier, and a garden. The rapid growth of successive vegetation has changed views to and from Thomas's Wharf, but overall the landscape has retained a significant amount of integrity.

In proposing to look at the significance of Thomas's Wharf as an archive, the issue of ordinary landscapes is addressed. The history of the wharf does not speak about great design or intention, but rather the everyday living as the impetus of settlement and change. Thomas's Wharf is an ordinary landscape. No great American citizen was born or lived there. No great battle was fought. It is a typical seaside landscape on the Eastern Shore of Virginia, a place where activity was frequent. Most importantly, it is a landscape of memory: memory in the remnants of prehistoric and historic human culture and memory in those people who recall when the wharf was in use. For the community of seaside residents and Eastern Shoremen, Thomas's Wharf is of local significance and a cultural treasure; one of the few places where the many histories of the Eastern Shore are not wholly erased.

NPS defines "cultural landscape" as "a geographic area associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values" (Birnbaum

and Peters 1996, 4). This definition is very broad and needs to be qualified, for it condenses cultural landscapes into four categories: those associated with a historic event, a historic activity, or a historic person, or those having other cultural or aesthetic values. The first three categories are very precise. A site is either important because it was the site of an event, a birthplace, or residence. It is important because the time period or person is easily recognized, such as its being the site of a Civil War battle or the birthplace of a famous American. What the definition does not address in great detail is the fourth category, or the cultural geographer's cultural landscape, "the landscape made by humans" (Lewis 1979, 11). This definition refers to the landscape that we see around us and live in on a daily basis: in other words, the ordinary landscape of everyday life. These places or areas are not associated with any event or person, but are representative of the evolution of generations of changes that have occurred, and continue to occur. All landscapes are altered by humans, and the question to ask is how and why these landscapes changed: what are the forces, issues, or technologies that dictate change in the landscape (Melnick 1983, 85-86)?

According to the National Register criteria for evaluation of significance, Thomas's Wharf's significance lies in criteria A and D: (A) association with events that have made a significant contribution to the broad patterns of history and (D) have yielded, or are likely to yield, information important in prehistory or history (McClelland et al. n.d., 20). What these two areas do not address is Thomas's Wharf significance as a place where layers of human influence on the landscape, both visual and just under the surface, have accumulated with little disturbance. Nature is changing the wharf landscape, deteriorating its characteristics (such as built structures), introducing vegetation, and manipulating topography. But remnants still remain.

Does the National Register definition of significance really begin to address Thomas's Wharf as a record of past people and activities that are significant to the local area and community? As determined from this study, National Register significance as proposed by NPS does not address a landscape, such as Thomas's Wharf, as a property that is part of the continuum of history. The National Register criteria limit the study of landscapes by not acknowledging them as significant because of their place in the continuum. Thomas's Wharf cannot be narrowed down to an event or individual. It is a place that is more broadly significant.

NPS has addressed the importance of landscapes as a context for traditional historic sites, as well as being an important cultural resource. The documentation, evaluation, and preservation of cultural landscapes, as proposed by NPS, is intended for a broader understanding of time, place, culture, and history. But the categories provided do not encompass the full significance of Thomas's Wharf.

Looking closely at the context of which the landscape is a part informs us and shapes our expectations and perceptions of a place. It gives some clues as to what is important in the landscape and why. These clues reveal how a place evolved and changed over time. And it is this evolution that is key to understanding the significance of Thomas's Wharf. The process of change and the remnants it leaves are critical in order to preserve and to continue experiencing the landscape. Knowing that landscapes are inherently dynamic, continued use will deposit another layer of change. The key is to continue using a property without disturbing what remains of previous histories.

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Visitor Impact at Logan Pass, Glacier National Park: A Thirty-Year Vegetation Study

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Introduction

Visitors have become an increasingly important ecological component in the alpine and subalpine regions of Glacier National Park. This research project was conducted to determine the nature and degree of disturbance, triggered by human activities, to the dry-meadow plant communities at Logan Pass. A portion of that long-term study is presented here.

While the problems of recreational damage to high-mountain vegetation have been recognized and described for over 85 years, detailed scientific research into these problems has been undertaken only during the past three or four decades (Price 1985). When this study was initiated in 1967, quantified, statistically designed visitor impact studies were rare. More recently, visitor impact studies have been conducted around the world which provide valuable baseline information—often geared to help guide resource managers.

In reviewing visitor impact studies, particularly those involving trampling treatments, it was discovered that most described the initial rates of deterioration, but very few continued plant community analysis and recovery beyond the first two or three years. In three exceptions, the studies ran four to eight years (Bayfield 1979; Grabherr 1982; Lance et al. 1989). Bayfield's (1979) trampling study recorded data for eight years, and concluded that "observation over a substantial period seems necessary to assess the responses of slow growing mountain vegetation to disturbance by trampling." Cole (1985) also pointed out the inadequacies of applying only one year of trampling treatments, and has initiated a long-term study in which trampling is being applied year after year until year-to-year change in vegetation and soil conditions becomes minimal.

Study Sites

Logan Pass, elevation 6,680 ft (2036 m) on the Going-to-the-Sun Road, is a prime park destination receiving large numbers of park visitors. This recreational demand triggers an overwhelming impact on vulnerable, herbaceous vegetation. Therefore, the study plots were placed near the Logan Pass Visitor Center.

Field Methods

The objectives were to ascertain any significant departure from unimpaired conditions in subalpine dry-meadow vegetation and to estimate the rate and direction of change triggered by human trampling. The research design included:

1. Studies on the number, distribution, and behavior of visitors to determine visitor densities, use patterns, and activities impacting high-mountain vegetation.
2. Vegetation sampling of trail-side plant communities to determine changes in vegetation brought about by long-term, *unquantified*, off-trail trampling. Sampling was accomplished by a point-quadrat method at decimeter intervals along transects running perpendicular to trail axes.
3. Experimental treatment plots placed in analogous plant communities to measure rates of vegetational change from *known quantities* of trampling treatments. Plots were designed to separate the impact of trampling on plants and soil from the impact of picking flowers and leaves without soil compaction. The nine subplots within the 3x3-m plots were given three levels of trampling treatments per week (0-15-50) and three levels of clipping (0-1-2) in 1967 (Figure 1). The plots were sampled using point-quadrats in a stratified random pattern. Periodic flower counts as a measure of reproductive potential were made throughout the study.

4. Laboratory analysis of underground carbohydrate reserves in selected plants to discover if metabolic pathways were blocked by trampling effects (see Hartley 1976).

	T-0	T-15	T-50
C-0	T-0 C-0	T-15 C-0	T-50 C-0
C-1	T-0 C-1	T-15 C-1	T-50 C-1
C-2	T-0 C-2	T-15 C-2	T-50 C-2

• 1968 — 1 year	• 1982 — 15 years
• 1969 — 2 years	• 1986 — 19 years
• 1973 — 6 years	• 1987 — 20 years
• 1976 — 9 years	• 1992 — 25 years
• 1977 — 10 years	• 1997 — 30 years

Figure 1, top: 3x3-m-sq plot with nine subplots. Left column (T-0) not trampled, middle column (T-15) trampled 15 times per week during the summer of 1967, right column (T-50) trampled 50 times per week during the same period. Top row (C-0) not clipped, middle row (C-1) clipped 19 July 1967, bottom row (C-2) clipped twice: 19 July and 11 August, 1967. Bottom: Yearly samples since treatments. The years in which plot sampling took place and the number of recovery years or number of seasons since treatments.

Results

Visitors. Between 1910 and 1998, approximately 67 million people visited Glacier National Park. During its 88-year history, annual park visitation increased from about 4,000 visitors the first year to over 2 million per year in the last decade, for an average 1.1% increase per year. However, the problem at Logan Pass is not just the total annual visitation; it is the concentrated seasonal distribution of visitors exactly coinciding with the short growing season. In early to mid-June, the snow plows open the Going-to-the-Sun Road and for the next 100 days Logan Pass receives 59% of the total park travel. The Logan Pass Visitor Center receives approximately 36% of the total park travel (Heyward et al. 1984). As seen in Figure 2, human impact at Logan Pass becomes most concentrated and therefore most critical at mid-day, on weekends, and during July and August.

Hidden Lake Trail is the most popular alpine-subalpine trail in the park. During mid-day in mid-summer, 200 to 300 people per hour are on this trail. One thousand per day is common (Tara Williams, Glacier National Park ecologist, personal communication, 1999). High visitor concentrations lead to the greatest destructive forces to trail-side vegetation. Small groups meeting on narrow trails often cause one or both groups to step off the trail, allowing the oncoming hikers to pass. Average hiker group size on Logan Pass area trails range from 2.6 hikers (Jope 1982) to 3.3, but about 25% are in groups of six to eight persons (Hartley 1976). From 1969 to 1972, the use of Hidden Lake Trail increased at an average rate of 25% per year (Seibel 1974). Visitor pressure became so great and trail maintenance so inadequate in the 1970s that the park found it necessary to harden the site by constructing an 8-ft-wide elevated boardwalk to protect the fragile ecosystem through which this busy trail traverses.

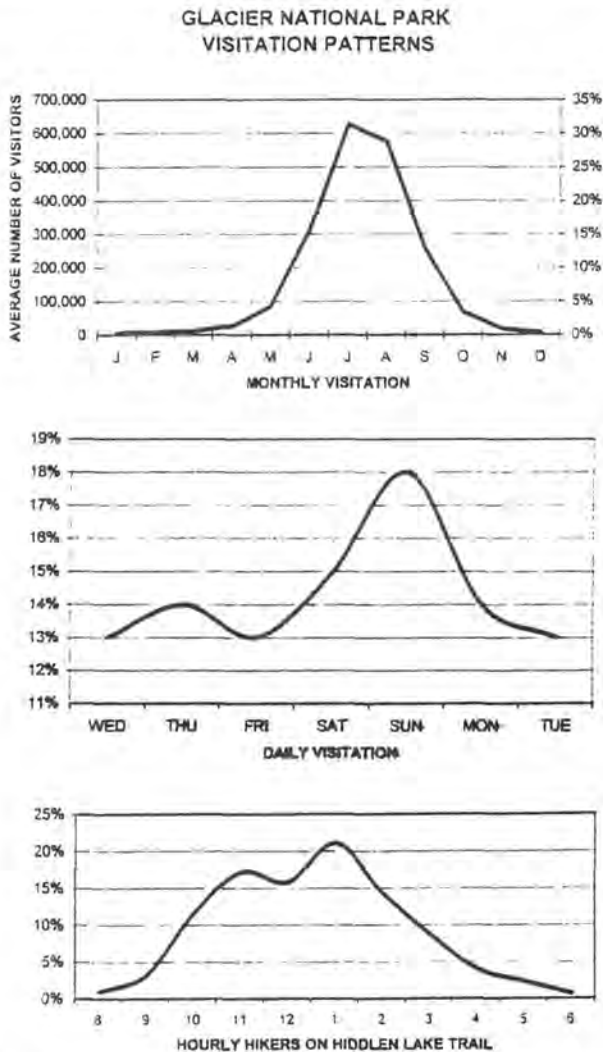


Figure 2. Glacier National Park annual and weekly visitation patterns; typical daily pattern on Hidden Lake Trail.

Trail-side vegetation sampling. In the summers of 1967, 1968, and 1969, 40,000 points were sampled along the heavily used trails in the Logan Pass area (Hartley 1976). In 1997, two sites were revisited: one near the lower end of the boardwalk on Hidden Lake Trail and the other near the head of Highline Trail. Grasses and sedges were dominant near the trail's edge at both sites and decreased in frequency with increasing distance from the trail. The frequency of several species, including *Erythronium grandiflorum*, *Erigeron peregrinus*, and *Sibbaldia procumbens*, was positively correlated with distance from the trails.

Along the Highline Trail, there was a very clear reduction in species diversity at trail's edge, with only seven species found in the first 0.5 m, dominated by *Carex nigricans* and *Carex phaeocephala*. At 1.5-2.0 m from the trail, 20 species were sam-

pled, dominated by *Erythronium grandiflorum* and *Luzula wahlenbergii*. At 2.5-3.0 m from the trail, *Arnica alpina* and *Erythronium grandiflorum* dominated among the 24 species recorded. Monocots, such as *Carex* species, and grasses dominated the trail-side plant community while herbaceous dicots were predominate at greater distances from the trail.

Experimental treatment plots. Frequency ratios of vegetation, litter, and bare ground averaged 90%, 15%, and 5%, respectively, in undisturbed dry-meadow vegetation near the peak of leaf-stem-flower development during July. By August, as senescence progressed, vegetation cover often decreased to 50%, while litter increased to 30% and bare ground to 20%. These natural, seasonal ratios shifted to greater extremes when the plant community was subjected to trampling treatments. Heavy trampling reduced vegetation cover to as little as 10-15% as dead plant material and bare ground increased to 85-90%. Vegetation cover in the heavily trampled plots took 25 years to return to about 90% cover. Those subplots receiving a single clipping and light trampling recovered to a greater degree than those receiving two clippings and heavy trampling.

Vegetation cover (all species combined) decreased dramatically during the 1967 season in direct response to trampling and clipping treatments. The subplots receiving 50 trampling treatments per week and two clippings experienced a vegetation cover loss from 80-90% in the early season before trampling to 8-15% at season's end after trampling. Fifteen trampling treatments per week caused a mean cover decrease of 24%. Overall, mean cover loss was 3.2% per weekly trampling treatment.

After 2, 20, and 30 years, the heights of the two most conspicuous species in the dry meadow, *Erythronium grandiflorum* and *Erigeron peregrinus*, were measured to find a means of detecting any long-term residual effects of trampling. Analysis of variance (ANOVA) of the 1969 data clearly showed statistically shorter plants and lower carbohydrate reserves in the trampled subplots when compared with untrampled controls (Hartley 1976). In 1987, after 20 years, and again in 1997 after 30 years, *Erigeron* inflorescence heights were still significantly shorter in trampled subplots than in controls. *Erythronium* heights were not significant in 1987 and in 1997. Plot sampling revealed, however, that significantly fewer individuals of both *Erythronium* and *Erigeron* were growing in the trampled subplots than in controls.

Flower counts within treatment plots of all species in flower were recorded 20 times during the 30-year period to measure reproductive potential of each species. The highlights from the 30th year are: (1) *Erigeron peregrinus* counts were significant between trampling treatments in one plot, but not when all four plots were combined; (2) *Erythronium grandiflorum* flower counts were significant in one plot, but not when all plots were combined; and (3) *Phyllodoce empetriformis* disappeared from the treatment plots in 1967 and none was seen for 25 years until 1992. In 1997, it had returned to its approximate pre-1967 distribution.

Figure 3 shows species response to treatments after 2, 15, and 30 years. The species mix changes from the early view in 1969 to the latest view in 1997. Five species—*Epilobium alpinum*, *Juncus drummondii*, *Phyllodoce empetriformis*, *Polytrichum juniperinum*, and *Sibbaldia procumbens*—continue to show significant differences 30 years after treatments.

The dry meadow of Logan Pass is dominated by *Erythronium* in July and *Erigeron* in August. Their showy inflorescence cover many hectares and draw millions of visitors into the Logan Pass trail system. As a result of off-trail trampling, these species are diminished at trail-side (Figure 4) and in experimentally trampled plots.

Discussion

Wilderness areas, ostensibly managed to perpetuate natural ecosystems, are often compromised by recreational use (Cole 1985). Alpine ecosystems are particularly

Two years after treatment: 1969 random point sample, all plots combined			
		Trampling treatments	
		Not significant	
		Significant @ 5% level	
Clipping treatments	Not significant	<i>Carex nigricans</i> (CN) <i>Carex tolmiei</i> (CT) <i>Claytonia lanceolata</i> (CL) <i>Hieracium gracile</i> (HG) <i>Hypericum formosum</i> (HF) <i>Juncus drummondii</i> (JD) Litter (LT) <i>Senecio resedifolius</i> (SR)	Bare ground (BG) <i>Epilobium alpinum</i> (EA) <i>Erythronium grandiflorum</i> (EG) <i>Luzula wahlenbergii</i> (LW) <i>Poa alpina</i> (PO) <i>Polytrichum juniperinum</i> (PX) <i>Sibbaldia procumbens</i> (SP) Total vegetational cover (VG)
	Significant @ 5% level	No species in this category	<i>Erigeron peregrinus</i> (EP)
Fifteen years after treatment: 1982 random point sample, all plots combined			
		Trampling treatments	
		Not significant	
		Significant @ 5% level	
Clipping treatments	Not significant	<i>Carex nigricans</i> (CN) <i>Carex tolmiei</i> (CT) <i>Claytonia lanceolata</i> (CL) <i>Epilobium alpinum</i> (EA) <i>Hieracium gracile</i> (HG) <i>Hypericum formosum</i> (HF) Litter (LT) <i>Luzula wahlenbergii</i> (LW) <i>Poa alpina</i> (PA) <i>Senecio resedifolius</i> (SR)	Bare ground (BG) <i>Erythronium grandiflorum</i> (EG) <i>Erigeron peregrinus</i> (EP) <i>Juncus drummondii</i> (JD) <i>Phleum alpinum</i> (PH) + <i>Poa alpina</i> (PO) <i>Sibbaldia procumbens</i> (SP) Total vegetational cover (VG)
	Significant @ 5% level	<i>Polytrichum juniperinum</i> (PX)	No species in this category
Thirty years after treatment: 1997 random point sample, all plots combined			
		Trampling treatments	
		Not significant	
		Significant @ 5% level	
Clipping treatments	Not significant	<i>Arabis drummondii</i> (AD) <i>Carex nigricans</i> (CN) <i>Carex tolmiei</i> (CT) <i>Claytonia lanceolata</i> (CL) <i>Deschampsia caespitosa</i> (DC) <i>Erigeron peregrinus</i> (EP) <i>Erythronium grandiflorum</i> (EG) <i>Hieracium gracile</i> (HG) <i>Hypericum formosum</i> (HF) Litter (LT) <i>Luzula wahlenbergii</i> (LW) <i>Poa alpina</i> (PA) <i>Phleum alpinum</i> (PH) <i>Senecio resedifolius</i> (SR) Total vegetational cover (VG) All grasses combined	Bare ground (BG) <i>Epilobium alpinum</i> (EA) <i>Polytrichum juniperinum</i> (PX) <i>Sibbaldia procumbens</i> (SP)
	Significant @ 5% level	<i>Juncus drummondii</i> (JD) <i>Phyllodoce empetriformis</i> (PE)	No species in this category

Figure 3. Differential species response to trampling and clipping treatments after two, fifteen, and thirty years as analyzed from combined plot data in a two-way analysis of variance. Significance at .05 or greater.

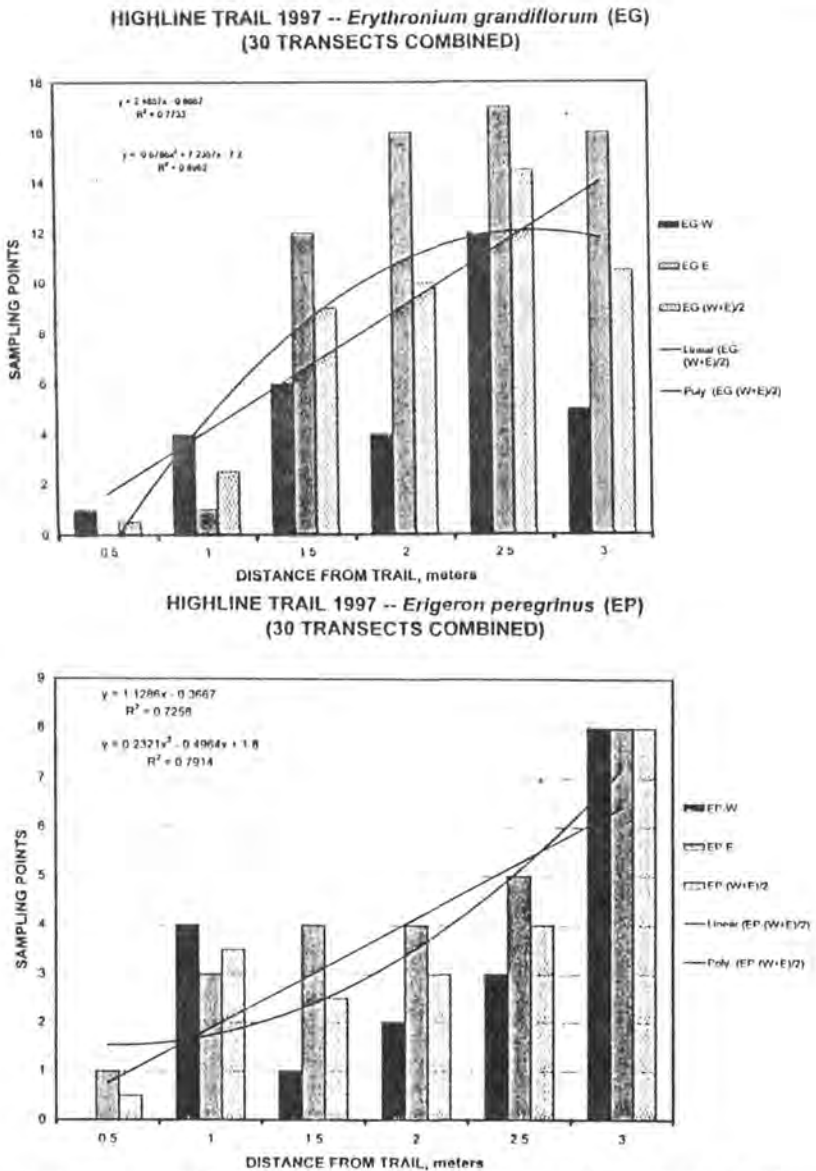


Figure 4. Distributions of two species, *Erythronium grandiflorum* and *Erigeron peregrinus*, among 24 species sampled along Highline Trail 21-28 m from Going-to-the-Sun Road at Logan Pass, 7 August 1997. On each side of trail, 15 three-m transects were placed perpendicularly to trail with sampling points at 1-dm intervals; 900 sampling points this study.

vulnerable to the presence of people in any numbers. There is a high degree of incompatibility between use by people, directly or indirectly, and the maintenance of ecosystem integrity in high mountains (Billings 1979). Strategies for solving the problems created by this inevitable incompatibility are presented by Cole, Petersen and Lucas (1987), and others.

If this study had ended in 1973 after a six-year period, only the data and conclusions from three sampling seasons would be available (Hartley 1976). However by continuing sampling about every five years thereafter, ten seasons of plot sampling and an additional quarter-century of useful data are available to enhance the understanding of long-term effects of trampling to the dry-meadow communities at Logan Pass. The 30-year data appears to show residual effects from trampling and clipping treatments rendered in 1967.

Trampling destroys photosynthetic tissue and triggers an energy-flow rate decrease through the plant. Stored carbohydrate in the underground portions of subalpine plants is at a lower-than-normal level; therefore, over-winter survival and early growth the following year are jeopardized. This depleted condition reduces the plant's ability to produce photosynthetic tissue the following year. Thus, plants are smaller and produce fewer flowers in the season following trampling treatments. Continued trampling triggers further breakdown of the system, leading to death of the plant (Hartley 1976). It is unknown how many growing seasons are required for return to normal metabolic rates, but current observations strongly suggest that full recovery may require many decades. Vegetation cover (all species combined) in plots took 20 years or more to return to pre-treatment levels (Figure 5).

LOGAN PASS TRAMPLING IMPACT STUDY
VEGETATION COVER 1967-1997
ALL PLOTS COMBINED

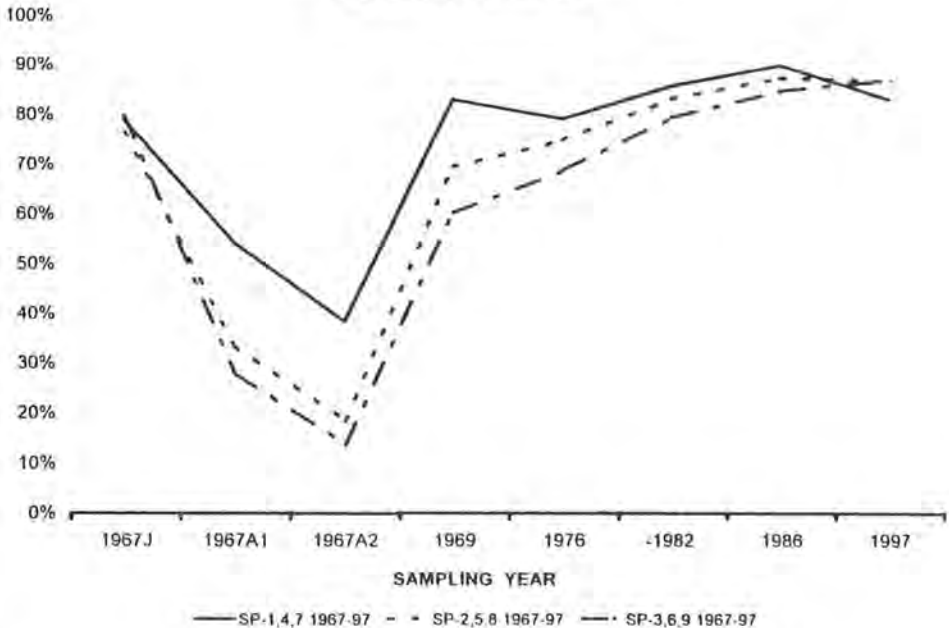


Figure 5. Total vegetation cover, combined data from four plots showing cover loss during 1967 and subsequent recovery through 1997. Top line: subplots 1 [C-0, T-0], 4 [C-1, T-0], and 7 [C-2, T-0]. Middle line: subplots 2 [C-0, T-15], 5 [C-1, T-15] and 8 [C-2, T-15]. Bottom line: subplots 3 [C-0, T-50], 6 [C-1, T-50], 9 [C-2, T-50]. T = trampling intensity. C = clipping intensity 1967] = July 1967. 1967A1 = early August 1967. 1967A2 = late August 1967.

Flower count data in 1997 also suggests some 30-year residual effects: *Erigeron peregrinus* stem heights were shorter in a heavily trampled subplot when compared with control subplots in one plot, but not when all plots were combined. Further analysis of the plot data may clarify this enigma.

Single individuals walking through the subalpine dry meadow vegetation usually leave imperceptible traces, but even a small group walking in single file leave a path of crushed plants (Hartley 1979). Such damage is temporary if the action is not repeated, but research strongly indicates that other visitors will see the path, retrace it, and perpetuate the disturbance. Just such an informal path was discovered in 1969 and was photographed. Photographic monitoring then continued through the years. The path continued to receive foot traffic and to persist for about 20 years. After a decade of abandonment, the path was recovering nicely in 1997, thanks to National Park Service protection.

Conclusions

The long-term implications of human impacts cannot be learned from short-term observations. Researchers should consider the real time invested in the actual field study in contrast to the real time required for full recovery. Liddle and Kay (1987) differentiated between survival after damage versus recovery after damage. To gain the most useful scientific and management information concerning plant community integrity and individual species responses from trampled plots, they should be monitored through a substantial portion of the recovery stage.

Recovery from a soil conservation perspective might well be satisfied by a return to normal ground cover by whatever species best holds the soil in place. Recovery from the perspective of ecosystem integrity, however, is not just a return to natural ratios of living vegetation cover, decaying plant litter, and bare ground. Recovery should be viewed in terms of a return to near-natural frequency and density ratios of species making up the plant community prior to the destructive impacts. There is no question that long-term studies have a much higher financial and human resource cost, but the results will equip resource managers with more reliable data upon which to base their management decisions. Long- rather than short-term studies provide more useful data in determining recreational carrying capacity and more clearly establish the limits of acceptable change.

Acknowledgments

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Post-Hurricane Vegetation Dynamics in Old-Growth Forests of Congaree Swamp National Monument

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Severe windstorms can influence vegetation structure and dynamics in temperate floodplain forests by causing direct mechanical damage and tree mortality. The vegetation structure of the forest, particularly species composition and stand age, also can influence the nature and extent of wind damage (Foster and Boose 1995). In floodplain forests, the hydrologic regime, particularly the depth and duration of flooding or of soil saturation, is the major environmental factor affecting tree species establishment and growth. In the southeastern United States in particular, hurricane-induced changes in the biotic and abiotic environment can interact with the underlying hydrologic regime to shape future forest composition. Furthermore, human alterations of floodplain ecosystems, especially changes to the hydrologic regime (including sediment transport and deposition), fire regimes, and herbivore populations, also may influence long-term forest establishment patterns.

This paper will focus on the impacts of Hurricane Hugo on the bottomland hardwood, slough, and seep forests of Congaree Swamp National Monument in South Carolina. This is the best example of old-growth bottomland forest that remains in the Southeast (Davis 1996). Hugo was a Category 4 hurricane when it struck the coast of South Carolina in September 1989. It maintained wind speeds in excess of 155 km/hr as it moved inland past the Congaree (Putz and Sharitz 1991). Hurricane Hugo may have been one of the most severe storms to strike South Carolina this century, but forests of this region have been subjected to 13 hurricanes in the last 110 years (Purvis et al. 1989). Thus, forest structure in the Congaree has been influenced by this long history of severe wind storms, as evidenced by tree architecture that reveals extensive loss of branches and resprouting from past storms (Putz and Sharitz 1991). The numerous trees of record or near-record size, often exceeding 50 m in height (Jones 1997; Thompson 1998), for which the Congaree Swamp National Monument is famous, are routinely subject to destructive winds.

Hurricane Hugo altered the composition of the Congaree forests by causing species-specific tree mortality (Sharitz et al. 1992; Allen et al. 1997). Damage type and extent differed across the forest communities, suggesting variable interactions between the vegetation and hurricane winds (Putz and Sharitz 1991). Likewise, recruitment of seedlings in the years following the hurricane has been influenced by the level of disturbance as well as by the hydrologic regime of the floodplain (Allen et al. 1994). The relatively short return interval for hurricanes and other severe wind disturbances relative to the life spans of the trees causes this to be a disturbance-mediated forest (Battaglia 1998).

The objectives of this study were to address two questions concerning hurricane impacts on forest composition and structure in the Congaree Swamp National Monument: How has stand composition changed over the eight years following the hurricane? and, Has the hurricane changed the future composition of the forest?

Methods

Study site. The Congaree River floodplain is a dynamic alluvial system located on upper edge of the Coastal Plain, in central South Carolina. The watershed of the Congaree River and its tributaries drains about 1.8 million ha (Knowles et al. 1996). Sediment eroded from agricultural lands in the Piedmont has been carried downstream and deposited on the river floodplain below the fall line. Congaree Swamp National Monument, established in 1976, occupies 8,900 ha. The vegetation within the national monument is strongly influenced by the hydrologic regime, especially by flooding frequency and duration. Bottomland hardwood forests, which cover a large

part of the floodplain, are flooded for short periods during the winter but are usually relatively dry during the growing season. These species-rich forests are dominated by *Liquidambar styraciflua*, *Quercus* spp. (at least 9 species), *Fraxinus pennsylvanica*, and *Pinus taeda* in the canopy, and by *Ilex opaca* in the understory. Slough forests occupying the low-lying areas, often old stream channels, are flooded for extended periods and are characterized by *Nyssa aquatica* and *Taxodium distichum*. Floodplain areas near the adjacent upland that are fed by groundwater and remain saturated throughout the year, called "seeps," are dominated by *Nyssa sylvatica* var. *biflora*. Nomenclature follows Radford et al. (1968).

Vegetation sampling. By studying vegetation in permanent plots through time, we may be able to identify and predict changes in community composition. Immediately following the hurricane, ten 1-ha permanent plots—six in bottomland hardwood forests, three in slough forests, and one in a seep forest—were established (Sharitz et al. 1992). Plots were arrayed across a gradient of forest damage, with three of the bottomland hardwood plots in heavily damaged areas and three in more lightly damaged areas. All woody stems ≥ 10 cm dbh (diameter at breast height) were measured, mapped, and assessed for hurricane damage and extent of vine cover. These plots were re-sampled in 1994 and 1998.

Results

Tree dynamics. Hurricane damage was much greater in the bottomland hardwood forests than in the seep or slough forests. In the bottomland hardwood plots (all plots combined), stem density dropped initially from 435.7 stems/ha to 386.2 stems/ha, and recovered to 428.2 stems/ha by 1998. Basal area also dropped from 45.4 sq m/ha to 36.4 sq m/ha, and recovered only to 38.1 sq m/ha by 1998. Large *Quercus* spp., *Pinus taeda*, and *Liquidambar styraciflua* suffered proportionally-greater hurricane mortality than did other canopy and subcanopy species. Slough forests were lightly damaged, and stem density and basal area have remained relatively constant at 641.7-652.3 stem/ha and 66.2-68.1 sq m/ha (Figure 1). The canopy dominants, *Nyssa aquatica* and *Taxodium distichum*, suffered primarily branch damage and had quite stable stem densities and basal areas. In the seep forest, density was reduced slightly to a low of 603 stems/ha after the hurricane and has since increased to 679 stems/ha in 1998, primarily due to recruitment of new *Nyssa sylvatica* var. *biflora* and *Liquidambar styraciflua* stems. Basal area in this forest has remained stable (42.5-44.6 sq m/ha).

Hurricane damage within the bottomland hardwood forest was patchy; different patterns emerge if we examine areas of low and high damage. In low-damage areas, 21-46% of trees ≥ 40 cm were snapped off, uprooted, or had extensive loss of branches. In the high-damage areas, damage levels ranged from 58 to 68% of the trees ≥ 40 cm. Pre-hurricane composition differed between the two groups of bottomland hardwood plots (Figure 1). The forests that were more lightly damaged were dominated by *Liquidambar styraciflua* (65% of basal area), *Quercus* spp. (9%), and *Ilex opaca* (11%). The high stem density in these plots reflects a high density of *Ilex opaca*, a shade-tolerant subcanopy species. Areas of high damage had lower stem densities and a more even species distribution, with *Liquidambar styraciflua* making up 43% of the basal area prior to the hurricane. Other canopy species, particularly *Quercus* spp. (15%), *Pinus taeda* (13%), and *Fraxinus pennsylvanica* (10%), were important components of these forests prior to the hurricane.

In bottomland hardwood areas with low damage, density dropped by 29.4 stems/ha after the hurricane and remained stable over the following eight years. Basal area was reduced 11% from 47.3 sq m/ha before the hurricane to 42.2 sq m/ha immediately afterward, and recovered to 43.5 sq m/ha by 1998. In more highly damaged areas, density was reduced from 356.7 stems/ha to 287.0 stems/ha after the hurricane, but recovered to 366.7 stems/ha by 1998. In these plots, basal area dropped 30% from 43.5 sq m/ha to 30.6 sq m/ha post-hurricane, and has recovered

only 0.3 sq m/ha/year, to 32.8 sq m/ha in 1998. At this rate of recovery, it will take about 50 years for the forest to reach pre-hurricane levels of basal area.

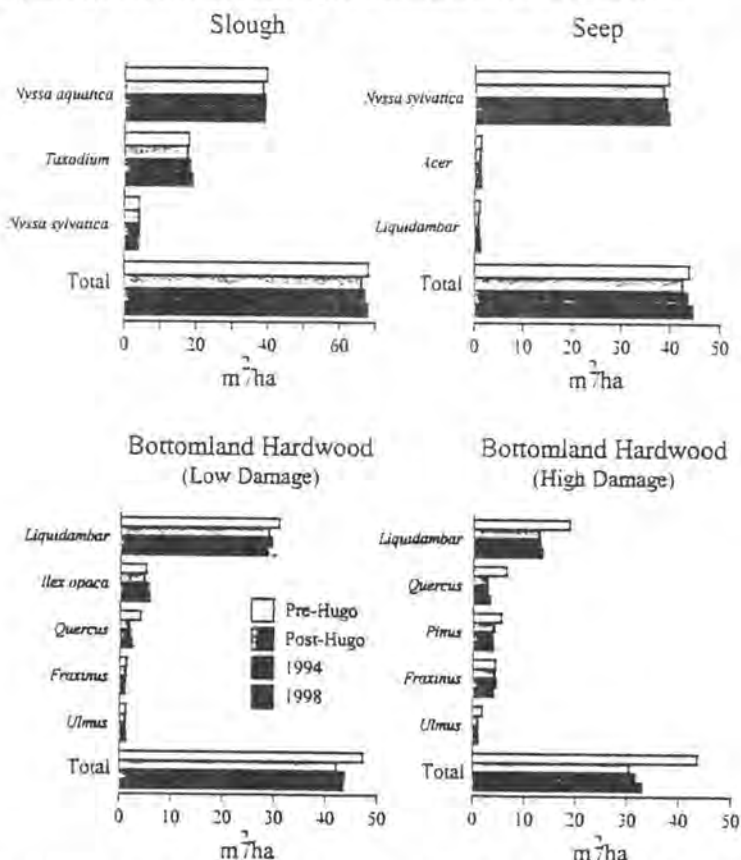


Figure 1. Changes in basal area of trees ≥ 10 cm in slough, seep, and bottomland hardwood forests of Congaree Swamp National Monument

Tree mortality patterns. Tree mortality rates were not uniform among species and forest types (Figure 2). In seep and slough forests, mortality from the hurricane was quite low (1.8% and 1.6% of stems ≥ 10 cm). In the eight years following the storm, continued mortality (background mortality rates) remained extremely low (0.2-0.4%/yr in seep and 0.5-0.8%/yr in slough forests). In the bottomland hardwood forests, the post-hurricane mortality was 11.4%, ranging from 5.7% to 19.5% in low- and high-damage plots, respectively. *Quercus* spp. had the highest mortality (18.2% and 48.0%, respectively), and the canopy dominants (*Quercus* spp., *Liquidambar styraciflua*, and *Pinus taeda*) had higher mortality than did subcanopy species. Background mortality rates of less-damaged stems were low, 0.8-1.0%/yr between 1990 and 1998. Most of the mortality resulting from the hurricane occurred among trees that were snapped off or tipped up. Branch loss, even at high levels, generally did not result in substantial mortality.

Tree recruitment patterns. Tree recruitment, or stems growing into the 10 cm or larger size class, was influenced by damage and by the composition of the smaller size classes. Most tree recruitment resulted from the growth of stems present as saplings

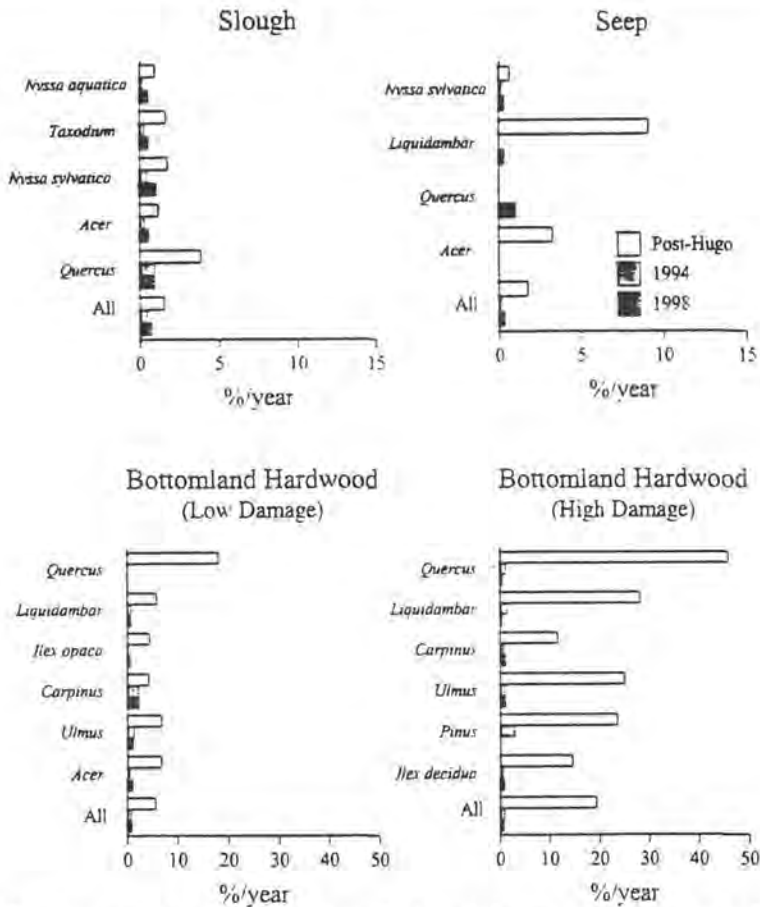


Figure 2. Tree mortality rates over time (%/year) for stems ≥ 10 cm in slough, seep, and bottomland forests with low and high damage in Congaree Swamp National Monument

prior to the hurricane (advanced regeneration). Recruitment rates of potential canopy species were highest in the seep forest (Figure 3). In both seep and slough forests, species composition of recruits reflected overstory composition, thus no shift in forest composition is projected.

In the bottomland hardwoods, recruitment rates were higher in areas of high damage and species diversity was greater (Figure 3). Although most of the new stems were shade-tolerant subcanopy species, a small number of stems of the shade-intolerant canopy dominants, *Quercus* spp. and *Liquidambar styraciflua*, were present. Recruitment rates of canopy species in areas of low damage were quite low, and few stems of *Liquidambar styraciflua* and *Quercus* spp. grew into the ≥ 10 cm size class. There was no recruitment of *Pinus taeda* in any of the bottomland forest plots. A shade-tolerant midcanopy species, *Celtis laevigata*, has been the most common recruit.

Discussion

Patterns of tree mortality, recruitment, and growth over the eight years since Hurricane Hugo may indicate future forest composition. Differences in seedling,

sapling, subcanopy, and canopy composition, particularly the abundance of potential canopy species in the understory layers, allow us to predict future stand structure. The trend of the current bottomland hardwood canopy dominants being recruited only in areas of heavy hurricane damage indicates that this forest is a disturbance-mediated system. In areas where wind damage was severe, the canopy species suffered disproportionately high damage and mortality and, while new stems of these species have been recruited, their recruitment rates are not sufficient to maintain the pre-hurricane species composition. One of the canopy dominants, *Pinus taeda*, has not been recruited at all following the hurricane and is rare in the sapling (Sharitz and Allen, unpublished data) and seedling layers (Allen et al. 1994; Pederson et al. 1997; Battaglia et al. 1999). Thus, it appears that the shade-intolerant species may require major wind disturbances to maintain their dominance, and their abundance in the canopy prior to Hurricane Hugo suggests that they were established as a result of earlier wind storms. Most recent recruits of potential canopy trees in the bottomland hardwood forests, even in areas of high damage, were shade-tolerant species (*Ulmus americana* and *Acer rubrum*). Most of these new tree-size stems were present in the sapling layer prior to the hurricane.

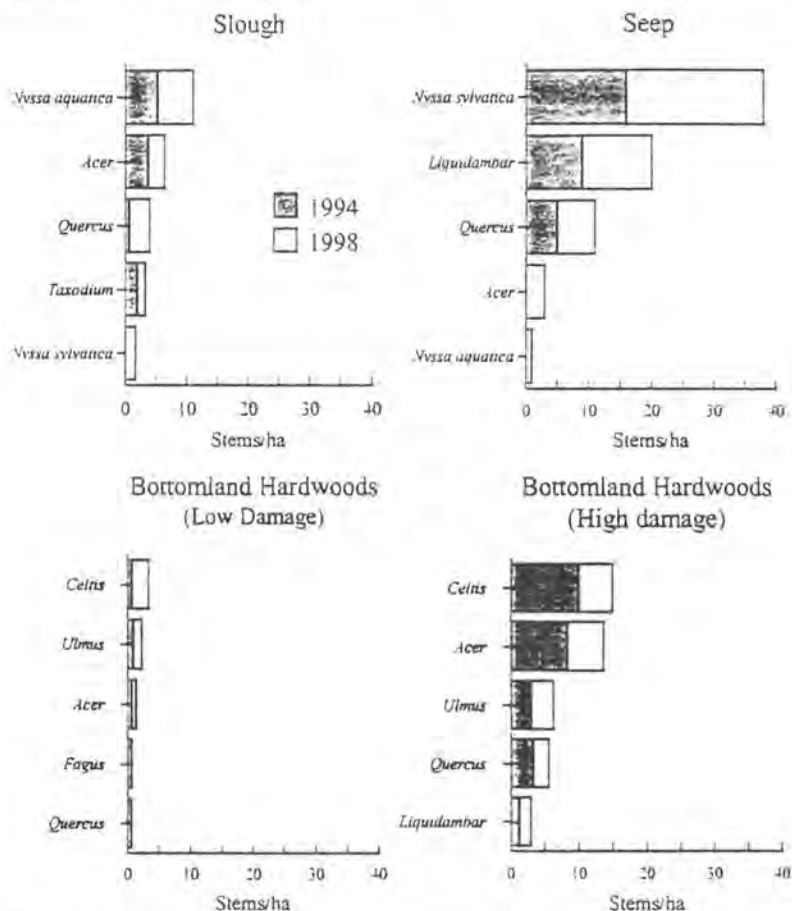


Figure 3. Recruitment of potential canopy species (stems ≥ 10 cm) in in slough, seep, and bottomland hardwood forests of Congaree Swamp National Monument

Pre-hurricane forest composition may have influenced the extent of hurricane damage, as evidenced by the species-specific damage and mortality rates. Within the bottomland hardwood forests, areas where damage was high had different abundances of both canopy and subcanopy trees prior to the hurricane than areas of low damage. In particular, *Pinus taeda* was more common in highly damaged areas and suffered high levels of mortality (Putz and Sharitz 1991; Battaglia et al. 1999). These compositional differences may reflect disturbance history, and further suggests the possibility of previous wind disturbance in the areas that were also damaged heavily by Hurricane Hugo. Putz and Sharitz (1991) noted that the forests of the Congaree have suffered severe storms several times during the last few decades. Trees that have been weakened by wind damage may be more susceptible to insect or fungal infestation and predisposed to future damage (Sharitz et al. 1992).

The national monument's resource management plan's stated objective "to protect and maintain the integrity of the natural ecosystems" may have unintended consequences for the floodplain forests. Managing a national monument where large, infrequent disturbances have played such an integral role in vegetation dynamics presents a challenge due to the length of the disturbance return interval (Dale et al. 1998). It must be recognized that these large, infrequent wind disturbances are a major component of the natural ecology of this old-growth system. The impacts of changing the natural hydrologic and fire regimes of this system are not well-understood, but they may influence species composition. The stated policy to confine wildfires and reduce fuel loads with controlled burns over much of the floodplain may affect the establishment opportunities for loblolly pine. The prohibition of deer and feral hog hunting following the formation of the monument in 1976 has allowed populations of these animals to expand. Feral hogs, a non-native species in this environment, may be highly destructive to the seedling layer. The long-term impacts of large populations of deer and feral hogs to the vegetation are not known, but their browsing and consumption of acorns and other seeds can alter tree regeneration patterns (Hough 1965; Anderson and Katz 1993; Boerner and Brinkman 1996; Rooney and Dress 1997).

Multiple processes have shaped the old-growth forests of the Congaree swamp. Since this is the floodplain of a major southeastern river, the hydrologic regime is the primary force in determining forest species composition. Flood tolerance and shade tolerance of the tree species may interact to direct regeneration following hurricanes and other wind events, as has also been suggested by Hall and Harcombe (1998). Furthermore, human manipulations of flood and fire regimes may have altered vegetation composition by influencing seedling establishment and growth. Large herbivore populations have not eliminated germination and establishment of the canopy dominants, but seedling and sapling pools of some species do not appear to be large enough to maintain the present forest composition (Pederson et al. 1997; Battaglia et al. 1999). Composition of this old-growth forest is far from stable (Thompson 1998), and hurricanes may play a primary role in this disturbance-mediated system.

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Climatic and Hydrologic Effects on the Establishment of *Tamarix ramosissima* in the Cold Desert of Northern Wyoming (Bighorn Lake)

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Introduction

Biological invasions by plants rank with the world's most intractable ecological problems (Vitousek et al. 1996; Williamson 1996). Many of these invasive plants have brought about significant changes in landscape function, with riparian habitats being especially prone (De Waal et al. 1994). Lack of knowledge of the biology, ecology, and environments of riparian invasive plants has become a major concern for land managers throughout the USA (Everitt 1980). One particular genus, *Tamarix*, a native of the Mediterranean region and introduced into the USA as an ornamental in the late 1800s, has been associated with declines in native biodiversity and water availability along desert rivers in the Southwest (Horton 1960). These riparian ecosystems are regional hot spots of biodiversity. It was presumed that *Tamarix* would not move northward due to its apparent preference for arid and semi-arid riparian environments (Baum 1967), yet establishment is becoming more widespread in northern Wyoming, especially along Bighorn Lake (Swenson et al. 1982; Knight et al. 1987; Akashi 1988). Even though *Tamarix* is known as a drought-tolerant species (Tomanek et al. 1960; Robinson 1965; Van Hylckma 1974, Van Hylckma 1980; Brooks 1971; Brotherson et al. 1986; Smith 1989; Shafroth et al. 1995; Cleverly et al. 1997; Devitt et al. 1997), it is unclear to what extent rates of establishment may be limited by colder climates in northern latitudes.

Another key question is the extent to which rates of *Tamarix* establishment are affected by certain hydrologic regimes. *Tamarix* appears to be particularly well-adapted to colonizing floodplains of artificially controlled reservoirs and rivers (Robinson 1965; Fenner et al. 1985; Akashi 1988; Knight 1994; Di Tomaso 1998). Altered flow regimes (peaks changed from spring run-off to summer and fall releases) and irregularly timed flood events appear to provide a suitable environment for successful *Tamarix* establishment (Horton 1977; Johnson et al. 1985). Rapid *Tamarix* invasion in the southwestern USA coincided with the building of many large dams (Brock 1994). The arrival of *Tamarix ramosissima* in northern Wyoming appears to coincide with the installation of the Yellowtail Dam on Bighorn Lake (Swenson et al. 1982; Akashi 1988). Reductions in water table or draw-down have been shown to cause mortality to established *Tamarix* stands (Horton 1977; Devitt et al. 1997). On the other hand, *Tamarix* seedlings can survive and grow from two to six weeks in inundated conditions (Horton et al. 1960; Gary 1963; Graf 1978; Gladwin 1998), but extended inundation of over six weeks or complete submergence for several weeks can kill mature shrubs (Kerpez et al. 1987; James et al. 1991).

In addition to questions of climatic and hydrologic effects on *Tamarix* establishment, it is unknown how rates of seedling recruitment in northern Wyoming contrast with sites in the southwestern USA. Previous research on *Tamarix* seedlings found that a moist soil substrate, placid waters, lack of competition, and a sunny site (shade intolerance) were needed for successful germination (Tomanek 1960; Warren et al. 1975; Kunzman et al. 1989). Also, seed viability was found to be up to five weeks, seed germination was generally within 24 hours, flowering occurred within the first year, and a lengthy seed dispersal period commonly occurred between May through October (Warren et al. 1975; Gladwin 1998). *Tamarix* is also a facultative phreatophyte and a halophyte, is fire-tolerant, and has the ability to layer, sprout, and develop adventitious roots (Merkel et al. 1957; Tomanek 1960; Gary 1963; Wilkinson 1966b; Brooks 1971; Horton 1977; Everitt 1980; Fenner et al. 1985; Bradley 1986;

Brotherson 1986; Kunzman et al. 1989; James et al. 1991; Shafroth et al. 1995). In the Southwest, studies have found very high first-year seedling density, which is reduced dramatically by the third year (Tomanek et al. 1960; Warren et al. 1975; Kunzman et al. 1989). In their first year, seedlings grow slower than any other riparian species, but by their second year shrubs can grow up to 3m with root length dependent on the water table (Merkel et al. 1957; Tomanek et al. 1960; Horton 1977; Goldsmith et al. 1982; Di Tomaso 1998; Gladwin 1998).

Study Objectives

The objectives of this study are to determine the effects of climate (temperature, precipitation, and potential evapotranspiration) and hydrology (peak lake levels and length of inundation) on the rate and success of *Tamarix* establishment in the cold desert environment of northern Wyoming. Study results will also provide basic information on the biology and ecology of *Tamarix* in northern Wyoming.

Methods

Study site. Bighorn Lake was formed in 1966 after the Yellowtail Dam was installed on the Yellowstone River at Fort Smith, Montana. Lake levels fluctuate (highs of 1,115 m; lows to 1,089 m) and the timing of reservoir releases are very unpredictable, based on spring run-off and agricultural needs. The lake is situated in the semi-arid cold desert basin (Knight 1994). The Bighorn Basin has an extreme continental climate with record lows of -37°C and record highs of 46°C . The average growing season is 125 days and average annual precipitation ranges from 127 to 203 mm (Martner 1986).

On 14 July 1997, the second-highest lake level (1,113 m) was recorded at Bighorn Lake. In late September, study areas were selected along the "bathtub ring" of *Tamarix* seedlings left behind after high waters receded at Crooked Creek, north and south banks (hereafter NCC and SCC), and Kane Causeway, east and west banks (hereafter EKC and WKC). Elevations were similar for all four study sites (1,113-1,114 m). Site vegetation communities include greasewood desert shrubland (*Sarcobatus vermiculatus*-*Artemisia tridentata*), floodplain shrubland (*Populus deltoides*-*Artemisia tridentata*), and sagebrush desert (*Artemisia tridentata*-*Chrysothamnus nauseosus*) (Knight et al. 1987).

Climate and hydrology. Data on daily precipitation and temperatures from 1951 to the present were collected from the National Climatic Data Center at the climate observation station for Western Sugar in Lovell, Wyoming (<http://www.ncdc.noaa.gov>). Daily lake elevations from 1966 to the present were collected for Bighorn Lake from the U.S. Bureau of Reclamation, Yellowtail Dam Unit, Montana Area Office (<http://www.gp.usbr.gov>).

Seedlings. Seedling density and mortality were measured by installing two line transects (15 m each; 30 m total coverage) on each of the four sites. For density, each line transect has ten 20x20-sq-cm density plots systematically located every 3 m starting at 1.5 m. All seedlings were counted inside the plot frame. Each density plot has four tagged seedlings to measure growth and mortality (N=154). Each mini-line transect has three tagged seedlings to measure growth and mortality (N=142). Density and mortality were measured from a total of 296 tagged seedlings and forty 20x20-sq-cm plots. Main stem growth was measured weekly from late September 1997 to May 1998. Final growth and mortality data was collected late September 1998. Soil temperatures were taken bi-weekly from late September to November 1997, then in April to May 1998 at depths of 5, 10, and 25 cm to determine growing season.

Mature stands. Representative stands of mature *Tamarix* were chosen within 10 m from the four seedling study sites to maintain similar site characteristics for comparison. Plot size was chosen (10x10 sq m) to be inclusive of variable shrub sizes and densities within each floodplain category. Within each plot, main stems were cut

below ground level (the deepest cut being 0.6 m) to find the root crown, and rhizome rings were counted to determine shrub age (Brotherson et al. 1984). Every third shrub was sampled within each plot, with a maximum of 15 sampled. Density was determined for each plot. Total sample size was 178 mature shrubs.

Analysis

Climate and hydrology. SYSTAT 6.0 (1997), including Pearson's correlation, one-way ANOVA, stepwise multiple regression, and Tukey's multiple range comparison test analysis, were used to examine the relationships between all climatic and hydrologic variables, and successful *Tamarix* establishment (Figure 1).

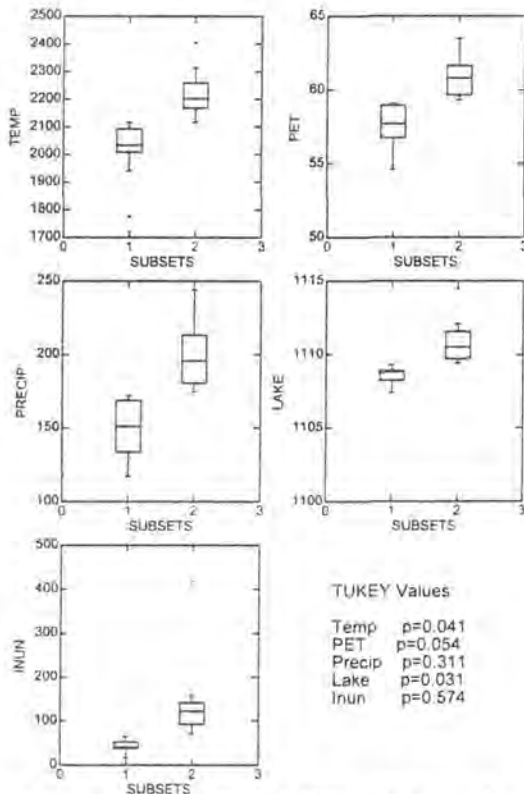


Figure 1. Climatic factors (temperature-GDDs, PET, and precipitation) and hydrologic variables (peak lake elevations and length of inundation) compared with the number of established *Tamarix ramosissima* shrubs at Bighorn Lake, Wyoming.

Annual means were calculated from daily temperature averages (minimum and maximums), then compared with the number of established *Tamarix* shrubs for each year. Growing degree-days (GDDs) were calculated from daily mean temperatures for each month of each year based on a 5°C baseline. The GDD lower limit of 5°C was chosen based on the standard temperature above which a plant becomes active in the Bighorn Basin of Wyoming (Lewis 1978; Martner 1986; Knight 1994). To further analyze temperature, subsets of "cool" and "warm" years were developed using GDD data sorted from coolest to warmest, then divided in half. Annual means

were calculated for precipitation, and subsets of "dry" and "wet" years were developed and analyzed.

Potential evapotranspiration (PET) was calculated using Thornthwaite's equation, which incorporates air temperature as an index of the energy available for evapotranspiration (Thornthwaite et al. 1957; Dunne et al. 1978; Brooks et al. 1991). Annual PET totals were compared with the number of established *Tamarix* shrubs for each year. To further analyze PET, subsets of "low" and "high" years were developed using annual data sorted from lowest to highest, then divided in half.

Annual peak lake levels were compared with the number of established *Tamarix* shrubs for each year. To further analyze peak lake levels, subsets of "low" and "high" years were developed from annual peak flow data sorted from lowest to highest, then divided in half.

Length of inundation was calculated by using the annual peak lake level as the baseline and determining the number of days the lake receded by 13 cm, 30 cm, 60 cm, 150 cm, 300 cm, and 450 cm, then compared with the number of established *Tamarix* shrubs for each year. To further analyze length of inundation, subsets of "short" and "long" years were developed from annual length of inundation data sorted from shortest to longest, then divided in half.

Seedlings and mature shrubs. A survivorship curve was developed for seedlings using weekly seedling counts (percent survival) from September to November 1997, then from April to September 1998. An age distribution graph was developed for the mature stands using sampled rhizome ring counts. Seedling height and overall growth differences, and mature stand density differences, were looked at by site location using Tukey's multiple range comparison test.

Results

Climate and hydrology. All climatic and hydrologic variables were found to be normally distributed. Pearson's correlations for temperature and number of established shrubs was ($r=0.316$, $n=120$) with potential evapotranspiration slightly lower ($r=0.298$, $n=120$). One-way ANOVA and stepwise multiple regression indicated no significant association between climatic variables and number of established shrubs. Tukey's multiple range comparison test suggested subsets of "cool" and "warm" temperatures ($p=0.041$, $n=120$), and subsets of "low" and "high" potential evapotranspiration ($p=0.054$, $n=120$) were significantly different with regard to the number of established shrubs. Years with warmer temperatures (GDDs ≥ 2117) had a higher number of established shrubs than cooler years. Years with higher PET (≥ 59 cm) were associated with a higher number of established shrubs than lower-PET years (Table 1).

Pearson's correlation for peak lake elevation and number of established shrubs was ($r=-0.412$, $n=120$), with no correlation found for length of inundation. One-way ANOVA and stepwise multiple regression results also indicated only peak lake elevation as being significant ($p=0.02$, $n=120$). Tukey's multiple range comparison test suggested subsets of "low" and "high" peak lake elevations were significantly different ($p=0.031$, $n=120$), but no significance was found for subsets of "short" and "long" length of inundation. Years with lower peak lake elevations (≤ 1109.3 m) had a higher number of established shrubs than higher-peak years (Figure 2).

Seedlings and mature shrubs. Average first-year seedling density for all study sites was 224/sq m; average second-year density was 15/sq m. Seedling survivorship curves for each site indicate the highest mortality occurring late into the second year (Figure 3). Average survivorship was 91% at the end of the first year (November 1997), then dropped to 17% by the end of the second year (September 1998). Long-term survival predictions based on mature stand density and initial seedling densities for a 10x10-sq-m plot averaged only 5%. Mature shrub age distributions for each site revealed uneven-aged stands despite obvious "bathtub rings."

Variables	N=120	Mean	SE	Pearson's <i>r</i>	<i>p</i> value	Adjusted <i>r</i> ²	<i>F</i>	Tukey
<i>Dependent (annual total)</i>								
Number of Established Shrubs		1.5	0.15					
<i>Independent (annual averages)</i>								
Temperature (GDD)		2125	11.4	0.168	0.07	0.02	3.4	* 0.041
Precipitation (mm)		174.8	2.9	-0.113	0.22	0	1.5	0.311
Peak Lake Elevation (m)		1110	0.2	-0.219	* 0.016	0.04	5.9	* 0.031
Length of Inundation (days)		80.4	3.9	0.018	0.84	0	0.04	0.574
Potential Evapotranspiration (cm)		59.2	0.2	0.157	0.09	0.02	3.0	* 0.054

Table 1. Statistical analysis results on climatic and hydrologic variables and number of re-established *Tamarix ramosissima* shrubs using ANOVA, Pearson's correlation, stepwise multiple regression, and Tukey's multiple range comparison test.

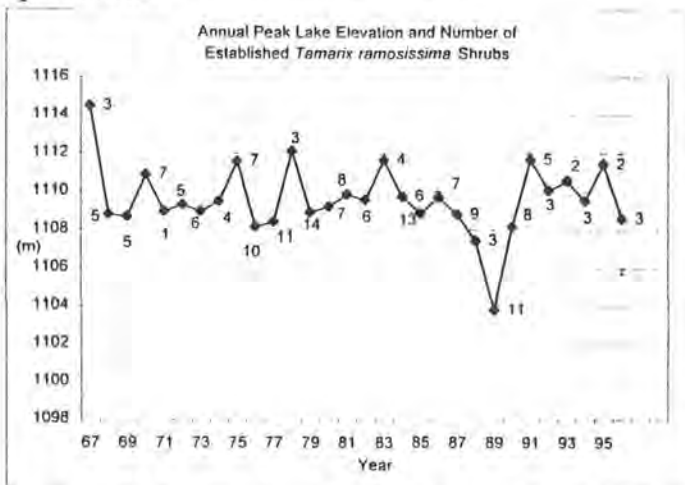


Figure 2. Annual peak lake elevations was found to be significantly influencing the rate of *Tamarix ramosissima* establishment ($p=0.016$). Low peak lake elevation years (<1,109.3 m) had the highest number of re-established shrubs.

Seedling height and growth. Average stem height at two months of age was found to be 5 cm for all study sites, which was similar to measurements from the Southwest. The average stem height in the second year varied by study site location, with the tallest stem measured at 52 cm and the shortest at 0.6 cm. Overall growth averages from September 1997 to September 1998 varied by study site location, with a high of 18.2 cm and a low of 4.0 cm. The average two-year stem height for all sites was 15.6 cm, and the average overall growth for all sites was 10.5 cm (Figure 4). No flowering was observed on these sites during the study period.

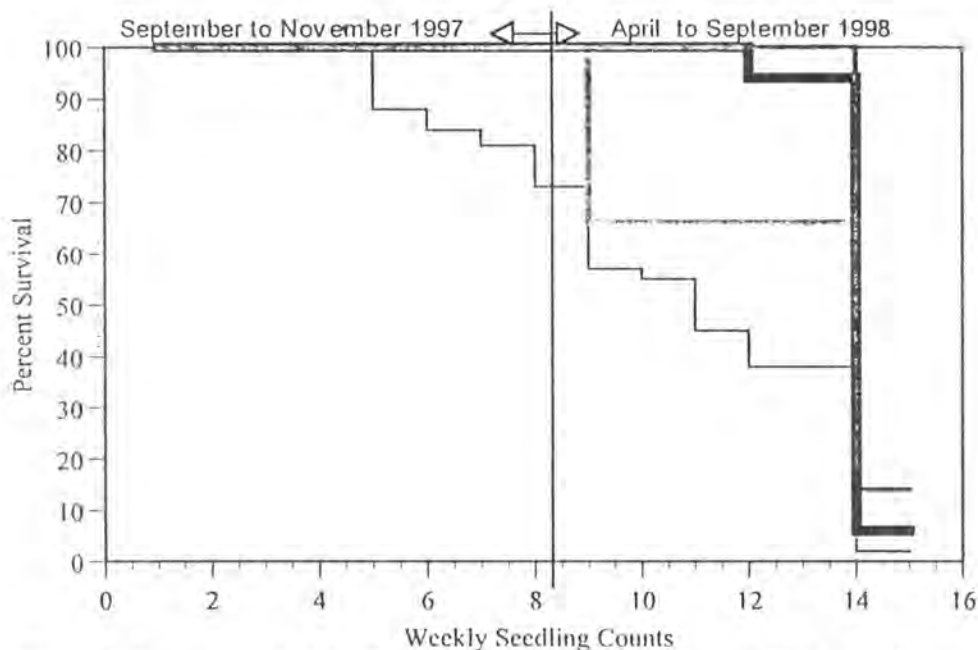


Figure 3. Percent survival for *Tamarix ramosissima* seedlings at Bighorn Lake, Wyoming, at the end of the first year was 91% for all four sites. By the end of the second year, average survival for all four sites was 17%.

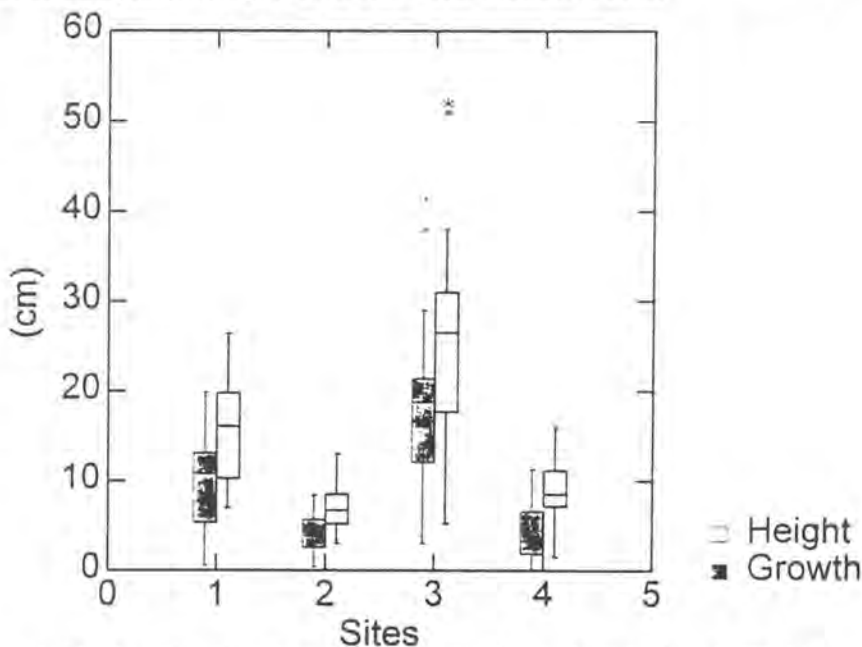


Figure 4. Final seedling height and overall growth as of September 1998. Sites include 1=SCC, 2=NCC, 3=WKC, and 4=EKC, with the average final height for all sites at 15.6 cm and growth at 10.5 cm.

Site Differences. Average seedling growth from September 1997 to September 1998 at the four study sites (NCC, SCC, EKC, and WKC) was found to be significantly different between certain sites and not others. Using Tukey's multiple range comparison test analysis, site differences were found between SCC and WKC ($p=0.008$), NCC and WKC ($p=0.000$), and WKC and EKC ($p=0.000$). Mature stand density was not found to be significantly different between sites.

Weeds and seedling establishment. Due to the extreme high waters of 1997, study sites were exposed and sunny, and seedlings germinated on minimally vegetated areas. However, other weed species appeared to be germinating on these sites as well. Field observations found weeds twice as tall as *Tamarix* on one of the four sites by the second year. Weed species found on this study site included pigweeds (*Amaranthus* spp.), which can grow up to 2 m. Other exotic competitors nearby included cocklebur (*Xanthium strumarium*), halogeton (*Halogeton glomeratus*), and Russian thistle (*Salsola iberica*).

Conclusions

It is difficult to unravel the complex network of relationships most likely involved in the successful establishment of *Tamarix*. However, these study results suggest that cooler temperatures, lower PET, and high peak-lake elevations were potentially constraining rates of *Tamarix* establishment at Bighorn Lake. In addition, we found lower initial densities, slower stem growth, a shorter growing season, and later flowering in northern Wyoming as compared with sites in the Southwest. Competition from other weed species and site-specific variables may also affect population dynamics. Yet, despite all of these limitations, there appears to be a minimal number of individuals who succeed each year. And, since these "stronger" individuals are surviving to reproductive age, successful physiological adaptations to colder temperatures may become more prevalent over time.

Management Recommendations

Ideally, now is the time to address new invasions along northern rivers where *Tamarix* is just beginning to take hold. Based on these study results from northern Wyoming, resource managers who are dealing with *Tamarix* invasions that far north may not find it necessary to treat new seedlings right away. It appears that natural mortality occurs rapidly for new seedlings. Especially in areas where *Tamarix* is just beginning to invade, the shrubs that are left by the third year will be minimal and easier to eradicate. Yet, it would still be important to remove shrubs prior to first seed dispersal.

In addition, an integrative model on hydrologic requirements for successful establishment of *Tamarix* seedlings should be developed. Mahoney et al. (1998) was able to design a model for cottonwood recruitment in Canada. Also, Baker (1990) explained successful cottonwood forest development based on flood events and interannual climatic fluctuations. A similar prescriptive model could provide resource managers with specific lake-level parameters that would allow for the manipulation of both the magnitude and timing of reservoir releases to control future invasions.

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The North Rim Complex: Integrating Wildland Fire Use and Resource Management at Grand Canyon National Park

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Until 1997, policy dictated that firefighters extinguish most wildland fires in national parks. Fire managers had few opportunities to allow naturally ignited fires to burn for potential benefits to ecosystem health. In July 1997, the National Interagency Fire Center adopted a new federal fire policy that provided greater flexibility to fire managers in the National Park Service (NPS). Under the new wildland fire use policy, fires do not have to be extinguished immediately. Instead, fire managers and an interdisciplinary team of resource managers evaluate the potential of each wildfire to achieve resource objectives while minimizing adverse impacts. In July and August of 1998, the North Rim Complex fires were managed under this new policy.

The North Rim of Grand Canyon National Park is characterized by rolling to moderately steep terrain from 7,500 ft to 9,100 ft in elevation, with four peninsulas extending into the canyon. Forests are drier at the southern tips of the peninsulas, consisting mostly of pinyon-juniper and ponderosa pine. Further north, these forests are encroached upon by white fir with mountain meadows and aspen, eventually becoming a mixed-conifer forest of spruce and fir above 8,000 ft. Fuel loads on the North Rim are above what is generally believed to be "natural" due to fire suppression activities over the past 100 years. A fire moving through these forests during summer would likely burn very hot, resulting in undesirable effects.

The North Rim Complex fires occurred in a former fire suppression zone where fires were extinguished immediately. Management-ignited fires were planned here, but were difficult to carry out due to heavy fuel loads, lack of personnel, and limited burning windows. Over 10 days during July 1998, lightning started six fires. Eventually, these fires grew to a combined size of 4,957 acres—the largest successfully managed fire in the park's history.

Before deciding to manage the North Rim Complex under the wildland fire use policy, fire managers convened planning meetings to determine appropriate resource objectives and identify resource concerns. Resource specialists with concerns were invited to attend, including wildlife biologists, archaeologists, the air quality specialist, and the wilderness coordinator. Since a working relationship between resource specialists and fire managers existed prior to the incident, fire managers had a general idea of issues and concerns. Consequently, the meeting proceeded smoothly and relatively quickly. To address concerns voiced in these meetings, one or more resource advisors were on scene throughout the incident. Morning briefings and shift plans included resource messages.

The concern for fires on the North Rim is that heavy fuel loading, if burned during a hot summer, could result in a fire which could do more damage than good. Fire history suggests a frequency in this area that has not been maintained over the past century, resulting in crowded, unhealthy forests. To prevent negative effects, fire managers attempt to burn as many acres as possible under a prescription that will reduce the fuel. The North Rim Complex provided an opportunity to let fires burn under the scrutiny of managers.

The park, as a Class I airshed under the Clean Air Act, is afforded the most strict air quality protection. Two major concerns are ensuring that public health is not threatened and minimizing obstruction of the canyon view. Grand Canyon's claim to fame is the view—filling the canyon with smoke is a fire manager's nightmare.

Fire managers recognized the need to be proactive with smoke management efforts long before the North Rim Complex began. They established a working rela-

tionship with both the park's air quality specialist and the Arizona Department of Environmental Quality (ADEQ) to facilitate burn approvals. Air quality monitoring machines (purchased by fire management) monitored smoke emissions at sites that had the greatest potential for human health impacts.

Once the North Rim Complex started, steps were taken to comply with smoke management principles. An aggressive public relations campaign began. Fire information officers interacted with the public on both rims, public service announcements were widely distributed, and entrance station staff informed visitors of the fire. The air quality specialist and ADEQ were invited to fly over the fire for a first-hand look at smoke impacts to the canyon and developed areas. Air quality was monitored with sampling equipment, photo documentation, and written descriptions from the rim and at a popular site in the inner gorge. Smoke observations were transmitted daily to ADEQ and the air quality specialist. To mitigate possible health impacts to visitors experiencing the canyon, the park superintendent and others drafted a plan to evacuate affected areas and close major trails. Such an action was unprecedented—especially during a high-visitation period. An on-site meteorologist provided up-to-date local forecasting to improve weather predictions and help fire decision-making. At one point during the Complex, a fire was contained short of the original control line due to air quality concerns. Although burning conditions were fine, fire managers realized that allowing the fire to continue burning would severely impact air quality. A conscious decision was made to contain the fire at a smaller acreage than originally planned.

All of the North Rim Complex fires occurred in proposed wilderness, as identified in the 1993 final wilderness recommendation for the park (National Park Service 1993). Within the NPS, land designated as proposed wilderness is managed as wilderness. Fire access was via roads slated to be closed and currently open only for administrative use. Additionally, the preservation of wilderness values such as natural quiet and a pristine environment with little evidence of human presence were considerations during this incident.

To mitigate these concerns, resource advisors stressed minimum-impact suppression techniques in crew briefings and these guidelines were generally followed. Among the most commonly employed techniques were flush-cutting stumps, bevel-cutting log ends, and camouflaging and scoring freshly cut stumps. Rather than digging hand lines, pre-existing human-made and natural barriers were often used, and crews rehabilitated hand lines that were constructed. Managers considered short-term impacts to natural quiet and other wilderness aesthetics as worth the long-term gains.

A 500-acre mountain meadow lies on the north boundary of one Complex fire. Meadows of this type are slow to recover from disturbances such as driving across them or staging equipment on them. To minimize impacts, resource advisors ensured that such activities took place only in designated areas. Advisors stressed meadow sensitivity in crew briefings and shift plans.

The most critical wildlife issues were impacts to threatened and endangered species and wildlife habitat (Ward 1999). The peregrine falcon, a threatened and endangered species, lives along the rim of the canyon where the fires occurred. The goshawk, a locally sensitive species, nests in ponderosa pines inside the fire boundaries. To mitigate possible impacts, wildlife biologists marked known goshawk nest trees within the fire boundary. Fire managers tried to minimize helicopter flights and the amount of smoke spilling over the rim near peregrine nests. Additionally, most snags along the fire line were marked to protect wildlife habitat.

Portions of the fire area contained or were expected to contain a high density of archaeological sites, but only about 20% of the anticipated fire area had been systematically surveyed, according to the park's archaeological site records. Most archaeological sites were prehistoric and would not be adversely affected by the low-intensity fire. However, historic fences, dendroglyphs, and a 1930s tree tower lay within the

fire boundary, and numerous historic structures were just outside it. To mitigate possible impacts, fire and cultural resource personnel protected known sites. Archaeologists surveyed proposed hand lines to ensure that cultural resources were avoided.

Resource managers feel they were appropriately advised of fire starts and proposed management actions in the early stages of the incident. Fire managers provided an opportunity for them to express concerns, and considered possible impacts from management actions. Both fire and resource managers indicated that a key to success in the management of the North Rim Complex was the existence of a good working relationship *before* the fires started.

For the past two years, an annual two-day meeting has been organized by the park's fire branch to share information about burning objectives and concerns with resource management staff. Resource managers have an opportunity to inform fire staff about new resource policies and concerns. Because of these meetings, staff in the two divisions have a greater understanding and appreciation of the other's tasks. These meetings also set the stage for future consultations and planning sessions.

The involvement of resource managers in early planning for the implementation of the wildland fire use policy proved to be a critical action in ensuring that resource concerns were identified and addressed. Resource specialists provided specific resource concerns and mitigation measures for anticipated fire spread and management actions. However, at these initial meetings, it was impossible to anticipate and discuss all of the tactical and operational contingencies possible over the life of the incident. We suggest that fire management initiate regular consultation with resource managers during the entire project, following the periodic fire assessment process outlined in the park's fire management plan amendment (National Park Service 1998). While resource advisors were on scene for much of the incident, they spent much of the day in the field with crews, ensuring resources were protected on the ground. During key points in the incident, such as the timing of large burn-outs, it would be beneficial to reconvene the resource specialists to discuss the effects of major management actions.

Amazingly, there were few formal complaints from visitors, although the fires burned over a month. A key factor was the fire information officer's orchestration of information exchange between the fire organization and park staff, visitors, and residents. A highly qualified fire information officer helped the public understand why the fire was not extinguished and led many visitors to appreciate the park's attention to ecosystem management. Grand Canyon will not manage another fire use incident of such magnitude without having a fire information officer on each rim.

Since this incident was a wildland fire for resource benefits, a post-fire meeting between fire managers and resource managers and advisors would be beneficial. After the North Rim Complex, *incident* managers met to discuss tactics, operations, and resource benefits of the fire. However, although resource advisors were welcome to attend, none could due to scheduling conflicts. A meeting of park resource advisors could be held weeks or even months after the incident when some initial post-fire evaluation had been completed. Although some resource managers reported results from the North Rim Complex at the park's annual joint meeting between fire and resource staff, there was little discussion on how to better manage such a fire next time. Concerns about the North Rim Complex were buried in the agenda and touched on briefly, rather than made a specific agenda item to be discussed in-depth.

At Grand Canyon, managers recognize that pre-fire planning is necessary to adequately address the myriad of resource concerns across the park's 1.2 million acres. In most cases, each resource discipline has only one subject-matter expert. Understandably, that one individual is not available every day through fire season. To ensure that resource concerns are known and addressed, fire managers are now planning for wildland fire use. GIS specialists are creating base maps that reflect resource concerns across the park. Subject-matter experts are preparing written descriptions

of their primary concerns and developing mitigation measures. In the resource specialist's absence, these documents will help prevent adverse impacts. However, they cannot replace the comprehensive knowledge of on-the-ground experts.

As part of this case study, we hoped to include documentation of resource benefits achieved and resource impacts prevented. We discovered that while most resource managers do not anticipate adverse impacts, due to staffing and budget constraints few post-fire studies have been conducted to evaluate the effects of the incident. Only vegetation data and air quality data were collected pre- and post-fire. Existing vegetation plots within the fire area will undergo long-term monitoring; however, the sample size is inadequate to be representative of the entire burned area. A long-term air quality monitoring station was down-wind of the incident. Consequently, years of baseline data exist to compare with data gathered during the fires, but the park lacks the personnel needed to conduct in-depth analyses. However, air quality data from a mobile particulate matter sampling device and a fixed instrument that measures visibility in the canyon will be correlated. In the future, this information will allow fire managers to indirectly measure visibility in remote portions of the canyon.

Most resource programs do not have the budgets or personnel to collect pre- and post-fire data. A few resource specialists plan to revisit the burn this summer and superficially examine the burned area, but clearly, some resource impacts will never be known. For example, it is impossible to determine if peregrine fledglings abandoned their nests and died since no one was able to visit nests immediately after the fire. Although firefighters were instructed to use minimum-impact suppression techniques in wilderness areas, there was no post-fire evaluation to determine if they were consistently followed and were effective in reducing the evidence of human presence in pristine areas. There was no post-fire evaluation to determine if the helicopter really needed to be used as much as it was, considering the availability of roads and short-term noise pollution. No meadows were photographed prior to, during, or after the incident to document protection efforts. Archaeological sites will not be monitored to see if unanticipated post-fire effects such as erosion are occurring or if protection measures were successful.

It is difficult to anticipate and plan for all effects from landscape-scale fires when resources aren't evaluated and monitored. How do we know when a fire has crossed over the imaginary resource-benefit line and caused excessive negative impacts? We anticipate future problems balancing resource benefits and impacts. Managers must decide when negative impacts to natural and cultural resources outweigh potential benefits from fire. Yes, fire may be restored to an ecosystem that requires it, but if five peregrine fledglings didn't make it due to smoke impacts, was the fire a success or a failure? Fire improves bird habitat over the long run, but there may be no fledglings in the short run. Which is better?

Unanimously, resource and fire managers at the park declared the management of this incident and the integration of resource managers into the fire management process a success. Everyone we interviewed cited the points outlined above as critical for that success—working relationships in place prior to the incident, and the involvement of resource managers in early planning to identify resource concerns.

Most of the problems identified in this case study are relatively minor and can be corrected by clear communication and by involving resource managers in key decisions through the life of the incident. However, a glaring problem in the nationwide implementation of the wildland fire use policy is the lack of post-fire evaluation. As the West faces the prospect of tens of thousands of acres burned annually for "resource benefits," it is critical to assess the effects of these fires and move our expectations beyond solely preventing catastrophic wildfires to the concrete goals related to the return of healthy ecosystems.

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Post-Fire Erosion Control and Vegetation Recovery Monitoring at Point Reyes National Seashore

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Introduction

In October 1995, Point Reyes National Seashore, north of San Francisco, experienced its largest wildfire in sixty years. The Vision fire burned more than 12,000 acres of state, federal, and private lands in three days (USDI 1995). Over 95% of the lands burned were within the Point Reyes National Seashore. The fire originated from an illegal campsite on Mount Vision. Fanned by 30-50 mph winds, the fire spread rapidly through multiple vegetation communities, from ridge top bishop pine (*Pinus muricata*) and Douglas-fir (*Pseudotsuga menziesii*) forests, to coastal scrub and sand dunes at the Pacific Ocean. Vegetation resources were affected to varying degrees as burn intensities varied across the landscape (USDI 1995).

A department of the interior burned area emergency rehabilitation (BAER) team was assembled to assist the park in assessing fire and fire suppression impacts that would require mitigation. Park staff and other local experts worked closely with the team, providing information and field assistance. Existing pre-fire data on vegetation communities, particularly rare plants and non-native plant infestations, were crucial to acquiring emergency funds to accomplish mitigation measures prescribed by the BAER team. The vegetation management staff at Point Reyes was directly involved with three projects funded by FIREPRO: rehabilitation of bulldozer and hand lines, non-native plant monitoring, and rare-plant recovery monitoring.

Rehabilitation of Bulldozer and Hand Lines

Suppression of the Vision fire resulted in the construction of 23.1 miles of bulldozer line, 6.4 miles of line constructed by hand tools, 10 safety zones, and 13 drop points and helispots (USDI 1995). Approximately eight acres of disturbed soil resulted from the construction of safety zones, drop points and helispots. In its soil and watershed resource assessment, the BAER team predicted "serious watershed deterioration problems" if suppression-related damage was left untreated.

Treatment of bulldozer and hand lines was prescribed to divert runoff from the lines and to break up concentrated flows. To rehabilitate hand lines, slash and other organic material was placed over mineral soil to stabilize the surface and aid in revegetation (USDI 1995). All bulldozer lines were treated in one of two ways. For areas with slopes of less than 30%, excavators were used to recontour the original slope, remove berms, and pull back displaced soil. A hummocked arrangement of soil and interspersed woody material was then created to slow and absorb runoff. Finally, the excavators distributed topsoil and plant material to restore local seed and microorganisms to the site.

Most bulldozer lines on slopes of greater than 30% were not excavated. These sites were covered with photodegradable erosion cloth. This material must be in direct contact with soil to effectively control erosion. Hand crews prepared the sites by smoothing the soil surface, installing waterbars and removing berms and large woody material. There were several drawbacks to using photodegradable erosion cloth. Installation and maintenance were very labor-intensive. The plastic netting holding the matting in place was unsightly and did not photodegrade completely. On windy

slopes, large pieces of netting broke free, littering the park and occasionally entrapping deer. The metal pins used to secure the matting were difficult to remove and often were left behind in the soil.

Hydrologic monitoring in the first and second years revealed rapid vegetation recovery and very little movement of soil on lines rehabilitated by excavators. Monitoring of lines covered by erosion matting revealed that waterbar construction was more effective than the matting in inhibiting soil movement (B. Ketcham, Point Reyes National Seashore, personal communication). It was speculated that the steepness of some slopes and high wind intensity at ridge tops caused the matting to be lifted from the soil. The matting also appeared to inhibit initial plant regeneration, but visible vegetation recovery at these sites was observed by spring of 1997.

Non-Native Plant Monitoring and Mitigation

The BAER team predicted that the loss of topsoil on newly disturbed sites would increase potential for the encroachment of non-native, invasive plant species. Heavy machinery used in fire suppression is also capable of introducing non-native seeds from outside sources. Recommendations were outlined for two years of monitoring fire suppression impacts on noxious weeds within the fire area (USDI 1995). During the second year of monitoring and mitigation, the need for further monitoring was recognized and funding was awarded for a third year.

Three years of post-fire non-native plant monitoring and removal provided extensive information on the response of a variety of non-native plant species to the Vision fire and to disturbance related to fire suppression. To facilitate monitoring, all trails, bulldozer lines, and hand lines in the burn were divided into approximately half-mile segments using ArcView-generated maps. Burn monitors were responsible for regular monitoring of assigned areas and for removing non-native species according to priorities established after monitoring.

Monitoring involved walking the length of each segment and documenting various aspects of vegetation regrowth, such as abundance and approximate percent cover of both native and non-native plant species. Populations of non-native species also were sketched on field copies of ArcView-generated maps, which were filed and updated as the season progressed. Pioneer weed populations and species of highest priority for removal were digitally mapped with Global Positioning System (GPS) units.

Monitors prioritized weed removal sites based on habitat type, size of the non-native population, and accessibility of the work site. Sites of controllable weed infestations in bishop pine habitat were given highest priority to encourage the survival of native pine seedlings. Plant phenology generally determined the schedule priorities for control of non-native species. Various thistles were targeted in spring, Australian fireweed (*Erechtites minima*) in early summer, and pampas grass (*Cortaderia jubata*) in late summer and fall. Over a three-year period, more than 3,000,000 non-native plants of 40 different species were removed from within the Vision fire area. Volunteer labor contributed significantly to this total. The numbers of each species removed at each site are maintained in an Integrated Pest Management (IPM) database.

Known locations of two "A"-rated noxious weeds, and one "B"-rated noxious weed, were disturbed by bulldozer activity during the fire. According to the California Department of Food and Agriculture, "A"-rated noxious weeds require eradication, quarantine, or other holding action at the state and county level. "B"-rated noxious weeds require intensive control or eradication, where feasible, at the county level. Monitoring of "A"- and "B"-rated noxious weeds in the burn will continue indefinitely, independent of fire-related funding. Known sites of giant plumeless thistle (*Carduus acanthoides*), fertile capeweed (*Arctotheca calendula*), and distaff thistle (*Carthamus lanatus*) populations were disturbed by fire line construction and are included under these categories. Between 1975 and 1995, giant plumeless thistle had been contained to three known sites that were monitored monthly for new

growth. In August 1996, a previously undocumented population of giant plumeless thistle was discovered in the Vision fire area. The population of 12-foot high flowering thistles covered two acres that had been covered by coastal scrub prior to the fire.

Qualitative assessments of areas affected by the fire and suppression activities supported the prediction of increased encroachment by non-native plants. Burned or disturbed areas that occasionally supported scattered occurrences of weeds prior to the fire often supported extremely dense, expansive occurrences after the fire. By late spring of 1996, for example, the plant species composition on many bulldozer lines was dominated by one or two species of non-native grasses and forbs—monocultures of weeds on otherwise diversely vegetated hillsides. Unfortunately, however, few conclusions can be made on the specific effects of the Vision fire and fire suppression activities on weed establishment and spread, or on the effectiveness of the weed removal program. This is due, in large part, to the following three factors:

- Little or no pre-fire data existed on the botanical resources of concern in the Vision fire area;
- This project did not involve rigorous quantitative assessment of weed recruitment, spread, or removal treatments; and
- Control plots outside of the burn were not established.

Without quantitative pre-fire data and systematic quantitative documentation of weed parameters both in burned and control areas, conclusions regarding the effects of the fire and project effectiveness must be qualitative in nature. It is not possible, for example, to separate the effects of the fire on non-native plant presence and abundance from the effects of climate and rainfall in the area from 1996 through 1998. The prolonged rainy season brought on by an El Niño system in 1998 resulted in prolific growth and an unusually long flowering period for native plants and weeds alike. It also is not possible to make conclusive statements about the effectiveness of non-native control methods used during this project.

Rare Plant Recovery Monitoring

Rare plant monitoring was conducted for one year after the Vision fire to document the post-fire recovery of known populations, to document the effects of the fire and fire-related suppression activities on species recovery, and to propose appropriate mitigation measures as needed (Semenoff-Irving 1996). Species composition was determined at each rare plant site according to the protocol outlined in the National Park Service Western Region's fire monitoring handbook (Semenoff-Irving 1996). California Native Plant Society survey data from previous years were used to compare pre- and post-burn density values within populations (Semenoff-Irving 1996). The following six rare plant species were monitored in 1996: Point Reyes bird's beak (*Cordylanthus maritimus* ssp. *palustris*), Marin knotweed (*Polygonum marinense*), fragrant fritillary (*Fritillaria liliaceae*), San Francisco owl's clover (*Triphysaria floribunda*), Marin manzanita (*Arctostaphylos virgata*), and Mount Vision ceanothus (*Ceanothus gloriosus* var. *porrectus*).

Of the ten sites monitored, only one site appeared to have been adversely affected by the Vision fire. A San Francisco owl's clover population, located on a ranch road, yielded only two individuals in 1996, a much lower count than the 474 individuals surveyed at the same site in 1988. Bulldozers disturbed the ranch road at this location during the fire (Semenoff-Irving 1996).

Revegetation

In the entire burned area, only one quarter-acre site required active revegetation. Locally collected coyote brush (*Baccharis pilularis*) cuttings were propagated at the Point Reyes nursery in 1996 and were planted along a severely eroded road cut (which was recontoured during post-fire rehabilitation) in Muddy Hollow in the

spring of 1997. Cuttings from new growth on burned stumps had a higher survival rate in the nursery than cuttings taken from shrubs which had not burned at all. Only a few plants survived the summer in the ground, but by fall, red alder (*Alnus rubra*) seedlings had become established.

Photodocumentation

Immediately following the fire, 29 permanent photopoints were established at sites of varying burn intensity. Yearly photographs taken at each site during the peak of the growing season illustrate vegetation recovery over time.

During the second year of vegetation monitoring, a pronounced difference in density and plant height was observed among populations of Australian fireweed in bishop pine forest. Populations of fireweed that had been removed in 1996 appeared significantly less dense in 1997 than populations that had not been treated. May 1997 photographs taken of treated and untreated sites reveal pine seedlings up to two decimeters taller where fireweed had been removed. Documentation of this type of competition is useful for its visual impact as an example of a species' invasiveness.

Recommendations

This section offers recommendations for future monitoring programs based on experience gained from the Vision fire.

Pre-fire:

- It is crucial to acquire reliable GPS units and have staff trained to use them. If possible, all rare plant and noxious weed locations, trails, roads, and landmarks should be recorded with GPS and digitally mapped.
- Learn as much as possible about the biology, life history, and response to fire of the weeds and rare plants in your park. Knowledge of aspects of weed ecology (e.g., the growth stage that will exhibit the greatest mortality when treated, seed longevity) will significantly increase your effectiveness at weed control. In addition, knowledge of the most effective control methods for your weed species will increase the success and cost-effectiveness of post-fire weed control.

During fire:

- Whenever possible, limit bulldozer activity. Assign a qualified resource advisor to the fire who knows the local topography and vegetation characteristics. Strongly emphasize ongoing communication between the resource advisor and the incident commander or the planning section chief. Get involved in the BAER planning process. Park employees who are directly involved in assisting with resource damage assessments become an invaluable source of information once the BAER team has been demobilized.
- Exercise caution when making decisions about post-fire seeding of burned areas. The pressure to seed may be great. Seeding often is not necessary and is ecologically unsound in many situations. Native, viable seed is present in the soil and seed will be dispersed into the burned area from adjacent unburned sites. The native seed will have a better chance of germinating if it is not competing with quantities of non-local seed.
- Take slide photographs of all activities. These will be valuable for historic records and public education. Label and archive slides as soon as possible.

Post-fire:

- Digitally map fire boundaries and all bulldozer and hand lines immediately. Use this technology to produce maps suitable for field monitoring.
- Hire monitors and organize weed removal crews early in the growing season. Assess equipment and tool needs and place orders immediately. Be prepared to adapt project priorities and crew size as the season progresses.

- Establish a database for managing weed removal data. These data are often crucial for funding requests and public information.
- Develop and implement quantitative, statistically valid protocols for all post-fire vegetation recovery (general vegetation, rare plants, weeds). Complement the quantitative monitoring with qualitative assessments such as photodocumentation. Establish permanent vegetation recovery and erosion photopoints. Ensure that funding is secured to continue monitoring for at least three growing seasons.
- Direct public concern toward participation in volunteer restoration programs. Consult with other parks—they often have successful programs and ideas to share.
- Collect seed and cuttings where appropriate for possible revegetation needs. Consider seeding or revegetating with natives at sites of large-scale weed removal. Clearing a site of one non-native species may simply enable a different non-native to encroach. Establish control plots inside and outside the burn to measure the effectiveness of weed control methods. Take “before” and “after” photographs of weed removal sites.

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Plant Community Mapping and Classification at Point Reyes National Seashore and Golden Gate National Recreation Area

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Introduction

Between 3 and 7 October 1995, the Vision fire burned 12,534 acres of private, state, and federal lands. Over 90% (11,598 acres) of the burned area was within Point Reyes National Seashore, an area administered by the U.S. National Park Service (NPS) that is north of San Francisco, California. In addition to burning wildlands, the fire consumed 45 homes in the town of Inverness Park. Fanned by winds up to 45 miles per hour, the fire moved quickly, burning 6,521 acres in 24 hours.

Due to the wildland-urban interface present and the associated threats to life and property, fire suppression efforts were aggressive. At the peak of suppression activities, 2,164 personnel were on site, encompassing 74 hand crews, 27 bulldozers, 7 air tankers, 7 helicopters, and 196 engines. Logistics, coordination, and planning were complicated and decisions had to be made quickly. At the time of the fire, Point Reyes National Seashore did not have a vegetation map. Had a map been available, it would have been of great assistance in making the crucial decisions associated with suppression of a major fire. The map would have helped in projecting rates and direction of fire spread, in implementing logistics and planning, and in ensuring fire-fighter and public safety.

The natural resources of the park, particularly vegetation and soils, were subject to significant adverse impacts as a result of suppression activities. These impacts primarily were associated with 23.1 miles of bulldozed fire line (13.6 miles occurred on slopes greater than 30%), 6.4 miles of hand line in designated wilderness, 13 helispots, and trees felled in streams. The department of the interior's interagency burned area emergency rehabilitation (BAER) team arrived at the park during the fire to assess the effects of the fire and fire suppression on natural and cultural resources. A vegetation map would have been invaluable to the BAER team for its impact assessment and for post-fire rehabilitation planning and implementation. Without a map, several of the team's post-fire analyses were only partially completed or were only moderately reliable. In addition, post-fire assessments of fuels and canopy cover, and determination of priority areas for prescribed burns require current information on vegetation types and distribution—information that is easily interpreted using vegetation maps.

Upon recognition of this critical gap in the park's resource inventory database, resource managers developed a proposal to create a digital vegetation map and vegetation classification. Although the NPS inventory and monitoring (I&M) program, in close cooperation with the U.S. Geological Survey Biological Resources Division (BRD), is in the process of developing vegetation maps for all NPS units, the projected date for mapping Point Reyes National Seashore was unknown. Point Reyes's proposal was a mechanism for accelerating the mapping. It involved financial contributions and support from NPS FIREPRO, Golden Gate National Recreation Area, the NPS I&M Program, the California State Department of Parks and Recreation, and Gulf of the Farallones National Marine Sanctuary, as well as from the park itself.

The two key components of this project involved development of the digital vegetation map, and concurrent collection and analysis of data to classify plant communities within the project area.

Vegetation Mapping

Vegetation mapping is being completed under an existing BRD-NPS contract with Environmental Systems Research Institute, Inc. (ESRI). A subcontractor to ESRI, Aerial Information Systems, Inc. (AIS), conducted aerial photo interpretation. The GIS-based map is being developed at a scale of 1:24,000, with a minimum mapping unit of 0.5 ha.

The project area includes approximately 155,000 acres, encompassing Point Reyes National Seashore, Golden Gate National Recreation Area, the Presidio lands, Alcatraz Island, Angel Island State Park, Samuel P. Taylor State Park, Mount Tamalpais State Park, and Tomales Bay State Park. Interpretation of intertidal areas and kelp beds also will be possible from the products of this effort.

At the initiation of the project, NPS provided ESRI with metric aerial photographs of the project area (in the form of natural-color diapositives at a scale of 1:24,000). Preliminary photo interpretation was done prior to a field reconnaissance. Photo interpreters from the ESRI-AIS team then visited the project area to determine the signatures associated with dominant vegetation types.

Photointerpretation was done to the alliance level for all polygons delineated on the aerial photos. Whenever discernible, interpreters also assigned a vegetation association to the polygons. Polygons were delineated on overlays on the aerial photos. These overlays then were transferred and geo-referenced to overlays on digital ortho quarter quad base maps. This overlay was scan-digitized and the linework was quality control-reviewed and correction-edited. Identification numbers were then overlaid on the polygons to facilitate linking spatial files to attribute files (QuattroPro files). Each polygon will have a unique identification number.

When photo interpretation was completed, the mapping team conducted a second field visit to resolve questions about specific problem areas identified during interpretation. These areas primarily included grassland and coyote brush scrub (*Baccharis pilularis*) vegetation types. The draft maps, digital data, and photographs were edited to reflect the field review.

In the summer of 1999, NPS personnel will conduct a field-accuracy assessment of the draft map. Accuracy-assessment point coordinates will be generated for all mapped alliances and associations. During the fieldwork, points will be documented using a Global Positioning System (GPS). Data collected from the accuracy assessment points will include dominant plant species and percent cover for the three vegetation layers (tree, shrub, and herb), general substrate information, slope, aspect, elevation, and general location information.

Vegetation Classification

Concurrent with development of the map, NPS resource management staff collected data to develop a classification system and key for identifying the vegetation types within the project area. NPS field crews collected data from 360 plots. Data collection and development of the classification system were done in conformance with BRD-NPS standards and protocols.

Vegetation data for the classification were taken from a sample of polygons representing each of the vegetation types identified during initial aerial photo interpretation. The number of samples from each type ranged from three to seven, and was based on the distribution and abundance of the type in the mapping area (e.g., more samples were selected for vegetation types that were common and widely distributed). Sample sites were located throughout the study area and attempts were made to ensure that they were relatively accessible. The objective was to select plots that were both geographically and ecologically representative of the study area.

Field-data collection methods largely followed methods for plant community classification developed by the California Native Plant Society (CNPS; Sawyer and Keeler-Wolf 1995), which are in conformance with BRD-NPS standards. Although the CNPS's methods use point intercept transects, for this project plant species

composition and percent cover were measured using a modified relevé approach. This approach was believed to provide data that were more representative of sampled polygons.

Specific plot locations within the polygons were subjectively selected in the field. Plots were positioned to provide the best possible representation of the vegetation within the polygon. Plots were either square or rectangular in shape. Plot size was dependent upon the configuration of the polygon and the plant community type. For herb- and shrub-dominated communities, plots were 400 sq m; for forest and woodland communities, 1,000 sq m.

Percent cover of each plant taxon was documented as both an actual percentage and as a cover class (<1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%). These data then were used to characterize the layering of vegetation present in the communities. The information on vegetation layers collected for this project provided more detail than that provided by using standard CNPS methods. Ten height classes were included: moss-lichen, low herb, medium herb, low shrub, high herb-medium shrub, high shrub, low tree, low-medium tree, medium-high tree, and high tree. These data facilitated development of the classification system and will be useful in fire management (e.g., fire behavior predictions, prescribed fire planning).

Following data collection, Todd Keeler-Wolf from the California Department of Fish and Game entered the plot data into a Paradox database, and conducted Twinspan analyses to determine appropriate divisions in the classification. Preliminary analyses resulted in identification of 55 alliances. Within these alliances were 57 plant associations and 95 vegetation types represented by one or more plots. In addition to developing the classification, a key was produced to facilitate rapid identification of plant communities in the field.

Conclusions

The vegetation map and classification resulting from this project will be used as a planning tool for a wide variety of resource management tasks, from prescribed fire planning to habitat suitability analyses for wildlife. The map and data will document baseline conditions against which future change can be measured and monitored.

The value of the map and classification are significantly increased by the fact that these planning tools are regional in nature. Mapping and classification are tasks that are ideally suited to regional, or ecological approaches, rather than strictly park-specific approaches. Vegetation mapping that is approached at a regional scale facilitates a bioregional approach to land management, as resources are viewed within a larger ecological context. For example, when formulating management plans for coastal prairie grassland, Point Reyes vegetation managers will have immediate knowledge of the presence and abundance of this plant community type within all areas covered by the map, both within and outside of the national seashore. With this information, the significance and relative rarity of Point Reyes' coastal prairie becomes more readily apparent, and management efforts can be tailored to this information.

Additionally, the regional approach provided an opportunity for partnering with and otherwise involving multiple organizations. When the project is completed, this partnership will have provided very high quality products at reasonable costs, as the costs were borne by several different entities. If each of the parties involved in the project had attempted to produce such products on its own, the costs would have been prohibitive. The effort that arose from the ashes of the Vision fire provides an example of a successful cooperative effort between federal and state land management agencies that can serve as a prototype for future vegetation mapping endeavors.

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Building a Program of Exotic Vegetation Management

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The 3 February 1999 presidential Executive Order on Invasive Species states that federal agencies shall "not authorize, fund, or carry out actions that ... are likely to cause or promote the introduction or spread of invasive species...." Even locations without known alien species problems must positively consider how to maintain native species and discourage exotics. This paper outlines the steps to create an exotic species management program.

Is There A Problem?

Obtaining an initial briefing on your resource doesn't have to cost a lot of money. There are many places to gather information about exotics, both in general and specific to your park. Databases and hard-copy reports in your park, or held by cooperators, contain much of what you need. The Web is a valuable search tool. (Unfortunately, Web addresses are highly ephemeral and change often. A few are listed below as examples.)

Species in your park. You must begin to learn which alien plant species are within your park. This should take the form of a progression in fact-finding from probable to extensive to intensive information. First, assemble existing information. In most cases, there is no need to start from scratch.

- Do the basics. Go through the park and division files for old botanical/forestry/site reports. Valuable information is found in park general management plans, facility development plans, and transportation plans, each with their associated environmental clearance documents.
- Natural heritage databases. These databases are maintained by state offices of The Nature Conservancy, and have an excellent reputation for accuracy. To obtain information within your state, go into their U.S. map index and click upon your state from <http://www.heritage.tnc.org/nhp/us/usmap.html>. Some levels of data are free, while sophisticated searches are fee-based.
- U.S. Department of Agriculture. This federal department has several databases of information and images. Access it from <http://plants.usda.gov/plantproj/plants/index.html>.
- Invaders database system. Maintained by the University of Montana, this is an excellent source of biological descriptions, photographs, and species ranges for the states of Idaho, Montana, Oregon, Washington, and Wyoming. Access it from <http://invader.dbs.umt.edu/default.htm>.
- NPFLORA. Though the accuracy of species occurrences in NPFLORA is questionable, it is a handy reference to get started. You may have this database in your park already, so ask around. The agency-wide National Park Service (NPS) database is maintained at the University of California at Davis. You can also click on specific species to determine what other parks are infested as well. The Web address is masked from direct access, so you must conduct a search using "NPFlora" in your search line at <http://agdean96.ucdavis.edu/search/default.htm>.

Next, think extensive, not intensive. By nature, extensive surveys provide qualitative data and a cameo of species distributions. One form of extensive survey is the long-term ecological monitoring system (LTEMS). You are not limited to that approach, however. A well-thought-out sampling design can be statistically effective and still affordable. With a few knowledgeable volunteers or borrowed staff time to

conduct field work, you can complete the job in six months to two years. Extensive information can help you:

- List what exotic species are present.
- Gain an understanding of levels of infestation.
- Confirm alien distributions. Where are the hotbeds of alien invasions? A spin-off is the opportunity to gather GPS locations of epicenters for GIS displays and analysis, if the technology is available.
- Gather photographs of local infestations and botanical mounts. Think public relations.
- Provide information for subsequent treatment prioritization.
- Provide a basis for an operations inventory to plan and monitor treatments and their effectiveness. This is a segue into intensive sampling.
- Provide sufficient data for subsequent grant-writing.

You may employ permanent or temporary plot sampling. The latter tends to be simpler and quicker to conduct. Even volunteer time is money when you supervise the volunteers. A big advantage to using a permanent system, however (where plots are monumented in some way for future remeasurements), is that you can monitor trends and treatment results with higher statistical confidence. It is much easier to correlate data from one time period to another when using the same points. This can be an important and budget-impacting difference.

As you can afford it, enact intensive sampling. Generally, intensive surveys are not indicated for park-wide problem-solving, but rather for focused study. Perhaps there are specific areas of concern, such as heritage areas or areas known to contain rare, threatened, or endangered species that need protection. Perhaps you wish to monitor treatment effectiveness. These are appropriate applications for intensive sampling. If you initially use a permanent extensive survey system, your intensive sampling can be an expansion of that work.

Learn about exotics in general. There is a growing knowledge base of alien species biology and effective controls technology. Many states and regional organizations are creating high-quality fact sheets for individual species. Pictorial references are also available to aid identification of hitherto unknown species. Many states have governmental offices or ad hoc task forces to come to grips with exotic species threats. Best first contacts are neighboring park specialists, NPS regional specialists, and state agricultural or forestry agencies. There are also interstate cooperatives and regional organizations emerging to provide information to land-owners.

Information on the Web. Here's a brief listing of current organizations with Web site information:

- Tennessee Exotic Pest Plant Council (an *excellent* Web site with links to many other sites as well; <http://www.webriver.com/tn-eppc/>)
- Florida Exotic Pest Plant Council (<http://www.fleppc.org/>)
- California Exotic Pest Plant Council (<http://www.igc.apc.org/ceppc/index.html>)
- Pacific Northwest Exotic Pest Plant Council (<http://www.wnps.org/-eppclet.html>)
- Southeast Exotic Pest Plant Council (fledgling)
- Mid-Atlantic Exotic Pest Plant Council (fledgling).

Reports and treatment manuals. Many helpful reports are available through federal offices. State and regional exotic pest plant councils (EPPCs) have created some very helpful manuals as well. These materials include programmatic status reports, symposia proceedings, and technical bulletins and reports. Refer to the References section at the end of this paper for some of the most helpful.

"I Wanna Kill!" Whoa—First, You Should Plan

Early on in your process of learning what invasive problems you face, it seems imperative to start the war on the alien invasion. It's exciting to get started. It's hard work but fun to uproot, spray herbicides, or burn exotics. But without planning and getting other park staff and neighbors on board, your efforts could become abortive, just fizzle out, or actually do harm. You need support and good input in arriving at the most effective strategy.

Cover the bases: Do NEPA and NHPA clearances. In large measure, the National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) laws are meant to get people to talk. Certainly they aim at protecting resources, but they are intended to get land managers to scope out issues with the public, talk openly about problems and potential cures, and arrive at informed decision-making. This is an excellent forum to get other park divisions to understand the issues and get their input for better results. This is also a good time to conduct exterior public relations efforts. Use some of the information you gathered in the initial assessment phase such as photos, species mounts, data, and mapping. Bring in experts. Tell the story and make your case.

Cite and strive to achieve GPRA goals. Here are some valuable national citations from GPRA, the Government Performance and Results Act:

- Mission Goal Ia: "Natural and cultural resources and associated values are protected, restored, and maintained in good condition and managed within their broader ecosystem and cultural context."
- Long-term Goal Ia1. "Disturbed Lands / Exotic Species—5% of targeted disturbed park lands, as of 1997, are restored, and 5% of priority targeted disturbances are contained."
- Mission Goal IVb: "The National Park Service increases its managerial capabilities through initiatives and support from other agencies, organizations, and individuals."
- Long-term Goal IVb1. Volunteer Hours—"Increased by 10%, over the 1997 level, the number of volunteer hours."

Use a quote or two. Sometimes you just have to use the words of important people to convince non-believers. Here are a few quotable quotes:

- "Many Americans are all too familiar with gypsy moths and other non-native insects that devour our gardens and trees. Few realize, however, that countless other non-native plants and animals are upsetting nature's balance, squeezing out native species, causing severe economic damage, and transforming our landscape." (Clinton 1999b)
- "In the report titled, *Invasive Plants: Changing the Landscape of America*, Secretary of the Interior Bruce Babbitt says, 'The invasion of noxious weeds has created a level of destruction to America's environment and economy that is matched only by the damage caused by floods, earthquakes, wildfire, hurricanes and mudslides.... This is truly an explosion in slow motion by opportunistic alien species with few if any natural enemies'" (NPS 1998).
- "NPS Director Robert Stanton calls invasive species 'one of the most significant threats facing the natural and cultural resources of the National Park System.... Although vast fields of flowering plants may look attractive to the visitor, many of these plants are actually silent, green invaders, slowly destroying the native, living natural heritage the parks are supposed to preserve'" (NPS 1998).

You must prioritize. Now that you know you have a certain amount of exotics, how do you decide where to begin? There are always those one or two exotic infes-

tations that you knew about before even getting organized, but what then? Getting prioritized requires a two-pronged approach:

- Prioritize your exotics. Hiebert and Stubbendieck (1993) provide a systematic approach to evaluate exotic species in their *Handbook for Ranking Exotic Plants for Management and Control*. The authors state:

The Exotic Species Ranking System is designed to first separate the innocuous species from the disruptive species. The separation allows researchers [and practitioners] to then concentrate further efforts on species in the disruptive category. The system is also designed to identify those species that are not presently a serious threat but have the potential to become a threat and, thus, should be monitored closely. Finally, the system asks the park manager and the ecologist to consider the cost of delaying any action.

The approach looks at two basic sets of questions (for each species): (1) What is its significance of impact? How pervasive is it in your area? What is its current level of impact? What is its biological potential for spread, its environmental dominance, and its resistance to control? (2) What is its feasibility for control? Is the technology present and affordable? What is the species' abundance in the park? This is a handy way to organize your thinking and focus upon the operationally feasible species to control. It is a point of beginning. The Hiebert and Stubbendieck manual is downloadable from <http://www.nature.nps.gov/pubs/-ranking/ranking.htm>.

- Prioritize your geography. Identifying areas for control is also important. Some species that did not rank sufficiently to begin controls (perhaps because they were too overwhelmingly present) might still need to be controlled in specific areas. The questions to ask are: (1) Do you have historical or natural heritage areas that need restoration or preservation? (2) Do you have rare, threatened, or endangered species that demand protection? (3) Do you have areas with only slight infestations that, with a little control work, would result in near-pristine conditions? (4) Do you have areas that need protection for the sake of visitor enjoyment? Answering these questions will adjust your initial species ranking into an operations approach to exotic species management.

Use appropriate technology. Most species can be controlled in several ways, using physical, biological and chemical approaches. Within those approaches, there are best management practices. As the profession gains more knowledge, the technology for controlling exotics is developing. Therefore, even if you are an old hand at vegetation management, you need to keep up with research and the informed grapevine. Here are some ways to gather technology updates:

- Call specialists at other parks or regional offices. Call specialists at other agencies. Ask about what's working for them on specific species.
- Join in state or regional EPPCs.
- Go to relevant technical training.
- Access the national resource management plan database and look for exotic vegetation management projects. Compare their approaches.
- Speak to or e-mail national NPS experts in the Washington office, such as Gary Johnston, biologist, and Terry Cacek and Carol DiSalvo, integrated pest management specialists, among others.

"Show Me The Money!"

The financial scene at most NPS areas is grim for new initiatives. Generally, it's very competitive to garner support in the ostensibly stable (but truly shrinking) ONPS park budget (i.e., NPS operations base funding). Though other divisions may appreciate the exotics situation, they are unwilling to sacrifice their programs to support an initiative. As with so many other important programs, that forces you to compete for regional and national call funds.

Funding sources. A large percentage of natural and cultural resource management is already funded through the competitive regional-national project proposal process. This will remain true for exotics projects as well. Here's a very brief rundown on the available pots of funding typically used for NPS projects. You should attempt to access these, but your success will depend on getting out of the box as well. Typical NPS funding sources include ONPS, NRPP-RM (NPS natural resource preservation program resource management and science), and NRPP-Threatened and Endangered Species (exotics work may fit in as a part of a larger approved recovery plan project). Other sources friendly to exotics initiatives include:

- National Fish and Wildlife Foundation (its "Pulling Together" partners' grants program);
- Native Plant Conservation Initiative (federal interagency programmatic funding, accessible from www.nfwf.org/programs.htm);
- "Expedition into the Parks" (Canon-National Parks Foundation grants); and
- "Species At Risk" (U.S. Geological Survey Biological Resources Division programmatic funding). This source will not fund control work, but may fit in with survey-monitoring and research questions.

To make your proposals more attractive, bundle your project with those of other parks for better economy of scale and to indicate more comprehensive need; this can be especially helpful for NRPP competition. Also, start cooperating with other land-owners and agencies—"Pulling Together" grants administered by the National Fish and Wildlife Foundation require this. Several other sources look very kindly on interagency cooperation as well.

Is this just another unfunded mandate? We surely hope not. The need is great. The current potential to act with existing funding is very low.

Are there any bright spots? National sources believe we are in a much better position to gain support for the exotics initiative than at any time in the last 10 years. The rhetoric from the administration, the department of the interior, and NPS Washington office is converging to request support from Congress. Western constituents have been lobbying for exotics funding for several years. Perhaps Congress, too, is ready to act with bigger support.

The NPS fiscal year 2000 budget proposal includes \$4.0 million for exotics and habitat restoration. Of that total, \$2.7 million is earmarked for exotic vegetation management. The Washington office intends to control those monies to fund two or three exotic vegetation "SWAT teams." "They would be based on the Lake Mead model and include 12-15 FTE [full-time positions]," said one source. Additionally, of the 12 proposals within the NPS director's Natural Resource Challenge, one specifically addressed exotics, including \$35 million to fund needed monitoring and treatments.

Conclusions

This may indeed be the opportune time to gear up an exotic vegetation management program at your park. The NPS mandate to "preserve and protect" is clear, and the threat of alien species is being recognized at high levels within federal and state governments. If your resources are being affected by invasive non-natives, those

resources must be protected. Luckily, there is a growing cadre of specialists and body of knowledge to help you get started in a logical manner, without having to suffer *all* the trial and error of others. Though adequate program funding response is very questionable at this time, there are ways to obtain general and on-site knowledge that will not break the bank. May you have success as you grow your program.

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On the 1967 Proposal for an Adirondack Mountains National Park

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Background

On 19 September 1968, New York State Governor Nelson A. Rockefeller announced the creation of a Temporary Study Commission on the Future of the Adirondacks to undertake an in-depth review of problems affecting the Adirondack Park and to develop alternatives for the future protection of this area.

The Study Commission was established largely as a response to widespread public controversy generated by the formal announcement the previous year of a proposal for creating a national park within the Adirondacks, a state park consisting of a mix of public and private lands. The national park proposal had been submitted to Governor Rockefeller, Secretary of the Interior Stewart L. Udall, and New York State Conservation Commissioner R. Stewart Kilborne by Laurance S. Rockefeller, the governor's brother and chairperson of the New York State Council of Parks. Conrad L. Wirth, former director of the National Park Service (NPS); Ben H. Thompson, also retired from NPS; and Roger Thompson, formerly research director for the New York State Senate Finance Committee, had been commissioned by Laurance Rockefeller to explore the possibility of an Adirondack Mountains National Park in the northern part of New York. In releasing the report the governor said: "The proposal to give National Park status to a section of the Adirondack State Park is a most interesting and imaginative one and will receive careful study and serious consideration."

The Adirondack Park and Forest Preserve

New York's Adirondack Park was originally created in 1892 to "be forever reserved, maintained and cared for as ground open for the free use of all the people for their health and pleasure, and as forest lands necessary to the preservation of the headwaters of the chief rivers of the state, and a future timber supply." Since this time, the boundary of the Park has been enlarged six times to its current size of approximately six million acres. It is the largest park in the contiguous United States, and is more than two-and-a-half times the size of Yellowstone National Park.

The regional economy of the Adirondacks has traditionally been based on forestry, tourism, and farming, with government services and real estate activities assuming greater importance in recent years. The 130,000 people who live in the Adirondacks on a permanent basis are served by 105 units of town and village government in 12 counties. The park offers some of the finest opportunities in the eastern United States for wildland recreation in a superb natural setting. In 1932, and again in 1980, the Lake Placid region of the northeast Adirondacks was the setting of the Winter Olympic games. Located here are the rugged and scenic "High Peaks," including the 5,344-foot Mt. Marcy, the highest point in New York.

State-owned lands in the Adirondacks largely comprise the New York State Forest Preserve, established in 1885 as a consequence of rising conservation sentiment against wasteful and destructive logging practices and associated threats to the state's water supply. The Adirondack Forest Preserve now consists of some 2.6 million acres, or 40% of the Adirondack Park. Since 1895, such lands have been subject to a provision of the New York State Constitution (Article XIV) which states: "The lands of the state, now owned or hereafter acquired, constituting the forest preserve as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed."

Of the more than 130 proposed amendments to this so-called iron-clad provision of the state constitution, relatively few have survived the requisite passage in two

consecutively elected sessions of the legislature and subsequent approval by voter referendum (VanValkenburgh 1979).

The National Park Proposal

On 30 July 1967, the plan for a national park within the central portion of the Adirondack Park was released by the office of the governor. It proposed an Adirondack Mountains National Park consisting of 1.12 million acres owned by the state as part of the forest preserve and 600,000 acres of adjoining properties owned by timber companies and other private landowners. Excluded from proposed federal acquisition were Lake Placid and four other village and resort enclaves that were envisioned to become the principal commercial service centers for the national park. The national park would include the best of the varied natural scenes and physiographic features that characterize the Adirondack Mountain region, including the High Peaks (Wirth, Thompson, and Thompson 1967).

The primary rationale for the national park idea was to offer federal protection to the core area of the Adirondacks by consolidating ownership into a large single block of public land. It was also thought that a strengthened federal role would make the region more readily known and available to 100 million people living in the northeastern United States. Interior Secretary Udall saw the Adirondacks as the "last true national park option left in all of the East."

Findings of an earlier assessment of the Adirondack Park prepared for the Council of Parks suggested that current state administrative policies and practices were inadequate, that the park concept competed with the forest preserve concept, and that the administrative structure of the Adirondacks urgently required attention (Liroff and Davis 1981). Conrad Wirth went so far as to suggest that the Adirondack Park in its present state existed only as a myth. In later years, Wirth upheld the notion that the Adirondacks were a good idea for a national park, contending that if the state of New York did not take the initiative, and acted accordingly, NPS could step forward with a national park proposal in the same manner as it had done with Cape Cod. He said that the need had been "doodling around" for too long. Wirth stated that Governor Rockefeller and Secretary Udall supported the idea of a national park, but then turned it down in light of the lack of state support (Wirth 1989).

Indeed, the national park proposal met with general disfavor by a broad spectrum of interest groups. These included local government, forest industry, fish and game organizations, The Wilderness Society, and the Adirondack Mountain Club. The chairman of the New York State Joint Legislative Committee on Natural Resources said: "The one good thing this proposal has done is to unite some people who have not always seen eye to eye" (Pomeroy 1967).

New York's Conservation Department, given the charge to study and respond to the proposal, contrasted state policies with those of Yosemite, Yellowstone, and the Grand Tetons. Largely on this basis the department argued that the proposed national park for the Adirondacks would irretrievably disorganize the lumber industry, dislocate much of the tourist industry oriented to recreation uses offered by both the state and private sectors, and disrupt the ecological balance of the Adirondacks due to a ban on hunting. Additionally, control of the main source of the state's water supply would be transferred, and an untenable situation in regard to the tax structure of local communities would result unless the federal government continued to pay taxes on lands sold or transferred to its jurisdiction (Conservation Department 1968).

The Association for the Protection of the Adirondacks and other conservation organizations felt that federal control would compromise the time-tried protection of the "forever wild" covenant of the state constitution. In responding to Laurance Rockefeller's request for a meeting of statewide organizations to discuss the proposed Adirondack Mountains National Park, a leading defender of the Forest Pre-

serve wrote that "even if many state conservation leaders espoused the proposal, the people as a whole would reject it."

The reason for this ... is that the citizens of New York State have personally identified themselves with proprietary ownership of the State Forest Preserve. They have been involved in long, weary, expensive and yet successful battles to prevent exploitation of the Preserve and in public referendums registered such opposition with pluralities of more than a million votes.... The people of our state feel themselves part and parcel of every acre of the Forest Preserve and will not transfer their personal ownership and control to any outside agency" (Schaeffer 1967).

The Temporary Study Commission

The public clamor over the national park proposal led to the establishment of the Temporary Study Commission on the Future of the Adirondacks. Governor Rockefeller noted that the national park proposal, in concert with its critique by the Conservation Department, performed "a great service by drawing public attention to the opportunities and unresolved issues for the future of the Adirondacks." The commission's charge was to take a broad, long-range look at the problems of the park, and to address specific questions, including: (1) What measures could be taken to assure that development on private land is appropriate and consistent with the long-range well-being of the area?; and, (2) Should there be federal participation in any phase of the plans, including a limited park or wilderness area? (Rockefeller 1968).

The Adirondack study commission undertook a complete, thorough, even exhaustive study. They found that land speculation and unplanned development on private land in the park were capable of despoiling public and private land once considered limitless. Also, recent completion of an interstate highway (the Adirondack Northway; I-87) through the eastern part of the park was accentuating the seriousness of the problem. Local governments in the Adirondacks were characterized as poor and fragmented, and generally not capable of establishing effective planning and land-use controls for their open-space areas. As a general conclusion the Temporary Study Commission stated that "the 3.5 million acres of private land in the Adirondack Park ... now generally free of restraint, poses a grave and growing threat to the entire Park. It is imperative, if the Adirondacks are to be saved, that the state develop an overall, long-range plan for all the public and private land in the Park and exercise a degree of control over the uses to which these lands may be put. Land use control powers over private land should not be assumed by a regular state administrative department, but should be vested in an independent Agency" (Temporary Study Commission 1970).

The legislation establishing such an agency—the Adirondack Park Agency (APA)—was subsequently approved by the state legislature in 1971. APA was charged with preparing a master plan for all state lands within the park, and with setting policy for management of the forest preserve. It was also charged with preparing a regulatory land-use and development plan for private lands, and was given review authority over major development proposals.

The 181 recommendations of the Temporary Study Commission went well beyond the call for a regional state agency with broad planning and regulatory authority over land use in the Adirondack Park. The commission urged an active state program for acquisition of scenic easements; that a state system of wild, scenic, and recreational rivers be created; and that Article XIV of the state constitution be retained without change. It also expressly stated that "there should be no participation by the federal government in the management of state or private land in the Adirondack Park" (Temporary Study Commission 1970).

It was the commission's contention that the entire Adirondack Park must be administered as an entity unique in the United States, an objective that could be at-

tained only through a massive state action to assure continued integrity of the park. Furthermore, the protection offered the forest preserve by the state constitution was seen as unequalled in the nation; that safeguards for protecting public land under federal management were not nearly so stringent (Temporary Study Commission 1970). State and private land outside the federal park area would be put at risk of being degraded by strip development of the type existing on the fringes of some national parks, with the "hole-in-the-donut" situation of a national park within a state park construed as an "administrative nightmare" (Jerry 1999). Other reasons for rejecting the national park alternative included the unnecessary disruption of the wood-using industry and displacement of park residents.

The Twenty-First Century Commission

In 1989, another examination of an expanded federal role in the Adirondack Park was conducted as part of a second gubernatorial commission established by Governor Mario Cuomo to address renewed threats to the wild and open-space character of the Adirondack Park (Commission on the Adirondacks in the Twenty-First Century 1990).

While this Twenty-First Century Commission reaffirmed the previous position made 20 years earlier by the Temporary Study Commission—namely, that "there be no federal presence relating to land management in the Adirondack Park"—it did see clear advantages in fostering a stronger partnership role with the National Park Service and other federal agencies (Cobb 1990). One recommendation called for including the park's wild, scenic, and recreational rivers system in the national system, with administration remaining at the state level as provided for in federal law. The commission further recommended encouraging federal programs for assisting education and research, technical assistance, and scenic by-way improvements. Full cooperation in the federally sponsored Northern Forest Lands Study was likewise called for, as well as support for the Champlain-Adirondack Biosphere Reserve that had been established in 1989. It further recommended appropriate consideration of including the Adirondack Park under the World Heritage Convention. This would be as a "mixed site", or an area that integrated ecology, history, and cultural value in the management of protected landscapes (Cobb 1992).

Conclusion

While recognizing that there are many approaches to protected area management, and that there is inherent value in having a variety of approaches, the Adirondack Park model is one that continues to evolve after more than a century of legislative measures, judicial rulings, and associated citizen involvement.

Of significant historical note, however, is that the 1967 debate over the merits of federal versus state protective action brought public attention to bear on impending threats to the integrity of the Adirondacks. Subsequent passage of the Adirondack Park Agency Act in 1971 has proven the most important measure to protect the region since adoption of the forever wild constitutional covenant in 1894. This law upheld and strengthened the principle of an integrated, or combined public and private approach to park administration, that is inherent to a relatively new phase of the American conservation movement for "greenline parks."

While Chapter 444 of the Laws of 1912 expanded the Adirondack Park to include the private as well as the state land as part of the Park, the 1971 APA statute provided these lands sufficient protection to have the Adirondack Park subsequently listed as a Category V protected landscape on the United Nations List of Protected Areas, a classification given to many analogous areas in western Europe (WCMC and WCPA 1998).

Though unsuccessful, the proposal for an Adirondack Mountains National Park did establish the national and international significance of the Adirondacks. As Conrad Wirth and his associates pointed out: "We are convinced beyond any doubt

that the Adirondacks are of national park quality, and if established as a national park would rate second to none."

The notion was not without precedent. Nineteen units under full or partial jurisdiction of the National Park Service have been established in New York. Saratoga National Historical Park was previously a state historic site. The suggestion that the idea for a national park in the Adirondacks was a political tactic to pave the way for the Adirondack Park Agency does not have a firm basis. Reflecting back on the original proposal, Laurance Rockefeller pointed out that "I always felt a little wistful that if Connie Wirth had not insisted on making it a Park over one million acres, and instead had thought merely to protect the scenic mountain area, it might have successfully gone through" (Rockefeller 1996).

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An Overview and Annotated Bibliography of Resource Management Policy Recommendations for the U.S. National Park Service (1988-1997)

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[Ed. note: Because of space limitations, the annotated bibliography originally accompanying this review could not be included in the proceedings. However, it is available on the Web at <http://www.tufts.edu/~cchester/nps.html>.]

Findings

The National Park Service (NPS) lacks sufficient funding, receives inadequate political support, offers limited public education, and is weak in science-based management. There is one thing, however, that the NPS has in abundance: a storehouse full of policy recommendations for natural resource management. Table 1 summarizes the recommendations of thirteen books, reports, and papers written since 1988. (It should be noted that my focus was on biological resources in national parks. However, many of the publications reviewed also comment on, for example, cultural, archaeological, historic, and recreational resources.) Each of these publications addresses the question: How can the NPS best protect the natural resources of the national parks?

The answers are numerous and diverse. Recommendations cover a wide range of issues, from limiting automobiles and issuing bonds to strengthening education and promoting ecosystem management. But within this diversity lie two strongly consistent themes: *science* and *professionalism*.

Science. The majority of the publications strongly advocate an increased role for science in park management. Although "science" is rarely explicitly defined, commentators are generally referring to the factual understanding of the natural resources of the National Park System. For instance, "science" includes the knowledge contained in biological inventories, the research conducted on natural histories of individual species, the interpretation of ecosystem relationships, and the determination of the effects of perturbations on living systems. According to most of the reviewed publications, many if not most of the resource problems facing the NPS result largely from a lack of such scientific information. Without this understanding, the NPS cannot make decisions that ensure resource protection.

Repeated appeals for "more science" may give the impression that science *per se* can "save the parks." This is illusory; the national parks manifest shared values implemented through politics—and values and politics are fundamentally nonscientific phenomena. But while science cannot define values and politics, science should provide crucial baseline data for management decisions that enhance conservation. Because preserving park resources often calls for making difficult decisions that are unpopular with specific user groups, these decisions must be implemented on the basis of credible evidence and demonstrated need. Without science to back up controversial decisions, the performance of the NPS in protecting natural resources will remain far below its potential. (For example, "ecosystem management" has become a widely accepted—although still ill-defined—standard for national parks and surrounding federal lands. While ecosystem management is subject to various definitions, nearly all agree that it can only work if it is based on "sound science.")

Professionalism. A fundamental component of professionalism in a resource management agency is the ability to incorporate scientific information into decision-making. So while park managers need science in order to protect natural resources, they also need *to be able to use* scientific information. Unfortunately, the NPS appears to have substantial weaknesses in this area; over half of the publications reviewed state that the NPS faces a serious problem in *declining professionalism* within its corps.

	1	2	3	4	5	6	7	8	9	10	11	12	13	T
<i>Science & Knowledge</i>														
Increase the role of science in park management	*	*			*	*	*	*		*	*	*		9
Increase public education on preservation				*		*	*		*	*		*		6
Increase scientific capacity of employees											*			1
<i>Site management</i>														
Promote the use of ecosystem management/interagency coordination					*			*	*	*		*		5
Strengthen partnerships with other institutions	*					*		*		*				4
Promote collaborative planning with local communities	*													1
Maintain public access without impairing preservation										*				1
Retain or transfer park units to emphasize preservation				*										1
Establish "quiet zones"									*					1
Limit number of visitors/autos									*					1
<i>Personnel</i>														
Improving employee professionalism/leadership		*		*	*	*		*		*	*	*		8
Link job description/career advancement to preservation				*					*					2
<i>Financial management</i>														
Give NPS control of user fees and more fund raising discretion	*		*	*										3
Lobby for increased funding and protection	*			*										2
Rely on market mechanisms	*		*											2
Do not rely on market mechanisms				*										1
Reevaluate the role of concessionaires									*					1
Allow NPS to issue bonds	*													1
Involve public in setting funding priorities	*													1
<i>Politics</i>														
Increase NPS independence from DOI and Congress			*	*					*					3
Strengthen legislative/executive mandate for preservation	*			*										2
Strengthen legislation for science								*		*				2
Increase NPS Director's authority in setting policy													*	1
Keep political bureaucrats out of specific park management													*	1

Table 1. Recommendations for improving NPS. Chart numbers correspond with publications as follows: 1 = Buccino et al. 1997; 2 = Sellars 1997; 3 = CEHC 1995; 4 = Lowry 1994; 5 = NPS 1994a; 6 = NPS 1994b; 7 = NPS 1993a; 8 = NPS 1993b; 9 = Frome 1992; 10 = NPS 1992; 11 = National Research Council 1992; 12 = CRRMP 1989; 13 = Hartzog 1988.

Not all documents use the term "professionalism." Some refer to the problems of managerial capacity or leadership qualities. A few reports, such as the *Vail Agenda*, specify weaknesses in recruitment and training standards. But all refer to the essential ability of NPS employees to accomplish the mission of the agency. And while different publications focus on different aspects of professionalism (e.g., financial expertise and public safety), the ability of NPS personnel to generate, support, and use science for resource protection is a dominant theme.

Going in circles? Neither of these critiques is new; the NPS has endured allegations of insufficiency in both science and professionalism since long before 1988 (the earliest of the publications under review in this paper). Not only are these critiques commonplace, but references to the *redundancy* of these critiques are now commonplace. To address these problems, commentators have recommended policy reforms in support of better science and strengthened professionalism—some of which have been nominally adopted by the NPS. But still these long-recognized problems persist.

What would it take for the NPS to address these problems? One response should be immediately ruled out: there is no need to commission additional studies of resource management. In light of numerous, repetitive analyses of the NPS, it is clear that *implementation of better science and higher professionalism is the fundamental prerequisite for change.*

As an outsider to the NPS bureaucracy, I began this examination as an effort to understand what "the experts" thought were the best ways to enhance the performance of the NPS. Considering the diversity of authorship, the thirteen publications were remarkably consistent. This is not surprising: knowledge (science) and capacity (professionalism) are fundamental to the success of any organization. Hopefully, the current "Natural Resource Challenge" will have a significant impact on the implementation of these goals. If not, perhaps someday this paper will be summarized in somebody else's review.

Overview of Policy Study Recommendations

Table 1 provides an overview of the principal recommendations made in thirteen publications critiquing the NPS. (Summaries of these publications are available on the Web at <http://www.tufts.edu/~cchester/nps.html>.) As can be seen in the References section below, the thirteen publications selected for review were chosen from over forty other publications on the NPS. Of the thirteen, two were chosen because they were recent (Buccino et al. 1997 and Sellars 1997), two because of their scale (*the Vail Agenda* and *Science and the National Parks*), five because they originated within the NPS, and the others because of the authors' diverse experiences and reformist ideas.

The annotated bibliography (on the Web site referenced above) attempts to condense and isolate conclusions reached in each of the publications reviewed. In some cases this was particularly difficult. There was no simple way, for example, to extract the essence of a report such as the *Vail Agenda*—which is chock-full of recommendations. Consequently, while I made a careful effort to condense each publication as the respective authors would see fit, the reader should take into account that my subjective biases will be evident throughout.

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Federal Protected Area Policy Deficiency and the Growth of The Nature Conservancy

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Introduction

Early in the twentieth century in the USA, the scientific community began a persistent and passionate call for the federal government to protect the nation's biological diversity. Such a government-based approach was consonant with the Progressivist belief in the ability of government to solve social and environmental ills. If unfettered capitalism was the cause behind the loss of biodiversity, the Progressive-era response should have been the creation of government programs to counterbalance the inexorable forces of the marketplace. (The authors note that the word "biodiversity" did not become widely used until the 1980s. For decades, the term "biological diversity" and earlier variants of "natural conditions with their multitude of species" were used to impart the same meaning.)

Despite this plea for government involvement in biodiversity protection, it never really happened. For various political and economic reasons, the idea was unable to gain currency within any of the major conservation agencies. Government efforts that eventually did emerge, namely last-ditch, single-species-oriented programs such as the Endangered Species Act, affect a very small proportion of the nation's most threatened biodiversity resources. To this day, the USA does not have a national biodiversity policy, nor is it party to the international treaty on biodiversity.

In this conservation policy vacuum, The Nature Conservancy (TNC), a non-governmental organization (NGO), was conceived and grew to become the nation's pre-eminent institution for the protection of biodiversity. With no competing government entity, TNC acted as a "policy entrepreneur," embracing as its *raison d'être* the preservation of "plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive."

This paper will address the following questions. First, why were federal agencies able to successfully elude the responsibility of protecting national biological diversity resources? Second, why was TNC successful in filling this gap?

An Unanswered Call

Progressive-era government conservation programs were preoccupied with four tasks: 1) soil conservation; 2) establishment of large tracts of public parks, forests, and wildlife refuges; 3) promulgation of laws and regulations to control destructive practices such as market hunting and slash-and-burn forestry, and; 4) eradication of animals and plants injurious to agriculture, forestry, game animals, and trapping. The argument underlying these programs was unwaveringly utilitarian: production of a sustained flow of agricultural, timber, consumptive and non-consumptive recreation, and tourism. In the best cases, these policies afforded serendipitous protection for native flora and fauna. In the worst cases, such as weed and animal control programs, federal conservation programs actively sought to reduce native biological diversity.

A convergence of disparate interests permitted Congress and the federal land management agencies to absolve themselves from adopting affirmative biodiversity protection programs. First among these interests was the dominance of a "wise use" philosophy of conservation that pervaded virtually all government agencies and programs. Whether the focus was on trees, soil, or tourism, this organizational culture called for the maximum yield of economic benefits wherever they could be extracted. Constituency-based, rather than ecologically based, this "resourcism" ideology was

advanced and perpetuated by a resource management elite comprising business, government agencies, and university research and education programs (Oelschlaeger 1990). Within this culture, the idea of protecting biological diversity was not only unimportant, it was blasphemous. Politically marginalized and lacking any identifiable public constituency, the biodiversity message of ecologists went unheeded.

Secondly, despite the warnings of writers from George Perkins Marsh to Robert Sterling Yard, there was little perception of a scarcity of natural diversity (Nash 1982; Allen 1982). National focus was still on economic expansion and maximum utilization of natural resources. Conversion of natural biological systems into production systems was seen as necessary to achieve this goal.

Third, the scientific concept of biological diversity was still in its infancy. Indeed, the discipline of ecology struggled for legitimacy up until the 1950s. The lexicon of the ecologist—words and concepts such as “viable population,” “ecosystems,” and “genetic variation”—was far different from the resource managers’ language of “sustained yield,” “board feet,” and “multiple use.” Ecological concepts were difficult to translate into policy objectives of interest to a public focused on economic expansion and leisure. The amorphous idea of preserving natural diversity was not on the national political agenda, nor in the forefront of most American’s minds.

The idea of establishing a comprehensive, ecologically driven protected area system was limited to a small contingent of ecologists and conservation biologists. Most prominent in the USA were people such as Lucy Braun, an ecologist at the University of Cincinnati, and Victor Shelford, a noted biologist from the University of Illinois. In 1926 the Ecological Society of America (ESA) Committee on the Preservation of Natural Areas published the *Naturalist's Guide to the Americas* (Shelford 1926). The authors and editors repeatedly suggested that government should be involved of the protection of unmanaged and unmanipulated areas for reasons that included not only recreation, game, and artistic inspiration, but also for scientific research focused on natural systems.

At the same time, Braun—a prominent member of the ESA—led an unsuccessful campaign to create a “primeval monument system” to be managed by the National Park Service (Behlen 1981). Charles Adams from Syracuse University, Joseph Grinnell from the University of California at Berkeley, and George Wright from the National Park Service (NPS) all argued that national park management should be based on ecological processes rather than manipulating the system for tourism (Sellars 1997; Pritchard 1998).

Response from Congress and the federal agencies was, at best, inaction; at worst, blatantly antagonistic toward biodiversity interests. In 1931, for instance, despite protestations from ecologists and wildlife biologists, Congress passed the Animal Damage Control Act, authorizing the secretary of the interior to conduct campaigns for the eradication of animals thought to be injurious to agriculture, forestry, and game (U.S.C. §§ 426-426c, 1931). In 1940, a small group of NPS wildlife biologists who had criticized fire suppression, predator control, and road construction policies were moved to the Bureau of Biological Survey, thus allowing NPS to maintain its policy of managing for recreation and scenery without internal admonishment (Sellars 1997).

Frustrated with this response, many leading ecologists began to look for a non-governmental solution. As early as 1920, the ESA and the American Association for the Advancement of Science (AAAS) recommended that areas be set aside outside of the National Forest and National Park systems for the protection of natural diversity for research and science. As part of their rationale, ESA and AAAS stated that the federal agencies lacked the “mandate for preserving natural areas” (Shelford 1920; Sumner 1920). It was slowly becoming clear that some sort of non-federal approach would be needed to protect the nation’s biodiversity.

Growth of The Nature Conservancy

The roots of TNC can be traced back to 1917 with the establishment of the Committee on the Preservation of Natural Conditions within the ESA. In 1946, a dispute led some members of the committee to splinter off and form the Ecologists Union. Their three goals were to maintain the status of existing protected areas, add unique new plant and animal communities of scientific importance, and encourage scientific research in protected areas (Behlen 1981).

Significantly, the British Nature Conservancy was established 1949. In early 1950, Richard Pough, then president of the Ecologists Union, visited with Prince Phillip and Prince Bernhart in order to be introduced to Great Britain's novel quasi-governmental approach to nature conservation (Pough 1999). That same year, U.S. Representative Charles Bennett proposed legislation to create "a Nature Conservancy" modeled after the British organization of the same name. Congress failed to act on the bill (TNC 1999).

With little hope of a government-based program, Pough suggested the Ecologists Union itself adopt the name of the "Nature Conservancy" (the capitalized definite article was added later) in order to be more practical and identifiable to the general public. Pough made the point that nobody knew what an "ecologist" was, much less would they be willing to join or support such an organization (Pough 1999). The name was formally adopted, and the organization was officially incorporated as a non-profit on 22 October 1951 in Washington, D.C. (TNC 1999).

The move was significant for several reasons. First, it represented a non-governmental response to what up until then most adherents had hoped would become a federal effort. Second, it marks the first attempt in the USA to build broad-based public support for what up to then had been a largely unknown and erudite discipline.

The organization grew slowly at first as Pough raised funds through civic and philanthropic groups. The mission of the organization also became focused on "saving America's heritage of wild nature" (TNC 1952). Yet there still seemed to be a reluctance to abandon the romantic preservation rhetoric so effectively used to establish the national parks. The TNC's 1952 annual report states that the organization's "specific object is to preserve natural areas as 'living museums' of the primeval wilderness" for their "scientific, educational and esthetic values" (TNC 1952). Fore-shadowing modern biodiversity language, its mission statement concludes that such tracts "also afford a home for the multitude of kinds of living things that would otherwise vanish from the earth, destroyed by our civilization." Over time, reference to "wilderness" and "esthetics" would be dropped from the mission completely.

In 1952, TNC published a plan entitled *A System of Nature Preserves* that called for a comprehensive system of preserves to protect rare species and unique habitats. It was also becoming clear that the primary tools for accomplishing this mission would be real estate acquisition and stewardship. By suggesting that TNC itself acquire and hold title to property, Pough found a non-governmental mechanism for actualizing the decades-old desire of ecologists for a system of natural areas. In 1955, the first land protection project was completed—a sixty-acre property in the Mianus River Gorge on the New York-Connecticut border.

With a focused mission and implementation strategy, public interest and support quickly grew. According to Ray Culter (1999), vice president and director of administration for TNC, this clear and limited mission, combined with consistent completion of real estate contracts and agreements, contributed significantly to this success. Today, TNC has chapters in every state, and in the USA alone manages over 1,500 preserves totaling nearly 1.2 million acres.

Why Was TNC Successful?

There are several policy explanations for TNC's rise. First, we've demonstrated that TNC acted as a "policy entrepreneur" in that it effectively exploited what was

(and remains) a void in federal land management policy. Repeatedly trounced in every effort to create a federal biodiversity protection program, the founders were nonetheless able to find success through a non-governmental approach.

Second, unlike efforts to catalyze federal involvement in biodiversity policy, TNC was able to activate latent public interest in its non-governmental approach to biodiversity protection. This interest had to be converted to philanthropic giving, which could be used to finance the implementation of programmatic solutions.

Third, TNC succeeded where the Ecologists Union could not because of TNC's focus on real estate acquisition (Goodwin 1999) and preserve management. Unrestrained by purchasing guidelines and bureaucratic red tape, the organization could act with the kind of speed and flexibility not possible for a government agency.

Lastly, TNC's success is at least partially attributable to the philanthropic culture in the USA, and tax laws that encourage donations to non-profit organizations. In the mid-1960s, the Ford Foundation gave \$500,000 to TNC. This was one of the Ford's first environmental grants—perhaps the very first—and enabled TNC to hire a paid president and professional staff (Goodwin 1999; TNC 1999). In the 1960s and 1970s, a growing perception of threats to the environment (including biodiversity) fueled a growth in the membership and capital holdings of TNC.

Conclusion

The rise of TNC is evidence that there was latent public desire to protect biodiversity, a desire systematically neglected by federal policy-makers. Clearly, the success of TNC is attributable to what was a void in federal policy. The question we now must consider is whether there is finally a great enough need for federal involvement. Across the country, small local environmental NGOs are using the existing laws and the courts to force the government to protect biodiversity. Despite TNC's success, grassroots interest appears to be growing for a comprehensive public program for protecting the diversity of North American ecosystems.

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The Wilderness Act and National Park Service Wilderness Policies

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In this paper I give a brief overview of the Wilderness Act, the way it supplements the National Park Service Organic Act, and its current interpretation in the new NPS wilderness policies. Pardon me if I get preachy.

In the beginning there was Congress,
And darkness was upon the face of the land,
So Congress said, "Let there be parks."
And there were parks.
Then, on August 25th, 1916, Congress said,
"Let the parks be joined together,
To conserve the scenery
And the natural and historic objects
And the wild life therein
And to provide for the enjoyment of the same
In such a manner and by such means
As will leave them unimpaired
For the enjoyment of future generations."
And there was morning,
And there was evening,
The first day of the National Park Service.
And the people saw that the parks were good.
Ages passed, and in the name of "conserving unimpaired"
The parks were developed,
With roads and trails,
With campgrounds and hiking trails,
With visitor centers and boat docks,
With park rangers and staff housing,
With water systems and landfills,
With educational institutes
And paved interpretive nature trails.
And so it came to pass, that Congress said,
"Let us assure
That not all lands be occupied
With expanding settlement
And growing mechanization."
But, being loath to smite the good law of parks,
Congress partook, not to change the law, but to supplement it.
And so it came to pass,
After 8 years, 9 hearings, 6,000 pages of testimony, and 66 rewrites,
That, on September 3rd, 1964, Congress said,
"Let there be wilderness."
And there was wilderness,
"Administered for the use and enjoyment of the American people,
In such manner as will leave them unimpaired
For future use and enjoyment as wilderness."
And the people saw that wilderness was good.

Or, stated in more secular terms, the Wilderness Act affirmed the protection that the public wanted.

The Wilderness Act was modeled after the NPS Organic Act, for the "preservation and protection" of lands "in their natural condition." For many years, NPS ig-

nored wilderness designation, considering it to be equivalent to park backcountry. NPS is now the lead wilderness agency in the federal government. Lands of the NPS, U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM), and U.S. Fish and Wildlife Service (USFWS) may be designated by Congress as wilderness. These lands are managed according to the Wilderness Act of 1964. The NPS directs wilderness management through the *Management Policies* (NPS 1988), the Director's Order No. 41, and the reference manual on wilderness preservation and management (NPS 1999).

The Wilderness Act gives two definitions of wilderness. First is the ideal or poetic version, which sets an unattainable utopian goal for management—a place where man and his works do not dominate the landscape; a place where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain; an area of undeveloped federal land, retaining its primeval character and influence, without permanent improvements or human habitation; all of which is protected and managed so as to preserve its natural conditions.

Second is a more legalistic working definition of wilderness—that which generally appears to have been affected primarily by the forces of nature; where the imprint of man's work is substantially unnoticeable; where there are outstanding opportunities for solitude; where one is afforded the opportunity for a primitive and unconfined type of recreation; which extends over at least 5,000 acres; and which may also contain other values.

The Wilderness Act is supplemental to the NPS Organic Act. Each agency—NPS, USFS, BLM, and USFWS—is responsible for preserving the wilderness character of its designated wilderness.

Wilderness management differs most from regular NPS backcountry management in Section 4(c) of the Wilderness Act. Here, it prohibits activities which the NPS Organic Act permits or leaves open to interpretation. Section 4(c) unambiguously places an additional layer of protection on NPS lands. Section 4(c) is what gives the Wilderness Act teeth. There are ten prohibitions: commercial enterprise, permanent roads, temporary roads, motor vehicles, motorized equipment, motorboats, the landing of aircraft, other forms of mechanical transport, structures, and installations.

On these ten commandments

Hang all the law and the prophets of wilderness.

But, unlike Moses' Ten Commandments, there are four types of exceptions to these ten prohibited activities. First, any federal legislation may include a special provision for activities normally prohibited by Section 4(c). Such legislative exceptions are often found in the wilderness enabling legislation for individual parks.

Second, the special provisions found in the Wilderness Act itself, in Sections 4(d) and 5, may authorize exceptions to activities normally prohibited by Section 4(c). Many of these special provisions are not applicable to NPS, so a careful reading is important. The special provision most familiar to those of us in the NPS is probably Section 4(d)(6), which allows for commercial outfitters and wilderness guides.

Third, existing private rights may exempt certain activities from wilderness prohibitions in 4(c). These may include unpatented mining claims, rights of way, or easements held before wilderness designation.

Fourth, and finally, certain agency activities may receive an exception to wilderness prohibitions in 4(c) if they are "necessary to meet minimum requirements for the administration of the area for the purpose" of the Wilderness Act. Probably the most difficult part of wilderness management is knowing when and how to invoke this last exception. If this exception is overused, then congressional wilderness designation means nothing, and we leave ourselves open to criticism. If this exception is appropriately and sparingly used, then we are protecting wilderness values as expected by the public. But then every administrative special interest becomes disgruntled, because wilderness restrictions impede their particular activity. Congress,

when passing the act, knew that proper wilderness management would not be cheap, convenient, or easy. Proper wilderness management is a very value-laden subject, dependent on the personal judgment and wisdom of individual wilderness managers and park superintendents.

The draft NPS reference manual for wilderness protection and management, containing the revised management policies and the new Director's Order No. 41, are available on the NPS Web site (www.nps.gov/refdesk/DOrders/DOrder41.html). These documents attempt to provide some consistency, but the crux of good wilderness management remains driven by individual values.

The revised management policies are very similar to the 1988 policies. There are added sections on cultural resources, environmental compliance, caves, waters, legal descriptions and boundary maps, and existing private rights.

The NPS has never had a numbered guideline for wilderness preservation and protection. The new Director's Order No. 41 serves to expand on the management policies. The Director's Order provides accountability, consistency, and continuity. It includes additional sections on the National Wilderness Steering Committee, management of the different wilderness categories, wilderness management plans, accountability of park superintendents and staff, geographic names, conversion of "potential wilderness" to "designated wilderness" once non-conforming uses are removed, application of the minimum requirement concept (a very important section), fire management, scientific uses, use by persons with disabilities, and training. It knowingly leaves out many subjects, including rock climbing, search and rescue, emerging technologies, fisheries, boating, trail standards, and carrying capacities. The topics were selected by the National Wilderness Steering Committee to address the most pressing needs of NPS, but not to be an exhaustive litany of issues and direction, especially in this first attempt at the Director's Order.

Definitions of some terms are included, such as "mechanical transport" and "proposed wilderness," but not for "structure" or "installation." An appendix includes additional detail on wilderness management plans and the minimum requirement concept.

The NPS has had great successes in wilderness preservation and management since our own 1986 and 1993 task forces criticized the agency. Instead of lacking national direction, we have the National Wilderness Steering Committee, a wilderness directorate (Wes Henry in Washington), and a deputy (Jim Walters in Santa Fe). Instead of inadequate guidance, we have the 1988 *Management Policies* chapter on wilderness, and the draft revised policies, Director's Order No. 41, and reference manual. Instead of inadequate planning, each NPS unit with any category of wilderness will have an approved wilderness management plan no later than 2002. Instead of inadequate training, NPS is a full participant in the interagency Arthur Carhart National Wilderness Training Center at Missoula, Montana, offering park, regional, and national courses on a variety of wilderness subjects. Instead of a failure to adhere to our own policies, we have new awareness of, and accountability for, wilderness preservation and management. We are realizing that wilderness preservation is not an isolated program, but is integrated into all our field operations.

Wilderness management is the highest form of stewardship we can offer.

And there was morning,

And there was evening.

And the people saw that the wilderness was good.

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Management of Commercial Air Tourism Over National Parks

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Background

Over the past decade, there has been a growing controversy regarding the role of air tourism and the protection of the natural and cultural soundscapes in America's national parks. It is one of a number of overflight issues facing the national parks. Agency meetings, media reports and editorials, legal briefs, and regulatory hearings have frequently been forums for contentious debate. Legislative action by the U.S. Congress and some local governments, as well as administrative actions by federal agencies, have tried to deal with the issue for specific park areas, but until now no approach has been found acceptable by both the aviation and environmental communities.

The scale of the issue ranges from Grand Canyon National Park, where over 30 commercial air tour operators provide approximately 100,000 tour flights per year; to the state of Hawaii, which experiences the next-highest volume of commercial air tour overflights in the nation; to Great Smoky Mountains National Park, where one air tour operator conducts multiple low-level overflights daily; to Rocky Mountain National Park, where several air tour operators have contemplated operations—and local, county, and state governments, as well as the state congressional delegation, have expressed their strong objections. The effect of commercial air tourism on park units is variable. Nevertheless, increasing numbers of overflights over noise-sensitive parks have sparked significant public debate and controversy related to safety and impacts on park resources and the visitor experience.

The National Park Service (NPS) recognizes that air tours of parks can provide a service to visitors in terms of sightseeing and access. At issue is the agency's ability to manage the use by allowing it where it is appropriate and compatible with resource protection and visitor experience, and limiting or prohibiting it where it is not. At the heart of this issue is the split jurisdiction between airspace and land management and the different purposes for which these are managed by the Federal Aviation Administration (FAA) and NPS, respectively. NPS regulates (and often limits) recreation and tourism activities in national parks for the purpose of preserving resources and providing for a high-quality, sustainable visitor experience. FAA regulates national airspace for safety and efficiency. Thus, the agencies have not had a common mechanism to address the management of air tourism over parks, the quality of the service provided to park visitors, or how this service might be provided in a way that minimizes impacts on park resources and visitors.

After two tour aircraft collided over Grand Canyon National Park, Congress, through the National Parks Overflights Act of 1987 (Public Law 100-91), asked NPS to identify the nature and scope of overflight problems in the National Park System, the nature of its effects (both adverse and beneficial), and what minimum altitude aircraft should maintain when flying over national parks. NPS came to the following conclusions in its report to Congress (NPS 1995):

- Commercial air tourism was a national park overflight issue that FAA and NPS needed to address.
- Establishing a minimum altitude for aircraft overflying national parks was neither feasible nor necessary because of the complex nature of impacts on individual

park units. The recommended approach was to use a full range of methods and tools (e.g., voluntary agreements, incentives for use of quieter aircraft, spatial zoning, altitude restrictions, temporal restrictions, noise budgets, limits on operations, and air tour operations as park concessions).

- FAA should develop an operational rule to regulate commercial air tourism over national parks, triggered by NPS, to address this park overflight issue. NPS further recommended that FAA implement a rule that would aid in the preservation or restoration of natural quiet—the natural and cultural “soundscapes” of the national parks.

In recognition of the growing significance, complexity, and controversy of this issue, in 1993 Secretary of the Interior Bruce Babbitt and Secretary of Transportation Federico Peña formed a joint interagency working group to begin addressing these recommendations. This group agreed that increased air tour operations at Grand Canyon and other national parks have significantly diminished the national park experience for some visitors, and that measures should be taken to preserve a high-quality experience while providing access to the airspace over national parks. But, despite this attention, progress toward resolution of problems was slow, and most of the attention of this initial working group was focused on Grand Canyon National Park, where P.L. 100-91 mandated a “substantial restoration of natural quiet.”

The National Parks Overflights Working Group

Seeing that the complexity and controversy surrounding the Grand Canyon rule-making resulted in rather desultory progress, President Clinton, in a 1996 Earth Day Executive Memorandum, directed the secretary of transportation to work with the secretary of the interior to quickly complete the process and develop an effective rule. While the agencies were subsequently able to complete the Grand Canyon rule-making in a timely fashion, careful consideration of the issues and the recent history of the overflights debate led the agencies to choose a new approach to regulating commercial air tourism over national parks. In May 1997, the department of transportation and department of the interior jointly established a national parks overflights working group (NPOWG) with the objective of letting affected parties develop recommendations on a regulation that would fairly regulate the air tour industry.

This first-of-its-kind joint federal advisory committee was convened from a group of private individuals with broad knowledge and experience in air tour operations, commercial air transportation, and general aviation—as well as in the policies, resources and management of the national parks. Rotary and fixed-wing operations, as well as private-pilot interests, were represented within the group, as were national and local conservation perspectives and the interests of Native Americans and tribal governments. Specifically, NPOWG’s task was to develop a recommended notice of proposed rule-making which would define a process for reducing or preventing the adverse effects of commercial air tour operations.

The NPOWG Recommendation

Over the course of a year, NPOWG achieved a consensus beyond what the agencies had thought possible. To a major extent, this was not the product of a mechanical compromise or deal-making. It was the product of long hours of analysis, deliberation, and debate on fundamental principles and detailed procedures. Individual members approached the issues from widely varying perspectives and held different views on commercial activities, resource protection, and visitor experiences in national parks. One thing that helped was that NPOWG made the conscious decision at the outset to conduct its deliberations in open meetings. Throughout a series of frequently difficult meetings, the group sought and accepted both technical information and counsel from many people, including private citizens and agency professionals within FAA and NPS. Common ground grew from a willingness to openly

communicate and honestly question positions and concerns. In the end, the members were able to establish a shared sense of reality regarding the management of air tourism over national parks and agree upon a fair and workable approach.

In December 1997, NPOWG recommended a consensus white paper that detailed a process for regulating commercial air tourism over parks upon which to develop a federal aviation regulation. This recommendation was endorsed by both the National Park System Advisory Board and FAA's aviation rule-making advisory committee, which directed FAA to cooperate with NPS in drafting a formal notice of proposed rule-making.

In constructing its recommendation, NPOWG built upon a set of shared fundamental principles. It was agreed that the federal aviation regulation should:

Be process-oriented. An effective regulatory framework should be based on principles that would apply System-wide, and practices that can be applied to all park units. Provisions, such as exemptions for the safe operation of aircraft and take-offs and landings, should allow for differences in terrain, weather conditions, and authorized uses within a framework that also would provide appropriate protection of wilderness values and sensitive resources.

Protect park resources. The sounds of nature are among the intrinsic elements which combine to form the natural environment of parks. This "soundscape" is an inherent component of "the scenery and the natural and historic objects and the wild life" in some national parks, and visitors to those parks ought to have the opportunity to enjoy quiet and the sounds of nature unimpaired in at least a portion of the park for at least part of their visit.

Be a cooperative process. The process should be a cooperative one because this is what would allow the two agencies to preserve their essential responsibilities intact.

Be a planning process. The process should be constructed in part as a planning process. After an air tour operator applies to FAA to overfly a park, NPS should determine the potential impacts to resources and visitors, and these should be addressed in the course of an air tour management planning process conducted by the two agencies. Agreements and environmental decision documents should be signed by both agencies. Consequently, this process could effectively combine publicly accountable planning procedures based on the National Environmental Policy Act, including full public participation in the development of alternatives and proposed actions.

Be implemented by FAA. The agreements and decisions in the resulting air tour management plan should be implemented through FAA-issued operations specifications, the standard tool for managing commercial air tours, air taxi operations, etc.

Use clearly defined management tools. The regulation should provide clearly defined management tools which could be employed to prevent or reduce impacts where air tours exist or are determined to be appropriate.

Treat visitors equally. All national park visitors, including flightseeing visitors, would be treated equally in this process. All visitor activities in national parks must occur "in such manner and by such means" so as to prevent impairment of park resources and values and their enjoyment by others.

Affect only commercial air tour operations. The process would only apply to commercial air tours, not general aviation, since air tour flights purposefully occur over parks, at lower altitudes, more frequently, and often at the same locations and attractions favored by ground-based visitors.

Be fair to air tour operators. The process should provide a means to significantly lessen or mitigate the effects of existing air tour operations and prevent unilateral expansion of air tour operations where they do not yet exist. It should not allow for a unilateral ban. Existing operations should continue under an interim operating authority while the two agencies conduct the process jointly. New air tour operations should not be authorized until the process is completed.

Be implemented through regulation and legislation. Although this process should be based on a workable combination of recognized policies, procedures, and responsibilities within NPS and FAA, these agreements are so novel that questions may arise within the agencies and the public about the authority of the agencies to implement it. Consequently, the agencies should proceed with the development of a proposed rule and seek to have it adopted legislatively.

Reflecting these fundamental agreements, the core of the NPOWG recommendation is that commercial air tour operations would not be conducted over national parks *except* in compliance with an "Air Tour Management Plan" (ATMP) developed and approved jointly by FAA and NPS. An ATMP could either authorize or prohibit air tour operations over national parks. FAA would implement the ATMP recommendations by issuing operations specifications to the air tour operator.

There is little doubt that the cooperative use and blending of agency authorities, policies, and procedures is unique. And it has withstood intense scrutiny. NPOWG's recommendations are so strong and cohesive that the recommendation to implement through regulation and legislation is coming to pass. Even as FAA has worked cooperatively with NPS on the development of a proposed federal aviation regulation, parallel legislation is working its way through the House and Senate with strong support—a testament to the soundness of the recommendation and the integrity of NPOWG members.

The Challenge of Implementation

Even the best ideas cannot survive poor implementation, and there are many challenges ahead, including:

1. How effective a working relationship can FAA and NPS build? FAA plans to implement the regulation or law through its western regional office in Los Angeles, while NPS is likely to provide a park support office in Denver. Coordination between the agencies will be a major challenge, and getting the right mix of personnel in each office will be essential.
2. When the rule goes into effect next year, as many as 50 ATMPs may be triggered. Despite congressional interest in completing this process very quickly, without a significant infusion of resources into the two agencies (which is unlikely), only a few ATMPs will be completed each year. One of the first priorities will be how to schedule the ATMP process and set priorities. The success of the first few planning efforts will set the tenor for the remainder of the plans. The agencies will need to carefully select the first parks for ATMP completion, and close attention will be needed from management and senior staff. It will be important to do this well in order to convert skeptics to believers.
3. Most of the funding and personnel are likely to come from within existing resources. This will be especially challenging for small parks with very little budget to start with, and both agencies may need some supplemental resources.
4. The agencies will need to address some important scientific challenges as well. What are the best, and least costly, methods of doing acoustic monitoring and modeling in low-noise-environment parks? And since the new regulation and law will require that one or more acoustic standards be set in parks, based on an enormous range of possible park resource and visitor experience factors, how is this to be done in an acceptable manner?
5. And finally, how can air tour operators become more effective visitor service providers? As these commercial interests engage the government, the public and other interest groups in this process, they are likely to evolve into more responsive service providers. An important challenge will be to explore how the two agencies can assist in this process.

Conclusions

FAA and NPS are supporting a unique way to address the controversial issue of managing commercial air tourism over national parks. The agencies chose to form a citizen advisory board comprising the most affected parties to develop recommendations. NPOWG has proven to be a great success, largely due to the extraordinary efforts of the its members. The cooperative process they recommended skillfully blends the authorities and management practices of the two agencies into a process that all parties believe to be a fair and effective compromise. That these recommendations are nearing adoption by the agencies and by both houses of Congress is a testament to their practicality and fairness.

Implementation will be a challenging process in terms of cooperative administration, budget, priority-setting, and science, but, if successful, it will be a useful model to explore wherever this issue may arise around the world in parks and wildland areas.

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Balancing Operational and Environmental Requirements for Military Ranges and Airspace

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Introduction

The purpose of this paper is to discuss a formula for resolving conflicts arising from the use of military ranges and airspace. The military must perform countless hours of weapons testing and aircrew training to prepare to respond to multiple contingencies around the world. Several million acres of ranges, several million square miles of airspace, and a variety of support activities (e.g., land stewardship and legal compliance) are essential to achieving this requirement. The people responsible for the support are sometimes viewed as obstructionists when conflicts arise that threaten completion of test and training activities. Additionally, a diversity of organizations and individuals compete for the same space for recreation, commercial endeavors, or other traditional uses.

Use of Military Ranges and Airspace

Military ranges and airspace are national assets. They encompass over 20 million acres of land and several million square miles of airspace where aircrews and ground troops train and test air-to-ground and air-to-air tactics, electronic warfare, joint scenarios with other services from the USA and abroad, and new weapons. The same areas used to sustain readiness are also considered some of the most ecologically important of all federal lands, based on their wealth of biological resources, pristine quality, and natural diversity (Leslie et al. 1996). Air Force ranges alone contain a vast array of natural resources, including 475,000 acres of commercial timber, 130,000 acres of grazing land, 100,000 acres of wetlands, and over 40 threatened and endangered species. Over 20,000 people participate in hunting and fishing programs annually on the ranges (Lillie and Ripley 1998).

The requirement for military training to provide combat realism while protecting complex and diverse ecosystems is an ever-increasing dilemma. Changes in land use, population growth, and a growing concern for protecting the natural environment in the proximity of ranges could constrain and limit operational flexibility, and ultimately affect readiness if not managed properly. While the public need for land and airspace has grown, the amount of land and airspace needed to conduct realistic military training exercises has also increased as new technology and military strategies have evolved. Military aircraft during World War II could shoot down enemy aircraft from a distance of about 0.2 km. Today's aircraft can engage and shoot down an adversary from 40 km or more. Similar changes have occurred in the capabilities of ground forces. In World War II, a brigade of 5,000 soldiers needed about 96 sq km for offensive operations. The current military operational scenario requires about 560 sq km for a brigade to maneuver and accomplish its mission.

The Department of Defense has recognized the existence of competing interests and developed procedures for balancing military readiness requirements with the environment and traditional land uses. The objective is to provide ranges and airspace which have the flexibility, efficiency, and realism necessary to maintain operational readiness while enabling commanders to minimize impacts associated with their readiness training (Chapman 1997). This is not a new concept. In the late 1950s, Air Force Chief of Staff General Thomas D. White said: "The mission of the Department of Defense is more than aircraft, guns, and missiles. Part of the defense job is protecting the lands, waters, timber, and wildlife—the priceless natural resources that make this great nation of ours worth defending."

The goals of the program are established by each military service, consistent with their training requirements. The Air Force's goals, as presented in a joint memo from the chief of staff and the secretary of the Air Force, are to: sustain readiness, be a good neighbor, and leverage resources. This can be a difficult task to implement. For ex-

ample, the Barry M. Goldwater Range, located in southern Arizona, is the primary training range for F-16 pilots. Much of the land and airspace used by the Air Force in that same part of Arizona is shared by the Tohono O'odham nation, national parks, wilderness areas, wildlife refuges, wilderness study areas, endangered species, and other interests. The Air Force, other federal land management agencies, and the state of Arizona have established an executive council to facilitate cooperative stewardship of the area. The Nature Conservancy and the Sonoran Institute are conducting an ecoregional initiative to identify critical conservation areas and establish long-term stewardship priorities. The military participates in and helps underwrite the initiative.

Potential Sources of Conflict Arising from Military Use of Ranges and Airspace

A variety of stakeholders represent the pieces of a complex puzzle that form the current test and training range picture. The pieces are often scattered, and sometimes the individuals and organizations they represent become confrontational. The military must identify issues and seek resolution when conflicts arise. Numerous sources of conflict exist, but they tend to fall into three categories: aircraft overflight, legal compliance, and public interest.

Aircraft overflights. Aircraft overflights and the noise they produce are the primary source of conflict. Most military training routes and operations areas are located in remote parts of the USA. Areas once devoid of people have undergone rapid social and economic development. The open spaces that remain are sometimes national parks, wilderness areas, Native American sacred sites, and recreation areas—places where many people expect to find pristine natural quiet. The roar of a military jet can startle people and disrupt a wilderness experience or sacred moment. Attempts to change military air routes and operations areas sometimes result in conflicts with commercial and private aviation.

Legal compliance. The number of environmental laws has increased dramatically since 1970. The Endangered Species Act is often the first statute that comes to mind as a source of conflict. The presence of a threatened or endangered species on a range could affect the type of activities that are conducted in certain locations. The National Environmental Policy Act (NEPA), and the people responsible for achieving compliance with it, have been viewed as a major obstruction in implementing new actions on military ranges. Stakeholders sometimes use the law to slow or stop new proposals, but, when used correctly, the NEPA process can identify potential impacts and lead to important changes in the proposal. Several other environmental laws, such as the Clean Water Act, Clean Air Act, and National Historic Preservation Act, have been the source of conflict at various times.

Public involvement. Many members of the public are seeking greater involvement in the stewardship of military ranges. They insist that the environment be protected and that the military demonstrate a valid need for every range. In some instances, several groups have joined together to have a stronger voice in addressing the development of new ranges or new activities on existing ones. They use a combination of the news media, letter-writing campaigns to government officials, and the law to influence the fate of range proposals. By listening, the military can often develop proposals that strike a balance between the needs of the military and the needs of the public.

Formula for Resolving Conflicts

At one time, when confronted about noise from aircraft, the military could simply say, "Pardon our noise—it's the sound of freedom." In the Cold War atmosphere of previous years, the public was content with that explanation, but it is no longer acceptable. Citizens want more details, and the law gives them a right to obtain the information. The formula for resolving conflicts involves identifying the stakeholders and their issues, and communicating and cooperating to achieve consensus.

The military has project officers trained in the NEPA process and risk communication. This training has given the project officers an appreciation for public rights under NEPA and how to communicate with the public and the news media. Once the

communication channels have been established, the dialogue must continue. Open communication builds credibility and demonstrates a genuine interest in hearing what the public has to say. The military has shown a willingness to work with the public to defuse conflict over activities near military bases and in areas beyond the front gate where aircrews train.

Public interaction has worked to resolve an overflight issue at Big Bend National Park on the Rio Grande in south Texas. Park officials and users complained about the noise and visual impacts from T-38 jet aircraft flying between 500 and 1,000 ft above ground level near a popular campground. Air Force and park officials identified the location of concern, time of the overflights, and point of origin of the aircraft. Through face-to-face discussions, the Air Force discovered that nearly 25% of the park's total annual visitation occurs during a four-week period in the spring when foliage is in bloom and the weather is mild. This provided an opportunity for consensus. The Air Force agreed to fly along a different air route during that time each year.

In another instance, residents of Circle Hot Springs, Alaska, complained about noise from jet aircraft. The town was a reference point on maps used to plan training activities. Pilots would use the reference point as a location for practicing combat maneuvers. The Air Force met with local officials and installed a threat emitter (i.e., a device used to simulate an enemy threat) to warn pilots to stay away. The Big Bend and Circle Hot Springs issues were both resolved without affecting Air Force training requirements.

The Navy is working two cases with the National Park Service (NPS) in which noise produced by aircraft overflight has resulted in public complaints in California. At Joshua Tree National Park, an existing military training route overlays the majority of campgrounds and other recreation areas, historic sites, the visitor center, desert tortoise habitat, and raptor nesting areas. The Navy and NPS are currently working on a joint environmental assessment to determine the environmental consequences of moving the military training route to another location in the park. At Sequoia and King Canyon National Parks, low-flying military aircraft transit the parks during routine training. The Navy has offered to restrict the use to transit only and the users would not be allowed to fly below 18,000 feet mean sea level. NPS plans to ask the Air Force and the Army to abide by the same restriction when flying over Sequoia and King Canyon National Parks.

Once the issues have been identified and an open dialogue has been established, the military and the stakeholders can cooperate and collaborate to form long-term partnerships and build consensus. The various pieces of the puzzle begin to fit together to form a recognizable picture. General Joe Ralston, vice chairman of the Joint Chiefs of Staff, said: "By working as a team we can preserve both the natural diversity of military training areas and our opportunity to train the way we plan to fight now and in the future."

The Way Ahead

Creating and sustaining long-term partnerships with stakeholders is the way of the future for managing and using military ranges and airspace. By maintaining a dialogue, the military and the public can address both military needs and public issues. Each side must be flexible and willing to balance operational requirements with the environment and traditional land uses.

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The Protection of the Soundscapes of the South Florida Parks

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There are many places in the National Park System which look very much like they did 200 years ago, but very few places which sound like they did even 20 years ago.

— *Chip Dennerlein, National Parks and Conservation Association*

The National Park Service (NPS) is slowly coming to grips with a resource that is present (but seldom monitored and even more rarely inventoried) at every NPS property across the country. It is a resource that is experienced by most visitors, sought after by many, and is, sometimes slowly, sometimes not so slowly, being degraded. That resource is the soundscape.

The deterioration of soundscape quality has been and is a matter of concern in the NPS. One early focus of that concern has been aircraft overflights, particularly air tour operations and military overflights. Many of you are familiar with the situation in Grand Canyon and some of the western parks involving one or the other or sometimes both types of aviation operations. Over the last two years NPS sites in another part of the country have been receiving intensive consideration—South Florida. The purpose of this paper is to talk a little about the South Florida situation, briefly describe the parks and the events associated with the catalyzing factors that brought the noise issue to the forefront in this region, discuss the work that has been done, and to try to summarize where we are now.

As many will remember, Hurricane Andrew demolished the Homestead Air Force Base south of Miami in 1992. Shortly after that it was decided that the base would be closed rather than rebuilt and the property was slated for disposal. Miami-Dade County proposed that the base be turned over to it for conversion into a commercial airport. In 1994 an Environmental Impact Statement (EIS) was completed by the U.S. Air Force based on this conversion plan. At the time the South Florida parks—Everglades and Biscayne national parks, and Big Cypress National Preserve—were somewhat distracted by their own post-Andrew cleanup and recovery operations and were not very much focused on the EIS process. Leaving out all of the messy details, as the potential consequences of the base conversion registered on the communities in the area, concerns mounted. In 1997, the decision was made to do a Supplemental Environmental Impact Statement (SEIS), completely revisiting the issues addressed by the original EIS and expanding the list of issues and alternatives. That SEIS process has been underway since that time. The present schedule calls for the process to be completed by the end of 1999 or perhaps early 2000. The lead agencies for the SEIS are the Federal Aviation Administration (FAA) and the Air Force. NPS, the U.S. Fish and Wildlife Service, and the Environmental Protection Agency are designated cooperating agencies.

The Measurement of Noise

At this point it is necessary to introduce some of the concepts and terms associated with the fine art of noise measurement. There's a large body of literature related to this and, because of the space available here, the discussion is going to be necessarily superficial.

Most of the work done with regard to outdoor noise monitoring has been done in noisy urban environments. Much of that work has been associated with airport noise issues. The criterion used by the FAA and the military to determine whether a proposed operation is acceptable is "annoyance." In other words, if not more than a certain percentage of the subject population reaches the point where they are quite annoyed by the noise, the noise is "acceptable." NPS has categorically rejected the ap-

plication of this concept, the associated guidelines, and a metric called "DNL" (or "LDN") as unsuitable for application to NPS settings.

The measurements of noise are frequently expressed in terms of a logarithmic measure called the A-weighted decibel level (dBA) which has been generally accepted as being a reasonable approximation of the range of frequencies to which the human ear responds. It is one of several such scales designed to help measure and explain noise. One aspect of this measure that is relevant to NPS interests is that the dBA scale under-weights that portion of the sound spectrum below 1,000 hertz. Because of the human ear's ability to respond to sounds of different frequencies, it is possible to detect a low-frequency sound, i.e., below 1,000 hertz, such as the drone of a distant aircraft, even though a sound-level meter may show no response in the A-weighted band. (The same sound source might show up clearly on a C-weighted measurement since the C weighting extends to lower limit to 250 hertz.)

A method commonly used to obtain a better understanding of the sources of noise is what we will call "observer-based" monitoring. Essentially, one puts a trained observer in the area of interest armed with some means of measuring and recording noise levels and a means of recording what the observer determines to be the source and duration of the noise events. In the simplest form this might involve a sound-level meter, a clip board and a pad of paper, and a stop watch. The observer starts the sound meter recording and starts the stop watch. When a noise is heard the observer notes on the pad the source the he or she identifies as causing the noise. When the observer stops hearing that sound, or another noise source intrudes, the observer notes the duration of the first event, shifts attention to the second, and repeats the process. The equipment used is frequently more sophisticated, but this is the core of the observer-based approach.

This method has several benefits. One obtains readings of the sound levels coupled with a record of the things causing the noise as determined by the observer. The observer is also able to record the conditions under which the measurements were obtained, e.g., the atmospheric conditions, what other things were happening, and the general setting in which the measurements were obtained. These pieces of information can prove valuable later in interpreting the audio record or for other purposes.

There are also a number of down-sides to this approach. One problem is that even an attentive observer will find attention wandering during the monitoring period, resulting in the failure to note certain sounds or the mis-labeling of sounds that are heard. The fact that "the observer said it was so" can complicate the interpretation of the audio record. Among the other weaknesses of this approach is that the quality of the observer's record depends on the skills and training of the observer. As suggested above, for example, the observer may become focused on a particular noise source, such as an airplane, because of training to give selective preference to aircraft noise or because the observer continues to hear the aircraft long after the meter has stopped recording its presence.

Another set of issues has to do with the timing of the samples—the amount of time the data are collected and the times of the day, week, month or year. The changes in noise levels and in the types of sounds that are dominant are significantly different in a secluded (or not-so-secluded) area of a park as compared with the noise in the flight paths for Miami International Airport. Insects, frogs, and a host of other fauna contribute in different ways and at different times to the soundscape of a park. The readings obtained at Eco Pond in the Everglades at 6 AM are likely to be markedly different from the readings at 6 PM, and the readings in April may be significantly different than the levels at the same site in October because of the life-cycle activities of the insects and animals, atmospheric differences, and a host of other factors.

NPS has also taken a long, hard look at the measures used to describe sound and found that many of them, while doubtless useful for work in noisy urban or suburban settings, have little relevance for applications to the parks. Metrics such as "LEQ," an

equivalent or average sound level over some specified period of time (an hour or a day, for example), tend to distort what seems to us to be the true picture of what is happening to the soundscape, especially as the time period grows longer than a few minutes.

One last item on the subject of noise. The goal of the noise measurement effort is generally to come up with some measure of "ambient" noise levels for a given situation. For example, one might conduct measurements in a neighborhood near an airport to determine the existing (ambient) noise levels with the goal of comparing those levels with the estimates produced by a model projecting changes in flight tracks or the addition of a new runway. Two common characterizations are the "existing" ambient noise levels and the "traditional" ambient noise levels. In the FAA lexicon, the former is a measure of all noise present, and the latter is the noise levels absent the noise of aircraft. Note that both measures focus on the upper end of the ambient noise spectrum. Neither assigns any particular weight to how quiet things might be, only on how noisy they are and how much noisier they might get.

NPS is moving more and more firmly in the direction of another measure of ambient noise—the "natural" ambient level. Broadly speaking, these are the sounds of nature, the wind, the water, the critters—no aircraft, no trucks, no visitor noise, no NPS noise. Essentially, this is the lowest level any setting might expect to enjoy if all other sources of human-caused noise were quieted. If one can measure this level and understand it well enough to describe it dynamically like the tides or the barometric pressure, one has a baseline that can be used to measure the "health" of a park's soundscape, develop noise mitigation strategies, and reverse the continuous soundscape degradation that most parks are suffering. Unfortunately, in many parts of many parks, the direct measurement of the natural ambient level is almost impossible. There are too many intruding noises at too high a level to measure it directly.

There is a way, however, to get a reasonable estimate of the natural ambient level—by looking at an estimate of the background (or residual) sound levels, those sound levels present in the absence of intruding sounds. If one looks at the one-second LEQs for a continuous noise recording, one can see that, even though the average levels may be high in any given time slice, there are periods in that portion of the record when the noise levels drop to very low values. The observer may, for example, record a period of three minutes when aircraft noise was dominant at an average level of perhaps 48 dBA. If one looks at that portion of the record on a second-by-second basis, one might also see that there were a total of 27 seconds when the meter was reading less than 25 dBA. This is because of the complex nature of sound. In the real world there are few truly continuous consistent noise events. Some of the background noise levels always slips through.

An approach commonly used to estimate the background sound level—an approach embedded in both practice and regulation—is the use of a statistic called the "L90." Essentially, if one were to take all of the one-second LEQ collected by a sound meter for a given period of time, sort those data from high to low, and go 90% of the way down the sorted list, the number one would find is the L90. In other words, it is the sound level that is exceeded 90% of the time. This statistic is likely going to become increasingly important to NPS in the near future if the fight to control noise accelerates as it appears destined to.

Noise Monitoring at the Four Federal Properties

In 1997, NPS employed a contractor, SID, Inc., experienced in the use of the NPS-developed "LOWNOMS" noise monitoring system, to perform noise monitoring at a number of park-selected sites in Everglades and Biscayne. A total of 32 hours of observer-based monitoring were completed in those parks during September and October. Eight sites had been selected in each of the parks, together with an additional two sites in the southern flight tracks of Miami International Airport, just

north of Biscayne. All sites received at least one hour of monitoring, with most sites receiving two separate two-hour monitoring sessions. The data from this initial monitoring effort were furnished to the Air Force, the FAA, and the SEIS contractor. Shortly after they received the NPS report, the FAA decided to send their crew out to do additional monitoring.

The FAA sent nine people out to monitor sites in Everglades, Biscayne, Big Cypress, and Crocodile Lake National Wildlife Refuge during the period 10-20 August 1998. NPS and USFWS representatives identified sites and times for which they would like to have additional monitoring data. These locations were based on the sensitivity of the sites and the information gained from the earlier SID work. The FAA's initial proposal was to conduct three separate three-hour monitoring sessions at each site. While most of the sites were visited at least once, some sites were skipped and others had shortened monitoring periods in favor of other sites that the FAA wanted to use to collect data to correct deficiencies in the estimates produced by their "Integrated Noise Model."

The FAA's approach was observer-based and employed an FAA-developed monitoring system named "VOLARE." Functionally, it is similar to the NPS LOWNOMS system, with some significant differences. One difference was the three-hour monitoring period used by FAA. Their argument was that such data were "more representative" than those captured by the NPS one-hour monitoring sessions.

The second difference, more significant in terms of the picture that resulted, was the monitoring protocol followed by FAA. Whereas the LOWNOMS system focuses on an effort to characterize the background noise levels and identify *intruding* noise, the FAA approach focuses on a hierarchy of events starting with "aircraft" noise, followed by "non-aircraft human," and working down to "natural" noise. The observers are trained, for example, to log "aircraft" as long as the observer hears or thinks he or she hears an aircraft, even if the observer also hears other sounds at the same time. Their draft report notes that "No human judgment was made as to which sound was 'acoustically dominant'—the hierarchy was conformed to in the strictest sense."

The consequence of this is evident when one looks at the logs of their monitoring. Whole sections of the record, many including acoustic measurements that appear clearly attributable to other causes, are attributed to aircraft. For example, the observer log may note "Faint distant rumble of aircraft, boats, talking" but, as long as the observers heard or thought they heard a faint aircraft rumble, that portion of the record was "aircraft noise." One consequence of this flawed methodology is that many of their monitoring events contain no data or very little data that they assign to "natural." As a consequence, they chose to use the "traditional ambient" (all noise but aircraft) as their baseline ambient for the parks. Coincidentally, the use of this measure as the baseline also presents the parks and refuges as having noisier soundscapes than NPS believes them to have. NPS has informed FAA that their draft report is unacceptable for the reasons identified above (and others).

The good news, though, is that the FAA acoustic people are professionals and do a good job of data collection with first-class equipment, whatever disagreements we in NPS have with them on data interpretation. They have made raw data from more than 160 hours of monitoring available to NPS. These data are being used by NPS to help characterize the soundscape of the area.

Following FAA's data collection, NPS sent SID back into the field for additional monitoring. We wanted to fill in some of the sites that FAA missed and try an additional technique. SID collected an additional 199 hours of data in November 1998.

Six of the monitoring sessions were hour-long, observer-based, and used the LOWNOMS system. The other 193 hours of data were collected using a tool that is likely to become a feature of future NPS noise monitoring—long-term, unattended noise measurements. Basically, this involves setting the microphone, data recorder,

power supply, etc., at a selected location, turning them on, and walking away. The apparatus is collected later and the data downloaded and analyzed. The time period monitored is a function of the power supply and data recorder. Our system was set to record one-second LEQs and ran from 23 to 33 hours at each setup. With suitable changes in the system the period can be extended without much loss in resolution. For example, by setting the system to collect two-second LEQs, the length of time covered by the record could be doubled. Given a suitable power supply and ancillary equipment, such a system could also be used to telemeter data back to a central location.

While the advantages of the observer-based systems are the disadvantages of unattended monitoring, unattended monitoring has some interesting benefits. It is quite a bit cheaper than observer-based monitoring, both in equipment and labor. It provides much more data on which to base the calculation of L90 values. In addition, it provides an interesting perspective on the diurnal variations that a site experiences.

This last point goes to one of the differences between NPS and FAA on the duration and timing of observer-based measurements. The NPS position is that, while it is true that a three-hour measurement period provides a *longer* sample than the one-hour LOWNOMS period, it is "better" only if one knows that the three hours sampled was a period of particular interest. If the same type of events occur frequently and randomly during the period both systems are deployed, each is likely to collect the same types of data. By using unattended monitoring as part of the design of a sampling program, one can both better estimate the background (L90) levels and also target particular times of the day when attended monitoring should be used to refine the knowledge of the soundscape.

Where We are Now

A funny thing happened on the way to the Homestead SEIS. Events were subsumed in a larger issue dealing with the management of noise in NPS. Many of the people from NPS who are present at this meeting have seen, or are aware of, an NPS educational publication called "The Nature of Sound." Unrelated in genesis to the Homestead situation, it describes the desired condition of the soundscape on NPS properties and provides direction for superintendents and others in managing noise, not just aircraft noise or "other" noise, but all noise, including the noise associated with park operations. A formal noise policy very similar to the theme of "The Nature of Sound" is in development.

The events related to the proposed conversion of Homestead had the effect of focusing management's attention on the broader issue of the deterioration of the soundscape in the south Florida parks. As a result, all three of the parks are in the process of planning the development of noise management plans that are specific to the legislation associated with each of the parks and NPS authorities. The data generated with respect to Homestead-related noise monitoring will provide an invaluable database for this effort.

In the course of the collecting and analyzing of these data we have also learned some things that we believe have general applicability for the NPS.

- Most of the historical noise metrics developed for noisy settings have little relevance to quiet natural settings, such as those in the parks. Some of them are quite misleading.
- We in NPS need to develop our own sampling strategies to gather the data needed to determine existing soundscape conditions and to establish the baseline for future noise management efforts. They need to be based on reasonable hypotheses, reconnaissance surveys, and detailed assessment of particular areas of interest.

- We need to institutionalize the process of monitoring and inventorying park soundscapes. Not only would these data provide the basis for developing more credible noise management plans, but they would also be useful to other parks in developing more effective monitoring strategies based on analogous soundscape conditions.
- We need to determine how to reasonably extrapolate data from the site at which it was collected to other similar conditions in the parks. Most parks are so large that the treatment of every monitoring site as a unique situation, i.e., unlike other points or areas in the park, would require an astronomical amount of money for noise monitoring. We must find a way to get our arms around these data and make sense of them.
- We need to raise the consciousness of people, both in NPS and outside, that the soundscape is a resource that we intend to protect and preserve.

If the work associated with the Homestead noise monitoring has contributed positively to helping us achieve these goals, the effort is time well spent in protecting a stressed resource.

Fundamental Principles of Sustainability for Parks and Public Lands

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Introduction

George Melendez Wright profoundly recognized that "consecration to the task of adjusting ourselves to the natural environment so that we secure the best values from nature without destroying it is not useless idealism" (GWS 1997). I regret not to have known George Wright personally ... and John Muir and Lowell Sumner and Bob Marshall and Aldo Leopold. I am delighted to know his legacy, and to be a part of this conference. George Wright was speaking in the above quotation directly to the heart of extremely important principles inherent in "sustainability."

I regret also that waves of students majoring in natural resources come annually on their proud march to graduation without sufficient grounding in the advance perspectives and fundamental principles of natural resource management. They are not solely at fault. Too many faculty members either do not understand or conveniently ignore these important matters in favor of perceived "cutting edge" paradigms. George Wright was noted for his keen insights and perceptions of problems: "His analyses were so far ahead of their time that they still sound modern even though they were written some sixty years ago" (GWS 1997). Since apprentices in this profession are lacking such important information, it is fair to conclude that cumulative problems with management programs and public understanding are also in need of substantial discussion. One cannot give what they do not know nor understand.

There is not only limited gratitude about the historical development of these concepts and principles, but also little appreciation for being "wise" as exemplified by George Wright and his compatriots. Motivating students beyond mere exposure to concepts into the higher realms of keen insights, creative problem-solving, deep understanding, and sound judgment makes higher education a noble profession indeed.

This paper is intended to dispel some of those oversights and carry on the tradition of this Society. Five natural resource concepts and associated principles pertaining to sustainability will be addressed. These are the same principles that are either inferred or sought by the contemporary uses of this term. The primary goals of this discussion are to invigorate the past with due appreciation and respect, to reassess the needs of stewardship for the future, and to promote renewal for an elevated relationship about appropriate protection for parks and public lands. It is necessarily and deliberately oriented toward conservation policy and principles that meet the obligations so prescribed.

Prescriptions for Sustainability

The concept of "sustainability" was recognized with the first utterance of "use" (whatever the form) and "maintain in an unimpaired condition." The history of natural resources management, often referred to as "conservation," is replete with policy examples that prescribed such sustainability. Historical highlights are provided in Table 1.

This recognition of a need to balance use with protection of nature without destruction is precisely the same insight that George Wright recognized sixty years ago. There has been further development of principles to implement and fulfill these philosophical foundations. However, they have not been sufficiently understood, endorsed, adopted, or utilized to stem the inappropriate destruction of nature in general and of some wild places unnecessarily.

Year	Sustainability Policy
1872	Yellowstone National Park withdrawal and reservation
1891	Forest Reserve Act
1906	Antiquities Act
1916	National Park Service Organic Act
1924	Gila Primitive Area designation
1929	L-20 Regulations
1939	U Regulations
1958	Outdoor Recreation Resources Review Commission
1960	Multiple Use/Sustained Yield Act
1964	Wilderness Act
1968	Wild/Scenic Rivers Act
1970	National Environmental Policy Act
1974	Rangeland/Renewable Resources Planning Act
1975	Eastern Wilderness Areas Act
1976	National Forest Management Act
1976	Federal Land Policy and Management Act
1980	California vs. Bergland

Table 1. Summary of major policies associated with sustainability for natural land management systems

Historical Foundations

The first concept relevant to this discussion is conservation. It is useful to revisit the words of Gifford Pinchot:

The term 'conservation' was deliberately adopted in 1907 as the name for a popular movement in the United States. The term was chosen to awaken a nation to the fast growing problems associated with natural resources. It was previously a term used to describe particular positions held by individuals or groups regarding the status quo of institutional aspects" (Pinchot 1937).

Differences of opinion about conservation began to emerge in short order between Muir (preservationism) and Pinchot (utilitarianism) and, as Pinchot elaborates, "The fundamental principle of the whole conservation policy is that of use; to take every part of the land and its resources and put it to that use in which it will serve the most people" (quoted in Nash 1982).

Such perspectives are more fully understood by looking at the "conservation movement" as a series of sustained mentalities as the nation developed. They are "rugged individualism," "conquer the frontier," "period of awakening," "period of enlightenment," and "period of stewardship." This is an on-going process due to old problems not getting fully resolved and new problems emerging.

This evolution of the concept of conservation has led to a commonly accepted definition: "wise use of natural resources." Since problems still persist even though a great deal of conservation had prevailed for 100 years, it is necessary to probe deeply into the real meaning of "wise."

An evaluation of various definitions of conservation offers keen insights and deeper understanding that prove useful. This normative analysis reveals the key elements of conservation. They are *use*, *time*, and *performance*. More importantly, sub-factors for each one increase understanding and applicability significantly. This information enhances understanding and positions managers and stakeholders to become more effective stewards.

A second important concept necessary for stewardship is an elevated understanding of natural resources. Such information was formulated during the early part of this century as conservation was gaining momentum (Zimmermann 1964). The most important principles to be recognized, beyond the existence of tangible substances of nature, are the functions and operations derived—"so that we secure the best values from nature without destroying it." These decisions are decided by public agencies and a market economy. Determination of the best combination of functions and operations is equivalent to selecting the type of use indicated in the key elements of conservation.

There are different forms of tangible substances in nature. This situation requires a systematic classification for good stewardship. An elementary version recognizes renewable and non-renewable classes. The fundamental basis for this classification system is the capability of a natural substance to renew itself over a meaningful time period. Subclasses, such as constant vs. cyclic, biological composite variable-flow, and soil, now take on the important distinctness they deserve.

Contemporary Practices

There is a wide range of uses, i.e., functions and operations. This situation has led to a third important concept known as "multiple use." As stated in the Multiple Use/Sustained Yield Act of 1960, it is an enlightened response to problems of finding the optimum combination of uses on the National Forest System and other national resource lands. It was shortly followed by the Wilderness Act of 1964. Such policies remove lingering doubt that preservation has its rightful place as a desired and important use. Management performance is not always at a desired level in this regard, however.

A fourth important principle has been adapted by this author from a related economic analysis of natural resource management strategy. It is called the "safe maximum standard," or "SMS" (Ciriacy-Wantrup 1965). It is an optimum use rate for the biological composite variable-flow subclass of natural resources. This use rate is a function of the type of use and is a critical zone to maintain a minimum amount of parent stock for the next generation. There are examples of such calculations, even though the principle is not well-understood. Such practices include allowable cuts, bag limits, animal-unit months (AUMs), and outdoor recreation carrying capacity.

Finally, a fifth principle for good stewardship and sustainability pertains to recreation experiences. Recreation is a use that crosses all public agency boundaries. There is continuing allegiance to classifying recreation resources by physical inventory approaches such as the recreation opportunities' spectrum (ROS). The concept of a spectrum is strongly endorsed. However, it should be elevated and based on classes of recreation experiences, rather than site characteristics only. Some expectations and experiences depend upon direct contact with nature, where the user is absorbed into that natural environment. This is the intent of wilderness and wild and scenic rivers.

At the other extreme is recreation that depends upon high user density, much socialization, definite supervision, and high levels of development. This is a social recreation experience as opposed to a wilderness recreation experience. A backcountry recreation experience can encompass differing blends of these extremes so as to fulfill expectations and preferences of users. This approach certainly creates a posture for both users and managers to coordinate more closely and to meet statutory obligations. Such is the real stuff of stewardship and sustainability.

Conclusions

Sustainability is certainly important. It is not a new concept although many factions are putting the term to regular use. Sustainable practices should definitely be encouraged and perfected.

There must be a clear delineation of and focus on what should be sustained. In addition, existing principles of sustainability should be given their just due and utilized. It is quite disappointing that a lack of understanding about these concepts is so prevalent. Without such understanding, keen insights and sound judgements will always be limited, and the full measure of stewardship excellence will not be attained.

Growing interest in sustainability by those facing vexing problems is certainly welcome. Proven principles inherent in the concepts of conservation, natural resources, multiple use, and optimum use rates should be helpful as the scope and complexity of problems continue to expand.

It is encouraging that as wildlands become more scarce, the view of land management agencies is oriented more toward the advocacy of unaltered nature and less toward the planned development of utilitarianism. The training of land management apprentices should be well-grounded in these concepts and they should be fully utilized in management programs. The USA is extremely fortunate to have so many wonderful assets in public ownership. Their value is increasing dramatically as society expands and greater scarcity prevails. These assets deserve the very best stewardship possible: stewardship based on sound policy and deep understanding.

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Trends in Stewardship Internationally

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"Stewardship" means, simply, people taking care of the earth. In its broadest sense, it refers to the essential role individuals and associations—and public and private organizations—play in the careful management of our common natural and cultural wealth, for now and for future generations. More specifically, it can be defined as "efforts to create, nurture, and enable responsibility in land-owners and resource users to manage and protect land and its natural and cultural heritage."

The stewardship concept draws on an array of tools to conserve natural and cultural values. Techniques include environmental education, technical information, demonstration projects, recognition of achievement, certification of met standards, voluntary management agreements, subsidized management, protected landscape and private reserve designations, deed restrictions, public-private partnerships in protected areas management, and conventional full-fee acquisition and management of property. These tools (with many others and more variations) represent a spectrum of options beginning with those that require little or no formal commitment or involvement and little per capita investment (e.g., education), to more "permanent" and specific protections (e.g., easements and acquisition) (Mitchell and Brown 1998).

Emerging trends in conservation and protected areas management set the stage for new approaches—or new applications of old ideas—that engage local people and direct stakeholders in the stewardship of land. This paper discusses some of those trends, supporting them with specific cases worldwide. It is neither a comprehensive nor a weighted analysis, but indicates a sweep of innovation in conservation in diverse places.

Management of protected areas is becoming increasingly inclusive. Worldwide, there is growing recognition that national parks and protected areas can no longer be treated as islands but must be placed in their broader context as integral components of a productive and secure environment (IUCN 1997). In this bio-regional view, protected areas would be planned and managed as part of a mosaic of land uses that contribute to meeting social and environmental needs (Saunier and Meganck 1995; Oviedo and Brown, in press). This was the main thrust of the last symposium of the World Commission on Protected Areas.

There is a trend away from "exclusive" management models of protected areas and toward "inclusive" ones, in which the interests of local communities are considered, resident populations are not displaced, and there is a high degree of local participation in planning and management of the protected area (Borrini-Feyerabend 1996).

Exmoor National Park in England is an excellent example of how one U.K. national park is working with a range of local interests (including farmers, foresters, private land-owners, and tourism operators) to safeguard cultural and natural heritage, and manage change, in one of Britain's special landscapes. In the late 1960s and early 1970s, agricultural practices within Exmoor led to the loss of over a thousand acres of moorland and the destruction of hedges. Exmoor made headlines as a vulnerable park. After national debate, mechanisms to compensate farmers for not damaging the landscape, as well as incentives for sound management of Environmentally Sensitive Areas (ESAs), were established. Now that farmers are able to tap a support system, moorlands and hedgerows have been restored, most threats disappeared a decade ago, and 70% of farmers have signed up for the ESA program. Though this example relies on direct compensation, which may not be economically feasible in many areas, it does illustrate a larger point: there has been a change in mind-set, with farmers valuing, and being valued for, their role as land stewards. Once contentious,

the relationship between the park authority and local farmers is now one of partnership.

The success of initiatives to ensure conservation of large-scale areas will depend on engaging private and communal land-owners. This point is so intuitively obvious that I will only mention a few examples: the "Green Backbone" of Europe project, which seeks to create a matrix of semi-natural restored habitat across the continent; the effort to establish an ecological corridor in the tropical Andes; and, here in the USA, the Silvio Conte National Fish and Wildlife Refuge, envisioned to affect New England's largest watershed.

The evolving cultural landscape perspective is helping to bridge the gap between conservation of natural and cultural heritage. One manifestation of this trend is an interest globally in the designation of protected landscapes and seascapes (IUCN Category V). With its emphasis on the value of the interactions between people and nature over time, this is a particularly appropriate protected area designation for cultural landscapes. According to the IUCN definition, it is:

... an area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection and evolution of such area (IUCN 1994).

A Category V protected landscape can comprise a mosaic of land ownership patterns, including private and communally owned property, and can accommodate diverse management regimes, including customary laws governing resource management. While these regimes should be subject to a degree of planning control, private land stewardship tools, such as easements and management agreements, can play an important role.

In several countries of the Andean region, nongovernmental organizations (NGOs) are advocating the use of Category V designation for mountainous landscapes. For example, Peru has just adopted new legislation to include Category V in its protected areas systems, and NGOs such as ProNaturaleza are in the process of nominating sites.

Several island states of the Caribbean, such as St. Lucia and the British Virgin Islands, are beginning to include Category V sites in their national systems of protected areas. National Trusts in these countries have found that the model is appropriate for small, intensively settled island countries where the landscapes reflect human interactions over time, much land is privately owned, and the pattern of ownership necessitates innovative management arrangements.

Stewardship projects provide alternatives where conventional protected areas have failed. The South Pacific Regional Environment Programme builds on a strong local stewardship ethic, long connections to the land, and traditional resource management practices. Now in its fifth year, it has 17 conservation area projects in 12 countries. Launched in response to the failure of efforts to establish strict protected areas in the conventional parks model, it seeks a "Pacific Way" of achieving biodiversity conservation along with sustainable use in the context of communal land ownership. A unique feature of the program is its emphasis on the involvement of customary owners and community leaders. The focus of the program is on building up the capacity of local communities to manage their biodiversity and natural resources well. The program offers an example of how the protected landscape/seascape concept can be realized in a developing-country context. However, in most instances stewardship approaches are designed to supplement, not replace, more conventional practices of wilderness and historic preservation.

Government policies which provide a strong legal basis and incentives for conservation agreements can encourage private initiative. Policies can provide

incentives for private land-owners to enter into agreements with government agencies or private land trusts to protect valuable natural and cultural resources.

In New Zealand, partnerships among the Department of Conservation (DOC), private and communal land-owners, district councils, and other interests are protecting significant natural and cultural resources. The Nga Whenua Rahui Fund has negotiated agreements and established joint management committees (involving DOC representatives and Maori land-owners) enabling indigenous land-owners to protect 200,000 acres of forest while retaining ownership and providing for traditional uses. The Queen Elizabeth II National Trust has protected about the same amount of land in approximately 1,300 covenants. Like conservation easements in the USA, covenants are usually "in perpetuity," making them an effective tool for conservation (Lucas et al. 1998).

In Brazil, recent passage of legislation establishing Private Reserves of National Heritage has created a legal basis for conservation on private lands, providing land-owners with tax abatements and access to conservation assistance from the government. Since the program's establishment eight years ago, about 100 land-owners have voluntarily declared portions of their land as reserves—land which is often critical habitat for species such as the golden-lion tamarin.

Political and legal systems in many countries are becoming more stable, creating opportunities for new stewardship tools. With many notable exceptions, many countries are developing stable legal structures and tenure systems, perhaps partly because of globalization. This foundation creates opportunities for less-than-fee conservation acquisitions, such as conservation easements. Most Central American countries now have precedents for easements, and The Nature Conservancy is promoting the technique in South America. One of the participants in the Atlantic Center's annual fellowship last year returned home and negotiated the first easement in Mexico.

Private reserve systems are proliferating. Seven percent of the land area of the Republic of South Africa is currently under private protection, slightly more than is managed under the government system of protected areas (Watkins and Green 1994). The black rhino would probably be extirpated from Zimbabwe by now were it not for private reserves, as national parks were unable to control poaching. Private reserve networks are now well-established in Ecuador, Colombia, Costa Rica, and Chile, to name just a few. A conference on private reserves across Latin America and the Caribbean in November 1999 will likely reveal even more success in this area.

Conservation projects must demonstrate economic and social benefits. In India, where over 80% of protected areas have resident or adjacent human populations, communities must benefit from protected areas in tangible ways. India's ecodevelopment strategy has grown out of the realization that resident and adjacent communities are crucial partners in the management of a protected area, as their activities ultimately determine its future. The program seeks to mitigate pressures on protected areas and encourage stewardship of natural resources, while helping local communities through a variety of local development initiatives, such as agroforestry, nontimber forest products, small-scale irrigation, ecotourism, and reduction of wildlife damage (Rao 1998).

Consumptive resource use programs also fall under this heading. The most famous example probably is CAMPFIRE in Zimbabwe, where local communities share in the profits from controlled trophy hunting of elephants with which they share the land. Stewardship projects also contribute to the development of civil society in countries with weak democratic structures or traditions. Participation in conservation decisions can lead to participation in other areas of decision-making.

In times of rapid transition, changing social, political, and economic conditions present new challenges and opportunities for land stewardship. Stewardship initiatives respond to dramatic social, political, and economic changes, as highlighted by examples from Central Europe. In Poland, for example, a political shift

away from state control has set the stage for a growing role by NGOs, private business, and local governments. In the Czech Republic, while the state continues to play a strong role, NGOs are building on and restoring an earlier tradition of private conservation.

To respond to rapid changes in land-ownership and use and to contribute to legislation and plans now being developed, Central European conservationists must form new partnerships with a range of institutions and constituencies. Protected areas managers, for example, must adjust to declining public resources available for protection, while at the same time work more closely with residents in and around protected areas. The stewardship approach therefore offers a way to deal with the forces of change underway in the region.

Stewardship provides practical means for active management of large landscapes that require it. There are many areas where no-action preservation is not an appropriate management option because one or more natural forces have been irrevocably removed. In these instances, biodiversity and ecosystem functions depend on active management to restore or maintain them.

As in much of the Upper Great Plains, agriculture in southern Minnesota is committed to row crops for livestock feed. Rainwater and snowmelt must be moved off the land quickly before it causes crop damage. Federal and state agencies have developed techniques, such as tiling and ditching, to get the water off the soil, and are trying to reduce impacts of flooding and erosion through conventional and creative engineering and hydrological techniques. The central premise is that the water must be gotten away from the fields within 24 hours.

The Land Stewardship Project, borrowing principles of holistic resource management, has been working with small groups of farmers to rethink the problem completely. After putting together teams of beef and dairy farmers, ecologists, hydrologists, and sociologists, and reviewing the experience of a few non-conventional farms, a number of farmers replaced all or part of their row-crop systems and experimented with rotational pasturage. After ten years, the results are astounding, with healthier soils and cows—and happier farmers, who are saving money!

In these farms, the emphasis is not on getting the water away quickly, but on *keeping* the water in the soil by restoring the soil to a healthy state. I'm not a soil scientist, but I'm told that rotational pasturing mimics the effects of buffalo herds. By carefully manipulating cycles of disturbance and rest, water retention rates go way up, eliminating much of the cause of unnatural floods. The farmers are also challenging ideas about riparian conservation: informal trials have shown that stream banks managed with the disturbance-and-rest regime are less susceptible to erosion than those on reserve land. What is significant in this case is not that this particular management regime is the answer for all Plains states—in fact, what they do in southern Minnesota may not be replicable in northern parts of the state. But the *process* of having a real collaboration of land-owners and scientists was the key to finding a new solution.

Challenges and Potential Pitfalls

There are, of course, many potential pitfalls and problems with stewardship approaches. Time does not allow a full discussion of them, but here are a few quick examples:

- Some private reserve systems could be or become elitist. Systems of private protected areas must recognize the land and resource rights of local and indigenous people. In this respect, appropriate bodies must take care to ensure that private land protection does not reinforce the interests of powerful private land-owners at the expense of landless or other marginalized groups.
- A common criticism of stewardship approaches such as protected landscape areas is that they represent attempts to weaken the protection of conservation areas and undermine the authority of managers. Several Latin American countries

are considering redesignation of all their protected areas in response to land-owner opposition, which is very disquieting. Nevertheless, protected landscapes based on true participation can be very powerful in many areas where strict reserves are not politically acceptable or economically feasible.

Summary

There is an essential tension between responding to opportunities that arise and taking a strategic approach. Many stewardship projects tend to be opportunistic by nature. But ecological integrity of landscapes and protecting representative ecosystems require strategic approaches. How can we be sure that protection of many small parcels, using different mechanisms and by many different actors will meet biodiversity protection goals? Given scarce resources, there is a need to strike a balance between opportunism and strategy. Partnerships—among local communities, government, NGOs, and the private sector—are essential to make efficient use of the unique potential of each. In a framework of multiple public and private agents engaging individual and associated land-owners and resource users, communication and education programs play an important role in creating a climate for cooperation with stakeholders. Significantly, stewardship projects serve an important education role, even if they do not result immediately in direct conservation gains.

Large landscapes are dynamic and change along with the communities living in them. To adapt to these changes, we need diverse tools and participatory frameworks. Any successful conservation strategy will require adaptive approaches which can be applied across a mosaic of land-ownership and use patterns. It will rely on processes that engage local residents and communities, and build on traditions of caring for natural and cultural heritage. It will respect the land and resource rights of all persons.

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Management of the First Full 3D Seismic Operation in a National Park Service Property: Lessons from Jean Lafitte National Historical Park and Preserve, Louisiana

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Petroleum exploration technology advanced into the National Park System in 1998 when a three-dimensional (3D) seismic operation was undertaken in Jean Lafitte National Historical Park and Preserve, the first in a U.S. national park. This new technology presented challenges for park managers to protect resources while providing for the exercise of nonfederal oil and gas rights consistent with the park's enabling legislation. Cooperative planning with the operator, Burlington Resources, and assistance from the National Park Service's geological resources division was crucial to reducing the resource impacts of this intensive operation.

The park's enabling legislation establishes certain activities to be allowed in its Barataria Preserve unit, a highly productive estuarine complex of floating marshes and forested wetlands. One of those activities is the exercise of nonfederal oil and gas rights. Furthermore, the legislation enumerates four values to be protected in the Barataria Preserve: (1) freshwater drainage patterns, (2) vegetative cover, (3) integrity of ecological and biological systems, and (4) water and air quality. The nature of 3D seismic geophysical exploration presented a challenge to protecting those values as well as the quality of the visitor experience and still allow for the exercise of the mineral rights. Regulations covering nonfederal oil and gas rights (Title 36 of the Code of Federal Regulations, part 9, subpart B) and numerous other laws provided the legal context for development of a plan of operations to protect both park resources and the rights of mineral owners.

As a geophysical exploration technique, 3D seismic technology is a relatively new application of an old skill: listening. Energy waves are generated near the surface by detonation of an explosive charge known as a "source." The energy travels through the earth to a subsurface target, where it is reflected back to the surface to be recorded on a grid of receivers. The recorded energy waves are then computer-analyzed to identify potential petroleum reserves. It is the grid of sources and receivers that makes 3D different from the 2D, or straight-line, operations of the past. It is also the grid that poses the greatest threat of damage to park resources and the visitor experience.

The Burlington Resources 3D seismic operation covered 32,000 acres and was centered over Lake Salvador to the west of the park. Within the Barataria Preserve, 6,360 acres were involved in the operation. Most of that area was freshwater and intermediate marsh characterized by a thick organic substrate that enables the marsh to float, commonly known as "flotant." Primary marsh vegetation communities within the shoot area are bull-tongue (*Sagittaria lancifolia*), spike rush (*Eleocharis* spp.), and maiden-cane (*Panicum hemitomon*). A floating-scrub and shrub habitat of wax myrtle (*Myrica cerifera*) is interspersed throughout much of the marsh, sometimes forming thickets that support unusual plant communities. The continuity of the marsh is interrupted by the presence of canals. Most of these human-made waterways are delineated by elevated spoil banks that support hardwood trees and are dominated by the invasive Chinese tallow tree (*Sapium sebiferum*). One of the primary concerns during the operation was the potential for damage to vegetation and marsh substrate resulting from the type and amount of equipment needed to survey, drill, detonate, and record the energy waves.

Eighteen months of planning culminated in the approval of a plan of operations and environmental assessment in April 1998. Working directly with the operator and the geophysical industry, creative solutions were developed to protect sensitive resources such as rare plant communities, popular hiking and canoe trails,

archaeological sites, and long-term research plots. Bio-remediating explosives were used to avoid water and soil contamination. Travel routes were carefully designed and equipment was modified to reduce weight to minimize compression of the organic marsh substrate and resulting hydrologic modifications. Very sensitive resources were designated as avoidance areas for all motorized equipment. Park newsletter and local newspaper articles kept the community informed, and a new interpretive wayside paid for by the operator explained this complex operation to park visitors. Although the planning effort was comprehensive, the strengths and weaknesses became apparent during implementation.

The survey phase began in late April and was accomplished using airboats and global positioning system equipment. Color-coded, biodegradable flagging and cane poles were used to mark the locations of source holes and recorders. Also, a magnetometer was used to identify subsurface pipelines, boats, and other hazards, which were flagged and avoided throughout the operation. Predetermined avoidance areas, such as research plots, archaeological sites, and wax myrtle thickets were surveyed and flagged. During the survey, access points were identified and mapped for subsequent phases of the operation. The use of designated access points was inherently problematic because it required that equipment leave the line of operation and trail across the marsh to get into or out of an access point. However, the alternative was to cut numerous access points and risk widespread erosion and colonization by non-native plants. Another problem was that fire ants destroyed the biodegradable flagging, thus resulting in lost points and the need to resurvey.

Next, the drilling phase proceeded, using aluminum marsh buggies to drill 100 ft below the surface and set a 5-lb explosive source. Bio-remediating sources were used to reduce contamination of waters and sediments, and the explosives were stored outside of the park until ready for use. Access for the drilling-rig marsh buggies was a major concern throughout the operation because of the amount of damage they can cause to marsh substrate and woody vegetation. Another concern was availability of surfacewater for the drill operation. Although the environment is a wetland, the peat substrate is floating or semi-floating, with little surfacewater available for drilling. Through trial and error, it was found that the weight of the marsh buggy was sufficient to depress the mat and eventually water would pool on the surface, much like squeezing a sponge. Use of this "sit and wait" technique allowed drilling to proceed without digging a hole through the marsh in most places; however, it was difficult to force the drilling crews to adopt this approach since they are paid by the number of holes drilled per day. Another unexpected problem was the frequency of hydraulic hose breaks on the drilling rigs, even using new equipment. Use of biodegradable hydraulic fluid and availability of spill kits reduced the threat posed by such leaks. It was also quickly observed that "trenasses," small waterways that connect the marsh to the canals, are not suitable access locations for marsh buggies. When trying to climb from the trenass into the marsh, the tracks dig into the soft sides, breaking off pieces of vegetated substrate. Access plans were then revised to direct marsh buggies to other points of entry and still allow airboats to use the trenasses. In all, 486 sources were drilled along 36 miles of source lines.

The simultaneous detonation and recording phases were completed in early July. The recording crews set up the receivers, which are small boxes of geophones with narrow rods pushed through the marsh. Approximately 1,300 receivers along 54 miles of receiver lines were used in the park. Recorders were hard-wired into every six receivers. The recorders were then manipulated from a control center, known as "the doghouse," located off park property. Radio frequencies were used to remotely check the status of each recorder and to transmit the data recorded. Deployment and troubleshooting of the receiver lines were done by airboats with helicopter support. The shooting crew also used airboats to access the sources that were set in place during the drilling phase. At each source location, a shooting pack was wired into the detonation cord connected to the source 100 ft down. Once the doghouse deter-

mined that the recorders and receivers were all functional for that hole, a radio signal was used to remotely detonate the source. Nutria, an exotic rodent in the park, posed an unexpected problem when the animals chewed through the wires connecting the receivers and recorders. The result was more troubleshooting and, consequently, more airboat passes through the marsh. Another issue was the theft of detonation cord between the time that the drillers set the source and the shooters detonated it. The copper wire in the detonation cord is valuable and provides an easy target for anyone with a boat. When the detonation cord was removed along with the cane poles and flagging, it was impossible to find the drilled sources. As a result, only 477 sources were actually detonated, leaving nine unexploded sources in the substrate beneath the park. The bio-remediating sources were designed to be rendered inoperable after six months of submersion, so there should be no lasting threat to public safety.

The final phase of the operation was restoration. As equipment was removed following the recording phase, access routes were immediately assessed and stabilized using organic matting and rolls. Plugs of marsh were replanted in small areas of rutting. Trees were replanted on spoil banks that had been cut to provide access for equipment. Overall, resource damage was minor and localized. Most plant communities had recovered by the end of the growing season. Aerial photography and visual inspections will continue for three years, as planned, but no long-term impacts are anticipated.

Essential to successful implementation of the planned operation was the use of third-party compliance monitors hired by the operator with approval by the park. Monitoring was accomplished by Coastal Monitoring, Inc., of Lafayette, Louisiana. Tom Hargis and Russell Walters, both wetland scientists who are very knowledgeable about the park's marsh environments, provided on-site control of all field operations under the guidance of the park's natural resource management specialist. The monitors maintained daily contact with the many field crews and provided comprehensive documentation of field activities during almost three months of continuous operations.

Many lessons were learned during this operation, some of which are specific only to coastal Louisiana environments or to 3D seismic operations. However, many of the lessons could be useful to resource managers who must deal with any large-scale or intensive activity over which they have limited control.

- Maintain communications through crew turnovers and be aware that your instructions will be condensed down to a few words. Develop a one-page written summary of the most important elements that can be provided to every crew member. Behind the scenes, see if your environmental protection requirements can be incorporated into every contract and sub-contract that will be involved in the operation.
- Be a part of morning safety meetings with each crew—80% of the day's decisions are made at that time. Also be a part of weekly or daily meetings with the crew bosses or other people in positions of authority. Communicate with adjacent land-owners and let them know what you are requiring of the operator. Consistency across park boundaries increases the ability of the crew to comply with all of the requirements.
- Require that a translator be provided with non-English speaking crews, so that you have some means of immediate communication with every person in the field. (Incidentally, Cajun-French airboat operators do not necessarily make good translators to communicate with Spanish-speaking shooting crews from Mexico.)
- Expect the unexpected, such as hydraulic leaks on equipment, nutria gnawing the receiver lines, theft of detonation cord, and fire ants eating the flagging and

- invading equipment. Realize that some things are inherent to the environment and work cooperatively with the operator to minimize risk as much as possible.
- Be adaptable and change plans to fit new information. Clearly communicate changes, both verbally and in writing.
 - Be mindful of pay incentives for crew members because they can undermine environmental protection measures. See if the operator is willing to consider incentives for environmental sensitivity.
 - Ask questions ... lots of them! You might inspire someone to think of a better way of doing a task.

To be the first at anything is not easy. Management of the first 3D seismic operation in a national park certainly posed many challenges and questions without easy answers. Our counterparts in the U.S. Fish and Wildlife Service as well as Louisiana Department of Wildlife and Fisheries provided invaluable suggestions during the planning phase of this operation. The common sense and scientific knowledge of the field monitors filled in many information gaps during the operation. Although woefully lacking in 1997, the published literature is now addressing many issues common to 3D seismic operations. And it is our hope that other resource managers can learn from our experiences. To facilitate that information exchange, in May 1998 we hosted a three-day workshop for other parks with nonfederal oil and gas rights to observe the field operations in the park. Other parks will certainly have the opportunity to learn from their own experiences. As 1998 drew to a close, Big Thicket National Preserve (Texas), Big Cypress National Preserve (Florida), and Padre Island National Seashore (Texas) were all in the planning or implementation process for 3D seismic operations, and more are likely to follow.

Adaptive Management on the Colorado River in Grand Canyon: Lessons and Challenges

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The Colorado River drains a 250,000-sq-mi area stretching from Wyoming to Mexico. Today, more than 25 million people depend on the river for their household water. Millions more depend on it for their livelihood. The human history of the river is a complex mix of events. Its waters have been diverted for human uses for over a thousand years. However, the Colorado River Basin remained largely undescribed until John Wesley Powell led an exploration down the Green and Colorado Rivers in 1869.

In 1905, the Gila River, a tributary of the Colorado, decimated California's Imperial Valley through 18 months of severe flooding. In the ensuing years, concerns over flooding and future water rights led six states to form an interstate compact, the Colorado River Compact of 1922. This agreement divided use of the Colorado's water between states upriver and downriver of Lees Ferry, Arizona. With later agreements and court decisions that subdivided water allotments among the states and with Mexico, it then became possible to undertake development of water resources throughout the entire Colorado River Basin. The plan, which was laid out in the Colorado River Storage Project Act of 1956, authorized four large reservoir projects, including one to be built at Lees Ferry, the dividing line between the Upper and Lower Basins. This project would become Glen Canyon Dam. Like other storage projects, Glen Canyon Dam was designed to regulate the flow of the Colorado River, store water for beneficial consumptive use, provide for the reclamation of arid and semiarid land, control floods, and maximize revenue from power generation. Creation of Lake Powell would also benefit the local economy, provide recreation, and enhance downstream wildlife habitat for several species. More specifically, the 27-million-acre-foot capacity of Lake Powell would make it possible for the Upper Basin states to meet their downstream water delivery obligations without severely curtailing use upstream during periods of extended drought. Excess runoff during wet years could simply be stored in Lake Powell to meet the needs of Lower Basin states during dry years.

However, the completion of Glen Canyon Dam in 1963 had substantial side effects, too. It submerged Glen Canyon under several hundred feet of water, and it markedly altered the Colorado River through Grand Canyon. The natural cycle of seasonal flooding was interrupted, except for rare high-runoff events, such as an unplanned flood that occurred in 1983. Sediments once carried by the river became trapped in the upper reaches of Lake Powell, creating a precarious balance between transport of sediment into and out of the downriver system. At the same time, power plant peaking operations were causing river levels to fluctuate as much as 13 ft a day, stranding people, boats, and fish, eroding beaches, and causing havoc with life cycles of aquatic organisms. As the reservoir filled, seasonal variations in water temperature also declined. Stabilizing at 46-48° F, releases fell well below the optimum for successful reproduction of native fish and became dangerously cold for whitewater boaters.

How were these environmental changes allowed to happen? Glen Canyon Dam was built before passage of the U.S.'s principal environmental legislation: the National Environmental Policy Act of 1969, the Endangered Species Act of 1973, and the National Historic Preservation Act of 1966. While the initial construction was not affected by these acts, later changes would be subject to their requirements. In the early 1980s, the Bureau of Reclamation began planning improvements to increase power capacity and peaking power output. Bureau managers knew that compliance studies would be required for these improvements, and they formed the Glen

Canyon Environmental Studies program to provide the information they needed. In 1989, after having reviewed the program's Phase I findings together with a report by the National Research Council, Secretary of the Interior Manuel Lujan made the decision to undertake an Environmental Impact Statement (EIS) on the full operations of Glen Canyon Dam. This decision was incorporated and expanded upon in the Grand Canyon Protection Act of 1992 (GCPA). The GCPA also confirmed broader natural, cultural, and recreational values associated with the river, and it directed the secretary to operate the dam to protect, mitigate adverse impacts to, and improve or enhance the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established.

The EIS identified a broad range of stakeholder concerns. Nine alternative operating criteria were evaluated in detail. These fell into three broad groups: unrestricted fluctuating flows, restricted fluctuating flows, and steady flows (adjusted monthly, seasonally, or annually). To protect resources and recreational users while the EIS was being prepared, an interim "low-fluctuating flows" alternative was implemented on 1 August 1991. A programmatic agreement was implemented in 1994 to address the requirements of the National Historic Preservation Act, and an informal interagency transition work group was established to improve communication among an expanded group of cooperating agencies and organizations.

The preferred alternative identified by the EIS was to allow "modified low-fluctuating flows." It established minimum and maximum releases and put controls on daily fluctuations and ramping rates. This alternative was expected to protect the tail water trout fishery, improve angler and boater safety, and maintain sediment in the downriver system, sediment that could be mobilized through flooding to replenish sand bars and protect traditional cultural properties. Other elements of the preferred alternative included implementation of an adaptive management program, resource monitoring and research, planned beach-habitat-building flows (BHBFs), and prevention of unanticipated flooding events, such as had occurred in 1983. The EIS also called for establishment of an independent monitoring and research center to plan and implement studies required under the GCPA. The Grand Canyon Monitoring and Research Center (GMCRC) was established to meet this requirement in November 1996, overlapping the final phase of the Bureau's Glen Canyon Environmental Studies program by one year.

An important element of the preferred alternative was BHBFs, also known as "spike floods" or "controlled floods." They were intended to restore some elements of the natural seasonal flooding cycle. Planned floods were anticipated to occur approximately once every five years, usually during early spring. Like natural floods, BHBFs were expected to include a mix of resource benefits and costs (Table 1). An experimental flood was planned for 1994, was postponed, and planned and postponed again in 1995. Finally, after negotiations to revise the preferred alternative for consistency with the Law of the River, all hurdles were overcome and the stage set for a seven-day flood during March and April 1996. This experimental flood was extraordinarily successful at mobilizing and redistributing sand from the riverbed, although apparently not powerful enough to rejuvenate backwater channels or to scour the exotic tamarisk from river banks. Although some non-native fishes were temporarily displaced downstream, neither native or non-native fish populations were significantly affected in the long term.

Six months later, Secretary of the Interior Bruce Babbitt signed the record of decision implementing the preferred alternative from the final EIS—with one very significant change. The conditions under which a BHBF could occur had been altered in a last-minute compromise to avoid a lawsuit from the states. This change dictated that BHBFs "will be accomplished by utilizing reservoir releases in excess of power plant capacity required for dam safety purposes." This minor change in wording would present a confounding set of challenges for the people who would plan and implement future floods. Releases required for dam safety purposes are not easily

Presumed beneficial:

- Rebuilding of sandbars and camping beaches
- Protection of eroding cultural resources
- Deposition of nutrients
- Scouring and rebuilding of backwater channels
- Scouring of exotic riparian vegetation
- Flushing of non-native fishes downstream
- Rare opportunities to test flood-related scientific hypotheses
- Opportunities to educate the public about ecosystem restoration

Considered detrimental:

- Riparian habitat loss within the flood zone
- Increased mortality of less-mobile wildlife within the flood zone
- Temporary interruption of some recreational uses
- Lost power revenue and replacement power costs

Table 1. Predicted effects of BHBFs

predicted, so the decision for or against a spike flood would either have to be made in a hurry, or planners would need to evaluate and develop decision criteria for the full range of possibilities, including spills in any month or year when watershed runoff might dictate. Even more importantly, the decision to shift floods from low-water to very-high-water years meant that any BHBF would almost certainly be followed by sustained high releases. This means that the newly formed beaches could be subjected to highly erosive flows for as much as several months after the flood. This would have profound implications for the long-term stability of newly formed beaches, as we saw during 1996 and 1997, when much of the sediment added to beaches during the 1996 spike flow was washed back into the eddies.

On 15 January 1997, Secretary Babbitt signed the charter for an adaptive management work group (AMWG). This group, established under the authority of the Federal Advisory Committee Act, was charged with advising the secretary on matters related to implementation of the GCPA. The duties and functions of the AMWG are advisory, since federal agencies cannot delegate their decision-making responsibilities. The charter identified 25 participating stakeholder groups, including five federal and one state agencies, six Native American tribes, seven basin states, two environmental groups, two recreation groups, and two federal power purchase contractors. The makeup ensures that no interest group has a clear voting majority. Cooperation is thus essential for the committee to function effectively.

The AMWG met for the first time in September 1997. One of their first actions was to designate a subgroup, known as the technical work group (TWG) to handle the detail work for the AMWG. Every AMWG organization has one representative on TWG, except for the National Park Service (NPS), which has one representative each for Grand Canyon and Glen Canyon. The U.S. Geological Survey was also added to the TWG because of their significant scientific presence in the canyon. Formation of TWG completed five of the six elements of the adaptive management program structure as proposed in the EIS. The five elements are the secretary of the interior, the AMWG, the secretary's designee (who leads AMWG), the TWG (led by an elected chairperson), and the GCMRC. The sixth element, an independent review panel, will be in place by early 1999.

The AMWG meets twice annually, and the TWG meets about once or twice a month. Adaptive management is an experiment and early indications are that it is working. However, its long-term prospects depend to some degree on how well we handle nine challenges in three basic areas.

- *We must promote cooperation, not competition, among participants.*
- 1. **Maintain trust.** Participants must bring issues to the table and to work towards consensus for this process to work. If members opt unilaterally to apply political, legal, or economic pressures to force actions, the team spirit will deteriorate and issues will become increasingly polarized. Most of the members are working cooperatively, although political end-runs still happen occasionally when participating organizations feel they will be unable to convince the group of the importance of their issue.
- 2. **Maintain confidence.** It has become apparent that large elements of the program budget may be controlled by agreements made outside the AMWG, but still within the influence of individual members. This is partly a consequence of federal regulations that do not allow agencies to delegate certain responsibilities and it is partly a reflection of resistance to participatory decision-making. Either way, it can lead to frustration if members feel their recommendations about priorities are being disregarded.
- 3. **Maintain the participation of knowledgeable and committed people.** The pace of activity has been very rapid, and participation as a TWG representative demands from 10% to 50% of an individual's time. Travel and salary costs of most members are not covered by the adaptive management program budget. Consequently, several organizations have participated only intermittently and some of the most active members have been replaced with less-experienced representatives from their organizations. Costs of participation must be kept low, and financial support may be necessary to ensure continued participation for some members, including tribes and nongovernmental voluntary organizations.
- *We should embrace an ecosystem approach.*
- 4. **Avoid the trap of single-issue management.** We must work to restore natural ecological processes to maintain the sustainability and biodiversity of the ecosystem as a whole, while anticipating and mitigating the effects on rare or non-renewable resources, and on economies and communities. The record of decision attempted to optimize for a wide range of resources, some of which were expected to benefit more than others. Advocates of single-issue resource management may become impatient with progress in some areas.
- 5. **Ensure long-term monitoring.** We must continue to refine the long-term monitoring plan to ensure that consistent protocols are followed for data collection, record-keeping, and evaluation, and that a broad complement of resource indicators are studied.
- *We should learn from experience, and apply the lessons learned.*
- 6. **Remember the plan.** We must evaluate the preferred alternative that was identified in the final EIS for long enough to document whether it is working before we call for changes to the record of decision.
- 7. **Keep adaptive management adaptive** by ensuring that managers continue to embrace experimentation, incorporate new findings in their decision processes, and involve a full complement of stakeholders in a cooperative advisory role.
- 8. **Manage for efficiency.** The adaptive management program is currently budgeted for about \$7-8 million annually, of which about three-quarters is available for monitoring and research. Most of the research, monitoring, and administrative costs are covered by power revenue, which has been constrained for several years by restrictions on daily fluctuations. Economic studies indicate the cost of restricted flows may be in the range of \$25-35 million annually, while economic

benefits (for both users and non-users) were estimated to be about \$60 million annually. Stakeholders agree that consideration of economic costs and benefits to society are valid aspects of ecosystem management.

9. **Remember the mission.** These NPS areas are national treasures, established to "...conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Will adaptive management help those of us in NPS to meet our mission? Time will tell. There will be many turbulent rapids to navigate, and doubtless a few unforeseen dangers, but the crew for this expedition is eager to go and the boat seems pointed in the right direction.

Reserve Design for Grasslands: Considerations for Bird Populations

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When you think of a park, you probably think of trees. Maybe mountains. Or possibly a lake or oceanfront. You probably don't think of prairie. Prairie? That's just ... well, grass. What can you do there? Certainly no fishing. No trees to camp under. And no majestic mountains to view.

And so it is. Huge areas of trees are given some protection in national and state parks and forests. America's national parks contain a large percentage of mountains. And lots of lakes and ocean shorelines are included in national seashores and other preserved areas. But prairies? Very little prairie has been included in parks (Flores 1996). For example, only 0.4% of National Park Service (NPS) lands are in grassland, and most of that actually represents badlands formations, atypical of prairie (Licht 1997). Most national parks with tallgrass prairie habitats were preserved for their cultural, rather than natural, features and thus tend to be small, isolated, and surrounded by urban areas or intensive agriculture.

This lack of attention to grasslands is reflected in the fact that prairies are among the most endangered ecosystems in the United States. Noss et al. (1995) indicated that 55% of all critically endangered ecosystem types in the nation were grassland, savanna, or barren. Most states have lost 99% or more of their native tallgrass prairie (Samson and Knopf 1994). Much grassland has been cultivated, primarily because of the rich soils underlying, and originally created by, the grassland.

Grasslands are beginning to receive due consideration. But progress is slow: Tallgrass Prairie National Preserve was created in the Flint Hills of Kansas, but it met resistance from local land-owners and politicians (see Madson 1995, 289). Currently, 4,449 ha have been acquired by the National Park Trust, and are managed by NPS (NPS 1997, 45). Other agencies are getting increasingly involved. The U.S. Fish and Wildlife Service, for example, is working on a northern tallgrass prairie habitat preservation area in western Minnesota and northwestern Iowa, intended to protect and enhance prairie remnants there (USFWS 1998). The Nature Conservancy has made native prairie a high priority in the Midwest. Canada developed a Prairie Conservation Action Plan, intended to protect representative prairies and encourage appropriate land-use practices (Dyson 1996). Ducks Unlimited-Canada has an emphasis on protecting native grassland (Anderson et al. 1996) and Ducks Unlimited, Inc., is initiating a major effort to preserve grasslands in the northern prairies of the USA (J. Ringelman, Ducks Unlimited, Inc., personal communication).

In addition to protection, the restoration of prairies is receiving greater attention. Most efforts are small-scale; the largest is the U.S. Fish and Wildlife Service's attempt to reconstruct tallgrass prairie and savanna on the Neal Smith National Wildlife Refuge, about 2,000 ha of Iowa fields used for decades to grow corn and raise livestock. Two recent books (Thompson 1992; Packard and Mutel 1997) focus on the restoration of prairies and allied habitats. Two journals, *Ecological Restoration* and *Restoration Ecology*, regularly feature articles on the re-establishment of prairie.

Birds are particularly an issue in grasslands, as many grassland-dependent species have been declining in number. North American Breeding Bird Survey results indicate that grassland species have shown greater and more consistent declines than other groups of birds (Droege and Sauer 1994). In recognition of the plight, the U.S. Department of the Interior (1996) recently developed a conservation strategy for grassland birds.

Fortunately, heightened interest in grassland birds has led to greater research attention. The objective of this article is to review relevant findings, particularly landscape issues to consider when designing grassland reserves for breeding birds.

What are Prairies?

Prairies (also known as "grasslands") are biological communities dominated by grasses and forbs, but few trees or shrubs (Risser et al. 1981). Although grass species make up most of the plant biomass, a majority of species are forbs (Freeman 1998). In grasslands, sunshine is ample, so plants need not devote a lot of their growth to leaves. Conversely, rainfall is low, so prairie plants have deep roots that capture as much of the limited water as possible. Although prairies look much less luxuriant than forests, they contain similar biomass, but most of it (67-80%) is below ground (Madson 1995; Rice et al. 1998). Not only is much of the plant material hidden, so too are most other living things, notably mycorrhizae, bacteria, and trematodes. Subterranean invertebrates constitute about 10 times as much biomass as their above-ground counterparts (Ransom et al. 1998).

Grasslands are nonequilibrium ecosystems, maintained by disturbances, notably drought, fire, and herbivory (Knapp and Seastedt 1998). Without such treatments, ecological succession will transform grassland into shrubland or woodland, depending on the precipitation regime. Attacks on above-ground growth—whether by fire, herbivore, or mowing machine—are well-tolerated (Manning 1995) because of the plants' deep root systems, and because the growth points of grasses are near the soil surface. Droughts, while termed catastrophes by humans, are a normal phenomenon, without which prairies would not exist (Manning 1995). Lack of moisture by itself is not sufficient to support prairie, however; other disturbances are necessary. The major ones are fire and herbivory.

Fire maintains grassland, especially in the eastern tallgrass prairie, where precipitation is adequate to support forest vegetation. The build-up of highly combustible dead grasses and forbs, open terrain that allowed winds to carry a fire long distances, and frequent summer thunderstorms that brought the match of lightning, all contributed to recurrent prairie fires. In the more xeric shortgrass prairie of the west and mixed-grass prairie between the shortgrass and tallgrass prairies, grazing by huge herds of bison (*Bos bison*), elk (*Cervus elaphus*), and pronghorn (*Antilocapra americana*), often in combination with fire, helped maintain prairie.

Americans have been ambivalent in their attitudes toward grasslands. To European pioneers, the prairies were a painful obstacle hindering them from getting from the eastern states to the West Coast, where gold was to be found. Or, for those who settled in the vast midsection of the nation, prairie was something to be turned upside down in order to farm. Yet, for some settlers, after trekking through hundreds of miles of thick forest, "seeing prairie was like seeing sun for the first time" (Madson 1995, 15). Humans had evolved in savannas, grasslands interspersed with scattered trees, so the "rush of freedom felt on encountering an open vista of grassland is racial memory" (Manning 1995, 51).

One reason that prairie has been underappreciated may be that much of it is hidden from view. But, as noted by William Least Heat-Moon, "The prairies are nothing but grass as the sea is nothing but water" (Knapp et al. 1998). Prairies harbor vitally important biological resources, including many endangered and threatened species, such as the black-footed ferret (*Mustela nigripes*), western prairie fringed orchid (*Platanthera praeclara*), and Dakota skipper (*Hesperia dacotae*). In Minnesota, 102 of 287 endangered species occur in prairie (Tester 1995). Some species are ghosts of prairies past; the plains grizzly (*Ursus arctos*) and gray wolf (*Canis lupus*) were dominant predators before settlement by Europeans. The elimination of these and other keystone species severely disrupted biotic communities.

Birds of the Prairie

A typical prairie contains fewer bird species than does the same area in forested habitats: for example, three to five species in 10 ha, versus 10-30 in eastern deciduous forest. Nonetheless, at a large scale prairies support considerable avian diversity: 42 regular breeders on the Konza tallgrass prairie in Kansas (Kaufman et al. 1998), and 80 breeding species in the mixed-grass prairie in North Dakota (Johnson 1996).

Although the species richness of grasslands is relatively low, the ecosystem is essential for the survival of several bird species, such as burrowing owl (*Athene cucularia*), mountain plover (*Charadrius montanus*), Sprague's pipit (*Anthus spragueii*), Henslow's sparrow (*Ammodramus henslowii*), and Baird's sparrow (*Ammodramus bairdii*).

Loss, degradation, and fragmentation of grassland habitats have contributed to the apparent decline of several grassland bird species (Herkert et al. 1993). Prescribed burning, grazing, and haying are used to maintain existing prairies or restore prairie habitats. Different grassland bird species react differently to these treatments. The habitat requirements and responses to management have been the subjects of numerous studies (although many of them suffer from lack of replication, controls, and random assignment of treatments). Syntheses of the literature on many grassland bird species are available on the Web (see USGS-BRD 1999). This article emphasizes landscape issues, especially those related to habitat fragmentation.

Habitat fragmentation involves the separation of large, contiguous areas of habitat into smaller patches isolated from one another. Three types of effects of fragmentation can be distinguished: patch size effects, edge effects, and isolation effects. Patch size effects are those that result from differential use or reproductive success associated with habitat patches of different sizes. Some of these effects may be induced by edge effects—phenomena such as avoidance, predation, competition, or brood parasitism that differ near a habitat edge compared with the interior of a habitat patch. And isolation from similar habitat can influence use of a particular habitat patch.

Each of these factors can affect (1) the occurrence or density of birds using a habitat patch; (2) reproductive success, either through predation rates on eggs or young or through brood parasitism rates; or (3) competition with other species. Effects due to competition are not well-known, but studies on the other features are summarized next.

Patch size effects: occurrence and density. Species that have lower densities or are absent from small habitat patches are referred to as "area-sensitive" (Robbins 1979). Species with large home ranges, such as greater prairie-chicken (*Tympanuchus cupido*), upland sandpiper (*Bartramia longicauda*), and northern harrier (*Circus cyaneus*), are typical area-sensitive species that are rarely present in small habitat patches. But even species with territories small enough to easily fit in small habitat patches can be area-sensitive, for reasons which are as yet poorly understood. Several grassland passerines have been identified as area-sensitive in different geographic areas: Baird's sparrow and grasshopper sparrow (*Ammodramus savannarum*) in Prairie Canada (McMaster and Davis 1998); Baird's sparrow, among others, in the northern Great Plains of the USA (Johnson et al., in preparation); grasshopper sparrow and western meadowlark (*Sturnella neglecta*) in Minnesota (Johnson and Temple 1986); Henslow's sparrow in Missouri (Winter 1998); grasshopper sparrow, Henslow's sparrow, bobolink (*Dolichonyx oryzivorus*), savannah sparrow (*Passerculus sandwichensis*), and eastern meadowlark (*Sturnella magna*) in Illinois (Herkert 1994); bobolink, savannah sparrow, Henslow's sparrow, and grasshopper sparrow in New York (Bollinger 1995); and vesper sparrow (*Pooecetes gramineus*), savannah sparrow, grasshopper sparrow, bobolink, and eastern meadowlark in Maine (Vickery et al. 1994). The extent of area sensitivity, however, varies geographically, probably because it depends on the structure of the landscape surrounding a prairie patch (see below).

Consistent with their area sensitivity, few grassland-dependent birds were observed by Powell (1998) in surveys of three tallgrass prairie national parks, all of which were small. In contrast, she found that the 4,449-ha Tallgrass Prairie National Preserve supported large numbers of area-sensitive species such as grasshopper sparrow, greater prairie-chicken, eastern meadowlark, and upland sandpiper (A. N. Powell, personal communication).

Patch size effects: nest success. Burger et al. (1994) indicated that artificial nests survived at a higher rate in larger than in smaller prairie patches in Missouri, but artificial nests may not accurately reflect real nests. Winter (1998) recently showed that dickcissels (*Spiza americana*) were more successful in larger than in smaller prairies in Missouri.

Edge effects: occurrence and density. Wiens (1969) suggested that savannah sparrows, grasshopper sparrows, and vesper sparrows tended to avoid forest edges in Wisconsin. Delisle and Savidge (1996) indicated that few grasshopper sparrow nests were located within 60 m of a habitat edge in Nebraska. Helzer (1996) found that, in wet meadows along the Platte River in Nebraska, grasshopper sparrows avoided woody and cornfield edges, and bobolinks avoided woody edges.

Edge effects: predation. Nests of bobolinks and western meadowlarks in Minnesota that were >45 m from a habitat edge were more successful than those that were closer (Johnson and Temple 1990). Burger et al. (1994) reported that artificial nests <50 m from woody edge in Missouri were depredated at greater rate than those farther away. Delisle and Savidge (1996) found no edge effect for grasshopper sparrows in Nebraska. Winter, Johnson, and Faaborg (in review) reported that, in Missouri, predation rates on Henslow sparrow and dickcissel nests were higher near shrubby edges, and that there was more activity by mid-sized carnivores near edges.

Edge effects: brood parasitism. Brown-headed cowbirds (*Molothrus ater*) lay their eggs in the nests of other species, thereby reducing the productivity of the hosts. Johnson and Temple (1990) detected higher parasitism rates of nests within 45 m of forest edge for the clay-colored sparrow (*Spizella pallida*) and western meadowlark in Minnesota. In Missouri prairies, Winter, Johnson, and Faaborg (in review) found higher parasitism rates for nests within 50 m of shrubby edge.

Isolation effects: occurrence and density. Winter (1998) reported that, for south-western Missouri, Henslow's sparrow and dickcissel densities were greater in patches with more grassland within 5 km, and were lower in patches with more forest within 5 km. J. R. Herkert (personal communication) indicated that grasshopper sparrows and bobolinks in Illinois were encountered more frequently in large patches with greater amounts of grassland within 5 km.

Isolation effects: nest success. Winter (1998) found that dickcissel nest success was higher in Missouri prairies with greater areas of grassland within 5 km.

Interactions and regional variation. Some features mentioned above may interact, or operate differently in different areas. For example, Winter (1998) detected an interaction between patch size and landscape in Missouri, where Henslow's sparrow densities were independent of patch size in landscapes with a lot of grassland, whereas in forested landscapes densities were lower in small patches than in large patches. She also noted that Henslow's sparrows occurred in 30-ha patches in Missouri, whereas Herkert et al. (1993) indicated that they required patches exceeding 100 ha in Illinois.

Conclusions and Recommendations

The overriding conclusion from studies reviewed here is that we need to integrate local and landscape scales to maximize the efficacy of management efforts. On a local scale, woody vegetation within or bordering prairie fragments should be reduced, because it attracts nest predators and consequently reduces nesting success. Because patch size influences both density and nesting success of grassland-nesting birds, grassland reserves should be large (>100 ha) if they are to support characteristic prairie

rie avifauna. Small prairies, however, can still support healthy populations of grassland birds if they are surrounded by other grassland habitat. Priority should be given to small habitat patches located in landscapes suitable to grassland-nesting birds over similar patches in forested landscapes. Ultimately, we must manage not only the prairie fragment itself, but also need to change the landscape surrounding a prairie fragment to positively affect grassland bird populations. A study now underway is focusing on the combination of patch size and landscape features as influences on the viability of tallgrass prairie birds (Winter et al. 1999).

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Third-Party Compliance Monitoring of Special Park Uses Provides a Valuable Tool to Resource Managers

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National Park Service (NPS) lands are sometimes subjected to intensive operations in the exercise of a property right or use, such as a right-of-way or mineral exploration. Such operations present a number of challenges to resource managers who must protect park resources while providing for the exercise of legal rights. Traditionally, park managers have relied on park staff to monitor such operations and enforce conditions of the permit or other legal instrument used to authorize park uses. However, many parks cannot afford the staff to monitor intensive operations that may continue for 12+ hours per day, seven days a week, for weeks or even months. Furthermore, it is often difficult, if not impossible, to recover the costs of continuous monitoring by park staff.

One solution to this problem is the use of third-party compliance monitors (hereafter referred to as "monitors"). Monitors are essentially contractors who are hired by the operator upon approval by the park manager. The monitors report directly to the park manager (or his/her designee) and act on behalf of the park manager by observing and reporting on the operation. Generally, monitors are in the field for the duration of the project and maintain the same working hours as the work crews. Acceptable operating standards and other conditions of the permit are established in the planning process by the park manager. The monitor then assures compliance with those standards and may be granted the authority to shut down the operation in the event of non-compliance. More importantly, the monitor maintains constant communication with the field crew to assure that everyone knows what activities are acceptable. This is often a difficult task considering that several different crews may be used for different portions of the operation, and the operation may be spread out over many acres or miles. Reporting requirements are established between the monitor and the park manager, and likely include some form of daily report and a summary weekly report. Such reports are an invaluable part of the administrative record of the operation and provide comprehensive documentation that may be useful to the long-term monitoring of the site recovery. The monitor also serves as a point of contact for park personnel who may work side-by-side with the monitor in the field part of the time. Furthermore, the use of a monitor does not diminish the legal responsibilities of the operator.

Third-party monitoring is not a new idea to many industries. In fact, many operations will have other monitors on site, such as a safety monitor, also essentially acting for some other regulatory authority. If presented with the idea early in the planning process, some operators may willingly provide a monitor. There are also authorities available to require third-party monitoring in some cases, and the NPS natural resource program center or regional offices can provide assistance in determining if it can be required in a given situation. It is important to realize that monitoring is expensive for the operator, so there may be some objection, particularly from small operators. However, some experienced operators may feel that it is a small price to pay if they believe that it increases compliance and thereby reduces the likelihood that the park will shut down the operation.

Two case studies are presented to illustrate the benefits of using third-party compliance monitoring as a tool for protecting resources in national parks.

Case Study #1: 3D Seismic Geophysical Exploration in Jean Lafitte National Historical Park and Preserve, Louisiana

In 1998, a new oil and gas exploration technique known as three-dimensional (3D) seismic came to the National Park System. Burlington Resources, one of the

largest petroleum producers in the country, acquired the leases to private mineral rights beneath the park's Barataria Preserve. Oil and gas activities within the park are subject to the nonfederal oil and gas regulations (Title 36 of the Code of Federal Regulations, part 9, subpart B) and numerous other federal laws that provide a means to protect both the park's resources and the rights of mineral owners. Thus the park and Burlington Resources worked cooperatively through the regulatory process to develop a plan of operations.

As a geophysical exploration technique, 3D seismic technology is a relatively new application of an old skill: listening. Energy waves are generated near the surface by detonation of an explosive charge known as a "source." The energy travels through the earth to a subsurface target where it is reflected back the surface to be recorded on a grid of receivers. The recorded energy waves are then computer-analyzed to identify potential petroleum reserves. The Burlington Resources 3D seismic operation covered 32,000 acres, including 6,360 acres of the park's Barataria Preserve unit—a highly productive estuarine complex of floating marshes and forested wetlands. Within the park, 477 sources were detonated on precise alignments along 36 miles of source lines. The generated energy was then recorded by 1,300 receivers along 54 miles of receiver lines laid out in an overlapping grid. The large amount of mechanical equipment necessary to complete this operation concerned park resource managers due to the potential for damage to the park's resources. Additionally, the scale of the project and the multiple work crews needed for each phase of the operation made communications a difficult task. Furthermore, constant monitoring of the operation was not feasible, as the park's only permanent natural resource staff consists of one natural resource management specialist who has many other duties in addition to managing oil and gas operations. These concerns were made clear to Burlington Resources early in the planning process. As a result, the company volunteered to provide third-party compliance monitors and the park worked cooperatively to select the best monitors for the job.

Monitoring was accomplished by Coastal Monitoring, Inc., of Lafayette, Louisiana. Tom Hargis and Russell Walters, both wetland scientists who are very knowledgeable about the park's marsh environments, provided on-site control of all field operations under the guidance of the park's natural resource management specialist. The monitors participated in the 5:30 AM daily safety meetings with each field crew, and attended the 6:30 AM daily crew boss meetings. The monitors then proceeded to the operation area where they provided roving monitoring and assistance from their own boats, returning with the crew in the late evening. They also conducted helicopter overflights several times a week to assess marsh condition and compliance with the regulations. As each new phase of the operation began, they provided detailed written and oral directions to every member of the crew. They made daily reports to the park's natural resource management specialist via telephone, and submitted weekly written reports that included maps and photographs as appropriate. As each phase was completed, they supervised restoration activities as needed to prevent erosion and revegetate the area. During 74 days of continuous field operations, they provided consistent monitoring and worked cooperatively with the work crews to assure compliance with the plan of operations and to protect park resources. Due to cooperative planning and effective monitoring, resource damage was minor and localized during this intensive operation and a full recovery is expected (Figure 1).

Obviously, the park was pleased with the monitoring effort. Surprisingly, the crews and the operator were also very pleased. In fact, the operator felt that the monitoring was so effective that they requested the monitors continue on the job for the remainder of the operation that was outside of the park's boundary, including a state wildlife management area. The state personnel were equally impressed with the monitoring, and have subsequently requested the same monitors be used for two other seismic operations in other wildlife management areas.



Figure 1. Monitor Tom Hargis of Coastal Monitoring, Inc., discusses appropriate travel routes with a drilling crew during a 3D seismic operation at Jean Lafitte National Historical Park and Preserve. NPS photo.

Case Study #2: Fiber-Optic Cable Installation in Big Thicket National Preserve, Texas

As part of the construction of a fiber-optic communication system from Houston to Washington D.C., Vyvx, Inc., installed approximately 1.7 mi of fiber-optic cable through Big Thicket National Preserve in 1998. The alignment was within an existing

oil and gas pipeline right-of-way held by Transcontinental Gas Pipe Line Corporation with the fiber optic cable located adjacent to an active 30-inch natural gas pipeline. The cable was installed by track-mounted cable plow and directional drilling across Little Pine Island Bayou and the Lower Neches River. Operations were conducted under a right-of-way permit pursuant to 16 U.S.C. 79 and Standard Form 299 ("Application for Transportation and Utilities Systems and Facilities on Federal Lands"). Terms and conditions of the right-of-way permit included an operational plan, special use permit for installation, and third-party compliance monitoring.

Coastal Environments, Inc. (CEI), provided the monitoring for the project. This long-standing firm had previously provided third-party monitoring for a variety of operations on public lands and had the expertise needed to successfully monitor the cable installation. Daily monitoring was provided by CEI's trained biologists and staff. The monitors provided daily written reports with digital photography to Doug Hutter, the park's minerals manager. Additionally, a final report was prepared and submitted via compact disc as comprehensive documentation of the project. The park was pleased with the effectiveness of third-party monitoring and the performance of CEI.

A Hydrostratigraphic Model for the Perched Aquifer Systems Located at Hagerman Fossil Beds National Monument

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Perched aquifer systems are causing slope failures within the Hagerman Fossil Beds National Monument in northwestern Twin Falls County, Idaho. Six large slope failures have occurred since 1979, damaging natural resources and private property. The slope failures are located on the hillside of the Bruneau Plateau along the Snake River. They typically range in size from 300 to 800 ft wide and up to 1,000 ft long, and have occurred about every two years since 1979. In 1987, a slope failure destroyed a million-dollar irrigation pumping facility and nearly killed two workers.

Snake River water is pumped onto the Bruneau Plateau and distributed by canal systems to agricultural crops. Irrigation water percolates down through the unconsolidated sediments and forms shallow perched groundwater systems. Photographs from paleontological expeditions dating from the 1930s to the present indicate that the initial aquifer development and discharge took place during the 1970s. The perched aquifers and slope failures are related to the development of Bell Rapids Irrigation District in 1970 on the plateau adjacent to park property (Young 1984; Summer 1986; Riedel 1992; Vector 1994).

Numerous studies have been conducted since 1984 in an attempt to define the aquifer systems, but none have resulted in a document that integrates all of the results. This study includes an analysis of all the previous data, in addition to field mapping and investigations, with the general objective of constructing a hydrostratigraphic model for the site. Many studies have addressed the slope stability problem and the following paragraphs provide a summary of the contribution from each study.

A hydrostratigraphic model was developed based on a geologic and hydrologic model. The model shows how three perched aquifer systems (upper, middle, and lower) flow in the plateau and the implications each system has for slope stability problems. Paleo-stream channels control the upper and lower systems, while the middle system is flowing primarily through fractured basalt. The flow regimes are dynamic, exhibiting both unconfined and confined characteristics.

The hydrostratigraphic model explains the spatial distribution of perched aquifer discharge zones and it will aid the development of a mitigation plan for slope stability problems. Results indicate recharge to the upper system is primarily near the canal inlet, while recharge to the middle basalt aquifer occurs in the area near the Fossil Gulch Pond. The lower system is receiving drainage from the middle system. Canal lining mitigation efforts will have the greatest impact on the middle aquifer system if applied near the Fossil Gulch Pond area. It is recommended to start groundwater tracer tests, and continue focused data collection and long-term monitoring to establish trends and define specific flow regimes.

Purpose and Objectives

The purpose of this report is to aid development of a mitigation plan for slope stability problems located at the Hagerman Fossil Beds National Monument. The general objective is to formulate a conceptual hydrostratigraphic model of the study area based on a review and compilation of results from existing studies, recently collected hydrogeologic data and focused field mapping. Specific objectives of the study are to:

1. Use available geologic and geophysical data to develop a geologic conceptual model of the site;
2. Use available canal leakage and water level data to develop an understanding of

- the groundwater flow systems;
3. Combine the geologic and hydrologic models to present a general hydrostratigraphic model of the site; and
4. Use the hydrostratigraphic model to explain spatial distribution of perched aquifer discharge zones and aid mitigation efforts.

Hydrostratigraphic Model

A six-layer hydrostratigraphic model is proposed for the study site based on the geologic and hydrologic models. The six layers are composed of three aquifers and three aquitards:

- Layer #1: Upper Perched Aquifer (Tuana Gravel Formation).
- Layer #2: Aquitard (Glenns Ferry Formation).
- Layer #3: Middle Perched Aquifer (Shoestring Basalt flow).
- Layer #4: Aquitard (Baked zone at base of Shoestring Basalt flow and underlying Glenns Ferry Formation).
- Layer #5: Lower Perched Aquifer (Glenns Ferry Formation stream facie).
- Layer #6: Aquitard (Carbonaceous Paper Shales).

Figure 1 is a generalized block diagram of the hydrostratigraphic model with three perched aquifers identified as the upper, middle, and lower systems. These aquifers flow through layers #1, #3 and #5. Paleo-stream channels control groundwater flow in the upper system, while the middle system is primarily controlled by the Shoestring Basalt flow. The lower perched system is controlled by a fine-grained stream facie resting on a package of carbonaceous clays. Figure 2 illustrates an aquifer discharge area compared with the model, which helps explain the discharge spatial distribution on the hillside.

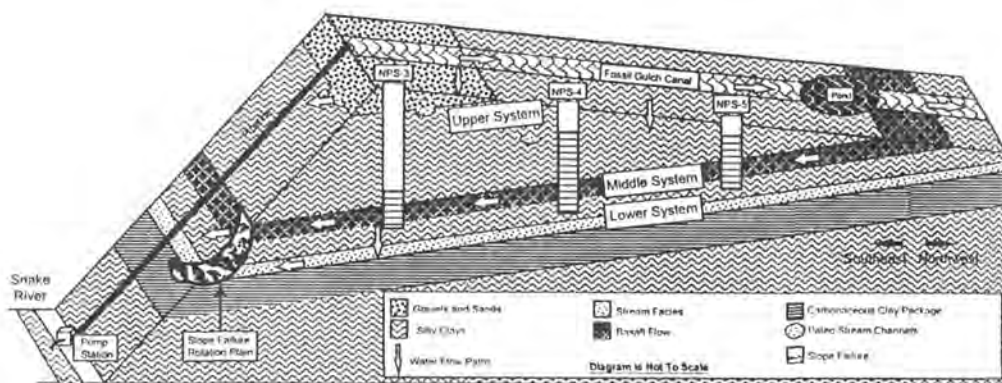


Figure 1. Block diagram of the hydrostratigraphic model, illustrating the main geologic layers controlling the upper, middle, and lower perched aquifer systems.

Upper Perched Aquifer System

The upper system is characterized by paleo-stream channels composed of primarily fine sand (Saddler 1997) along localized, sinuous, and meandering paleo-stream channels. Figure 2 shows these localized point-discharge paleo-stream channels as heavy isolated vegetation growth surrounded by sagebrush. This system has the shallowest depth below ground surface and shortest groundwater flow paths from recharge to discharge. Based on field observations, these channels exhibit unconfined flow conditions with discharge rates typical of seeps.

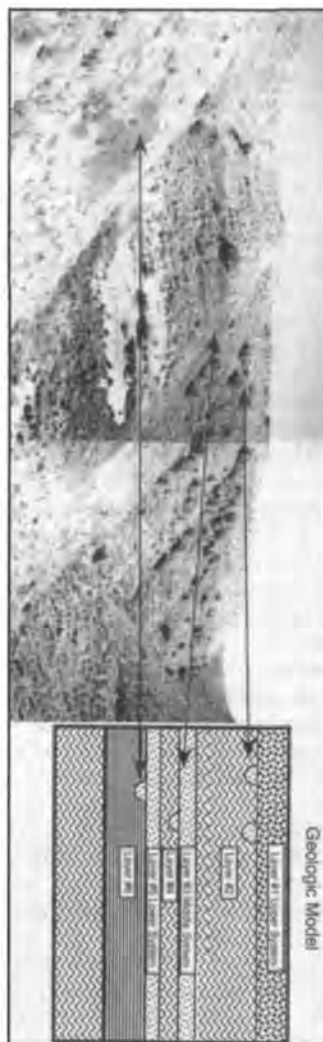


Figure 2. Photograph of the three aquifer systems, keyed to the geologic model and explanation of the spatial distribution of the discharge patterns. The upper system discharges from individual paleo-stream channels, as seen by the two green areas just below the horizon. The middle system exhibits a broad band of green vegetation in the center. The discharge locations of the lower system have green vegetation growing at the paleo-stream channel locations.

Middle Perched Aquifer System

The middle system is primarily restricted to the Shoestring Basalt flow at an elevation of about 3,200 ft in the discharge area, and transmits groundwater through fractures and joints. Groundwater likely follows the geologic dip of the flow, which was determined from a seismic study to be southerly. The basalt flow is not areally extensive; where the flow pinches out, fine-grained sediments control groundwater flow.

Geologic and hydrologic models indicate the area of recharge to the basalt aquifer system is primarily in the vicinity of the Fossil Gulch Irrigation Pond. Basalt is observed in direct contact with irrigation water at an elevation of about 3,300 ft in this area. Hydrographs from monitor wells illustrate how a recharge pressure wave propagates through the basalt system from recharge areas to the discharge. Geophysical evidence of recharge for the pond area is based on the Misa-a-la-masse and Schlumberger studies performed by Vector Engineering (1994). The high response of Misa-a-la-masse and Schlumberger data near the Fossil Gulch Pond area correlates with the geology and the hydrographs from monitor wells.

This system has intermediate-length groundwater flow paths from recharge to discharge zones. The basalt flow has the greatest hydraulic conductivity of the three perched systems and it discharges the greatest volume of groundwater. Figure 2 illustrates how the greatest vegetation growth correlates to discharge from this aquifer system. The basalt has a basal baked zone that is well lithified but fractured. This baked zone and underlying silty clays are acting as an aquitard to the basalt aquifer.

Lower Perched Aquifer System

The lower perched aquifer system is characterized by a fine-grained paleo-stream facie resting on a 20-ft-thick package of carbonaceous paper shales. In some areas the stream facie exhibits preferential flow paths through paleo-channels, as shown on Figure 2. The lower perched system is the least defined due to a lack of data. However, this system correlates with the elevation of the rotational failure planes for the 1991 and ca. 1979 slope failures.

Groundwater recharge to the lower system likely encompasses a larger area, and flow paths are the longest of the three perching systems. Additional water may be draining from monitor wells into the lower system due to long effective screen intervals. The discharge volume of the lower system is significantly less than the basalt system, and at most locations evapotranspiration is greater than discharge. There is evidence for the expansion of the lower system in recent years. The green vegetation located at a paleo-stream channel in the lower perched system on Figure 2 did not exist a few years ago based on historical photos.

Conclusions and Recommendations

The hydrostratigraphic model developed from this investigation identifies:

1. Three perched aquifer systems and explains their discharge patterns and spatial distribution on the hillsides;
2. The location of the main recharge area for the middle perched system, based on geologic, hydrologic, and geophysical data.
3. An association between the failure planes for the 1991 and ca. 1979 landslides and the carbonaceous paper shale package;
4. The potential of each aquifer system for slope stability problems; and
5. An explanation of well hydrographs responding to a recharge pressure wave.

The three perched aquifer systems occur within the plateau and have different implications for slope failures. Paleo-stream channels control groundwater flow of the upper system that causes point discharge locations on the hillsides. They have very low discharge rates typical of seeps. Any slope failure associated with these indi-

vidual channels will likely be small relative to the magnitude of failures associated with the middle and lower systems.

The middle system has the greatest discharge rates and lateral extent. Recharge to the middle basalt system is primarily from the irrigation system, with unknown quantities recharging from field application of water. Recharge to the middle system occurs in the Fossil Gulch Pond area, based on the hydrostratigraphic model. The main component of groundwater flow is likely following the southerly dip of the basalt flow. Hydrographs from monitor wells and water chemistry illustrate a recharge pressure wave propagating through the basalt aquifer. The volume of water discharging from the basalt flow saturates sediments in the discharge zones and erodes the slope face, causing over-steepened slopes.

The third and lowest perched aquifer system is controlled by paleo-stream channels. This system is particularly susceptible to slope failures because of the presence of a finely laminated paper shale package with occasional deposits of diatomite and volcanic ash. The existing 1991 and ca. 1979 slope failure planes are about 40 ft below the Shoestring Basalt flow, which corresponds to the elevation of carbonaceous paper shale package of the lower system. Data for this system are sparse, but recharge likely occurs from leakage of the middle basalt aquifer system and water draining from upper systems into lower systems from monitor wells constructed with long effective screen intervals.

Recommendations for Further Study

1. Continue groundwater monitoring on a monthly basis.
2. Continue water quality data collection for all wells and specific perched aquifer discharge locations.
3. Perform tracer tests to define groundwater parameters and identify flow paths with discharge locations that will aid mitigation efforts.
4. Based on field data, focus canal lining efforts near the Fossil Gulch Pond area so as to affect the middle system.
5. Drill a series of drain wells up-gradient from the perched aquifer discharge zones down to the regional aquifer. Construct the wells to capture water flowing toward the slope face effectively diverting it down to the regional aquifer.

A problem with drain wells will be water quality implications from draining perched aquifer water into lower aquifers (aquifer interconnection). The advantages to this option are that it:

- Provides a permanent solution with little or no maintenance compared with the relatively short life spans (30 years) for canal-pond synthetic liners.
- Eliminates potential problems with future irrigation dredging activities to remove sediments in the synthetic liners.
- Costs less than a lining. The least expensive option of lining the canals and ponds using HDPE flexible membrane is calculated to be \$3.6 million.
- Involves no de-watering pumps, which require capital, maintenance, and electrical costs.
- Can be constructed on federal lands, as opposed to installing linings, which will occur on private land.

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A Science Review Process for National Parks

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Introduction

Performance evaluation has been used in assessing corporate, institutional, and government programs as to their overall performance and to review strengths and weaknesses. Program evaluation, or, as noted in this case, a science review, serves the same function in providing a contemporary assessment and analysis for the use of managers.

It is estimated that during 1995-1996 approximately CDN\$9 million was expended nationally on natural science research by Parks Canada (Munro 1997). Expenditures on research or ecosystem science made up approximately one-third of the overall expenditures allocated to ecosystem management. This was augmented by other government organizations and universities increasing the overall support for park research. Managers and resource management professionals are interested in how program and supplementary funding and in-kind support are used and to what effect. This paper proposes a science review process for national parks. This process could be applied across the national park system to gain a more comprehensive overview of the ecosystem science contribution to parks management.

In November 1996, the auditor general of Canada noted that Parks Canada needed to "improve its knowledge about the state of the natural resources within national parks in order to develop a sound ecosystem-based management approach. " He further commented that "the results of these efforts [various activities dealing with ecological integrity] however often occur over long periods and may not be immediately apparent." These comments provided some of the stimulus for the development of a science review process and the development of a framework to set the basis for an assessment process that provides some measure as to both the quantity and quality of park science. Impetus for a science review also came from a meeting with Atlantic field unit managers in 1997. A more comprehensive evaluation of parks science was recommended by the managers. Other than the Auditor General's audit observations, there has been little if any broad evaluation of the ecosystem science that Parks Canada undertakes. Although the *State of the Parks* reports presented to parliament provide some assessment of the ecological integrity of national parks, they do not specifically reflect on the capacity and character of park science programs.

Purpose

The overall purpose of the review is to gather relevant data that will provide insight into the nature and magnitude of ecosystem science in Atlantic Canada's seven national parks. The intent is to identify potential indicators that can be used to establish baseline information that allow for monitoring over an extended time-frame. The objectives are: to confirm categories of enquiry, select evaluation criteria, gather relevant data to establish benchmark information, and to analyse the data and outline observations and recommendations.

Methodology

The science review is very much in keeping with the meaning of program evaluation, which is the systematic collection, analysis, and reporting of information about a program to assist in decision-making. In considering the individual criteria, selection favoured criteria that are reflective of the effectiveness of the park science program, either independently or in combination with other criteria. Developing criteria for evaluating scientific credibility and importance to decision-making is of particular relevance (Beanlands 1996). It is essential to ensure in the questionnaire design that the criteria chosen will result in increased understanding and prove useful for the target audience of

the review. In this case, the field unit superintendents and the ecosystem management staff would consider the observations and findings of the review.

Inclusion of criteria related to ensuring that the information would be relatively easy to collect, reliable, relevant, understandable, and comparable. "Comparability" in this case would be between parks and, in the case of a specific park, over a period of time so as to be able to measure progress or retrogression overall or in specific elements of the science program. Parameters for each criterion and component should be clear in order to ease interpretation and comparability.

Since much of the data are located at the field level, data collection involved a cooperative approach with each park. Park management plans, ecosystem conservation plans, resource description and analysis reports, and *State of the Parks* reports served as the primary data sources, along with the research permit and environmental screening registries. Criteria were initially suggested by the author and were reviewed, expanded, and refined in discussions with park staff and a few university researchers. Initially, seven categories of relatively autonomous enquiry emerged in reviewing the criteria. A supplementary eighth category was added because of the potential interrelationship between the perceived ecological integrity of the park and the nature, scope, and magnitude of the science program. As ecological integrity is a key mandated requirement for monitoring in Parks Canada, its inclusion is considered appropriate in any overall assessment of ecosystem science (Table 1).

<i>Categories of enquiry</i>	<i>Number of criteria</i>	<i>Number of components</i>
1. Park staff	4	7
2. Research infrastructure	3	13
3. Research activities	9	16
4. Research partners	5	12
5. Communication of research and science issues	5	14
6. Research funding and support	7	8
7. Management application of science	6	7
8. Ecological integrity-related issues	20	30
TOTAL	59	107

Table 1. Categories of enquiry

The questionnaire was jointly filled out by the author and park staff, with the chief park warden and the park ecologist acting as the primary contacts. The data collected were for the period 1997-1998 and are to serve as a reference point for in-park comparisons in future years, and can also serve as a comparative base between parks for those years. A second section, a summary, was derived from the questionnaire for each park to assist in the simplification and standardization of the data, and was vetted by each park. Comparative tables and figures were developed for selected criteria to enable analysis of selected components in graphic form.

Observations and Results

The majority of criteria was completed by all parks and provides a benchmark reference and perspective on research and monitoring activity. Those components that were incomplete reflected data gaps or information that proved too difficult to collect or was not readily available, e.g., the capital cost of science infrastructure. Due to the large number of criteria and components, only selective data representative of each category are presented.

1. Park staff. This category was deemed essential in providing information on the

number and qualifications of staff working on ecosystem science—the assumption being that parks having a greater number of staff and higher qualifications would make greater progress in advancing and using ecosystem science.

There was relatively little variation between parks in that most had either three or four person-years allocated to science activities. Only one park had significantly less, with one person-year allocated. The educational level of person-years varied from technical to Ph.D., with about a third at the technical level, the same at the Bachelor's level, and the remaining third made up of graduate-level staff (Figure 1). Kejimikujik had the greatest proportion of technical staff involved (approximately 70%), yet this park has a significant research program that relies on a number of partnerships. The total number of years of experience of park staff was not recorded, but could be of value in future surveys.

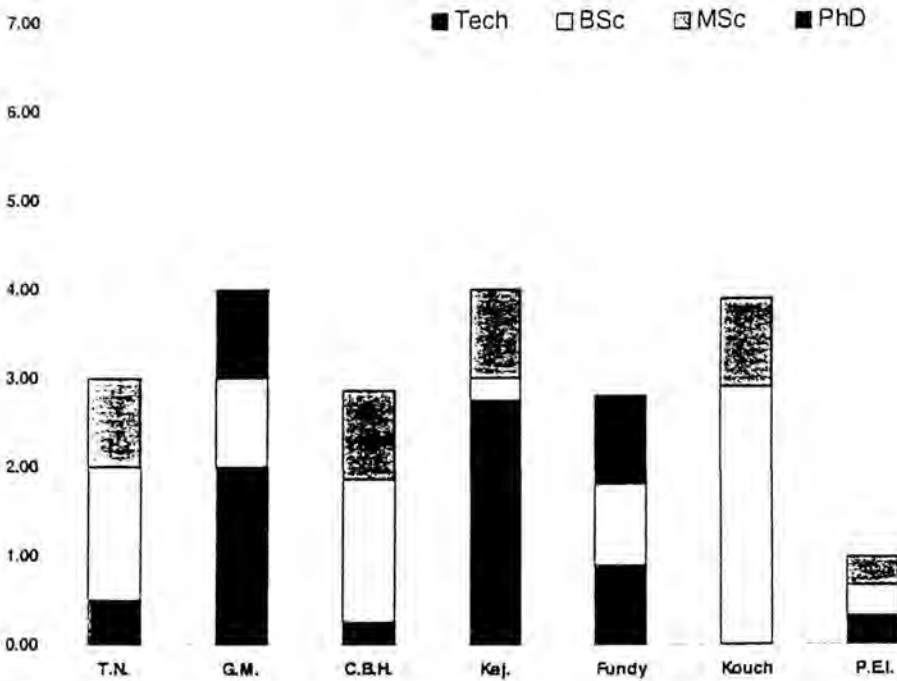


Figure 1. Parks staff and education levels. Park key: T.N. = Terra Nova; G.M. = Gros Morne; C.B.H. = Cape Breton Highlands; Kej. = Kejimikujik; Kouch. = Kouchibouguac; P.E.I. = Prince Edward Island.

2. Park infrastructure. This was considered to be an essential factor in considering the potential attractiveness of a park for researchers. For instance, five of the seven parks had some level of laboratory facility, four had office space available for researchers, and five had some accommodation available. With respect to monitoring infrastructure, all parks had a basic level of infrastructure such as a climate monitoring station, water quality monitoring program, biodiversity plots, and a wildlife monitoring program. As for basic reference material, all parks had a resource description report which documents the major abiotic and biotic resources of the park, such as climate, geology, geomorphology, flora, fauna, limnology, etc. It was found that the inventory and analysis of the data could

be more complete, with much of the biological inventory requiring an update. Other areas, such as invertebrates, need to be either initiated or completed. These observations tend to be confirmed by the auditor general's report of 1998, where he states that "the quality and quantity of the information included in data sets varies among parks. The level of effort on data collection presently depends to a large extent on resources available to park superintendents. Parks Canada will need to give a higher priority to acquiring, updating and analyzing the information contained in the data bases for all its parks."

3. Research activities. In an effort to ascertain the level of ecosystem science-related activity, nine criteria with 16 components were surveyed. As a research permit system exists, it was of interest to see the number of permits that were allocated and compare that with the number of research summaries received, which is an obligation on the permit (74%); as well as to compare the number of permits with the number of science projects approved. One would normally expect the number of projects approved to be equal to the permits allotted, which was the case in two parks. Two other parks had a greater number of research permits than projects, which reflected additional research projects that were sponsored and funded by others. In one other case there were more projects than permits, which suggests that some of the research projects were likely more resource conservation projects rather than research and would not require a permit. In this latter case, they should not be considered as part of the ecosystem science research and monitoring program in future.

Sixty percent of the principal investigators undertaking research were from other organizations, primarily universities or other government departments. The majority of research has an applied bias, which is in keeping with the objective of ensuring that research is available to aid decision-making by park managers. The parks made good use of the ecosystem science advisory board for reviewing and refereeing ecosystem science projects. Ninety-two projects were reviewed by the board (including multi-park projects) of which 63 (67%) were approved for funding allocation.

4. Research partners. Partners play a significant role in contributing to research undertaken in the parks. What was not understood was the magnitude of this contribution. Over 106 partners were involved with the seven national parks, reflecting a strong interdependence on the research community beyond park borders. This interdependence is fostered as the national parks are becoming increasingly recognized as centres for research because of their relatively undisturbed condition and their legislated protective status.

Managerial encouragement and support for on-going research and monitoring has also improved over the last decade. In many parks this has been encouraged by the establishment of research or greater park ecosystem advisory groups composed of members of the research community and other participants from the local community. The development of ten memorandums of agreement with universities and community colleges in support of research and educational use has provided a climate that encourages park research. Some parks are also involved in either the Model Forest Program (Canadian Forestry Service) or the Ecological Monitoring and Assessment Network (Environment Canada). Both programs promote integrated multi-discipline research at participating sites.

5. Communication of research and science issues. Essential to the success of scientific research is the communication of the results—particularly recommendations that have application to management. It is also important that visitors have an increased understanding and familiarity with park science and conservation issues. This category provided an appreciation of the level and nature of communications activity in imparting contemporary science information to the public. Results showed that three of the seven national parks made good use of refereed publications to communicate with other researchers and managers. Communication external to the parks reflected a good level of communication with the scientific community as well as with the media, but in some parks less emphasis on communication with local populations. In considering on-site interpretation directly with park visitors, the parks provided little information on research

and monitoring programs, although some parks had researchers or warden staff give presentations at evening programs or lead special events. Similarly, there were few special visitor centre displays that portrayed research undertaken at the park. A few parks highlighted some of the research studies that were being undertaken in their park orientation handout. Some had relevant publications available for distribution from other government agencies, e.g., on acid rain and wildlife.

6. Research funding. One and a half million dollars was allocated to ecosystem science in the Atlantic region, with specific park allocations varying between 3.2% and 12.4% of overall capital expenditures, or, in monetary terms, between \$80,600 and \$292,000. Supplementary or in-kind contributions from other government organizations and universities also amounted to \$1.5 million, and varied from \$122,000 to \$380,000 by park. Total expenditures for research and monitoring, by park, varied from \$223,400 to \$557,500. In considering expenditures on ecosystem research there is a strong interdependency, through contract or on-going research and monitoring programs of other government departments and by the universities.

7. Management application of science. Some of the means for including science in management documents were assessed. All park management plans made some reference to science or research programs, although the amount of coverage could be more comprehensive. This was also the case with the three-year, operation-oriented business plans. The use of environmental screenings is well-accepted, with 64 screenings being registered. The auditor general noted (1996) that parks do not have science research strategies. This reflects the situation with the seven parks surveyed. It should, however, be mentioned that the parks' ecosystem conservation plans make reference to research activities and deficiencies that need to be addressed and, to a large degree, provide short-term strategies for research. The direct involvement of field unit managers in science (such as sitting on greater ecosystem advisory boards) is minor, although some are particularly interested in having an in-depth understanding of significant ecological resources in relation to their sensitivity to visitor use and the mitigating measures that might be required.

8. Ecological integrity indicators. At the time of the survey, a suite of ecological indicators had been adopted by Parks Canada as a framework for considering specific indicators for each park (Skibicki et al. 1994). The *State of the Parks Report* in 1997 reflected the ecological stressors for each park updated from 1992. Four parks noted an increase in stressors, two showed a modest decrease, and one remained the same. The most dominant stressors (noted in five or more parks; Figure 2) for the Atlantic provinces were: (1) forestry operations, (2) urbanization (settlement) on adjacent lands, (3) park management practices, (4) sport fishing, (5) utility corridors, and (6) visitor and tourism facilities.

Although there were no quantitative parameters at the time for determining the stressors, the values were determined through multi-function consensus at each park and can be considered representative of relevant ecosystem management issues that need to be addressed. The stressors noted above were part of the suite of indicators developed by Stephen Woodley (1993) along with others for biodiversity and ecosystem function. Most parks have developed a tentative list of indicators that require refinement before adoption.

As ecological stressors are the prime measuring index for ecological integrity, at present, there is a need to clarify the parameters for each. As an example of what might be envisioned a parameter for acid deposition within aquatic ecosystems is suggested. A level of pH 5.0 in aquatic ecosystems puts great stress and increases mortality in fish eggs and fingerlings and is consequently proposed as a potential parameter for this stressor (Figure 3). Parks that have a pH range at 5.0 or below would be considered stressed and would be so noted on the stressor chart. It should be noted that in this case it would qualify as a major stressor in the Atlantic provinces. Similarly, parameters need to be developed for dams (both upstream and downstream impacts need recognition) and climate warming (sea-level rise as well as flora and fauna impacts), and a time-frame of

	TN	GM	CBH	Kej	Fundy	Kouch	PEI	Total
Agriculture			X		X	X	X	4
Acid precipitation				X				1
Climate change					X			1
Commerical fishing	X	X		X		X		4
Dams			X		X			2
Exotic birds			X		X		X	3
Exotic fish			X		X		X	3
Exotic invertebrates			X		X			2
Exotic mammals	X	X	X				X	4
Exotic vegetation		X	X		X		X	4
Forestry	X	X		X	X	X	X	6
Heavy metal pollution				X				1
Human disturbance					X	X	X	3
Mining	X	X	X			X		4
Park infrastructure			X	X	X	X		4
Park mgmt practices	X		X		X	X	X	5
Pesticides			X		X	X		3
Petrochemical pollution			X		X			2
Poaching						X		1
Sewage			X					1
Solid waste	X				X	X	X	4
Sport fishing	X	X	X	X	X	X		6
Sport hunting		X			X	X		3
Urbanization	X	X	X			X	X	5
Utility corridors	X	X	X		X	X	X	6
Vehicle collision	X							1
Visitor-tourism facilities	X	X	X	X	X	X	X	7
TOTAL	11	10	17	7	18	15	12	90

Figure 2. Ecological integrity stressors in Atlantic Canada national parks. (For park key, see caption to Figure 1.)

impact also needs inclusion. The delineation of parameters for each indicator would increase the objectivity and improve the evaluation process.

Other indicators of ecological integrity could be included, such as the area of a park within the watersheds draining through the park. This would provide an index of park hydrological integrity. In the case of the Atlantic national parks, this index ranged from 3.6% to 95.8%. This index reflects the potential vulnerability to park aquatic systems and would also reflect the need to work with adjacent land-owners in establishing appropriate watershed management guidelines.

Future Considerations

The analysis phase of the science review could be extended to provide a classification of results to aid interpretation. This would be based on information received from all of the parks. For instance, when considering the total number of research collaborators and partners, a classification could provide some rating on how interactive a park was in involving external partners. Similarly, the classification could be used for indicating the level of research activity by quantifying research permits that were approved. The following are examples that might be used, based on results to date (Table 2).

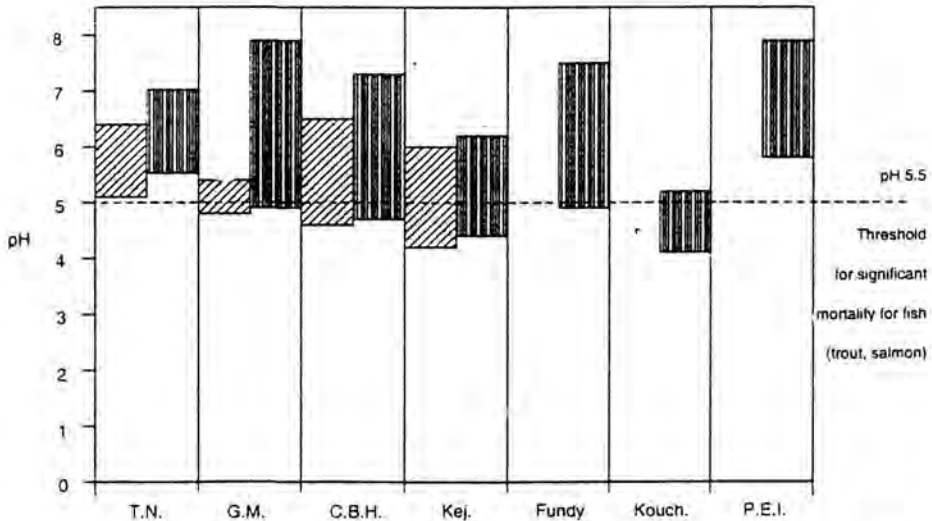


Figure 3. Aquatic pH (lakes and rivers) in Atlantic Canada national parks. Diagonal cross-hatching = year-round observation (Clair et al. 1994). Vertical cross-hatching = summer observation (Kerekes 1982). (For park key, see caption to Figure 1.)

	<i>Example 1</i>	<i>Example 2</i>
Level of interaction	Number of collaborators (organizations)	Research permits
0-10	light	light
10-15	modest	active
15-25	high	very active
>25	intense	extremely active

Table 2. Hypothetical classification of research activity with external partners

Conclusions and Recommendations

The following suggestions are in response to selected observations noted in the science review:

1. To enhance staff capability and credibility, continue to improve the experiential and educational qualifications of staff working on ecosystem science through encouraging technical, Bachelor's, and graduate-level training, including distance-

- learning opportunities and in-house training.
2. Continue to improve park science infrastructure to attract researchers.
 3. Ensure that the research permit system is applied at all parks and for all projects.
 4. Continue to stress the importance of data management and archiving of research data and findings as an essential element of doing park science.
 5. Increase communication of research studies and results to the visiting public, local communities, researchers, and managers. Each park should have a science forum at least once a year to share the results of research these groups.
 6. Ensure adequate long-term base funding for ecosystem research and monitoring (target 10% of the capital budget).
 7. Update biodiversity inventories, particularly non-vascular plants and invertebrates.
 8. Develop an Atlantic Provinces National Park Research and Monitoring Strategy; and concurrently develop a core list of ecological integrity indicators applicable to all parks.
 9. Strengthen the link between ecological integrity objectives (in park ecological integrity statements) and park initiatives in business and management plans.
 10. Encourage participation in science activities by field unit superintendents.
 11. Establish parameters for individual ecological stressors and for other park ecosystem integrity indicators so as to more objectively determine their applicability to individual parks.
 12. Consider the expansion of science reviews to other parts of the country to provide a national perspective.

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Research Administration in Wilderness: Defining the "Minimum Requirement" Exception

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Both research and the Wilderness Act provide powerful tools for protecting resources. When it comes to administering research in wilderness, inconsistent interpretations of law and policy abound. I am going to discuss the Wilderness Act in three levels: Wilderness 101—the basics of the Wilderness Act; Wilderness 102—the "minimum requirements" exception; and Wilderness 103—the "minimum requirement analysis." Then I will give a case study of a successful wilderness research permit.

First, let me state a few "givens."

- It is a given that proper wilderness management includes active manipulation, not hands-off management. Exotic plants and animals must be removed, extirpated species must be reestablished, and disturbed areas must be actively restored to a natural condition.
- It is a given that the information derived from research is vital to successful wilderness protection and management.
- It is a given that the issuance of a research permit, and the activities that follow, is a federal action, so the National Environmental Policy Act (NEPA) applies.
- It is a given that there is a continuum from applied research to pure research.
- It is a given that there is a continuum from no impact to total impact; from taking satellite imagery of a park to the experimental removal of all plants, animals, and topsoil. Because of these two continuum scales—applied to pure science and level of impact—it is a given that wilderness management decisions will always depend largely upon the personal values of the manager.

Wilderness 101—The Wilderness Act of 1964

The Wilderness Act (Public Law 88-577) was a very popular bill in 1964, with strong public and congressional support. It passed by a vote of 373 to 1 in the House of Representatives. The embarrassed lone dissenter quickly said he voted against it because it didn't set aside enough wilderness. In the Senate, the vote on a more restrictive version was an overwhelming 73 to 12.

The act states that the (one singular) purpose of wilderness is the preservation and protection of lands in their natural condition. The act directs that wilderness lands "be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness."

In the "definition of wilderness" section, the act states that wilderness "may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value." This makes it clear that scientific value may be present within wilderness land, and that such scientific values do not need to cease, nor do scientific values make land unsuitable for wilderness designation.

In the "use of wilderness" section, the act states that wilderness is supplemental to the purposes for which national park units are established and administered. Wilderness designation unambiguously places an additional layer of protection by prohibiting activities which the National Park Service Organic Act permits or leaves open to interpretation.

Except for prohibited uses, "wilderness areas shall be devoted to the public purposes"—note the use of the plural—"of recreational, scenic, scientific, educational, conservation, and historical use." So scientific use of wilderness is recognized, along with recreation, as appropriate and compatible. Some wilderness advocates misin-

interpret the Wilderness Act and wrongly believe that all research, even non-impactive research, must be applied to wilderness protection or be denied.

Section 4(c) is the heart of the act. In it are listed the ten prohibited activities: commercial enterprise, permanent roads, temporary roads, motor vehicles, motorized equipment, motorboats, landing of aircraft, other forms of mechanical transport, structures, and installations. Section 4(c) also provides for the allowable exceptions to the ten prohibitions. For scientific uses, the exceptions are provided in the phrase, "except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act." (Other legislation, especially wilderness enabling legislation for individual parks, may also contain provisions for exceptions.) This general exception to prohibited activities is for agency activities only, such as the issuing of a research permit and the scientific activities that follow, or inventory and monitoring activities.

Wilderness 102—The Minimum Requirements Exception

The minimum requirements exception is not the same as the selection or use of the "minimum tool" or "primitive tool." The full nineteen-word phrase makes up the exception: "except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act." If a scientific project must include one or more of the ten prohibited activities, then the following must be true in order to get approval. First, it must be "for the purpose" (singular) of the Wilderness Act—the preservation and protection of land in a natural condition. Second, it must be "for the administration of the area" (for the purpose of the act). That is, it must be applied science, aimed at resource protection. Third, it must be "necessary" (for the administration of the area, for the purpose of the act). Finally, it must be "the minimum" (necessary for the administration of the area, for the purpose of the act). This last step alone is the minimum tool. The minimum requirements exception is applied through a process called the "minimum requirements analysis."

Wilderness 103—The Minimum Requirements Analysis

The minimum requirements analysis is the process for evaluating and documenting decisions regarding proposed activities in wilderness in order to protect its character and resources. It is a process applied to all activities, not just those involving one or more of the ten prohibitions in Section 4(c). It is integrated into the basic NEPA analysis of any project in wilderness. For those alternatives which do include one or more of the ten prohibited activities, the minimum requirements exception must apply as above. If the minimum requirements exception cannot be applied, then that alternative must be dropped.

For all projects, the benefits and impacts to wilderness character and resources are identified, along with other project costs and benefits. NPS management policies direct that potential disruptions of wilderness character and resources will be considered before, and are given significantly more weight than, cost or convenience. The failure to recognize impacts to wilderness character, or to give these impacts sufficient weight, appears to be a common problem in scientific proposals.

Other usual NEPA evaluation criteria are applied when developing and analyzing alternatives, such as, "Can the alternative safely accomplish the project purpose?" and "Can the project purpose be accomplished outside the wilderness area?"

The analysis is completed, a management decision is made, and the decision and rationale are recorded in either a documented categorical exclusion, Environmental Assessment/Finding of No Significant Impact (EA/FONSI), or Environmental Impact Statement/Record of Decision (EIS/ROD). The minimum requirements analysis is simply this documented process for evaluating wilderness impacts. The final decision may or may not include exceptions to prohibited activities under 4(c).

A Case Study from Death Valley National Park

Death Valley National Park received a proposal from a well-respected professor for a geology research project to test some detail of tectonic theory and to map geologic structures in a wilderness area. The wilderness issues included the proposed landing of a helicopter (a prohibited activity) to establish and remove about forty cache sites, and the use of a gas-powered rock drill (motorized equipment, a prohibited activity) to extract a few hundred small paleomagnetic rock samples. The caches in wilderness are considered facilities or installations (a prohibited activity).

There was significant pressure from the well-connected researcher to approve the project, for which he had already received a \$300,000 National Science Foundation grant. There also was significant pressure from the environmental community, especially the Wilderness Society and the National Parks and Conservation Association, to assure appropriate wilderness protection.

It was difficult for the park to make the determination that the theoretical geology research project was "necessary for administration of wilderness." In the end, this determination was made, based on the benefits that the project would provide to basic park resource information, interpretation, and regional groundwater hydrology protection.

Through the NEPA process, and a minimum requirements analysis, some new alternatives were examined. We found that there was some flexibility in the cache locations, and that new sites could be found which were accessible by horse and pack stock as well as by helicopter. Through peer review, we learned that there was a debate among scientists about the need to take paleomagnetic rock samples with a power rock core, and that bulk samples may be adequate. Since this issue was not resolved during peer review, we presented both sides in the EA, and took the more resource-protective approach of bulk samples, which require no motorized equipment. We offered the researcher the opportunity to demonstrate that the proposed rock drill technique was necessary for accomplishing the purpose of the project. In the final EA/FONSI, the project was approved, horses were used rather than the helicopter, bulk samples were taken rather than using the rock drill, and caches were approved and mitigated with camouflage netting and a mandated temporary time frame.

In the end, the park and the researcher were satisfied because the project was able to go forward to completion. Likewise, the park and the environmental groups were satisfied because the project was implemented with reasonable protection of wilderness character and resources: a "win-win" situation.

Summary

- Wilderness lands are more protected than non-wilderness, so research administration is more restrictive in wilderness than in non-wilderness, especially if one of the ten prohibitions of 4(c) is involved.
- Wilderness protection (i.e., restrictions) can lead to the development of innovative techniques.
- The scientific value of wilderness is derived from its undisturbed condition.

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Regulating National Park Service Research and Collecting: A Fifty-Year Search for a Legal, Flexible, and Standardized Approach

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It would seem that nothing should be simpler than devising a process for permitting research and collecting in national parks. On the verge of World War II in 1941, National Park Service (NPS) Director Newton Drury issued a new, uniform policy on authorizing the taking of specimens from all national parks. It was intended to be a simple, straightforward process. A solicitor's opinion was requested to review the legal propriety of the procedures. The solicitor's opinion (Margold 1942) referenced the 1916 Organic Act that established NPS and the 1894 Act relating to Yellowstone, and cited their language containing provisions prohibiting "all hunting, or the killing, wounding, or capturing at any time of any bird or wild animal, except dangerous animals, when it is necessary to prevent them from destroying human life or inflicting an injury." The legal opinion provided NPS quite a surprise in its conclusion: "It is my opinion, therefore, that ... the Secretary [of the Interior] is precluded from granting permits to private individuals or institutions for the taking of animal life." The only exception to this was the "power of the Secretary to authorize National Park Service employees to take specimens of animal life."

The protection of "birds and wild animals" from hunting or killing was extended to preclude the taking of specimens for scientific purposes, except by employees. Research activities often required the collection of specimens by outside scientists and were considered a necessary part of the NPS mission. The solution adopted to solve this problem was to grant employee status to outside researchers and take advantage of the employee's exception provided by the solicitor's opinion.

Many a current NPS employee has been puzzled by the "WOC Collaborator" check box on the 1957 version of the "Application for Permission to Collect Specimens of Plants, Rocks, Minerals, and Animal" (Form 10-741). This "Without Compensation Collaborator" category was used to grant employee status (without salary) to outside scientists for the purpose of collecting animals. The 1957 permit created two classes of permits. Class A permits covered the collection of "insects, spiders, plants, rocks, and minerals," which were defined as not being wild animals. Class B permits covered animal life in addition, but required that the applicant be either a "paid employee" or a "WOC Collaborator." For WOC status beyond a 180-day appointment, a security clearance was also required. Beyond the issue of whether such a solution was tortured at best, this permit process proved very difficult to implement.

Summarizing a host of problems, in 1966 the chief of the division of natural sciences in Washington, George Sprugel, described in retrospect the agency's frustration with the cumbersome process:

My concern, at the time, stemmed from a desire to improve the Service's somewhat tarnished image in the eyes of the scientific community and to, thus, provide for a more suitable climate within which we might be able to accelerate the cooperation and participation of university scientists in meeting the natural science needs of the parks.... Reasonable progress seemed to occur for a while but then, somehow, the NPS problem became a Departmental problem, and, despite our needling [sic] and cajoling, this progress ground to a halt.... [Now] we are back where we started: the Service continues to be the object of certain external ridicule as it tries to explain and justify the irrational and scientifically unsound distinction.... While other park administrators have thrown up their hands at trying to abide by the regulations and now pay little attention ... thousands of manhours are wasted an-

nually as Service personnel attempt to understand and implement this unworkable mechanism.... [T]he most discouraging of our findings is that much more able and wiser members of the Service than we have been calling attention to this problem and have been trying to obtain corrective action for more than 25 years with few tangible results!

Sprugel called for quick action: "The important thing is to eliminate the need for a Class B permit and to do it now—well before the onset of another research season in the parks" (Sprugel 1966).

Though his call was urgent and Sprugel was well placed in the bureaucracy to achieve this goal, it would still be another 10 years before new regulations were passed that corrected the problem. During this time, a number of NPS regions developed their own permit forms that bypassed the problems of WOC employees, but they shared a questionable legal status. In July 1976, NPS adopted new regulations on scientific specimens (36 Code of Federal Regulations 2.25) that contained a simplified set of requirements: (1) permits are only issued to representatives of scientific or educational institutions, not individuals; (2) specimens taken become part of a permanent collection or are made available to the public; (3) proposed activities that would result in disturbing natural features or mar their appearance are not permitted; and (4) permits for rare natural objects may be granted by the NPS director upon proof of scientific need. The issue over requiring employee status to collect appears to have been solved through new laws and the experiences of other agencies. Though no specific legal citations were found, the plethora of environmental laws over this 35-year period, such as the Fish and Wildlife Act of 1956 and the Wilderness Act of 1964 (Musgrave et al. 1998), undoubtedly influenced NPS's approach.

After the 1976 regulations became effective, few difficulties with permits were documented outside of efforts to improve the permit process on a park-by-park basis. In 1983, these regulations came up for revision as part of a broader plan to update 36 CFR Part 2. I, along with John Dennis, Christine Schonewald, and others in the Washington Office, contributed suggestions for improvements, including the desire to track what research was occurring, what specimens were collected, and where they were deposited for permanent storage. We felt that national parks were probably well-represented in many museum collections, but we were unaware of where specimens existed due to lack of a tracking system. As the proposed language went through revisions and comments, significant explanations and details were pared down to short phrases, some of which caused quite a bit of misunderstanding. One phrase was: "A permit shall not be issued if ... the specimen is readily available outside of the park area." This suggested that collections be denied unless the park was the only nearby source of specimens. But this phrase came out of a discussion where the sole need of the research project was for samples and didn't directly link to park resources. We called this the "park as a convenient, vacation-type place to collect" prohibition. It was not intended, as some would later interpret, as a justification to deny approval to research requests that didn't immediately help the park address current needs. I would learn time and again the lesson that words can mean many different things to different professionals.

The other much-shortened language was intended to create a method to track specimens, and came out as "specimens placed in displays or collections will bear official National Park Service museum labels and their catalog numbers will be registered in the National Park Service National Catalog." Starting with *NPS-53: Special Park Uses* in 1986, and followed by *NPS-77: Natural Resource Management Guidelines* in 1991 and *NPS-28: Cultural Resource Management Guidelines* in 1992, this statement was interpreted as requiring that all specimens collected under permit remain the property of NPS and be accessioned as museum property. Even though no specific mention is made in the regulation of such a property requirement, the logic used was along these lines: the regulation requires NPS labels and numbers be en-

tered into the agency's national catalog; we only enter our own property numbers in the museum catalog (except for loans and field numbers); therefore, the regulation implies that all specimens collected under permit and permanently stored must remain our property. Correctly interpreting the regulation or not, this requirement would create numerous conflicts between good scientific and resource management decisions, and the property requirements the NPS guidance was placing on itself. In its latest form, it has even been required that collectors be responsible for accessioning and cataloging into the NPS museum property system, at their own expense, any specimens they collect (National Park Service 1996).

Occasional complaints about the property requirement were received during the 1980s, but most went undocumented. A few NPS regions conducted surveys of parks concerning their experiences with research and collecting permits (NPS 1989a, 1991a, 1991b). The results suggested that a wide variety of (mostly small) problems were occurring, but that, more importantly, parks had a tremendous diversity of approaches to conducting the permit process. Some parks kept computerized database tracking lists, while others maintained no records at all. Only a few parks followed up with reporting requirements. Some purposely did not require NPS ownership of collections. Many seemingly misunderstood one or more aspects of the process.

Around this time more formal complaints started to appear. An NPS research scientist was quoted by his superintendent (National Park Service 1989b) as stating that he is "convinced more than ever that the current NPS interpretation of 36 CFR 2.5 is unworkable." Outside scientists were even more to the point: "I've run into a serious snag in completing the work on the alpine flora and I need your help. I've been trying to follow NPS policy regarding the handling of specimens and find that in doing so the work has been brought to a complete standstill" (Washington State University 1989). Some considered the NPS policy to be so counterproductive they attempted to undertake a protest: "This letter should be construed as a protest of the law, however well intentioned, to account for specimens taken from National Parks.... [T]hat law lies astride the herbarium protocol ... over the last century and a half. Specimens deposited at herbaria become the property of the herbaria, a kind of quid pro quo for mounting and preserving the specimen.... Therefore, to protest a ridiculous law and a wasteful procedure, we are returning your specimens to you and are loaning our mounting sheets to you. We will expect you to account for the mounting sheets from time to time" (Brigham Young University 1990).

By 1992, the Association of Systematic Collections had received enough expressions of concern from its members that it wrote NPS providing six arguments in favor of changing the regulations. The benefits listed in revising the regulations included the valuable services that outside repositories could provide in preserving, identifying, and researching collections; reduction of duplicative efforts; and the professional, stable environment of major universities and museums (Association of Systematic Collections 1992). Not too many years after this letter, the decision to revise the regulations gathered momentum. Still, complaints continued to arrive even through third parties to permits: "How did I ever agree to the conditions.... That is too bureaucratic for normal herbaria to deal with.... Common practice in plant systematics is to send material to be identified as a gift for the institution performing the service. Rarely do we accept loans for determination. There has to be something in it for the specialist" (New York Botanical Garden 1995). Collections are not the only part of permitting to receive complaints; other aspects continue to cause friction. Just this year, an open letter to a superintendent (Wernicke et. al 1999), signed by 14 professors of geology, described six major complaints about the NPS research and collecting permit process.

A task force on research and collecting was formed in 1997 under the leadership of Tim Goddard of the NPS natural resources information division in Fort Collins, Colorado. It has just completed a revision of the scientific permit process in the

agency. The task force (which includes the author) consists of 15 members from parks and central offices as diverse as Acadia, Colonial, Denali, Everglades, Grand Canyon, Shenandoah, and Yellowstone. We looked at a dozen park-designed permit forms that had been developed and used in parks. The diversity of the approaches was impressive, from simple one-page forms to elaborate descriptions of required research proposals along with information on wilderness, the National Environmental Policy Act, field equipment, ground disturbance, etc. Another challenge was to meet the legal requirements of the Paperwork Reduction Act of 1995, which requires all federal survey instruments (or informational requests for public responses) going to more than nine respondents to get the approval of the Office of Management and Budget (OMB). The approval requires a calculation of the average number of hours for a respondent to complete the submittal, which is designated as the amount of "burden hours." Each agency has an allocation of total burden hours it can require of the public. Without OMB approval, survey instruments may have a problem when parks attempt to enforce violations in a court of law.

A revision of the research and collecting regulations in the last few years has been developed, reviewed, and should appear this year in the Federal Register for public comment. It contains a provision to allow superintendents to convey ownership of specimens to qualified institutions and to retain the right to royalties from present and future commercial applications made from collected specimens. This latter point addresses the dilemma that we have been justly criticized for, where we touted the parks as containing gene pools that could benefit humankind, but didn't allow any commercial uses of specimens, which is one of the ways that gene pools produce direct benefits to society. However, the legal authority for such royalty agreements is still very new, and court cases are being argued today over this issue. Nevertheless, the new regulations have been included in the new permit process as part of the package submitted to OMB for approval. The current plan for implementing the new regulations and standardized permit process include the development of an Internet site for information dissemination and automated management of the permit process. The work on the site has already begun and is expected to be on-line as early as October 1999. Under park control, the server-based software system will allow parks to receive, review, approve, and track permits and provides a permanent record of the research and collecting that has gone on.

The complexities of these goals, coupled with an ever-shifting legal foundation, imply that the search for a final system will continue for many years to come. Perhaps NPS's new system will provide a template for a department of the interior-wide system. In any case, our past difficulties should provide us with an ever-improving idea of what a legal, flexible, and standardized approach should be. If anyone tries to tell me how simple it should be to achieve this, I can only assume that history is about to repeat itself.

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Integrating Science and Management in Canadian National Parks

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A Science Model and the Flow of Knowledge

This paper grew out of a request from a developing-country client of a Canadian technology transfer project. It builds upon an earlier paper by Munro (1997). While understanding the importance of science in a general way, the client wanted to know how Parks Canada integrates the fruits of science into the management of ecosystems. We expect that protected area agencies in developed countries share many of the same science-management linkages described here. Harmon (1994) presents a more general discussion of this topic, and includes numerous guidelines to help park managers use science and develop good relationships with scientists. Most of what Parks Canada undertakes is mission-oriented science or related scientific activities, solving problems at a specific place and time, or surveys and monitoring in support of routine operations. We also sponsor or participate in applied science to solve multi-park or long-term problems. In general we do not conduct pure research, the curiosity-driven search for knowledge. Figure 1 portrays a science model for national parks.

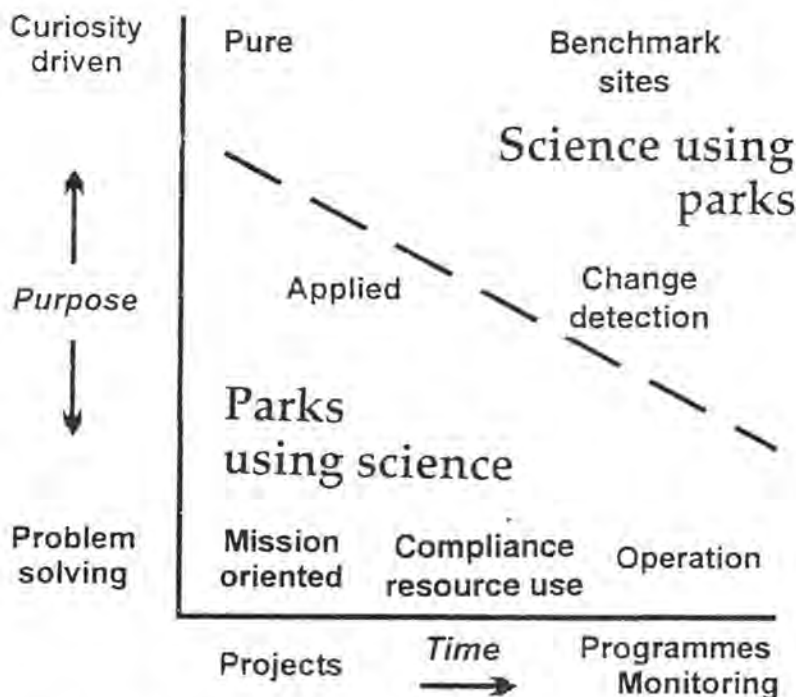


Figure 1. A park science model

Science is a process and knowledge its product, expressed as data and information. Data are facts and descriptions of objects and processes. They may be formatted as lists, tables, or maps, such as species counts or soil maps. These data must then be formatted into information that is useful to a park manager or understandable to a park visitor. Information may be text, pictures, maps, or tables, such as a description of ecological linkages, a plant succession diagram, or a map of soil sensitivity to some human activity. In Parks Canada, this transformation involves three stages (Table 1). Primary knowledge, mostly data, is collected by specialized researchers and technicians. It is transformed into secondary knowledge, mostly summary data, derived data, and specialized information, intended for use by multi-disciplinary staff and consultants. Management and public understanding come about through a transformation into tertiary knowledge, as seen in plans, interpretive programmes, and state of the parks reports.

Level	Characteristics	Format, type	Providers	Users
Primary our source data	Edited Cleaned Archivable	Maps, databases Journals Geology Topography Wildlife observations Etc.	Governments Consultants Universities Park ecologists	Park ecologists Warden specialists Planners Researchers Consultants
Secondary in which data becomes information for specialists	Synthesized Analyzed Generalized	Park atlases, descriptions Reference works Landscape maps, classes Paleogeography maps, history Habitat assessments Fragmentation maps Sensitivity maps Visitor opportunity analyses Risk assessments	Consultants Park ecologists Warden specialists	Planners Wardens Park ecologists Resource managers New staff Interpreters Interdisciplinary researchers
Tertiary in which information goes to the public and generalist managers	Summarized Simplified Illustrated Interpreted	Overviews, briefings, e.g. in internal and public planning documents State of the Parks and State of the Environment reports Descriptive works, e.g. glossy books, pamphlets, videos, web sites. Guided tours	Planners Interpreters Consultants Researchers Park ecologists	General public Senior managers Parliamentarians

Table 1. Parks Canada's knowledge flow by people and level of processing

The remainder of this paper describes the policy and management tools that link applied and mission-oriented science and related activities to park management. These links did not emerge from an overall science strategy, but evolved over at least two decades. Within the limits imposed by policy and regulation, each park has considerable flexibility in how it accomplishes its objectives. Therefore, these links may be applied differently between parks. Conversely, this independence can stimulate new strategies which others may then choose to adopt.

Legislation and Policy

Our National Parks Act (Parks Canada 1988) states that the "maintenance of ecological integrity through the protection of natural resources shall be the first priority when considering park zoning and visitor use in a management plan." This reinforces the primacy of ecological integrity as a factor in considering land use decisions. This legal statement triggered a great deal of study into how ecosystems function, what should be the ecological goal of a park, and how to measure the attainment of those goals. The act also requires us to complete a state of the parks report every two years, detailing ecological threats to parks and measures to combat them. Because this report is presented to Parliament, it has become an important tool to encourage managers to support rigorous science in parks. The act also requires that changes to a plan be tabled in Parliament. In this way the plans are also an accountability tool that fosters due care and diligence, i.e., science, in studying problems and proposing solutions.

Our policy is approved at the federal ministerial level, and so, like the act, has legal force (Parks Canada 1994). It states that "protecting ecological integrity takes precedence in acquiring, managing and administering heritage places and programmes. In every application of policy, this guiding principle is paramount." The policy also declares that "decisions should be based on the best available knowledge and be supported by research, including integrated scientific monitoring." It recognizes that parks cannot be managed in isolation, but that "decision making must be based on an understanding of surrounding environments and their management." This implies that one must have comparative studies external to a park to understand the wider ecosystem, and not just within the area that holds legislated protective status.

The Environmental Assessment Act requires that an environmental impact assessment be completed for projects that receive federal funding, land, or authorization, including those undertaken by the government itself, and to projects having an interprovincial or international impact. Major projects are subject to public review. Close scrutiny by the public, non-governmental groups, and other agencies ensures that proposals and analyses are well-grounded in science. Under a separate process ordered by the federal Cabinet, policy and programme proposals such as park management plans are also subject to environmental assessment.

The Environmental Protection Act, the Fisheries Act, and other federal and provincial laws govern the use, disposal, and clean-up of hazardous and toxic materials, such as pesticides, fuels, and lubricants, wood preservatives and paint. As well as using such chemicals for some aspects of park management, we own contaminated sites left over from before park establishment. Although Parks Canada relies on other agencies to conduct research into hazardous materials, our staff must understand the correct procedures for handling and disposing of these materials, why those procedures are needed, and what the ecological and human health risks are. This requires that our resource managers be grounded in the basic biological and physical sciences. We achieve this through recruitment standards and in-house information sessions.

Natural Resource Management Process

The natural resource management process follows three tracks (Parks Canada 1992; Figure 2). The first compiles existing, regional-scale data to aid park establishment. Another track deals with specific issues or sub-areas, and the development of plans and procedures. Examples are monitoring of sport fish catches to set annual quotas, and site rehabilitation after reservoir draining. The most important track encompasses a basic resource inventory and resource description and analysis (RDA). As well as providing sectoral studies and reports, the inventory integrates themes into an ecological land classification map, at scales of between 1:50,000 and 1:125,000, to give an understanding of the linkages between ecosystem components

and support integrated natural resource management. The RDA is the major reference for identifying park themes and key features, explaining the links between ecosystem components, assessing sensitive resources for initial zoning and planning, orienting new staff, and developing interpretive programmes. An RDA presents generalized versions of thematic data and accompanying monographs, and includes derived maps and narratives such as forest fire history, wildlife habitat assessments, visitor risks, and terrain sensitivity.

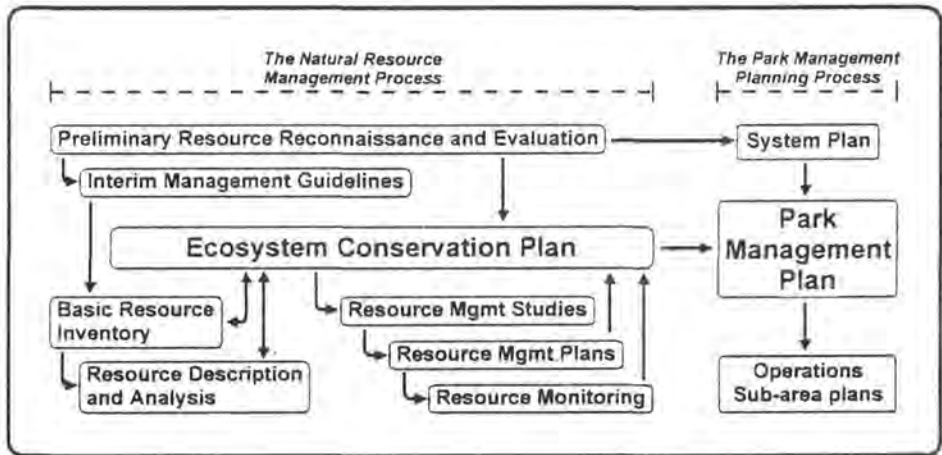


Figure 2. The natural resource management process

These tracks come together in the park's ecosystem conservation plan (ECP), the document that addresses environmental issues and that forms the basis of business plans and input to park management plans. In an ECP, all resource management issues are described, ranked, and given a recommended course of action and cost estimate. The ECP is periodically updated, and gives direction to annual and multi-year work plans, such as for inventory updates, ecosystem restoration, or impact mitigation.

Visitor Activity Management Process

This process matches visitor interests with educational and recreational activities that respect the integrity of ecosystems. It also provides information programmes so that all Canadians, not just visitors, come to understand and appreciate their national parks. Much of the process creates tertiary knowledge (Table 1), particularly in delivering public education and management options. Visitor activities and facilities, such as hiking and trails, are assessed for impact and hazards.

Funding and Science Strategies

A national framework was recently developed to assess the ecological integrity of national parks, and will become the basis for state of the parks reporting. During 1999, an external review panel examined the state of ecological integrity and man-

agement systems of national parks. Parks Canada has also prepared a strategy for sustaining the integrity of ecosystems. A science strategy is under development. These documents include more specific direction to the use of science in support of management than the policies and processes described above.

In regional examples, a framework has been adopted to evaluate the quality of ecosystem science in Parks Canada's Atlantic region, and to judge its value for park management. The region's Science Advisory Board reviews science proposals and recommends ways to improve them. The board is composed primarily of field staff, but also has headquarters and external representatives.

Communication

Communication is vital to improving relationships between researchers and managers, yet both parties must want to ensure that it is open and productive. Scientific journals are important in the research world, but managers are unlikely to read research papers for their park, particularly if the paper does not refer to the park in its title or keywords. Mechanisms that focus on summarizing highlights and findings are more effective, e.g., newsletters such as our *Research Links* or *Park Science* by the U.S. National Park Service. Another mechanism is local and national media reporting that can provide in-depth coverage of science and management issues. Managers and researchers often find themselves articulating similar values and positions.

Partnerships

Cooperative agreements provide shared funding and expertise for science, increase the credibility of the results, and help to resolve management issues. Without the help of outside agencies, many of our science activities could not be executed. Often these agreements are based solely on research permits given to scientists and lasting for a specific duration. Sometimes we enter into a formal agreement with a university, government department, or non-governmental group. These agreements are written as very general documents, stating the intentions of partners, their roles, and the support or results that they will give to each other. These agreements carry significant value in satisfying short- and long-term research needs in exchange for logistical support for researchers.

Training and Recruitment

Seminars and training programmes for staff and managers increase their awareness of new knowledge, policies, concepts, and methods, and show how to fit these ideas into park management. Examples are training workshops on Geographic Information Systems, the concepts of ecosystem management, ecological monitoring, ecological integrity, and cooperative management for greater park ecosystems.

To be recruited, park wardens must graduate from a university natural sciences programme or from at least a two-year renewable resource technology programme. They must also know resource management principles and techniques. In practice, these and other minimum qualifications are easily exceeded, and most wardens have at least a Bachelor's degree in an environmental science. Many now have a Master's degree.

Recommendations and a Conclusion

The effective use of science in a protected area requires a clear view of what type of science it needs for itself, and what other science to support.

- The focus should be on mission-oriented science and related science activities.
- Ecosystem management agencies should cooperate in applied sciences to resolve shared issues.
- Parks should provide support-in-kind for pure and applied research and for related scientific activities.

- Park science should be coordinated by in-house specialists who identify science needs, maintain databases, and transform the results into a form understandable by managers and visitors.
- There must be active senior leadership to foster the recognition of the value of science.
- Recruitment and training should be based on post-secondary education standards.
- Park professionals should make frequent use of newsletters, seminars, and co-operation with the news media.
- Legislation should state the importance of maintaining and reporting on ecological integrity.
- Policy documents should detail the principles included in the legislation.
- Partnerships share the cost of science and increase the credibility of the results.

Does management really benefit? Undoubtedly, and especially when steering controversial resource management actions through local opposition. However, many practitioners say that science too often yields to political and business pressures, and the leading barrier to the integration of science and park management is a lack of explicit recognition of science in corporate circles.

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Venturing Beyond Our Boundaries: Rocky Mountain National Park's Involvement in Adjacent Land Use Issues

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Congress established Rocky Mountain National Park, located in north-central Colorado, in 1915. The significance of the park lies in preserving, and availing for public use and enjoyment, some of the finest examples of the spectacular physiographic, biologic, and scenic features that typify the southern Rocky Mountains. These resources are even more significant because of their proximity to the metropolitan areas located along the Front Range of Colorado. It is estimated that 2.2 million people live in the eight-county Denver metropolitan region. Driving time from the Denver area to Rocky Mountain National Park is two hours or less. Visitation at the park has exceeded 3 million people per year for the past five years, with over one-third of all park visitors residing in the Front Range communities of Colorado.

Rocky Mountain contains 265,354 acres (107,430 ha) and has a boundary that is 137 mi (220 km) in length. Privately owned lands border 55 mi (89 km) of the park boundary. Public lands, administered almost entirely by the U.S. Forest Service, border the remainder.

The largest area of adjacent privately owned land is the 32-sq-mi (8,290-ha) Estes Valley on the east side of the park. It is estimated that 10,000 people currently reside in the Estes Valley, and new home construction is occurring at a rapid pace. On the average, 175 new homes are constructed each year in the valley. The town of Estes Park estimates that the population will double within the next 20 years.

Park boundaries often are not representative of ecosystems of which they are a part. At Rocky Mountain, a significant portion of the park boundary, particularly where it interfaces with private land, comprises a series of straight lines and right angles that bear no relationship to the ecosystem on which they have been superimposed. Development on adjacent private land has the potential to negatively affect park natural resources and other values that are important to park visitors. Examples include: (1) loss and fragmentation of wildlife habitat and migration corridors, (2) invasion of noxious weeds, (3) increased potential for catastrophic wildfire and decreased ability to use fire as a management tool, (4) marring of scenic vistas, (5) loss of nighttime sky due to excessive or poorly designed outdoor lighting, and (6) conflicts over trail access to the park.

For the past decade, park managers at Rocky Mountain have been keenly aware of the fact that park resources are inextricably linked with activities that take place on adjacent lands. In 1992, the park established a new permanent position to proactively work on the protection of park resources through collaboration with neighboring land-owners, local government, and other entities. To avoid the perception that the federal government was meddling in local land use planning matters, the title "land use specialist" was given to this position instead of "land use planner."

In the seven years since this position has been established, there have been some tangible benefits for the park:

- The land use specialist is now the point of contact in the park for external land use issues. This has resulted in improved communication between the park, local government, neighboring land-owners, and land use consultants, and they now have a better idea about the park's main interests and expectations.
- In 1995, the park began work on a "related lands evaluation" to identify resources and other values on surrounding privately owned lands that are significant to the park and which could be negatively affected by certain land uses. Through the involvement of interested neighboring land-owners, and

using the park's Geographic Information System (GIS) and Global Positioning System (GPS) capabilities, detailed maps have been prepared for the Estes Valley which cover the following topics: (1) visual sensitivity of lands surrounding the park when viewed from important vantage points within the park; (2) important habitat and movement corridors for elk, bighorn sheep and mule deer; (3) wildland fire potential; (4) locations of noxious weed infestations; and (5) trails on private lands outside the park that connect to trails within the park. Copies of the related lands evaluation report and maps were sent to over 500 interested land-owners. Copies were also provided to local officials and consultants involved in land use planning in the Estes Valley. The park also made it clear that the land use specialist would evaluate local land use proposals based upon the information contained in the related lands evaluation.

- The park has actively participated in the development of three land use master plans for adjacent counties and communities. Through this participation, and using the results of the related lands evaluation, the park was able to clearly communicate how these master plans could be improved to preserve resources and values that are important to the park. For example, wildfire hazard and wildlife habitat maps that were prepared by the park have been incorporated into the Estes Valley comprehensive plan.
- The park has actively participated in the preparation of two zoning codes for adjacent communities. The park's land use specialist was appointed to serve as a technical advisor during the preparation of the Estes Valley development code. Through this participation, the park was able to strengthen zoning regulations dealing with preservation of views and wildlife habitat, as well as protection of the night sky.
- Land use matters that are referred to the park by local government are reviewed in detail, and the implications for the park are fully analyzed and presented in writing and orally to the project proponents and local government during the development review process. As a result, some local land use decisions have been changed for the benefit of the park. For example, when a new church was proposed on land adjacent to a park entrance, the land use specialist met on site with the project engineer and a representative from the church to explore alternatives that would reduce the environmental and visual impacts of the project. By the time Boulder County approved the final plans, several important modifications had been incorporated into the project design. Most notable among these were a 35% reduction in the building footprint, lowering the structure into the ground, elimination of parking in a visually sensitive portion of the site, and a change in the exterior of the structure from metal siding to wood siding with native stone and log accents. These modifications helped to make the project more compatible with the park.
- Presentations to local civic groups and home-owner associations have succeeded in raising public awareness about topics that are important to the park. For example, many local residents are now aware of the park's concerns about noxious weeds and exterior lighting—two issues that have received little attention in the past.
- The park has been able to provide land use planning assistance to a neighborhood adjacent to the park. This proactive effort resulted in a set of design guidelines that will help to preserve the outstanding character of the neighborhood, and at the same time protect the park.
- The park has collaborated with the Estes Valley Land Trust, the Rocky Mountain National Park Associates, and the Larimer County Open Lands Advisory Board to identify lands for protection. To date, the Land Trust has acquired conservation easements on 2,132 acres in the vicinity of the national park. Several parcels are adjacent to the park.

Since the land use specialist position has been in existence at Rocky Mountain National Park, some valuable lessons have been learned. These lessons can benefit land managers who wish to become more involved in local land use matters.

1. Lead by example and walk the talk. Land managers who want to influence development decisions beyond their own boundaries should ensure that their own projects demonstrate leadership in the areas of sustainability, environmental sensitivity, public involvement, project design, and implementation.
2. Building trust with community groups, local government officials, and land-owners takes time, particularly if there is a history of ill will between the community and the land management agency. Mistrust can be overcome in time if the agency is able to involve the community in management decisions in a meaningful way.
3. Land use decisions with the potential to threaten private property rights must be acknowledged in a sensitive way. Land managers must be very careful not to overstep their authority or to appear heavy-handed when working with local communities and neighboring land-owners.
4. Open and frequent communication is essential to maintain trust, avoid misunderstandings, and to dispel misperceptions about government motives.
5. Land managers should initiate and maintain contacts with stakeholders. A broad program of outreach can help to build local support for protected areas and their management.
6. Seize opportunities to be proactive. More can be achieved for protected area management by being proactive rather than reactive. For example, by initiating a corridor management plan for an adjacent neighborhood, Rocky Mountain National Park now has a reasonable assurance that compatible development will occur along its borders.
7. Learn from mistakes, make amends quickly, and move on.
8. Internal support is essential. Without internal support from the agency, an outreach position will lack credibility with the community and will be ineffective. Strong internal leadership is needed to break from traditional ways of doing things.
9. Maintain focus. If an outreach position is comes under the catch-all "Other duties as assigned," it will not receive the commitment of time necessary to sustain a vital, effective program.
10. Longevity, consistency, and roots in the community are important. Building trust takes time, and if outreach personnel are moved around frequently, or are brought in from a central office, trust between the community and park managers can be compromised. The process of rebuilding trust which occurs each time that a new person is involved in the program can be time-consuming. Residing in the community and active community involvement can greatly enhance the effectiveness of the position.

The Rhetoric of Land Health

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One of Aldo Leopold's greatest intellectual strengths was his ability to synthesize, to make a unified whole out of a jumbled mess of ideas and observations. He exercised that intellectual power most famously when he came to see the land as a community of life, including human life, rather than as merely a gathering of plants and animals that happened to live in a given place and competed with one another for space and food (Flader 1974). When Leopold looked out over the southern Wisconsin landscape surrounding his Madison home, he saw, not thousands of distinct parcels of land, each with a separate owner. He saw a single community with many interconnected members. It was a community that was in trouble, he believed, and it was troubled precisely because the land-owners who lived there and who made decisions about the land failed to perceive it in communal terms (Meine 1988).

Leopold also saw a need for synthesis within the conservation community. Despite the rhetoric of Gifford Pinchot, the conservation movement in the 1930s was as fragmented as the Wisconsin landscape. It was a grab bag of ideas and land use reforms, each addressed at a particular evil and each pushing the land-owner to focus attention differently. What the conservation movement needed, Leopold believed, was to gather their reform ideas and visions into a single, overriding goal. That goal needed to fuse the many changes that were urgently needed in land use practices. It also needed to incorporate society's ethical impulses toward the land, its broadening ethical horizons that, Leopold believed, were slowly coming to include the land as part of the community of life that counted in moral terms. Then there were the aesthetic issues, the yearnings that many people had to restore the land's natural beauty. These too needed to become part of the conservation synthesis.

Leopold is well-known today for the constellation of ethical and ecological ideas that he brought together in his now-familiar land ethic (Tanner 1987; Meine 1988). What is less well-known is that the land ethic was closely related in Leopold's mind to another, perhaps even more important idea. The land ethic was how people ought to live on the land so that they respected the entire land community. The aim of the land ethic, the end that it helped foster, was what Leopold came to term "land health." In Leopold's mind, land health was the rightful organizing goal for all conservation work. It was a unifying idea, a synthesis that brought harmony to the ideas, practices, and understandings of the fragmented conservation movement (Leopold 1946). Leopold wrote about land health far more often than he did his land ethic. By the end of his life, it was the polestar of his work.

Land health became an indispensable idea to Leopold, even though he didn't know how to define or measure it exactly (Callicott 1992). What he did know was that land health had to do with the functioning of the land as a fertile, productive, beautiful community. Whenever Leopold probed the idea of land health (and its opposite, land sickness), he always began with the soil and the need to retain it and keep it fertile (Leopold 1935; 1941). He also spoke about water flows and the hydrologic cycle, and about retaining native species and keeping species from erupting into pests (Leopold 1944; 1945; 1946). He sensed some connection in a given landscape between species diversity and stability, particularly over human time-frames, but he was never sure just what that connection was. On the ethical side, he sensed moral worth in all other species and encouraged their retention as community members (Leopold 1949). He sensed too that his generation had a duty to preserve opportunities for later generations, like the opportunity to take a two-week trek across a little-altered wilderness area. Land health was about all of these things (Leopold 1944; 1946).

Leopold's lament, in one of his last, unpublished writings about land health, was that ecologists simply didn't know enough to understand what made the land tick, yet there was urgent need for action to combat obvious evidence of land sickness (Leopold 1946). There simply wasn't time to wait until scientists could figure out how the land community functioned. Best guesses were needed, guesses, Leopold believed, that should be made humbly and with generous respect for human ignorance. He had no illusion, he wrote in late 1946, "that the thousands of ecological questions raised by modern land-use can all be assessed by ecologists" (Leopold 1946). What ecologists could reasonably offer, and urgently needed to offer, were their best predictions "on just one basic question: what are the probable conditions requisite for the perpetuation of the biotic self-renewal or land health?"

Leopold was prepared to offer his own prediction about the essential elements of a healthy landscape. Good conservation work, he believed, needed to focus on the health of the land community, and so did the rhetoric used to push land-owners to conserve. The conservation movement, that is, needed to develop its own, good propaganda. Propaganda was a distasteful thought, but good propaganda was necessary, he argued, because conservationists had to combat the bad propaganda that agricultural schools, extension agencies, and the culture at large had put forth (Leopold 1943). As Leopold explained in 1945, "We must *undo* the propaganda, brought to bear on landowners for the last century, which teaches that the land is a factory to be operated solely for profit" (Leopold 1945).



The subtitle of this session is "Working Across Lines on the Map," and the focus is on integrating land management efforts so that, working together, land managers can nourish the good of an entire landscape (Knight and Landres 1988). But coordinated land management isn't challenged just by lines on the map, or even by fences on the ground. It's challenged by lines that exist in people's minds. It's challenged by the fragmented ways that people understand and talk about the land and their place on the land (Freyfogle 1998). To use Leopold's words, it's challenged by generations of bad propaganda.

When the modern mind looks out onto the land, what it sees is mostly a collection of pieces and parts, a collection of land parcels and natural resources and a few useful species mixed together with lots of worthless ones (Freyfogle 1998). Waterways are mentally disconnected from surrounding lands, as if water flows and water quality were unaffected by land use patterns. Pest species are viewed as separate natural components that people can attack at will, without disturbing the land's other members. Fragmented thinking like this is dangerous, and it poses just as much an obstacle to sound conservation as do fences and map lines.

Regrettably, it is not just ordinary citizens and land-owners who suffer from this kind of fragmentation, and who might turn for guidance to Leopold's efforts at synthesis. The conservation movement, too, continues to need the kind of coherent focus that Leopold was working on during the final years of his life. Conservation efforts too often still push against one another. More troubling, the conservation community still doesn't have a coherent message.

Conservation work in the next century will succeed best if it centers around a simple goal, a goal that's easily grasped in the way that Gifford Pinchot's utilitarian vision was easily grasped a century ago (Freyfogle 1998). By centered around, I mean that conservation work, and the messages delivered by conservationists, need to tie into and reinforce this goal, always keeping it in mind and striving to achieve it. A sound goal, naturally enough, needs to arise out of the realities of ecological interconnection, yet in thinking of interconnection we need to cast a wide net. Our interconnections are more than just physical. We share a common aesthetic landscape, as Leopold proclaimed when he called on community members to promote the land's

beauty. We are also interconnected ethically, given how many of our ethical strivings are achievable only through collective action.

A sound conservation goal, then, needs to focus on the entire community and to stimulate people to recognize how they are parts of that community and connected to all other parts. Leopold, of course, understood this, and fortunately so do some land managers today. But not enough of them do, and the major conservation organizations and conservation-focused land agencies overall have simply not been loud enough and clear enough in articulating such a goal. They haven't, that is, developed the necessary rhetorical context for their work, the necessary verbal phrasing of a long-term, community-centered goal, a goal that helps listeners grasp how nature's pieces fit together and why the health of the whole is so vitally important.

With these comments as background, let me offer a half-dozen observations.

1. In the work of conservation, ideas are important and rhetoric is important, just as important as fences, map lines, and political boundaries, and the fragmentation of nature in the modern mind is a dangerous predicament and a profound challenge (Ehrenfeld 1978). Good conservation rhetoric—good propaganda, if you will—is needed to challenge this deep-rooted intellectual fragmentation.
2. When government agents and others talk about conservation issues and options they necessarily present depictions of nature and implicit goals for conservation. For instance, when we talk about drinking water quality as a discrete issue, we necessarily imply that the water we drink is somehow separate from the water in rivers and aquifers and that the reason to clean up water is simply to protect human drinkers from contamination. Or again, when we talk about soil erosion solely in terms of a farmer's crop yields, we suggest that growing crops is the soil's only notable role, and that if crops are abundant, all is well. Conservation professionals, of course, know better than this. What they may not know is how harmful their utility-focused rhetoric can be when it reinforces a view of nature as a collection of parts, valuable only insofar as they're useful for humans.
3. The conservation of landscapes won't really take place until people think of the landscape as a single entity (Freyfogle 1993). They need to think of the land as a community, just as Leopold described it, and of themselves as community members with duties as well as rights (Jackson 1994). For most people this is a new idea, and it can be a threatening one, given how it cuts against our culture of liberal individualism and our zeal for negative liberty (Hartz 1955; Freyfogle 1995; 1998). The problem here is one that cannot be overemphasized.
4. This kind of community-centered thinking won't happen unless and until conservation workers themselves talk more overtly and consistently about the land in just this way—as an interconnected whole that can be more or less healthy in its overall functioning (Freyfogle 1997). The rhetoric of conservation needs to become a rhetoric of community. One group that knows this is the National Wildlife Federation, and it is usefully promoting the idea with its new slogan: "Conservation: It's About Community." Others ought to follow its lead.
5. Probably the best rhetorical framework for conservation in the dawning century remains Leopold's rhetoric of land health (Costanza, Norton, and Haskell 1992). When we talk about land health, we need to describe it as he did, as a matter of ethics and aesthetics as well as ecology. And we should be forthright in admitting our ignorance about the land and explaining, plainly and emphatically, why ignorance should lead to humility and restraint.

Land health needs to be understood, not just as an overriding goal, but as a practical process that enables people to work in concert. As farmer-writer Wendell Berry puts it, conservation is a matter of doing good work, and quite often it needs to be coordinated, shared work (Berry 1993). Good decisions aren't made by people acting alone and in haste; they arise more slowly, and are the result of study, deliberation, and seasoned reflection. Not inevitably, but far

too often, people acting alone look after themselves and focus on the short term. For good decisions to arise, better decision-making processes are needed, ones that encourage people to come together as citizens to learn about their shared homes and make thoughtful, ethical, ecologically informed decisions about them (Kemmis 1990).

6. The need for good rhetoric is nowhere more important than when addressing the matter of private land ownership. Private property has become a rallying cry for all manner of opponents of conservation. Behind the cry are industry groups that pollute and degrade the land, and that would prefer to keep doing so. But in front of the cry, either taking the lead or pushed into the lead, are ordinary landowners who genuinely worry that increased land use rules are dangerous threats, not just to their liberty as individual land-owners, but to the institution of private property that has been such a critical, defining element of American culture.

Private property, as institution and symbol, is a big subject, and only a few points are possible here. The rhetoric of property that anti-conservation forces use is seriously flawed, legally and historically. Those who study the institution soon learn that communities have always regulated land uses to foster the common good. Landowners have never possessed the right to impose harm, either on their neighbors or on their community, and the concept of harm has always been an evolving one. It is entirely appropriate for communities to restrict land uses that degrade the land's health, now that we have come to view such activities as harmful. Many people who resist such land use rules do so because they don't see the harm, or, seeing it, they think the cost of halting it is too high. These concerns aren't legal ones: they raise issues of ecology and economics, and the proper response is not to argue about property rights but to get people to study matters more carefully. Land-use rules that preserve the community's health are entirely consistent with private ownership as a legal and economic institution.

When private property is used as a defense against conservation measures, it needs to be understood as a flag. Often it is a flag announcing the people don't understand, they don't see the harm, they're worried about the costs, they distrust motives, they don't see how the entire land community, including its human members, will benefit. Sometimes, to be sure, it is necessary to respond to the libertarian, free-market property rhetoric in kind, with an alternative property rhetoric that pays attention to the community's good and that emphasizes the responsibilities that inevitably accompany private ownership. More often, though, the wise route is to put the property rights issue to one side. When people see the harm, and consider the long term, and ponder the ethical aspects, property rights concerns can become more tractable.



Federal agencies can do a lot to promote the long, hard work needed to achieve land health, not just on federal lands but on the landscapes that federal lands help compose (Freyfogle 1997). Good science, of course, is a must. But good rhetoric, consistently used, would also help immensely. Whenever possible, land health needs to be squarely presented, both as overall goal and as the context for considering individual management issues. The question always needs to be: What is needed to maintain the healthy functioning of *this* land? What is needed to keep *this* land fertile, bountiful, and beautiful? What kind of local landscape should be left for later generations?

Beyond good rhetoric, agencies can do immeasurable good by finding ways to stimulate and strengthen local processes that promote land health, processes that encourage study and understanding of the land, that facilitate deliberation and discussion of long-term goals, and that help people imagine how they might best live in

their chosen homes, generation upon generation. Good processes are particularly needed to counteract the bad propaganda that Leopold talked about, the pseudo-ecology, the inflated cost estimates, the denial of connections, the rejection of community, the fragmentation of the web of life.

By crafting his land ethic as he did, Leopold called upon private citizens to learn more about the land, to reflect on it ethically, and to reassess their aesthetic preferences. Land managers today, reaching across boundaries to their neighbors, need to repeat that message, and they need to work together with their neighbors to heed it.

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Removing the Blinders: A Call for National Park Service Involvement in Regional Development Issues

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"If the people of Gardiner [Montana] cannot refrain from slaughtering the game of the Park, then it is time for the American people to summon the town of Gardiner before the bar of public opinion, to show cause why the town should not be wiped off the map."

—*Yellowstone National Park Superintendent William Hornaday, 1913*

Introduction

William Hornaday was neither the first nor the last Yellowstone park superintendent to lock horns with the surrounding communities and rural residents. Those feelings have often been mutual, with frequent verbal attacks on park policy and staff by regional politicians, newspapers and citizens. As development increases on lands surrounding Yellowstone, the need to stop the bickering and begin to collaborate on efforts to manage growth becomes imperative. Creating and maintaining a constructive working relationship between park managers and the regional public will not be easy, but the alternative is not acceptable. Without immediate collaboration there will not be a significant change in growth patterns and trends. If it fails, the preservation of Yellowstone and the maintenance of a high quality of life for local residents is in serious doubt.

Background

Yellowstone was created in 1872, largely by entrepreneurs associated with the Northern Pacific Railroad who recognized the tremendous income generating potential this "wonderland" had to offer (Sax 1980). The struggle between those who view Yellowstone as a cash cow, and those who defend its more intrinsic values, has not abated.

At the time Congress was debating park designation, regional newspapers were predicting dire consequences if the government decided to "keep the country a wilderness and shut out travelers for many years ... [it would be] a great blow struck at the prosperity of the towns of Bozeman and Virginia City" (*Helena Rocky Mountain Gazette*, 1 March 1872). Though the government decided to "keep the country a wilderness," it ultimately had just the opposite impact on nearby towns. The park has served as a magnet for pulling in new residents and businesses and it is now viewed by many as a catalyst for economic and population growth.

Though large by any standards, it was realized early on that Yellowstone's original boundaries did not encompass all of the habitat necessary to protect its wildlife and geothermal resources. Yellowstone's elk and mule deer, for example, often move beyond park boundaries in search of winter range. Studies of the geysers and hot springs revealed that the subterranean plumbing that maintains these unique features also sprawls beyond the boundary of the park (Glick, Carr, and Harting 1991). As early as 1882, General Sheridan suggested doubling the size of Yellowstone to make it a better game sanctuary. In 1918, legislation was introduced in Congress proposing the addition of 1,265 sq mi of wildlands to the existing park. At a 1919 public hearing in Jackson, Wyoming, a proponent of the extension, Park Superintendent Horace Albright, was "hooted off the platform by enraged citizens" (Ross 1927).

Such "hooting" has been more the norm than the exception. Past and contemporary history of Yellowstone is punctuated with skirmishes between park managers and gateway community interests. Recently, the "Fires of '88" underscored the distrust and anger that characterizes the relationship between Yellowstone and many of its neighbors. In an effort to restore the ecological processes that shape and maintain

natural ecosystems, Yellowstone managers enacted a natural burn policy in the 1970s. During the summer of 1988, record heat, drought, and wind teamed up to produce the wildfires of the century, ultimately affecting over 1.4 million acres of parkland (Williams 1989). Neighboring communities feared both a catastrophic impact on tourism—and, in the case of West Yellowstone and Cooke City, imminent destruction—as walls of flame raced toward the towns. Though neither tourism nor the towns themselves were destroyed, park managers were verbally thrashed by local elected officials and residents, and by both of Wyoming's senators (Williams 1989).

The fires served to demonstrate the real and perceived relationship between park policy and regional economic development. Expanding regional development was affecting the health of park resources, and regional residents were viewing the park with an increased sense of entitlement. Beginning in the 1970s, accelerated resource extraction on the national forests surrounding Yellowstone severely fragmented habitats that play a critical role in maintaining park wildlife. Over 7,500 mi of roads had been built on the national forests of the Greater Yellowstone Area to facilitate the cutting of billions of board-feet of timber. In some cases, this cutting occurred right up against Yellowstone's boundaries and is clearly visible on satellite imagery. And, on private lands, the great Rocky Mountain land boom converted thousands of acres of riparian habitat, winter range, farms, and ranchland to ranches and trophy homes. By the 1990s, over a million of Greater Yellowstone's three million acres of private land had been subdivided (Glick, Carr, and Harting 1991). The park is becoming an island of wildness surrounded by a rising sea of development.

This decade has seen some notable, though ill-fated, attempts by the National Park Service (NPS) to broaden its scope of concern and action beyond the borders of Yellowstone. Best known is the so-called Vision Document process of the early 1990s. This attempt to develop a long-range plan for the future of the region's public lands (both NPS and U.S. Forest Service), and to bridge the communication gap between land managers and residents, was initiated by the Greater Yellowstone Coordinating Committee (GYCC). The GYCC, composed of park administrators and forest supervisors, crafted a set of principles for maintaining the ecological integrity of 14 million acres of public land in Greater Yellowstone and fostering the transition to sustainable economic development in neighboring communities. This initiative was significant in many ways. It acknowledged that the well-being of Yellowstone is tied to the ecological well-being of the surrounding region. It also implied an end to the era of business-as-usual for the extractive industries on public lands and more direct involvement by federal agencies in private land development issues (Greater Yellowstone Coordinating Committee 1990).

Though the plan had its proponents, especially environmentalists, many regional businesses and elected officials and nearly all of the extractive industries organized in opposition. With the aid of congressional delegates from Idaho, Montana, and Wyoming, the GYCC was forced to scrap its original Vision Document (Litchman and Clark 1994).

Though extractive industries still threaten the ecological integrity of the larger region, on the eve of the 21st century Yellowstone is perhaps more in danger of being loved to death by visitors and new residents in the region. Traffic jams and sewage spills in the park get the headlines, though development pressure near park borders may be an even greater problem. Growth rates in the 20-county Greater Yellowstone Area are among the highest in the nation. Between 1990 and 1996, the region grew 12%, though some counties experienced growth as high as 20%, 22%, and even 50% (Bureau of the Census 1996). As great a concern as rates of growth is the pattern of growth. Rural areas are growing at a faster rate than communities. The resultant low-density sprawl eats away at open space and wildlife habitat. Favored building sites include the interface between public and private lands and along biologically rich river corridors. The "suburbanization" of public land boundaries in Greater Yellow-

stone is restricting wildlife migrations, degrading habitat, and increasing human wildlife confrontations (Greater Yellowstone Coalition 1999).

A good case in point is the proposed Duck Creek development just north of the town of West Yellowstone on the western side of the park. This 330-acre parcel is separated from Yellowstone by a 200-yd strip of Gallatin National Forest land. Park elk and bison regularly move through the property on their migration to and from winter ranges. Grizzly bears use the riparian vegetation along Duck Creek (which flows through this property) to hide their movements as they forage outside park borders. In 1996, the owner of this property requested a zoning change from the Gallatin County commissioners which would increase potential build-out from a maximum of 32 houses to 969 single-home sites, as well as allowing commercial development and the installation of a golf course. NPS took an uncharacteristically strong stance against the proposed change, citing the property's ecological importance to park wildlife. Boldly stated written and oral comments by Yellowstone park personnel were delivered to the commissioners, even in the face of backlash by some gateway community residents who had a vested interest in seeing this project approved. Still, the commissioners approved the zoning change (although this is being contested in court by environmental groups).

Though NPS opposition to the Duck Creek project fell on deaf ears, it was significant that Yellowstone administrators actually stated a position, and a strong one at that. At almost the same time, a proposal for a gold mine near the northeast corner of Yellowstone was terminated through an agreement reached between the mining company and the federal government. The proposal had sparked vocal opposition from NPS, environmental groups, and, ultimately, from citizens around the nation. Yellowstone's superintendent, Mike Finley, ultimately played an important role in helping to defeat this project. During this battle, he and NPS locked horns with other federal and state agencies, drew the ire of a number of elected officials, and angered at least some local residents. Nevertheless, they stayed the course (Greater Yellowstone Coalition 1996).

These recent actions seem to indicate a new willingness by NPS to recognize and influence development activities beyond park borders. They are, however, for the most part reactive rather than proactive. Almost totally ignored by NPS has been long-range planning efforts underway in the counties adjoining Yellowstone. In the past decade, every county bordering Yellowstone has drafted a comprehensive land use plan and is in varying stages of plan implementation.

Perhaps gun-shy from the Vision Document debacle, NPS employees have been for the most part conspicuously absent from these processes. This is perhaps understandable, considering the level of animosity which exists between the park and some of its neighbors and the history of (primarily failed) efforts to work collaboratively with these communities. But, as a major land-holder that has the most significant impact on regional economies and land use, NPS owes it to its neighbors and to itself to be a player in shaping the region's efforts to plan and deal with growth. The question, then, is not whether the NPS should be involved in land planning and growth management, but rather how it can be a more effective and constructive participant in these processes.

The challenges of this task are many and formidable. First and foremost is that fact that growth management efforts in the region have been, with or without NPS involvement, mostly failures. While many communities have crafted comprehensive plans or community visions, they have proven to be little more than "New Year's resolutions," with little effect on the character and pattern of growth. Even much-heralded community-based planning has produced mixed results. Citizens in the town of Gardiner, on the northern border of Yellowstone, organized a "Successful Communities" workshop in the early 1990s. This well-attended event generated an ambitious set of community development and conservation goals and the beginnings of an action plan. But conflict over strategies for achieving the goals stymied efforts to

implement the plan (Julia Page, personal communication). Other communities, such as Red Lodge, Montana, have had more success with their planning efforts, but the pace of development is overwhelming even those communities which have growth plans in place.

Sacrosanct private property rights, a hallmark of the West, are another major barrier to effective NPS involvement in land use planning (and in general a barrier to any community's efforts to manage growth). Even when NPS is not attempting to directly influence land use, its administrators are still attacked (sometimes viciously) by land-owners and elected officials who believe that park policy and its effect on resources outside of the park are causing the need for restrictions on land use. A recent example occurred in Park County, Montana, where property owners along the Yellowstone River are fighting efforts to regulate development and restrict bank stabilization projects.

In this anti-regulatory, anti-government, anti-planning climate, how can NPS not only constructively engage in land use planning, but also help to make these meaningful, productive exercises? The answers to these questions are neither simple nor formulaic. In addition, recommendations aimed solely at NPS would not get the job done. Communities and private land-owners also need to change the way they do business with NPS. Without an honest attempt by both sides to reconcile differences and move forward to create a future that is both good for the land and for the people, the prognosis is grim.

Conclusion and Recommendations

Despite the important role that Yellowstone National Park has played as a catalyst for regional development, much of this has occurred by default, not design. Such a piecemeal and parochial approach may have been appropriate in the era of the Wild West, but those days have gone the way of mountain men and cattle drives. Present challenges call for effective relationships between NPS, other public land managers such as the U.S. Forest Service, and outside partners, including neighboring communities and interest groups. Without proactive, collaborative planning, Yellowstone park will most likely become both ecologically and philosophically isolated from the surrounding region. Ultimately, the park will lose many of the wild qualities it was created to preserve.

Perhaps the best approach to meeting the challenges is to move forward with efforts to develop long-range, integrated conservation and development plans. These could ultimately help to sustain wildlands and wildlife, as well as communities and regional economies (Glick and Clark 1998). Some communities and public land managers are already pioneering efforts that reflect these goals.

The following recommendations are directed toward both public land managers and the communities of Greater Yellowstone.

1. Many communities in Greater Yellowstone lack effective community or county development, land use, or growth management plans. To begin the process of planning for community sustainability, shared community visions and development plans should be created. Crafted with a solid understanding of local and regional environmental, economic, and social trends, these visions should include an inventory of local assets (natural, cultural, and economic) identified by the community. An action plan which includes the tools and strategies for achieving these goals should be part of this vision. A key to the success of these processes is to put into place a strategy for the long-term financial and technical support before planning efforts even begin.
2. In collaboration with local, state, and federal officials, communities should develop a regulatory framework bolstered with market incentives and other non-regulatory tools for guiding development while protecting local and regional assets.

3. Communities can formalize relations with public land managers through the drafting of memorandums of understanding or other mechanisms for sharing information for more effective management of both public and private lands.
4. NPS can help create or support non-governmental efforts for integrated development and conservation goals at the community level.
5. Effective and inclusive means of coordinating management activities on public and private lands that are ecologically interconnected should be identified and implemented.
6. Full use should be made of new technologies that can facilitate improved and streamlined communication and cooperation on regional development issues.

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Working Across Lines on the Map: Lessons from New York's Adirondack Park

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Scientific studies of biological diversity demonstrate that we are in the midst of the sixth great extinction of species in the history of the world. Wilson's (1992) definitive analysis of the causes and consequences of this extinction makes it clear that future efforts to preserve biodiversity must focus on the protection of large natural ecosystems. This, in turn, provides the rationale for an examination of the policies, programs, and management strategies that may help us to work across the "lines on the map" that often hinder our efforts to protect those ecosystems.

New York's Adirondack Park is one of the oldest and most ambitious attempts to preserve a large natural ecosystem through government intervention. Established in 1892, this six-million-acre preserve combines public (40%) and private (60%) land to form the largest park in the contiguous United States. This combination of public and private land means that *this* park is also a place where large numbers of people live and work. In addition to the 10 million people who visit each year, the Adirondack Park has approximately 250,000 permanent and seasonal residents. It spans 105 units of town and village government and 12 counties. Within its boundaries are 46 peaks over 4,000 ft in elevation, 1,800 lakes and large ponds, and more than 30,000 miles of streams and nearly 5,000 miles of wild and scenic rivers.

It is the Adirondack Park's conscious attempt to integrate human communities with large wilderness areas that make it such an important model for those who wish to develop policies, programs, and management strategies that unite natural ecosystems across human boundaries. This grand experiment has produced spectacular successes and abject failures in its more than 100-year history, and this analysis draws on both to provide some insights into the challenges and rewards of working across lines on the map to protect natural ecosystems.

The Adirondack Park's most notable success is probably the famous "Forever Wild" clause, which is often referred to as the strongest piece of environmental legislation ever passed. The "Forever Wild" clause has its roots in historical events that took place more than a century ago. The Adirondacks have rugged terrain, poor soil, and a short growing season, and this combined to keep most settlers out of the region until the mid 1800s. But the industrializing economy of the late 19th century United States ran on wood (in much the same way our modern economy runs on oil), and timber was a resource the Adirondacks had in abundance. By the end of the century, virtually the entire Adirondack region had been clear-cut or destroyed by the forest fires that followed in the wake of the clear-cutting.

In 1885, the state of New York began to purchase land in the Adirondacks with the goal of halting the destruction, and in 1892 the legislature drew a line around the scattered purchases and created the Adirondack Park, with the intention that they would eventually buy all the land with the boundary. But the creation of the Adirondack Park did not halt the destruction of the Adirondack forests, as unscrupulous members of the State Forest Board sold timber rights and allowed private firms to illegally cut timber on large tracts of state land.

In 1894, the continuing destruction of the Adirondack forest was addressed by amending the state constitution to read: "The lands of the State, now owned or hereafter acquired, constituting the Forest Preserve as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold, or exchanged, nor taken by any corporation public or private, nor shall the timber thereon be sold, exchanged or destroyed" (Graham 1978, 131).

It is not just powerful language that makes the "Forever Wild" clause a watershed piece of environmental legislation. By virtue of its constitutional status, the protec-

tion afforded the state-owned lands in the Adirondack Park cannot be undone by executive agencies or the State Legislature. Any change to the "Forever Wild" clause must be approved in a state-wide referendum, and that referendum must be preceded by approval of the proposed amendments in two successive sessions of the State Legislature. In practice, the "Forever Wild" clause has allowed environmental groups to defeat every major attempt to alter the wilderness character of state lands within the Adirondack Park (e.g., by building large dams) over the past 100 years. Without constitutional protection, it is likely that several attempts to alter the Adirondack wilderness would have quickly been implemented before environmental groups could marshal their resources and build public support. The general lesson we can derive from the success of the "Forever Wild" clause is that policies that provide for delay and public referendum may be essential to the long-term protection of the wilderness areas that lie at the core of efforts to protect natural ecosystems through regional land use planning.

But the failure of a recent effort to address shortcomings in the Adirondack Park Land Use Plan may provide the most important lessons about policies, programs, and management strategies for protecting natural ecosystems. Since its creation in 1971, the Adirondack Park Agency's (APA) regional land use plan has been a source of persistent controversy. Park residents perceive the restrictions placed on private property by the land use plan as the worst kind of governmental intrusion in their affairs, while environmental groups frequently complain that the plan is fundamentally flawed, particularly with regard to the regulations that are designed to protect shoreline from over-development. So park residents proceeded to dump truck loads of manure on the lawn on front of APA headquarters while the town of Clare voted to secede from the Park, and environmentalists proceeded to form the Adirondack Council, a watchdog group that does not hesitate to sue the APA when they feel it is lax in discharging its duties.

In the late 1980s, New York Governor Mario Cuomo was often touted as a possible Democratic presidential candidate, but his résumé suffered from a notable lack of environmental initiatives, and a growing controversy over development in the Adirondack Park provided him with a golden opportunity. Cuomo certainly knew that high-profile environmental groups such as the Audubon Society were heavily involved in the effort to reform the Adirondack Park land use plan, and that most of the relative handful (in terms of their impact on state politics) of park residents who opposed reform were already solidly aligned with the Republican Party. In 1989, Cuomo appointed the Governor's Commission on the Adirondack Park in the Twenty First Century, and charged it to examine "recent developments [that] suggest that we may be entering ... an era of unbridled land speculation and unwarranted development that may threaten the unique open space and wilderness character of the region" (Commission on the Adirondacks in the 21st Century 1990, 3). Cuomo gave the commission a one-year deadline to complete their work, a deadline that would have been impossible to meet had Cuomo not "packed" the commission with members sympathetic to the environmentalist viewpoint.

Whether it was the result of impatience, presidential aspirations, or both, in retrospect it is clear that the one-year deadline and packing the Governor's Commission with environmentalists virtually guaranteed that it would fail to correct the problems it was created to address. Adirondack Park residents quickly noted that, not only were none of the commissioners drawn from local governments within the park, none were even park residents by their standards (not surprisingly, residents did not accept environmentalists who owned a seasonal residence in the park as their representatives). Equally galling to park residents was the fact that of the fourteen public hearings held by the Governor's Commission, only two were held within the park's boundaries, and these during the final months of the process. When a "turncoat" member of the Governor's Commission revealed that the final report was virtually

completed before the hearings in the park were held, any shred of legitimacy disappeared as far as park residents were concerned.

The Governor's Commission released its report to a conspicuously absent Governor Cuomo in April of 1990, and the controversy continued to grow. Residents responded to the release of the report with protests, civil disobedience, and scattered acts of vandalism and violence. None of the Commission's 245 recommendations were enacted into law, and the political gridlock that developed in the state legislature continues to block any initiatives designed to address the critical issues of shoreline development. "Wise-use" groups that developed in response to the Governor's Commission continue to wield influence within the park today, and local governments have recently blocked purchase of some additional parcels of state land and funded an investigation of the APA's regulatory practices and authority by a "wise-use" research institute. Mason's (1995) examination of land use planning in British Columbia demonstrates that successful regional land use planning is dependent upon the following factors: access to information, opportunities to be heard by public officials, a decision-making process that is open to all relevant interests, explicit legal bases for decision-making authority, public accountability, written reasons for significant decisions, and an independent appeal process. One important lesson that regional land use planners can take from the failure of the Governor's Commission on the Adirondack Park in the Twenty First Century is that they ignore Mason's principles at their peril.

A more general lesson that emerges from the failure of the Governor's Commission is the danger that radical environmentalism poses to the mainstream environmental movement. The willingness of mainstream environmentalists to participate in this undemocratic process is evidence of the penetration of radical ideology in the environmental movement. In the late 1980s and early 1990s radical environmentalists had successfully created the impression within the larger environmental community that mainstream environmental groups had compromised their principles and fallen into the trap of "creeping conservatism." In the radical's view, adhering to democratic principles in efforts to protect the environment was, at best, too slow and messy, and at worst a sham exercise that blocked real progress. The danger of this perspective is illustrated by Goldfarb: "When one thinks ideologically and acts ideologically, opponents become enemies to be vanquished, compromise becomes a kind of immorality, and constitutional refinements become inconvenient niceties" (1991, 9). In the Adirondacks, the failure of the Governor's Commission created a climate of polarization and political gridlock that hampers efforts to protect natural ecosystems in the park almost a decade later.

Fortunately, there are signs that environmental groups active in the Adirondack Park have retreated from the radical tactics that undermined the Governor's Commission. In 1997, Champion Paper Company put approximately 150,000 acres of its Adirondack Park holdings up for sale in an effort to cut costs and sell off "unnecessary" assets. These holdings included several undeveloped lakes, wild rivers, and woodlands that were home to threatened species. There were more than 40 potential bidders for the parcel, including private companies that wished to subdivide the land, and environmental groups desperately sought to put together a purchase and easement deal that would prevent this from happening. But the legacy of the failure of the Governor's Commission left many park residents opposed to the sales of additional land or land rights to the state, and their local governments indicated that they would use their veto power (acquired in the aftermath of the failure of the Governor's Commission) to block state acquisition of the parcel.

With private investors accelerating their efforts to purchase the property, a complicated deal involving state government, private investors, and foundations that was acceptable to park residents was struck to avoid the potential sub-division of this valuable parcel. An essential element of the deal was the purchase of 110,000 acres by the Forestland Group, a company that specializes in environmentally sound forest

management, with the understanding that New York State will hold an easement that guarantees public access and restricts logging to methods that preserve the environment. New York will also purchase 29,000 acres of the most fragile, unspoiled areas, including the spectacular Grass River, whose meandering path is punctuated with striking waterfalls. The final lesson that emerges from this recent Adirondack success is that compromise, technical innovation, and market-based strategies can be used to build the kind of coalitions that are essential to the future of efforts to unite natural ecosystems across human boundaries.

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Influencing Land Use Decisions on Lands Adjacent to Your Park or Protected Area: A Planning Commissioner's Point of View

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Barring the privatization of public lands, cross-boundary cooperation between managers of public lands has time to mature. By the same token, with unprecedented urban and rural sprawl in all parts of the United States, there is much less time in cases where park boundaries adjoin private lands (Lamm et al. 1998; Reibsame et al. 1998). Unless protected area managers everywhere become more involved in the local government land use planning and decision process, and are able to influence the amount, type, and location of new development occurring near their boundaries, protected areas will increasingly become islands surrounded by incompatible land uses (Hales 1989; Myers 1984).

Land subdivision next to protected natural areas, however well intentioned, almost always produces impacts that make ecological gradients steeper. Such impacts include: fragmentation caused by roads, fences, or changes in vegetation; wildlife disturbance from human activity; subsidized predators (cats, dogs, etc.), and the increase in generalist species; increased introduction of exotic species from landscaping and traffic; increases in soil erosion and contaminants; increases in administrative problems related to easements, trespass, poaching and liability; and a reduced ability to allow natural processes, such as fire and spring flooding, to occur (Knight et al. 1995; Knight and Landres 1998).

Most of the important land use decisions made near a protected area involve local elected officials, citizen boards and commissions, and professional planning staffs at the city and county level, with input from a large number of citizens and other agencies. Due to a set of factors that can impede cross-boundary collaboration—especially with local government (Yaffee 1998)—protected area managers have been slow to participate in these planning and decision-making activities in spite of the profound effects that external land use changes are having on their ability to achieve management objectives (Knight and Landres 1998). As both a protected area specialist and a county planning commissioner, I would like to discuss why you should and how you *can* influence land use decisions on lands next to your protected area.

A Generic Description of How Land Use Decisions are Made

First, a very concise overview of how land use decisions are made. The federal government has passed the responsibility for land use to the states, and the states, in turn, have passed most decisions on to county and municipal governments. State constitutions typically direct local officials (county commissioners or city councils) to appoint planning commissions, develop master plans, and a land use code that includes zoning ordinances and subdivision regulations. Local government hires planning, health, public works, and other professionals who help analyze and process development proposals and provide technical advice to board and commission decision-makers.

Due process, as well as public and stakeholder involvement, are required for nearly all land use decisions—for the development of master plans, land use codes, and during the on-going development review process itself. Development proposals are reviewed by agencies and other stakeholders since board and commission decisions are quasi-judicial in nature and, by law, must follow these procedures. In some rural areas, the procedures for a systematic and democratic approach to local land use decisions are still being established (Glick 1998).

What You Can Do to Influence Land Use Decisions So That They are More Compatible with Your Park or Protected Area

There are a number of ways protected area staff can legitimately participate in local land use decisions in order to influence the location, extent, type, and spatial patterns of development near their protected areas.

Designate a land use specialist. This person should be assigned to work with a wide variety of local government, land-owners, home-owners' associations, and non-profit organizations (such as land trusts) in order to address adjacent land use issues. Much of this work will occur outside the park. This person needs to have the support of his or her supervisors, have the necessary resources to manage spatial and other information, and be given time to establish a presence in surrounding communities.

Do a boundary analysis. Most parks have extensive internal resource data, often displayed in a GIS format. Few have analyzed their perimeters as thoroughly, or are equipped to analyze and predict the effects of adjacent land use. To compensate for this, information layers for such an analysis might include: (1) a base map showing current land use, infrastructure, ownership, and zoning (available from local government); (2) a theme showing unique ecosystem components that extend beyond boundaries (wildlife migration corridors, unique habitat, fire-prone areas, important vistas, etc.) and those areas that are important for establishing connectivity to other parks or protected areas; and (3) a theme depicting current and potential development activity as indicated by projects under review, ownership characteristics (e.g., whether it is speculative, absentee, stable, etc.), available infrastructure, quantity of land for sale, and volume of land recently sold. This type of information helps managers to determine the *vulnerability* of boundary segments, the *ecological gradient* at any point, and mitigation *priorities*.

Anticipate "buildout" and the accompanying impacts next to your protected area. Many parks and protected areas still have adjacent private land uses that are extensive but that involve only limited development. Relative compatibility is temporarily provided by ranches, farms, or large-acreage owners who value natural surroundings. On most private lands in the USA and Europe, however, is an underlying zoning classification which will allow a certain level of development and a set of permitted uses, ranging from commercial to low-density residential. In Colorado, for example, all land-owners have the right to subdivide into parcels of 35 acres or larger without going through the local government review process. In most U.S. counties, one may subdivide into parcels of from 2.29 to 10 acres per residential unit (or smaller if a public sewer is nearby) by going through the review process. In the few jurisdictions where local governments that have still not adopted a zoning ordinance, development in rural areas may be limited only by lack of infrastructure and natural constraints, such as slope and soils.

"Buildout" can be thought of as *the subdivision and development of all land in a given geographical area at the maximum level allowed by the underlying zoning for that area (resource constraints considered)*. Recent studies indicate that areas next to public lands are proceeding towards buildout at a rate much faster than anyone had anticipated, and that land values near protected areas are well above those of equivalent lands further away. When commercial and residential development can out-bid nearly all other uses of land, the only safe assumption for managers is that adjacent land use will proceed towards, and likely achieve, buildout unless some form of land conservation (purchase or transfer of development rights, easements, etc.) intervenes. A powerful exercise for any protected area then, is to model what buildout on adjacent lands would look like. This can be accomplished by superimposing the infrastructure, development, and use patterns utilized by built-out developments with similar zoning on top of existing land uses that are not yet built out.

Participate in the development or revision of the comprehensive (master) plans for the counties and cities adjacent to your protected area. A local govern-

ment's comprehensive plan is the foundation document that usually contains a vision statement and the goals, objectives, principles, themes, guidelines, and actions to achieve those desired conditions in a city or county. It is the document that is seen as the legal basis for the zoning, subdivision and other regulations contained in the land use code. A master plan is a policy document; it frequently has sections addressing growth management, current and desired land use, public facilities and services, transportation, environmental resources, and hazards, and ends with an action or implementation plan. Land use goals related to protecting sensitive natural areas, wetlands, endangered or threatened species, wildlife habitat and migration routes, viewsheds—if they are to exist—will be in this document. It is possible and important to reference the quality of life contributions made by parks and natural areas and describe the importance of mitigating impacts to them. It is in the master plan, especially the implementation section, that reference should be made to the specific strategies for collaboration between local government and your protected area. These might include the creation of overlay zones, memorandums of understanding with a protected area, and other actions that will be suggested here.

The opportunity to participate in the development of a master plan will most often arise as local jurisdictions revise existing plans, which happens every 5-10 years. It will also arise as rural counties or municipalities that do not currently have such plans begin the process of developing them, something that is common when growth arrives in relatively undeveloped rural areas.

Participate in the development or revision of the land use code for the counties and cities adjacent to your protected area. It is the code which establishes the rules for development. This includes regulations for zoning, land subdivision, the procedures for the review of proposals, access and grading permits, rural road standards, and, importantly, the performance standards for all development. It is here that permitted densities and uses are spelled out and performance criteria are set for things such as setbacks and the location of building envelopes, fencing, landscaping, lighting, emergency access, handling of human waste and graywater, and design for storm drainage. All such details have many implications for protected area managers, and local government may well be amenable to modifying how these regulations are applied near a given park or protected area.

Impacts will always be greatly reduced if density can be reduced and permitted uses made more compatible with the needs of the protected area. Performance criteria for site design, roads, fencing and other variables can reduce the fragmentation effect of development on resource management, wildlife and the experience of visitors. Criteria for landscaping can reduce the introduction of exotic species and preserve or even enhance biotic diversity. Criteria for night lighting can preserve the night sky and standards for mobile radio service facilities could greatly reduce the proliferation of and visual impacts from communications towers and antennas. It is where the code outlines steps in the review process that collaboration with public land managers becomes institutionalized.

Propose the creation of an overlay zone near your protected area. One of the best ways to expedite cross-boundary collaboration is for the local government and the protected area to agree to the creation of a land use overlay zone that is superimposed on existing zoning. Such a zone would be placed on lands within a certain distance of the protected area, and a county or municipality would agree to work with managers to adjust some combination of allowable density, permitted uses, performance standards, and criteria for development within that zone. Sending areas for transferable development rights might be created within the zone. Both parties would also agree to a more thorough joint review of development, not only within the overlay zone but also within the protected area, for projects that local government might have an interest in or which could have an effect on adjacent private lands. Final approval for projects adjacent to the park, however, would be made by local

government officials, and by the public land agency officials for developments within its boundaries.

Participate in the review of development proposals that could affect management objectives. Once a development proposal is brought forth that would affect a protected area, there are several stages where managers can provide input (Figure 1). There is usually some type of *pre-application conference* where staff discusses the project and procedures with the developer. During those discussions, staff can also make the applicant aware of the special criteria that are applied for projects adjacent to public lands and protected areas. Applicants may be sent to talk to other agencies, and this includes talking to protected area managers about their special needs or requirements. Next, applicants are usually asked to submit some type of *sketch* or *concept plan* that is sent out to other agencies for review. This initial review is the best place for area managers to comment on the specifics of a project before the applicant has invested heavily.

A *site visit* is then made by planning staff and can include the land use specialist from the protected area as a member of the team. After local government staffers receive all the information back from the agency referrals, they submit a report with *recommendations to the applicant*. Many jurisdictions then hold a *neighborhood meeting* of land-owners who live near the site of the proposed development. While managers would not be active participants in that meeting, they can be present to provide information and answer questions. The applicant then submits a *general development plan* for large projects or *preliminary plat* for other land subdivisions. This step requires soil tests, survey work, and a scaled site plan with infrastructure, building envelopes, lot lines, etc. This goes back out to a variety of agencies for a more in-depth review and may involve a second site visit.

The staff then writes a report with recommendations for denial, approval, or approval with conditions. A *public hearing* on the preliminary plat is held by the planning commission with planning staff, the applicants, agencies, and the public in attendance. Planning commissioners discuss what they have heard and then vote to approve, deny, or table the proposal. After the vote, the decision is forwarded to elected officials who hold a public hearing and accept or reject the planning commission's recommendation. If the proposal is approved, this procedure is repeated for the *final plat*. Protected area managers again have opportunities to provide input. Early input to applicants is almost always more efficient and less argumentative than input during the final public hearings. Protected area presence and testimony at hearings is important, however, since it is there that the applicant's final intentions are discussed and decided upon. Some applications will be more controversial and require more time than others.

Collaborate with local open space programs and efforts to protect agricultural lands. Open space and agricultural land protection programs typically purchase, retire, or transfer or restrict the development rights on the properties that they choose to acquire or protect. Open space and agricultural land uses next to protected areas can preclude many of the hassles created by more intensive forms of development (Mitchell et al. 1998; Knight et al. 1995). It is easier to allow fire, insects, disease, and wildlife to move naturally across such boundaries than it would be if land subdivision and development were present. Such acquisitions by local government and non-profit organizations can also multiply their effect for both parties when they are located adjacent to other protected areas. There has been a remarkable increase in public approval for locally and state funded open space and agricultural land protection programs. Such programs broaden the scope of biodiversity protection by connecting protected areas to the larger landscape and with each other and reduce the dependency on existing public lands areas for ecosystem protection.

Develop a memorandum of understanding. In order to legitimize the activities listed above, it is advisable to summarize them in a memorandum of understanding which describes mutual concerns and how you will initiate actions such as those

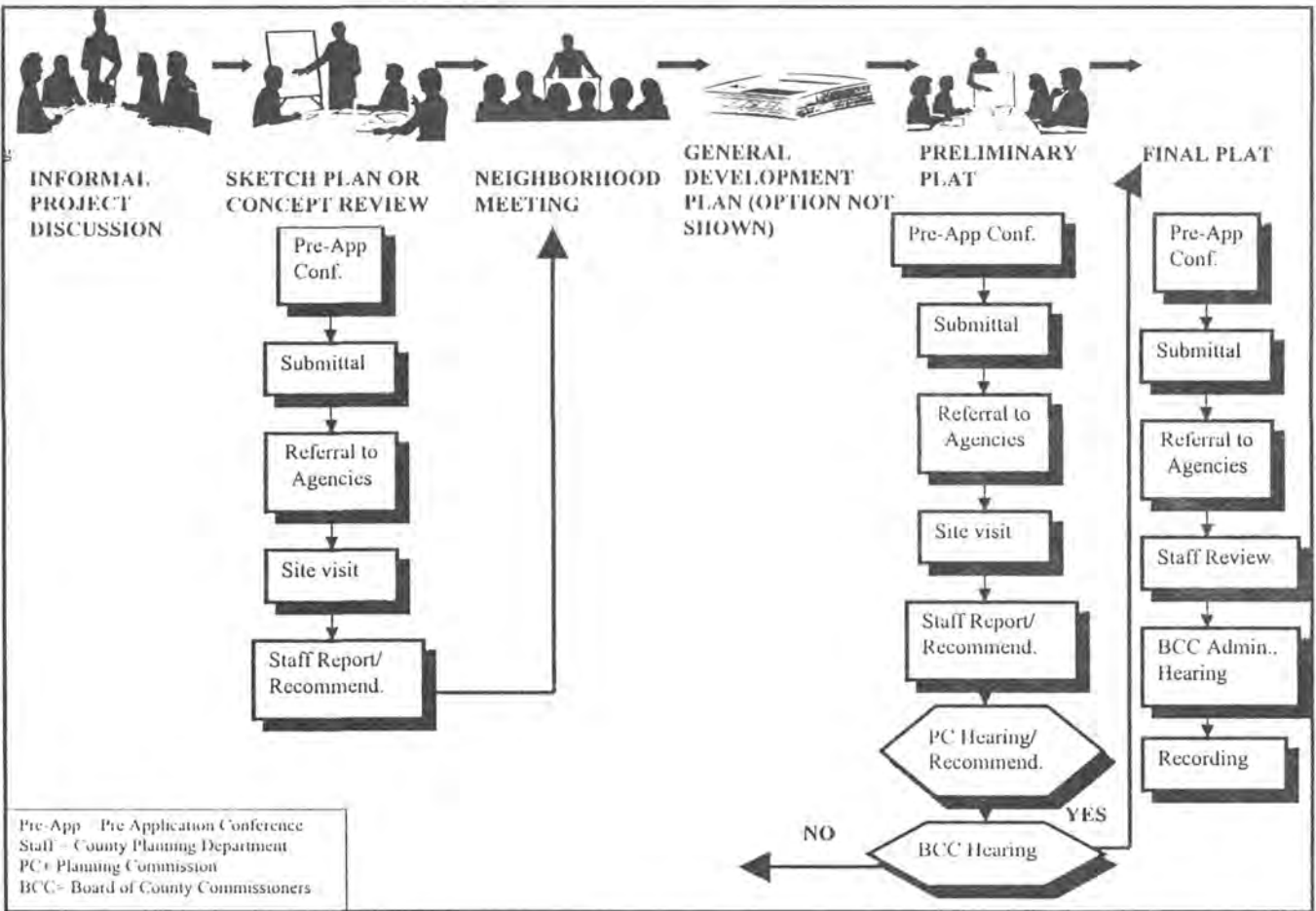


Figure 1. The land division review process: Minor subdivision, planned development, conservation development

listed above. Long-standing legal and territorial differences must be overcome to manage across boundaries. Federal land managers have not participated in most local land use decisions (states have principle jurisdiction over water, wildlife, air quality, etc.) and local government officials are under no legal obligation to collaborate with protected area managers. To overcome this, memorandums of understanding can identify particular matters of mutual concern, interdependencies, and specify the actions that will be taken to address them.

Use these opportunities to be an advocate of land and community health. Finally, involvement in the land use decision process is an excellent forum for managers to carefully explain issues of land health to those who are not natural resource professionals. The long-term implications of the loss of biotic diversity, the rationale behind ecosystem management, and the cumulative impact accruing to protected areas from adjacent development are poorly understood by the public (Freyfogle 1999). Hearings are now televised in many communities, and issues related to land use covered daily in local newspapers. Testimony during development review shapes opinion and becomes part of the public record. Decisions of record can slowly shape our collective attitude towards land health, protected areas and the relation of both to the quality of life in a community. Curt Meine (1998) observed how, early on, Walt Whitman encouraged Americans in *Leaves of Grass* to transcend boundaries with concepts of land health and cooperation. Among the passages on this theme is this one worth striving for:

*Come, I will make the continent indissoluble...
I will make the divine, magnetic lands...
I will plant companionship thick as trees along all the rivers of America and along
the shores of the great lakes, and all over the prairie.....*

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Resource Management and Monitoring Using Large-format Photography and GPS and GIS Technology

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Background and Purpose

In its 60-plus years of existence, the Historic American Buildings Survey (HABS) has used large-format photography extensively as a documentation tool. Its collection of over 175,000 photographs, along with other extensive documentation, is held by the prints and photographs division of the Library of Congress. These photographs are produced under a rigorous set of standards: they must be black and white, between 4x5 and 8x10 inches in size (with 5x7 being the most accepted standard), and taken with a view camera. This type of camera allows an experienced user to correct for distortions and to show a resource in its true perspective. There are also standards for the processing and handling of the photographic negatives and prints. The technical aspects of this type of photography goes well beyond the actual mechanics of operating the view camera; consideration of the historic significance, construction processes, materials, and structural attributes of the resource must be considered when composing the photograph. Documentation of a historically significant site is the primary purpose of the survey, but it is also the goal of the photographer to produce an aesthetically pleasing photograph within the context of producing a permanent, useful, record.

The management potential of this collection goes far beyond simple static documentation and inventory. Photographic documentation at various periods can show such variables as change and deterioration of the resource as well as change in the surrounding landscape. In order to utilize this documentation, it must be ensured that photographs are taken from the same vantage point at each occurrence. While a person might want a broad temporal variability, the geographic location of the camera must remain constant. Up to this point, information on camera location was held by the photographer and remained with them when they left or retired. With the advent of portable and accurate Global Positioning System (GPS) units and user-friendly Geographic Information System (GIS) software, the recording and display of camera positions, at least for outside shots, became a relatively simple matter. The GPS and GIS technology creates a legacy that remains with the photographs instead of the photographer. With this in mind, Blaine Cliver and Jack Boucher of the Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) approached John Knoerl, head of the cultural resources geographic information system facility of the National Park Service (NPS) heritage preservation services, about collaborating on a project in Puerto Rico.

NPS, in cooperation with the U.S. Army Corps of Engineers, has undertaken work to stabilize and restore parts of the walls of the fortifications within the San Juan National Historic Site. This has been a ten-year, \$45 million undertaking. Part of this work focuses on treating deterioration of the exterior stucco layer. Sandstone rubble and mortar were used to construct the walls. A sand, lime, and water stucco outer coating was then applied as a barrier to weathering and erosion. The present fortification walls are a result of over 400 years of development, which includes additions and demolitions over that period. In many areas of the fortifications the outer stucco layer is eroding or completely gone. There is archival evidence that replacement of the stucco was done as maintenance during the time of Spanish occupation. To determine the areas and extent of deterioration, Boucher was asked to re-photograph the walls from the precise vantage points he had used in documenting the walls and forts in 1960. In that survey, photographs were taken of the forts El Morro, San Cristobal, and El Canuelo and their related features. It was hoped that photographs

from different periods would not only show where the deterioration was occurring, but also alleviate concerns over the actual need for the re-stuccoing.

Methodology of Photographic Survey

Boucher returned to San Juan on 25 June 1998 and, working seven days a week, re-photographed the site, completing the survey on 7 July. Copies of the 1960 photos, as well as prints taken in the 1940s and earlier, were used as guides. Before the survey the photographs were labeled with a number and then roughly located on site drawings. Once in the field the sites were toured with park staff and the original vantage point was located as closely as possible for each photograph. The cooperation of park personnel and the local knowledge they had was crucial to the success of the project; Paul Hartwig, the superintendent, and Mark Hardgrove, the assistant superintendent, extended every courtesy and showed real enthusiasm for the project. Without the help of the maintenance supervisor, Angel Diaz, many of the locations would have been very hard to find. When Diaz was unable to accompany us as a guide in our initial search, he arranged for one of his staff to help us.

Finding the actual vantage point of the original photo was just the first step. Boucher then sought to re-create, using different lenses, the extent of the structure seen in the photographs. Other factors considered in reproducing the shots were the quality of the lighting and the angle and extent of shadows cast by the sun. Getting the appropriate level of lighting on the walls proved especially difficult, the original photos having been taken at different times of the year under different sun angles, yet this was a crucial component in producing images that showed the same detail as the originals. During this survey, more than 120 unique (and over 240 total) photographs were taken from 88 positions on the ground, as well as numerous 4x5 aerial (helicopter) shots and photographs in which a U.S. Coast Guard boat was used as a platform.

GPS Survey and GIS Development

During the photographic survey, a GPS position and attribute data were recorded at the camera position—a feature called a “photopoint.” GPS is a combination of hardware and software which, used together with a constellation of 24 communications satellites orbiting the Earth, can accurately calculate one’s position in map coordinates and capture attribute data related to those points at the same time. No other surveying system can produce the same accuracy combined with great speed. In addition, no other positioning methods can capture additional data about the coordinates you collect, and attach this information to the physical location for use in a GIS. GPS works by triangulating your position on the earth using both the constellation of satellites and a portable receiver. Using signals broadcast from the satellites, the receiver calculates the distance from your position to at least four different satellites, allowing the receiver to locate itself, and thus the feature being mapped, on the Earth’s surface.

The author used a Trimble ProXR unit, with real-time differential correction, and a TDC-2 data logger (a small hand-held computer) to collect the GPS data and record attributes. This GPS unit is accurate to within plus-or-minus 1 m after the data are corrected for errors. A data dictionary was developed prior to fieldwork in order to simplify entry of attribute data for the feature being mapped. This data dictionary contained attributes that reflected items Boucher would collect during a photographic survey. This will allow for the duplication of the field work by another trained photographer in the future. The attributes collected included a unique identifier for each photo, which corresponded to the photographic negative numbering system used by Boucher. Other attributes collected were a location (fortification name), structure name, camera bearing, and a field for a text comment. The GPS unit also recorded date and time information—important for capturing the same manner and level of light and detail in future photographs. Additional ancillary fea-

ture data were collected. This ancillary data included locations of Corps of Engineers benchmarks, points for registration of aerial photos and measured drawings, fortification walls, and some roads. The collected data were viewed and edited daily and exported as an ArcView shapefile format using Trimble Pathfinder Office 2.0 software.

The photopoint data collected in the field were combined with base data in ESRI ArcView 3.1 GIS software. The base data allows the photopoints to be shown in the context of the fortifications and the city of San Juan. The base layers include a map of Old San Juan and environs based on CAD drawings, HABS/HAER measured drawings of the fortifications, aerial photographs of Old San Juan and the areas including forts El Morro and San Cristobal, and a U.S. Geological Survey 7.5-minute digital raster graphic (DRG) of Isla de Cabras and the area of Fort El Canuelo. In the creation of this GIS, the various base data layers were geo-registered to the Universal Transverse Mercator (UTM) projection, zone 19, using the collected ancillary data. The CAD (.dwg) files were registered through the use of a world (.wld) file, and each layer was converted to an ArcView shapefile. The aerial photos and measured drawings, in TIFF (.tif) format, were registered using the REGISTER module in ESRI ArcInfo 7.1 to generate a TIFF world (.tfw) file. Scanned copies of all available photographs were hot-linked to the corresponding photopoint in the GIS. The GIS software gives access to the location of the photopoints on a base map, to related attributes, and to digital copies of all photos for that photopoint.

Conclusion

The use of GPS and GIS technology to document photographic surveys provides a legacy for this valuable form of documentation and formalizes the corporate memory. Managers can use this tool to quickly determine what photodocumentation they have and what areas are documented, and to provide a means to accurately re-photograph the site for monitoring purposes. Time is saved in the planning and execution of subsequent photographic surveys, accurate repetition of camera placement is achieved, and the season and time previous photographs were taken can be repeated during these surveys. The long-term benefits for the management of resources are numerous, and the ability to precisely measure change and detect deterioration is greatly enhanced.

The Historic American Buildings Survey and GPS

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"Here today, gone tomorrow!" could very well be the rallying cry of the Historic American Building Survey (HABS). According to estimates, of the more than 22,000 structures recorded by HABS during the first 50 years since its founding in 1933, nearly half had vanished over that period!

HABS was founded to produce a record of our nation's architectural heritage according to the highest standard of quality, using measured drawings, large-format architectural photographs, and written histories. These records are maintained for posterity in the Library of Congress' prints and photographs division in Washington. They are available to all for the minimum cost of reproduction only.

"The Historic American Buildings Survey: From Privies to Palaces" is the title of a talk I often deliver, and it is an apt description of this documentation program. The collection is a cross-section of architectural styles, types, and periods from the 12th century to the present, and from the vernacular to the extravagant. HABS' companion program, founded in 1969, is the Historic American Engineering Record (HAER). The documentation goals, policies, and procedures are similar, though HAER's emphasis is on bridges, railroads, mills, processes, and technologies. The HABS/HAER collection is primarily produced by summer teams of students laboring under the direction of professors of architecture from various schools throughout the country; by firms of architects, engineers, and preservation consultants working on mitigation projects (i.e., those in which structures are endangered by civilization's "progress," and where federal funds are involved, thus mandating that the structures be recorded); and even by qualified persons donating their time for a special cause to produce records.

The count changes daily, but at present there are records of roughly 35,000 structures in the collection, representing every state and possession in the Union. Drawings, photographs, and written histories total more than a quarter-million pieces. It is worth noting that the collection is no musty, dusty archive. Of more than 25 million pieces in the prints and photographs division at the Library of Congress, about 40% of the demand is for the one-one-hundredth portion of the collection that is HABS/HAER.

The photographs, drawings, and histories are found reproduced in thousands of books, magazines, journals, exhibits, and displays, and are also used to illustrate lectures. There have been cases in which structures have been lost and HABS/HAER photographs, drawings, and histories not only facilitated restoration, but justified compensating an insured party. Specific examples include records that have enabled the restoration or reconstruction of structures ranging from a church in Sitka, Alaska, to a Frank Lloyd Wright House partially destroyed by fire near Uniontown, Pennsylvania (not Fallingwater, but a house ten miles away, the Hagen House).

Records of our nation's history are priceless, for we learn from our past. The records HABS/HAER are now compiling are much the sort of records that would cause today's scholars to rejoice had ancient civilizations possessed the technology to produce similar documentation of their built environment. To my knowledge, only one other nation has a comparable program: England, with its superb National Monuments Records.

The "built environment"—it has a strong, a mighty ring to it. But how fragile it truly is. And, if anything, ours is less stable than those of ancient days. Modern construction is undertaken with a life expectancy of a single generation—about 25 years. The fact that in many cases this is quite fortunate is beside the point. Seriously, for

better or for worse, our architectural and engineering structures are a part of our patrimony.

Let me illustrate. Some years ago a portion of a lengthy assignment for me in Utah was to photographically record the city of Mercur, founded during the waning years of the 19th century, and significant as a gold mining center. Since we often make an effort to copy historic views for the archives, I was given a view of Mercur taken around 1905 (Figure 1). Taken from a hilltop vantage point, the image begged to be duplicated today to show how Mercur had developed. As anticipated, nearly a century had changed the topography and urban sprawl somewhat, but, after a good deal of time searching—GPS not having existed in 1905—I found what appeared to be camera ground zero. A little experimentation gave me the lens of the proper focal length, and I took a modern photo. Figure 2 shows Mercur today. So fragile was this built environment that it vanished well within a century!

Another assignment took me to a southern town to photographically document among other structures, a newly restored, grand, board and batten, Gothic Revival plantation house. Nearly a million dollars had been spent, and, as the carpenters and painters were moving out, furniture was being moved in (Figure 3).

This is a good moment to digress and tell you that, in documenting a structure such as this plantation, HABS will usually start with one or two views from a substantial distance to show the environmental setting—the structure's relationship to other structures, even to trees and topographic features. We then shoot an elevation—a photograph that is from a point directly and squarely in front of the main façade. We place in front a visible scale stick—a 14-ft telescoping pole marked in 1-ft white-and-red stripes. Then we'll take the same image without the scale stick. From there we proceed to perspective views and close-up details until we have, roughly, a dozen photographs of the exterior, including sides and rear, of the average two-and-a-half-story house. We'll then go inside and make about six or eight interior views of stair halls, significant rooms, fireplace, hardware, systems (heating, communications or early electrical), and attic trusses and other features significant to the structure. Exterior photos require a half-hour each to make; interiors can take from one to several hours each.

So it was that after two days at this plantation I still had another full day's work to complete. But, time had run out and other obligations and appointments waited. I knew I would be returning to the area in three months, so I left the rest to be done at that time. But about a month before I was to return, the director of the plantation called and said, "Jack, don't bother returning—we've had a problem." One night, during the period they were moving furnishings back into the house, it caught fire and was about 50% destroyed (Figure 4). HABS photographs were virtually the only graphic record of the restored house, and they enabled the house to be re-restored and furnished.

A city, a public building, a house, a canal, a railroad, an industrial complex ... what humans have built, either humans, nature, or both will tear asunder. There is a statue in front of the National Archives Building in Washington. On the pedestal is the inscription: "The heritage of our past is the seed that brings forth the harvest of the future." It is so that seed—represented by the elements of our built environment—is not lost to posterity that HABS and HAER were created.

The people that use the HABS/HAER measured drawings consider them not only superb records but artistically extraordinary, and they are accurate to a fraction of an inch in 100 ft. Historical documentation requires our historians to seek out primary (original) sources, and facts are carefully documented. Our photographs, about which I am most qualified to speak—it being my responsibility with HABS—are produced using a 5x7 inch large-format view camera fitted with engineering levels to ensure perspective correction within one-fourth of a degree (and, in practice, probably within one minute).



Figure 1. Mercur, Utah, ca. 1905



Figure 2. Mercur, Utah, late 1980s



Figure 3 (left). The stair hall in a newly restored Gothic Revival board-and-batten plantation house in South Carolina, when HABS arrived to photodocument the building. Figure 4 (right). Two months later, the stair hall and 50% of the house had been reduced to rubble by fire.

All work is done in black and white; because only black-and-white films are archivally stable. We do make a limited number of exposures in color, and these are used for as long as they last—seldom more than a few years. The film is medium speed (about ISO of 325), and all films are developed in an eight-step process to ensure archival stability. Once dry, they are handled with gloved hands, preserved in pH-neutral envelopes, in a temperature-controlled environment. When we make prints from these negatives, they are transported from storage to lab in a portable cooler. “Exposure”—no pun intended—to heat and moisture is therefore kept to a minimum.

To anticipate a question I’m often asked, with today’s very fine-grain films, why don’t we permit a camera and film size smaller than 4x5 inches? The answer is that, if anything, we would go to 8x10-inch format were it viable to do so. Financial constraints limit the number of photographs we can make in documenting a structure. We make photos that will record many details in a single view. And as a result, users of the collection will often require great enlargements of infinitesimal areas of a negative to reveal minute details such as cornice brackets, decorative elements, and so forth.

Since the majority of structures are identified as to location by a street address, or a country road description, locating structures for posterity has long been a problem. I’ve not read personally every entry in the HABS/HAER collection, but it would not surprise me to see an entry from the early days—or even recently as a decade ago—that reads, “From the intersection of Opossum Hollow Road and Township Road 2345, go 2.3 miles west on 2345 to the big oak tree. Turn left on the gravel lane just past the tree....”

I am exaggerating a bit. We do use UTM (Universal Transverse Mercator) coordinates now, and the records do include drawn-to-scale maps. But ... topography changes—remember Mercur, Utah? Structures vanish. *Cities* vanish.

Even a street address is not adequate; after all, Mercur has no streets left. There is no Mercur left! But even large cities change, as we are all well aware. An eight-block neighborhood is at this moment being buried by a massive convention center in Washington, D.C. It was once an area with fine row houses, stores, and churches. It was an area where many distinguished and historic public figures lived. The old structures are already gone without any record, and in our own backyard, so to speak! Even had they been recorded, there would have been no way, until recently, to pinpoint locations of documented structures precisely and in a practical manner.

This brings us to a recent joint effort in the National Park Service to re-document the wall of the massive fortress, Castillo de San Felipe del Morro in Old San Juan, Puerto Rico, part of San Juan National Historical Park. The walls of the fort have been stuccoed at times over its existence. The stucco was protecting the fabric, the stone, beneath it. But because of natural exposure to the elements and time, the stucco was decaying and falling off. For various reasons it became essential to make a photographic record of the walls. A photographic record had been made nearly forty years before. These views were now considered historic! That I was the photographer that had made the historic views in 1961 made the assignment very interesting. The views had to be retaken from exactly the same vantage point for comparison purposes.

The age-old question arose instantly: how to identify the exact spot from which each image has been taken—with certainty. It was done by park staff, partly through visual recognition, partly by taking a stack of a hundred 8x10s enlargements of the “historic” views out on the windy ramparts and battlements and eyeballing the scene. Again, GPS did not exist in the early 1960s!

This brought my colleagues, John Knoerl and James Stein, and yours truly together for the first time in what I am certain will be a long and highly desirable relationship. Stein and I sweated in the Caribbean sun for two weeks, duplicating a tad more than 100 views. After finding the approximate location by eyeball-matching the

5x7 ground glass camera image to the historic photos, I would make the exposure and move the camera after marking the center point beneath on the ground. Stein would then move in with his GPS equipment, and the rest you all know far better than I.

But I am guilty of oversimplification. The Linhof Master TL 5x7 monorail view camera (Figure 5) is a beast that, with the usual lens—which is but one of seven I have available in varying focal lengths—weighs about 32 pounds. It is mounted on a very large Gitzo tripod capable of elevating the camera 12 feet into the air. The tripod weighs about 22 more pounds. We transported our photographic and GPS gear in small electric golf-type vehicle, often carrying necessary items over terrain that was impossible for the little vehicle to traverse.



Figure 5. Angel Diaz (left) of San Juan National Historical Park and the author with the Linhof Master TL 5x7 monorail view camera

Replicating the historic views entailed siting the camera at a location where we could use the proper focal length lens, avoiding foreshortening caused by a telephoto lens that is too long, or diminishing elements by selecting an angle lens that is too wide. It was not unusual to spend a full hour replicating a single view. Even the time of day was critical: the sun had to be close to the original position for each view, lest the image appear contrived.

To show the effect of 40 years of weathering, and even of visitor impact in some cases, the comparisons had to be unaffected by light, cloud cover, and even the presence of visitors—no mean problem in a historic fort popular with tourists.

After the camera location and lens were selected and the photo was composed, the camera was leveled using the previously mentioned pair of engineering levels (accurate to approximately one minute) attached to the back of the camera. Focusing was done under a large black cloth with special magnifying bifocal glasses to ensure crisp detail.

The result is that now we know the location of some of the seeds that have been spread over the Earth ... the built environment ... that will contribute to the harvest of the future! Scholars, architects, historians, and more will profit by these records, the value of which are enormously enhanced by the ability to exactly locate the position from which the images were made through GPS.

Applying GPS to Historic Preservation and Architectural Surveys

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Increasingly, new technologies are expanding the horizons of historic preservationists, making their fieldwork and research more efficient and their contribution to regional planning more significant. As Global Positioning Systems (GPS) technology grows in effectiveness as well as accessibility, it will also become a major tool for cultural resource management. At the National Park Service (NPS) cultural resources GIS program, we already are exploring the use of GPS, in combination with Geographic Information Systems (GIS), to better manage and protect the resources within park boundaries. As part of our efforts, we engaged in a new project to determine the utility of GPS in architectural surveys. Our goals included the investigation of how GPS could enhance and improve the survey process, as well as the development of methodologies which could be used by others.

For historic preservation and cultural resource management, accurate locational data is key to our success in learning about past building traditions, settlement patterns, and past lifeways. Identifying and following trends on the landscape requires that we be able to locate resources on the ground. In addition, for management, conservation, and physical preservation of these resources, we also want to know the environmental and human influences that might pose any adverse effects to specific resources. Collecting the locational data with GPS as well as basic attribute information associated with individual features, and combining that with the power of GIS to integrate different data sources, allows preservationists to take advantage of these technologies in planning and researching cultural resources.

Architectural Survey and Documentation

Architectural survey and documentation form the cornerstone of historic preservation efforts. Resources identified during the survey process provide the information base from which planners, cultural resource managers, and other preservation professionals make decisions, develop theories, and study material culture through structures.

Surveys are conducted through State Historic Preservation Offices (SHPOs), Tribal Historic Preservation Offices (THPOs), certified local governments (CLGs), and federal agencies that are all charged with developing and maintaining an inventory of historic resources. For NPS, this inventory would include the List of Classified Structures. The National Historic Preservation Act of 1966, which created SHPOs, THPOs, and CLGs, requires that any agency receiving federal monies for development—including NPS—to conduct surveys of cultural resources, both architectural and archaeological, which may be adversely affected by the construction or disturbance.

Surveys may be conducted at different scales, and collect different information about each resource, depending on the agency conducting the survey and its goals. For the most part, these surveys take the form of either a reconnaissance or intensive level of data collection. All architectural surveys collect basic information regarding structures over 50 years old, including basic conditions, integrity, form of the structure, and identifying features. Reconnaissance surveys take a more cursory look at a buildings, collecting only the minimum of data, while an intensive-level survey would involve investigating a structure's interior and associated features, as well as the background and history of a structure or group of structures.

Once resources have been identified as significant through the survey process, the documentation process ensures that no information encapsulated within the resource is lost if destruction is imminent or the resource is threatened in some way. Conducted at differing levels of intensity (similar to the survey itself), documentation of a

structure might include a variety of activities ranging from taking a series of photographs which captures the significant features of the resource, to creating measured drawings which accurately reproduce the structure on paper, to constructing a detailed history of the property through historic documents.

In particular, measured drawings—which depict the structure in floor plans, elevations, sections, or site plans—enhance our understanding of a resource. Placing these drawings with real-world coordinates using GPS and associating photographs, documents, and survey information, as well as related spatial data through GIS, offers preservationists a new way to examine the resources in relationship to each other or individually, re-establishing the historic context of the structures and making them an even more informative research tool.

Purpose of Our Project

The main purpose of our project was to investigate the utility of GPS for architectural survey and documentation and to expand our experience mapping cultural resources with GPS. But we also wanted to develop some useful methodologies which other national park units, states, organizations, and researchers could apply to their own work. First, we chose to add GPS to the standard reconnaissance architectural survey to determine if we could effectively capture the required data and reduce the amount of time spent in the survey process. Second, we chose to add GPS to standard documentation practices to determine the utility of geo-referencing site plans depicting the location of a variety of historic resources in relationship to each other. To accomplish this, we worked with the Historic American Building Survey (HABS), a branch of NPS, on a project to document Fort Washington National Historic Site, a nineteenth-century fortification outside of Washington, D.C.

At Fort Washington (Figure 1) we pursued the use of GPS in both architectural survey and documentation. The HABS documentation team created a detailed site plan of the fort, including the ramparts themselves, as well as the various related structures within the walls. In conjunction with the HABS efforts, we collected locations on both individual resources, such as gun emplacements within the fort, and significant points of reference, such as the location of transits used in the documentation itself. Additionally, throughout the fort and associated grounds we collected locational and survey data for building footprints, as well as single points on structures within the shadow of the walls.

Methodology

Our basic methodology employed a combination of standard procedures for conducting both a GPS survey and an architectural survey and documentation. We began by assessing the probable end uses of the data for both of the projects. Once we determined this, we decided on the type and the level of positional accuracy we would need for the end data and what features and attributes to collect in the field. Once the features were defined and the associated attributes determined from the National Register of Historic Places form (a national standard), a data dictionary was developed.

For both the architectural survey and the site plan geo-registration, we determined that the collection of accurate vertical data would not be necessary: at this point, the end use was only to look at the X,Y location of the resource in a GIS format. Other sources of data, ranging from U.S. Geological Survey (USGS) topographic maps to digital elevation models, would be used to get elevation as needed.

In the case of the architectural survey, the anticipated end use was having a point or polygon to represent a building and place it on the X,Y plane of a USGS 7.5-minute topographic quadrangle map. In the context of such maps, with an accuracy standard of plus-or-minus 12 m, the data could be collected and differentially corrected to an accuracy of plus-or-minus 1 m (mapping grade).



Figure 1. Fort Washington National Historic Site

For the architectural survey we chose to use the National Register form, developed by NPS to define the associated attributes to be collected. The attributes could also have easily been defined from the List of Classified Structures, more familiar to park units, or from any other relevant sources. Working with the data dictionary, the specific unique features we were targeting were a point or polygon, representing the location of either an individual building (point) or footprint (polygon). Only sections from the National Register nomination form that included menu picks and short answers were included in the data dictionary. Sections that called for descriptive narratives or sketches and drawings will still be completed on a hard-copy form or laptop computer. It should also be noted that developing a data dictionary is an iterative process and changes will, and should, be made to reflect knowledge gained through use.

The end use of the site plan registration was a little more complicated: the uses ranged from simply showing the real-world relationship of numerous planimetric drawings of the cultural resources at a site, to using the drawings to do query and analysis of the GIS data. Another consideration in choosing the accuracy of registration points is the fact that many of the plan drawings of cultural resources are at a large scale, inches representing feet, and have a high level of detail (Figure 2). In view of this, it was decided to record carrier phase to allow the collection and differential correction of data to an accuracy of 1 decimeter (survey grade).

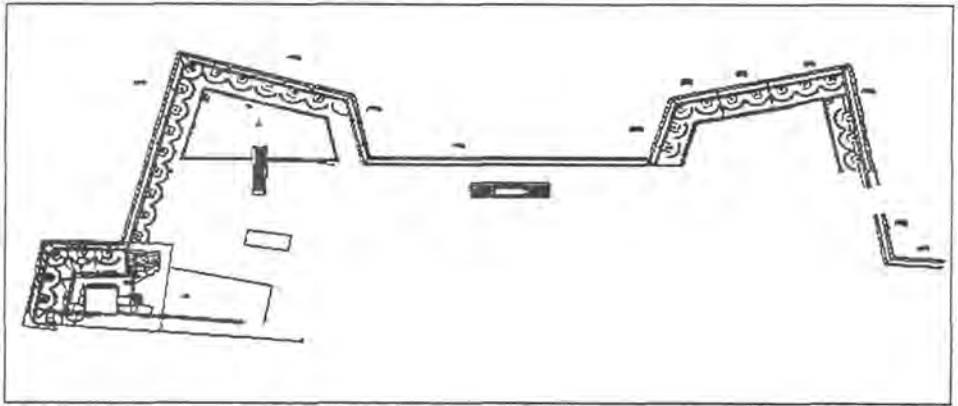


Figure 2. Measured site plan of Fort Washington

Minimal associated attributes would be collected since the GPS data would be used to register the drawings only and would probably not be part of any query and analysis. This data could easily be taken using the generic point feature in the default data dictionary. We used a simple point feature with the attributes being a point identifier, simply a number, and an optional comment.

Trimble ProXL and ProXR 12-channel GPS units were used for all fieldwork at Fort Washington. The post-processing and editing of the data were completed in Trimble Pathfinder Office 2.01. The data was exported as a sample ArcView shapefile set-up for use in ESRI's ArcView 3.1 GIS software, but the use of Pathfinder Office allows for the data to be exported into various formats for use in other software packages.

During the architectural survey project fieldwork, we collected the locational data as both point and polygon (as a building footprint). The same attribute data was collected for both types of features, a version of the National Register nomination form. We also filled out the complete hard-copy version of the survey form to compare the times for completion of both formats. In addition to the architectural survey, we took ancillary data, such as the location of streets and roads (Figure 3).

Results of the Survey and Documentation Projects

The results of our field trial were mixed, yet they did provide us with good information about the utility of GPS for architectural survey and documentation, as well as helping to define what we could realistically expect from GPS technology for preservationists. We found that, overall, GPS could be an extremely useful tool for architectural surveyors; however, because of particular constraints on this type of survey, users must take into account some significant drawbacks to using this technology. The use of GPS for geo-registering site plans and other measured drawings proved even more successful.

With the survey process, we found that, because of the height of buildings (or, in our case, the height of the solid masonry fortification walls), reception of the satellite signal was often blocked. In addition, taking building footprints was difficult and time-consuming. We encountered physical barriers (fences, outbuildings, etc.) when

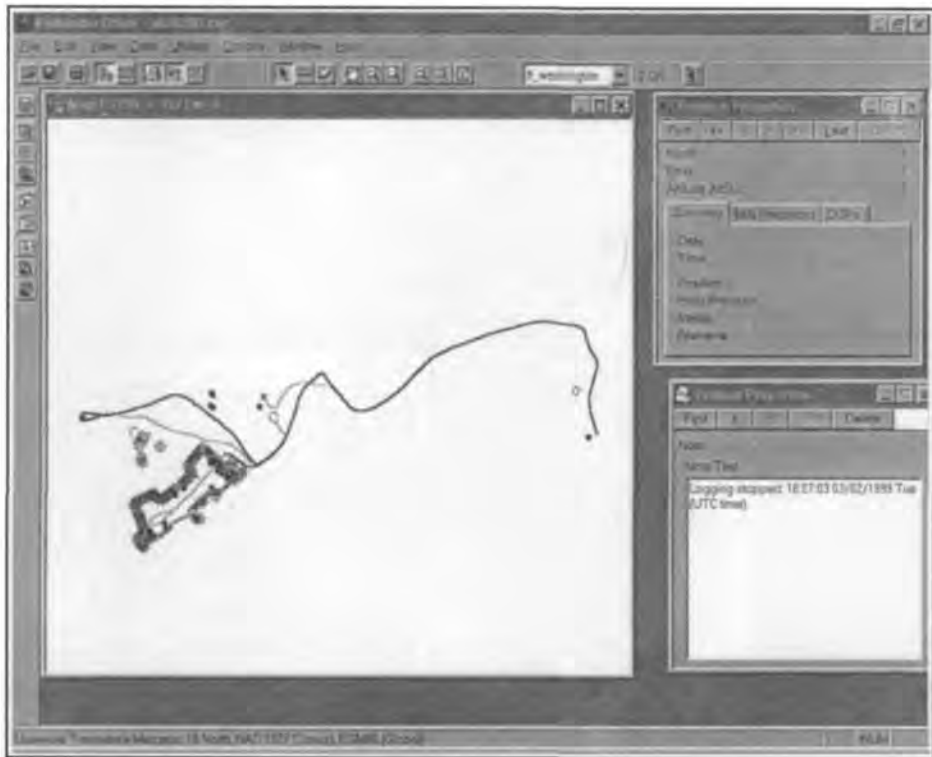


Figure 3. Ancillary data for Fort Washington site

attempting to map building footprints. The blocked reception made it necessary to use the offset option to take points on a majority of the buildings. Offset distance and bearing were measured using a tape and compass; the use of a laser range-finder would have made the measurements more accurate and quicker. The use of the point feature to map the locational data of the architectural survey worked each time we attempted it, and the time it took to complete was minimal. The data collected lined up well after post-processing and export (Figure 4) and when overlaid on a USGS digital raster graphic 7.5-minute topo quad.

When taking the attribute data, we found no significant time difference between entering the data in a data logger by keyboard and entering them on the traditional paper survey form. In addition, the data are already in a digital format, eliminating the manual entry into a digital database format. These data can then be exported into a database format from Pathfinder Office. Additional time is saved by having the building located in real-world coordinates with meter accuracy, something traditionally done with a measuring device off of a paper map (often a Universal Transverse Mercator (UTM) counter and a 7.5-minute topo quad map). The accuracy issue can not be overemphasized: the techniques eliminates the built-in map accuracy standard error and the human error that creeps in while taking measurements manually.

Using the site plan drawings in the field, matching points on the ground and the site plans were chosen as registration points to test the GPS for registration. The points were chosen such that they appear very clearly on the plans and in the field, and are widely separated around the site. Carrier phase mode was used to record the

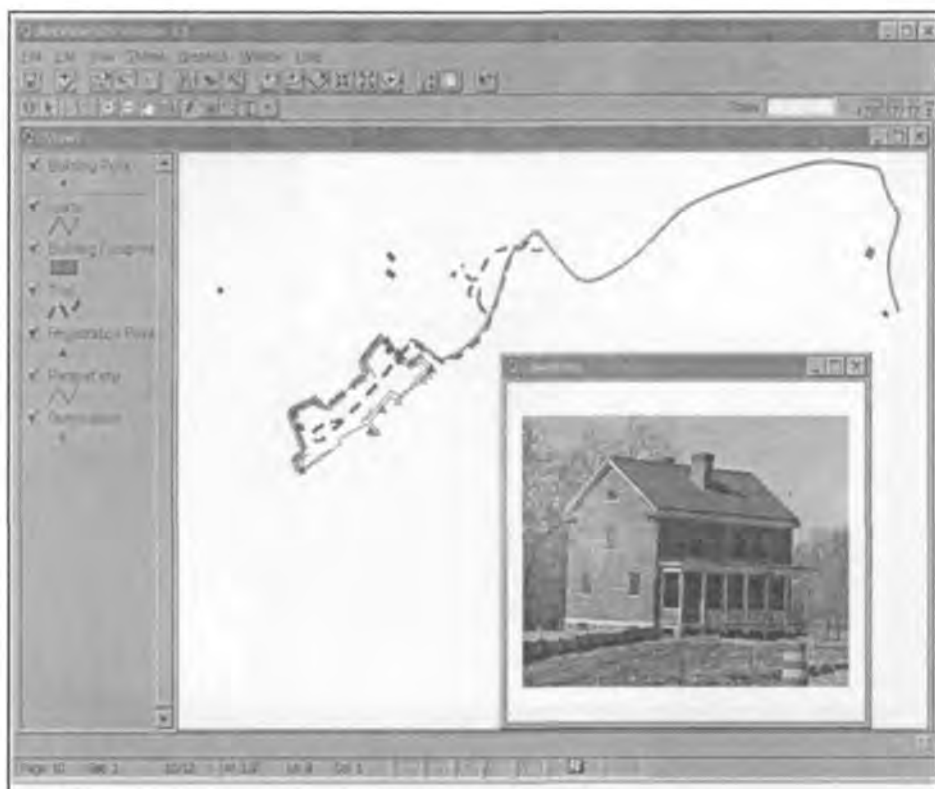


Figure 4. Post-processed data

registration point feature in order to get high (decimeter) accuracy. To successfully record in carrier phase mode the antennae must remain stationary (i.e., be mounted on a tripod) for the entire time of occupation (we used the Trimble suggested occupation time of 10 minutes), and at least four satellites must be visible during this time. Because of these limitations, Fort Washington is a perfect site for a test: it is a walled masonry fort on the crest of a hill, and the walls are higher than surrounding vegetation and buildings. A clear line of site was available on top of the fort to maintain reception of visible satellites.

Once registration points were chosen, the set-up is very straightforward. Options are entered in the data logger ("phase" soft key in GPS Rover Options). The antennae height must be entered to get an accurate measurement (only required when recording in carrier phase mode). Carrier phase mode can be made optional, with a prompt appearing before a point feature is recorded. The registration points are then used to geo-register the site plan drawing. We used ArcView 3.1 GIS software (Figure 5). The software one uses will determine the accuracy of the geo-registering. In our case, the site plans were in a computer-assisted drawing (CAD) format (.dwg) and the registration in ArcView was done by referencing only two points (a .wld file was linked to the drawing). The degree of accuracy was therefore relatively low.

The accuracy of geo-registering can be improved by using software which allows for the use of numerous points. The accuracy needs of the user must be determined before the data are collected; one may not need to record points in carrier phase mode for decimeter accuracy, and when deciding on a geo-referencing strategy.

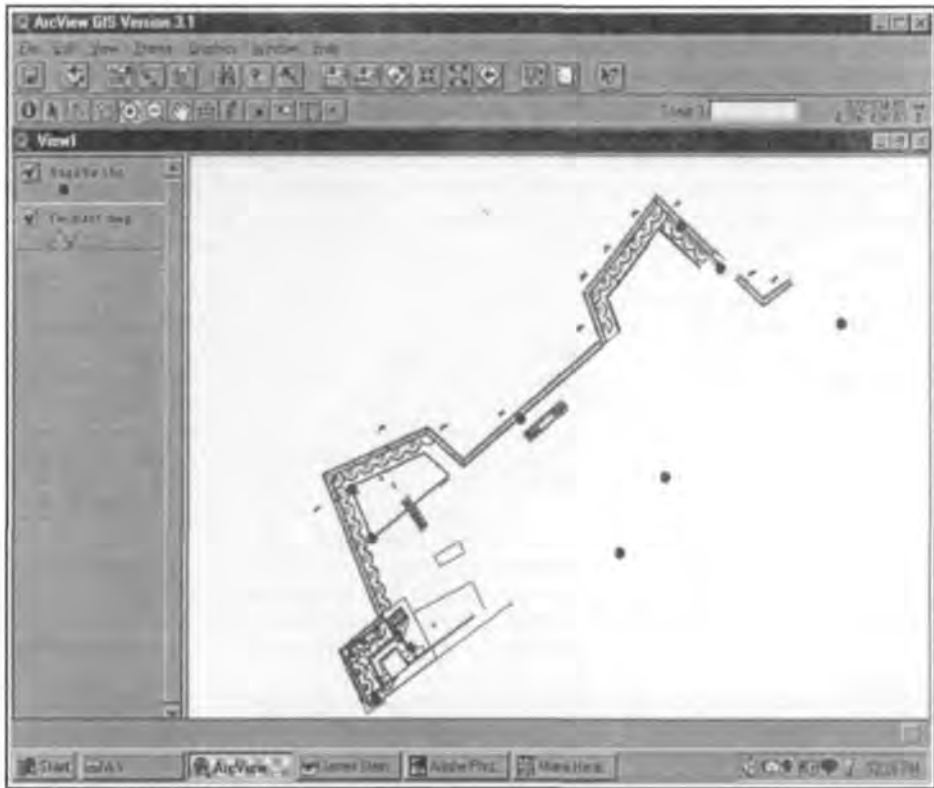


Figure 5. Site plan

Conclusion

This initial use of GPS in architectural survey and documentation was successful in producing meaningful results. We found that we can improve on locational accuracy in the architectural survey process, and in fact produce locational data where surveyors may not have collected this information, even if only a single point (rather than a building footprint) is collected. In addition, this process of collecting locational data does not significantly increase the amount of time spent in the field, and it greatly reduces the amount of time surveyors may spend recreating their paper forms in a digital database after the survey is completed.

Working with HABS/HAER representatives, we also concluded that georeferencing site plans added significantly to the interpretation of historic resources. Through the referencing process and the use of a site plan in a GIS, architectural historians and conservationists were able to locate features, determine treatments, and form various hypotheses regarding the spatial relationships between elements of decay or potential threats to features of the fortifications.

GPS technology already plays a role in cultural resource preservation, and it will become even more important as GIS becomes more widely used by cultural resource professionals. The strategies for the use of GPS that we present are only two of many uses for this technology in the field, and they are only models and need to be perfected and tailored for individual projects. It must also be emphasized that GPS is only a tool, one of many, and this tool is only as good as the user. Care must be taken in all aspects, from pre-planning to data collection to post-processing.

Based on our experiences with this project, the dynamic combination of GPS and GIS can make architectural survey and documentation a more efficient and useful process so that preservationists and planners can work together with other cultural resource managers. The methods we used can enhance the preservation of structures, as well as the ability of preservationists to understand and manage resources. In the future, these technologies will play a critical role in capturing and maintaining cultural resource data, managing the resources themselves, and planning for their proper treatment.

Policies and Strategies for the Sustainable Management of Protected Areas in Vietnam

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Background

Article 31 of Vietnam's forest protection and development law (1991) states: "Special use forests are to be used for the conservation of nature and of nationally representative ecosystems, as flora and fauna gene banks, for scientific research, for the protection of historical and cultural heritage and of beauty spots, and to serve tourism and relaxation purposes..." In Vietnam, special use forests are understood to be protected areas, and are classified as: national parks, natural reserves, historical heritage areas, and scientific research areas. In 1962, the government designated Cuc Phuong Forbidden Forest, which later became the first national park of Vietnam. Since then, a system of special use forests has been created, along with many legal documents governing system management and development.

Currently, Vietnam has designated 107 special use forests, with a total area of 2,119,509 ha, equivalent to 7% of the total area of the country (MARD 1997). There are 11 national parks, 64 natural reserves, and 32 cultural, historical, and environmental sites. These special use forests, distributed from north to south, are representative of different ecosystems and climates: from tropical to non-tropical, from wet to dry, from highland to delta and islands. They encompass broad- and narrow-leaf forests, mangroves, and wetland. They also conserve many of the endemic species of Vietnam.

The special use forest system carries a high value in terms of biodiversity, not only for Vietnam but also for the region and globally. Scientists inside and outside the country have undertaken many investigations on the biodiversity and different ecosystems of Vietnam. These studies have discovered new mammals, such as *Pseudoryx nghetinhensis* (1993) and *Megamuntjack vuquangensis* (1994), and, more recently, the mini-muntjack (1997). If the special use forests are adequately managed, 70% of Vietnam's rare and threatened species would be secured (Dang 1997).

The special use forests are located mostly in mountainous, remote, and socio-economically poor areas (Hoang 1997). About 250,000 people still live in the special use forests, mainly from Vietnam's ethnic minority groups. These local peoples often have important and long-standing relationships with the forests. For centuries they have depended on the resources of these areas for their livelihoods, and the forests' resources have shaped their culture and traditions. They hunt wild animals, pick fruits, and cultivate land on the mountainsides. Historically, they live in harmony with nature. They were the earliest ones who knew how to protect nature and exploit it sustainably. Their customs and habits express that clearly (Vo 1997). Now, however, their living standards have fallen and traditional knowledge has eroded. They still practice shifting agriculture, and have destroyed many primary forests. But even more striking is the large number of people living in the buffer zones of the forests: about 5 million in 100 communes. They do not have enough land to cultivate, and on top of that the population growth rate is very high and living standards are poor. Buffer zone residents often log forest trees for timber and firewood, and gather other forest products as well as hunt forest animals. These are the factors that have the most impact on the stability of special use forests.

The government has formed various forest protection districts and management stations in and around the special use forests. Up to now, only 50 of the special use forests are managed directly by a separate management board. The remainder are managed by their respective provincial forest protection departments (MARD 1997).

Constraints on Special Use Forest Management in Vietnam

There are many constraints on the management of special use forests in Vietnam. The most serious is the conflict between communities living in the forests and buffer zones and the management boards or other protection authorities. This conflict has gone on ever since Cuc Phuong was designated in 1962. This is actually a conflict between nature conservation and community development. There is a need to have appropriate policies and strategies to solve the conflict, that is, to achieve conservation targets while at the same time enhancing peoples' living standards and welfare (To 1997).

Constraints related to system configuration and areas:

- Some nature reserves with special value are too small in size (<10 000 ha)—not sufficient to encompass home ranges of wildlife.
- There is a need to have more marine parks, wetland reserve, and transboundary nature reserves.

Constraints related to management:

- Basic surveys of forest resources are still in their early stages. Many new species have been found, but their numbers and distribution still unknown.
- The organization, staffing levels, technical skills, and facilities of the management boards are still inadequate. Personnel, including top personnel at local levels, still lack the professional skills to be able to accomplish their given tasks.
- Vietnam lacks a national protected area management body, so the allocation of special use forest management is still blurred between different sectors of government. Overlap still occurs, there is a lack of cooperation in management, and the activities being carried out are not really in focus.

Constraints related to investment:

- Up to now, about 50% of the special use forests has not been financed, thus affecting the management, protection, and organization of activities (MARD 1997).

Constraints related to policies:

- We still haven't got an effective policy on enhancing the living standards and providing employment for people living in the buffer zone. There is a need to provide land and employment for local people, especially the poor and the ethnic minorities.
- Once the government designates as special use forest an area where the people have lived for a long time and have always depended on the forest for a living, it means an important source of their livelihood has been lost. How will these people carry on? Moving them out of the area is not necessarily the best solution—and besides, this is never an easy solution. On the other hand, letting them stay in an area that needs to be protected to a sustainable level in terms of biodiversity is not a simple job either. Up to now, regulations on this issue have been unsuited to the characteristics of the communities living in the special use forests.

Proposal on Developing the Special Use Forest System in Vietnam, 1997-2001

Development philosophy:

- Conserve the biodiversity of national and international value. Conservation must be considered along with development.
- Wholeness: nature conservation means the conservation of forest, wetland, and marine ecosystem. Ecosystems representing all regions of Vietnam must be conserved.
- The protected area must be in proportion to the area of the country as a whole, as well as to that of forested land, suitable with the potential of Vietnam's tropical

forest potential compared with that of similar countries in the region and around the world.

- The government is to be the owner of special use forests, and each year would invest money (mostly from the basic development budget) in the forests.

Planning and feasibility studies:

- The government should re-evaluate existing special use forests to discard those that are no longer valuable, expand those that are, and, at the same time, designate more areas as special use forest, as appropriate. The legal documents for special use forests must be better defined, and proposals in existing feasibility studies must be implemented. The proportion of special use forest should be 10% of the total area of forested land (MARD 1997).
- There should be large-scale maps for all special use forests. Boundaries must be defined both on the map and on land to a level of detail equivalent to that of the commune unit.
- All newly proposed special use forests should have a feasibility study done.
- There is a need to define clearly the right to own and use land inside the special use forests, so that appropriate and detailed policies can be developed.

Organization:

- The government is to regulate special use forest management, defining functions, responsibilities, and organizational structures for each type of special use forest. Each special use forest should have its own management board. They should be run as economic units generating their own incomes. Special use forests are not to be managed by companies (even state-owned enterprises).
- A classification of special use forests should be undertaken, applying the standard IUCN classification categories (IUCN 1994), with adaptations for Vietnam's situation.
- Service activities should be developed, especially to support scientific research and tourism.
- Management duties should be clearly allocated, avoiding overlaps, so as to enhance management effectiveness. The national Ministry of Agriculture and Rural Development should directly manage the national parks and nature reserves of national value. Other nature reserves can be managed by provincial peoples' committees.
- A management body that take responsibility for all special use forests should be created.

Information dissemination, education, and training:

- Information dissemination, education, and training activities should be promoted to people living in buffer zones to increase their conservation knowledge while at the same time encouraging activities aimed at increasing income, creating more employment, and using natural resources in a more sustainable way.
- The management capacity and professional skills of officers who work in special use forests should be improved by short- and long-term training, including workshops both within and outside the country.

International cooperation:

- International cooperation should be promoted so as to learn more about and make use of the experiences, facilities, training, and finances of foreign countries as well as international organizations (e.g., IUCN, United Nations Development Program, the Food and Agriculture Organization of the United Nations, World Wide Fund for Wildlife, Swedish International Development Agency) and non-governmental organizations, especially those in Asian countries similar to Vietnam.

Policies and Strategies for Sustainable Management of Special Use Forests in Vietnam

Up to now, many policies and legal documents governing special use forests have been implemented. However, they are not very realistic, cohesive, or effective. Evaluation of the effect of existing policies, and proposals for new management policies, are a necessity. New policies should emphasize both integrated rural development and forest protection.

Looking back to the existing policies, one can see that most of them concentrate on prohibitions and punishments of people who violate regulations. Very few of them pay attention to socioeconomic conditions in the buffer zones. It is important to recognize that, unless policies benefit the people, any prohibitions and punishments will be hard to implement (To 1997).

There is a need to have additional policies that:

- Regulate investment, cooperation, and development in special use forests;
- Encourage ecotourism;
- Address socioeconomic needs in the buffer zones;
- Promote tight cooperation between management boards and local governments to help people improve their agriculture techniques, and gradually establish a new life within the special use forests (Vo 1997);
- Foster a multi-disciplinary and multi-level approach to forest management;
- Provide incentive policies to entice people to become officers and staff in the special use forests (recalling that most of these forests are in remote and difficult-to-reach areas); and
- Pay more attention to personnel training so that there are thousands of qualified officers—a work force able to take responsibility for managing special use forests in the coming century.

Sustainable management of special use forests should begin with eliminating poverty by developing integrated rural development projects, while at the same time enforcing laws and regulations consistently and even-handedly, firmly punishing violators. Policies and regulations should work together to enhance the living standards of people in the buffer zones (Nguyen 1997). Only when this happens will Vietnam's special use forests be truly protected.

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United States National Park Service Assessment of Haiti National Parks in the Context of Ecotourism

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Haiti, the poorest country in the Western Hemisphere, is suffering a rapid deterioration of its natural resource base. With a population of seven million people on about one-third of the island of Hispaniola, Haiti has the highest population density in the Western Hemisphere. Despite its relatively small size, Haiti has an unusually diverse array of ecosystems and endemic species. Ecosystems include alkaline, inland lakes, coastal mangrove forests, dry-scrub forests, savannas, and moist forests on peaks reaching 3,000 m of elevation. About 30% of Haiti's plant and animal species are endemic to the island of Hispaniola—a greater percentage than is found in the larger and less environmentally degraded Dominican Republic. This richness is due to the wide range of rainfall and topography and to the fact that Haiti is a combination of two geologically distinct islands supporting different biological systems—one originating in the North American continent, the other in South America.

Haiti's natural resources, especially its forests, have been exploited since colonial times. Europeans cleared mountain forests (chiefly mahogany, ironwood, and logwood) to establish coffee plantations, and used agricultural practices that promoted soil erosion. Haiti's rural poor, especially the landless and land-poor, have traditionally cleared forests to farm and to sell timber and charcoal. Fuelwood, and especially charcoal used in cities, have historically accounted for most of the energy resources used in the country.

The pace of degradation of forest resources accelerated rapidly over the past several decades. According to World Bank assessments, these resources are now close to the point of total depletion. Forest cover dropped nearly 40% between 1956 and 1978, and is now estimated to represent less than 2% of all land area. Twenty-five of the 30 major watersheds are devoid of closed-canopy forest. Forests are now reduced to small and isolated patches usually associated with steep ravines and high mountain peaks. As a result, many plant and animal species are severely reduced, and many face extinction. In many situations, the unsustainable exploitation of trees is the only remaining income-generating option available to the rural poor.

A majority of the remaining forest in Haiti is located in and around three national reserves—the Pine Forest National Reserve, the Macaya National Park (Parc Macaya), and La Visite National Park (Parc La Visite; Figure 1). These three areas encompass the habitats of a great number of threatened and endangered endemic animal and plant species. For instance, some 80% of remaining Haitian bird species are represented in Parc La Visite. Additionally, these park areas are located at the headwaters of several of Haiti's most productive agricultural areas and the aquifer from which Port-au-Prince draws most of its potable water.

An assessment team from the U.S. National Park Service (USNPS) visited two of Haiti's three major protected areas, Parc Macaya and Parc La Visite, in March 1999. The team planned to explore park management issues with Haitian personnel and the potential for ecotourism in Haiti's parks. However, these concerns seemed premature, if not irrelevant, in light of more elemental problems that were identified. The team found the sites in very degraded condition, few signs indicating park boundaries,

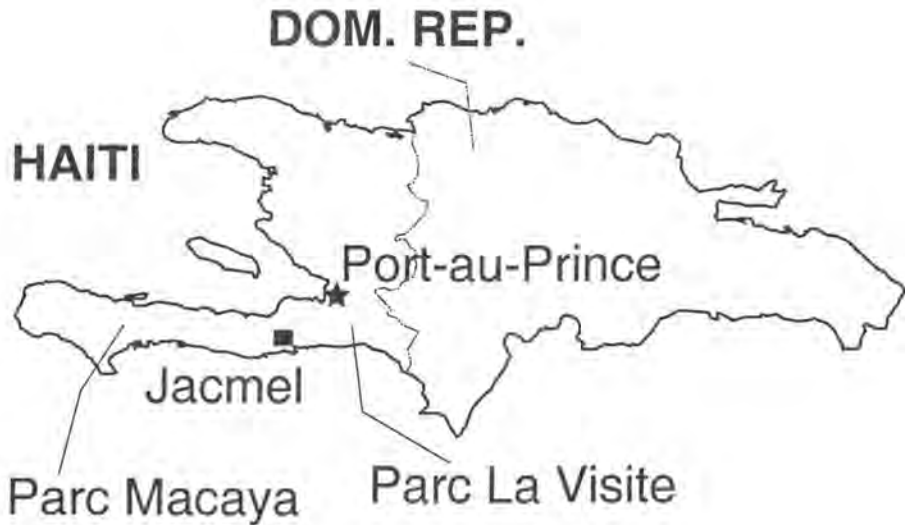


Figure 1. Location of Parc Macaya and Parc La Visite, Haiti

little evidence of on-going conservation activity, and no park officials residing in the park or the local communities. In short, the assessment suggested that developing new government organizational structures and acquiring equipment for officials resident in Port-au-Prince had taken precedence over the more basic goals of the project—protecting park resources and providing alternative activities to generate income for people living in or adjacent to the parks.

While there are understandable problems and delays in creating a brand new park service, it should not come at the expense of establishing the actual parks. Without a “field first” orientation in activities, there will soon be no habitat for the park service to protect. This paper provides a summary of our impressions from the park sites and from our meetings in Port-au-Prince with individuals and groups working towards conservation of these highly valuable regions. A variety of problems and possible solutions are discussed, as well as the great potential for conservation and development efforts in the parks.

Better health, education, access to potable water, and economic alternatives for residents living along the borders of the park are environmental issues. If local people do not see tangible benefits of conserving the forest, the local pressure to overexploit remaining resources will overwhelm the park service. Current economic programs

seem too narrow in focus and hindered by the bureaucracies of state agencies, ministries, nongovernmental organizations (NGOs), and consultants. The pace of implementation appears to be a chronic problem and not just one of initial start-up delays. The current political crisis in Haiti cannot be accepted as an excuse because it, too, is likely to be chronic over the next several years.

The structure of the Haiti Forest and Parks Technical Assistance Project (ATPPF) program is ambitious and well-thought-out. However, there are both short- and long-term needs among local people that will not easily be met under the current bureaucratic structure. The team suggests that a private foundation outside the project be contacted to provide integrated services and local training. (The Soros Foundation is active in select locations in Haiti.) Current programs based on NGOs will be slow to respond to the needs of relatively large populations with diverse problems of access to resources and power. Local people must have alternative avenues to solve problems that are now passed off as the responsibility of some other government ministry.

A professional, non-confrontational presence in the parks by should be established by providing a residence for an on-site superintendent, complete with the amenities and incentives to make living in it desirable. In the case of Macaya, which has three different regions with different access routes, there may be a need for more than one superintendent. While recognizing the issues of family and bureaucratic obligations in Port-au-Prince, there is no substitute for having the park service represented by a person or persons who will integrate themselves within the buffer zone communities and demonstrate to them a commitment to conservation and development.

The need for demarcation of the park boundaries can be found in the project documentation going back as far as 1988. While this process is just now starting to take shape in this project, there are many areas of both parks that even the local people already recognize as belonging to the state. Beginning with these easily recognized zones (such as those above 1,300 m or within the most densely covered broad-leaf forest), the superintendent should establish boundaries. By doing this on state-owned lands, the park service can begin identifying and focusing on those residents who are dependent on these areas for gardens, pasture, or fuelwood while limiting the problems of future encroachment by outsiders.

No issue was as readily apparent to the USNPS team, local residents, and Haitian park personnel as the need for improved roads up to and inside the parks. While the issues of overexploitation because of improved access are formidable, the plans for future conservation and development will probably not occur with the current road system. Inadequate roads and trails not only keep out the casual visitor, they also cripple technical assistance programs, destroy productive farmlands, and make life dangerous for residents. A variety of alternatives should be explored for improved roads and trails surrounding the parks and crossing through the protected areas. The needs of local people on this issue must be addressed. The project cannot be considered participatory if certain alternatives are rejected out of hand because of the risk posed by roads. Local people throughout the Macaya region, for example, have often exploited this issue by blocking the access roads and thereby asserting their power over outsiders in their four-wheel-drive vehicles.

Great potential to develop ecotourism exists in both parks we visited, but it will have to be subsidized financially, at first—perhaps for five years or more. Each of the parks could be developed according to a different model. In both models, sustainable infrastructure would include roads, lodging, power, and water. Ideally, these amenities would eventually be shared with the local peoples. And immediate economic benefits should be provided to help them move from direct use of park resources to indirect benefit by managing tourist activities and services.

The government is taking steps to create a Haitian National Park Service, but it needs a clearly defined and concise statement of its national mission as well as clearly

understood goals and directions for the individual park. Employees are in urgent need of training in park management and resource protection. There is no consistent professional presence within the parks now. This contributes to the loss of credibility with the local population. The few local jobs that have been created for park guards have led to jealousy and open hostility among the resident populations of both parks. In Parc La Visite, guards recruited from the buffer zone communities are inclined to initiate a potentially dangerous conflict with families living inside the park boundaries. It is critical to have a strong, consistent local presence by a professional park manager at each park unit.

The USNPS and the Haitian National Park Service could collaborate in many areas. The USNPS could highlight the parks of Haiti in USNPS visitor centers, and Haitian handicrafts could be sold in park gift shops. The two nations could share training opportunities, and assignments abroad could enhance career development for the employees of both countries' park agencies. A general collaborative agreement between the USNPS and Haitian National Park Service might feature a number of programs and projects. Included among them might be:

- **Exchange visits.** Key representatives of the Haitian park system could visit with USNPS managers and superintendents for exposure to the management and operation of natural areas such as Assateague Island National Seashore and cultural sites such as George Washington Birthplace National Monument.
- **Training.** A four- to six-week natural resource training course for guards and rangers could be developed and used to identify Haitian trainers to help in future training and certification. The possibility of creating a year-long internship or parks partnership position at a U.S. park should be explored. It would be designed to reinforce park management techniques among Haitian park personnel.
- **Technical assistance activities.** A Web site could be developed to promote Haitian parks to domestic and foreign publics and to park professionals worldwide. Professionally produced video tapes about the Haitian parks could be screened for airline companies, travel agencies, environmental organizations, university groups, foundations, churches, museums, and others. A visit to such ecotourism pioneers as the U.S. Virgin Islands National Park and Estate Concordia could be arranged for Haitian park officials so they can assess opportunities and services requirements. Information about ecotourism and sustainable tourism, including relevant seminars and conferences, could be provided. USNPS could help Haiti establish ties to international conservation and park protection organizations, such as Earthwatch and the Ecotourism Society.

At Parc Macaya, a long-term commitment could be accompanied by the building of sustainable ecocabins resembling the concession at Maho Bay associated with the U.S. Virgin Islands National Park. The key elements of this program would need to include actually sustainable practices, such as generating off-grid electricity by wind and solar power. While the road is being built, the cabins could be established, and tourism could begin, on a small scale, to service trekkers and visitors brought up by horse or mule. When the road opened, a market for the ecotourist activities in Parc Macaya would already exist. This project would be government-supported until it generates enough income to re-invest in infrastructure.

At Parc La Visite, there is potential for a different model of park development. While the need is more urgent to protect the park from destruction by the local population, the potential for partnership with private enterprise is much stronger. Outside Parc La Visite there is a small, charming guesthouse-and-farm operation. It and similar enterprises could cooperate with the park to provide visitors with meals and lodging, and perhaps horseback transportation and interpretive services in the park. Each model can provide employment for the local population. Given the lack of infrastructure, however, both will require substantial financial support to get started.

In both models, the park adventure should be integrated with other regional assets to produce a coordinated Haitian heritage package for visitors. For example, in the Parc Macaya model there seem to be links to beaches adjacent to Cayes and Île à Vache, to cultural resources (examples of regional architecture and former plantation sites), and to Jacmel, the birthplace of John James Audubon. This could be combined with a trekking or horseback experience to an enhanced site at Citadel Les Platons and linked eventually to an ecocamp at Parc Macaya. The visitor's experience at Parc Macaya might include birding, trail hiking, and visits to the local community's medicine man or to the area's weekly market days.

The long history of conservation efforts in both Parc Macaya and Parc La Visite by Charles Woods at the University of Florida is a model for future collaboration. Through the encouragement of Woods, more scientists visited the Macaya region in the 1980s than at any time before or since. When the University of Florida began its buffer zone development project (with funding from U.S. Agency for International Development), agricultural economists, agroforesters, agronomists, and others had the opportunity to visit the park and do research. This model, along with a relationship with a research institution such as the Smithsonian or the ecotourism programs arranged by the National Audubon Society, could have a major impact by exposing the region to outsiders and by providing technical assistance.

Neither the government of Haiti nor the NGO community lacks sound, imaginative conservation strategies and park development programs. These have been detailed in excellent reports and studies by academics and consultants from Europe and the United States and updated with some regularity. Nevertheless, the loss of critical park resources has continued unabated in some regions we visited, and we suspect the same for many remote areas of the parks. The destruction of the hardwood forests in Parc La Visite as they were converted to gardens in the past 20 years is indicative of the deforestation and erosion that will affect lands inside the parks and in all of the buffer zones. As environmental and economic conditions worsen in the regions surrounding the parks, the pressure for encroachment will increase.

Expanding Protected Natural Areas in Times of Social Change: The Russian Zapovednik (Strict Nature Preserve) and National Park Systems from 1991 to 1998

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Introduction

During the first seven years since the fall of the Soviet Union, the social, political, and economic conditions in the Russian Federation have been characterized by turmoil and instability. As a corollary to the social turmoil, the protected area system has experienced radical changes. Since 1991, the system has had draconian budget cuts and suffered increased pressure to utilize the natural resources therein. Beneficial changes include landmark legislation and an expansion in its total hectareage by nearly 60% (Ostergren and Shvarts 1998). The Russian protected area system includes local, regional, and national designations that set aside areas of natural, historical, cultural, aesthetic, and recreational significance. Two primary designations are the focus of this article. Zapovedniks (a literal translation is "strict nature preserves") are unique to the former Soviet Union and are dedicated primarily to scientific research and the protection of rare and typical ecosystems. The second important category is the national park system. Much like other national park systems in the world, the Russian national parks are geared toward cultural and historical preservation, and nature-based recreation. This article discusses the challenges and opportunities of Russian protected areas since the fall of the Soviet Union. Although the system is often characterized as on the brink of collapse, some positive policies and strategies have evolved with the new socioeconomic conditions in the Russian Federation.

Methodology

The strategy to collect data for this article was built around my doctoral research on six central Siberian zapovedniks in 1994 and 1995, and follow-up research in 1999. I conducted a series of structured, open-ended interviews with zapovednik directors, policy analysts in Russian and international nongovernmental organizations (NGOs), as well as central administrators in Moscow and researchers from Moscow State University. Data from the interviews were corroborated with personal observation as well as research in archival sources and publications (internal and external) on protected area policy.

A Long Tradition

In the late 1800s, soil research stations in the black-earth, steppe region of the Ukraine and southern Russia inspired a system of preserves dedicated to scientific research. In 1919, Ilmen'ski Zapovednik was the first area in the world to be federally designated strictly for scientific purposes. Through the 1930s, ecologists struggled to define and designate preserves as areas of unique or typical habitat, dedicated to scientific research and large enough for natural ecological processes to occur. The system slowly expanded to over 12 million ha throughout the first half of the century (Weiner 1988). Tragically, both Stalin (in 1951) and Khrushchev (in 1964) initiated re-organizations which culminated in the elimination or reduction of many preserves (Borieko 1993; 1994). Gradually, from 1965 through 1989, the preserve system expanded and cultivated wide political and financial support. International agreements such as the UNESCO Man and Biosphere Reserve program supported the creation of more zapovedniks (Pryde 1984). Other signs of support include adequate supplies, satisfactory pay for border inspectors, and funding for research projects for staff scientists or cooperating universities (Ostergren 1998).

Zapovedniks are structured with two main departments. Management sees to issues such as the annual budget, supplies, and border protection. A system of outposts surround most large preserves where inspectors (with their families) live and maintain a presence. The other department conducts scientific research. Mammalogy, botany, hydrology and soil science exemplify some of the material in the Russian archives (Volkov 1996). By 1991, seventy-seven zapovedniks inside Russia's border protected 20 million ha of habitat (Amirkhanov et al. 1997). In European Russia the preserves were smaller and focused on specific plant or animal populations. The Black-Earth Zapovednik is actually several parcels of land, up to 10,000 ha, protecting remnant steppe. Large preserves in Siberia encompassed up to 880,000 ha and were generally contiguous.

Transition and Change

After the fall of the Soviet Union, financial support for zapovedniks slowly drained away. The most prominent results of a 60-80% reduction in federal funding included the elimination of helicopter support, no funds to buy gas or repair vehicles, a drop in wages that motivated employees to move, employees being compelled to tend to gardens to survive, and zapovedniks being unable to support extensive research (Ostergren 1997).

While zapovedniks suffered from reduced funding, a more dangerous threat to the system emerged from social conditions (Pryde 1997; Wells and Williams 1998). The fall of the Soviet Union eliminated the authority of inspectors. If inspectors discovered a violation, they were obliged to call the militia to effect an arrest—a cumbersome and all-but-useless system. As the borders of the former Soviet Union became more permeable, poachers accessed world markets for illegal trade. Impoverished Russians profited from animal parts such as Siberian tiger skins and gall bladders from bear. Furthermore, as people lost their income, hunting and fishing in the zapovednik "pantry" was a matter of survival.

By 1995, the inspectors were in a state of crisis. Poachers threatened to burn them out of their outposts—or worse. In one incident in 1994, four employees of Sayan-Shushensky Zapovednik disappeared and were presumed murdered. In that region, the central conflict is around unresolved land issues between the zapovednik and the people evicted by the Soviet authorities when the zapovednik was created in 1976 (Williams and Simonov 1995). Under dire conditions, zapovednik directors made a direct plea to President Boris Yeltsin for support and relief (Nikiforev 1995).

Nonetheless, some changes after 1991 were positive. Through personnel exchanges and conferences, the international community gained a fresh, extensive appraisal of Russia's protected area network, while Russian managers were able to gather information on Western strategies. Furthermore, although contributions are no substitute for federal funding, international NGOs began directly aiding critical situations. Another unanticipated benefit was an expansion of strategies to manage zapovedniks. By 1995, newer zapovedniks were utilizing environmental education and alternative funding sources, such as a "March for Parks" (Wells and Williams 1998).

Although expanding an impoverished system seems counter-intuitive, in the early 1990s new zapovedniks were created, such as the 4-million-ha Bolshoi Arctic Zapovednik. One reason for the expansion of the protected area system is Decree No. 1155 of President Yeltsin (2 October 1992), which states that expansion of protected areas is an important aspect of Russian environmental policies. This decree included the goal of setting aside 5% of Russia in protected areas by 2005. Another contributing factor to protected area expansion was the emergent, politically powerful environmental movement. Part of its agenda included creating and expanding protected areas. Because many areas had been under consideration for 5-15 years, the flurry of new designations was relatively straightforward. By 1994, 89 zapovedniks protected 29 million ha (see Table 1).

Year	Zapovedniks			National Parks		
	Number	Area, 1,000 sq km	% of Russia	Number	Area, 1,000 sq km	% of Russia
1991	77	199.14	1.16	17	36.50	0.21
1992	79	202.85	1.19	22	42.88	0.25
1993	84	284.76	1.39	25	44.49	0.26
1994	89	292.77	1.44	28	64.21	0.38
1997	95	310.27	1.53	32	66.45	0.39

Table 1. Cumulative increase in the number and area of zapovedniks and national parks, 1990s (from Amirkhanov et al. 1997)

The specter of land reform was another motivation behind quick designation of protected areas. Land in Russia was (and remains) almost completely under government jurisdiction (96%). Post-Soviet government officials and businesses speculated on the privatization of Russian land. As a result, some NGOs and administrators pushed very hard for new protected areas (Sobolev et al. 1995). The theory was that it is far easier and less expensive to designate land within federal jurisdiction, rather than buy it on an open market.

The Younger National Park System in Russia

During the late 1960s and early 1970s, a social movement for outdoor recreation encouraged thousands of people into the forests. The inevitable pressure on existing zapovedniks to allow recreation jeopardized their pristine qualities. A few zapovedniks allowed limited access to areas within their borders, and several suffered extensive impact. In partial reaction to the demand for public recreational areas, Russia started designating national parks in 1983, and by 1991, 17 parks under the administration of the Federal Forest Service protected 3.6 million ha with natural, historical, and cultural significance (Amirkhanov et al. 1997). One contributing factor for the relatively late inception of Russian national parks is that, under Communist doctrine, all land belonged to the people and there was relatively little pressure to set aside parks for recreation (Gaava et al. 1984).

Russian national parks are zoned to accommodate multiple uses. Between 50% and 100% of a Russian national park is protected for natural (undisturbed) conditions. Road-building and resort-type lodges for the public are permitted within the tourism zones. Russian national parks are similar to national parks in the United Kingdom in that some zones may include villages or agriculture (IUCN 1994). The land in these zones is not directly controlled by the park authority, but remains under the jurisdiction of other ministries.

The Russian national parks were in a different political situation, but suffered from financial woes similar to those of the zapovedniks. As part of the Federal Forest Service's commitment to contribute to Russia's protected area system, by 1994 twenty-eight parks encompassed 6.4 million ha—nearly double the 1991 levels. Unfortunately, the Forest Service was unable to allocate sufficient funding to the national parks. The official expectation was that the national parks would generate most of their revenue from fees and concessions. In a nation that lacks a middle class, this expectation failed to materialize. Although technically preserved for natural conditions, scarce human and financial resources did not guarantee adequate protection for the national parks. One result was that the managers turned to international aid and voluntary help to conduct basic maintenance.

Landmark Legislation

In 1995, two changes turned the political (if not the financial) tide for zapovedniks. The first was the creation of a Department for Zapovednik Management in the Ministry of the Environment. It coordinates national strategies and acts as a unified voice. However, the most significant change in policy was the passage of the Law on Specially Protected Natural Areas (SPNAs). Significantly, the law was the first official delineation of rights and duties for zapovedniks since the beginning of the 20th century. The mission of the zapovednik system is the conservation of biodiversity, ecological monitoring of natural systems, preservation of unique or typical natural areas for scientific research, conservation training for professionals, environmental education (which may include limited ecotourism), and expertise in regional development projects (Government of Russia 1995).

In addition to stipulating national goals, the 1995 law gave authority to inspectors to make arrests, confiscate contraband, and assess fines. Many examples exist of renewed enforcement activities (Ostergren and Shvarts 1999). In January 1999, inspectors at the Black-Earth preserve arrested two poachers and confiscated their snowmobiles. The preserve itself could not afford the much-needed machines. In general, the directors and employees of zapovedniks are pleased with the rights and responsibilities as presented in the 1995 law (N. Maleshin, personal communication, 1999).

Environmental education is a successful strategy spearheaded by Natalia Danilina in the organization "Zapovedniks." The organization's strategy is to disseminate zapovednik goals to all sectors of society. In conjunction with the Biodiversity Conservation Center, they utilize school programs, awareness campaigns, and influence ministry officials through publicity and personal contact. The general philosophy is to increase political support by educating the general population. Publications in English target an international audience (e.g., *Russian Conservation News*, available from PEEC/RCN, R.R. 2, Box 1010, Dingmans Ferry, PA 18328 USA).

Ecotourism, as a form of education, is the subject of an on-going debate (Rhodes 1998; Nikitina 1998). On one hand, ecotourism offers a potential source of foreign income. The lure of vast, beautiful landscapes, harboring rare species, may eventually attract a significant number of foreign tourists. Opponents of ecotourism suggest the construction of an infrastructure and the presence of human activity violates the preserves' mission and will change the nature of the job for inspectors. As one analyst put it, "How much of an area can you transgress before it isn't ecologically undisturbed anymore?" (A. A. Nikol'ski, personal communication, 1999).

The passage of the 1995 law on SPNAs was less dramatic for the national parks than the zapovedniks. As part of the Federal Forest Service, the park rangers were technically (if not physically) able to enforce regulations and charge fees for use of parklands. The 1995 law reinforced rangers' authority and provided an official role for national parks in the federal protected area system. Park staff are expected to provide recreational opportunities, conduct biological research, and manage the lands for conservation. Because Russian national parks are dedicated to long-term environmental health, park managers also address issues of land use in neighboring areas or within national park zones that allow utilization (Chebakova 1997). Currently, 34 parks protect nearly 7 million ha (Zabelina et al. 1997). The continued lack of an affluent middle class continues to hamper a fee-based strategy for funding. Substantial federal funding will be necessary to maintain a national park system.

An Uncertain Future

The pace for creating new preserves has slowed down since the early 1990s. In contrast to the Soviet era, the initiative for designating new areas must be local (e.g., from local scientists or citizens' groups). To expand existing zapovedniks, the initiative originates with the director. A difficult step is to receive permission from the current land managers, such as the Federal Forest Service or the Ministry of Agriculture.

Years of lobbying and political pressure are required to create a zapovednik. A recent trend is that new preserves are becoming less common (e.g., only one was created in 1998).

In the spring of 1998, the zapovednik system was budgeted the equivalent of US\$7 million for operating expenses for 100 preserves to protect 32 million ha—an inadequate amount by any standard. In fact, six preserves remain “paper preserves,” without any staff or facilities whatsoever. They illustrate a deep divide in philosophies for the future. The paper preserves are either insurance for future protection of biodiversity (i.e., more are better), or examples of an inadequate system that needs to be overhauled (i.e., more are worse). Optimists suggest that Russia will eventually recover financial stability and the preserves will become a part of the legacy of the zapovednik system.

In the early summer of 1998, a difficult situation became worse with the devaluation of the ruble and further budget cuts. The effective budget for the zapovednik system was estimated as being as low as US\$2 million (Stepanitski 1998). The Russian national parks are faring no better. Thus, the reliance on international assistance is now greater than ever. A partial list of international contributors includes The British Know How Fund, the Government of the Netherlands, World Wide Fund for Wildlife, IUCN, the Global Environmental Facility, Earth Island Institute, the U.S. Fish and Wildlife Service, and the Pacific Environmental Resources Center.

Conclusion

The near future for Russian protected areas is full of political and financial obstacles. Nonetheless, dedicated protected area staff, administrators, and Russian NGOs are adapting to changing social circumstances and the challenging demands of the 1990s. Despite a decreasing budget and increasing pressure on the resources, the system has expanded by 60% to protect nearly 37 million ha. The political climate was right for creating new zapovedniks and national parks, land was still under federal jurisdiction, supportive legislation and decrees were issued, and a strong, persistent lobbying effort has been maintained by government officials, NGOs, and protected area directors.

Experts are optimistic that Russia will eventually solve its economic problems and re-invigorate protected areas. The directors believe that the greatest potential for long-term international collaboration is through research projects. Russia's zapovedniks and national parks both offer a wide range of research opportunities. They represent virtually every ecosystem in northern Eurasia, and have management conditions ranging from strict exclusion to working in conjunction with small communities. International collaboration can join environmental education, limited ecotourism, community outreach programs, and, primarily, federal funding to maintain one of the most threatened and most extensive protected area systems in the world.

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