The George Wright

FORUM

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IV

World Congress on National Parks and Protected Areas
Congreso Mundial de Parques Nacionales y Areas Protegidas

Workshop "Research in Protected Areas"
Taller "Investigación en Areas Protegidas"

The George Wright Society

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The George Wright Society is a member of
ICOMOS, The International Council on Monuments and Sites,
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The George Wright FORUM

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RESEARCH IN PROTECTED AREAS

Papers from a workshop organized by the George Wright Society and IUCN at the 4th World Congress on National Parks and Protected Areas, Caracas, Venezuela, February 1992

(continued next page)

On the Cover: The Estación Biológica de Rancho Grande in Venezuela's Parque Nacional Henri Pittier was a field-trip destination for many of the participants at the 4th World Congress on National Parks and Protected Areas.
(See article by Badillo & Visbal starting on p. 161.)
Photo courtesy of Stephen D. Veirs Jr.

William E. Brown

Letter from Gustavus

A New Day Dawning

December 10, 1992

Let us keep our silent sanctuaries,
for in them the eternal perspectives are preserved.
– Sénancour

In preserved lands and hallowed grounds people of the United States (and around the world) find solace in storm-driven times. These refuges of the spirit lift us above present urgencies, restore our judgment, and, like beacons, correct our errant courses, both private and public.

Yet, over the past dozen years, the public lands of the United States have suffered assault and regression—preserved lands corrupted for profit: utility lands wantonly wasted and mistreated. Public trustees of these lands, symbolized by the incorruptible ranger, have watched their landscapes degrade, and been forced out when they objected. Political appointees debunked their professional standards and rejected their advice. Thus the nation's sacred and secular landscapes have been debased and their guardians become unwilling accessories or outcasts.

Well, there is a new day dawning. It showed at the George Wright Society's Seventh Conference in Jacksonville, Florida, November 16-20, 1992. This was a broad-based public lands forum hosting representatives from all major U.S. federal land-management agencies, along with park and resource-management people from state agencies and several other countries, and many others.

From the still-effervescing wake of the U.S. election, ideals long caged and clipped rose on strong wings. Indeed, the mood of the conference partook of an old-time tent revival meeting. Smiles and high hopes abounded. (A published volume of major papers and proceedings will share the good news and the substance of the conference in 1993.)

Consider: This was the fifth George Wright Society conference held during the ideological winter of our discontent. This seemingly endless era—symbolized by the primitive notions and radical actions of U.S. interior secretary James Watt—reversed evolution, taking public-land policy and practice back to the Robber Baron epoch. At Jacksonville the lowering clouds had already started to break, and their rosy hue gave promise of returning enlightenment.

It must be noted that during the warped times now mercifully ended, the George Wright Society meetings and the pages of its quarterly, the FORUM, gave many of us the opportunity to reaffirm the honorable history and the intelligent practice of U.S. conservation law and policy, whether of the John Muir or Gifford Pinchot tradition. And in these times of stress the Society broadened its concerns, beyond parks and equivalent reserves, to include those protected lands that provide essential commodities for the nation. Despite past differences of philosophy and use, many agency managers found common cause in the threat to dismantle conservation as a whole. Today, as never before, the idea of a public lands mosaic is understood and supported by public-land managers. Preserved lands are parts of that mosaic; commodity lands make up the other parts, with sustained use the objective where possible, and rehabilitation where necessary. On the broader conservation front, these different kinds of public lands can and in the future must be complementary if watersheds, forests, soils, and ecosystems are to be maintained. As always, these are the nation's primary wealth—all other derive therefrom. Perhaps we should take comfort from the good that James Watt and his accomplices have done. He has forced us to a new synthesis. The term "wise use" will one day be restored to intelligent discourse.

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The election has not solved all problems. Nor, in the straitened circumstances of the new administration—heir to domestic neglect, fiscal disaster, and foreign disorder—can public-land trustees expect massive transfusions of money and positions. We *can* expect a sympathetic philosophical and political climate—one that restores the balance between public and private functions in this country, that rebuilds pride in public service, that revives enlightened conservation policy and a government of laws.

For the first time in many years, firing-line practitioners—superintendents, district managers, rangers, scientists, resource specialists, interpreters, maintainers—will look up the chain of command and see at least some smiling faces. They will be *encouraged* to be active, assertive guardians of the lands and resources in their charge. The expression of ideal or aspiration or even professional common sense will not be followed by the automatic kick in the groin. Imagine standing tall again, instead of hunched over and sideways! Imagine waking up and rushing breakfast because you've got exciting work to do—carrying on that work with friendly, supportive people and supervisors that urge you on—coming home tired but happy because you've pushed forward in something that counts. These things we can expect soon. And then we'll find a way to take care of the long-term needs and backlogs.

Meanwhile, we must all start adjusting to life in the sun again. The mushroom life is over. *This will not be easy.* Our spiritual and emotional reorientation is prerequisite to the full measure of good we can do. Smart supervisors will take heed, will think deeply about the mode and substance of these personal transformations—especially among young employees who have never experienced positive, as distinct from suspect, public service. Good leaders will help themselves first, then show the way to tap the latent energy of an idealism that, for many, has had no place to go. This is the first task.

Keep the faith,

Bill Brown

Franklin Receives Inaugural George Melendez Wright Award

The forest ecologist Jerry Franklin has been named the inaugural recipient of the Society's highest honor, The George Melendez Wright Award for Excellence. The award is given to recognize senior-level contributions to the Society or in furtherance of its purposes. Franklin accepted the award on November 19 at the conference in Jacksonville.

Franklin was born in Waldport, Oregon—he says during a forest fire. His middle name, in fact, is Forest, and he spent summer vacations with his family in the old-growth forests of the Columbia National Forest and Mount Rainier National Park. In the process, he came to love the forests of the Pacific Northwest. Franklin earned degrees in Forest Management at Oregon State University and in 1966 received his Ph.D. in Botany and Soils from Washington State University. He worked as a research forester at the U.S. Forest Service Pacific Northwest Research Station in Corvallis, Oregon, from 1959 to 1973. In 1973, he became the director of the Ecosystem Studies Program at the National Science Foundation. In 1975, he returned to the research station in Corvallis as chief plant ecologist, also holding a professorship at Oregon State University. He currently is Professor of Ecosystem Analysis in the College of Forest Resources at the University of Washington in Seattle.

In 1969, as the Forest Service was backing away from research in older forests, Franklin was successful in obtaining International Biological Program funds to study old-growth tracts on the Andrews Experimental Forest through his relationship with Oregon State University. He became the leader and spark plug of a group of researchers and students with an ecosystem perspective at Corvallis, conducting studies of forests and forest processes in the national forests and national parks of the northwestern United States. In 1962, he wrote his first proposal for a research natural area and later worked with Lee Talbot to resuscitate the National Natural Areas Coordinating Council in 1973. Franklin was involved in the Long-Term Ecological Research Program from its initial glimmerings during his work with the National Science Foundation and has been involved in the continuing work of that program in the Northwest. Not surprisingly, Franklin played an important part in the efforts to examine the long-term ecological effects of the 1982 Mount St. Helens eruption, coordinating the Forest Service and other researchers' efforts in the months and years following the blast. He is president-elect of the Ecological Society of America for 1993-1994.

Over the years, Franklin has fostered and encouraged research involving natural areas, forested ecosystems, long-term ecological preserves, and national parks. He has been in the forefront of developing, invigorating, and communicating important concepts in science, land management, and conservation, including old-growth forest processes, issues surrounding habitat fragmentation and edge effects, and "new forestry" concepts.

In his research, writing, leadership, and educational roles, Franklin has had an outstanding and continuing career demonstrating the importance and values of natural reserves and their study, resulting in a larger understanding of natural processes and ecosystem dynamics. He epitomizes the values George Melendez Wright demonstrated during his lifetime.

On Diversity within the GWS: A Note of Explanation and Apology

As part of our mission to promote a sense of shared purpose in the professions of protected area research and management, the George Wright Society is committed to fostering increased diversity in our own activities and in the professions at large. The GWS's position is that we must strive for a situation in which protected areas serve the needs of all segments of society, with the professionals working in protected areas fairly representing the complete spectrum of diversity in society. As a beginning step toward these goals, the Society arranged (thanks to generous scholarship funding from the U.S. National Park Service) to have fifteen participants from the Native American, African-American, Asian-American, and Latino-American communities attend our conference in Jacksonville this past November.

Unfortunately, during a plenary session on the final day of the conference, one of the invited speakers, representing another nongovernmental organization, made use of an epithet which was derogatory to Asians and people of Asian descent. Although the use of the epithet was intended to be taken in a sarcastic or ironic sense—indeed, the speaker was decrying the lack of racial diversity and gender representativeness within the fields of cultural and natural resource management—the effect of her remark was offensive and insensitive. While the Society cannot control, and has no wish to control, the comments and sentiments offered by participants in our conferences, the Board of Directors takes responsibility for the use of this epithet and apologizes to all the conferees and to the GWS membership at large. The Board invites your suggestions on how we can do a better job of including people from all sorts of backgrounds in our work.

The speaker in question, Loretta Neumann, would like to offer this additional note of clarification: "The George Wright Society has no need to apologize for something I inadvertently said during one of the sessions at its recent conference. Indeed, the Society in its very sensitive statement graciously allowed me to keep my anonymity, if I so chose. I do not so choose. My message, that the National Park Service must become more reflective of society as a whole—in race, ethnicity, and gender—was important. I regret that it was blurred by an unfortunate choice of words. If anyone was personally offended, I am truly sorry. The fact that I or anyone else who cares so deeply about racial and ethnic integration could say something to offend, however well-meaning the intent, shows that we must all be ever more careful in what we say. Certainly I will be in the future."

The Public Lands of the United States—An Endangered Species

Gaylord Nelson

THE WILDERNESS SOCIETY
Washington, D.C.

Presented as the concluding address to the George Wright Society's Seventh Conference on Research and Resource Management in Parks and on Public Lands, Jacksonville, Florida, November 1992

This conference is largely about federal public lands—national forests, national parks, national wildlife refuges, Bureau of Land Management (BLM) lands. It is about their role and purpose; what they are; what they should be; and, more importantly, what they will become if current trends continue for another three or four decades.

My observations concerning the overall management of the public lands are rather strongly negative because it is my view that current management policies are contributing significantly to the degradation of those special qualities which distinguish our unique public lands system. The responsibility for these policies is spread around among the Congress, the president, the land managers, special interest groups, an indolent press, and an ill-informed public.

One missing factor needs to be added to this failed policy mix. That missing factor is the unheard voices of the career professionals within the agencies. Instead of a free and open debate, an exchange of viewpoints aimed at getting the best answer, the tightly controlled top-down political management of the agencies permits little dissent or creativity. Under the new administration in 1981, Department of the Interior secretary James Watt and Department of Agriculture assistant secretary John Crowell quickly made it clear that the dominant policy would be maximum exploitation and commercialization of all resources available on the public lands. Any other values on those lands, such as wildlife habitats, recreation, scenic beauty, etc., were simply of secondary consideration. Even in the parks, Watt made it clear that the interests of the concessionaires came first, as he made explicit in his first few months.

During the past twelve years, the ideologues have changed but the basic management policies have not. The abrupt removal of the National Park Service's regional chief in Denver, Lorraine Mintzmyer, and the Forest Service's regional forester in its Northern Region, John Mumma, from their respective positions a few months ago is a dramatic case in point. They had jointly prepared the so-called Vision Document for the Yellowstone ecosystem. Presidential chief of staff John Sununu became emotionally outraged over the idea that two professionals in the public service had the temerity to make a proposal for the region that was not completely compatible with the private interests of those who believe it is their divine right to exploit the public lands for their own private profit.

Mumma committed an additional offense. He called for a reduction of the timber cut across the Northern Region on the ground that the directed level of cut could not be met without damaging the environment and violating the law. I doubt that any lawyer or scientist would challenge his reasons on their merits, and, incidentally, neither did Forest Service chief F. Dale Robertson.

Both Mumma and Mintzmyer were demoted to jobs they didn't want. A new job without any real duties was created for Mumma in Washington, D.C. Mumma declined the offer and resigned instead. Incidentally, this new position remains empty—waiting to be filled, no doubt, by some other employee who feeds into the system an honest professional judgment that is politically incorrect. Several well-established knee-jerk policy issues were at stake in this case, plus the powerful political interference of members of Congress from Montana and Idaho.

It is, sadly, another blow to the integrity of the public service system that neither Robertson nor Park Service director Jim Ridenour had the courage to stand behind the sound, reasoned judgment of their own professional staff, and, worse, that they couldn't even contrive a plausible explanation for their failure to do so.

Any close reading of the past twelve years forces us to the tragic conclusion that politics within the natural resources agencies has, for all practical purposes, driven science out of the decision-making process whenever science comes into conflict with any opportunity for private profit from the public lands. Until there is a much better public understanding of the major public lands issues and conflicts, we will continue stumbling blindly along the same destructive course.

To achieve the goal of better understanding, agency professionals must be able to participate much more freely in the education process. You have a responsibility to come up with some proposals to achieve this goal. No one knows the problems or issues as well as you do.

I will make a couple of modest suggestions at the conclusion of my remarks—but your input is critical.

At this point it is appropriate, or at least timely, to observe that on election day the incumbent elite anti-government ideologues received an invitation from the voters they couldn't refuse. It will be a relief to have an administration that doesn't believe the government is an enemy of the people, and that recognizes that public service is an honorable vocation of the highest order. It is time to re-learn the lesson that the central role of government is to serve the general welfare, not the special interests of a favored few. As Colorado governor Richard Lamm put it, "The private sector can no more assure protection of the public interest than government can 'make' the market place function efficiently."

My remarks are addressed in general to the status of our federal public lands system and to those forces that influence the management of that system.

The multiple forces that influence management policies is an incredibly complicated social, economic, and political mix. Very often it isn't clear what factors went into the decision-making process resulting in a bad land-management decision. What is clear is that there are many bad management decisions resulting in serious, adverse impacts on our parks, forests, refuges, and BLM lands. It is also clear that we must reverse the current downward trend if we are to save this rare heritage.

The Congress, at best, might be dimly aware that something bad is happening to our public lands. What is needed is a forum that will both inform and arouse the Congress, the public, and the media to demand action that will protect the uniqueness, the special character, of the public lands system.

It should be noted that special economic interests and user groups supported by members of Congress from the region and local politicians frequently have more influence over the management policies of our parks, forests, refuges, and BLM lands than Congress as a body or the general public.

This is all by way of saying there is an urgent need for a comprehensive evaluation of the multiple threats that endanger our whole public lands system. To develop a clear picture of what is happening to these lands, they must be approached and evaluated in their totality as a public lands system, rather than a divisible bunch of parts and pieces—separate, independent, unrelated to each other, and uncoordinated in their policies and activities and, as a consequence, frequently working at cross purposes.

The federal public lands are a rare national treasure, whether found in the parks, forests, refuges, or in BLM areas. It is important to recognize that these lands are part of an interrelated mosaic and to understand that any degradation of natural areas on these lands is in fact an attack on the whole system. Tragically, this priceless heritage is being compromised and degraded bit by bit and is, in fact, approaching the threshold of a precipitous decline. The whole system is endangered by threats, pressures, and intrusions which need to be addressed before it is too late.

While we all are mightily concerned about endangered species, we tend to forget that among the most important endangered species of all is America's unique heritage of wildlands, wilderness, and natural landscapes. At stake is 610 million acres—almost a million square miles—25% of America's total land base. This remarkable inheritance is found in our national parks, wildlife refuges, forests, and BLM lands. No other country has preserved such a vast estate for public use and enjoyment; for wildlife habitat, scenic beauty, watershed protection; for education and scientific study; for varied and endless opportunities for recreation in a natural setting remote from the intrusions of modern society. Here are some of the last untouched remnants of nature's work, a million years of evolving landscapes unaltered by human activity.

Only on the public lands have we preserved such vast areas, representing every land form from deserts to grasslands to forests to mountain peaks and valleys. If a significant portion of natural America is to be preserved for this and future generations, it must be here on these lands.

Though we tend, complacently, to assume that the laws, the public land managers, and congressional oversight assure the protection of these areas, the fact is that tremendous pressures for expanded use and more exploitation are changing the character of these lands. Under this constant pressure, the land managers tend to yield here and there, little by little, year by year. The changes are gradual, subtle, and little-noticed from one year to the next, but the cumulative impact over the past three or four decades is transforming the face of these landscapes in significant ways. The fact is most of this degradation could be avoided or minimized if the spirit of the law were faithfully implemented, as Congress intended, by those responsible for managing our public lands.

In short, the national parks, forests, wildlife refuges, and BLM lands, and the wilderness areas within their borders, are all at least prospective candidates for the endangered species list. All are being compromised and degraded in manifold ways–by soil erosion, air pollution, water pollution, aircraft noise pollution, overcrowding, excessive road-building, excessive timbering, excessive grazing, stream siltation, over-development, habitat destruction, scenic degradation, and the disappearance of biological diversity.

Ideally, congressional oversight would, on some regular schedule, review and evaluate the impact of all threats to the public land system as a whole. Irregular, periodic oversight by several congressional committees, each with jurisdiction over part of the public land system, is inadequate to monitor and evaluate the cumulative impact of hundreds of decisions and legal interpretations made by these individual agencies each year. Further complicating matters, each agency tends to interpret the letter of the law and congressional intent to suit its own institutional desires and biases. By the time Congress catches up, it is too late!

The U.S. Forest Service is a classic case in point. For example, as one reviews the provisions of the Multiple-Use Sustained-Yield Act of 1960 and the National Forest Management Act of 1976, one is struck by the brazen effrontery with which the Forest Service evades, misinterprets, or ignores provisions of the law that do not suit its own bureaucratic purposes.

The Multiple-Use Act of 1960 mandates that the forests shall be "administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes." Balanced multiple use is the objective of the statute. However, in practice the Forest Service considers its timber program as the dominant purpose of the forest with all others of secondary importance. Whenever there is a conflict, timbering almost always prevails. Repeatedly, the Forest Service has destroyed wildlife habitats, watersheds, and trout and salmon streams in order to subsidize the sale of timber that should have been left alone.

The reality is that the Forest Service pays only minimal lip service to the concept of balanced multiple use as intended by Congress. Arbitrarily selected timber goals drive the planning process. Once the goals are selected whatever is left is considered by the Forest Service to qualify as balanced multiple use.

Probably the Forest Service's most flagrant abuse most flagrant abuse of common sense and the law is its policy of massive below-cost timber sales. The intent of the law is clear. Section 6(K) of the National Forest Management Act provides that the secretary of agriculture "shall identify lands" which are not economically suited for timber production and "no timber harvesting shall occur on such lands for a period of ten years." It further provides that such lands shall be reviewed every ten years and shall not be returned to production until it is determined that they have become suitable for it.

What is meant by economic suitability is subject to interpretation and the Forest Service contrives to interpret this law and the concept of multiple use in such a way as to justify massive sales of below-cost timber.

Half of the national forests lose money every year because of below-cost timber sales. In the past five years, below-cost timber sales have cost the taxpayer well in excess of a billion dollars—averaging between $200 million and $300 million a year.

Another provision of the National Forest Management Act specifies that "timber will be harvested from National Forest System lands only where soil, slope, or other watershed conditions will not be irreversibly damaged." Despite the clear language of the law, the Forest Service regularly cuts timber on steep slopes with highly erosive soil, causing severe and permanent damage to watersheds, salmon spawning grounds, and trout streams.

These are but a few examples of a Forest Service timber program which is out of control.

Another case in point is the National Park System. If we are going to save our national parks, then we must more faithfully comply with the clear and specific mandate of the 1916 congressional act that created the National Park Service. That law provides that the parks shall be managed "to conserve the scenery and the natural and historic objects and the wildlife therein, and provide for the enjoyment of same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Slowly but surely that mission is being compromised. Significant impairment of the parks is currently underway. Internal and external threats to the parks have been widely documented by the Park Service itself.

Indeed, the state of the parks report to Congress, prepared by the Park Service in 1980, concluded:

It is clear that events are taking place that are causing demonstrable and severe damage to the natural and cultural resources of the nation's national parks, monuments, historic sites and other units. Although some impacts are subtle and not immediately obvious, long-term consequences can be disastrous.

We must begin soon to address these threats, or the next generation will see the end of the parks as Congress conceived of them. A few recent headlines and news stories are revealing: "Everglades' slow death blamed on cane growers" (Orlando, Florida, *Sentinel*); "New coalition declares open season on public lands" (Missoula, Montana, *Examiner*); "Yosemite concessioner fighting conservation plan" (San Luis Obispo, California, *Telegram-Tribune*). The Yosemite Park and Curry Company is using its guest list to contact 93,000 people and ask them to lobby the National Park Service to abandon its 1980 plan to ease crowding.

Here's another example: an excerpt from an article by John Lancaster in *The Washington Post* titled "Two visions blur Yellowstone's future":

One is the Yellowstone that nature built. . . . The other is the recreational Yellowstone, where . . . the visitor can rent a motorboat or snowmobile, rough it in a $95-a-night hotel. . . . One proposal involves a planned 350-mile snowmobile trail linking Lander, Wyoming, and West Yellowstone, Montana. The trail would traverse Yellowstone for 37 miles. Heavily backed by the Wyoming congressional delegation, the project is considered key to state efforts to boost winter tourism in the area. . . . Park authorities in the 1970s agreed to remove stores and campgrounds from the area known as Fishing Bridge, which is heavily used by grizzlies, in order to compensate for the building of a new village elsewhere. But the Park Service backed down–only part of the development was removed–after bitter opposition from the Wyoming congressional delegation, the local tourist industry, and motor home owners.

If the public lands are to be managed to carry out their statutory responsibilities with minimum depreciation of their natural values and characteristics, then Congress must actively re-assert its leadership. The letter and the spirit of the law are not self-enforcing. The only effective counterweight to pressures for more exploitation of our public lands is Congress itself.

It is time now for a comprehensive re-evaluation of our public land uses and a clear and unequivocal restatement of their purposes.

What kind of questions should we ask? What kind of answers do we want? The issues are complicated because the public lands are vast, varied, and complicated, and because each of the four categories of public lands have different missions. The role of the national parks and wildlife refuges is relatively clear and uncomplicated compared with those of the national forests and BLM lands.

Administration of forests and BLM lands is complicated by the fact that they have both a conservation-environment responsibility and a commodity-supply responsibility, and frequently they are in conflict. Managing that conflict to minimize environmental damage was clearly the intent of Congress but it has failed to work because the agencies have strongly tended to give first priority to commercial exploitation of the resources over any other multiple use.

In re-examining the role of the public lands, it is vital to recognize from the start that these lands provide a wide range of unique experiences, services, amenities, opportunities, and special environments which cannot be supplied by the private sector from private lands because they no longer exist there.

Preserving the uniqueness of this huge estate of natural landscapes should be a first priority of our society. If we continue to permit overuse, overdevelopment, excessive and unnecessary commercialization, then, finally, these lands will lose their special character. Once lost, it can never be recovered and there will be nothing left to replace it.

"Carrying capacity" is the appropriate general standard of measurement for activities to be permitted on these lands. Those activities that do not degrade the natural quality of the resource base are generally acceptable, and those that do are not.

Ironically, current law would generally be adequate to protect this resource base if the land managers consistently resolved conflicts in favor of preserving the integrity of the resource base instead of yielding to pressure for uses that degrade it.

Both the Park Service and the Forest Service seem to be more interested in attracting more visitors and providing more facilities and accommodations for the public than preserving those unique qualities which provide the public with an experience that cannot be duplicated on private lands.

The uniqueness of the public lands will be destroyed if we are going to duplicate on public lands the goods and services provided by the private sector on private lands. The law did not intend that these lands would be used as tree farms or modified theme parks, but that is the direction they are headed. Like the current problem of air tour flights over the Grand Canyon, twenty years from now Congress, too late, will wonder how we got into the theme-park business and how to get out of it.

Listen to the words of Harold Ickes, the secretary of the interior under Franklin Roosevelt, as he spoke to park superintendents over a half-century ago:

> *I suspect that my general attitude on what our national parks ought to be is fairly well known. I do not want any Coney Island. I want as much . . . nature preserved and maintained as possible. . . . I am afraid we are getting gradually alienated from that ideal. We are becoming a little highbrow; we have too many roads. We lie awake nights wondering whether we are giving the customers all of the entertainment and all the modern improvements that they think they ought to have. But let's keep away from that, because if once we get started, there will be no end.*

The lesson to be learned is that once an activity is permitted within any category of public lands it becomes difficult, if not impossible, to control or stop it, even though that activity is seriously degrading the basic resource itself. In 1987, Congress belatedly attempted to deal with such a situation in the Grand Canyon with the adoption of some mild palliatives that left the problem unsolved. The problem: intrusive noise from air tour flights over the Grand Canyon.

In the five years since the 1987 amendments to the law, flights have nearly doubled. During peak periods, at some places park workers counted a helicopter or airplane overhead every two minutes. This is another park that will not be left "unimpaired for the enjoyment of future generations" as mandated by the 1916 National Park Service Organic Act.

Sixty years ago, Ickes warned against permitting airplane flights over the parks, saying, "If we encourage the airplane business, we will see Glacier, Yellowstone, and Yosemite from the air at a hundred miles an hour. . . . I don't see any sense in catering to that sort of thing."

In 1985, Arizona governor Bruce Babbitt testified that noise in Grand Canyon is "equivalent to being downtown in Phoenix at rush hour or listening to an alarm clock go off, and that's not what a national park is for." That's a far cry from the novelist Zane Grey's description of the Grand Canyon in 1906 when he wrote: "One feature of this ever-changing spectacle never changes—its eternal silence."

With a little bit of foresight and a little bit of leadership, it could all have been prevented by not permitting the activity to start in the first place.

The Grand Canyon debacle is not just an isolated accident of history. Rather, it is a quite typical example of an ongoing process that is depreciating the unique quality of our whole public land system.

National parks are being overpressured by visitation that has risen tenfold in the past forty years. Wildlife refuges are being deprived of water and poisoned by selenium and dieldrin from agricultural runoff. BLM lands continue to be degraded by overgrazing subsidized by the taxpayer.

It is not my purpose here to compile a compendium of those activities that are changing the character of our public land system in undesirable ways, and are doing so without changing the laws, without public discussion, and without congressional debate. Comprehensive, carefully designed congressional hearings are urgently needed to identify the major threats to the public lands systems as a whole and provide the Congress and the public with a picture of what is happening to these lands.

In my view, it would require a series of hearings extending over a period of at least two years to explore the issues involved. Joint House-Senate hearings would focus attention on the issue and involve the committees of jurisdiction in both bodies.

The end objective is to secure enough information and stir up enough interest and enough understanding and support to move the Congress and the land managers to design and implement a long-range, environmentally sustainable management plan for the public lands. The current combined multiple activities on the public lands in the lower forty-eight states already exceed the carrying capacity of those lands. That level of activity is not sustainable without destroying the essence, the heart, the soul of this magnificent gift of nature.

Without such a plan, this remarkable heritage will be gone in another four or five decades—leaving just a mishmash of modified theme parks, outdoor zoos for tame wild animals, clear-cut forests converted to tree farms, destroyed watersheds, traffic jams, concessionaire stands and boutiques to satisfy every whim, full-service trailer parks and more—all of this on the public lands.

If this sounds like a bit of hyperbole, don't be fooled. The only exaggeration here is my suggestion that it might take four or five decades to get there. All of the above is happening right now.

Incidentally, you get some idea of what these subtle, hardly noticeable incremental degradations of the system can do by just considering Yosemite for a moment. I first visited there fifty-seven years ago when I was an impressionable college freshman. I was awestruck by the grandeur and beauty of it and still am. However, I am also awestruck by what has happened to the beautiful Yosemite Valley since then. Sadly, it has been turned into an overcrowded, traffic-jammed, commercialized tourist trap with some 7,000 overnight visitors and campers. As someone aptly described the scene, "after the sun goes down, the valley looks like downtown Los Angeles at night." What a tragedy! What incredible mismanagement! And what a shame if we sit idly by while the system continues to deteriorate—which we are doing. Twelve years have passed since the 1980 Yosemite management plan was adopted and the Park Service is still hedging and waffling over its implementation. If they cannot put in place their own plan prepared by their own staff, what does this tell us about leadership?

It doesn't require any special insights to recognize the destructive course we are pursuing. Listen to the words of James Bryce, British ambassador to the United States, speaking in 1912:

> *What Europe is now, is that toward which you are in America are tending. Presently steam cars stop some 12 miles away from the entrance of Yosemite. . . . Surely development should come no closer. . . . If you were to realize what the result of the automobile will be in that wonderful, that incomparable valley, you will keep it out.*

In 1953, the author Bernard DeVoto, a resolute defender of the public lands, had become so exercised by what was happening to the parks that he proposed in an article in *Harpers* that the largest park "be closed and sealed, held in trust for a more enlightened future." If Mr. DeVoto were still around, I doubt if he would be prepared to unseal that park. The enlightened future he was thinking about has yet to arrive.

These are but a few of the advisories and warnings we have gotten from many wise observers and ignored over a period of many decades. What happened? Why? What can we do about it?

As previously mentioned, I think the core of the problem is the failure of Congress and the public to fully appreciate what is happening to our public lands. Extensive congressional hearings, publicity, and public debate would begin the necessary education process. Without public and congressional understanding, the issue simply will continue to be ignored. No one seeks an answer to a problem they don't realize even exists.

Though I don't have a simple all-purpose answer to the political problems that plague the public land agencies, it strikes me that there are three obvious things that employees can do to initiate the process of publicly exploring the status of our vast heritage of public lands.

First, prepare a petition to the congressional committees with jurisdiction over public lands requesting hearings on the status of the public lands system, their future under increasing public pressures, and what measures need to be taken to preserve this remarkable heritage.

Second, employees should be afforded the opportunity to express their views on important management and policy issues on some regularized basis through the use of a comprehensive questionnaire once every two years. Half of the questions for the questionnaire to be selected by employees; the other half by management. Answers to the questionnaire to be distributed to the appropriate congressional committees and the press.

Third, request a meeting with the vice president to discuss public land management and personnel issues. Such meetings should be scheduled twice a year.

These proposals present the opportunity to begin a national public dialogue on the status of our public lands. In conclusion, I'm sure you can think of other approaches to further this enterprise.

RESEARCH IN PROTECTED AREAS

Papers from a workshop organized by the George Wright Society and IUCN at the 4th World Congress on National Parks and Protected Areas, Caracas, Venezuela, February 1992

INTRODUCTION TO THE WORKSHOP

Effective action must be based on accurate information, and the more widely shared the information, the more likely it is that individuals and institutions will agree on the definition of problems and solutions. Developing and using information is therefore an essential part of conservation at all levels, from the local community to the global community, particularly to prescribe management action and to assess changes over time; biological, economic, social, and managerial parameters all need to be considered. On the international scene, Unesco has been deeply involved in this field, and many biosphere reserves have excellent research facilities.

Yet in most parts of the world, the application of research findings has lagged far behind the capacity of scientists to generate the data. What needs to be done to facilitate the greater application of science to management and by managers? What can researchers do to make their work more accessible to managers, thus promoting the application of their findings? The workshop focused on these two questions. It was attended by some 30 people, representing Latin America, Africa, Asia, Europe, Australia, and North America.

On the first day, after a discussion and revision of the Congress's draft recommendations, eleven presentations of short duration were given. The revised recommendations were submitted to the Congress Secretariat in time for consideration by the its recommendations committee.

On the second day, five short presentations were given. Then the participants divided into two groups, one English-speaking and one Spanish, to discuss the management-research interface. The discussions were keyed to five areas: (1) Making sure research is a priority in funding; (2) Ensuring that sufficient facilities and information resources are available for research; (3) Making research available to other researchers, managers, and the public—in forms each group can understand and use; (4) Facilitating research exchanges; (5) Recognizing and promoting protected areas as sites for research.

CONCLUSIONS OF THE PARTICIPANTS

1. Well-planned research, combining natural and social science, is a vital part of the management of protected areas. Protected areas are natural laboratories: in some countries, the last such places available to serve as "baselines" for the surrounding landscape. Universities, governments, and other bodies concerned with research need to explicitly recognize (within policies and regulations) the function of protected areas as research sites.
2. Research that is valuable from a purely scientific viewpoint is not necessarily useful to protected area managers. To be truly worthwhile, research needs to be presented in three formats: for peers in science and cultural resource professions, park managers and their agencies, and the general public.
3. Researchers have many needs that are not being met: protected area authorities often have no policies to guide use of their areas as research sites, there is a lack of political support for long-term research, and there is a lack of investment in research, which produces a shortage of facilities, directories, and training opportunities.
4. A special problem related to research in the developing world is the lack of trained nationals to carry out research. Some countries are suffering "brain drains" of their best researchers, leaving a situation in which expatriates control the research in a given country's protected areas. In many countries, basic information about their protected areas is not widely available to local universities, and often is unavailable in the local language(s). We should be working toward a situation where developing-world researchers can receive a PhD in their own regions rather than having to study in developed countries.
5. A related problem is the practice of visiting researchers from developed countries taking with them upon the completion of their work all of the data collected, without supplying copies to the host country. This seems to be a widespread problem even when the lodgement of data and reports before departure is a condition of the entry permit.
6. Facilities are a great attractant to a researcher, but they need not be elaborate: housing, a dry place to work, and so on. There is a high correlation between the presence of such basic facilities and the amount of research that is done in a protected area.
7. Extra efforts must be taken to integrate socioeconomics into protected area research. This is hindered by the widespread view that social sciences are somehow not rigorous fields of enquiry and therefore should not be accorded the same status as natural science. Yet the key factors shaping the ecosystems of protected areas are in many cases socioeconomic.
8. This leads to a corollary conclusion: the co-participation of local people is just as important to the success of protected area research as it is to protected area management. Local people

have little interest in supporting a "natural laboratory" unless the research being done there has some relevance to their lives.

9. Attention needs to be paid within the research community to building alliances with like-minded institutions. If individual research projects can be coordinated and fitted into a network among institutions, the studies will be complementary rather than duplicating each other. In this respect, the Latin American protected areas network (coordinated by the Food and Agriculture Organization of the U.N.) needs to be strengthened, and similar networks formed in other regions. Networks involving individual institutions in the developed and developing worlds should be fostered.

FOLLOW-UP TO THE WORKSHOP

The major product from the workshop will be guidelines on making research useful to and usable by protected area managers. These guidelines are being prepared under the direction of the George Wright Society, in collaboration with workshop participants, the Science and Management of Protected Areas Association (Canada), the Smithsonian Institution, and IUCN. The guidelines will be published by IUCN in 1993. Other possible products are: a project proposal to IUCN to prepare a list of protected areas that are in need of research, which could then be circulated to academic institutions and other research bodies; a project proposal funnelled through IUCN to establish a program to twin parks in the developed world with those in developing countries for exchanges of information, personnel, and, possibly, financial support; a project proposal to donors to fund the set-up of basic research facilities in protected areas that have none; and a project proposal to fund the development and maintenance of central repositories of park-related information in developing countries.

The first product of the workshop is this double issue of *The George Wright* FORUM, which contains the papers presented in Caracas.

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Situación Actual y Perspectivas de la Investigación Biológica en las Areas Protegidas de Bolivia

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INTRODUCCION

La conservación de la biodiversidad ha pasado en pocos años a ser uno de los intereses centrales de la comunidad internacional y los países han comenzado ha percibir la imperiosa necesidad de mantener opciones de uso diversas, basadas en la investigación, que permitan ampliar las posibilidades de aprovechamiento racional para el futuro.

La investigación básica, es uno de los pilares de las acciones de conservación y debe ser desarrollada abarcando tanto los inventarios biológicos, la dinámica de los ecosistemas y las normas técnicas y tecnologías que permitan mejorar la planificación y el manejo de los recursos vivos.

El conocimiento insuficiente de la biodiversidad que se enfrenta actualmente, a nivel mundial, obedece principalmente al gran esfuerzo que debe invertirse en el proceso y también a la pequeña cantidad de financiamiento disponible, originando que cada vez menos instituciones y científicos se dediquen a dicha actividad (McNeely et al. 1990).

La investigación biológica en Bolivia se encuentra en una fase de desarrollo inicial; se ha impulsado en los últimos 10 años y se enfrentan problemas adicionales como el insuficiente número de personal científico especializado, dando por resultado que los pocos profesionales formados desarrollen múltiples tareas, cuyo resultado se traduce en la dispersión de esfuerzos y por lo tanto un retraso en cuanto a la investigación.

La investigación en Bolivia no ha respondido a directrices claras relacionadas al desarrollo del país; no existe una política nacional al respecto y tampoco han podido definirla las Universidades, que son las encargadas de realizar la mayor parte de la investigación. La investigación ha respondido más a inquietudes institucionales, muchas veces a criterios personales, y también al financiamiento disponible, factores que han generado trabajos importantes pero han dejado grandes vacíos en el conocimiento biológico. El avance rápido de la ocupación de territorios, sin una planificación adecuada es otro de los factores que exigen que la investigación biológica y ecológica debe ser impulsada y no debe concentrarse únicamente en las áreas protegidas ya existentes, sino también en las regiones científicamente desconocidas.

Bolivia es un país que presenta una gran diversidad de ambientes y biota; es poseedor de extensas áreas sin o poca intervención humana. Sin embargo hasta hoy en día, vastas regiones del territorio son biológica y ecológicamente desconocidas, determinando que el hallazgo de especies nuevas para Bolivia y para la ciencia sean noticias comunes. Aún no se conoce el número exacto de especies de flora y fauna que existen en el país, pero los estudios y estimaciones realizadas arrojan estimaciones de 15.000 a 20.000 especies de plantas vasculares de acuerdo al *Herbario Nacional de Bolivia* (LPB) y alrededor de 2.800 especies de vertebrados (Ergueta 1990).

A pesar de albergar aún extensas áreas con poca intervención humana, la trayectoria de explotación de sus recursos ha sido tal, que extensiones considerables de terreno han sido fuertemente afectadas por el hombre de acuerdo al *Plan de Acción Forestal de Bolivia* (Plan de Acción para el Desarrollo Forestal de Bolivia 1991).

Una de las acciones destinadas a la conservación, tanto de la flora, la fauna y los ecosistemas es la creación de áreas protegidas; sin embargo la protección no es la única finalidad que cumplen dichas áreas, y la mayoría de ellas son territorios propicios para el desarrollo de la investigación biológica. La Ley General del Medio Ambiente, en proceso de aprobación define a las áreas protegidas como áreas naturales con o sin intervención humana, declaradas bajo protección del estado mediante disposiciones legales, con el propósito de proteger y conservar la flora y fauna silvestres, recursos genéticos, ecosistemas naturales, cuencas hidrográficas y valores de interés científico, estético, histórico, económico y social, con la finalidad de conservar y preservar al patrimonio natural y cultural del país.

La primera declaración de área protegida del país data de 1939 (Parque Nacional Sajama) y a lo largo de 5 décadas se han creado paulatinamente más de 30 áreas protegidas en el país (Morales 1990). Diversos autores proponen un número diferente de áreas protegidas y las cifras varían de acuerdo al criterio de inclusión o exclusión de áreas como las Reservas Forestales y Fiscales. En general se estima que existen 38 áreas protegidas declaradas, de las cuales 33 son de protección indefinida y 5 son reservas forestales, es decir de protección transitoria y con destino futuro de producción forestal.

En forma general, las áreas protegidas de Bolivia han sido creadas sin estudios biológicos previos que permitan determinar la importancia biológica de las mismas, y en muchos casos tampoco estudios socioeconómicos. La falta de estudios biológicos es una de las razones por las cuales una vez creadas más de 30 áreas protegidas en el país, la cobertura de las mismas en cuanto a ecosistemas y especies de flora y fauna es insuficiente; ecosistemas importantes como los valles secos o los del complejo chaqueño no cuentan con un área protegida declarada.

Otro aspecto determinante en cuanto a la creación de áreas protegidas, en el pasado ha sido la falta de vinculación entre las instituciones de investigación básica con las instituciones gubernamentales encargadas de la "creación" de áreas protegidas en el país y el escaso desarrollo de las instituciones relacionadas con el control y administración de los recursos renovables.

En los últimos años, el gobierno ha mostrado una clara voluntad para lograr la conservación de los recursos bióticos, por lo que ha iniciado una serie de acciones encaminadas a este fin. Se ha decretado la **Pausa Ecológica Histórica** y se han iniciado una serie de acciones como el establecimiento del **Plan de Acción Ambiental** dependiente de la Secretaría Nacional del Medio Ambiente), la definición de las **Políticas y Acciones para la Gestión Ambiental** (Fondo Nacional para el Medio Ambiente y Secretaría General del Medio Ambiente 1991), la elaboración de **Estrategia de Conservación de Ecosistemas** (Plan de Acción Forestal de Bolivia 1991) y la estrategia de **Conservación de la Biodiversidad y los Ecosistemas en las Areas Protegidas de Bolivia** elaborada por el Instituto de Ecología y la Fundación Amigos de la Naturaleza (Fondo Nacional para el Medio Ambiente 1991) y la reciente aprobación de la Ley General del Medio Ambiente, valoran la investigación como uno de los pilares de la conservación.

LA INVESTIGACION BIOLOGICA REALIZADA EN LAS AREAS PROTEGIDAS

La investigación biológica multidisciplinaria sobre las áreas protegidas se inicia en Bolivia en la década de los 80, en coincidencia con la creación de instituciones de investigación como el Instituto de Ecología y el Museo Nacional de Historia Natural, ambos en la ciudad de La Paz. Posteriormente se crea el Museo de Historia Natural Noel Kempff Mercado, en la ciudad de Santa Cruz. Se firma un convenio entre la Universidad Mayor de San Andrés y la Academia Nacional de Ciencias de Bolivia para la creación del Herbario Nacional de Bolivia, y un convenio similar entre las mismas instituciones determina la creación de la Colección Boliviana de Fauna. Tanto el Herbario Nacional de Bolivia como la Colección Boliviana de Fauna, son los mayores depositarios de colecciones científicas del país. Otras instituciones bolivianas ligadas la investigación biológica en el país son el Instituto de Investigaciones Forestales Amazónicas de la Universidad Técnica del Beni en el departamento de Beni, el Instituto Boliviano de Tecnología Agropecuria en La Paz, el Departamento de Biología de la Universidad Mayor de San Simón de Cochabamba, la Universidad Autónoma Gabriel René Moreno en Santa Cruz y el Centro de Datos para la Conservatión en La Paz. Varias instituciones internacionales como el Missouri Botanical Garden, el American Museum of Natural History, el Museo de Biología Suroccidental de Albuquerque, Nuevo México y la Estación Biológica Doñana entre otros han realizado estudios en varias áreas protegidas.

Cuentan con algún tipo de investigación menos de 20 áreas protegidas declaradas: 6 Parques Nacionales, 3 Refugios de Vida Silvestre, 1 Bosque Permanente de Protección, 1 Reserva Fiscal, 1 Reserva Biológica y la única Estación Biológica existente en el país (Figura 1 y Anexo 1).

La recopilación preliminar de información documental la existencia de una expedición científica a Laguna Colorada en 1925 (Anexo 1). Dicha expedición, se realizó más de 4 decenios antes de la declaratoria de Laguna Colorada como parte integrante de la Reserva Nacional Eduardo Avaroa, establecida como área protegida en 1973. Varios estudios se han llevado a cabo en la Reserva y es considerada una de las mejor conocidas en términos bioecológicos.

Estudios sobre vegetación y pasturas se realizan en la Reserva Nacional de Ulla Ulla; posteriormente los estudios sobre avifauna acuático y camélidos se inician y han dado lugar a varias publicaciones y tesis de grado.

Investigaciones biológicas multidisciplinaria se inician en 1985, en la Estación Biológica Beni, posteriormente declarada Reserva de la Biósfera. Se organiza el "Reconocimiento Preliminar de la Estación Biológica Beni" (Baudoin 1986). A partir de esta fecha la investigación ha sido constante en dicha área (Anexo 1), y es actualmente la única área protegida que cuenta con un plan de manejo (Plan de Manejo de la Estación Biológica Beni 1991).

El Refugio de Vida Silvestre Estancias Elsner Espíritu ha sido objeto de varios estudios, tanto inventarios, como estudios ecológicos. La información generada ha sido considerable, bastante completa y actualmente se encuentra en procesamiento (Hanagarth com. pers.).

Los Parques Nacionales Amboró y Noel Kempff cuentan con una administración adecuada y la investigación básica se realiza en forma constante.

En la Reserva Nacional Manuripi Heath se ha desarrollado recientemente un programa de investigación biológica básica, que permitirá realizar una reestructuración de la misma y en un futuro implementar un plan de manejo de la Reserva (Salm y Marconi 1992).

Sobre especies importantes desde el punto de vista para la conservación se han realizado algunos estudios biológicos en áreas protegidas, entre los que se destacan el estudio sobre el caimán (*Melanosuchus niger*) (Pacheco 1990) en el Refugio de Vida Silvestre "El Dorado", la vicuña (*Vicugna vicugna*) en la Reserva Nacional de Ulla Ulla, varios estudios sobre los flamencos en la Reserva Nacional Eduardo Avaroa, y sobre el psitácido endémico de Bolivia (*Ara rubrogenys*) dentro de su área distribución.

En general, la investigación realizada hasta el momento en las áreas protegidas ha sido productiva, considerando que ha sido realizada en un corto período de tiempo, con las deficiencias de personal científico capacitado ya mencionadas, los bajos financiamientos asignados a la misma y también con las dificultades que se presentan debido a que son pocas las áreas protegidas que ofrecen una infraestructura adecuada. Muchos de los estudios realizados han significado un alto esfuerzo de desplazamiento de personal, riesgos elevados y una coordinación logística compleja.

PERSPECTIVAS DE LA INVESTIGACION BIOLOGICA EN LAS AREAS PROTEGIDAS

La investigación biológica en las áreas protegidas de Bolivia es una actividad que ha contado con un importante aporte en los últimos 5 años, especto que se refleja en los trabajos producidos y en la importante cantidad de especímenes e información bioecológica depositada en las diferentes instituciones científicas tanto nacionales como internacionales (Hanagarth 1990).

AREAS PROTEGIDAS Y SUS CATEGORIAS	1	2	3	4	5
PARQUES NACIONALES					
1. Parque Nacional Sajama	P	A	-	-	P
2. Parque Nacional Tuni Condoriri	P	-	-	-	-
3. Parque Nacional Territorio Indigena Isiboro Secure	P	-	-	-	-
4. Parque Nacional Amboró	A	P	P	P	-
5. Parque Nacional Noel Kempff Mercado	P	P	P	P	-
6. Parque Nacional Histórico Cruz La Vieja	P	-	-	-	-
REFUGIOS DE VIDA SILVESTRE					
1. Huancaroma	-	-	P	P	-
2. Estancias Elsner "Espiritu"	A	A	P	P	A
3. El Dorado	-	A	-	P	P
SANTUARIOS					
1. Flavio Machicado Viscarra	P	-	-	-	-
RESERVAS NACIONALES					
1. Reserva Nacional Ulla Ulla	A	A	A	A	P
2. Reserva Nacional Eduardo Avaroa	A	A	P	P	P
3. Reserva Nacional Manuripi Heath	P	P	-	-	-
RESERVAS BIOLOGICAS					
1. Reserva Biológica Ríos Blanco y Negro	P	P	-	-	-
ESTACIONES BIOLOGICAS					
1. Estación Biológica Beni	A	A	P	P	P
RESERVAS FISCALES					
1. Lagunas Alalay y Angostura	A	-	-	-	-
BOSQUES PERMANENTES DE PROTECCION					
1. Bosque Permanente de Protección Sajta Ichilo	P	P	-	-	-

1 = Inventarios
2 = Vegetación
3 = Biologia de especies
4 = Poblaciones
5 = Otros estudios ecológicos
P = Preliminar
A = Avanzado

Figura 1. Las áreas protegidas declaradas de Bolivia en relación a la investigación biológica realizada

Los estudios biológicos son requeridos con una frecuencia muy alta, apoyados en la importancia vital de la investigación, tanto básica como aplicada percibida por los planificadores y también debido al mayor apoyo financiero que reciben las áreas protegidas.

El reciente establecimiento del Sistema Nacional de Areas Protegidas (Fondo Nacional para el Medio Ambiente 1991) en la Secretaría Nacional del Medio Ambiente, con susdiferentes programas priorizan a la investigación tanto básica, básica aplicada y aplicada en las diferentes áreas que integrarán el sistema. Cada una de las áreas protegidas integrantes del sistema contará con lineamientos de investigación adecuada a sus necesidades, aunque ciertas normas generales deben ser establecidas por el Sistema.

La estrecha colaboración que actualmente existe entre las instituciones no gubernamentales, académicas y científicas con es sector estatal, encargado de la administración del Sistema Nacional de Areas Protegidas debe mantenerse y consolidarse con la implementación de las diferentes acciones y programas, tanto de investigación como de capacitación de recursos humanos previstas y en diseño.

Los conociemientos básicos sobre la ecología de las diferentes regiones del país son esenciales para un ordenamiento territorial y debe desarrollarse una estrategia de **investigación diferenciada** y que considere tanto la **investigación básica** en regiones no conocidas, que actualmente no forman parte integral de un área protegida, así como en áreas protegidas. Muchas de las áreas protegidas no cuentan con información básica y en la mayoría de ellas es necesario fortalacer la investigación. La investigación básica debe ser obtenida en forma rápida, para lo cual se requiere la formación de equipos de trabajo especializados y los resultados pueden ser utilizados para la elaboración de los planes de manejo previstos para los próximos meses. La investigación básica en las áreas protegidas será desarrollada en coordinación con el Sistema Nacional de Areas Protegidas, y en una primera fase permitirán definir las áreas establecidas que integrarán el Sistema y las áreas potenciales importantes para el establecimiento de unidades de conservación.

La **investigación ecológica** requiere de la implementación de studios de larga duración y seguimiento. Solamente el Refugio de Vida Silvestre Estancias Elsner "Espiritu" y en menor proporción la Estación Biológica Beni y la Reserva Nacional de Ulla Ulla cuentan con estudios ecológicos, que han permitido el desarrollo de las áreas y del conocimiento científico del país.

Los estudios ecológicos deben ser aplicados para ejecutar la **investigación aplicada** relativa al manejo alternativo de recursos naturales, especialmente en las áreas of amortiguación. Es indispensable estudiar y recopilar la información sobre uso tradicional de los recursos, de manera de lograr la sustitución progresiva de la caza y recolección intensivas por el uso sustentable de los recursos silvestres.

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Morales, C. 1990. Bolivia: Medio Ambiente y Ecología Aplicada. LIDEMA. Instituto de Ecología. 326 pp.

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Salm, H. y M. Marconi (Eds.). 1992. Reserva Nacional Amazónica Manuripi Heath. Fase II. Programa de Reestructuración. Centro de Estudios Ecológicos y de Desarrollo Integral. Centro de Datos para la Conservación. 275 pp.

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Anexo 1
Lista Preliminar de las Publicaciones Sobre Investigacion Biologica en las Areas Protegidas de Bolivia

A. Parques Nacionales

Parque Nacional Sajama

Jordan, E. 1980. Das durch Warmemangel und Trockenheit begrenzte Auftreten von Polylepis am Sajama Boliviens mit den höchsten Polylepis–Gebüschvorkommen der Erde. Tagungsbericht Deutscher Geographentag Göttingen 1979. Weisbaden. Pp. 303-305.

Liberman, M. 1986. Microclima y distribución de Polylepis tarapacana en el Parque Nacional del Nevado Sajama, Bolivia. Documents Phytosociologiques 10(2):235-272. Camerino.

Parque Nacional Amboró

Anderson, S., B. R. Riddle, T. Yates y J. Cook. (sin fecha). Mamíferos en la región del Parque Nacional Amboró y Santa Cruz de la Sierra, Bolivia. 118 pp. (No publicado.)

Clarke, R., B. P. Walker y G. Cox. 1989. Informe preliminar de las aves del Parque Nacional Amboró. Revista Boliviana de Investigación 4:293-298 y anexo. Santa Cruz.

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Dunstone, N. 1987. Quest for the river wolf. Report of 1987 Durham University Expedition to Bolivia. England. 30 pp.

Parque Nacional Noel Kempff Mercado

Bates, J. M. y J. V. Remsen. 1989. Final report to the National Geographic Society for NGS Grant 4089-89. "Ornithological exploration of the Serranía de Huanchaca." (No publicado.)

Bates, J. M. y T. Parker. (sin fecha.) Report on an avifaunal inventory of Parque Nacional "Noel Kempff Mercado," with comments on the biological importance of the park, and suggestion s for its further protection. (No publicado.) Santa Cruz.

Braza, F. y J. E. García. 1988. Rapport preliminaire sur les singes de la région monstagneuse de Huanchaca, Bolivia. Folia Primatologica 49:182-186.

Parque Nacional Pilón Lajas
(no incluido en la legislación boliviana)

Smith, D. N. 1990. Botanical Inventory of Pilon Lajas, Beni Department, Bolivia. Midterm Report, Missouri Botanical Garden (St. Louis) and Herbario Nacional de Bolivia (La Paz). 6 pp.

Smith, D. N., T. J. Killeen y D. A. Neili. 1991. Quantitative inventory of one hectare of tropical wet forest on the Rio Colorado in the western Beni, Bolivia. (No publicado.)

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Refugio de Vida Silvestre Estancias Eisner Espíritu

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Barro Colorado Island, Panamá, Basic Research, and Conservation

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INTRODUCTION

To design reserves for protecting biodiversity and preserving representative ecosystems, we must know (1) what factors limit the populations of various representative kinds of plants and animals, (2) what factors allow these populations to persist, (3) which species are particularly crucial to the integrity of their communities, and (4) how the integrity of these communities depends on events in their surroundings, or in the biosphere as a whole.

Social questions also confront conservationists. Biodiversity cannot be preserved if the hope of the rural poor is taken away, or if human populations continue outgrowing their resources. The preservation of ecosystems requires that local people be able to support themselves decently without destroying them. Speaking *practically*, right relationships between humans and nature cannot be based on grossly inequitable relationships among humans. This paper considers only the (equally essential) biological dimension of conservation.

This paper relates research on Barro Colorado Island (BCI) to problems connected with conserving tropical forest and its diversity. This research yields no immediate prescriptions about how large a viable park must be, how many habitat types it must contain, etc. Indeed, research at many sites is needed to answer such questions. We merely identify factors which must be considered in making such decisions, and suggest where appropriate information may be found.

First, some background (from Windsor 1990): BCI is a 1,500-ha island isolated about 1913 from the surrounding mainland of central Panamá by the rising waters of Gatun Lake. BCI's rainfall has averaged 2,600 mm/yr over the last 60 years. A severe dry season extends from December into April or May; the median rainfall for the first 13 weeks of the year is 84 mm. BCI's vegetation is considered characteristic of fertile soil (Foster and Brokaw 1982, 1990). Human populations lived on BCI before the Spanish conquest (Piperno 1990). Mature forest has covered parts of BCI's central plateau uninterruptedly for 2,000 years, but other parts of BCI probably were more thickly settled.

How can basic research on this island help answer our questions?

ANIMALS

Population regulation Monitoring the timing and extent of flowering, fruiting, and leaf flush among BCI's plants, and studies of the behavior and demography of vertebrate frugivores and folivores in relation to seasonal changes in their food supply, suggest that the forest controls its vertebrate herbivores by seasonal shortages of fruit and new leaves (Leigh 1975, 1982; Leigh et al. 1982, 1990), even though parasites may eliminate overly malnourished individuals (Milton 1982, 1990), and predators eat surplus young (Smythe et al. 1982, 1990). Fruit is most abundant on BCI from March through May and from August into October (Foster 1982a). Fruit and new leaves are most scarce from late October into the dry season. During this seasonal shortage, there is not enough fruit to feed the frugivores, a circumstance reflected in their behavior and demography (Table 1). As in Peru's Parque Manú (Terborgh 1986a, 1986b), each species which shares in the bounty when fruit abounds has its own specialty in the lean season, as if to avoid competitive displacement during this critical period (Zaret and Rand 1971). When fruit is rare, coatis, *Nasua narica*, hunt animals in the leaf litter; pacas, *Agouti paca*, browse seedlings; agoutis, *Dasyprocta punctata*, dig up seeds buried in the time of abundance, etc. (Smythe 1978).

Collectively, folivorous insects are most abundant soon after the rains begin, when leaf flush is in full swing (Wolda 1978, 1982, 1990; Smythe 1982, 1990). Insectivorous bats and birds tend to breed in this season of insect abundance (Bonaccorso 1979; Leigh and Windsor 1982, 1990). We know the population density or aggregate feeding rate of *no* kind of folivorous insect, not even leafcutter ants, *Atta* spp. Nevertheless, comparing the population sizes and feeding rates of insectivorous birds with estimates of insect folivory from damage to litter leaves suggests that BCI's birds eat enough folivorous insects to control their numbers (Leigh and Windsor 1982, 1990). One Australian eucalyptus forest depends demonstrably on its birds for protection against folivorous insects (Loyn 1987): is this equally true for tropical forests?

What do different animal populations need to persist? A species can only persist if it has enough suitable habitat to maintain a viable population, enough habitat types to meet its various needs, and access to enough of the resources it needs to assure it a living, secure from superior competitors, even in bad years (Leigh 1981, 1990; Karr 1982). White-lipped peccaries, *Tayassu pecari*, travel very widely in large herds.

Table 1. Evidence that a seasonal shortage of fruit and new leaves controls BCI's populations of vertebrate herbivores

1. Quantitative data

- ✦ During the lean season, measured fruit supply is insufficient to feed, e.g., terrestrial frugivores (Smythe et al. 1982, 1990) and manakins, *Pipra mentalis* and *Manacus vitellinus* (Worthington 1982, 1990)
- ✦ Failure of September fruiting peak in 1970 caused mass starvation among BCI's mammals (Foster 1982b, 1990b)
- ✦ Mortality, reproductive activity and population density of squirrels, *Sciurus granatensis*, changes from year to year in accord with availability of principal foods in successive years (Giacalone et al. 1990)

2. Seasonal changes of behavior in relation to food supply

- ✦ Species which share in the same abundance of fruit during the season of abundance each specialize to a different diet during the lean season; e.g., terrestrial frugivores (Smythe 1978)
- ✦ Animals are more easily trapped during the lean season; e.g., terrestrial frugivores (Smythe et al. 1982, 1990) and squirrels, *Sciurus granatensis* (J. Giacalone pers. comm.)
- ✦ Animals range further and take more risks to find food; e.g., terrestrial frugivores (Smythe et al. 1982, 1990) and coatis, *Nasua narica* (Russell, 1982, 1990)
- ✦ Animals show less care for their young in the lean season; e.g., agoutis, *Dasyprocta punctata* (Smythe 1978)

3. Relationship of demography to food supply

- ✦ Coatis who have never bred before delay breeding for a year in a year when food is short (Russell 1982, 1990)
- ✦ Death rates, especially among young, are higher in the lean season; e.g., agoutis, *Dasyprocta punctata* (Smythe 1978); howling monkeys, *Alouatta palliatta* (Milton 1982, 1990, 1990b); and sloths, *Bradypus variegatus* (Montgomery and Sunquist 1978; Milton 1990b)
- ✦ Births are timed to produce young in the favorable season; e.g., iguanas, *Iguana iguana* (Burghardt et al. 1977; Rand and Greene 1982); coatis, *Nasua narica* (Russell 1982, 1990); insectivorous bats: *Saccopteryx bilineata* (Tannenbaum 1975); frugivorous bats, *Artibeus jamaicensis* (Morrison 1978); and others (Bonaccorso 1979)
- ✦ Birth rates are lower during the lean season; e.g., whitefaced monkeys, *Cebus capucinus* (Mitchell 1989); howling monkeys, *Alouatta palliatta* (Milton 1982, 1990); and squirrels, *Sciurus granatensis* (Glanz et al., 1982, 1990)

Such herds disappeared from BCI in the 1930s, 20 years after its isolation (Glanz 1982, 1990a), although individuals have been reported since. Big cats need large territories: puma, *Felis concolor,* were photographed on BCI in the 1930s (Glanz 1982, 1990), but the last sighting was in 1958 (Martin Moynihan, personal communication). The only jaguar, *Panthera onca,* ever recorded on BCI was seen in 1983. Is BCI too small to support such species indefinitely?

Many bird species of young second-growth have disappeared from BCI as its forest has aged (Willis 1974), as if BCI has too few kinds of habitat to maintain high bird diversity. Some bird species, which migrate to streamside habitats, have disappeared from BCI, which lacks permanent streams (Karr 1982). Similarly, isolating La Selva, in Costa Rica, from montane forest would eliminate those many species of birds which migrate seasonally from lowland forest up nearby mountainsides in response to changing fruit availability (Loiselle and Blake 1991). Finally, some species of large ant-following birds with very specialized feeding requirements have disappeared (Willis 1974), as if BCI were too small to assure them a reliable food supply.

In sum, animal diversity presupposes diversity of plants *and* vegetation types. The principle of competitive exclusion implies that species coexist only if their numbers are limited by different factors, say, different predators or availabilities of different foods or habitats. A rainforest's vertebrates, whether at BCI (Leck 1971; Jones 1977; Smythe 1978; Bonaccorso 1979), Manú (Terborgh 1983; Terborgh et al. 1990) or Gabon (Emmons 1980; Emmons et al. 1983), differ enough in diet or habitat, at least during the lean season, to ensure coexistence. The same probably applies to insects. The diverse rhythms of flowering, fruiting, and leaf flush among a rainforest's plants, and the lack of winter cold, ensures that fruit and insects are available all year round, even though selection by herbivores (Aide 1988) has shaped a forest-wide rhythm that controls the number of vertebrate herbivores (Leigh 1975, 1982). The continual, if uneven, supply of suitable food allows many more kinds of frugivorous and insectivorous mammals and birds in the tropics than in the temperate zone (Emmons et al. 1983; Terborgh and Robinson 1986; Emmons 1989).

Keystone species for animal populations Of the 1,500+ plant species in Peru's Parque Manú, just 12 "keystone" species, including figs, *Ficus* spp., and palms, *Scheelea* spp. and *Astrocaryum* spp., provide food, tiding frugivores over the lean season. These 12 species set Manú's carrying capacity for frugivores (Terborgh 1986a, 1986b). On BCI, *Ficus insipida, Ficus yoponensis, Scheelea zonensis* and *Astrocaryum standleyanum* are keystone species with fruit in the lean season (Morrison 1978; Handley and Leigh 1991; Glanz et al. 1982, 1990). *Astrocaryum* seeds, moreover, are durable enough to bury against future shortages (Smythe 1989). Keystone species for BCI's smaller frugivores are not yet identified, but, as at Manú, they include pollen- and nectar-producers.

Are big cats (Felidae) keystone species which BCI lacks? They annually kill 8% of Manú's standing crop of mammals weighing over 1 kg, a predation pressure similar to the Serengeti's (Emmons 1987; Terborgh 1988, 1990), yet frugivores are as abundant there as at BCI (Terborgh 1986a). Do big cats merely stabilize prey populations, weeding out the weak, the sick and the surplus, as wolves (*Canis lupus*) do at Isle Royale? Or have big cats caused the differences between BCI and Manú mammal faunas (perhaps by thinning mammal populations enough to allow more species to coexist in the Manú)? Views on this subject differ widely (Glanz 1990; Janson and Emmons 1990).

PLANTS

Population regulation Why there are so many kinds of tropical plants is one of biology's greatest mysteries (Leigh 1990; Leigh et al. in press).

The forest as a whole is limited by abundance of light, water, and nutrients. On BCI, upland forest equilibrates at a density of slightly over 400 trees/ha ≥ 10 cm, and 4,800 stems/ha ≥ 1 cm, in diameter at breast height (Richard Condit, personal communication). However, trees are so long-lived that changes devastating for a forest's future diversity can pass unnoticed by any but the most practiced eye. We now think we understand the population dynamics of *one* of BCI's tree species, *Trichilia tuberculata*, the most common canopy tree on BCI's 50-ha Forest Dynamics Plot (Hubbell et al. 1990). This triumph was attained by mapping *and* recensusing all of this plot's 240,000 stems ≥ 1 cm thick, an immense project of unknown environmental impact.

This 50-ha plot has shown that few species specialize to particular habitats (such as slope vs. ridgetop) or particular sizes of treefall gap (Hubbell and Foster 1986), suggesting that habitat heterogeneity is not essential to (although, according to Gentry 1988, it often enhances) tree diversity.

What do plant populations need to persist? What factors help maintain the diversity of BCI's trees? The seeds of many (but not all) trees have better prospects when dispersed well away from the parent plant (Howe and Smallwood 1982), to avoid species-specific herbivores (Howe et al. 1985) or pathogens (Augspurger 1983) around the parent. *Virola surinamensis* seeds are 44 times more likely to become six-week-old seedlings when removed 45 m from the parent crown than when dropped under the parent (Howe et al. 1985). Pests can thus promote tree diversity by providing room for other species between a parent and its surviving young (Janzen 1970). Moreover, fruit production and recruitment of different tree species varies drastically, and contrastingly, from year to year (Hubbell and Foster 1990; Leigh 1990). Such "sorting in time" of reproductive success may help prevent competitive displacement (Chesson and Warner 1981), thus promoting tree diversity. These contrasting reproductive responses must, in part, reflect contrasting responses to yearly differences in abundance of various pollinators, dispersers, and seedling-browsers. Indeed, the diversity of pollination and dispersal mechanisms (Foster 1982a, 1990a), exploiting the diversity of possible carriers, suggests a premium on novelty for its own sake, as if a novel reproductive response to environmental change favored persistence. If so, animal diversity is crucial to plant diversity.

Perhaps competitive exclusion is irrelevant to plant diversity (Huston 1979, Hubbell and Foster 1986). Are animals *demonstrably* essential for maintaining some plant populations? The seeds of the black palm, *Astrocaryum standleyanum,* can only escape destruction by weevils if agoutis peel their flesh *and* bury them (Smythe 1989). This instance is not isolated. Even after toucans, *Ramphastos* spp., disperse them, agoutis must bury seeds of *Virola surinamensis* (= *nobilis*) to save them from weevils (Forget and Milleron 1991). Islands of 1 ha or less near BCI, which were forested when isolated and not cleared since, have been largely taken over by four species of tree, *Protium panamense* (Burseraceae), *Swartzia simplex* (Leguminosae), *Oenocarpus mapora* (Palmae), and *Scheelea zonensis* (Palmae) (Putz et al. 1990; Leigh et al. in press). These islands lack mammals, so their seeds remain unburied. The seeds of the first three of these species are not infested by insects, while the bruchids which plague *Scheelea* early in its fruiting season disappear by October, leaving late-falling *Scheelea* seeds uninfested (Wright 1990). (On BCI, the latter fall during the lean season and are immediately eaten by mammals.) Are mammals crucial to the survival of many tree species?

The diversity of regeneration in the rain forest at Las Tuxtlas, Mexico, where mammals are very rare, is much lower than in a much larger expanse of rainforest with roughly similar diversity and species composition of canopy trees, but with many more mammals, in Chiapas, Mexico (Dirzo and Miranda 1990, 1991). In the Neotropics, the least-seasonal forests have the highest tree diversity, the highest proportion of animal-dispersed trees, and the highest diversity of frugivorous animals (Emmons 1989). The first animals to be hunted out are potential seed dispersers. Such hunting imperils tropical tree diversity.

Plant diversity and keystone animals Many tree species at both the Taï Reserve, in the west of Côte d'Ivoire, and the Parc National Banco, near Abidjan, had seeds designed to be dispersed by elephants, *Loxodonta africana* (Alexandre 1978). On much of BCI, at least in some years, agoutis eat nearly all the seeds of *Dipteryx panamensis.* Young of this species are abundant only on certain peninsulas of BCI. Are agoutis rarer there, or are these young more abundant because more light reaches the forest floor of these peninsulas? This question is in dispute. On the mainland points near BCI, where there are fewer agoutis, and where the forest is younger and perhaps thinner, and at La Selva, *Dipteryx* regeneration seems quite adequate (De Steven and Putz 1984; Clark and Clark 1987). Similarly, agoutis may be keystone animals for maintaining BCI's tree diversity.

Are jaguars also keystone animals for plants? Agoutis are much more common on BCI than at Manú. BCI's lack of jaguars must play some role in this difference (Glanz 1990b). Again, on BCI agoutis eat so many seeds of *Dipteryx panamensis* (Leguminosae) that this species is regenerating only on certain peninsulas where agoutis are rare. At La Selva, and on the mainland points near BCI, where agoutis are rarer, *Dipteryx* regeneration seems quite adequate (De Steven and Putz 1984; Clark and Clark 1987). Will *Dipteryx*—or other species—disappear from BCI for lack of jaguars?

Global environmental change and plant responses Atmospheric content of carbon dioxide (Hogan et al. 1991) and methane (Keller et al. 1990) is increasing, thanks to a variety of human activities. How will these changes affect rainforest plants? How should reserve design reflect these effects?

Answering these questions must begin with plant physiology. Changing CO_2 levels affects photosynthetic rate and water use, and might increase plants' tolerance for higher temperatures (Hogan et al. 1991). How will these atmospheric changes affect plant-animal interactions? Among other things, we must understand the physiology underlying phenological rhythms of flowering, fruiting, and leaf flush in different rainforest plants. Synchronous fruiting, and synchronous leaf flush, helps protect seeds, seedlings, and new leaves from herbivores within a species (Augspurger 1982, 1990; Aide 1991) or in whole forests (Ashton et al. 1988). Speedy leaf flush. (Aide and Londoño 1989), or flushing leaves in the dry season when insects are rarer (Aide 1988), are also possible defenses against herbivory.

Our devastating ignorance of plants The greatest service of BCI's 50-ha Forest Dynamics Plot has been to reveal the depths of our ignorance of the lives of plants. Saplings whose nearest canopy neighbor is a conspecific grow more slowly, and die more rapidly, than those with nearest neighbors of different species (Hubbell and Foster 1990). Is this effect strong enough to enhance tree diversity? No one knows. The plot's common trees tended to grow more common, and rarer trees rarer, between the first two censuses (Welden et al. 1991). Does this reflect the later stages of a plant succession after the Spanish conquest eliminated BCI's human populations (Piperno 1990)? Did the Amerindians actively *maintain* plant diversity (Irvine 1989)? Or do these changes reflect a continuing response to the onset 11,000 years ago of wetter conditions (Bush et al. in press)? These are tricky questions. The vegetation of eastern North America has been changing continuously since the last glaciers receded. These changes were considered evidence for disequilibrium in North American plant communities, but a more thorough study (Prentice et al. 1991) suggests that the vegetation has remained in equilibrium with a continuously changing climate.

More general questions remain unsettled. The potentially high pest pressure in tropical forests promotes effective plant dispersal. Dispersal is often enhanced by attractive fruits (Howe and Smallwood 1982). Calculations suggest that, if a tree's seeds disperse well beyond the "neighborhood" of the trees with whom the roots or leaves of their parent competes, it pays the parent to increase seed and fruit production, even by means which benefit neighboring trees; harming neighbors at the expense of slowing one's own growth or reproduction no longer pays (Wilson 1980; Leigh 1991). Many naturalists have considered tropical rainforest to be the apex of mutualism (Corner 1964; Jacobs 1988): the nature and extent of its interdependences have hardly begun to be explored. Are insect pests, through their effect on seed dispersal, crucial to the diversity and productivity of tropical forests, the complex interdependencies among their species, and the luxuriance of their mammal populations?

CONCLUDING REMARKS

We understand something of what factors affect the diversity of vertebrates and perhaps—despite our stunning ignorance of them—even insects. At bottom, however, animal diversity presupposes plant diversity (Hutchinson 1959).

Therefore, our abysmal ignorance of tropical plants may be *the* stumbling-block for formulating appropriate long-term conservation strategies. Our ignorance of plants, however, is no excuse for neglecting animals, for we know least about the many ways plants depend on animals (Table 2). Alexandre's (1978) demonstration that elephants are keystone animals for West African plant diversity was nearly universally ignored. The corresponding role of agoutis for BCI's forests is a remarkably recent discovery.

Table 2. How tropical plants depend on animals: What we know (•), what we must learn (∞), and management implications (§)

- ✦ **Animals pollinate plants.**
  - ✦ Animal pollinators allow scattered individuals to outcross, permitting high tree diversity (Regal 1977).
  - ✦ Birds, bats, and insects serve as pollinators (Appanah 1990; Bawa 1990; Schatz 1990).
  - ✦ Some pollinating birds (Feinsinger 1980), bats (Lee 1980) and insects (Williams 1958) migrate.
  - ✦ The bats in Malaysia which pollinate durians also eat mangrove pollen. The destruction of mangrove habitats and bat caves in Malaysia thus imperils its durian industry.
  - ✦ What proportion of pollinators migrate? We must identify migrant pollinators.

Table 2 (continued)

- ✦ We must protect alternate habitats and resources of migrating pollinators.

✦ **Animals protect plants against herbivores and pathogens.**

- ✦ Are insectivorous birds needed to protect a forest's trees from defoliation by insects?
- ✦ Excluding insectivorous birds leads to defoliation and death of Australian *Eucalyptus* forest (Loyn 1987).
- ✦ On BCI, excluding insectivorous birds allows insect populations to build up in aerial tangles of *dead* leaves (Gradwohl and Greenberg 1982).
- ✦ Rough calculations suggest that half the "consuming biomass" of a tropical forest's leaf-eating insects are destined to be eaten by birds (Leigh and Windsor 1982, 1990).
- ✦ Management practices (such as using insecticides) which kill insectivorous birds should be avoided.
- ✦ Animals help seeds escape species-specific pests by dispersing seeds away from their parents (Janzen 1970).
- ✦ In the most diverse rainforest, over 90% of tree species are dispersed by animals (Gentry 1982; Emmons 1989).
- ✦ Some plants cannot replace themselves unless their seeds are dispersed. On BCI, Panamá, seeds of *Virola surinamensis* must be dispersed to survive (Howe et al. 1985). In Guanacaste, Costa Rica, seeds of *Hymenaea courbaril* must be dispersed by agoutis (Hallwachs 1986). In Côte d'Ivoire, seeds of *Saccoglottis gabonensis* must be dispersed by elephants (Alexandre 1978).
- ✦ On BCI, seeds of *Astrocaryum standleyanum* (Smythe 1989) and *Virola surinamensis* (Forget and Milleron 1991) must be buried by agoutis to be saved from destruction by insects.
- ✦ On BCI, *Virola surinamensis* regeneration depends on the intervention of both toucans and agoutis (Forget and Milleron 1991).
- ✦ Some dispersers, like toucans, migrate (Foster 1982b); some are prize game, like agoutis (Smythe 1978), some need special nest sites, like hornbills which nest in dead trees (Jacobs 1988).
- ✦ What species require their seeds to be dispersed or buried by animals in order to regenerate? We must identify crucial dispersers and "protectors," especially those which migrate, those prized by hunters, and those with unusual requirements.
- ✦ We must protect crucial dispersers, and the alternative habitats and foods they require (Terborgh 1990b).

✦ **Animals facilitate the coexistence of different kinds of plants.**

- ✦ Insect pests keep at least some tree species rare, making room for others (Janzen 1970; Howe 1990).
- ✦ Each tree species attracts different defoliators, pollinators, and dispersers (Janzen 1981, 1983), which respond differently to the climate differences of successive years, causing their host plants to respond differently as well (Leigh 1990).
- ✦ These different reproductive responses create a "sorting in time" of reproductive success.
- ✦ Theory predicts that this sorting facilitates coexistence of different species (Chesson and Warner 1981).

Table 2 (continued)

- ✦ Does this "sorting in time" of reproductive success contribute substantially to tropical tree diversity?
- ✦ If so, animal diversity must be protected for the sake of plant diversity.

✦ **Do pests favor evolution of higher fruit production and increased populations of game animals?**

- ✦ Insect pests favor dispersal of a tree's seeds far beyond the "neighborhood" of adult trees with which their parent's roots or crown competes directly (Janzen 1970).
- ✦ Seed dispersal thus promotes reproductive competition between different neighborhoods (trait-groups) of adult trees (Wilson 1980).
- ✦ Theory predicts that competition among neighborhoods favors increased seed and fruit production, even by means which also benefit neighboring trees, and selects against "spiteful" competition which reduces the agent's own growth rate in order to harm or kill competitors (Wilson 1980).
- ✦ How might a tree benefit its neighbors by increasing its own growth rate and fruit production?
  (Perhaps by making leaves which rot and release nutrients more readily when they fall, or by using types of mycorrhizae that neighbors can share: Leigh 1991).
- ✦ What are the observable effects of this theoretical competition among neighborhoods?
- ✦ It is essential to consider evolutionary as well as ecological consequences of management decisions.

We need to understand the natural history of tropical forest. Autecological studies of especially interesting species will not suffice. We need field stations where many students work independently on different organisms and share their results. Low-budget student projects at the primitive, ill-equipped Manú (Terborgh 1983, 1990; Terborgh et al. 1990), have been especially spectacular. (The Manú's lack of financial support is the most stunning condemnation we know of the funding priorities of both the U.S. National Science Foundation and non-governmental organizations.) Such arrangements would facilitate the identification and study of the interactions which maintain the integrity of ecosystems (Karr 1990).

Research at a single site, even one with the Manú's pristine glory, cannot provide a sufficient basis for conservation strategies appropriate to all habitats. For example, BCI's agoutis bury seeds dispersed by other animals (Forget and Milleron 1991), but agoutis of Costa Rica's dry forest disperse seeds (Hallwachs 1986). Migration patterns—in birds (Loiselle and Blake 1991), butterflies (Williams 1958), moths (Smith 1976, 1990), and bats (Handley et al. 1991)—will differ from site to site. Local research stations are needed to establish conservation policies appropriate for local conditions (Rubinoff and Leigh 1990).

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Bialowieza National Park and Science

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BIALOWIEZA NATIONAL PARK
Bialowieza, Poland

BIALOWIEZA NATIONAL PARK AS A RESEARCH OBJECT

Bialowieza National Park (BNP) lies in the center of a great forest complex: Bialowieza Forest (145,000 ha), divided by the state border between Poland and Belorussia. BNP has 5,346 ha. Its main function is as a strict preserve (4,747 ha so managed) containing mainly forest ecosystems with stands of natural origin. They are the best-preserved European lowland forest lying in a zone of deciduous and mixed forest, which could be defined as "natural" or "old-growth" forest. The BNP is a biosphere reserve and World Heritage Site.

BNP's value to research arises from:

✦ the exceptional state of its ecosystems, which are minimally altered by human activity;

✦ the strict protection under which the park is kept, which makes it possible to realize long-term investigations based on permanent study plots;

✦ its position at the center of a great forest complex, with economic forests and partially preserved forests, that makes it possible to investigate the course of chosen processes and phenomena in primeval forests, economic forests, and forests with limited economic activity;

✦ the park's containing numerous rare and endangered species of plants, fungi, and animals–relicts of primeval forests that are important for science; and

✦ the exceptional biogeographical location of the Bialowieza Forest near the range of natural distribution for numerous species of plants, fungi, and animals, as well as vegetation types.

Thanks to the protection of the park since 1921, a well-known center of biological and forest sciences was created in the village of Bialowieza, which now contains four research institutes: the Polish Department of Protection's Forestry Research Institute; Bialowieza Geobotanical Station of Warsaw University; the Mammals Research Institute of the Polish Academy of Science; and the Plant Populations Laboratory Institute of Botany. BNP itself also has a small research laboratory.

Goals of Research

The main goals of investigations in BNP are to:

✦ inventory all elements of nature, e.g., flora, fauna, individual and population variability, geological structure, soils, hydrology, and registration of meteorological phenomena;

✦ establish the representativity of BNP for the wider Bialowieza Forest and the general borderland region between Central and Eastern Europe;

✦ study natural processes, especially long-term ones, that can proceed unimpaired only in protected areas like BNP;

✦ recognize the differences between processes under natural succession in a forest free of human impact and those which take place in a forest subject to different levels of human activity (especially those processes that should have a direct or indirect influence on natural elements of timber production);

✦ investigate the mechanisms and degree of influence of human activity within the park—including scientific investigations themselves, educational activities, and tourism—as well as activities in surrounding areas; and

✦ monitor the state of the environment.

Organization of Research

Because BNP is relatively small, it is necessary to reconcile different functions of the park without conflicts. For this reason, BNP is divided into zones: (I) mass tourism and education; (II) intensive scientific investigations and education at the secondary or high-school level; (III) research and experiments requiring larger or relatively isolated plots; and (IV) observational research of unlimited duration, requiring total isolation.

All research in BNP is coordinated by the park's Scientific Council (an advisory body of the park administration). Experimental investigations are permitted only if they do not make visible changes in the flora, fauna, or natural course of ecological processes. Complementary investigations are to be realized outside of the park in existing reserves set aside for the purpose. In practice, all research projects need approval by the Scientific Council of BNP from start to finish. In 1991, over 50 research projects based in Poland were carried out in BNP. Some of these were carried out together with foreign specialists.

The main form of research is that done on long-term, permanent study plots. The oldest, an investigation of changes in tree stands free from human impact, was established in 1936 (Kowalski 1982). There are actually over 100 permanent study plots in the park, complemented by points for monitoring groundwater levels, air pollution, or tree genetics.

The laboratory equipment at the research institutes located in the village of Bialowieza greatly facilitates the preliminary preparation of collected samples. There also exists results of previous investigations (both raw documentation and publications), basic data on climate, vegetation, soils, geological structure, and inventories of the main groups of plants, animals, and fungi. In the library of BNP are catalogued all publications relating to Bialowieza Forest. Nearly all are available in Bialowieza's libraries. The park also has information on the location of comparative collections of different systematic groups from its territory. Nearly 8,300 publications on the area had been produced up to the end of 1990, apart from popular weekly magazines thematically connected with Bialowieza Forest. From that total, 3,872 present results of original investigations made in Bialowieza Forest. A bibliography on Bialowieza Forest is published regularly (Karpinski and Okolów 1967; Okolów 1976, 1983, 1991). It is necessary to mention that in the Belorussian part of Bialowieza Forest—now proclaimed as a national park—is a research department, and its investigations are published too. The establishment of a transboundary biosphere reserve in Bialowieza Forest (now being undertaken) calls for the coordination of research and monitoring systems so that the results will be comparable.

Review of the Most Important Research Results

From numerous works of inventory of selected systematic groups of plants and animals, one of the most interesting, in broad scale, are investigations of Polyporaceous fungi, which, apart from their value as inventories, have made an important contribution to the taxonomy and ecology of this group (Dománski et al. 1973). Of similar importance from zoology are investigations on diurnal butterflies that reveal threats to several species and protective measures (Krzywicki 1967). Autecological work has been carried out on selected species of fungi, higher plants, terrestrial vertebrates, insects, and intestinal parasites of mammals. The discovery of seasonal changes in the dimensions of the skull of shrews, known as "Dehnel's phenomenon," is particularly well known (Dehnel 1949).

Beginning with the first director of BNP, Józef Paczoski, who was a founder of geobotany, wide work on vegetation was attempted to develop this branch of science in Poland (Paczoski 1930). Its continuation over a half-century is summarized by Falinski (1986). Many ornithological investigations have been carried out since 1975 by a team under the leadership of L. Tomialojc (Tomialojc and Wesolowski 1990). Based on permanent census plots, their work is of interest to the ecology and breeding biology of bird communities. Finally, since 1978 a predator study has been continuing, checking the movements of lynx, pine marten, weasel, and polecat (Jedrzejewski et al. 1990).

Examples of Work Important for Nature Protection

Almost all investigations in the park have some importance for the protection of nature locally, but some are relevant to all of Poland and even beyond.

Work by field biologists based in Bialowieza village discovered that BNP does not contain all the natural communities typical of Bialowieza Forest as a whole. This led to the creation of a network of complementary preserves (Sokolowski 1976). Thanks to these investigations, Bialystok Province now has Poland's richest and most comprehensive set of landscape parks and nature preserves. Scientists from Bialowieza prepared plans for the creation of Wigierski National Park and Knyszynksi, Narwianski, and Suwalski Landscape Parks. Work compiled at the Bialowieza Geobotanical Station—Falinski's (1975) map of the anthropogenic changes in Polish vegetation—was a principal tool in determining the prospective network of reserves for the entire country.

Numerous important data sets have been collected on the recovery succession of vegetation in abandoned hay meadows lying in swampy river beds (Falinska 1990) and on low-quality habitats used in former times as farmland (Falinski 1980). They help to predict vegetation succession in several existing and proposed protected sites. Research on local ecotypes of trees, begun more than 40 years ago (Kociecki 1968), recently was continued by Poland's Department of Nature Protection; it has importance for forestry practices and protection of genetic resources.

Finally, BNP is world-famous for the work done there on reintroduction of European bison. This work was possible only because of parallel wide-ranging investigations on the bison's morphology, biology, ecology, physiology, and role in forest ecosystems (Krasinski 1978). It is understandable why the the IUCN's Species Survival Commission group on European bison is chaired by a scientist from Bialowieza, and why the bison's pedigree book is maintained at BNP. Employees of the park helped establish free-ranging populations elsewhere in Poland, as well as a breeding center (initially stocked by animals from Bialowieza) in Margeride, France.

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Ecology of Oilbirds in Venezuela: Implications for Protected Areas

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INTRODUCTION

In recent decades, our biosphere has experienced unprecedented changes because of human-induced disturbances (e.g., global climatic fluctuations; air, water, and soil pollution; tropical- and temperate-forest destruction; and extinction of species). These changes have affected biodiversity negatively at all levels: gene pools, species, and natural community (World Resources Institute 1990).

The most efficient way currently accepted by wildlife managers to preserve biodiversity from human threats is to adequately manage critical habitats where natural communities and ecosystems occur. Five aspects of applied research are pivotal for the correct management of a park or protected area: flora and fauna inventories, research on species of special management significance, ecological relationships among key species of the ecosystem, monitoring and assessing dynamics of change, and socio-economics of the area (Thorsell 1990). Only recently, and then in just a few isolated cases, has applied research been used to design and manage parks of Latin America and the Caribbean.

The objectives of this paper are, first, to show how applied ecology from a species of special management significance (the oilbird *Steatornis caripensis,* or *guácharo* in Spanish) was used to manage and maintain the integrity of Guácharo National Park in Venezuela and to enlarge its limits; and, second, to show how park managers might include research on keystone species in their management strategies.

Guácharo National Park was created in 1975 with the aim of protecting the local watersheds, the Guácharo Cave Natural Monument, and the colony of oilbirds in the cave. When the park was created there was insufficient data about the ecology of oilbirds (Tannenbaum and Wrege 1978, 1984). Since one management aspect of Guácharo park was to conserve the colony, it was most consequential to determine the oilbird's habitat requirements and importance to the ecosystem. In this paper I am presenting two basic objectives of my research:

1. Foraging ecology:
   - ✦ Determine foraging ranges, habitat use, and dispersal patterns of oilbirds using radiotelemetry.
   - ✦ Evaluate the role of oilbirds as seed dispersal agents in tropical forests.
2. Conservation
   - ✦ Determine how habitat loss influences the foraging ecology of the species; in particular, how does the destruction and disturbance of the primary forest influence the foraging movements of both individuals and the colony as a whole?
   - ✦ Apply knowledge about the oilbirds' foraging ecology to the design and expansion of a new Guácharo National Park, and to provide a conservation model for future projects involving oilbird colonies in South America.

The natural history of the oilbird

Oilbirds are the only nocturnal frugivorous cave-dwellers in the world. They are the only species of the family Steathornithidae: Caprimulgiformes. These birds are about 46 cm long, average 400 g in weight, and have a wing span of 1 m. They guide their flight through dark caves by echolocation (Griffin 1953). They are monogamous and nest on ledges up to 50 m high. The normal clutch is two to four eggs. Both sexes incubate the eggs for about 32 days. Young oilbirds remain in the nest until they are 95-120 days old. During that time they accumulate the great deposits of fat that have led to their being exploited for oil. At about 70 days the young weigh much more than the parents (up to 600 g). The young are fed on whole undigested fruit during most of their development (Snow 1961, 1962). When oilbirds forage for fruit, they pluck and swallow it whole, digest the edible pericarp, and regurgitate the seed intact. In Trinidad, they forage on approximately 10 plant families and on at least 36 different species. Most of the species belong to the Palmae, Lauraceae, and Burseraceae (Snow 1962; Snow and Snow 1978; Roca 1991).

The range of the oilbird is restricted mainly to South America (Colombia, Venezuela, Trinidad, Ecuador, Peru, and Bolivia), but also occurs in Panamá. Despite its wide range, it is extremely vulnerable to human activities. Through both direct effects, such as the taking of nestlings from nests, and indirect effects, such as habitat destruction, the oilbird is suffering drastic reductions in numbers throughout its range. Snow (1962) reported the extinction of five of the thirteen known colonies in Trinidad. Bosque (1986) indicated that seven of fifty-four colonies in Venezuela have disappeared.

STUDY AREA AND METHODS

My field work was done during 1986, 1987, and 1988. The oilbird colony studied inhabits the Guácharo Cave close to the town of Caripe, in northeastern Venezuela. The cave is a Natural Monument (since 1949) existing within Guácharo National Park, a 15,500-ha area of seasonally dry mountainous forest. The park is included within the northeastern mountain range of Venezuela. The area has a seasonal rainfall pattern, but rains occur most of the year, with an average annual total of 1,178 mm. The average temperature is 21°C.

Radiotelemetry The major technique used in my study was radiotelemetry. Avian radiotelemetry is a powerful and reliable technique for monitoring movements and activities (Greenwood and Sargeant 1973; Gilmer et al. 1974; Erikstad 1979; Herzog 1979; Johnson and Berner 1980; Sayre et al. 1981). My portable radio equipment was obtained from the Telonics company of Mesa, Arizona, USA. The basic equipment consisted of two TR2 receivers, two hand-held Yagi antennas, two five-element Yagi antennas, two headphones, and twelve subminiature transmitters of 32 grams each. Each transmitter's weight was about 8% of the bird's weight, which is within the safe range (Caccamise and Hedin 1985). The equipment was tuned between 150 and 152 MHz. The two-stage transmitters were designed for an operating life of eight to ten months.

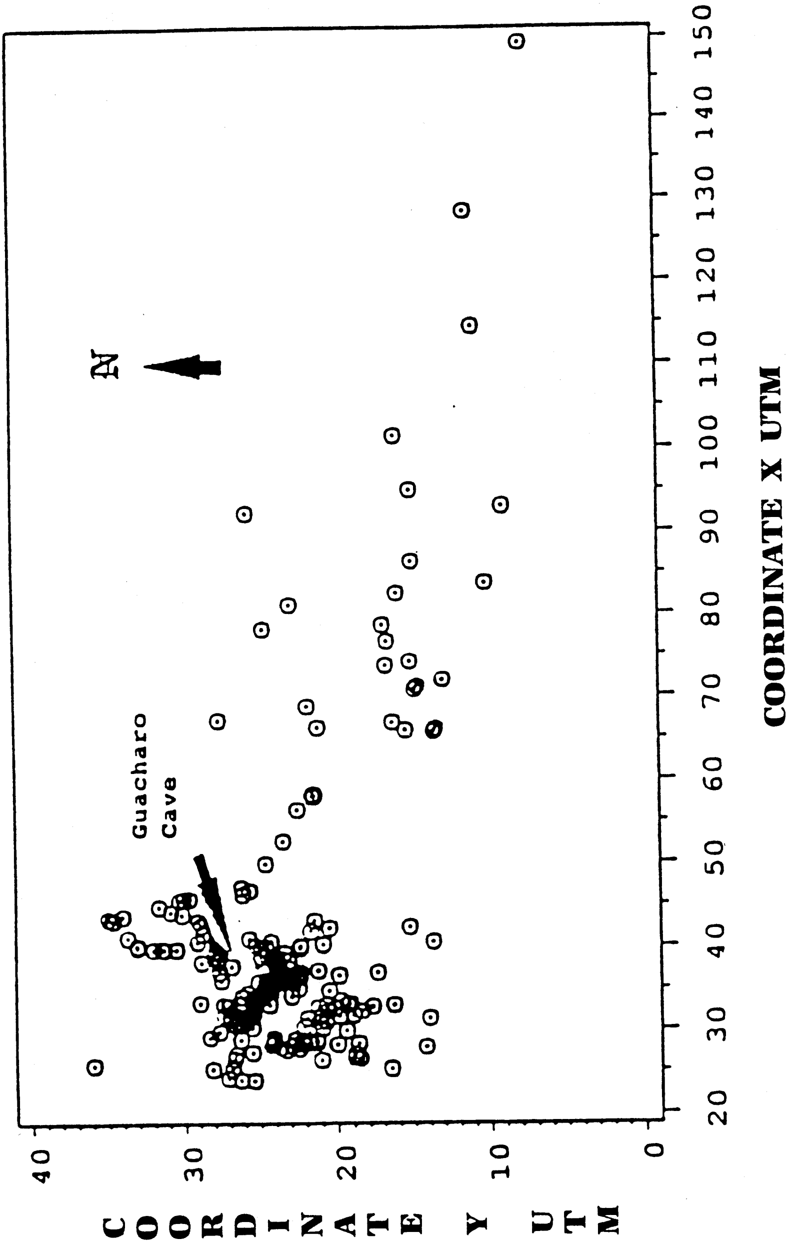
I selected the highest mountains of the area as monitoring stations. The elevations of my stations greatly increased the maximum reception distance. Nevertheless, due to the long distances flown by radio-tagged birds and the hilly topography, periodically we switched our radio stations. Twelve radio stations were used during the study.

The position of a tagged oilbird was ascertained by triangulation (Heezen and Tester 1967). We tracked oilbirds for two or three consecutive nights each week during the study. We recorded the bird's position continuously all night long due to their constant movement. We tracked individual birds every five minutes for up to an hour. Birds were located using both the average method and the loudest signal method (Springer 1979). Radiotelemetry information was subsequently analyzed by excluding all triangulation locations that presented an angle between bearings less than 45°. This criterion was especially important for selecting adequate remote foraging locations. Strong birds weighing between 370 and 410 g carried the transmitters without apparent problem. We used a cotton-nylon harness that would hold the transmitter on the back of the birds. Using this method, we radio-tagged 11 adults during the study.

RESULTS

Foraging areas Figure 1 shows the foraging places visited by ten tagged oilbirds during the breeding season. Each circle represents the area visited by a tagged bird at a given time. The blank areas among the circles were places never visited

Figure 1. Foraging areas of ten tagged oilbirds, 1986-1988



Note: Each circle indicates a location obtained by triangulation of 240 locations. The coordinates correspond with the Universal Transversal Mercator System (UTM). To simplify numbers, I included the last two digits of the Mercator grid. 1 UTM unit = 1 km.

by the tagged birds. Those areas, like blanks among the more clumped points, correspond with heavily disturbed habitat where towns, coffee plantations, and orange groves occur. The least-harmful crop for the oilbirds is coffee. When clearing the forest, local owners deliberately leave some tall shade trees for the coffee plants. Some of those trees are members of the Lauraceae and Burseraceae and are food plants for the oilbirds. The home range of the colony during the breeding season was 1,350 sq km. Oilbirds exploited discrete foraging patches of primary forest, showing long-term fidelity (six to eight weeks) to patches (Roca 1991).

Oilbirds show exceptionally long-range foraging movements. Every night oilbirds can forage at least 100 km away from the Guácharo Cave but most of their foraging areas occur in a 40-km radius from the cave. The variance-to-mean ratio (V/m = 10.96 / 0.841 = 13.02) clearly shows that the feeding areas of the oilbirds present a contagious arrangement. The foraging pattern of the birds corresponds with the clumped distribution of their foraging areas. The aggregation might be the result of both habitat destruction and preference for patches of primary forest. Although the birds foraged mainly within a radius of 40 km around Guácharo Cave, the long-range of their foraging movements is striking. The rest of the foraging localities were scattered mainly southeast of the cave. The maximum distance between feeding localities is about 150 km.

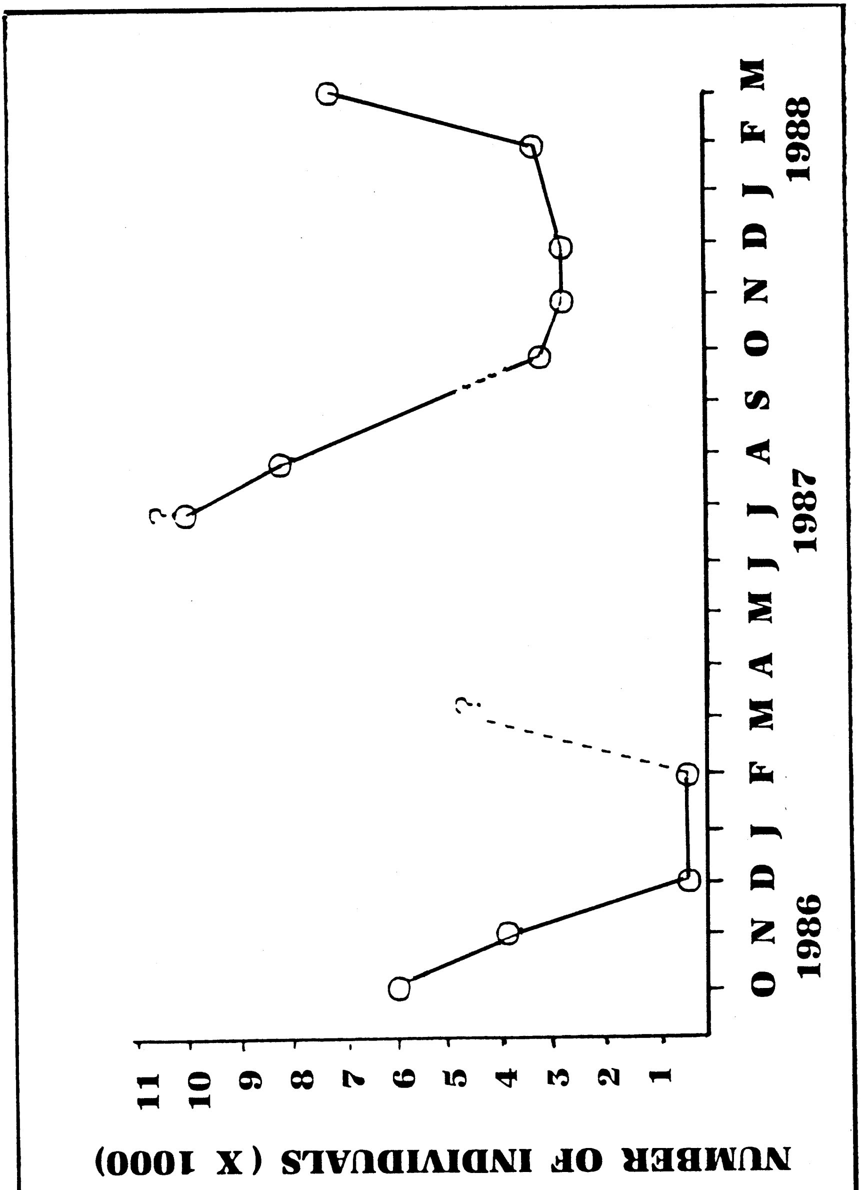
The colony showed an inverse relationship between the frequency of visits to specific places and the distance of those places to the cave. The colony used the habitat unevenly. Some places were visited more often than others. Oilbirds were observed in the same places up to 25 times during two months. Close foraging areas were visited repeatedly by breeding and non-breeding birds. Breeding birds used the habitat more intensively than non-breeding birds.

The birds foraged in the nearest patches of primary forest and then "skipped" the disturbed areas to forage in more remote suitable habitats. The distances involved were 20 km or more. Disturbed habitats not only deprived the colony of its resources but also forced it to forage farther (Roca 1991).

We censused oilbirds as they left Guácharo Cave through its only opening. We counted the number of birds leaving the cave per minute during the departure of the entire colony. The colony size fluctuated conspicuously and showed an annual cycle (Figure 2). There were monthly differences between 1986 and 1987 regarding times of both dispersal and return. At the end of both years the number of individuals roosting in Guácharo Cave decreased conspicuously. A small proportion of the colony stayed in the cave for two to four months. After that time, a massive return of oilbirds occurred, increasing considerably the colony size. The returning individuals nested and roosted in Guácharo Cave for five to six months. The cycle was then repeated. Post-breeding migration of oilbirds in various Venezuelan colonies have been reported by Bosque (1988).

Post-breeding foraging movements Oilbirds dispersed to the southeast, about 24 km from Guácharo Cave, to another cavern system in the region, Mata de Mango. They

Figure 2. Population dynamics of the Guácharo Cave oilbird colony, 1986-1988



Note: Based on censuses taken at the cave. The solid line indicates monthly trends. The dashed line shows predicted trends. The question marks are estimations of the colony size based on census data and personal observation.

switched foraging grounds and obtained fruits from an entirely different habitat. When not breeding, oilbirds foraged mainly outside the boundaries of the mountain range. At that time, they foraged in the extensive flooded plains of the Orinoco Delta. To reach their remote foraging patches, oilbirds were capable of flying at least 240 km both ways every night. Each night the birds averaged ten hours outside their caves. The guácharos foraged and dispersed towards the same area both years of the study.

Seed-dispersal analysis I analyzed seeds collected in seed trays placed underneath solitary nests of various brood sizes (Roca 1991). I also used my radiotelemetry data to determine the amount of time adults spent in the forest.

It is apparent that breeding pairs bring back to the cave mainly the fruits needed for their offspring. I observed no seeds in the seed traps while the birds were incubating their eggs. Additionally, my radiotelemetry data showed that both non-breeding oilbirds and breeding pairs late in the breeding season returned to the cave only once per night (Roca 1991). On the conservative side oilbirds might regurgitate, throughout the year, at least 60% of the seeds collected in the forest.

OILBIRDS: A "NATURAL MANAGEMENT TOOL" FOR PROTECTED AREAS

The oilbird's ecological attributes highlight the role of the species in the ecosystem. Their annual breeding cycle, long life span, short- and long-range foraging movements, large home range, post-breeding dispersal, broad diet, high densities, and function as good seed dispersal agents make them a keystone species for the tropical forest.

The highland and lowland forests benefit from having guácharo-dispersed seeds throughout the vast area that encompasses various plant communities. I have calculated a conservative estimate of the magnitude of their seed dispersal. An adult oilbird needs an average of 50 fruits per day to supply its daily metabolic demand. I used Nagy's (1987) field-metabolic-rate equation and my own calorimetry data. An individual bird regurgitates 1,500 fruits monthly. The guácharo colony regurgitates 15,000,000 seeds monthly. That amount represents a biomass of about 21 tons of seed, excluding the aril, that are regurgitated each month by the entire colony. Whether adults disperse all the seeds or only a fraction remains to be determined. My results suggest that oilbirds regurgitate seeds in the forest during both the breeding and non-breeding season.

Oilbirds constitute an excellent ally of mankind in the hard task of preserving wildlife areas. Oilbirds could be considered as a natural tool for management of regions, like Mata de Mango, that require special protection. Through their seed dispersal role, oilbirds may contribute to the maintenance of plant diversity of the watersheds. Limestone formations are particularly sensitive to erosion. The plant cover is the only way these geological processes are slowed. Any major element of the ecosystem that supports the forest structure, in this case oilbirds, is important and must be protected.

ENLARGEMENT OF GUACHARO NATIONAL PARK

I applied my information on the foraging ecology of oilbirds to assure the survival of populations occurring in my study area and most especially to adequately manage and protect a vast pristine patch of forest (Roca and Gutiérrez 1989). The central theme of the proposal was based on the information that oilbirds forage only on about 25% of the area of the existing Guácharo National Park (Roca 1991). Most of the colony forages outside the confines of the park preferring remote patches of primary forest and avoiding disturbed areas. I proposed to include the karst zone of Mata de Mango as part of Guácharo National Park. The annexing of this area to the existing park guarantees not only the protection of food and cavern resources for the oilbird colonies inhabiting the region, but also the protection of a complex hydrological network that supplies water to the local agricultural and oil activities.

Ecological value of the karst zone of Mata de Mango Mata de Mango comprises 34% of all the oilbirds colonies reported for Venezuela (Bosque 1986). Other colonies are scattered through the country. The area is probably the most important habitat for the species throughout its range.

Mata de Mango is also a natural refuge for the flora and fauna of the northeastern part of the mountain range. The area is like a "mountainous island" surrounded by small farming villages. Unfortunately, the size of the "island" is being reduced because of the slash-and-burn techniques practiced by the growing number of farmers, or *conuqueros*, of the area. Their activities not only threaten the fauna and flora but also undermine the fragile hydrologic network of the Caripe region. The conuqueros are catalyzing the sedimentation and erosion processes that normally should take thousands of years. Mata de Mango embraces 33 headwaters of a lowland river, the San Juan. Most of the San Juan waters are navigable. The river flows into Cariaco Gulf. Its characteristics make the San Juan the preferred route of fishermen and large oil tankers coming to the town of Caripito. The erosion and sedimentation of the hydrological network of the highlands would negatively affect the main economic activities of the area. It would have a major impact on the farms in the vicinity of Mata de Mango.

The enlargement of the existing park does not pretend to preserve the flora and fauna *per se*, and does not stop development projects of the Monagas state. If established and protected, the park complements and guarantees a sustainable development process in harmony with the region's natural heritage.

Annexing the proposed area Since the proposed area is about 15 km from the park, two methods of expansion are possible. First, the areas could be connected by means of a natural corridor, or "greenway." The new park would not be fragmented and some fauna, mainly mammals and birds, could use the corridor. Second, the areas would remain unconnected, but could be close enough for birds to commute. The first alternative would give unity to the park and be more beneficial to the flora and fauna as a whole. But, in reality, management of any land takes into account non-biological information. The desires of land owners, extent of private lands, and location of villages, agricultural zones, and state-owned lands are all important. The success of a proposal depends on its feasibility within this larger context.

An adequate natural corridor is difficult to determine. Most of the land between the current park and the proposed area is heavily populated. The town of Caripe, as well as various small villages and coffee and orange plantations along the Caripe Valley, pose numerous administrative and legal hindrances to the establishment of the corridor. The second alternative proved to be the more expedient.

The borders and size of the proposed area were delimited following four major criteria:

1. All the caverns and sinkholes of the area were included.
2. A large patch (66,400 ha) of mainly primary forest, similar to the home range size of the colony, was included.
3. All 33 headwaters of the San Juan River were included.
4. Most of the towns, small villages, farms, and private lands were excluded.

The second design was accepted without major changes by the government of Venezuela and its park authority, INPARQUES. The new and expanded Humboldt National Park is now a reality. In December 1989 the minister of the environment, Enrique Colmenares Finol, officially declared the extension of Guácharo National Park by 66,000 ha. The minister's action indicated the receptive attitude of the Venezuelan government towards the preservation of the country's natural heritage.

IMPLICATIONS FOR MANAGEMENT OF PROTECTED AREAS

First, research on keystone species is essential to determine critical habitats to be managed and protected within a park. Second, applied research on the ecology of important frugivores and their role within the ecosystem must be encouraged and included in long-term management strategies. Finally, whenever possible the boundaries of parks and other protected areas must be redefined using adequate information on species of special management concern.

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Social Science Research: Essential Tools for Managers

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INTRODUCTION

In 1982, at the Third World Congress on National Parks and Protected Areas in Bali, the participants acknowledged a shift from the approach that a park should be protected *against* people, to the approach that it should be protected *for* people. Thus, if protected areas are for people, then they and their tangible contributions are also worthy of research. The field of "science" that researches people is social science. Those resources that represent the tangible aspects of culture with significance and integrity are called *cultural resources.*

Social science and cultural resources are important management tools. They can be used to study local populations and learn what is important to them. By recognizing the significance of local history and culture and by preserving tangible resources, managers can develop a rapport with and support from local communities. When managers find something in a local culture worthy of preservation, they increase that culture's self-esteem. When local communities believe that managers are interested in them as people and important to the protected areas, they will support the policies and practices of the managers.

Traditionally, site managers have accepted the concept of national significance but have resisted the concept of local significance. Although national laws provide for the preservation and protection of locally significant cultural resources, well-meaning managers—eager to "restore" a natural area—frequently neglect and even willfully destroy such resources. If managers recognized the value of local significance in winning local constituents and valuable political allies, they might apportion more time, planning, and management to these poorly managed resources. In short, managers need to perceive social science and cultural resources as assets, not liabilities.

SOCIAL SCIENCE AND CULTURAL RESOURCES

To most protected area managers, social science means sociological and economic studies. But social science also includes the disciplines of history, anthropology, historic architecture, historic landscape architecture, and curation. Sociology, economics, and social anthropology study contemporary peoples; the others study past events, cultures, and settlements and their associated sites, structures, landscapes, and museum collections.

Cultural resources, like natural resources, occur in nearly every protected area in the world. Unlike many natural resources, they are non-renewable: once their significant material aspects are gone, they are lost forever. Good site managers try to minimize the loss of historic material and maximize the expression of historic character—those attributes that are most important for public appreciation.

Managers of protected areas generally acknowledge that research of natural resources is important. But research must be comprehensive—all-inclusive. To focus only on the flora and fauna minimizes the effectiveness of the manager. In addition, past cultures provide additional resources that enhance national pride and offer greater understanding of national events. More important, all research—whether it is natural or human- related—is ultimately and intimately linked.

For research to be of value to site managers, it must be useful. Just as scientific research inventories natural resources, social science research inventories cultural resources. It also evaluates their significance to local and national populations, examines the needs and values of the local communities and the visiting public, and offers data for planning and management decisions. These data can assist site managers in confronting bogus charges of elitism and negative cost-benefit studies. In fact, with social science studies, managers can turn hostile landowners into strong constituents.

SOCIOLOGICAL RESEARCH

Sociological studies help managers learn more about their visiting public. Visitors can be educated to support protected areas in the nation's political and budgetary processes. They pay taxes and entrance fees, spend money in local communities, and become an "industry" potentially compatible with the protected area. They can also be detrimental to the environment and destroy, inadvertently or deliberately, what should be saved.

These studies collect fundamental information on visitors, their activities, and their use patterns. They explore visitor expectations, values, and interests. They address overcrowding issues. They examine special populations, such as older people, foreign tourists, handicapped visitors, and minority groups. Finally, they assess what recreational opportunities should be provided, what constraints should be applied to protect the natural and cultural resources, what should be done to avoid conflicts among visitors.

Economic Research

Most managers find economic studies among the most valuable. Economic analyses demonstrate precisely how much, where, and in what ways protected areas contribute to the business development, employment opportunities, tax base, economic stability, and overall well-being of local communities and local-area economies. Such studies are effective in countering potentially harmful development forces.

These studies produce comprehensive economic analyses to quantify the value of protected areas. They assess how protected areas affect local and regional economies, measure intrinsic values, and rate community values and a protected area's contribution to the quality of life. They also examine regional tourism travel patterns and assess tourism's economic impacts.

Most protected areas have tried to avoid exploitive tourism incursions and encourage the more compatible ecotourism. Economic studies have found, however, that ecotourism does not always channel economic benefits back to the protected areas or local communities. They have also shown that, for ecotourism to work effectively, carrying-capacity limits are important to maintain the quality of the visitor experience.

Social Anthropological Research

In tandem with sociological and economic studies, managers should consider anthropological studies. Social anthropology and ethnography offer tools to help understand local peoples and how they use protected areas. By working systematically with local communities, anthropologists identify resource and planning issues and the effect on them of protected-area policies. For example, the subsistence patterns or the recreational uses that a local community have impact the protected area. In turn, policies restricting the consumption of wildlife or the equipment used for recreation affect the community's quality of life.

Anthropological research studies all aspects of a local group's culture and how it uses the protected area. They assess physical use as well as spiritual—hunting trails and place names to songs and religious landmarks. Information is gathered on harvest techniques and traditional uses of sites, structures, objects, and landscapes. These studies assess the importance of the natural and cultural resources for the culture's social, economic, and political systems.

By knowing a local culture, managers develop insights into working with them. They learn how local peoples perceive the protected area, how they use it and why, and how to turn adversaries into supporters without harming the resources.

Historical Research

The most fundamental study to learn about an area's cultural resources is a comprehensive regional history. It provides greater understanding of national events, human motivations, and cause-and-effect relationships. Equally important, it surveys, identifies, and evaluates the significance of most cultural resources, such as buildings, structures, and landscapes. The regional history should not be limited to the boundaries of the protected area, but should seek continuities and patterns of past activities that bind the protected area to local populations. Moreover, a well-written narrative history can sensitize the site manager to past cultures whose non-renewable resources—tangible and intangible alike—should be protected. For the pragmatic manager, historians can trace the evolution of park issues—poaching, developmental intrusions, pollution—and evaluate the effectiveness of management action in dealing with them. For the natural-resource manager, historians can track changes in natural resources through time, allowing the manager to understand ecological processes more fully.

ARCHEOLOGICAL RESEARCH

Archeological resources can be any surviving physical evidence of past human activity, representing both prehistoric and historic time periods. They are found above and below ground and under water. All are inventoried, studied, and preserved.

Each protected area should have an archeological field survey to locate, describe, and evaluate the nature, characteristics, and estimated scientific value of its archeological resources. The survey may cover all or part of a park and should precede any planning or development activity. While archeological resources should be left undisturbed if possible, excavation can be justified for protection, research, interpretation, or development. The emphasis, however, should be on preservation and avoidance of sites—not excavation.

Archeological sites provide information on past civilizations and cultures that can only be obtained from buried resources. Some of these cultures were pre-literate, and archeology offers the only data and interpretation for understanding such lost worlds. But archeology can also add dimensions to cultures whose written history did not include details on how people lived together in individual houses and villages. Archeology yields knowledge that would otherwise be lost.

HISTORIC ARCHITECTURAL RESEARCH

Historic structures are constructed works consciously created to serve some human activity. They include buildings, statues, dams, ships, tunnels, roads, and prehistoric ruins. Research identifies and evaluates historic structures. It also defines historical integrity, character, and the causes of material deterioration. Historic structures can be restored and used as museums or adapted and used for administrative purposes.

Prior to restoration or adaptation, however, historical architects and historians should research the history of these structures. This research should document developmental history based on both documentary research and structural examination.

Preserving and restoring historic structures require the skills of historic craftsmen. These specialists have learned carpentry, masonry, and ironwork as it was taught in the past. They can duplicate in materials, design, and workmanship an elaborately carved door or a structurally complex arch. They work in tandem with historical architects to preserve the world's most famous structures, as well as remnants of vernacular architecture. Often these craftspersons learn traditional skills and techniques that can be used to preserve the historic structures. Through the preservation of cultural structures of local significance, protected area managers can develop rapport with local populations and win their reciprocity.

CULTURAL LANDSCAPE RESEARCH

Cultural landscapes are complex resources that contain both cultural and natural resources. In fact, cultural landscapes are expressions of human adaptation and use of natural resources over time. Managing a landscape as a cultural resource begins with identifying its character-defining features, both natural and cultural, and understanding them in relation to one other through time.

Cultural landscapes recognize both the natural resources and the culture that molded them. By identifying and preserving these landscapes, managers prove their sincerity and sensitivity to local communities. The traditions and customs that shaped the land are recognized and valued. In turn, visitors are charmed by the authentic look and feel of the land, reinforcing both the culture and its preservation.

MUSEUM COLLECTIONS RESEARCH

The last type of cultural resource that should be researched and managed is museum collections. They comprise archeological artifacts, biological and paleontological specimens, and historic objects of human activity. Research ensures the appropriateness of a collection, validates the authenticity of objects, analyzes them for proper care and treatment, and determines appropriate furnishings for historic structures. The museum collections of each protected area should define the limits of the collection based on the purpose of the area. Once museum objects are acquired, they should be accessioned to establish legal ownership. Then the objects should be cataloged and conserved if necessary. If objects are to be used in exhibits or furnished historic structures, appropriate plans should provide for their preservation and security.

Museum objects are used in interpretive exhibits, furnished historic structures, and scientific research collections. They add depth to the knowledge of earlier ecosystems and cultures. Through museum collections, researchers can study the details of ordinary life of a culture or the complexities of biodiversity.

CONCLUSIONS

Most research will make the tasks of management easier. When there are political and economic pressures, research can provide the data that support uncomfortable management decisions. While scientific research can show the effect of people on natural resources, social science research can help managers understand the people–both the visiting public and the local resource users. This knowledge can be used to educate people about their impact on resources and to mitigate the impact of the protected area on their culture and lifeways.

Social science research can counter opposition to protected areas. It can show managers how to "market" protected areas, how to develop ecologically sensitive tourism, and how to accommodate to the needs of local communities.

Through the preservation of significant cultural sites, structures and objects, protected area managers can refute charges of insensitivity and ignorance of local cultural values. Thus, managers will use research results if they find them useful, accurate, and responsive to their needs.

Researchers, however, can ensure that managers will apply their research if they take a few pragmatic steps. First, their research reports should be readable. Scientific jargon should be avoided. It may be necessary to write one report for scientists and another for managers, emphasizing scientific accomplishments in one and managerial recommendations in the other. All graphics should be meaningful. Figures with columns of numbers that require statistical training for their interpretation are useless to the busy manager. Researchers should provide frequent oral briefings to managers and their staffs. Managers need a constant flow of data to manage resources–for them, some is better than none and sooner is better than later. Moreover, by keeping the manager apprised of research results, the manager becomes a participant in the project and more willing to apply the results and support funding. Researchers should also consider working with interpreters to ensure that current research results are funnelled into interpretive programs. Finally, researchers should provide viable recommendations to managers. While they should not alter professional findings to fit political needs, they must take into account the socio-economic aspects and political realities of protected area management.

Thus, the social scientist, in particular, offers skills, knowledge, and results that enhance the comprehension of local issues. With the recognition and preservation of local cultural resources—achieved through the talents of the social scientists–the site manager converts potential enemies into champions of protected areas.

NOTE OF ACKNOWLEDGMENT

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Role of U.S. National Parks in Global Change Research

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INTRODUCTION

During the hot, dry summer of 1988, the greater Yellowstone area burned with an intensity probably not seen for 150 years or more. In a few weeks, an ecosystem was transformed. In 1989, Hurricane Hugo, with peak winds exceeding 330 km/hr, plowed the reefs and forests of the Virgin Islands, then reworked the shoreline and flattened the evergreen forests of the South Carolina coast. The effects of these disturbances will be studied for decades as the ecosystems establish a new dynamic. We cannot say whether global warming was a factor, but we do know that these are the kinds of phenomena to be expected more frequently under global change.

In the next century, natural ecosystems may begin to experience unprecedented changes in the magnitude, seasonality, frequency, geographic extent, and duration of climatic extremes. The effects of changes in wildfire, drought, severe storms, unusual precipitation patterns, and extremes of heat and cold would be interactive and cumulative with the effects of CO_2 fertilization, sea level rise, enhanced ultraviolet radiation (related to stratospheric ozone depletion), and other factors in global change. Species would be affected differently according to their sensitivity to the particular combinations of stresses. Under such conditions, ecological communities that took millennia to develop could disassociate rapidly. To address this situation, aggressive management on a scale unimaginable today would be required to enable the continuing evolution of many species in the wild. Whether such management of natural ecosystems will even be possible is highly problematical (U.S. National Academy of Sciences 1991). However, managers must begin to address the consequences of global change predictions that currently exist (Joyce, Fosberg, and Comanor 1990).

In recent decades, we have learned much about the practice of ecosystem management. We routinely prescribe burns to restore the natural role of fire in fire-dependent ecosystems, such as those at Everglades and Sequoia National Parks. We are successfully restoring wetlands and endangered species, especially mammals and vascular plants, and using integrated management approaches to control exotic species. The goal of U.S. national parks and many natural areas is to restore natural processes disrupted by human influences, either directly or indirectly. The implicit assumption is that once we repair the damage, we can reduce or eliminate the need for active management to sustain the natural processes and species populations.

Rapid directional changes in atmospheric composition and global climate would have profound implications for national park managers. Protected areas would become unsuitable for many species they now support, and newly suitable for species now found elsewhere. For many species, migration across natural barriers or landscapes fragmented by human uses would be especially problematical. For some, migration to or from protected area habitats without management assistance would be impossible. Under such conditions, cooperative management of large biogeographical areas offers the best chance for maximizing biodiversity and minimizing the biological impoverishment of the protected areas (Parsons 1991).

Cooperative management of biogeographical areas is a desirable management goal. However, it is difficult to achieve in practice. Managing agencies and organizations often have had vastly different policies and public constituencies. Consensus on management goals is often difficult to achieve. In this environment, cooperation in developing and sharing scientific information now can pave the way for stakeholders to work together later on the more difficult task of responding to complex regional management issues. Unfortunately, most biogeographical areas do not yet have a cooperative framework for pooling intellectual, technical, and financial resources to develop and share information.

A biogeographical area may be defined as a geographic area within a terrestrial biogeographical province (*sensu* Udvardy 1975) or coastal region (*sensu* Ray 1975) that is distinguishable on the basis of some combination of physiography, climate, vegetation, characteristic species, natural processes, human populations, and characteristic resource uses. It is essentially a biogeocultural region (*sensu* U.S. MAB 1989) containing one or more protected areas that provides an optimal scale for managing most components of biological diversity, and for practical actions to address many human influences on ecosystem processes. The scale is suitable for integrating the natural and social sciences in understanding the complex factors in ecosystem sustainability, and for demonstrating participatory democratic approaches in using scientific information effectively for solving ecosystem management problems.

THE PROMISING ROLE OF BIOSPHERE RESERVES

The scientific and educational value of the world's outstanding conservation areas may ultimately be their finest legacy to human society. Biosphere reserves uniquely enable these areas to contribute relevant scientific information for sustaining ecosystems at scales ranging from local to global (Dyer and Holland 1991). A biosphere reserve offers the potential of linking park-based research with other research in the biogeographical area, the larger biogeographical province, other biogeographical provinces within the same biome, and among the biomes constituting the global earth system. These linkages strengthen the role of protected areas to society as bellwethers of ecosystem change and benchmarks for assessing the effects of human activities. By expanding the constituency for this role, biosphere reserves encourage commitment to long-term research programs.

Biosphere reserves help their stakeholders achieve a balance among ecosystem uses in a way that sustains the natural ecosystem processes and the biological resources of their biogeographical area. Many countries have organized multi-sector associations of government, nongovernmental entities, and local people around the unifying biosphere reserve concept. Flexibly adapted to the conditions of the biogeographical area, the new organizations provide needed permanent forums for stakeholders in ecosystem sustainability to discuss the resource issues that concern them on a regular basis, and learn the art of cooperation. They are building the broad public constituency for the research, education, and demonstration projects that make solutions possible. Ultimately, these cooperative organizations may prove to be the biosphere reserves' greatest contribution. As these emerging organizations succeed in pooling intellectual, technical, and financial resources locally, opportunities for links with issues and activities at wider scales will inevitably emerge. Some biosphere reserves are already contributing useful data to improve general circulation models and predictions of the regional effects of global change. However, their practical management benefits will come in the future as biosphere reserves use the models to formulate and demonstrate adaptive strategies for sustaining ecosystems and biological diversity under conditions of global change.

THE USNPS'S GLOBAL CHANGE PROGRAM: A BIOGEOGRAPHICAL AREA APPROACH

The U.S. National Park Service (USNPS) Global Change Program seeks to provide predictive and holistic understanding of the effects of global change on species populations, ecological communities, watershed processes, and landscape dynamics through the coordinated use of parks as benchmark research sites within larger biogeographical areas. In each biogeographical area, cooperation with other agencies and organizations involved in global change research is an important program goal. To optimize the possibilities for networking inherent in the biosphere reserve model, each biogeographical area includes at least one existing or potential USNPS unit of the international network of biosphere reserves. This core research area is the focus of most of the USNPS research. However, in some biogeographical areas, one or more contributing USNPS units are also involved. These support the biogeographical area program by providing complementary resources, research capabilities, and data sets. They also provide the opportunity to complete the research design, corroborate results, test research hypotheses, and apply predictive modeling to the biogeographical area and the larger biogeographic province.

The USNPS Global Change Program also includes thematic initiatives that complement the biogeographical area programs. These primarily involve coastal and marine systems. They are multi-regional, and focus on specific research topics. An initiative to understand potential global change effects on coastal barrier dynamics is underway, and another on the structure and physiology of coral reefs is planned to begin in 1993.

Each biogeographical area has a designated research coordinator and funding for operational support of a long-term research program. Most coordinators are located at regional universities, which provide access to interdisciplinary research capabilities. To date, we have initiated global change research in six temperate-forest biogeographical areas: the Olympic Peninsula, the central and southern Sierras, the Glacier National Park area, the Colorado Rockies, the Ozark highlands, and the western Great Lakes. During the next year, we expect to add biogeographical areas in the central grasslands, South Florida (Everglades), Sonoran Desert, and the Gulf Coast. At full development, the program is planned to include 20 biogeographical areas representing most of the biomes in the United States (Figure 1). Research will be initiated as funding and cooperative research opportunities develop.

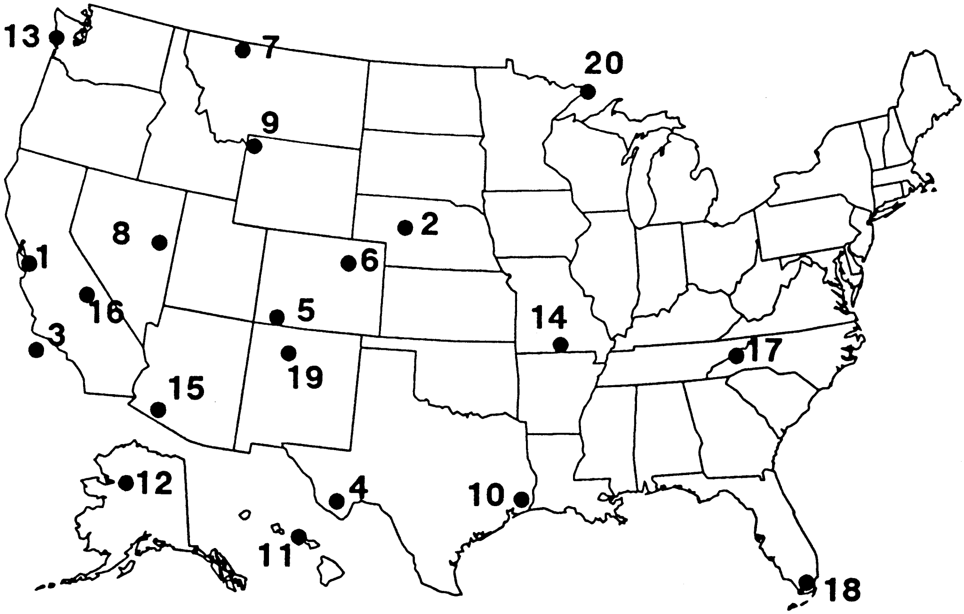
Ongoing research varies among the biogeographical areas, reflecting (among other things) the historical research strengths of the participating parks, the park and university expertise, the sensitivity of the resources to global change, and the results of a rigorous peer-review and competitive selection process. Ongoing projects support four of the seven science elements in the interagency U.S. Global Change Research Program (Committee on Earth and Environmental Sciences 1991): earth system history, ecological systems and dynamics, biogeochemical dynamics, and climate and hydrologic systems. The initial projects emphasize particular areas of disciplinary study (Table 1). However, the long-term objective is to link these studies with future USNPS and outside research at many scales to develop interdisciplinary assessments and, eventually, adaptive response strategies for the larger areas.

Table 1. Committee on Earth and Environmental Sciences research elements by USNPS biogeographical area, 1991

	Ecological Systems & Dynamics	*Earth System History*	*Biogeo-chemical Dynamics*	*Climate & Hydrologic Systems*
Central Grasslands	•			•
Colorado Rockies	•		•	•
Glacier NP area	•		•	
Ozark highlands	•	•	•	
Olympic Peninsula		•		•
Sonaran Desert*	•	•		
South Florida*	•	•		•
South/Central Sierra	•	•		
Western Great Lakes		•		

*** Initiation proposed for 1992**

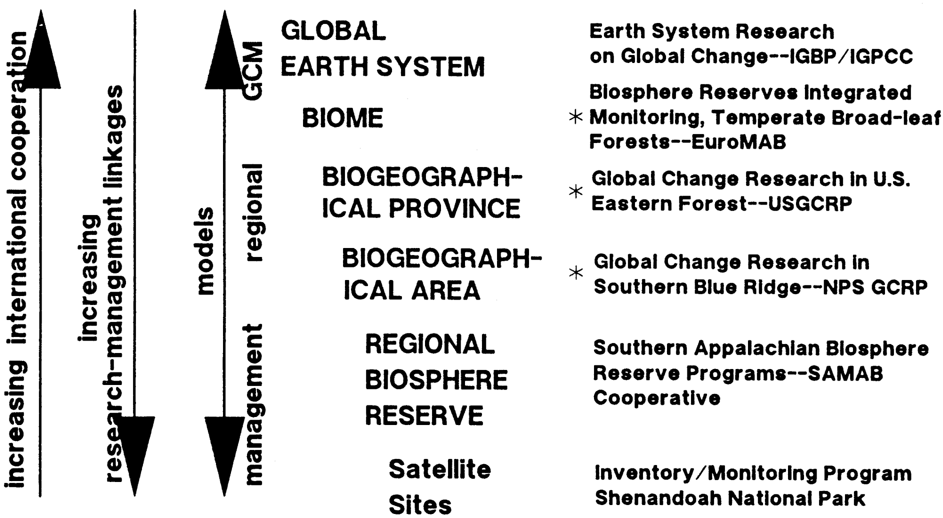
Figure 1. USNPS Global Change Research Program biogeographical areas



1. *Central California Coast*
2. *Central Grasslands*
3. *Channel Islands*
4. *Chihuahuan Desert*
5. *Colorado Plateau*
6. *Colorado Rockies*
7. *Glacier National Park area*
8. *Great Basin*
9. *Greater Yellowstone*
10. *Gulf Coastal Plain*
11. *Hawaiian Islands*
12. *Northwest Alaska*
13. *Olympic Peninsula*
14. *Ozark highlands*
15. *Sonoran Desert*
16. *Southern/Central Sierra Nevada*
17. *Southern Blue Ridge*
18. *South Florida*
19. *Upper Rio Grande*
20. *Western Great Lakes*

Figure 2 shows opportunities for global change networking, using the Great Smoky Mountains National Park as an example. The park has a long history of site-level monitoring and research relevant to global change. It participates in the Southern Appalachian Man and the Biosphere Cooperative, an organization of eight federal and state agencies for cooperating on regional resource issues. The Cooperative's activities focus largely on the Southern Appalachian Biosphere Reserve, which includes Great Smoky Mountains, two long-term ecological research areas, three additional areas nominated for inclusion, and a large surrounding "area of cooperation." A nonprofit Southern Appalachian Man and the Biosphere Foundation facilitates private-sector participation. The park is also part of a large biogeographical area which is being considered for inclusion in the USNPS Global Change Program. The biogeographical area includes Shenandoah National Park, a satellite research site recently selected as a prototype for biological inventory and monitoring to help address many issues, including global change. At wider spatial scales, the U.S. Global Change Research Program facilitates regional and national research links. International biome-based links for global change research will benefit from efforts of European and North American Man and the Biosphere programs to strengthen cooperation among their biosphere reserves, and the international activities of the Intergovernmental Panel on Climate Change (IPCC 1990, 1991) and Scientific Committee on Problems of the Environment (SCOPE 1990).

Figure 2. Potential program-scale links for temperate broad-leaved forests



A Preliminary Program Assessment

Integrating national parks into the complexities and many scales of global change research will take time. However, the USNPS Global Change Program has taken important steps that have broad implications for strengthening the role and credibility of research in national parks, and the role of parks in addressing issues of ecosystem sustainability. We provide a brief assessment of the program's strengths and weaknesses at this early implementation stage to assist others contemplating a similar research effort.

Program development relied on an open competition of proposals based on a conceptual research plan for the biogeographical area. The process tapped the creativity and experience of agency and outside researchers. It resulted in the selection of parks in western mountain areas with a strong history of research. On the other hand, plans and proposals reflected the limited familiarity and experience of park researchers with global change issues. Many were not well-focused on the research issues and priorities of the USNPS Global Change Program. The initial selections were not biogeographically balanced.

This program has the most extensive outside peer review of any program USNPS has undertaken. The review, which occurs at both concept plan and proposal stages, has helped establish credibility both inside and outside the agency. Yet this critical evaluation resulted in rejection of many proposals that were desirable to achieve in an integrated, interdisciplinary program but did not meet the scientific review criteria.

This is the first link of U.S. national parks to a highly structured domestic and international research program to address a global issue. Although the program was designed to contribute significantly to this effort, a more modest than expected funding level has delayed the initiation of research in many biogeographical areas.

A committee of USNPS scientists and managers, selected on the basis of professional expertise, coordinates the national program. This is the agency's first use of such a mechanism, which has been particularly successful.

This is also USNPS's first nationally directed research program to have a full-time data administrator. This underscores commitment to contribute well-document, high-quality data sets to the national effort.

The program has created a field organization to facilitate research on a biogeographical area rather than administrative-area basis. While the approach has enhanced possibilities for ecologically based cooperation, coordinators supported under the national program have sometimes had difficulty coordinating activities across administrative areas having different capabilities, interests, and local priorities.

We are the only U.S. federal land-managing agency to adopt the cooperative biogeographical area approach for global change research. However, cooperation has been easier to conceptualize than to carry out because agency development of on-site research has necessarily taken priority over inter-site links in the first program stage.

CONCLUSIONS

The USNPS's Global Change Program's success has been reflected in the quality of the research proposals, the enthusiastic support of field units, and in the intense competition for the field coordinator positions. However, achieving the larger goal of an integrated, multi-agency, cooperative biogeographical area research effort would benefit from having biosphere reserve research links with other agencies and organizations in place before preparing global change research plans. These associations could help coordinate research objectives among agencies in the biogeographical area and link them to Global Change Program milestones. Proposals could be considered in "sets" rather than individually, brought up to standards, and integrated before the biogeographical area is funded and the research begins. If necessary, the type of research desired in each biogeographical area could be cooperatively specified at the start, and proposals solicited by the participating entities accordingly.

Our initial experience indicates the utility of organizing global change research on a biogeographical area basis, with emphasis on the use of biosphere reserves. These areas may provide the most suitable framework for communication among the many sectors with a stake in achieving ecosystem sustainability in ways that maintain biological diversity under changing environmental conditions.

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Management and Change in Natural Areas

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Yellowstone, the first national park, was set aside as a pleasuring ground for people in recognition of its magnificent natural and scenic attributes. In time, the U.S. National Park Service was formed to "conserve the scenery and the natural and historic objects and the wild life [in the national parks] and to provide for the management of the same, in such manner and by such means as will leave them unimpaired for the enjoyment of the future generations." For many years parks and similar preserves were set aside and protected from modern human consumptive influences, such as poaching and timber harvest, and from the effects of natural processes, such as fire and predation by carnivores. In doing so, it was thought all would be well.

Now we understand that well-intended protection does not produce an "unchanging vignette of primitive America" (Leopold et al. 1963) or such a thing anyplace else on earth. Our smallest natural areas are mere fragments of ecosystems surrounded by change, cut off from migratory avenues, exposed to edge effects, deprived of natural processes which reset their ecological clocks. Our largest, most remote areas are subject to air pollution, modification of natural fire regimes, and losses of their top predators to past hunting, pesticide use, and habitat conversion. In the infancy of ecology and conservation, park managers were largely innocent of the knowledge truly necessary to manage and protect the resources of the natural areas in their charge according to the mandate of the USNPS Organic Act quoted above; much less were they able to predict the landscape and global changes resulting from modern growth in human population, industrialization, and energy conversion.

Yet, more than sixty years ago, enlightened biologists were recognizing many of the changes being wrought upon natural-area parks by human land-use practices in and around U.S. national parks. George M. Wright, in whose name a non-profit society for protected-area professionals was founded in 1980, was a young American student of Natural History at the University of California at Berkeley. In 1927, Wright was an assistant park naturalist in Yosemite Valley. There he recognized the problems of tame deer, garbage bears, predator removal, and the effects of hunting and trapping along the park boundary. He recognized, even then, that parks are not islands that can stand aloof from the rest of the world. With his own funds, and with the sanction of the USNPS director, Wright undertook a wildlife survey of the national parks, publishing the results in the first two monographs of a series entitled *Fauna of the National Parks of the United States* (Wright, Dixon, and Thompson 1932; Wright and Thompson 1934). Wright, in these two seminal publications, described wildlife problems in the parks related to direct and indirect historical human influences, the failure of parks as independent biotic units because of the lack of complete habitat, external influences and encroachment, and direct conflict between humans and animals within the parks. Wright was killed in an auto accident soon after these works were published, the Great Depression deepened, fire control became a well-established policy in U.S. forests, and the parks were put to sleep for World War II. Our understanding of the important role of natural change in parks languished, but the rate of modern world change accelerated.

Today the managers of natural-area parks have no shortage of concern about changes in the world around them. The hue and cry of conservationists, ecologists, preservationists, climatologists, and zealots are heard everywhere.

What can be done? We used to think that parks were the changeless baselines against which we could measure the changes in our environment. But the parks are changing around us in subtle and not-so-subtle ways: assailed by human use, habitat conversion, introduction of non-native species, disease, pollution, pesticides, etc. In most cases, we know little about the more subtle changes because we have inadequate descriptions of our park resources and the natural processes that dominate them. Our inventories are old and incomplete. We monitor few biotic or physical attributes of our parks. How can we recognize changes that take place on a longer time scale than the typical protected-area manager's tour of duty or career?

Park managers must develop methods to inventory and monitor the resources of their parks and the systems of which they may be a part. They must obtain baseline information using valid scientific methods against which physical and biological changes can be measured. While these baselines are being established and monitored, managers must foster research designed to understand the role of specific processes such as fire, drought, competition, grazing, and migration in the successional patterns of their parks. They may also need to determine the scene they wish to present and perpetuate. Will it be early succession, climax, or a dynamic of both? Will it be a "historic" scene or will it reflect the aboriginal indigenous human scene? Will they attempt to restore long-extirpated predators? It's a tough, complicated business.

Park managers can no longer make environmental decisions about their preserves from the saddle of their horses. They need the assistance of scientists and technologists. They need good scientific advice based upon valid research and historical information. In a more prefect world, we would have better resource allocation; limits on the growth of human population, resource consumption, and environmental alteration; and money left over for research. In the absence of a more perfect world, what can be done by the park manager of limited means and almost limitless problems (or questions, at least)?

In the U.S., the National Park Service is attempting to understand the magnitude of their problems and deal with them in a time of limited resources. They are in the process of surveying the existing state of knowledge regarding the natural resources of the parks. They are mapping out methodologies and policies for inventorying and monitoring the resources of the parks. [See the article by Ruggiero, Stohlgren, and Waggoner in this issue]. They are strengthening the resource management planning process and they are providing central-office project-funding to resolve natural resource management and research needs beyond the scope of individual park areas. They are funding a global climate change research program [see the article by Comanor and Gregg in this issue] and are obtaining working geographic information systems that can be used for resource analysis. But these efforts may not help you at your park. What can park managers do to help themselves?

In my work at the USNPS Cooperative Parks Studies Unit at the University of California at Davis, I have come to realize that many subject-area specialists in universities and elsewhere can assist park managers to quickly assess what may be known about the resources and resource problems of a park, an ecosystem, or a region. They just need to be asked. We use a loose procedure called a "scoping session" to bring together knowledgeable scientists and park resource managers for anywhere from two to five days. This yields a quick assessment with recommendations for needed resource management and research projects with suggested priorities. The material provided is employed in preparation of the park resource management plan, a document which I feel is essential to the operation of any natural area. Such a plan includes a brief assessment of the resources of the area, the state of knowledge of the resources, and the research and resource management actions needed to restore or perpetuate natural or near-naturally-functioning park ecosystems. Park managers in developed and developing regions can assist themselves by providing some form of inexpensive facilities at the reserve which will accommodate volunteer teams of researchers or technical experts willing to share their knowledge and skills with the field area manager and staff. The manager also needs to make known the availability of such facilities. Perhaps IUCN could assemble a registry of such scientific support facilities, no matter how spartan they might be. Similarly, parks in developing regions might adopt a sister-park relationship with the resource management and research staffs of developed nations with similar biotas, whether montane, marine, grassland, or deciduous forest. Perhaps the professional park societies, such as the George Wright Society or IUCN through its Commission on

National Parks and Protected Areas and *Parks* magazine, could be helpful in arranging partnerships that would accommodate sharing information and expertise.

You as park managers can be creative in your approach to sharing the scarce commodities you need to do your job well in this day and age. Yet you cannot push sand uphill. You must also be player, a counsellor, an advocate, and a practitioner in the modern political scene which shapes the allocation of human and natural resources, and which formulates population and energy and conservation policies. Unless the effects of global changes driven by human population, energy use, and pollution are moderated, the managers of natural areas will have rather less to oversee than they have today.

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Whales, Science, and Protected Area Management in British Columbia, Canada

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INTRODUCTION

When the mandate of a protected area includes the conservation of free-roaming animals, there is a need for the inclusion of specific autecological and synecological information in both the initial design and management stages for the area. Similarly, when the scenario includes human interaction, as virtually every protected area does, there is a requirement for social science information. The human element can no longer be managed under the simple models that have characterized the human dimensions of protected area management in the past.

Perhaps nowhere are the problems of matching wild animal ecology, human dimensions, and the administrative simplicity of area protection more clearly contrasted than in the case of marine parks and reserves. This paper will focus on the specific case of establishing reserves to protect whales. Management of wild whales has historically depended on a theoretical exercise in population modeling that carried little relevance to reality (Holt 1985). As a result of flawed theoretical foundations, managers incorrectly estimated sustainable harvest and failed to protect large whale stocks from the risk of extinction (Holt and Talbot 1978). As our interactions with whales changed over the past 25 years, we have expanded the current paradigm to include protection of both whales and habitats (e.g., U.S. National Park Service 1984; Canadian Parks Service 1988), recovery of endangered populations (U.S. National Marine Fisheries Service 1989), and the management of recreational nonconsumptive use (Duffus and Dearden 1991).

At this juncture, the difficulty with reserving areas in the marine environment comes to its problematic apogee: setting aside an ecologically significant volume of ocean for a species group whose spatial domain is unknown. And, within that, to impose management plans that mediate human interaction at levels suitable to the maintenance of healthy population functions. This somewhat daunting task has been attempted in several cases. In the Gulf of St. Lawrence, on Canada's east coast, endangered beluga whales *(Delphinapterus leucas)* have had areas set aside and human behaviors mediated to try to protect a failing relict population (Canada Department of Fisheries and Oceans 1989). Similarly, in Hawaiian waters U.S. federal authorities attempted to establish a national marine sanctuary over humpback whale *(Megaptera novaeangliae)* calving and nursing areas, although local authorities blocked the sanctuary's establishment as a barrier to development and commercial fisheries. The International Whaling Commission allowed a non-whaling zone to be established in the Indian Ocean. Mexico established a national park over the gray whale *(Eschrichtius robustus)* calving lagoons at Laguna Oje de Libre.

This paper will focus on the role of science in the establishment of management measures for two concentrations of whales on the Pacific coast of Canada, where recreational use and resource management conflict have progressed to the point where the public has called for intervention. By focusing on these cases, the paper will endeavor to illuminate some of the important contributions science can make to the design and management of marine protected areas.

CASE STUDIES

Whales concentrate at two locations on the Vancouver Island coast. Gray whales migrate north from the wintering areas along Baja California (Mexico) to the summer feeding grounds in the Bering Sea. Those that do not undertake the entire migration with the bulk of the eastern Pacific population spend the summer feeding in the bays and inlets along the western coast of Vancouver Island (Figure 1). The research described here focuses on individual and small groups feeding and traveling in the southern reaches of Clayoquot Sound. Killer whales also form a summer feeding aggregation on the northeast coast of Vancouver Island in Johnstone Strait. Small matrifocal subpods use a core area at Robson Bight for various periods throughout June, July, August, and September to take advantage of migratory Pacific salmon *(Onchorhyncus* spp.*)* stocks as the pass through the narrow Johnstone Strait.

At both locations, recreational whale-watching has developed over the past decade; as well, other water and land uses have the potential to affect the local ecosystems. At the gray whale site, no protective designation has been made over marine areas for the conservation of the whales, while British Columbia has created a provincial ecological reserve covering a small part of the marine area used by killer whales. In the former case, we will discuss the use of scientific information applicable to the design of a reserve; in the latter, the use of science in the management of the existing reserve.

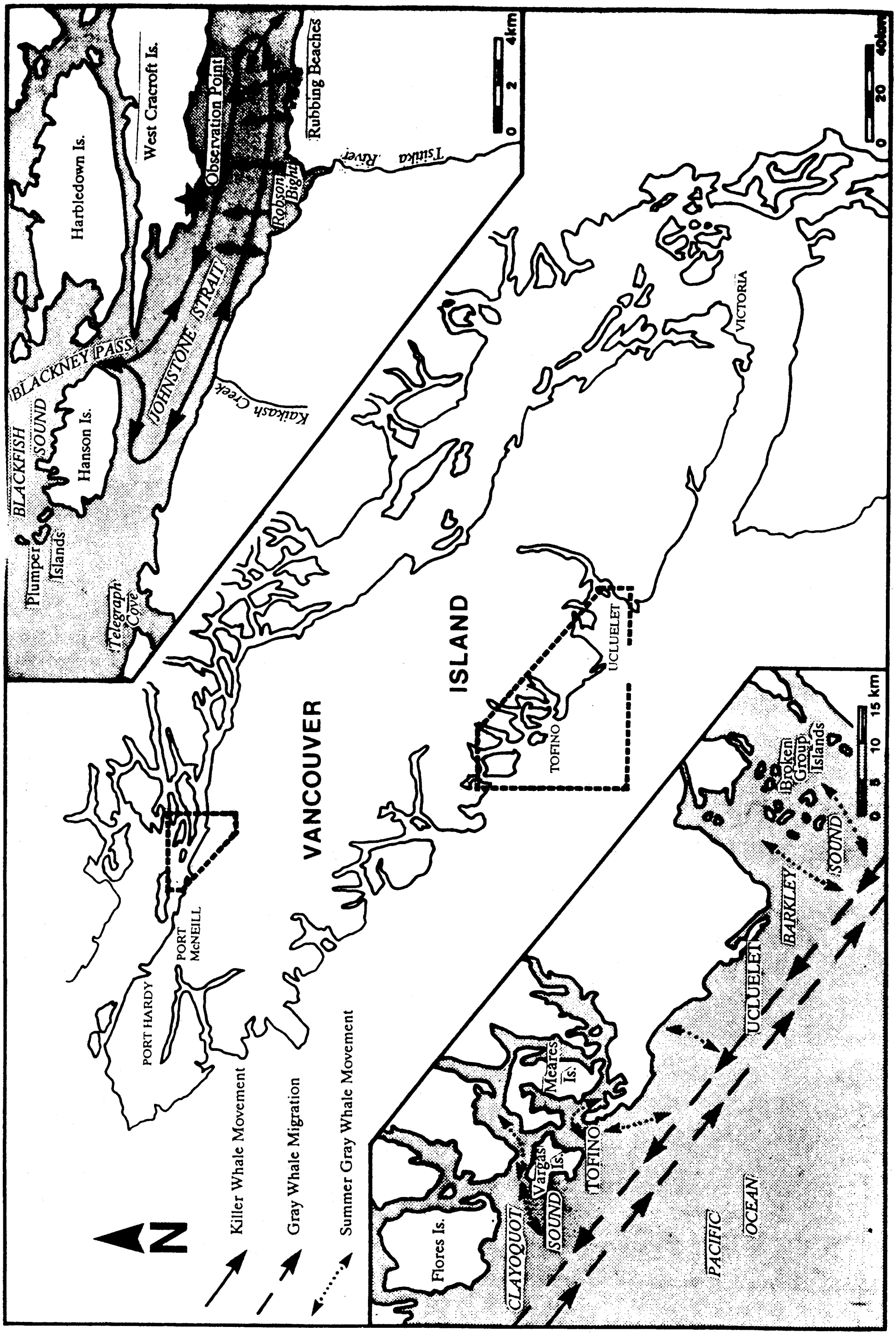

Figure 1. Whale concentrations in Vancouver Island coastal waters, British Columbia, Canada

Gray whales of Clayoquot Sound

As gray whales leave the main migratory group along the Vancouver Island coast, they distribute themselves to take advantage of economical feeding opportunities from a number of sources. Feeding behavior of the species is known from several locales, although the mechanisms of food selection and the predator-prey dynamics are poorly understood. In Clayoquot Sound, whales exhibit several feeding strategies that have implications for their spatial distribution. They either feed on suprabenthic swarming invertebrates, or feed on benthic organisms in the substrate itself (Guerrero 1989). When food sources have been located and are deemed substantial, a feeding whale may attract others, creating aggregations of four to six animals. Using the marginal value theorem (Charnov 1976), an optimal foraging strategy dictates that the decision to stay in one site is a product or the quality and quantity of the food, balanced against surrounding feeding opportunities. Another factor in the understanding of spatial behavior is the avoidance of disturbance. If whales are disturbed, they may be induced to switch feeding sites. Perhaps the most common source of potential disturbance is recreational whale-watching vessels from the commercial fleet in the nearby settlement of Tofino.

Research data regarding the influence on whales by vessels is inconclusive. Some observational studies suggest gray whales are disturbed by whale-watching activity, but they generally lack scientific veracity because of flaws in research design. Whale-watching, primarily via commercial charter vessels, has grown rapidly in this area. Peaks of activity occur during the spring migration in March and April, and during the summer between July and September. There is little other water-based activity at this time in the southern portions of Clayoquot Sound except for small vessel traffic. Other potential threats that arise from the larger region include debris pollution, oil discharge, and land-based pollution, primarily suspended sediment from forestry operations.

The designation of a protected area for the summer aggregation would be desirable in both an ecological and human sense. Although gray whales are the only large whale to show significant population recovery from commercial whaling, and now reach near-historical numbers, they still require protection. The migration route, summer feeding areas, and calving areas all overlap with areas of significant human activity. Within the range of this population, the whales pass near heavily industrialized areas, cities, several fisheries, heavily used vessel traffic routes, and recreational areas. In addition, the whales experience the natural mortality forces of predation and disease. Summer feeding aggregations likely represent juvenile or anestrous individuals, and pairs of cows and calves (Swartz 1986). It is therefore beneficial to separate these animals from the breeding nucleus as a short-term measure against catastrophic losses in other population pools, and, in the long term, as a source of genetic diversity in the population.

Planning and design of a whale reserve in Clayoquot Sound has several data requirements. Initially, spatio-temporal patterns should be established to locate areas where different behavioral sequences occur. Feeding areas, resting areas, travel corridors, and predator-avoidance sites will create the spatial blueprint for an area designation. This is then extended into the depth dimension to ascertain the submarine topography, materials, and ecosystem characteristics. Within each three-dimensional space, planners can then implement mediating measures for human activities. The initial step is to describe the range and timing of activities within the boundary, then develop plans for buffering the reserve from outside impacts. Thus, behavioral, ecological, and biophysical data requirements include gray whale time budgets, substrate types, feeding ecology, differential use of space, and human activities and their impacts.

Our current research program developed a preliminary database of time budget and use of space. Whales were visually located on 33 days between 4 July and 26 August 1991. Location and behavior were recorded at all times, and data were subsequently mapped to provide a basis for further study. In 1992, we will record and map the location of all whales encountered. Maps of the ocean bottom, including substrate materials, and prey distribution will be created using combinations of bottom samples and side-scan sonar as well as direct observation and mapping. The whale and biophysical data will be analyzed on a GIS system to develop an understanding of the feeding ecology and spatial system. This will not only provide us with the spatial interaction dimensions of one important site, but a preliminary understanding of the variables that constitute habitat for the summer feeding aggregations. If these can be further mapped on a regional basis, coupled with historical information on whale movement pattern, then some estimate may be forthcoming of other areas suitable for protection to conserve and manage the whales, and recreational use.

Killer whales of Johnstone Strait At the second site, killer whales have been studied for about 15 years (Bigg et al. 1989). The aggregation is part of a range contraction in a group of 180 whales, known as the "northern resident community," who congregate during the salmon migration in Johnstone Strait. At this time, the 17 subpods of the resident ecotype, which feeds primarily on fish, enter the strait on an irregular basis, travelling in cycles throughout the local region that range from daily to bi-monthly. Certain subpods are rare visitors, while others are sighted daily. Outside of the Johnstone Strait core area little is known about their movements and behaviors.

The resident whales frequent two small beaches on the Vancouver Island shore where they rub on the gravelly substrate, and, in travelling to and from the beaches, spend time in a small bay and the outer estuary of the Tsitika River. The ecology of the site-organism relationship is unclear. Various researchers have pointed to behavioral and acoustic phenomena associated with the sites, although none have specifically postulated any cause-and-effect link between site and behavior, nor has there been any research into the "criticalness" of any particular phenomenon. Interestingly, the site is the focus of numerous research projects, and the core of recreational whale-watching. The little that we do know about the whales' microrange characteristics is at least in part an artifact of limited research outside of the core area. Furthermore, since feeding is primarily on mobile prey in a deep water column, feeding ecology has remained poorly known.

Because of the frequency of use and affinity for these sites, the area was deemed critical and set aside as an ecological reserve by British Columbia. This measure holds a fairly limited potential to protect a marine area. It is a provincial designation, yet the federal government has jurisdiction over marine shipping, fisheries, and marine mammals. The only matters on which the provincial government is authoritative are recreational use and land use on adjacent shorelines and in the nearby Tsitika River valley. Unfortunately, the ecological reserve's land area is small and narrow, providing few buffering services to the marine area. All shipping, fishing, and management of the killer whales are beyond the protective capabilities of the designation. Therefore, the boundary is highly permeable, and buffers of outside impacts are almost non-existent.

Managers need to use detailed knowledge regarding the nature of interaction between whales and fisheries, of both general and whale-watching vessel traffic, and of the ecological links between the presence of killer whales and biophysical characteristics, including those related to water quality and the shoreline. Some work has attempted to analyze whale response to whale-watching vessels. Research has tended to focus on a few measures of whale response. Kruse (1991) concluded that whales travel faster in the presence of whale-watching vessels, although the conclusion is not based on the data presented. Further, Kruse presents no reasoning as to the effect of a small change in swimming speed over a short period of time. Simple presence or absence is the current focus of government research, though the research model does not include use with any other parts of daily range, or ecological variables (Briggs 1991). The potential for intervening cause-and-effect linkages is high. Our past research, relying on simple behavioral categories, has been similarly unable to discriminate between behavior sequences taking place when whale-watching vessels are present as opposed to being absent. Our current research is aiming to establish the range and magnitude of change in several observable behaviors and link these to potentially disturbing influences.

None of the research has yet gone beyond the focus on recreational vessels, leaving unstudied the entire issue of influence by fishing vessels—which are ubiquitous in the core area during the summer. Other studies in this area were largely unsuccessful in linking fisheries data to whale presence (Nichol 1990), and no studies have been done to ascertain links between beach morphology, freshwater inflow, or water quality of the nearby Tsitika River. Currently, forestry operations are carried out in adjacent uplands that have the potential to influence the shore environments.

The scientific knowledge on which the provincial ecological reserve designation is based, and upon which its management is predicated, is almost non-existent. The whales do use the site and the two beaches to a varying degree each summer. Beyond that, there has been no research into the entire seasonal spatial domain, nor the relationships between this so-called critical space and other space in the whales' daily range. Rather, the philosophy behind establishing such a small protected area within a larger range is what we term a "requiem" reserve—a place of rest. Unfortunately, since we know little of the nature of disturbance, especially that associated with underwater acoustics (the main subsurface sensory mode of killer whales), we have no way to validate the reserve's capacity to provide rest.

The total lack of a scientific foundation may or may not obviate the utility of the reserve. It is known that, for whatever reason, the whales do congregate there during an important feeding period. That may make it a high priority for protection. On the other hand, the fallacy of tokenism—that is, giving the public the appearance of protecting an important whale habitat when neither the importance of the site to whales nor the veracity of the protection is established—creates a political "success" that may mask an ecological failure. Clearly, calling this a "killer whale reserve" is only justified in a semantic sense.

HUMAN DIMENSIONS OF WHALE RESERVES

Human dimensions of marine area protection may have little relevance for some sites; in others, information requirements may be sophisticated. In both cases, there is a need for social science information because recreational use and resource conflict are priority management issues. Research areas run the gamut from policy and institutional analysis, regional economic and total economic value studies, social impact assessment, to recreational satisfaction and motivation.

Management programs arise out of policy milieux that frequently cross jurisdictional boundaries. With the advent of Exclusive Economic Zones, nations have taken on varying degrees of management authority in open waters and over some species that migrate through the EEZ. Federal states, such as Canada, frequently have arrangements with coastal provinces to allocate jurisdiction over resources among the most competent and appropriate administrative body. Using Canada as an example, there are frequently cross-jurisdictional aspects to many programs, and a working knowledge of these sometimes-informal processes are fundamental to understanding how protected area management fits into the wider scope of resource management.

A frequent management concern that develops at the initial planning stages of a protected area involves the potential costs and benefits to the local area. In the marine case, protected areas may intersect with existing fishing interests, transportation routes, or allowable effluent deposition. Thus, protection may incur costs. Equally, protection may provide revenues to local areas as visitor-service requirements expand. Both regional economic impact, as well as more complete valuation techniques, will be useful planning tools to fit the protected area into the existing local system, and to inform players in various economic sectors of potential influences for mitigation or development purposes. Both the examples discussed in this paper have significant economic aspects produced by recreational use and burgeoning nature tourism. In both cases, significant infrastructure and monies are transferred into the service sector of what were formerly economies based on the primary sector. Certain marine activities such as whale-watching generate fairly high indirect benefits to local economies, as the activity is generally non-substitutable, creating steep demand curves.

Foregone opportunities may be part of management plans. In the case of the Johnstone Strait killer whales, economic activity in the adjacent forests and changes in fishing behavior may place costs on existing area users. A cost-benefit comparison would reveal not only the magnitude of the economic trade-offs, but also identify which sectors gain or lose. In both that case and the gray whale case, designation alters (or would alter) commercial whale-watching behavior, though in the long run it may support the longevity of whale-watching and provide opportunities to enhance the product.

The social domain of marine protected areas includes aspects in common with terrestrial sites. Relationships between visitors and host communities, and stress on host facilities, as well as recreational behavior, may be more specialized due to the marine component and types of use involved. Duffus and Dearden (1990) provide a framework for analyzing non-consumptive use in terms of both the site and the use by analyzing variables associated with the growth of use and specialization of the users. Management of use behavior is simpler if the motivation, satisfaction, and nature of demand is known. Plans can use fairly standard tools such as zoning, interpretation, and licensing for commercial recreational purveyors to adjust the fit of the protected area to the local environment.

CONCLUSIONS

Marine protected areas require more specialized planning than do terrestrial areas. Most of their complement of plants and animals go about their lives hidden from human view. Similarly, many environmental changes, such as water quality, may go undetected. Within the human domain, most visitor patterns and their associated impacts are relatively new and thus in need of study. The case described here, reserving areas for the benefit of particular species, introduces a set of more detailed problems. Theoretical development of biological principles for conservation is still new in terrestrial protected areas (e.g., Shafer 1991), and most marine species are less well known. Baseline research, as well as theory building, will therefore be required; this poses a significant cost and delays initiating scientifically based design principles and management plans in the marine sphere. Nevertheless, reserves set aside without attention to scientific principles will be less able to fulfill the protection mandate, and may become a burden in the future when adjustments are necessitated by more critical examination.

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Investigación en Areas Silvestres Protegidas en América Latina y el Caribe

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INTRODUCCION

La investigación científica relacionada con las áreas silvestres protegidas es muy importante como fuente de conocimientos para el progreso de la sociedad. En este sentido, las áreas silvestres protegidas constituyen un importante patrimonio disponible para la investigación en la actualidad y, más aún, en el futuro, ya que son verdaderos laboratorios para ciencias naturales, cuyas características garantizan una relativa permanencia en el tiempo, en las condiciones de conservación necesarias. Estas condiciones no han sido conveniente aprovechadas hasta hoy, pese a las enormes posibilidades que representan, ya que las investigaciones que se realicen teniendo como base los recursos genéticos y la comprensión de sus fenómenos naturales, puede significar la solución de muchos de los problemas del hombre. Un aspecto fundamental es su aplicación al manejo, con el fin de mejorar el conocimiento de los ecosistemas que se deben conservar y manejar.

Los países de la Región, durante la Segunda Reunión de la Red Latinoamericana de Cooperación Técnica en Parques Nacionales, otras Areas Protegidas, Flora y Fauna Silvestres, realizada en Costa Rica en febrero de 1988, acordaron realizar un taller sobre investigación en áreas silvestres protegidas.

La FAO atribuyó gran importancia a una reunión en esta materia y, debido al interés demostrado por Ecuador, por ser país sede del Taller, se acordó entre la Oficina Regional de la FAO para América Latina y el Caribe y la Coordinación Nacional de la Red citada en ese país, la conveniencia de llevarla a cabo. Esta actividad, que fue apoyada por el Proyecto FAO/PNUMA sobre Manejo de Areas Silvestres, Areas Protegidas y Vida Silvestre en América Latina y el Caribe se realizó dentro del marco de la Red y con la colaboración de la Dirección Nacional Forestal del Ministerio de Agricultura de Ecuador.

El taller se planificó y realizó teniendo en cuenta los siguientes objetivos, general y específicos:

Objetivo general:

Conocer los avances en la investigación en las áreas protegidas de la Región, analizar los problemas e impedimentos en esta materia, comparar las diferentes políticas y el reglamento relacionado con el control de la investigación en las áreas protegidas y determinar las prioridades y las posibilidades de colaboración entre los países, en este tema.

Objetivos específicos:

- ✦ Evaluar la experiencia de los países de la Región en el desarrollo de la investigación en las áreas silvestres protegidas.
- ✦ Examinar los proyectos de investigación existentes en las áreas silvestres protegidas de los países de la Región.
- ✦ Analizar los problemas y necesidades que existen actualmente en este campo.
- ✦ Crear las bases para un sistema de colaboración entre los países de la Región, relacionado con diferentes aspectos de la investigación en las áreas silvestres protegidas.
- ✦ Analizar las distintas fuentes de apoyo para la investigación en las áreas silvestres protegidas.
- ✦ Elaborar un documento con los resultados del taller y la información aportada por los país, que sirva de ayuda a los países de la Región para el establecimiento de políticas, legislación y reglamentación de la investigación en las áreas silvestres protegidas.

Para lograr los objetivos se distribuyó anteriormente un cuestionario destinado a reunir datos actualizados sobre este tema, comparables entre los países de la región latinoamericana y el Caribe y una ficha de antecedentes básicos sobre investigación para cada una de las áreas silvestres protegidas de los países de la Región. Además, los participantes presentaron un informe sobre la situación de la investigación en su país, basándose en la pauta preparada por la Oficina Regional de la FAO.

En consecuencia, el presente documento está basado en las respuestas obtenidas del cuestionario por país, en los informes individuales presentados por cada país al Taller, y en la información adicional que entregaron los participantes durante las discusiones y trabajos en grupos.

ASPECTOS INSTITUCIONALES DE LA INVESTIGACION EN AREAS SILVESTRES PROTEGIDAS: DIAGNOSTICO

Instituciones encargadas de la administración de la investigación

Nueve países señalaron poseer una sola institución encargada del manejo del sistema nacional de áreas silvestres, mientras que cuatro poseen más de una entidad. Muy pocos ejercen la administración y manejo de las unidades de conservación a través de organismos de carácter ministerial, aunque comparten o delegan la administración de otras áreas con entidades adscritas a ellas. En la mayoría de los casos, las áreas protegidas se administran por medio de organismos descentralizados o de oficinas adscritas a la Presidencia de la Nación, las que tienen directamente a su cargo la administración de los programas de investigación en dichas áreas.

Políticas para la investigación Un sólo país posee una política de investigación claramente definida. Una proporción importante considera que estas políticas son sólo medianamente adecuadas o poco adecuadas, mientras que unos pocos países definitivamente han declarado no poseer políticas de investigación en áreas silvestres protegidas.

Legislación para la investigación Doce de los trece países presentes en el Taller poseen cuerpos legales que norman la investigación en las áreas silvestres protegidas, aunque esta legislación es de carácter general, ya que sólo dos países poseen leyes específicas sobre investigación en estas áreas.

En general, la legislación actual es considerada medianamente efectiva en siete países y de efectividad baja en tres. Sólo dos países manifestaron poseer legislación altamente efectiva, mientras que uno declaró inexistencia total de cuerpos legales en esta materia.

Autorización para la investigación La emisión de permisos para investigación no presenta grandes problemas en la Región, ya que la mayoría de los países exige autorizaciones expresas.

En casi todos los casos es la propia administración central la que se encarga de mantener un control administrativo del desarrollo de proyectos de investigación, apoyándose en el personal de cada área, y recibiendo copia de los resultados de los estudios realizados en las unidades de conservación.

Mecanismos administrativos para la investigación Para la ejecución de los programas o proyectos de investigación es muy frecuente la realización de contratos y convenios, tanto a nivel nacional como internacional, aún cuando no se cobran derechos por la realización de la investigación. Sólo tres países están adoptando esta última modalidad.

Uso de las instalaciones para el desarrollo de las investigaciones La mayoría de las áreas silvestres protegidas de los países que integran la Red Latinoamericana de Cooperación Técnica en Parques Nacionales, otras Areas Protegidas, Flora y Fauna Silvestres, carecen en la actualidad de un número aceptable de instalaciones e infraestructura para un desarrollo adecuado de las investigaciones científicas.

Impactos ambientales relacionados con las investigaciones Las medidas que actualmente toman los países en relación a impactos ambientales consisten en:

a) evaluación de las solicitudes para la realización de investigaciones científicas, para determinar la posible ocurrencia de impactos;
b) circulación de resoluciones de permiso que indiquen la cantidad mínima necesaria permisible de colección de especímenes de la flora o de la fauna, según el tipo de estudio presentado;
c) prohibición de colectas de especies de flora y fauna silvestres en peligro de extinción, endémicas y raras;
d) utilización de una contraparte nacional que acompaña al investigador, cuando éste es extranjero.

Utilización de los resultados de la investigación Los resultados de las investigaciones se han utilizado especialmente en la preparación y elaboración de planes de manejo para las áreas silvestres protegidas. Al mismo tiempo, hay una tendencia a aplicar dichos resultados en la asignación de la categoría de manejo más adecuada a las áreas estudiadas. Además, se están utilizando estos resultados para fortalecer los programas de manejo y protección de ecosistemas de las unidades, para apoyar las actividades de educación ambiental e interpretación, para la realización de monitoreo ambiental, para fortalecer la capacidad de gestión de las instituciones encargadas de las áreas silvestres protegidas y para determinar el estado bioecológico de los recursos existentes en estas áreas.

Obligaciones respecto a la entrega de los resultados de las investigaciones por parte de los investigadores En todos los países representados en el Taller se está llevando a cabo el mismo procedimiento para establecer las responsabilidades y obligaciones del investigador frente a las instituciones que le otorgan las autorizaciones para investigar. Entre otras disposiciones obligatorias se pueden señalar:

a) entrega de resultados preliminares y finales de la investigación realizada;
b) entrega de los recursos colectados durante la investigación;
c) acopio del material fílmico y fotográfico derivado del desarrollo de las investigaciones;
d) presentación por parte del investigador de una exposición oral acompañada de un audiovisual sobre el proyecto de investigación ya finalizado;
e) obligatoriedad de que un investigador nacional acompañe a los investigadores extranjeros, durante el tiempo de vigencia del permiso.

Situación presupuestaria y financiera para la investigación Las entidades nacionales encargadas de administrar áreas silvestres protegidas en la Región asignan un promedio de 18% de sus presupuestos para la investigación.

Si se analiza la cantidad de presupuesto asignado a la investigación por hectárea protegida, la media regional expresa un valor muy bajo.

Mecanismos indirectos de financiamiento Tal como se expresara con anterioridad, muy pocos países cobran tarifas para realizar investigaciones, e incluso, entre quienes lo hacen, la tarifa no es monetaria, sino que consiste en la obligación impuesta a los investigadores de incluir en sus programas la participación de estudiantes o investigadores nacionales.

Casi todos los países tienen convenios con organismos nacionales para realizar investigación en áreas silvestres protegidas, y la mayoría capta fondos internacionales a través de organizaciones nacionales privadas, particularmente fundaciones. Ecuador es el único caso en el cual la investigación en áreas protegidas, en particular en el Parque Nacional Galápagos, se realiza por intermedio de una organización internacional (La Estación Científica Charles Darwin).

Mecanismos directos de financiamiento Una proporción alta de todos los países de la Región financian la totalidad de su propio presupuesto destinado a la investigación en las áreas silvestres protegidas. Sólo muy pocos reciben fondos de entidades privadas nacionales.

Unicamente Chile puede utilizar directamente fondos internacionales privados; del resto de los países el 65% no puede utilizar estos fondos internacionales privados y el 27% lo hace a través de transferencias a otras entidades nacionales.

Solo pocos países utilizan directamente fondos provenientes de organismos internacionales, a través de la organización estatal de administración de las áreas protegidas. La gran mayoría simplemente no obtiene fondos de este tipo de instituciones. No obstante, las relaciones bilaterales para el financiamiento de la investigación se dan de diferentes maneras, como es el caso de la ayuda en especies.

México ha desarollado un sistema particular consistente en utilizar directamente los fondos que llegan a las entidades y grupos de trabajo que ejecutan los proyectos, pero el organismo estatal que maneja las áreas protegidas controla el uso de estos fondos y los asigna.

Personal para la realización y/o apoyo de la investigación en áreas protegidas En ocho países existe personal exclusivamente dedicado a labores de investigación, siendo su número muy variable entre un país y otro. No obstante, se calcula que el total de investigadores de tiempo completo o parcial para la Región alcanza estimativamente a 300 personas. Estos profesionales son apoyados por investigadores de otras instituciones, siendo el caso más relevante el de Colombia, donde 360 investigadores de nivel universitario apoyan la investigación.

En los cinco países restantes, la investigación no es realizada directamente por la institución responsable del manejo de las áreas silvestres, sino que se lleva a cabo a través de contratos y/o convenios con universidades e institutos de investigación de carácter nacional e internacional. Sin embargo, existe personal dedicado a analizar proyectos, elaborar términos de referencia y supervisar la investigación en dichas áreas, en el que se incluyen estudiantes universitarios de pregrado y postgrado. Se destaca el caso de México donde esta labor comprende 45 profesionales de distintos niveles académicos.

Capacitación para el personal de investigación Sólo tres países cuentan con un programa regular de capacitación para el personal de investigación que labora en las instituciones encargadas de la administración de las áreas silvestres protegidas. El resto de los países no cuentan con este tipo de programas con un carácter permanente.

Necesidades de orden institucional La necesidad que aparece con más alta prioridad es la consecución de medios financieros. Dentro de éstos, las fuentes financieras internacionales tienen alta prioridad, aunque está señalado igualmente como factor de alta prioridad el financiamiento proveniente del propio país.

En segundo lugar se señaló como necesidad el contar con suficiente personal científico, técnico de nivel medio, y operativo de apoyo. Siete países le concedieron alta prioridad a las necesidades de personal científico y técnico de nivel medio y sólo dos países consideraron prioritario al personal operativo de apoyo.

En tercer lugar de prioridad se señalaron los medios materiales. Sólo un país los señaló como la necesidad institucional de primer orden.

ASPECTOS CIENTIFICOS DE LA INVESTIGACION EN LAS AREAS SILVESTRES PROTEGIDAS: DIAGNOSTICO

1. Existe mayor experiencia y volumen de investigación en el campo biológico que en el campo socioeconómico y cultural.

2. Dentro del primer aspecto mencionado, las lineas de investigación relativas a inventarios y biología de especies han recibido mayor atención, en comparación con el manejo de especies, a excepción de especies amenazadas y especies migratorias. En terminos generales se puede expresar que todas las líneas de investigación son incipientes o poco intensas.

3. En cuanto al campo socioeconómico y cultural, las líneas de investigación que han tenido menos atención son las correspondientes a legislación, políticas y economía de áreas protegidas. Esto último parece tener como consecuencia un limitado interés de los políticos en las decisiones que se toman sobre las áreas protegidas. En relación al ámbito de percepción y educación, el nivel de investigaciones realizadas

también se considera poco intensivo.

4. Las líneas de investigación desarrolladas históricamente en las áreas silvestres protegidas, no concuerdan respecto a las prioridades asignadas y a la experiencia adquirida, con las actuales necesidades y prioridades de investigación para el manejo de dichas áreas.

RECOMENDACIONES

Los grupos de trabajo formularaon entre otras las siguientes recomendaciones:

1. Aumentar la participación de las comunidades incluidas o cercanas a las áreas silvestres protegidas, informándoles sobre las actividades de investigación que se desean realizar, así como de sus objetivos y resultados esperados.

2. Buscar el apoyo de la comunidad regional y nacional mediante programas de concientización para que contribuya a la toma de decisiones favorables en el campo de la investigación científica y su relación con el manejo y uso sostenible de los recursos en el corto, mediano y largo plazo.

3. Realizar estudios de carácter socioeconómico y programar investigaciones con énfasis en aquellos aspectos que satisfagan expectativas de un mejor nivel de vida de las comunidades cercanas a las áreas silvestres protegidas, y en la búsqueda de alternativas que compatibilicen los intereses de desarrollo sostenible regional y las gestiones de conservación de esas áreas.

4. Desarrollar y aplicar experimentalmente métodos de evaluación de los valores económicos e intangibles producidos por las áreas protegidas, en beneficio de las comunidades locales y nacionales.

5. Buscar un contacto sistemático con el nivel político que influya directamente sobre las políticas en materia de conservación de áreas silvestres e investigación científica, de acuerdo a las necesidades reales que surjan en este campo y con el fin de iniciar el establecimiento de una política para la investigación.

6. Conseguir el apoyo de la comunidad científica nacional e internacional para influir favorablemente sobre las políticas que deciden en materia de investigación en las áreas silvestres protegidas. En este sentido se enfatiza en la necesidad de establecer políticas de investigación en aquellos países que no cuentan con ellas, convocando a las organizaciones que puedan contribuir a su formulación. Además, fijar los términos de referencia para una legislación específica para la investigación, con el fin de que los proyectos tengan un apropiado respaldo legal.

7. Desarrollar mecanismos dirigidos a establecer o mejorar la transferencia de información sobre la importancia de las áreas protegidas a los niveles de decisión política.

8. Incrementar y fortalecer las acciones de investigaciones binacionales o multinacionales, así como el establecimiento de canales de cooperación entre los diferentes países en materias que representen problemas o intereses comunes, ya sea en aspectos biofísicos o socioeconómicos y culturales en áreas protegidas. En los convenios bilaterales existentes se debe incluir el tema ambiental.

9. Establecer intercambios anuales de experiencias y listas bibliográficas de investigaciones realizadas y en progreso, a través de la Red Latinoamericana de Cooperación Técnica en Parques Nacionales, otras Areas Protegidas, Flora y Fauna Silvestres. Además, intensificar el esfuerzo de los países para el establecimiento de las redes y/o subredes nacionales.

10. Que los países que lo considren conveniente, busquen la colaboración de profesionales en organiza-

ciones de la región latinoamericana, con experiencia en preparación y aplicación de programas o planes de investigación. Además, dentro del marco de intercambios técnicos de la Red Latinoamericana de Cooperación Técnica en Parques Nacionales, otras Areas Protegidas, Flora y Fauna Silvestres, organizar programas de capacitación de personal de investigación.

11. Realizar una reunión técnica de expertos de los países con mayor experiencia en el marco de la Red Latinoamericana de Cooperación Técnica en Parques Nacionales, otras Areas Protegidas, Flora y Fauna Silvestres, con el objeto de elaborar una metodología apropiada para el otorgamiento de permisos y la gestión posterior del desarrollo de investigaciones. Esta metodología debería incluir términos de referencia para la evaluación del impacto ambiental (medidas de mitigación, contingencia, monitoreo ambiental, etc.), así como criterios para la toma de decisiones, evaluación de resultados, mecanismos de control y seguimiento y análisis de resultados de forma multimodal.

12. Que las instituciones gubernamentales con ingerencia en las áreas silvestres protegidas proporcionen mejores condiciones de trabajo, incluyendo remuneraciones más atractivas a los funcionarios que trabajan en investigación, con el objeto de establecer equipos profesionales sólidos y permanentes en esta actividad. Además, majorar la infraestructura en general para la investigación.

13. Fomentar la contratación de personal dedicado a la investigación, con recursos financieros externos, en las instituciones públicas y adoptar un sistema de capacitación y evaluación para incentivar a este personal.

14. Que los organismos que administran áreas silvestres protegidas intenten el aumento de fondos destinados a la investigación a través de una mayor integración interinstitucional, tanto a nivel nacional como internacional, mediante métodos directos e indirectos. Entre estos últimos, por ejemplo, se consideran contratos y convenios de programas de investigación en áreas protegidas con organismos nacionales dedicados prioritariamente a la investigación (Academia de Ciencias, Consejos Nacionales de Investigaciones Científicas y Técnicas y otras instituciones idóneas).

15. Elaborar planes de manejo otorgando alto grado de prioridad al programa de investigación, y proceder a la revisión y actualización de estos planes al término de su período de vigencia.

16. Evaluar el perfil socioeconómico y de expectativas de los usuarios de las áreas protegidas para apoyar la toma de decisiones en el manejo futuro.

17. Desarrollar y establecer mecanismos de monitoreo permanente para evaluar la interacción del manejo de las áreas silvestres protegidas con actividades productivas tradicionales en áreas adyacentes.

18. Preparar y actualizar permanentemente una lista de prioridades de investigación, e instar a los organismos que financian esta actividad para que consideren las prioridades establecidas en esta materia para cada país.

19. Tender al empleo de metodologías replicables y universales en la investigación, utilizando referencias geográficas y especiales precisas, que permitan determinar en forma exacta el sitio en que se llevó a cabo una actividad de investigación, describiendo de manera precisa los procedimientos de medición y toma de muestras, así como las medidas tendientes a neutralizar los efectos de parámetros externos.

20. Crear un archivo de datos base que debe mantenerse en un lugar conocido y ser accesible a la institución administradora de las áreas protegidas y a los investigadores que

requieran la información en el futuro.

21. Dar prioridad a las investigaciones que tiendan a establecer series de datos medidos en forma sistemática por largos períodos de tiempo.

22. Profundizar a través de la Red Latinoamericana de Cooperación Técnica en Parques Nacionales, otras Areas Protegidas, Flora y Fauna Silvestres, el análisis de las líneas de investigación, incluyendo aspectos de percepción y educación así como de economía, legislación y política.

23. Buscar fondos a todos los niveles (nacionales como internacionales), destinados a la investigación. Se consideran también el cobro de aranceles al investigador y el turismo extranjero.

CONCLUSIONES

1. En la mayoría de los países existe una falta de convencimiento y decisión política sobre la investigación en áreas silvestres protegidas, por parte de los más altos niveles de decisión de la administración de estas áreas.

2. Resalta la ausencia de políticas nacionales de investigación en las áreas silvestres protegidas, en la mayoría de los países de la Región.

3. No existe suficiente personal capacitado en distintos niveles para realizar investigación y/o para llevar a cabo labores de apoyo a esta actividad.

4. La falta de planes de manejo ha significado ausencia de directrices que guien la investigación en áreas silvestres protegidas de una manera apropiada, la que en muchos casos es inexistente.

5. La poca integración de las áreas protegidas al desarrollo socioeconómico regional desincentiva la inversión en investigación por parte de los más altos niveles de decisión administrativa.

6. La administración de áreas protegidas depende de otras instituciones que financian la investigación en estas áreas.

7. No se cumplen los principio básicos para llevar a cabo la investigación, desaprovechando de este modo las ventajas y oportunidades que presentan las áreas protegidas para este fin.

Un Centro de Investigación de Espacios Naturales Protegidos

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La Comunidad de Madrid presenta un territorio muy humanizado, lo que se puede comprender teniendo en cuenta que su superficie está muy próxima a las 800,000 Hectáreas, con una población que alcanza cerca de 5 millones de personas.

Hay que añadir, que desde tiempos antiquos el hombre ha venido aprovechando la naturaleza madrileña sin grandes cuidados, y los avatares históricos han influido sobre el medio natural, hasta tal punto, que prácticamente todo el territorio de Madrid está alterado por causas antropógenas.

Nos encontramos así, con que este territorio está muy modificado, y sobre él siguen incidiendo tanto de forma directa como indirecta actividades humanas.

No obstante, a pesar de estos tintes dramáticos, todavía permanecen espacios que mantienen valores naturales dignos de ser resaltados, como es el caso de la comarca del alto río Manzanares, vertebrada a lo largo del cauce de este río.

Por la Ley 1/1985, de 23 de enero, se declaró el Parque Regional de la Cuenca Alta del río Manzanares, que estableció como espacio natural protegido a esta comarca y a eu zona de influencia.

La Ley pretendía buscar un equilibrio entre el mantenimiento de los ecosistemas de la comarca y el desarrollo de las actividades socioeconómicas que tradicionalmente se llevaban a cabo dentro de ella.

Se hizo necesario tener en cuenta por una parte, que muchos de las poblaciones que residían en las áreas del Parque lo utilizaban para obtener recursos y por otra, que esta comarca a causa de sus altos valores naturales era muy visitada por los habitantes de la capital que la consideraban y consideran como lugar de esparcimiento, recreo y ocio.

La Ley pretendia dos objetivos: la preservación y protección de los recursos naturales del territorio (gea, flora, fauna, aire, agua y paisaje) muy amenazados por la presión de la gran ciudad; y la potenciación de las actividades productivas compatibles con las características de la comarca, especialmente, las relacionadas con la agricultura, la ganadería y los bosques. Si en cualquier manejo de un espacio natural protegido, donde hay que cuidar en extremo a la naturaleza, es necesario tener los suficientes conocimientos científicos, en este caso, es mucho más preciso contar con las bases de la ciencia para llevar a cabo una buena gestión del espacio. Esto es debido aquí, a que hay que gestionar el territorio natural con el cuidadano dentro, y además, a que se trata de un visitante que mantiene y alardea de un alto espíritu crítico.

¿Cuántas veces aunque los espacios cuentan con buenos técnicos, éstos han fallado en su gestión, por no tener los adecuados conocimiento científicos? No hay que olvidar que para manejar la naturaleza es necesario unos perfectos conocimientos ecológicos que muchos veces no los poseen los técnicos.

El Parque Regional del Manzanares tiene entre su personal técnicos preparados para realizar una buena administración del mismo. No obstante, se creyó oportuno para mejorar esta administración buscar un apoyo científico que sirva de refuerzo a la gestión.

Para ello, se habilitó una casa tradicional en un pueblo de ámbito del Parque Regional donde establecer un Centro de Investigación de Espacios Naturales Protegidos. En este Centro se pretendió se desarrollaran estudios relacionados con las actividades científicas para apoyar y asesorar al personal encargado de la gestión del Parque.

También se pensó, que aunque este Centro se ocupe especial y principalmente de investigar sobre el Parque Regional de la Cuenca Alta del Manzanares, debería en un futuro centralizar y coordinar todas las labores de investigación que se lleven a cabo en las otros espacios naturales protegidos de la Comunidad de Madrid.

Para poner en marcha el Centro se estimó que un Centro de estas características y finalidades debería contar con científicos de reconocido prestigio que supusieran una garantía para su buen funcionamiento. No se podía iniciar el Centro situando científicos con poca experiencia o recién formados. Pues este Parque por sus connotaciones con la población de Madrid precisaba que los trabajos y tareas que apoyen su gestión, tengan la suficiente seriedad y rigor para avalar una buena gestión. Por otra parte, un Centro de este tipo, dedicado únicamente a investigar sobre espacios naturales protegidos era novedoso en España, y no podía jugarse su futuro y continuidad por fallos en sus principios.

Para el arranque del Centro se creyó oportuno contactar con el Departamento universitario de más prestigio en temas ecológicos de la Comunidad de Madrid. Este es el Departamento Interuniversitario de Ecología que integra expertos ecólogos de las Universidades Complutense y Autónoma de Madrid.

La Agencia de Medio Ambiente de Madrid, que es de quien depende el Parque Regional, estableció un Convenio de colaboración con el citado Departamento Interuniversitario. Mediante este Convenio, el Departamento proporciona el personal científico adecuado para llevar a cabo las labores del Centro y planifica y desarrolla los programas de investigación. Por otra parte, la Agencia de medio Ambiente aporta la infraestructura y los medios económicos para su puesta en marcha, igualmente, corre a cargo de los gastos de mantenimiento y conservación del Centro. Además, los alumnos de las dos Universidades efectúan prácticas en el Centro de asignaturas ligadas a temas de la ecología del Parque.

El Centro desarrolla las siguientes funciones:

- ✦ Realización de investigaciones potencialmente útiles para la solución de problemas ambientales y la conservación de los recursos naturales del Parque Regional.
- ✦ Implantación de líneas de investigación que conduzcan a un mejor conocimiento de las características y valores del Parque Regional.
- ✦ Establecimiento de un sistema de seguimiento de los procesos ecológicos en el Parque Regional (monitorización).
- ✦ Realización de trabajos de investigación sobre las interacciones entre el Parque Regional, sus usuarios locales y sus visitantes.

Dentro de estas funciones el Centro ha establecido las siguientes líneas de trabajo.

- ✦ Cartografía ecológica, para lograr la expresión y representación geográfica del sistema de relaciones que existe entre los elementos que configuran el paisaje, elaborando una síntesis geótica, una síntesis bioclimática, una síntesis ecológica y las variaciones del matorral según el gradiente altitudinal.
- ✦ Aspectos estructurales y funcionales de los ecosistemas del pastizal del Parque, a fin de mejorar los aprovechamientos ganaderos y hacerlos compatibles con la conservación del medio natural.
- ✦ Microorganismos edáficos y sucesión ecológica en los ecosistemas mediterráneos, con el fin de conocer la dinámica de los ecosistemas que incidieran en el reciclado de los macronutrientes e intervendrán de modo singular la producción de los ecosistemas naturales y explotados.
- ✦ Percepción y uso del territorio por el ganado en una dehesa del Parque Regional, con el fin de conocer cómo el propio ganado diferencia el uso del territorio de acuerdo con su fisonomía.
- ✦ Limnología. Directrices para la recuperación ecológica del tramo medio del río Manzanares que se encuentra sometido a fuertas degradaciones.
- ✦ Recuperación de ecosistemas perturbados debido a las prácticas tradicionales de pastoreo, agricultura o selvicultura que viene desarrollando el homre.
- ✦ Educación ambiental para reconocer los valores y aclarar los conceptos para aumentar las aptitudes y las actitudes necesarias para comprender y apreciar las interrelaciones entre el homre, su cultura y el medio natural.
- ✦ Pautas de uso recreativo con el fin de lograr que la gran cantidad de visitantes que afluyen al Parque regional tengan hábitos de comportamiento compatibles con la conserva-

ción de los valores naturales que encierra.

Dentro de las líneas de trabajo apuntadas se han organizado las actividades de investigación en tres programas prioritarios.

Agroecosistemas El objetivo general de esta línea pretende expresar la estructura de las relaciones ecológicas, socioeconómicas y culturales que sustentan los diferentes tipos de sistemas agrarios característicos del Parque. El conocimiento de las relaciones entre condicionantes físicos, biológicos y productivos agrarios permitirá destacar las problemáticas ambientales más relevantes, con cuyo conoclimiento optimizar la gestión agraria del Parque, canalizar más eficazmente las ayudas o subvenciones y ensayar alternativas novedosas para un mejor aprovechamiento de los recursos naturales según áreas geográficas prioritarias, respetando los objetivos de conservación que la creación del Parque contempla.

En esta línea se están desarrollando dos proyectos simultáneamente: "Cartografía y caracterización de la estructura agroecológica del Parque Regional" y "Estudio y desarrollo de alternativas ecológicas para los sistemas agrarios de alto impacto ambiental en el Parque Regional." Ambos proyectos abordan el estudio de la estructura de los sistemas agrarios del Parque a dos escalas distintas de detalle y con objetivos específicos que se complementan.

✦ Cartografía y caracterización de la estructura agroecológica del Parque Regional, con el objetivo específico de identificar las limitaciones ecológicas o de gestión subyacentes a las principales problemáticas agrarias del Parque, y poder así acometer soluciones basadas en la optimización del uso de los recursos o en las mejoras de infraestructura que minimicen los efectos de las limitaciones detectadas. Los tipos principales de relaciones analizadas serán plasmadas cartográficamente mediante métodos automáticos con el fin de obtener una base cartográfica adecuada para la toma de decisiones de gestión ambiental, dependiendo del tipo de problema afrontado en cada caso.

✦ Estudio y desarrollo de alternativas ecológicas para los sistemas agrarios de alto impacto ambiental en el Parque Regional, con el objeto de introducir métodos y técnicas más ecológicas en los aprovechamientos agrarios del Parque, que minimicen la contaminación, optimicen el aprovechamiento de los recursos naturales y provean de productos de mayor calidad alimenticia y sanitaria a los consumidores.

Se han instalado parcelas experimentales en fincas del Parque Regional para desarrollar trabajos con los criterios, enfoques y objetivos del Parque. En su primer paso, estos trabajos se centrarán en los sistemas de aprovechamientos agropecuarios por su importancia y representatividad en el Parque.

En esta primera serie de experimentos, se trata de observar el efecto sobre los pastos de medidas que suponen una intervención mínima en los sistemas actuales de aprovechamiento. En el primer caso, rescatando usos tradicionales y en el segundo, aplicando métodos modernos de agricultura ecológica.

a) *Técnicas de manejo de las explotaciones,* p. ej.: abonado, cultivos forrajeros, medidas de mejora de los pastos, otros cultivos, soluciones para las enfermedades, alimentación del ganado, tipo de ganado, dependencia de la explotación de compras en el exterior, cosechas alternativas, etc.

b) *Características socioeconómicas,* p. ej.: tamaño de explotación, cabezas de ganado, propiedad, entradas brutas, otras fuentes de ingreso, experiencia del ganadero, edad, nivel de formación, origen rural o urbano, fuentes habituales de información, relación con el mercado, etc.

c) *Preocupación por el medio ambiente,* p. ej.: consciencia del efecto de sus sistema de aprovechamiento sobre la calidad del plantas, sobre el paisaje y la vida silvestre, interés en una agricultura viable más ecológica, interés en participar en un proyecto de investigación en este sentido, etc.

Cartografía ecológica Planteamiento: El objetivo de esta línea es identificar y cartografiar las principales relaciones entre un conjunto amplio de variables ecológicas del Parque, detectando aquellas que tienen un mayor valor predictivo del sistema de relaciones ecológicas existentes. Estas relaciones espaciales pueden ser observadas mediante el análisis de la concurrencia y correlación espacial entre elementos, detectándose grupos de éstos que tienden a aparecer conjuntamente en determinadas posiciones del espacio.

La proyección cartográfica permite resumir y expresar la variación espacial de los sistemas de interacción que se dan utilizando solamente las variables indicadores, lo cual, puede resultar muy útil para los estudios de planificación y gestión de recursos, al permitir centrar el proceso de valoración y diagnóstico del territorio en unos pocos elementos.

Análisis de comportamientos y actitudes ante el paisaje en los visitantes del Parque Regional Los objetivos que nos hemos marcado en esta línea de investigación pretenden abordar la comprensión de las preferencias paisajísticas de los visitantes y de los elementos del medio desencadenantes de interés en los sujetos, así como, comportamientos y preferencias de utilización del entorno (baños, paseos, observación de la naturaleza, picnic, etc.). Esta labor va encaminada a recabar información sobre cuáles son los lugares elegidos por los visitantes para desarrollar sus actividades de esparcimiento en el Parque Regional, qué características físicas caracterizan estos espacios, qué tipo de actividades se realizan en éllos, y por último, cuál es el tamaño y la composición de los grupos de visitantes. De igual forma, se pretende conocer cuáles son las áreas de mayor presión de visitantes, encaminándonos con ello a la minimización del impacto producido por estos sobre aquellas.

Benign Research on a South Atlantic Jewel: Towards a Management Plan for Gough Island

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INTRODUCTION

In a changing world, uninhabited oceanic islands form one of the few habitats that remain relatively unaffected by direct human disturbance. However, many oceanic islands have been affected by the introduction of alien biota, especially predatory mammals such as cats and rats (e.g., Moors 1985). Uninhabited oceanic islands that are free of introduced predators are of special conservation significance and warrant the highest form of protection. In this paper we discuss the conservation status of Gough Island, a "jewel" in the South Atlantic, and suggest how it may best be managed to maintain its current near-pristine state.

A BRIEF DESCRIPTION OF GOUGH ISLAND

Gough Island is in the central South Atlantic Ocean. It is a British possession, under the dependency of the government of Tristan da Cunha, which in turn is a dependency of St. Helena. Gough Island lies some 350 km south-southeast of the Tristan da Cunha islands at 40 degrees 20 minutes south latitude, 9 degrees 56 minutes east longitude, just south of the Subtropical Convergence. It has an area of 6,500 ha. It is mountainous and of volcanic origin, rising to 910 m, with high coastal cliffs (Ollier 1984; Chevallier 1987). The climate is cold temperate with strong winds and heavy rainfall (Höflich 1984; Ryan in prep.). The low-lying vegetation includes woodland and fernbrake, but the higher altitudes support only wet heath and feldmark (Wace 1961). The vertebrate fauna is made up primarily of 22 species of breeding sea and land birds (Table 1), southern elephant seals *Mirounga leonina* and subantarctic fur seals *Arctocephalus tropicalis,* some of which occur in large numbers (Holdgate 1965; Swales 1965; Williams and Imber 1982; Williams 1984; Watkins 1987; Bester 1990). Endemic species of flora and fauna occur (Wace and Holdgate 1976), notably the two land bird species (Collar and Stuart 1985). The island supports practically the complete world population of the small northern race of the wandering albatross *Diomedea exulans dabbenena* (Watkins 1987; Ryan et al. 1990) and an estimated 48% of the population of the northern rockhopper penguin *Eudyptes chrysocome moseleyi* (Cooper et al. 1990). Introduced aliens are restricted to house mice *Mus musculus,* invertebrates, and plants (Holdgate 1965; Holdgate and Dickson 1965; Wace and Holdgate 1976; Wace 1986; FitzPatrick Institute, unpublished data). More detailed descriptions of the environment and biota of Gough Island are given by Wace (1961), Holdgate (1965), Wace and Holdgate (1976), Chamberlain et al. (1985), Clark and Dingwall (1985), and references therein. Watkins and Cooper (1983) give a scientific bibliography for the island.

Table 1. The breeding birds of Gough Island

northern rockhopper penguin *Eudyptes chrysocome moseleyi*	greybacked storm petrel *Garrodia nereis*
wandering albatross *Diomedea exulans*	whitefaced storm petrel *Pelagodroma marina*
yellownosed albatross *D. chlororhynchos*	whitebellied storm petrel *Fregetta grallaria*
sooty albatross *Phoebetria fusca*	common diving petrel *Pelecanoides urinatrix*
southern giant petrel *Macronectes giganteus*	subantarctic skua *Catharacta antarctica*
greatwinged petrel *Pterodroma macroptera*	brown noddy *Anous stolidus*
Atlantic petrel *P. incerta*	Antarctic tern *Sterna vittata*
Kerguelen petrel *P. brevirostris*	Gough moorhen *Gallinula comeri*
softplumaged petrel *P. mollis*	Gough bunting *Rowettia goughensis*
broadbilled prion *Pachyptila vittata*	
grey petrel *Procellaria cinerea*	
great shearwater *Puffinus gravis*	
little shearwater *P. assimilis*	

A BRIEF HISTORY OF GOUGH ISLAND

Gough Island is named after Captain Gough of the *Richmond*, who sighted the island in 1731. However, it is thought to have been first discovered in 1505 by Goncalo Alvarez, a Portuguese seaman. The first landing may have been in 1675 by Antoine de la Roche (Wace 1969). Early visits were primarily for the purposes of seal hunting and gangs sometimes stayed ashore for extended periods prior to the 20th century (Wace 1969). The island was not formally annexed as a British possession until 1938 (Crawford 1941).

Scientific observations at Gough Island commenced with the sealer G. Comer in 1888 (Verrill 1895). Short visits by mainly exploration and research expeditions (listed in Wace and Holdgate 1976) set the pattern for the next 67 years. In 1955, the first detailed research was undertaken at Gough Island by members of the Gough Island Scientific Survey, a private expedition. This six-month expedition resulted in the first topographical map of the island (Heaney and Holdgate 1957), a number of scientific publications, mainly biological (see references in Wace and Holdgate 1976), and a popular account (Holdgate 1958). The 1955-1956 expedition field hut at The Glen was taken over by the South African Weather Bureau in 1956, who operated a meteorological station there until 1963, when it was moved to Transvaal Bay, where it continues today. Gough Island is currently inhabited by a seven-member meteorological team year-round, with more people (up to 40) staying ashore during the three-week annual relief period.

Following on from the published results of the Royal Society Expedition to Tristan da Cunha in 1962, which did not visit Gough (Holdgate 1965; Wace and Dickson 1965), and a "Conservation Survey" in 1968 (Wace and Holdgate 1976), subsequent research on the island has been undertaken largely during the annual relief periods, primarily by staff of the Percy FitzPatrick Institute of African Ornithology of the University of Cape Town, as part of the South African National Antarctic Programme (SANAP). A total of 13 expeditions has been undertaken by the FitzPatrick Institute between 1979 and 1990. Unfortunately, support for a 1991 visit was not forthcoming from SANAP. However, P.G. Ryan visited the island in October 1991 during the annual takeover at the request of the British authorities to conduct an environmental inspection, in his capacity as a conservation officer of the Tristan da Cunha government (Ryan 1991a).

RESEARCH AT GOUGH ISLAND BY THE FITZPATRICK INSTITUTE

Research at Gough Island by the FitzPatrick Institute since 1979 has concentrated on aspects of the population sizes (e.g., Williams and Imber 1982; Williams 1984; Watkins 1987) and ecology of the large populations sea birds, primarily albatrosses, skuas, and penguins. A long-term demographic study of yellownosed albatrosses , *Diomedea chlororhynchos* commenced in 1982 (Furness 1982; Cooper and Lutjeharms 1992). Birds banded as chicks have been recorded visiting the study colony as six-to-eight-year-olds, but none has as yet been recorded breeding (FitzPatrick Institute unpub. data). In 1987 a comparative study was commenced on the diets of both surface- and burrow-nesting seabirds (Klages et al. 1988; Klages and Cooper 1992). Less research was conducted on the two endemic landbirds of the island (Watkins and Furness 1986) which are listed as rare by Collar and Stuart (1985). In addition to ecological research, members of FitzPatrick Institute expeditions to Gough Island have conducted taxonomic, behavioral, anatomical, and physiological studies on seabirds (e.g., Brooke et al. 1980; Brooke 1989; Hayes et al. 1990; Jackson in press).

In the last few years the research activities of the FitzPatrick Institute at Gough Island have broadened to include a wider investigation of the island's biota than its birds, with special attention being paid to studies of greater conservation significance. The sighting on the island of what was thought to be a rat *Rattus* sp. in October 1983 (Wace 1986a, 1986b; Watkins and Furness 1986) and the accidental introduction of several new species of alien plants in April 1983 (Wace 1986c) were spurs to this broadening of research scope. No subsequent sightings of rats have been made despite investigations, and we now believe that the 1983 sighting was of a house mouse, which attain very large sizes at Gough Island (Rowe-Rowe and Crafford 1992). Recent research by the FitzPatrick Institute at Gough Island has been "benign" in nature, in that no indigenous members of the biota have been killed or excessively disturbed, in keeping with the island's protected status under the 1976 Conservation Ordinance.

Examples of recent conservation research by the FitzPatrick Institute at Gough Island include studies of mercury levels in seabirds, plastic ingested by seabirds, stranded artifacts, and the impact of the lobster fishery on seabirds (Furness 1985; Furness et al. 1986; Ryan 1987, 1991b; Ryan et al. 1988). In 1990, an eight-person team from the FitzPatrick Institute visited the island and *inter alia* undertook investigations into the suspected role (Breytenbach 1986; Ryan et al. 1989) of the house mouse in affecting the regeneration of the island tree *Phylica arborea*, the present status and distribution of alien flora on the island, and a study of the endemic Gough bunting *Rowettia goughensis* (Ryan 1992; Rowe-Rowe and Crafford 1992; Milton et al. in press; FitzPatrick Institute unpub. data). In 1991 P.G. Ryan made observations on the effects of heavy rainfall on the spread of alien plants and continued studies of the yellownosed albatross and Gough bunting as part of his environmental inspection on behalf of the government of Tristan da Cunha (Ryan 1991a, submitted MS).

The Conservation Status of Gough Island

In March 1950, the Wild Life (Tristan da Cunha) Protection Ordinance gave legal protection to the landbirds of Gough Island. Primarily as an outcome of the Gough Island Scientific Survey and concerns about introduction of aliens and the capturing of birds for the zoo trade, calls were made to improve further the conservation status of Gough Island (Anonymous 1957; Holdgate 1957). In April 1976 the island and its territorial waters out to three nautical miles were protected in terms of the Tristan da Cunha Conservation Ordinance of 1976 and proclaimed a wildlife reserve. The 1950 ordinance and its 1952 amendment were repealed by the 1976 ordinance. The Gough Island Wildlife Reserve is classified as IUCN Category I, Scientific/Strict Nature Reserve (Clark and Dingwall 1985). The reserve is protected in terms of the ordinance from exploitation of its biota. The ordinance further protects Gough Island from the erection of buildings without permits, agricultural activity, and the importation of alien biota and their propagules. However, a commercial fishery for Tristan rock lobster *Jasus tristani* takes place within territorial waters and therefore within the reserve (Pollock 1981). Drift-netting for tuns (Scombridae), along with incidental mortality of northern rockhopper penguins and other marine life has occurred recently within a 200-nautical-mile zone around

Gough Island, although the area is protected by the Tristan da Cunha Fisheries Limits Ordinance of 1968, as amended by Ordinance No. 3 of 1977 (Ryan and Cooper 1991).

A ten-year lease between the governor of St. Helena (who has jurisdiction over the Tristan Dependency) and the South African government allows for the demise of approximately 16 acres (6 ha) of land at Transvaal Bay for the erection and maintenance of a weather and wireless telegraph station. The lease allows for scientific research to be undertaken at the island if permission is obtained from the governor of St. Helena in advance. Other terms of the lease deal with disallowing the introduction of livestock, domestic animals, and flora other than potatoes. The current lease is due to expire on 31 July 1993. A request for a new lease has recently been made by the South African authorities (A.P. Kirk, South Atlantic and Antarctic Department, United Kingdom Foreign and Commonwealth Office, *in litt.*).

In his report of the 1991 inspection, P.G. Ryan (1991a) made 18 specific suggestions towards improving the conservation status of the island (see Table 2). These recommendations are currently being taken up by the British authorities.

WORLD HERITAGE CONVENTION

In November 1985, Lord Elton, the U.K.'s environment minister, announced that Gough Island had been placed on the indicative list of sites that the U.K. proposed to submit to the Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention) for inclusion in the World Heritage List (U.K. Department of the Environment 1985). To date, however, no nomination has been made to the World Heritage Committee (A.H. Corner, Heritage Division, U.K. Department of the Environment *in litt.*). The indicative list justified Gough Island for World Heritage status because of its being "one of the most spectacularly beautiful and least disturbed of the temperate islands in the southern hemisphere" and for its importance for scientific research.

In a review of required conservation action in U.K. Dependent Territories, Oldfield (1987) recommended that Gough Island be formally proposed as a World Heritage Natural Site. The 18th Session of IUCN, held in Perth Australia, in late 1990, called upon nations to consider their subantarctic islands for nomination to the World Heritage Convention (IUCN 1991). Although Gough Island is not considered to fall within the subantarctic biogeographic region (Smith and Lewis Smith 1987), the 1990 IUCN resolution can be taken to include Gough, considering that IUCN's Commission on National Parks and Protected Areas (CNPPA) included the island in their review of "Insulantarctica" (Clark and Dingwall 1985). In 1990, the Australian government formally nominated the subantarctic Heard and McDonald Islands to the World Heritage Convention (Rootes 1991), and the Tasmanian government called for comment on its proposal to nominate subantarctic Macquarie Island (Anonymous 1990). The Heard and McDonald Islands' nomination was deferred and will be reconsidered during 1992 (J. Thorsell, IUCN, pers. comm.). The Australian government has now submitted a nomination for Macquarie Island (J.D. Harrison, World Conservation Monitoring Centre, *in litt.*). However, no island in the Southern Ocean has as yet been included in the World Heritage Convention (P.R. Dingwall, CNPPA, in litt.). The subject of World Heritage Convention status for "subantarctic islands" (including Gough Island) was discussed at a joint Scientific Committee on Antarctic Research (SCAR)/IUCN

Table 2. Summary of recommendations arising from the 1991 inspection of Gough Island

1. Rat excluders should be on all ships' hawsers prior to sailing for Gough, and there should be an annual inspection of the base area on Gough for signs of rats.
2. No leafy vegetables should be landed, and poultry products should be incinerated.
3. All material that is landed should be inspected for propagules. In particular, sand and other construction materials should be steam-cleaned before coming ashore. Landing of such material should be kept to a minimum.
4. The pantry at the base should be thoroughly cleaned and infested foodstuffs removed from the island to eradicate infestations of flour weevils *Tribolium* spp.
5. The upper magnetometer hut and the area downstream of it should be inspected annually for signs of two localized alien plants, *Conyza sumatrensis* and *Senecio burchellii.* Any plants found should be carefully weeded out (including roots) and incinerated.
6. Paths on the upland areas should follow ridges to reduce slope erosion.
7. A more robust pipeline should be used for pumping diesel ashore.
8. Traps should be built under the diesel tanks and taps to contain accidental spillages.
9. Effective blackout blinds should be fitted to all windows on the weather station., and the number of outside lights reduced.
10. Ships anchored off the island should also keep their light emissions to a minimum.
11. The switch to satellite-based communications should be encouraged to allow the reduction in the number of radio aerials.
12. The exhaust from the crane's generator should be redesigned to void upwards.
13. Emphasis should be given to educating short-term visitors to the island, to ensure suitably "environmentally friendly" attitudes, including the necessity to sort refuse at its source, and the dangers of leaving on lights after dark.
14. All visitors should be explicitly warned not to dispose of noxious wastes in the wastewater system (e.g., photographic chemicals, turpentine, etc.).
15. The current incineration system should be reviewed to reduce the risk of tussock and peat fires and the spread on unburnt and partially burnt material. Consideration should be given to adopting a "garbage in-garbage out" approach to the weather station.
16. Degradable packaging should be used, given the problem of windborne litter.
17. Dumping of persistent wastes (all except food and sewage) by vessels fishing around the island should be prohibited.
18. An annual inspection should be conducted by a Tristan conservation officer with biological training and experience of Gough Island, and of the alien plants and animals found there. Such inspections should incorporate long-term monitoring studies to assess human impacts on the biota.

Source: After Ryan (1991).

Workshop on Protection, Research and Management of Sub-Antarctic Islands, held at Paimpont, France, in April 1992.

In terms of the operational guidelines for the implementation of the convention (Unesco 1991), "State Parties are encouraged to prepare plans for the management of each natural site nominated." Accordingly, the Foreign & Commonwealth Office of the U.K. government, which has the responsibility for the nomination of sites in U.K. Dependent Territories to the Convention, has delayed formally nominating Gough Island until a management plan can be prepared and implemented (A. H. Corner *in litt.*), although the existence of a plan is not a formal prerequisite for nomination (Unesco 1991).

A Management Plan for the Gough Island Wildlife Reserve

In their monograph "Man and nature in the Tristan da Cunha Islands," Wace and Holdgate (1976) gave guidelines for environmental management and recommended that Gough Island by conserved for scientific research on its native biota. Clark and Dingwall (1985), in a conservation review of southern islands for the CNPPA, recommended the production of a detailed management plan for Gough Island and "regular monitoring of the efficiency of conservation measures." Detailed management plans or equivalent documents have been published or are in draft form for a number of the cold temperate and subantarctic islands of the Southern Ocean (New Zealand Department of Lands and Survey 1983, 1984, 1987; Decante et al. 1987; Keage 1987; Bonner and Croxall 1988; Tasmania Department of Parks, Wildlife, and Heritage 1990), but no such plan currently exists for Gough Island (or for any other island in the Tristan-Gough group).

In August 1990, the administrator of Tristan da Cunha, B. E. Pauncefort, approached the authors in their capacities as conservation officers of the Tristan da Cunha government with a request for a management plan for the Gough Island Wildlife Reserve. After acceptance in principle of the request, Pauncefort applied in early 1991 to the United Kingdom section of the World Wide Fund for Nature (WWF-UK) for funding towards the costs of producing a plan. Later in 1991 WWF-UK granted partial funding, with the balance being provided by the U.K. Foreign & Commonwealth Office (A.P. Kirk *in litt.*). A contract was formally entered into in January 1992 and a draft management plan is to be submitted by the end of the year. An idea of the planned contents is in Table 3.

Table 3. Management plan for Gough Island: Draft table of contents

1. *Summary*
2. *Introduction*
3. *Description and resource inventory*
    - 3.1 Position, national and conservation status, and applicable legislation
    - 3.2 Locality, discovery, and derivation of name
    - 3.3 History of human activity
    - 3.4 Size, topography, geomorphology, and geology

Table 3 (continued)

    - 3.5 Climate

3.6 Surrounding seas, bathymetry, and oceanography
3.7 Terrestrial biota–vegetation
3.8 Terrestrial biota–animals, including population estimates of seals and birds
3.9 Marine and littoral biota and resources
3.10 Resource significance
3.11 Conservation considerations

4. *Management and policy statement*
   4.1 Terrestrial and littoral environment
   4.2 Marine environment
5. *Prescriptions for management*
   5.1 Administrative authority
   5.2 Access, and use of helicopters and boats
   5.3 Protection of historical sites and artifacts
   5.4 Protection of terrestrial, littoral, and marine biota
   5.5 Resource inventories and monitoring
   5.6 Research
   5.7 Alien biota control and monitoring
   5.8 Management zones, specially protected areas, and scientific study sites
   5.9 Management and policing of offshore resources
   5.10 Code of conduct for meteorological station staff and visitors
   5.11 Treatment of human-derived wastes and pollution prevention
   5.12 Control of imported material
   5.13 Fires and fire control
   5.14 Paths, erosion, and peat slips
   5.15 Provision of beacons, field refuges, and huts
   5.16 Safety and rescue provisions
   5.17 Application and issuing of permits
   5.18 Contraventions and penalties
   5.19 Environmental impact assessment procedure
6. *Revision of management plan*
7. *Acknowledgments*
8. *References*
9. *Selected bibliography on the literature on Gough Island*
10. *Appendices: Maps, illustrations, legal documents, species lists, populations estimates, and examples of permits*

It is expected that the plan will *inter alia* recommend that the Gough Island Wildlife Reserve be formally nominated to the World Heritage List, thereby further improving the conservation status of a "fragment of paradise" (Oldfield 1987), and that the continuation of benign research on the island's biota should be both encouraged and supported by the U.K. and South African authorities.

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La Recherche dans les Espaces Protégés Français

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ABSTRACT

Since the 1970s, the fundamental and applied scientific activities developed in French protected areas have been organized for the conservation and management of the natural heritage. The scientific committees of the national parks participate in the definition of park policy and deal with specific questions. The *Direction de la Protection de la Nature*, a department of the French Ministry of the Environment, coordinates these scientific programs. The relationships among scientific institutions are varied, from direct and long-term involvements to specific and contractual operations. In other types of protected areas, studies are developed by different organizations: the *Conférence permanente des Réserves naturelles* (Natural Reserve Council) and the *Fédération des Parcs naturels de France* (French Natural Park Federation). Four scientific programs are briefly presented as a model of our organization. This paper explains the generalization of management plans, the development of the natural heritage observatory, and new opportunities for protected areas with

the establishment of the French Environmental Institute. The relationships to conservation biology and to interdisciplinary programs are discussed.

DES ACQUIS EN PROTECTION DE LA NATURE

En France, les premières Réserves ont été créées au début des années 1910. En 1991, 30 formes différentes de protection sont recensées (Levy-Bruhl et Coquillart 1989), concernant 25% du territoire national, départments d'Outre-Mer inclus, dont 2% en protections fortes (Parcs nationaux, Réserves, Sites classés, propriétés du Conservatoire du littoral) (Chabason et Theys 1990). Ces réglementations visent à sauvegarder le patrimoine naturel et culturel. Contrairement à d'autres pays, il n'existe pas de sites protégés uniquement en raison de leur intérêt scientifique. Les concepts structurant les actions de conservation ont évolué au cours du temps. Après une première phase de protection stricte et passive des sites, fondée sur les inventaires des richesses biologiques présentes, la gestion des écosystèmes est aujourd'hui réalisée grâce au maintien de certaines activités humaines et à la restauration des populations végétales, animales et des habitats. Les recherches dans ce domaine se développent surtout dans les Parcs nationaux, les Réserves de la biosphère, certains Parcs naturels régionaux et Réserves naturelles. Ces programmes scientifiques sont fondamentaux et appliqués et font appel à un large éventail de disciplines appartenant aux sciences de la terre, de la vie ou aux sciences humaines.

LES INSTITUTIONS PHARES

Les Parcs nationaux Les sept Parcs nationaux français ont pour objectif d'assurer la conservation à long terme du partimoine naturel qui leur est confié. Dès l'origine, chaque Parc, autonome aux plans réglementaire, financier et administratif, a été doté d'un Conseil d'administration constitué de fonctionnaires, d'élus, de personnalités représentant les usagers et d'experts, où sont arrêtés les principales orientations et les choix budgétaires de l'organisme. Le président du Conseil scientifique où siègent des chercheurs et des experts de diverses disciplines est membre du Conseil d'administration. Le Conseil scientifique donnes son avis sur toutes les décisions et actions susceptibles d'avoir un impact sur le patrimoine naturel du Parc. Il participe à la définition des travaux scientifiques jugés utiles pour la gestion de ce territoire. La recherche se fait grâce aux moyens financiers attribués par le Parc ou par d'autres organismes nationaux (ministères de l'Environnement, de la Recherche, de l'Education nationale, ou internationaux: CEE, Unesco). Le personnel du Parc a un rôle a'animation des programmes, de collecte et parfois de traitement des données. Suite à un Colloque organisé à Florac en 1979 (Anonyme 1981), une Cellule interparc a été créée pour coordonner les travaux scientifiques menés dans les Parcs. Il s'agit de détecter les sujets prioritaires, de clarifier les problématiques, de repérer les équipes compétentes et disponibles, de monter des dossiers et de trouver les crédits. Grâce à cette dynamique, des programmes conséquents ont vu le jour (voir cidessous 7).

Les Parcs naturels régionaux Ils sont au nombre de vingt-six et ont un pourvoir réglementaire réduit dans le domaine de la conservation de la nature. Leur principal objectif est d'inciter à une meilleure prise en compte de l'environnement sur leur territoire. Il s'agit de regroupements de collectivités locales adhérant à une charte agréée par l'Etat. Certains Parcs régionaux ont mis en place un Conseil scientifique au champ d'intervention variable selon les cas. L'animation scientifique se fait au sein de la Fédération des Parcs natural de France et de la Cellule interparc. Les Parcs naturels régionaux ont développé des recherches originales sur les races d'animaux domestiques (reconstitution de tropeaux) et sur les variétés fruitières (Conservatoire botanique). De même, des programmes en sciences humaines (éthnologie, sociologie, économie) visant à connaître les usages traditionnels des ressources présentes ont été initiés à leur demande.

Les Réserves naturelles Les cent-six Réserves naturelles françaises, en général moins vastes que les Parcs, bénéficient d'une réglementation particulière visant à protéger la nature. Elles peuvent d'ailleurs se trouver localisées dans un Parc national ou régional. Chaque Réserve a un Comité consultatif composé d'élus locaux, d'usagers et d'experts, qui définit des orientations et suit les dossiers concernant ce territoire. La mise en oeuvre des actions est confiée à un organisme *ad hoc:* une association, une collectivité ou un organisme public. La coordination des activités de recherche se fait grâce au Comité scientifique de la Conférence permanente des Réserves. Les recherches sont variées, allant de l'étude de l'écologie d'espèces remarquables à celle d'écosystèmes particuliers. Depuis 1991, les Réserves rédigent leur plan de gestion. Un test effectué sur dix sites représentatifs de la diversité des conditions écologiques et administratives rencontrées dans le réseau des Réserves, a permis une adaptation des diverses méthodes de plans de gestion existantes (Lierdeman 1991). A moyen terme, l'élaboration et la mise à jour régulière de ces plans vont déboucher sur la constitution d'une base de donneés trés utile pour compendre l'évolution des milieux en fonction de divers types d'interventions appliqués (Barnaud et al. 1991).

Les Réserves de la Biosphère Dès leur création et en raison de leur statut, les sept Réserves de la biosphère sont devenues des sites propices au développement de programmes de recherche coordonnés dans le cadre des réseaux du MAB-Unesco. Certains de ces sites bénéficient d'ailleurs d'autres types de protection (Parc national, Parc régional, Réserve naturelle).

L'INTERET SCIENTIFIQUE DE CES TERRITOIRES

Le rôle important que pourraient jouer les espaces protégés comme observatoires des changements écologiques, sociologiques et économiques, a été reconnu dès le début des années 1980, lors du lancement du Programme interdisciplinaire de recherche sur l'environnement par le Centre national de la recherche scientifique (Jacques 1985). Toutefois, des obstacles d'ordre institutionnel ou scientifique ont eu raison des divers projets formulés (Parcs de la Vanoise, des Pyrénées), mis à part le cas du Parc national des Cévennes. L'émergence, au plan international, des problématiques d'étude des changements globaux renforce de nos jours cette option. D'ailleurs, les Américains présentent leurs Parcs nationaux comme des sites privilégiés d'étude (Comanor 1991). De surcroît, la permanence scientifique, assurée par les équipes des Parcs nationaux comprenant des gardes ainsi que des attachés ou des conseillers scientifiques compétents, docteurs en écologie, en biologie ou naturalistes confirmés, représente un atout important. La situation est beaucoup plus variable pour les Parcs régionaux et les Réserves, car seulement certains organismes disposent d'un personnel qualifié en écologie.

LES PARTENAIRES SCIENTIFIQUES

A la différence d'autres pays, il n'existe pas en France de centre de recherche fondamentale ou appliquée affecté spécifiquement aux espaces protégés, et aucun laboratoire de recherche ne s'est engagé pleinement sur les problématiques directement liées aux besoins des gestionnaires d'espaces protégés (Ramade 1991). La recherche écologique se fait au sein d'institutions (Centre national de la recherche scientifique, Univeristé, Múseum national d'histoire naturelle, Institut national de recherche agronomique, ORSTOM) sous tutelle de plusieurs ministères: Recherche, Education nationale, Agriculture. Mise à part la cotutelle récente (1992) du Múseum national d'histoire naturelle, le ministère de l'Environnment n'a pas d'institut de recherche propre. Créé en 1991, l'Institut français de l'environnement est le correspondant national de l'Agence européenne de l'environnement qui collecte et traite de manière thématique (eau, biotopes, air, sol, etc.) les données environnementales. L'intervention du ministère est donc essentiellement financière et prend la forme d'incitations contractuelles à la recherche. Certains responsables de programmes de recherche fondamentale utilisent les territoires et parfois le personnel des Parcs et Réserves, mais ceci en fonction de leurs propres priorités. Généralement, les questions posées par les responsables d'espaces protégés nécessitent le lancement de recherches finalisées et pluridisciplinaires jusqu'à présent mal perçues par les instances nationales d'évaluation. Ce contexte explique le peu d'engagement des scientifiques. Les exceptions méritent d'être soulignées et tiennent pour la plupart à l'abnégation et à la persévérance de quelques responsables scientifiques. Différents organismes à vocation plus technique (Centre national du machinisme agricole, du génie rural, des eaux et des forêts, Office national de la chasse, Conseil supérieur de la pêche) ainsi que des bureaux d'études privés, participent également aux travaux menés dans les espaces protégés.

LES RELATIONS ENTRE GESTIONNAIRES D'ESPACES PROTÉGÉS ET SCIENTIFIQUES

Lorsqu'un responsable d'espaces protégés est confronté à un problème de gestion, la procédure normale consiste à commander un bilan des connaissances sur la question à une équipe de recherche, puis à indentifier les recherches complémentaires à mener. La programmation se fait alors avec l'aide de scientifiques motivés par le sujet qui établissent des programmes précis soumis aux divers créanciers potentiels, le plus souvent dans le cadre d'un appel d'offre. En régle générale, cette procédure, basée sur une large concertation, se révèle être riche d'enseignements mais reste longue et fastidieuse. La Direction de la protection de la nature au ministère de l'Environnement coordonne les interventions et soutient les projets. Schématiquement, les recherches peuvent être séparées en deux grandes catégories: (1) les programmes inter-espaces protégés pluriannuels portant sur des thématiques communes, qui sont complexes aux plans scientifique et institutionnel; (2) les programmes spécifiques à un site donné, d'envergure plus modeste et ayant pour objectif de répondre à une question précise liée à la gestion du territoire concerné. Cette dernière catégorie, la plus courante, donne lieu à publications dans les Annales scientifiques des Parcs ou toute autre publication de ce type. Les sujets traités étant nombreux et variés, nous avons donc choisi d'exposer brièvement quelques exemples représentatifs de la dynamique scientifique et des relations entre recherche fondamentale et appliquée. Sont concernées trois opérations inter-espaces protégés et un programme spécifique à un site bénéficiant du label Parc national et Réserve de la biosphère (Figure 1).

QUELQUES EXEMPLES DE RECHERCHE MENÉES DANS LES PARCS

Programme "Formations pâturées d'altitude" L'objectif des travaux (1982-1991) était de compendre l'evolution des écosystèmes pâturés de montagne et les relations entre les ongulés sauvages et domestiques. Deux Parcs nationaux (Mercantour, Pyrénées occidentales) et deux Parcs régionaux (Vercors, Corse) étaient impliqués, confèrant à ce programme une bonne implantation biogéographique. Huit laboratoires participaient aux travaux. Des recherches pluridisciplinaires (écologie, éthologie, sociologie, économie) étaient menées de manière intégrée. L'impact du tourisme et des activités rirales était également abordé en tenant compte de l'environnement socioéconomique général. Les études sout maintenant terminées et certains résultats appliqués à la gestion rationelle de l'espace en intégrant les transformations sociales, leurs conséquences sur les divers éléments constitutifs de l'écosystème et les possibilités d'usage multiple de ces écosystèmes. Ce programme a reçu le label MAB en 1984 et les équipes bénéficient à ce titre d'échanges internationaux renforcés. A partir de cette dynamique, le Centre international pour l'environnement alpin (ICALPE) a vu le jour en 1888 (MAB-France 1990). L'ICALPE anime des programmes européens (Intégralp, Futuralp, Médimont) où se retrouvent divers partenaires scientifiques et responsables de Parcs, impliqués dans le programme "Formations pâturées d'altitude." Mis à part l'édition d'un bulletin de liaison aujourd'hui arrêté et les nombreux mémoires et thèses issus de ces recherches, la diffusion des résultats se fait grâce aux publications de synthèses (Anonyme 1991), à la participation à des colloques (Systèmes d'information environnementale, Grenoble 1990; les colloques d'EURO-MAB montagnes).

Programme "Bouquetins" L'objectif est de réintroduire dans des habitats favorables, le Bouquetin des Alpes *(Capra ibex ibex)* disparu de nombreux massifs en raison de la chasse (Gauthier et Villaret 1990). Au cours d'une première étape débutée en 1986, les stratégies de régulation des populations originelles et en cours de colonisation active ont été étudiées dans deux Parcs nationaux (Vanoise, Mercantour) et dans des Réserves naturelles et de chasse et Haute Savoie, Savoie et Isère avec l'aide de chercheurs indépendants (Gauthier et al. 1991). Les critères de sélection des sites favorables au développement des bouquetins sont maintenant déterminés. Le programme en cours, réalisé par le personnel des Parcs, l'Institut de recherche sur les grands mammifères et l'Office national de la chasse, consiste à suivre les populations de bouquetins réintroduits dans deux Parcs nationaux (Ecrins, date de lâcher mai 1989; Mercantour, mai 1987 et 1989) et dans un Parc régional (Vercors, mai 1989). Les techniques utilisées (marquage, radiopistage, balise ARGOS) permettent de compendre les stratégies de colonisation de l'espace, de reproduction, l'évolution des structures sociales, facteurs décisifs vis-à-vis de la réussite ou de l'échec de ces opérations. Les acquis de ce programme serviront, entre autres, au projet de réintroduction de Bouquetin des Pyrénées *(Capra ibex pyrenaica)* dans le Parc national des Pyrénées occidentales. Les chercheurs ont présenté leurs résultats techniques et scientifiques dans plusieurs colloques nationaux ou internationaux *(Radiotelemetry for Track*

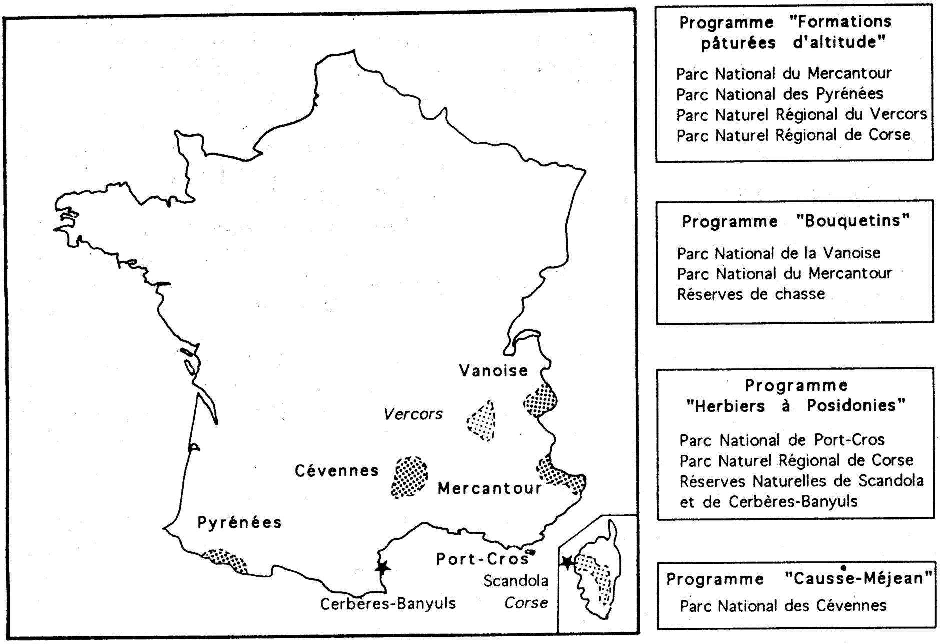

Figure 1. Localisation des Parcs nationaux, Parcs naturels régionaux et Réserves naturelles impliqués dans les programmes de recherche donnés en exemple

ing Terrestrial Vertebrates, Monaco, décembre 1988; Réintroductions et renforcements de populations animales en France, Saint-Jean-du-Gard, décembre 1988; *World Conference on Mountain Ungulates,* Camerino, septembre 1989; Colloque international sur les Ongulés, Toulouse, septembre 1991).

Programme "Herbiers à posidonies" Des menaces pèsent sur les herbiers à posidonies *(Posidonia oceanica),* espèce protégée dont les formations en récif jouent un rôle fondamental en zone littorale. Pour compendre et remédier aux causes physiologiques, écologiques, mécaniques de leur régression, un programme pluridisciplinaire a été initié dès le début des années 1980 à l'initiative du Parc national de Port-Cros en collaboration avec un Parc naturel régional (Corse), deux Réserves naturelles (Scandola, et Cerbère-Banyuls) avec l'aide de laboratoires d'écologie et d'océanographie. Actuellement, l'objectif est de connaître le fonctionnement et de modéliser l'écosystème "Posidonie" en Méditerranée pour le protéger efficacement. De nombreux résultats sont déjà acquis sur les différents compartiments composants cet écosystème marin: les populations de *Posidonia oceanica* (photosynthèse, reproduction, survie, etc.), les espèces végétales (épiphytes) et animales (poissons, échinodermes, holothuries, faune vagile, endofaune) vivant dans ces formations (réseaux trophiques, consommation, prédation), les flux de matière organique et les facteurs abiotiques (lumière, température, substrat, etc.). Le résultat escompté est de pouvoir prédire et quantifier les impacts des activités humaines (urbanisme, port, tourisme). Là également, plusieurs thèses et publications récapitulent l'ensemble des résultats (Francour 1990). La valorisation de l'information est assurée par l'organisation de colloques internationaux (Boudouresque et al. 1984; Meinesz et al. 1989) et par la diffusion d'un bulletin *(Posidonia Newsletter).*

Prgramme "Causse-Méjean" du Parc national des Cévennes En 1981, un programme de recherche interdisciplinaire destiné à établir les fondaments d'un "observatoire des changements écologiques, sociologiques et économiques" (Jollivet 1985) a été initié par des laboratoires appartenant à diverses institutions (CNRS, Universités, INRA, Institut national d'agronomie, Ecole des hautes études en sciences sociales), en collaboration étroite avec le personnel du Parc, de l'Office national des forêts et des partenaires locaux. Les sites étudiés sont les Causses et les Cévennes, zones fragiles de moyenne montagne. L'étape descriptive est maintenant relayée par une phase d'expérimentation portant sur les phénomènes d'érosion, les potentialités pastorales et la reconstitution de la productivité de milieux perturbés (Jollivet 1989, 1992). Actuellement, les paramètres à suivre dans le cadre de l'observatoire permanent des changements sont déterminés pour le Causse Méjean et une base de données conçue comme un outil de prospective pour la gestion de la zone concernée est en cours du création. Une partie de ce Parc national est une Réserve de la biosphère (1984). A ce titre des programmes de recherches sont développés sur la châtaigneraie cévenole et les bassins versants du Mont-Lozère et le Séminaire international des Réserves de la biopshère méditerrannéennes a été organsimé dans les Cévennes (Florac) en septembre 1986 (MAB-France 1988, 1990).

QUESTIONS DE FOND ET PERSPECTIVES

Par sa couverture géographique et la variété de ses statuts, le réseau des espaces protégés français est représentatif d'un grand nombre de problèmes environnementaux ayant des implications économiques et sociales aux plans national et européen. Les questions de fond en biologie de la conservation peuvent y être abordées avec certaines garanties de pérennité et de permanence scientifique: analyse des répercussions des changements globaux, évolution de milieux où les pratiques traditionnelles sont abandonnées, connaissance et gestion à l'échelle des paysages de populations animales ou végétales menacées ou, inversement, envahissantes.

Selon son statut, chaque espace protégé est plus ou moins pertinent pour l'implantation de tel ou tel type de programme. Par exemple, les Parcs nationaux de montagne, par la nature de leur communautés végétales et animales adaptées aux fortes contraintes, sont des lieux privilégiés de suivi des conséquences des changements climatiques. Dans le mesure où les inventaires et les recensements des espèces ont été réalisés sur une certaine durée, ces données sont d'ores et déjà directement exploitables dans ce contexte. La nécessité de permettre un accès aisé aux informations accumulées au cours du temps et de modéliser les évolutions actuelles, a été à l'origine de l'utilisation d'un Système d'information géographique (GIS). Trois Parcs naturels régionaux et deux Parcs nationaux en sont déjà dotés. A moyen terme, l'ensemble des parcs nationaux devraient employer ce type de traitement des données.

Les espaces protégés peuvent également être considérés comme des zones "test," permettant d'élaborer et d'appliquer de nouvelles pratiques d'aménagement et de gestion compatibles avec un développement durable. Cette dimension est capitale si l'on souhaite une meilleure intégration territoriale des espaces protégés, donc leur extension.

Cependant, le développement de ces axes de recherche reconnus par l'ensemble des partenaires comme crucial pour l'avenir, est limité par les effectifs réduits de la communauté scientifique concernée et le caractère trop souvent ponctuel des programmations.

CONCLUSIONS

Les espaces protégés ont un rôle important à jouer au moment où les exigences en conservation, donc en connaissance des milieux, se font plus pressantes à l'échelle européenne (Directive "Habitat") et internationale (Charte de la biodiversité). Ces sites bénéficient d'un passé scientifique et d'inventaires relativement complets. En s'appuyant sur les données et les connaissances scientifiques disponibles, des actions de gestion du territoire dans un objectif de conservation du patrimoine naturel et des paysages ont progressivement été entreprises. La valorisation de ces expériences passe par l'application des résultats techniques à l'ensemble du territoire grâce au développement du génie écologique (Blandin 1991). Dans ce contexte, les programmes d'information scientifique et d'éducation menés dans les espaces protégés favorisent l'extension des opérations de gestion en dehors du réseau. Pour arriver à une action globale sur l'ensemble du territoire, il est nécessaire d'améliorer la répresentativité de ce réseau afin que tous les types de milieux recensés en France puissent bénéficier d'un site de référence correspondant à un laboratoire de recherche en vraie grandeur.

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A Strategy to Inventory the Biological Resources of the National Park System of the USA

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We would like to report our progress on a program that the United States National Park Service (USNPS) has begun to (1) assess and document its extant biological resources, (2) standardize and synthesize that information, and (3) provide a foundation and direction for future biological inventory efforts.

The U.S. national park system contains 357 units, 250 of which have significant natural resources. Each national park unit was created by its own federal act of Congress or presidential proclamation to recognize outstanding examples of the nation's heritage, to be preserved forever. The 1916 Organic Act that established the USNPS did so to "conserve the scenery and the natural and historic objects and the wild life therein and to provide for the management of the same, in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The national park system represents most of the major ecosystem types of the United States. Thirty national parks have also been designated International Biosphere Reserves by Unesco because of their representation of the world's major ecosystems.

Because of a national commitment to preserve these special places and their ecological significance, the director the USNPS, James Ridenour, stated in a 1991 interview in *Life* magazine: "The parks can and should be our national 'canaries in the coal mine,' telling us about our work and our environment. They can tell us what is happening in the areas of global warming, clean air, clean water, acid rain. We're set to take the temperature of the country. The parks are great reservoirs of science." Nonetheless, despite the fact that the USNPS is over 75 years old and Yellowstone, the first national park, is 120 years old, we still know very little about the actual biological structure of our parks.

Indeed, this problem is not new. In 1933, George Wright and others recommended in the first volume of the series *Fauna of the National Parks of the United States* that "a complete faunal investigation, including the four steps of determining the primitive fauna picture, tracing the history of human influences, making a thorough zoological survey and formulating a wildlife administrative plan, [should] be made at the earliest possible date."

In 1990, we began an intensive effort to address the widespread problem of the lack of biological information. Our goal is to have a basic inventory of vascular plants and vertebrate animals of the national park system by 2000. The product will be a complete listing of vascular plant and vertebrate species for the 250 national park units that have significant natural resources. Each species entry on the list will also contain information on presence, documentation, special status, origin, availability of distribution data, resident status, and abundance with appropriate bibliographic references.

Before proceeding with data collection on a grand scale, though, we have first begun to organize what we already know. That is, we are assembling five databases, in the dBASE software format, to create an "inventory of inventories." The five databases are: the biological inventory status, national park flora, national park fauna, remotely senses information, and thematically mapped information. We report here on only the first of these, the biological inventory status database. It is now complete, with the others still being compiled.

The biological inventory status database describes the current status of biological inventories for vascular plants, mammals, birds, reptiles, amphibians, and fishes for each park. Each of these groups was given a score of one to six or one to seven in each of four categories of completeness: taxonomic, geographic, ecological, and seasonal.

A score of one in a category indicates greater than 95% completeness; a score of six or seven indicates poor or no data. Taxonomic completeness refers to coverage of major taxa, such as families, of a group; geographic completeness refers to area coverage; ecological completeness assures that all major habitat types have been surveyed; and seasonal completeness indicates that the group has been surveyed in all appropriate seasons. The first three scores were then combined to give a composite score for each group at each park.

In looking at completeness information for 250 national park units, we found that:

- 33% of the parks have 80% or better inventories of vascular plants;
- 18% of the parks have 80% or better inventories of mammals;
- 27% of the parks have 80% or better inventories of birds (the best-represented of the vertebrate groups);
- 13% of the parks have 80% or better inventories of reptiles and amphibians (the worst-represented of the vertebrate groups); and
- 18% of the parks have 80% or better inventories of fishes.

By October 1992, we plan to produce:

- An inventory of "candidate" flora and fauna of the national park system in both printed and database format, specific for individual parks and aggregated for regional and national levels;
- A "user-friendly" computer program and associated database for each park that can be consolidated at the regional and national levels;
- A system-wide analysis of the biological similarity among parks based upon flora and fauna information; and
- A strategy for acquiring and managing new flora and fauna data.

By 2000 we hope to have:

- A complete inventory of the vascular flora and vertebrate fauna of the national park system;
- A determination of the contribution of the national park system to conserving the nation's biological diversity, relative to that of other public and private land management agencies or organizations; and
- An updated archive of collections representing national park flora and fauna.

We do not believe that the existing low level of biological inventory completeness is desirable. We do believe, though, that we have taken a necessary first step to assess our current situation on a systematic basis. We believe that the national park system biological inventory can be a valuable prototype for other agencies and organizations and perhaps a pilot program for a larger and much-needed national biological inventory, or even a systematic inventory of the flora and fauna of the world's international biosphere reserves.

The Impacts of Environmental Change on Protected Areas: A Study of the Impact of Drought on Animal Utilization of the Makgadikgadi Pans Game Reserve

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INTRODUCTION

When we talk of environmental change in protected areas, we cannot separate wildlife, or indeed any living organism, from the environment it inhabits and from which it derives its sustenance. The drought which hit Botswana during the period 1981-1987 had an adverse effect on the Makgadikgadi Pans Game Reserve and on animal numbers and movements. Because rainfall was below average (100 mm), the Boteti River, which bounds the reserve on the west and flows only ephemerally even under normal conditions, was virtually dry. The condition of the vegetation was poor.

Makgadikgadi Pans Game Reserve has abundant wildlife, with animal species such as zebra, wildebeest, springbok, ostrich, gemsbok, hartebeest, kudu, giraffe, lion, impala, and other smaller species occurring in varying densities. The water-dependent species are numerous compared with less water-dependent ones. During the drought, there were a lot of die-offs, mostly of zebra and wildebeest, due to lack of good grazing and water. The surviving species wandered outside the protected area in search of water. The less water-dependent species were not severely affected.

Water-dwelling species, such as hippopotamus and crocodile, crowded into discrete permanent pools along the Boteti. Artzen and Veenendaal (1986) stated that it appears that movement of animals in Botswana is, in general, influenced by rain and hence partly erratic. They concluded that wildebeest and zebra in Makgadi-kgadi Pans Game Reserve show seasonal movement from the grass plains along the Ntwetwe Pans in the wet season to the lower Boteti in the dry.

STUDY AREA

The reserve encompasses approximately 3,700 sq km and extends between 24 and 25 degrees east longitude and 20 and 21 degrees south latitude. It is part of the Makgadi-kgadi Pans complex, an old dry and flat lake bed (Mbano 1984). The Boteti River on the western boundary was dry during the drought except for a few pools. Around June 1989, floods finally reached the Boteti, which depends on overspill from the Okavango River to the north. On its southeastern side, the reserve is bounded by great salt pans which may accumulate rainwater during the wet season. However, due to low rainfall, high evaporation, and free-draining soil, surface water is scarce, with the pans generally drying up during the dry season.

The study area gets between 450 and 500 mm of rainfall per annum. The rain falls during the summer months (October to March). The rainfall in the reserve has a 40% variation and 200 mm deviation. Its intensity varies considerably (Mbano 1984).

METHODS

Two methods were used to monitor the numbers, movement, and distribution of the reserve's animal species.

Aerial survey Wet- and dry-season aerial surveys were conducted. The reserve was flown at 4% coverage by a fixed-wing single-engine light aircraft at an altitude of 300 ft. The plane was flown along transects with a fixed strip width of 200 m on both wings. Animal species seen on both sides were counted and recorded. Later, the results were put into a computer to calculate estimated numbers, confidence limits, density biomass, etc., for each species seen.

Road survey Road counts were done every month, starting in 1989, to intensify the monitoring. The method was adapted from that of Dasmann and Mossman (1962). The following parameters were recorded during the road counts: (1) perpendicular distance from the vehicle to the sighting, (2) distance traveled, and (3) number of species sighted. These parameters were used to calculate strip width, survey area, animal density index, and estimated population.

RESULTS AND DISCUSSION

The movement of wildebeest is similar in pattern to that of the zebra and the estimated numbers of species do not differ very much (see Table 1) but do vary between seasons. These species are found at the Boteti River during the dry season in herds of varying sizes. Counts along the river during the wet season indicate absence of these species. Although these species were the most affected by the drought because of their dependence on water, they seem to be more numerous in the reserve than other species that are less dependent. Following the drought, the animals seem to have been able to increase their popula-

Table 1. Population estimates of selected animal species in Makgadikgadi Pans Game Reserve, 1989-1991

Species	Season	Survey Method	1989	1990	1991
Zebra	wet	road	888	63,529	36,031
		aerial	–	667	33,775
	dry	road	35,455	53,662	518
		aerial	62	10,816	27,571
Wildebeest	wet	road	185	13,801	17,767
		aerial	–	128	2,379
	dry	road	23,921	33,386	76
		aerial	14,793	6,993	3,622
Springbok	wet	road	–	–	910
		aerial	–	–	7,026
	dry	road	33,948	37,876	642
		aerial	13,403	154	–
Ostrich	wet	road	–	3,796	1,406
		aerial	–	1,275	1,275
	dry	road	1,887	2,620	1,147
		aerial	1,392	1,050	1,087
Gemsbok	wet	road	2,812	3,585	1,976
		aerial	–	1,550	814
	dry	road	3,404	2,102	814
		aerial	416	450	764

Table 2. Population estimates of selected animal species in Makgadikgadi Pans Game Reserve, 1974-1987

Date	Wildebeest	Zebra	Springbok	Ostrich	Gemsbok
Nov. 1974	23,500	22,750	6,000	2,900	1,250
Mar. 1979	53,000	100,300	–	–	–
Feb. 1982	23,700	59,200	3,000	4,500	500
Feb. 1987	10,000	21,100	6,300	4,700	120
June 1987	–	300	10,800	1,400	360

tions. Yet there were years after the drought which had little rainfall; therefore, population estimates have fluctuated. Note the sharp drop in dry-season road counts for both zebra and wildebeest in 1991. Even within years there is considerable variation in zebra numbers between the wet and dry season. In 1989, the number of zebra increased greatly during the dry season, indicating the possibility that they came into the reserve from adjacent areas to utilize the river. But in 1991 the opposite happened, when both wildebeest and zebra appear to have left the reserve in large numbers during the dry season. This could have been caused by the fact that the Boteti did not flow at the expected time and hence was almost dry for most of the dry season that year.

The less water-dependent species (springbok, gemsbok, and ostrich) seem not to have been as affected by the drought since their numbers have not changed much from pre-drought levels (compare Tables 1 and 2). However, in 1987 the dry-season population of ostrich was reduced from 4,700 to 1,400, possibly due to hunting or poaching. In contrast, gemsbok and springbok increased during that dry season. But, as Table 1 shows, springbok were absent from the reserve during the wet seasons of 1989 and 1990, only to reappear in large numbers during the dry season. The springbok can both graze and browse, but tends to favor the latter. It is possible that the springbok lag behind in adjacent areas to utilize the herbs outside the reserve, moving in after the zebra and wildebeest have gone to the river. Then the springbok graze herbs that were hidden by the grass until it was grazed by the zebra and wildebeest. This also shows the possibility that facilitation, as explained by Maddock (1984), might be taking place between the three species, which are separated by the difference in their food requirements. In addition, by moving to the pans, which provide seasonal grazing, they avoid competition with other ungulates for a large part of the year. Maddock further states that the main factor determining both the animal movements and variation in them is rainfall, through its effect on food supply.

CONCLUSION

Makgadikgadi Pans Game Reserve offers suitable habitat to the ungulate species usually found there. These species use the reserve's habitats in varying degrees, with zebra and wildebeest the most widely distributed and most often encountered. Springbok and gemsbok are more localized in herds. The effect of the 1981-1987 drought varied among the species, and there were wide differences in the seasonality of use of the reserve.

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Estado Actual y Perspectivas de la Investigación Científica en las Areas del Sistema de Parques Nacionales de Colombia

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ABSTRACT

Colombia has 42 protected areas which comprise national parks, fauna and flora sanctuaries, and natural reserves. The National Park Division has seven main programs, three of which are devoted to activities concerning scientific research: "University in Parks," "Education in Parks," and "Voluntary Service." These three programs have increased the quality and quantity of research projects including the participation of national and international universities and research centers. Research projects undertaken in these areas have to follow the established procedures by the National Park Division, including the monitoring, the control and the coordination of the different techniques and methods used.

Among the main topics of research undertaken in these protected areas are the following: inventories, ecology, geology, ethnobiology, and oceanography, and some concerning social aspects such as ethnography, ethnology, sociology, human geography, etc. The National Park Division has a research plan which establishes some priorities, such as the elaboration of a global diagnostic of the protected areas, master plans for each area, ecological studies, and studies concerning social problems.

INTRODUCCION

En Colombia la institución encargada del manejo, administración y en general de la elaboración de las políticas de las áreas naturales protegidas es el Instituto Nacional de los Recursos Naturales Renovables y del Ambiente (INDERENA), que a lo largo de los últimos 22 años ha logrado consolidar un Sistema de Parques Nacionales conformado por 42 Unidades de Conservación en cinco categorias diferentes: Treinta y tres (33) Parques Nacionales, seis (6) Santuarios de Fauna y Flora, dos (2) Reservas Naturales y una (1) Area Natural Unica que abarcan una extensión aproximada de 9,015,000 hectares, o sea cerca del 8.5% del territorio nacional.

A lo largo de este periodo se han elaborado, desarrollado y concluido numerósos proyectos de investigación dentro de estas Unidades, bajo los criterios y objetivos permisibles según la legislación ambiental existente (Código Nacional de los Recursos Naturales Renovables, Decreto Ley 2811 de 1974 y su Decreto reglamentario 622 de 1977 en materia de Areas Protegidas).

En un principio, toda esta investigación estuvo enfocada hacia la obtención de información básica sobre los valores naturales y culturales representados en estas áreas (inventarios), lo que permitió la adquisición y el acopio de un gran volumen de información.

A partir de 1986, se procuró dar una nueva orientación a los mecanismos y procedimientos para la obtención de un mayor rendimiento en los programas de investigación incorporando el proceso "Investigación — Participación" y conformando una serie de programas interrelacionados que son los siguientes: Universidad en los Parques, Educación en los Parques y Servicio de Guardaparques Voluntarios, lo cual permitió un incremento significativo en el monto investigativo e informativo sobre las Areas Protegidas (Castaño, 1989).

ASPECTOS DE LA ADMINISTRACION DEL SISTEMA DE PARQUES NACIONALES

El programa de investigación para el Sistema de Parques se ha venido realizando a través de:

- ✦ Investigación intrainstitucional (INDERENA);
- ✦ Investigación interinstitucional (otras instituciones del Estado e INDERENA);
- ✦ Investigación universitaria;
- ✦ Investigación Fundaciones y Organismos No Gubernamentales

Este Programa presenta unos mecanismos para el monitoreo, control y gestión concordantes con los siguientes objetivos estipulados por Ley (Decreto 622 de 1977):

a) Reglamentar en forma técnica el manejo y uso de las áreas del Sistema.
b) Investigar los valores de los recursos naturales renovables del país, dentro de las áreas reservadas, para obtener su mayor conocimiento y promover el desarrollo de nuevas y mejores técnicas de conservación y manejo de tales recursos, dentro y fuera de las áreas del Sistema.

c) Proveer de puntos de referencia ambiental para investigaciones, estudios y educación ambiental.
d) Establecer y proteger áreas para estudios, reconocimientos e investigaciones biológicas, geológicas, históricas o culturales.

Con respecto a la administración del Sistema, contemplada en el mismo Decreto se establecen como funciones del INDERENA las siguientes:

a) Regular, autorizar y controlar el uso de implementos, métodos y periodicidad para la realización de investigaciones;
b) Aprobar, supervisar y coordinar los programas que adelanten otras instituciones y organismos nacionales en lo relacionado con el Sistema de Parques.

MANEJO DE LA INVESTIGACION Y CONSIDERACIONES LEGALES

Dentro del Articulo 28 del mismo Decreto, se establece que quien obtenga autorización para hacer estudios o investigaciones en las áreas del Sistema de Parques Nacionales deberá:

a) Presentar al INDERENA un informe detallado de las actividades desarrolladas y de los resultados obtenidos.
b) Enviar copias de las publicaciones que se hagan con base en tales estudios e investigaciones.
c) Entregar al INDERENA dupicados o por lo menos un ejemplar de cada una de las especies, subespecies y objetos o muestras obtenidas.

Por otra parte, existe una reglamentación específica para la realización de proyectos de investigación por parte de organismos, entidades y/o personas naturales o jurídicas que corresponde al Acuerdo No 033 de 1978, donde se establece, entre otros, los siguientes puntos: como presentar la solicitud al INDERENA, los aspectos que debe incluir (objetivos, justificación, metodología, tecnicas, cronograma, financiación, etc.), las normas que se deben cumplir para la entrega de los resultados y de los ejemplares de las colecciones.

MECANISMOS DE CONTROL PARA LA REALIZACION DE INVESTIGACIONES

Como se ha mencionado, cualquier investigación que se realice en un área del Sistema de Parques Nacionales, debe contar con una autorización por parte del INDERENA, de manera que cada investigación tiene un expediente particular que consta de una Ficha de Datos para proyectos, en la cual los usuarios diligencian todos los datos sintetizados de éste, de los investigadores que lo realizan, del plantel o entidad que lo respalda, el tipo de ayuda que solicitan, el tipo de financiación con la que cuentan, los nombres y el lugar de trabajo del director científico y/o adadémico del proyecto y del asesor técnico que debe ser un funcionario del INDERENA, quien se constituye en el interventor de la investigación.

En esta misma ficha se relacionan las salidas al campo, los inventarios entregados a cada uno de los Jefes de los Parques respectivos y los informes entregados.

Conjuntamente con la Ficha de Datos, el expendiente contiene una copia del proyecto de investigación, requisito indispensable para cualquier solicitud, la aprobación por parte del INDERENA, del centro académico o del organismo solicitante.

Debido a que cada proyecto debe contar con un cronograma definido de salidas de campo, la División de Parques puede realizar el monitoreo respectivo sobre los avances del proyecto, sus fechas de finalización y entrega de los resultados.

Con respecto a las investigaciones interinstitucionales o las realizadas por Organismos No Gubernamentales los trámites son los mismos pero estas se realizan, en la mayoría de los casos, a través de Convenios o Contratos que garantizan el cumplimiento de los objetivos.

Las obligaciones de los investigadores para desarrollar los proyectos en un área del Sistema son:

- Presentar un proyecto debidamente aprobado por la entidad universitaria;
- Especificar en el proyecto, un estimativo del tiempo en que se permanecerá en la Unidad, número de investigadores o auxiliares, tipo de financiación;
- Entregar Hoja de vida;
- Contar con un asesor del INDERENA;
- Entregar informes periódicos de avance y el informe final;
- Entregar al INDERENA las colecciones (ejemplares únicos o copia de duplicados).

CARACTERISTICAS GENERALES DE LOS PROGRAMAS DE INVESTIGACION EN EL SISTEMA DE PARQUES NACIONALES

La División de Parques Nacionales a través del Programa Universidad en Los Parques, ha convocado a los estamentos académicos y científicos del país a participar en este programa cuyo objetivo principal es el de promover una acción conjunta de investigación en las Areas Naturales Protegidas, de manera que se logre una mayor participación para la conservación de las mismas.

Este programa además, pretende promover la investigación universitaria tanto de profesores como de estudiantes de tesis, en todos aquellos aspectos relacionados con los valores de los recursos naturales y culturales, con el objeto de obtener un mejor conocimiento y promover el desarrollo de nuevas y mejores técnicas de planificación y manejo de las áreas.

Por otro lado, la División de Parques ha contado con importantes proyectos de investigación realizados por funcionarios adscritos a cada una de las Unidades, en especial por personal profesional, sin embargo, este personal resulta insuficiente para atender los múltiples frentes y aspectos de las Unidades, ya que deben dedicar gran parte de su tiempo a labores administrativas.

A través de Programa Guardaparques Voluntarios se ha logrado fortalecer la gestión en varios aspectos, ya que los objetivos de este programa son los de establecer un grupo voluntario para el trabajo en las Areas Protegidas, que complemente al personal existente y que a su vez logre comprometer la participación ciudadana en la conservación de estas áreas, este personal viene trabajando básicamente en dos frentes: el apoyo de la investigación científica y la atención a visitantes.

Con respecto a la investigación realizada por otras instituciones del estado o a través de Organizaciones No Gubernamentales, estas últimas han venido influyendo de una manera significativa en la realización de investigaciones las cuales, en la mayoría de los casos, se han realizado bajo la modalidad de Convenios interadministrativos, contratos, prestaciones de servicio o formación de Fondos Especiales de acuerdo a los intereses del INDERENA y de las otras entidades.

Aunque hasta el momento ha existido una amplia participación de casi todas las disciplinas posibles del campo científico (investigación básica y aplicada), se documenta un mayor número de trabajos en el campo de las ciencias naturales, seguido por las ciencias humanas y sociales (Figura No. 1).

Los grandes temas que se han establecido son los inventarios faunísticos y florísticos, biología y

TEMA INVESTIGACIONES	Plan Guia Manejo	Plan Manejo	Inventario Fauna	Inventario Flora	Biología y Ecología	Biología Marina	Oceanografía	Palinología	Glaciología	Geología-Geomorfología	Edafología	Climatología	Etnobiología	Antropología	Arqueología	Salud	Turismo	Educación Ambiental	Comunicación	Socio-Económico	Ambiental	Ingeniería	Arquitectura	Planificación	Geografía-Fisiografía	TOTAL
TOTAL	6	6	72	73	82	23	3	6	4	9	9	24	16	12	10	5	34	14	16	18	18	19	12	16	5	508
Generalidades																	4	1	4		1			3		13
Macarena			4	1						1		1								3	2			1		13
Tama	1			2																				1		4
Nevados		1	2	5	8				1		2	3					4		1	2	4					33
Purace		1	2	1	3												3	1	4	1	1	3	2			22
Katios	1		2	2	3												1									9
Sanquianga	1		1	1	4															2						9
Iguaque			5	6	3									1			2	1	2	2			1	3		26
Chingaza			6	4	9			1		2	1	2						1		1	1	1	1			30
Gorgona			9	7	16	4	1	1		3	1	3			2	2	6	2			1	6	4			68
Cahuinari			6	2	2								7	2												15
Orquideas			2	2	2												1									7
Corales		1	5	7	7	13	1				1	1					3	1		1	1			1		43
Salamanca			1	2	3	1					1	1								2	2	4				18
Utria	1		4	10	2	2						2	2				1	2						2	1	13
Tuparro	1		4	2	2							1			1											12
Cocuy		1			1				1	1		1		1			2	2					2	1		13
Corota				1	2				1								1		1	1					1	8
Cienagagrande			1	1	2																2					6
Sierranevada		1	2	5	4			2	1			2	4	4	4	2	2	1	1			3		1	3	42
Tayrona		1	3	2	6	3	1			1		1			3		4	2	2	1		2	2	2		35
Paramillo			2	1						1	3	2							1		1					12
Nevadohuila			3	1	2			1				1														8
Munchique			2	4								1								1	1					9
Macuira			1	1								1									1					4
Amacayacu	1		5	3	1			1				1	3	4		1				1				1		21

ecología, biología marina, oceanografía, palinología, glaciología, geología y geomorfología, edafología, climatología, metereología, planificación, etnobiología (botánica y zoología), antropología, arqueología, etnohistoria, ecoturismo, arquitectura, educación, recreación y por último, geografía y fisiografía.

Desde 1987, se han venido estableciendo contratos sucesivos para realizar los Planes Guias y Planes de Manejo de un alto porcentaje de las unidades del Sistema.

PROBLEMATICA PRESENTE EN MATERIA DE INVESTIGACIONES EN LAS AREAS DEL SISTEMA

A pesar de la normatividad expresada anteriormente que podría permitir a la División de Parques Nacionales llever un inventario completo de los proyectos de investigación que se realizan, en muchos casos, en las Unidades de Conservación se llevan a cabo estudios sin que se pida la autorización respectiva, por lo que se pierde la documentación de los resultados y del material biológico, debido entre otros a estos factores:

- Desconocimiento por parte de los investigadores de que un área determinada pertenece al Sistema;
- Desconocimiento de las normas legales;
- Falta de personal que garantice la presencia del INDERENA en todos los frentes de penetración a un área;
- Falta de presencia institucional en algunas de las áreas.

Por otro lado, las normativas existentes para la realización de investigaciones (Acuerdo 033 de 1978) se sircunscribe unicamente a los aspectos de flora y fauna silvestre, terrestre y acuática para el contexto nacional. Aunque estas directrices legales viene siendo aplicadas, los otros aspectos del patrimonio presentes en las áreas (clima, geología, arqueología, turismo, cultura, etc.), no se encuentran contemplados, lo cual dificulta enormemente los procedimientos de análisis, seguimiento y control de ese tipo de investigaciones.

Otros de los problemas que se han presentado, que concluyen principalmente en la pérdida permanente de material genético e información, al no cumplirse con los requisitos exigidos es la carencia de una planificación, que de los lineamientos para la investigación lo que ha permitido en muchos casos, que los temas tratados no son prioritarios, la duplicidad de trabajos y la discontinuidad de las investigaciones, entre otros.

A partir de 1988, se ha observado un descenso en el monto investigativo e informativo, identificándose como las causas del mismo que la División de Parques ha realizando un mayor esfuerzo para controlar el cumplimiento de las normas establecidas para la realización de las investigaciones, de manera que muchos centros académicos o investigadores particulares no estan conformes en las restricciones y documentación que allí se exigen.

Por otro lado se ha procurado encaminar los temas a investigar en las prioridades que se han identificado para cada una de las áreas, de manera que las investigaciones respondan realmente a resolver problemas o vacios de información existente.

Uno de los grandes cuellos de botella para la gestión en las áreas del Sistema, ha sido los escasos recursos financieros con los que ha contado, que no permiten brindar, de una manera más adecuada, la financiación de proyectos de investigación. Dentro de este mismo aspecto, el país no cuenta con una conciencia acerca de la importancia de la investigación, por lo que no se facilita el acceso a recursos para el fomento de la investigación, no solo a nivel de Areas Naturales Protegidas, sino en general para otro tipo de necesidades de investigación a nivel nacional.

PERSPECTIVAS DE LA INVESTIGACION CIENTIFICA EN LAS AREAS DEL SISTEMA DE PARQUES NACIONALES

Se ha considerado que la investigación científica es, sin lugar a dudas, una de las actividades fundamentales que deben realizarse en una Unidad de Conservación, como mecanismo, no solo para disponer de bases seguras para proyectar acciones sobre el medio y obtener los patrones de manejo que deben implementarse, sino para identificar la problemática de las comunidades que pueblan las zonas periféricas a éstas y que a través de la acción de extensión comunitaria que el INDERENA y otras entidades adelanten, se puede lograr el desarrollo de programas de uso sostenible de los recursos naturales para garantizar una mayor protección y conservación de las áreas reservadas.

La División de Parques Nacionales ha identificado las prioridades de investigación en cada una de las áreas del Sistema a través de los Jefes de las mismas, en un Seminario-Taller realizado en el Parque Nacional Natural Tayrona denominado "Procedimientos, metodología y establecimiento de un estatuto para la investigación cient ífica en las áreas del Sistema de Parques Nacionales," donde se planteó un Plan de Investigaciones para el Sistema dentro de los siguientes puntos a desarrollar:

1. Como realización a corto plazo y base para el desarrollo de las investigaciones en las áreas del Sistema se hace necesario la recopilación de la información existente, de tal forma que permita establecer un diagnóstico global del Sistema de Parques Nacionales y llevarlo a un banco de información debidamente sistematizado.

Este primer punto podría esquematizarse así:

BANCO DE INFORMACION

- **CENTROS DE DOCUMENTACION**
- **Recuperación (Copilación)**
    - **existente publicada** — **Visual**, **Audio**, **Automatizada**
    - **Inédita**
- **Ordenamiento (Unificación)**
- **Uso y Manejo**
- **Difusión**

2. Otro aspecto a corto plazo es la elaboración de los Planes de Manejo e través de la investigación de los recursos naturales incluidos en cada una de las áreas obteniendo por ende, un mejor conocimiento de los atributos y características y promoviendo el desarrollo de nuevas y mejores técnicas de conservación y manejo, siendo la clave de operación efectiva de toda área protegida, ya que en él se establecen los objetivos a corto, mediano y largo plazo, la zonificación del área y la formulación de las directrices y propuestas técnicas y económicas.

Posteriormente a este Plan de Manejo, se desarrollaria la elaboración del Plan Operativo en el cual se implementarian todas aquellas acciones y politicas de manejo ya establecidas.

Los siguientes tres puntos se consideran de igual importancia y deben desarrollarse paralelamente.

3. Con respecto a los inventarios, estos deben orientarse de manera tal que sean en realidad estudios ecológicos de especies, con los cuales se permita no solo hacer inventarios faunísticos y florísticos como tales, sino que se involucren todos aquellos aspectos abióticos y bióticos que rodean a estas especies.

Como prioridades en este sentido se tienen:

- ✦ Especies amenazadas o en peligro de extinción
- ✦ Especies bioindicadoras
- ✦ Especies endémicas
- ✦ Especies promisorias

4. Dada la presencia de poblaciones humanas dentro y fuera de los Parques, ya sean comunidades indígenas, negras, campesinos, que continuamente estan interactuado con las Unidades de Conservación, se hace necesario realizar un diagnóstico, en el aspecto social, de cada una de las áreas que permita determinar los lineamientos para el trabajo con las comunidades que viven dentro y fuera de las Unidades de Conservación, este diagnóstico tendría entre otros los siguientes puntos: Censo de población, Organización social y política, Demanda de recursos en general, Historia local y Procesos de aculturación.

5. El aspecto de manejo de recursos de gran importancia para garantizar la conservación del patrimonio natural, paisajístico y cultural presente en las áreas del Sistema tiene varias actividades para desarrollar:

- ✦ Elaboración de un Plan de Contingencia para la prevención, atención, control y recuperación ante desastres.
- ✦ Ya que en la actualidad muchas de las Unidades del Sistema muestran serios problemas de disturbio ambiental, causados ya bien sea por acción antrópica o por fenómenos naturales, que requieren de una atención para disminuir o recuperar los ecosistemas, biomas o comunidades específicas de fauna, flora, gea o etnia, se considera importante desarrollar una serie de investigaciones tendientes a lograr una recuperación de las mismas (Regeneración natural, recuperación de condiciones, reforestación, revegetalización, etc.).
- ✦ Investigaciones tendientes a la implementación de actividades de extensión y fomento como la zoocría, viveros, acuicultura, maricultura, reforestación, huertas caseras.
- ✦ La determinación de tecnologías apropiadas y alternativas de uso sostenible de recursos por medio de modelos tecnológicos que permitan el uso adecuado de la oferta ambiental que

ofrecen las áreas protegidas.

- Investigaciones requeridas para determinar y lograr un Ordenamiento (pesquero, territorial y/o agronómico) en aquellas áreas que por sus características así lo requieran.
- Biotecnología y Control Biológico.
- Dentro de el aspecto de manejo de recursos, cabría lo referente al Ecoturismo, enfocado a la determinación de la infraestructura existente en las zonas circunvecinas a las Unidades de Conservación que puedan ser aprovechadas por el turismo. Así mismo, la elaboración de diagnósticos sobre los atractivos turísticos en las áreas protegidas y sus zonas amortiguadoras para definir las estrategias de un adecuado desarrollo de la actividad turística.

Large Marine Ecosystems and Marine Protected Areas:
Information for Managing the Great Barrier Reef Marine Park

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INTRODUCTION

For centuries, science and its role in society has been a topic of considerable debate. In recent years, the debate has spread to the environment, and in particular to management of protected areas, because of increasing public concern about degradation of the natural environment, loss of recreational opportunities, and the viability of the world's life-support system. The report *Our Common Future* (World Commission on Environment and Development 1987) has helped to stimulate and focus attention.

In Australia, the Great Barrier Reef has attracted special attention in this debate. It is an area of high conservation value, both nationally and internationally, and it supports important commercial industries. The scientific community has been and continues to be a major user of the reef and promoter of its conservation. The Great Barrier Reef Marine Park Authority (GBRMPA) is a small federal government agency based in tropical north Queensland. This paper describes how GBRMPA acquires and uses information and science to address the problems of managing the Great Barrier Reef Marine Park.

BACKGROUND

The marine park, at nearly 350,000 sq km, is the largest marine protected area in the world. It represents about 5% of Australia's 200-mile fishing zone. It is bigger in area than the United Kingdom and similar in length to the west coast of the United States. The biological diversity and ecological complexity of this tropical marine region is possibly the greatest of any natural system in the world. This area is of cultural and economic importance to Australians and supports diverse activities related to tourism and fishing. The public is very sensitive to activities that may negatively affect the reef–they often generate significant media attention (Mellor 1990). In 1982, the Great Barrier Reef region was listed for protection under the World Heritage Convention.

The Great Barrier Reef Marine Park Act establishes a management authority and specifies its functions; these include making recommendations for the declaration of areas as marine park, zoning, education, and research (Kelleher 1986; Woodley 1985). The marine park is not a national park. It is a multiple-use protected area, fitting the definition of Category VIII in the IUCN classification system and meeting the criteria for selection and management as a biosphere reserve (Category IX). The management objective is conservation, with provision for reasonable use, enjoyment, research, and preservation. By balancing conservation and use, GBRMPA makes decisions about the allocation of scarce environmental resources. Some of these decisions are irreversible (e.g., the construction of a large marina); most affect the distribution of social and economic benefits among different users or concerned groups (e.g., access to fish resources or commercial dive sites). The conservation and economic stakes are high and therefore there is pressure from the community, users, and governments on GBRMPA to be equitable and base its decisions on sound information.

The marine park act is arguably the most powerful environmental legislation in Australia, having statutory powers that can prevail over most other legislation (including fisheries) in the event of conflict. There is also shared management with the Queensland state government, which has jurisdiction over most land within and adjacent to the marine park. Since 1976, when GBRMPA was established, the entire park has been zoned and management plans have been implemented.

GBRMPA RESEARCH AND MONITORING PROGRAM

Information and the role of science

GBRMPA has four statutory functions under the law: planning and management, environmental impact assessment, education, and research and monitoring. The marine park act provides a mandate for GBRMPA "to carry out, by itself or in co-operation with other institutions and persons, and to arrange for any other institutions or persons to carry out, research and investigations relevant to the Marine Park." This is broad and does not provide explicit direction on the outcome (information) or how it is to be acquired. As a consequence, the existing research and monitoring program is a result of administrative policy derived from interpretation of the marine park act.

The research and monitoring program exists to meet the needs of GBRMPA and has an aim of "obtaining and interpreting information relevant to the Great Barrier Reef and to the implementation of GBRMPA programs" (GBRMPA 1990). It is not an end in itself, but a means to an end. Information is interpreted in the broadest sense and is analogous with Haas' (1980) definition of knowledge as being "the sum of technical information and theories about that information which commands sufficient consensus at a given time among interested actors to serve as a guide to public policy."

Science is expected to assist the research and monitoring program to meet its aim in two ways. First, it is one way of acquiring information. The scientific method is considered to be systematic and objective because it involves the posing and testing of hypotheses and the reporting of results in a manner that allows criticism and confirmation. Second, science can produce technological solutions to problems. For example, engineering methods and new materials can reduce the impacts of dredging and construction of buildings and other facilities, and underwater fences and poison injection guns assist with control of crown-of-thorns starfish. Also, advances in computer technology, such as satellite mapping and GIS, improve the ability of environmental management agencies to manage information.

However, science is not the only source of information. Another source in the marine park is the two-stage public participation process involved in zoning plan development and review. Considerable information, often anecdotal or deriving from observations made by persons untrained in science, is obtained. This has been described as an "impressionistic or commonsense approach" (Underdahl 1989). Often this is the only source of information. It is also used to check or supplement information from a scientific source.

There are at least four factors limiting how much science can contribute to policy development and decision-making. First, the results of scientific reef-related research are often not comprehensive or conclusive for reef managers. This is not surprising. Marine sciences are new, many are not exact (i.e., not all variables can be controlled and precise cause-and-effect relationships predicted; see Andresen 1989), information as basic as species inventories are incomplete, and there is a great deal of uncertainty because of the natural variability, complexity, and size of the Great Barrier Reef ecosystem.

Second, reef scientists often also provide results that are highly qualified. While this approach is laudable for ensuring scientific rigor and integrity, it is not always compatible with a demand for quick and simple management solutions. The ownership of intellectual property—research results—is a contentious issue. Some scientists believe that they should be able to publish before releasing data to GBRMPA, which leads to delays in decisions. Current contracts are written to ensure that absolute ownership resides with GBRMPA. A flexible approach that meets the needs of both groups is being developed, however.

Third, consensus among scientists is not always possible and often there is heated dispute within or between disciplines about the design and conduct of projects and interpretation of results. This may not be surprising and some scientists may say it should be expected because the scientific method involves critical assessment and reinterpretation of data, but the reef manager must try and find a solution to this conflict. Reef managers have had to develop and apply conflict resolution skills when dealing with scientists, in the same way as dealing with groups of conservationists and developers.

Fourth, decisions of reef managers are made within a legal and administrative framework, often involving public participation and with statutory time limits. Research information represents only part of the information base, and scientists unfamiliar with this process have expressed frustration and concern with the manner in which research results are used—or not used.

Research and monitoring program administration Research and monitoring is a distinct program with specific funding that is intended to make explicit the role of research and science with respect to marine park management programs and issues, provide for proper management of research projects, and make visible research priorities and budgets (see Figure 1).

The current annual research and monitoring budget is about AUS$1.8 million, or 13% of the total GBRMPA budget. Up to 100 projects may be funded each year. A project management approach is used and most research is contracted out. This is the delivery of a service—usually information to answer a question—with agreed-upon methodology, time, and price. GBRMPA aims to use the best available expertise, regardless of source; this includes universities, other government agencies, and individuals. Choice depends on expertise, past performance, and cost (see Table 1).

It has been found that a policy of using the best available scientific expertise on a contract basis avoids the need to employ specialists for each relevant discipline and to purchase specialist equipment—an expensive and inflexible strategy for a small agency with interests in marine research. Research institutions have a mandate and the resources to undertake high-quality research. GBRMPA could not hope to attract or retain scientists who wished to continue with experimental research. Most research is funded on a shared basis with the contract institution, which increases their commitment to an outcome and recognizes the benefits that they achieve through the research.

Table 1. Distribution of GBRMPA research contracts, 1975-1986

Organization	Percentage of Contracts
Universities	59
Federal agencies	20
Private agencies	11
State agencies	6
Museums	2
Others	1

The total number of contracts awarded was 201, not including 91 student research travel grants.

However, a policy of contracting out research does not guarantee efficiency. Contractors must be managed on a continual basis by people with appropriate skills. Projects are managed by a small team of professionals: eight out of a total GBRMPA staff of 125. Research and monitoring staffers work with policy officers and scientists to assist in defining the questions for research, monitoring progress, and assisting in formulating results so that they can be understood and used. Research and monitoring staff are not expected to be expert in all disciplines. Rather, they are expected to become expert in project management. They must understand the scientific method, maintain a network of experts, and be able to communicate in a range of disciplines. They must also understand the policy development and implementation role of government.

Identifying suitable scientific expertise for a project is done either by staff actively seeking out an expert individual, advertising to seek expressions of interest, or following through with unsolicited research proposals. The marine research community in Australia is not large and experts become known to reef managers. Where possible, research is coordinated with other organizations with expertise, interest, or overlapping responsibilities. Interagency agreements are one mechanism used to facilitate coordination.

Expert peer review is used at the project's development stage and at the final report stage. Expert advisory committees (Figure 1) have also been created to provide additional independent advice on large interdisciplinary projects of priority (e.g., crown-of-thorns starfish, water quality, and effects of fishing). The use of advisory committees and peer assessment are critical elements. While GBRMPA cannot and does not abrogate its responsibility for decision-making, it can share the responsibility for determining what is good research and show that it consults widely in the scientific community.

GBRMPA also attempts to influence and encourage other institutions to undertake reef research of interest and relevance to management. This includes sponsoring workshops, maintaining the Australian Marine Research in Progress database, providing advice to the Australian Research Council (the main granting body for Australian marine research), assisting university students with research travel grants, and providing research fellowships.

Research priorities The program is multidisciplinary in nature, reflecting GBRMPA's management needs. It includes the natural, physical, and socioeconomic sciences (GBRMPA 1990):

- marine biology
- marine geoscience
- oceanography
- monitoring marine chemistry
- information systems
- management strategies
- analysis of use
- bathymetry and survey

During the initial planning stages, the emphasis of research was to describe the living and non-living resources, analyze use, and ensure the proper analysis and dissemination of information. The emphasis has since shifted. Zoning plans are operating and a boom in tourism, recreation, and fishing has increased pressure on planning and management to a level not anticipated (Kelleher 1990; Ottesen 1990) and there are changes occurring in the ecosystem that cannot be easily explained. The community now expects that a more detailed assessment of activities be done before decisions are made, that research information be widely disseminated, and that the results of decisions be monitored. Activities that require

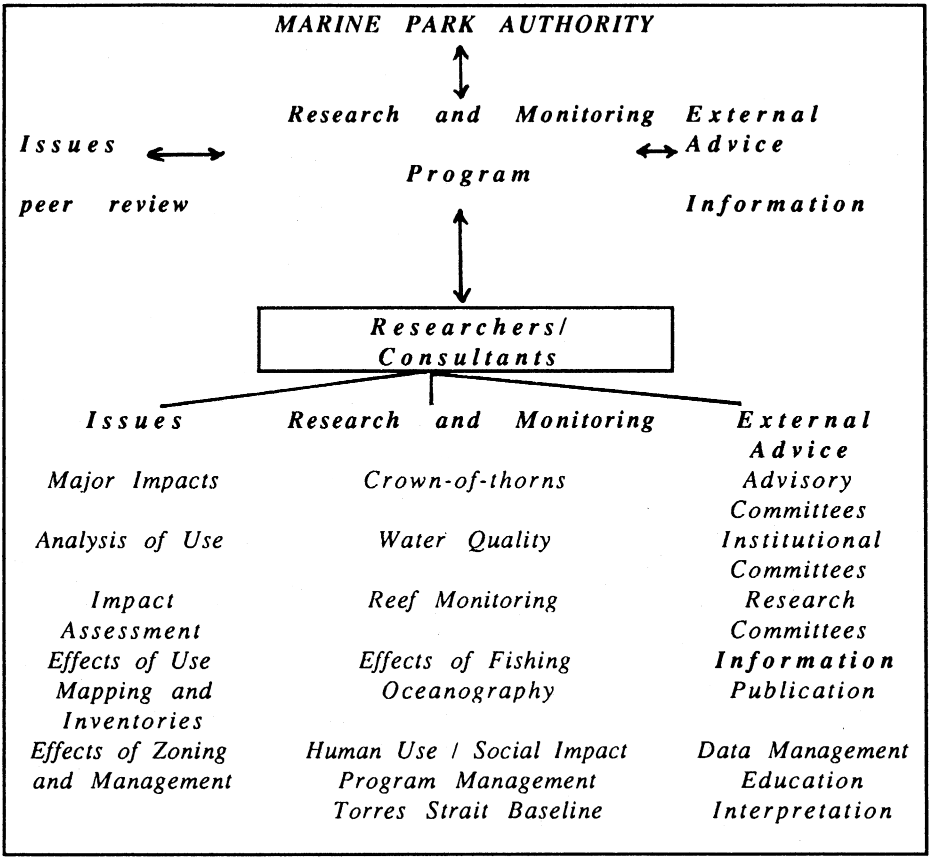

Figure 1. Operation of GBRMPA research and monitoring program

permission to be carried out in the marine park are now often subject to detailed multidisciplinary environmental impact assessments and monitoring programs. The proponents pay for these studies and in some cases research and monitoring staff act as project managers on behalf of the proponent to ensure proper design, execution, and objectivity, and to control ownership of data. There is greater focus on bigger issues, which requires an interdisciplinary research approach. The balance between long- and short-term research has become more critical. The issues now arising require research and monitoring that will increase understanding of the biological and ecological processes, increase understanding of the effects of resource use, measure the effects of resource use in comparison with predictions, and provide for the detection and measurement of natural variability.

As a consequence, research is now managed according to the following nine priority program areas. (1) The *impact of crown-of-thorns starfish* on the Great Barrier Reef has been a major issue for 25 years. (2) *Fishing* has been a major use of the reef, and with increasing recreational fishing pressure there is a need for information on its effects. (3) *Monitoring* can produce long-term data sets, which are essential to understanding natural variability and against which human-induced changes can be detected and measured. (4) There are *water quality issues,* such as the nutrient enrichment of coastal waters from agricultural sources which has the potential to cause severe degradation of corals. (5) *Human use* is increasing, as are conflicts among users, so that zoning plan controls are becoming more sensitive. (6) Understanding *oceanographic dynamics* is basic to understanding and predicting impacts of use. (7) The *risks of damage from oil spills* go up with increased shipping and the prospects of exploration in the Coral Sea. (8) GBRMPA also administers a *baseline study of Torres Strait,* an area outside the marine park but which is of concern because of mining pollution. (9) A final program aims to ensure *effective research program management.* The priority areas are further detailed in Table 2.

The programs involve aspects of short- and long-term research, both basic and applied; they may be reef-wide or confined to a specific site. This program management approach helps managers, scientists, and the public focus on the major issues. The nine programs were identified internally by staff or as a result of advice from and consultation with user groups (including scientists) and government.

The Scientific Community and its Relationship with GBRMPA

There has developed a strong commensal relationship between GBRMPA and the Australian marine research community, similar in nature to the relationships that Mukerji (1989) has described as existing between science and policy in the United States of America.

The Australian scientific community played a key role in establishing the marine park. It continues to monitor closely the performance of GBRMPA and is quick to express criticism to maximize public and political attention. It has also earned considerable benefits. Areas favored for research have been protected, and the scientific community has received additional funds from governments and commercial operators who are required to provide information about the potential impacts of their activities because of the authority's administrative and legislative requirements.

The scientific community is a reef user that has been given the opportunity to influence the direction of research and assist in interpreting results, which in turn can influence policy decisions. The advisory committees and interagency agreements on cooperation are typical mechanisms (e.g., funding of a marine modelling unit at James Cook University (JCU) of North Queensland and the development of a tripartite agreement involving GBRMPA, JCU, and the Australian Institute of Marine Science. This influence may be positive because scientists in general are benign users and they have special expertise; however, they must be careful to not be seen as exerting too much influence or achieving an advantage at the cost of other users. Otherwise, their image of independence and objectivity can suffer (Young 1989).

Universities in particular have benefitted from GBRMPA funding through support for teaching and research programs. Research on the development of quantitative monitoring techniques at JCU has immediate management implications. This interest in the reef is also leading to new teaching and research studies, e.g., the JCU School of Tourism Studies.

The marine science community, based in Townsville, Queensland, and involving the Australian Institute of Marine Science and JCU, has now established a reputation for tropical marine research and management expertise. Part of this success is due to the research support

Table 2. GBRMPA priorities for research and monitoring, 1990-1991

Crown-of-thorns starfish

- ✦ Extent, progress, and impacts of outbreaks of starfish; monitoring of coral recovery
- ✦ Abundance of starfish in Cairns Section
- ✦ Capability of predicting benthic community structure dynamics following starfish outbreaks
- ✦ Trophodynamic implications of starfish for selected reef processes
- ✦ Starfish behavior, age structure, and reproductive biology
- ✦ Effects of hydrodynamic processes and anthropogenic inputs on starfish, larval dispersal, and outbreaks
- ✦ Role of predation in life history of starfish and outbreaks
- ✦ Past geological history of starfish outbreaks
- ✦ Publicizing of results of starfish research

Effects of fishing

- ✦ Effects of line fishing on reefs, of trawl fishing in inter-reef areas, and of both together on abundance of particular species, such as coral trout, that are directly affected
- ✦ Effects of line and trawl fishing on species affected indirectly through ecological processes
- ✦ Recovery of populations of organisms when reefs closed to fishing
- ✦ Effects of inter-reef trawling on timing of recovery

Reef monitoring

- ✦ Effects of zoning provisions and uses during life of zoning plans
- ✦ Abundance and magnitude of variability in population density and distribution of representative organisms
- ✦ Effects of permitted uses on marine park and adjacent areas

Water quality research and monitoring

- ✦ Background levels and natural fluctuations in nutrients
- ✦ Trends in nutrient levels
- ✦ Effects of higher levels of nutrients on coral reef and seagrass communities; determination of whether such effects are detectable
- ✦ Observed changes in nutrient levels and reef degradation caused by human influence and natural change

Human use monitoring and social impact assessment

- ✦ Development of methods
- ✦ Surveys of reef-based recreation (for planning purposes)
- ✦ Guidelines for assessment of social impacts in management planning and environmental impact assessment processes

Oceanography

- ✦ Relationship between source and sink reefs for larval transport (for planning purposes)

Torres Strait Baseline Study

- ✦ Levels and source of heavy metals in sediments, water, and biota
- ✦ Geochemical and trophic pathways of trace metals
- ✦ Impact of higher levels of metals on selected marine organisms

Table 2 (continued)

- Assessment of potential effects of mining on sediment loads and trace metal concentrations
- Baseline for future monitoring of pollutants

Oil spills and exploration
- Bioremediation and seabird cleaning
- Clean-up and containment
- Effects of fuel and dispersal agents on coral
- Effects of exploration in areas adjacent to the reef

Research program management
- Efficient management of projects
- Dissemination of information from projects
- Communication with other GBRMPA program areas and research community

requirements of GBRMPA. This relationship and success has benefitted GBRMPA. A highly skilled scientific community better able to understand and research management issues has evolved.

FUTURE

As research becomes more focused on large complex problems, there is pressure for more funds to be committed over many years. Governments tend to operate on shorter budgetary horizons and are imposing strict financial constraints, so it will be a challenge to secure long-term funding commitments. Governments in Australia are also attempting to make research agencies more accountable for funds and be mission-oriented. There is now a requirement that government agencies obtain 30% of annual funding from sources other than direct government appropriations. Universities are also under pressure to obtain research funds from other sources. These factors are forcing research institutions to compete with private consultants and be responsive to management agencies like GBRMPA.

By maximizing the acquisition of quality information through the use of science, the authority's research and monitoring program and supporting policies has led to better management of the Great Barrier Reef Marine Park. However, the program will need to evolve to meet the increased demand for information by government and the public.

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Research in Tropandean Protected Areas of Ecuadorian Landscapes

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INTRODUCTION

Ecuador is a small country (270,670 sq km) located on both sides of the equator, in the crescent of the Andes in northern South America. It occupies the transition zone between lowland wet and dry tropical and Andean landscapes. Therefore, the whole country can be considered as a naturally heterogeneous ecotone that varies clinally among altitudinal and latitudinal domains (Sarmiento 1992). Ecuadorian landscapes extend from the beaches along the Pacific Ocean to the Chimborazo heights of 6,130 m above sea level, and down again towards the Amazon (see Figure 1).

As one of the "megadiversity" countries, it contains at least three main "hot spots" for biological diversity (Myers 1991); hence, rarity and endemicity indexes are presumed to be very high despite the dearth of inventories and information on the natural history of many species. In places where careful floristic studies have been done, astonishing numbers of species have been

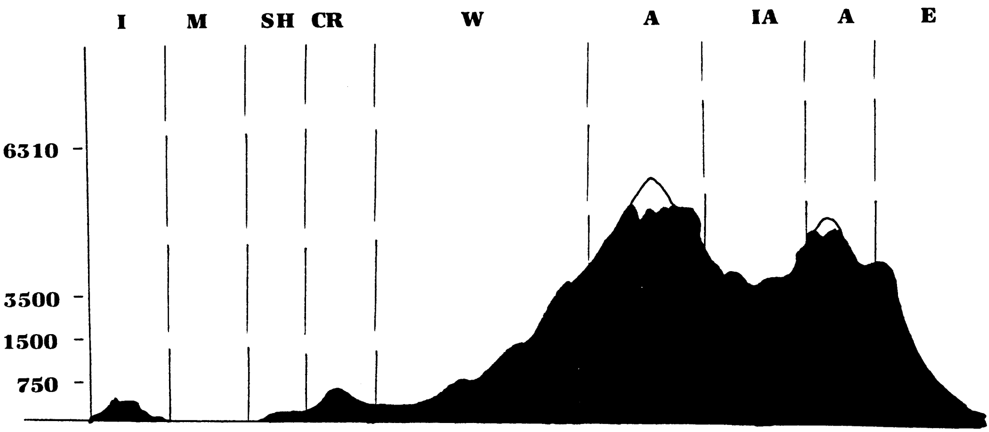

Figure 1. Transect relief of Ecuador

I = Insular; M = Marine; SH = Shore; CR = Coastal Range; W = Western (Costa); A = Andean; IA = Interandean (Sierra); E = Eastern (Oriente)

Altitude references in meters.

reported and show uniqueness in the phytogeography of the region (Balslev 1988). Río Palenque, for instance, was recognized as the world's single most species-rich place (Gentry 1982), even though it is a small patch of forest within a heavily used matrix of agricultural land in the piedmont of western Ecuador.

Two biotic provinces are endemic to the area: the Galapagos Islands, along with their surrounding marine environments, about 1,000 km off the coast, and the tropical dry deciduous forest of southwestern Ecuador, where a curious petrified forest (Puyango) is also located.

Another typical feature of the country is the sequencing of *hoyas*, or interandean valleys (Sarmiento 1986). This is a system of several plateaus at the bottom of intermontane catchment basins between the two main snow-covered mountain ranges that run in parallel, connected by transverse ranges, or *nudos*. This topographic feature has been regarded, since the time of the naturalist and biogeographer Alexander von Humboldt, as the "avenue of volcanoes" (note that northern Colombian valleys are extensive low plains below 2,500 m between the mountain ranges, and southern Peruvian valleys emerge to *meseta*-like extensive high plains *(altiplano)* above 3,500 m).

The western tropical forests of the Chocó Province and the eastern Amazon headwaters within the Napo-Ucayali drainage system share similar characteristics of luxurious diversity (Colinvaux 1989).

In summary, the unique combination of 26 life-zones (*sensu* Holdridge) interconnected by dynamic meteorological and geological processes (Cañadas 1983), supporting landscapes that have been modified by humans since prehistoric times (Sarmiento 1982), makes *heterogeneity* a key component of tropandean ecosystems.

A System for Conserving Natural Areas

Ecuadorian national parks and protected areas represent about 11% of the territory, roughly 3.2 million hectares (see Figure 2). According to MAG [the Ministerio de Agricultura y Ganadería, or Ministry of Agriculture and Livestock], the current conservation system covers almost all representative ecosystems in each of the natural regions (MAG 1991). However, the strategy reviewed by MAG and Fundacíon Natura (1989) proposes an increase in the number of areas—and the establishment of new management categories to ensure the maintenance of the great variety of habitats have given the country such a rich biodiversity (Sarmiento 1987).

The Pululahua Reserve was the first of the officially declared protected areas, after its relevance with the French mission for establishing the latitude of 0 degrees 0 minutes 0 seconds. The colonial government declared the area a "national treasure" that all generations should care for. Later on, the independence movement brought new emphasis on protection and some of Simon Bolivar's environmental proclamations helped save Camelidae in the high *paramos.* Then, at the turn of the century, mangrove swamps and other wetland features disappearing around Guayaquil were given special treatment by the Congress in order to protect white herons and other waterfowl of the coastal swamps. In 1959, the Ecuadorian government declared the Galapagos Islands as its first national park, because of their strategic position.

It was not until the late 1970s that a core system of protected areas (the "Minimum System") was set under the legal administration of the MAG. It continues under the same agency, which administers an array of 15 management categories covering 45 existing and proposed areas for protection.

Current Threats and Outlook

Several reserves are at risk because of the pressure for economic development (Cabarle et al. 1988). The most threatened reserves are those located in areas now considered to be part of the frontier economy, because of the open-access resource structure maintained by the government in all degraded lands, where agriculture was not possible at the beginning of the definition of the conservation system. At that time, land tenure and developmental constraints limited the scope of the protection coverage to a Minimum System, with an ambitious plan to progressively include other areas into an Amplified System for the future (Putney 1976), which was to satisfy conservation needs into the next century.

Ecuadorian agrarian reform encouraged a fragmented redistribution of arable land, where the indigenous people were prevented from using good soils with appropriate drainage and pluvial regime, forcing locals to rely on unexploited forested watersheds nearby (Harden 1991). Clearly, poverty and urgency for short-term profitable exploitation drove deforestation, over-hunting and over-grazing to exacerbate the problem of erosion and land degradation (Southgate and Whittaker 1989). Furthermore, to compensate drought effects felt in the 1970s in the provinces of Manabí and Loja, an extensive colonization effort began in the last remains of continuous forest cover in the newly opened areas of the Oriente, where the oil fever was about to produce smoke, wildfires and spills, as well as promoting colonization of the jungle (Rudel 1983). An eloquent call to protect the western tropical rainforest, which is now undergoing the

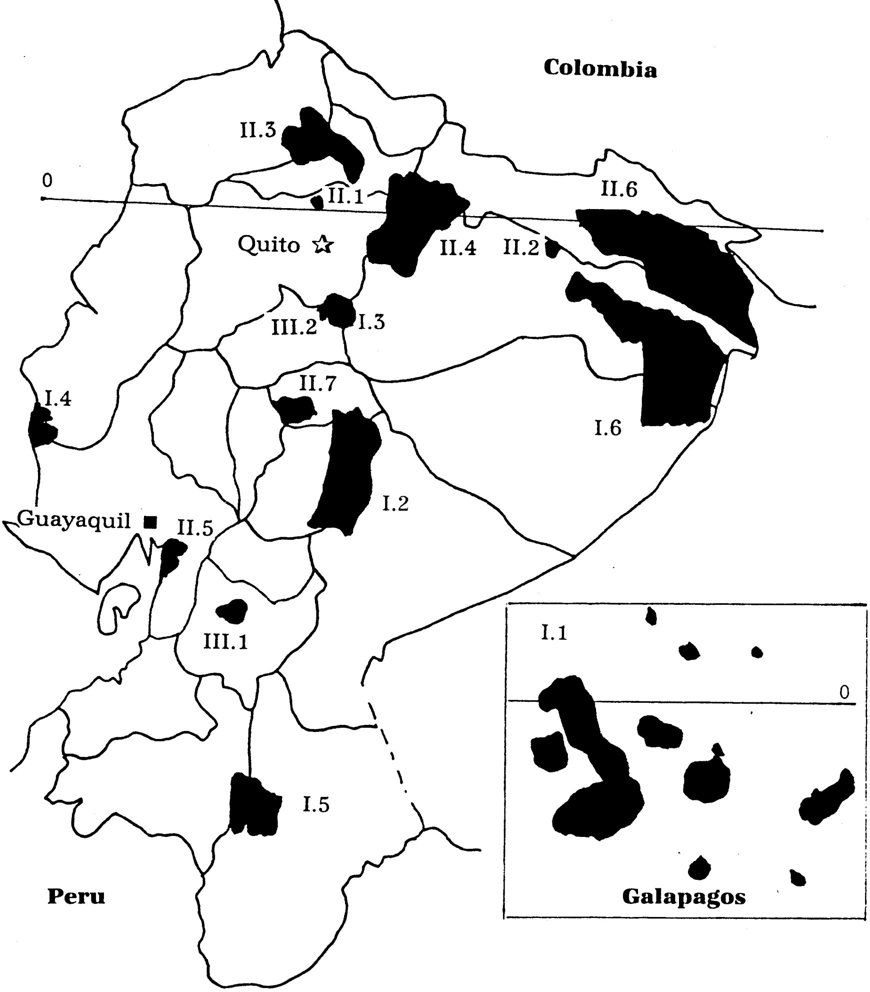

Figure 2. Location of the Ecuadorian Minimum System areas

I. National parks
- I.1: *Galapagos (also biosphere reserve)*
- I.2: *Sangay (also biosphere reserve)*
- I.3: *Cotopaxi*
- I.4: *Machalilla*
- I.5: *Podocarpus*
- I.6: *Yasuni*

II. Reserves
- II.1: *Pululahua Geobotanic*
- II.2: *Limoncocha Biological*
- II.3: *Cotacachi-Cayapas Ecological*
- II.4: *Cayambe-Coca Ecological*
- II.5: *Manglares-Churute Ecological*
- II.6: *Cuyabeno River Faunal Production*
- II.7: *Chimborazo Faunal Production*

III. National recreation areas
- III.1: *Las Cajas*
- III.2: *El Boliche*

same fate, is presented in Lipske (1992).

Lack of public funds for conservation and a lack of interest in the forestry sector for holding on to stocks that eventually could be used for production resulted in a weak presence of the national parks office within the more powerful and politically stronger units at the MAG (Fundación Natura 1988).

THE ROLE OF RESEARCH IN PROTECTED AREAS

After the rediscovery of Humboldt's insights into biogeography and the interest in Neodarwinian postulates to explain evolution, Ecuador has been the focus of studies in both natural history and systematics. As a preferred destination for long-term expeditions, the protected areas of Ecuador were always a magnet for great thinkers and pioneers of modern ecology. Moreover, earth sciences were the only ones dealing with those pristine environments, and the difficulties in logistics and communications were to account for research activities with very poor registered Ecuadorian participation. Few qualified national counterparts were chosen based upon their capacities for science, but rather on their ability to facilitate the collecting and exporting of specimens.

Almost all of the biological richness collected in those expeditions was shipped abroad. Even before Ecuadorian independence, the treasure in specimens collected by Don Pedro Franco Dávila, from Guayaquil, was brought to Madrid. Here, the Royal Museum of Natural History of Spain was created, and he became the empire's naturalist. Since then, unfortunately, most of the paleontological, archeological, botanical, and faunal archives are held by foreign natural history museums, academies, and other research institutions, therefore limiting in-country research and training of local scientists.

The lack of a clear policy regarding research in the country as a whole has made it even more difficult to establish this important activity within the protected areas themselves. However, not all areas have experienced the same pattern. The case of the Galapagos Biosphere Reserve (Sarmiento 1986) is different and has to be analyzed separately.

GALAPAGOS: ANOTHER STORY

The presence of the Charles Darwin Foundation in the development of Galapagos National Park was crucial to building an outstanding tradition of research in this protected area. The role of the Charles Darwin Research Station in the definition of policies and management priorities has been essential for the Ecuador National Park Service. With rather limited access to islanders in the beginning, the research station has now opened a new option in science-oriented careers. It is used by students for training, thesis research, special short courses, workshops, and the like. International support and multiple funding sources have helped maintain different programs (such as introduced animals, introduced plants, marine bird colonies, geological monitoring and fisheries, and publications) and the development of new ones (environmental education, science training, reforestation and community forestry, pest management, and ecotourism), as well as the establishment of a reference library.

Although up to now no Ecuadorian biologist has had the distinction of directing the research station, the participation of local scientists has been growing slowly but steadily. The selection of an Ecuadorian secretary general of the foundation made community-driven expectations more equitable. Also, the appointment of an Ecuadorian administrator to the sub-directorship, as well as nationals to most of the staff and visiting trainee positions, has been much more appealing to the resident population in Puerto Ayora and the archipelago as a whole. Galapageians are also getting more involved in research; there are now several professional biologists, four graduate students with a master's-level degree, and one working for a PhD.

Research in the Galapagos National Park not only has been conducted under international standards of professionalism in science and education, but has provided living examples for other protected areas around the world, setting itself new standards and even more ambitious goals. This contrasts sharply with what continental protected areas face in regard to scientific activities.

CONTINENTAL RESERVES AS MELTING POTS

On the mainland, research was carried out by a few dedicated "apostles" of scientific methods. Without financial support, most of the field work was done privately with limited results.

In the early 1970s virtually no infrastructure was present at any reserve, other than small houses used for shelter or guard posts. Facilities built in remote areas for other uses were also used for research-related activities in protected areas, such as with the U.S. National Aeronautics and Space Administration (NASA) satellite tracking station (near the Cotopaxi National Park), whose presence encouraged extended visits by naturalists from Quito, the capital. Later on, the nearby area was declared a National Recreational Area and is now the number-one destination for internal tourism.

During this time, few universities had programs for biologists or conservation-oriented professionals; hence, involvement of academic institutions was sporadic and occurred mainly when a big expedition from abroad approached the targeted area. Therefore, there were no regulations with respect to the routines for collections, observations or field surveys. Expeditions were a very risky adventure with a flavor of individualism.

RESEARCH TAKES OFF

With the advent of nongovernmental organizations (NGOs), a renewed interest in research in protected areas appeared mainly in the form of biological inventories, censuses of wild populations and control of the alarming traffic of "exotic" animals.

During the period 1973-1983, departments of traditional universities became involved in long-term projects with a flavor of "cooperation" with institutions from abroad. Several natural history careers were created with the returning PhDs, and the "boom" of conservation was about to begin. An Institute of Natural Resources was created. There were also cases in which distinguished professors came to survey the country, conduct research, teach elementary courses, conduct workshops, etc. In the late 1970s the National Museum of Natural History was created, with the goal of facilitating scientific research, collection, storage, study, preservation, education, and exhibition of the astonishing Equatorial natural wealth. A separate Institute for Cultural Heritage was also created to normalize activities regarding archeological, paleontological, ethnographic, and linguistic research.

Following the awareness of environmental issues, a plethora of new organizations have been created to emphasize research in protected areas. Fundación Natura has been, by far, the most well-known Ecuadorian NGO, working together with the Office of National Parks to support research activities among other programs. Fundación Ciencia, Fundación Maquipucuna, Fundación Ecociencia, Fundación Trópica 2000, Ecuadorian Council for Bird Research and Conservation, Fundación Herpetológica del Ecuador, Fundación Botánica del Ecuador, Ecuadorian Foundation for Conservation and Development, Ecuambiente, Fundación Arco Iris, Grupo Ecológico Tierra Viva, AECOTAL Environmental-Ecological Consulting, Fundación Llanganates, Sociedad de Flora y Fauna, and Sociedad de Defensa de la Naturaleza are just a few examples of the growth of Ecuadorian conservation NGOs.

PRIVATE RESEARCH INITIATIVES

Because of unreliable bureaucratic management of the reserves, data generated in those studies were poorly publicized. Most of the information on inventories, assessments and other evaluations was kept for MAG employees only. This motivated the creation of private reserves, accompanied by the owners' quixotic attitudes to go ahead with their own research activities in these *de facto* reserves. The Scientific Center "Río Palenque" is a good example: Callaway Dodson, who also started the program for naturalists at the Universidad de Guayaquil, segregated a patch of forest surrounded by tropical crops within his own property. The good maintenance of the area and the facilities that little-by-little were added, gave Río Palenque Science Center a unique appeal for field biologists in Ecuador, allowing inventories and permanent quadrants for long-term surveys. This circumstance allowed Río Palenque to survive and become known as the richest place for biodiversity of angiosperms on earth (Gentry 1982).

Another example is the Equatorial Garden in the San Antonio de Pichincha and his *finca* near Ambato, where Misael Acosta-Solis maintained samples of original vegetation and conducted research (Acosta 1977).

With the construction of the railroad from Ibarra through the northwestern forest towards San Lorenzo, a forestry station was built in the forest of Lita where the giant toad *Bufo bomblergii* was collected and continues to be exploited as a gastronomic eccentricity. Further north, the train station itself, at San Lorenzo, hosted expeditions and served as a base camp for field research.

On the western slope of the Pichincha volcano, Paul Feret, with support of the Friends of Nature Society, established "Las Palmeras" field site for research and ecotourism. Nearby, Jaime Jaramillo established his private research station "Guajalito" for cloud forest ecological surveys.

Limoncocha, created by the Summer Linguistic Institute (a missionary organization) in the Ecuadorian Amazon, is an exceptional type of private initiative. It attracted not only priests for evangelization of silvicolous tribes, but researchers from many disciplines related to the tropical rainforest. With its own fleet of aircraft, boats, and other modern technology, Limoncocha Research Station was easy to reach by flights from Miami or Quito. By the late 1970s, the Institute was running the best field station that Ecuador had ever seen, on the banks of the Napo River, with its headquarters in the capital city. The scientific production of the Institute was really impressive. Its newsletters, books, journals and other communication materials reflected a great variety of interests. Ornithological surveys, for instance, made the place famous as having the highest bird diversity on earth (Pearson 1972). Still, the station was primarily for evangelization, carrying out a mission of acculturating indigenous people. It put the jungle in contact with the western world. Today, even though Limoncocha was recently designated as a Biological Reserve, not much is left; oil exploration, tourist impact and social dislocation are few of the residuals from the once-sacred paradise for research in the tropical forest.

Attempts have been made elsewhere, with partial success, to achieve the same degree of efficacy. In the early 1980s, an idea to build a multimillion-dollar research station in Yasuni National Park (the proposed Research Station Napo, with support from the Smithsonian Institution) did not come about. A renewed attempt is being made with the assistance of the Catholic University of Quito.

Fundación Natura is managing a protected forest near Quito, in the last remnant of interandean or transandean (Sarmiento 1986) montane forest. Mostly used for environmental education and interpretation, the Environmental Education Center at Pasochoa has also supported research on a small scale.

The Maquipucuna Foundation is now operating the Richard Davis Research Station on his property at Nanegal. The Foundation for Conservation and Development operates a research station in Sacha-Pacha, Zancudococha. Ecuambiente operates a field site near Tiputini. Jatun Sacha Foundation is operating a research station in terra firme forest of the Amazon headwaters in Jatun Sacha, Puerto Napo, where some field courses are also offered. The Catholic University has a research station in Cuyabeno Faunal Reserve, one of the few areas in the Ecuadorian Amazon that shows the flooding dynamics of the Igapo and Varzea forest. The group Tierra Viva operates a field site in Mazan near Cuenca. The Antisana Foundation operates a field site in the paramos of Antisana. The University of Guayaquil operates its field site in Jauneche and Fundación Natura operates one in Capeira. The Arco Iris Foundation operates a field site in the Podocarpus National Park. Ecociencia is establishing permanent plots for continual censuses, within field studies sites for "La Perla" and "Baeza," The University of Esmeraldas operates a field site at the "Jardín Tropical," with emphasis on captive wildlife research. The Ecuadorian Council for Bird Conservation and Research is developing a suitability analysis for a private reserve in the Piedmont of Naranjal where the newly discovered El Oro parakeet (*Pyrrura orcesi*) has been reported (Ridgely and Robins 1988).

GOVERNMENTAL INPUT

As a result of the Forestry Law, passed in August of 1981, and the revision of it as the Forests and the Conservation of Natural Areas and Wildlife law of 1990, rules and regulations now govern research in protected areas (MAG 1990), providing a legal framework for these activities.

Tax incentives, reduced tariffs on equipment imports, and other benefits for promoting research are encouraging. However, the current system, with few professionals working in research and development, is still limiting. Chapter VIII of the regulatory listings deals with research and training, in which a research committee is created as an advisory board to cope with the needs of research-related issues, made up from the department heads of the Forestry sector. A formal office for Authorization and Licenses is now in full operation and establishes guidelines for scientific research, including collecting, maintenance, treatment and exporting (Ecuador is a member of CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora), collection, and experimentation activities.

During the years 1979-1982, governmental protected areas (*de jure* reserves) were getting delineated.

Some areas had to be designated as "security zones" to prevent invasions by settlers and other interventions. Remote places were reached with the help of the local military that served as liaisons and, sometimes, guides to such distant areas. The military, therefore, played a big role, because, in most cases, it was the only way to reach faraway reserves. A chronicle of the expedition to Puruhanta Lake (Sarmiento 1988) gives an example of their contribution.

The infrastructure now available at most parks is still weak. There are attempts to organize a better system for research in the country, where the National Council for Scientific Research would have a key role, as recommended by the Ecuadorian scientific community (Romo 1986). However, in most cases, research in protected areas must still be conducted rather conservatively.

A few public scientific institutes have done field research in protected areas; e.g., the National Institute for Agricultural Research has developed forestry-related projects in field sites at Payamino Forest and San Carlos Research Station. The facilities of the Ecuadorian Institute for Electrification (INECEL) at the "Reventador" has also served scientific purposes by studying the San Rafael waterfall area and the eastern slope of the Andes in Cayambe-Coca Ecological Reserve. Municipal and provincial facilities (such as those related to irrigation programs, potable water, electrification and so on) have provided base camps for research in most of the protected areas.

The Ecuadorian Museum of Natural Sciences, realizing the limitation of personnel, has taken a rather interesting approach. It has promoted research in protected areas by contacting world class scientists to work towards the completion of the biological inventory of the country.

By having advisory boards from the universities, other governmental agencies, the Biological Society and the Ecuadorian Academy of Biological and Natural Sciences of the Ecuadorian Culture House, a variety of collaborative programs have been facilitated. Italian researchers have helped prepare the paleontological chart of Ecuador; French systematists have compiled butterfly and cricket listings; Swiss workers have gathered information on frog parasites while including new species in the amphibian listings. Denmark has helped initiate botanical collections; The Netherlands, with ornithological training.

The U.S. Academy of Natural Sciences continues working on developing the avian inventory and supports institutional strengthening and training of personnel. The Western Foundation of Vertebrate Zoology of Los Angeles prepared a list of nest and eggs of Ecuadorian birds and also trained employees. Ohio State University carried out paleoecological studies as well as botanical expeditions. The University of Wisconsin-Madison helped to initiate osteological collections. Northern Kentucky University helped organize limnological references. The Smithsonian Institution has completed surveys of aquatic insects. The Missouri Botanical Garden has helped to establish the National Herbarium, which supports field training, research and collection management, and training of local botanists. With a different agency (UTEPA) the Smithsonian Institution has recently developed a collaborative project to support research in the western tropical rain forest, through the technical unit for the Awa Binational Reserve.

The Navy controls big areas offshore. Along with the Oceanographic Institute and the Institute of Fisheries, it helps to provide logistics for research in marine reserves around the Galapagos and Machalilla National Parks. They have even gone to Antarctica twice in research-related journeys.

RESEARCH RESULTS

Most research results in protected areas are concentrated in inventory work and few, if any, of the outcomes have been evaluated. Most of the knowledge generated over the years has not been available to Ecuadorian students and researchers due to financial constraints to obtain scientific literature and professional journals. In addition, the low pay at research institutions in the country has not helped to motivate a demand for research-related careers, hence creating an elite of science-oriented scholars.

Lack of communication between the researchers themselves and between institutions (Sarmiento 1984) has promoted local rivalries for scarce resources. This is exacerbated by the fact that peer review is not well practiced and criticisms have traditionally affected personalities and prides. Only recently has the Ecuadorian Society of Biologists established an annual meeting; now in the *Jornadas de Biología* it is easier to find research contributions on protected areas and endangered species.

There is no continuity in the publication of professional journals. Almost every scientific magazine with articles dealing with protected areas has suffered the impact of a crisis economy, where the first activity to experience budget cuts has always been publications. The influence of medical research on the *Boletin de Informaciones Científicas Nacionales* is overwhelming. The sequencing of the *Revista del Museo Ecuatoriano de Ciencias Naturales* is aperiodical. Nor has the National Parks and Protected Areas Division maintained a publishable account of hundreds of scientific reports that, by law, must be given to the forestry authority after the finishing of a study. Annals of certain universities show few contributions in the field and some academic units have not even published a list of theses or other projects associated with protected areas.

ALTERNATIVE OPTIONS

The Ecuadorian scheme for science and conservation is in flux. There is a new breed of field biologists, ecologists, and environmental professionals, with better training and expertise, that must be supported with suitable working conditions.

Research in protected areas is mainly stimulated by the presence of basic lodging facilities. It is of primary importance that infrastructure to support field research in Ecuadorian protected areas be built accordingly. The training of local scientists is also crucial. Much more emphasis has to be given to completion of graduate studies at the doctorate level for Ecuadorians so they can become leaders in research and conservation. Programs for international studies have traditionally offered fellowships only at the Master's level. On the other hand, doctorate-level training is undermined in local universities by political activism and outdated materials and curricula.

MAG should give much more attention to the Division of National Parks and Wildlife Resources. Its intrinsic value for protecting national forests is opposed to the attitudes of the traditional forestry sector, which would like to use the reserves as timber mines. However, protection alone will not suffice. A much more dynamic current approach is needed to cope with the needs of research (both basic and applied) as well as those of sustainable development. If we expect protected areas to persist, the value of biodiversity protected inside reserves must be internalized within the formal economic structure of the nation.

In this regard, the traditional approach of selecting big areas of untouched ecosystems has to change towards a more realistic and manageable scheme of smaller conservation units (Sarmiento 1990) selected for their role in connectivity among patches of rather isolated remnants of primary vegetation supporting metapopulations of rare animals. This is particularly important in the cloud forest belt of the western Andean slope and extremely urgent in southwestern Ecuador (Robert Ridgely pers. comm.). Research should be directed toward priorities encompassing sustainable development and rural empowerment by means of non-traditional forest resource usage, as is being demonstrated by the Tagua Initiative™ of the NGO Conservation International in northwestern Ecuador (Tangley 1992).

SUITABLE APPROACHES

An independent administrative structure of protected areas within the framework of governmental hierarchies dealing with natural resources management is needed. A much more realistic approach to regulating collections and export of natural specimens should be developed with the goal of helping build internal Ecuadorian research abilities in protected areas, especially by creating infrastructure for science development at the national level. Publication of scientific literature as means of professional development, encouraging peer-reviewed contributions and refereed editions, is a must.

Also, new concepts for utilizing extractive reserves (*sensu* Instituto de Biodiversidad in Costa Rica) to bolster local villagers and the overall economy of the region are needed, with adjustments geared toward Ecuadorian realities. Establishment of privately owned reserves should be encouraged through the consent and co-participation of the communities. Financial incentives should be directed towards private research facilities and programs.

International cooperation in developing mutually beneficial projects between Ecuadorian research institutions and foreign counterparts is needed; not a mere strengthening of the physical plant and machinery, but a whole change in attitude regarding scientific activities (including professional training). Inclusion of local principal investigators with shared budgetary responsibilities will help, as will the activation of overheads at Ecuadorian institutions and fees for administrative collaboration and technical assistance to foreign researchers.

The participation of industry (timber, pharmaceutical, oil, transportation, etc.) to provide incentives for conservation through the sponsorship of scientific research in protected areas is also desirable. So too is a new approach to natural areas management, including research-extension programs supported by local enterprises that provide real benefits to nearby communities. If biodiversity is to be maintained, its benefits to the people must be demonstrated.

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Estación Biológica de Rancho Grande: 40 Años de Investigaciones Científicas en el Parque Nacional Henri Pittier

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ABSTRACT

The Rancho Grande Biological Field Station is situated in Henri Pittier National Park (North-Central Venezuela), which is considered to be the country's richest protected area in terms of biodiversity. (Its various ecosystems are, for example, the habitat of 6.5% of the world's avian species.) William Beebe of the New York Zoological Society, who arrived at the Rancho Grande building in 1945, was the first to use it as a base for biological research. The building itself had b een intended as a luxury hotel, but it was never finished; construction was abandoned in 1935, three years after work began. The building is currently administered jointly by INPARQUES (National Parks Institute; a governmental organization) and the Agronomy Faculty of the Central University of Venezuela. The Field Station's primary aim is to carry out biological and ecological research into the natural resources of Henri Pittier National Park, but it also serves as the base for various environmental education programs. Among the most important achievements over the last 40 years has been the discovery of Portachuelo Pass, one of the most important migratory routes for birds and insects known in South America; contributions to furthering biological and ecological knowledge of tropical cloud forests and the plant and animal species which live in them, and the foundation of the Museo de Biología de Rancho Grande (Rancho Grande Biological Museum), the most complete collection of vertebrates in Venezuela. The Rancho Grande building is currently undergoing full renovation, further enhancing its importance as a center for research, education and conservation in the South American Tropics.

El Parque Nacional Henri Pittier, está ubicado al norte de Venezuela, en el sector centro-occidental de la Serranía del Litoral de la Cordillera de la Costa. Limita al norte con el Mar Caribe y al sur, con los Valles de Aragua donde se encuentra el Lago de Valencia. Tiene una superficie de 107,800 hectáreas y está situade entre los 10°14'25" y 10°32'40" Latitud Norte y entre 67°24'36" y 67°52'54" Longitud Oeste. Su topografía es principalmente montañosa, con una variada gama de formaciones vegetales naturales, cuya distribución espacial está condicionada naturalmente por las diferentes fajas altitudinales, encontrándose desde selvas nubladas altas hasta formaciones típicamente áridas de cardones y cujies. El pie de monte se extiende desde el nivel del mar en la vertiente norte y desde los valles de Aragua, a 450 m de altitud, en la vertiente sur, siendo su mayor altura el Pico El Cenizo, a 2,436 m de altitud. El Parque fue decretado el 13 de enero de 1937, constituyendo la primera área protegida del país.

La gran variedad de condiciones ecológicas en el Parque han permitido el desarrollo de una gran diversidad de animales y plantas, llegando a una exuberancia tal, como pocas existen en el mundo. Por ejemplo, en estudios botánicos realizados por VARESKI (1986) se pudo determinar que la selva nublada de Rancho Grande, presenta el óptimo climático para las comunidades vegetales con el mayor indice de diversidad vegetal encontrada hasta ahora en el mundo, lo que lo convierte en un importante banco de germoplasma de la biodiversidad mundial. Con respecto a su fauna, el Parque aún no ha sido objeto de un inventario completo, sin embargo el conocimiento de algunos grupos son un indicio claro de su alta riqueza, así los mamíferos están representados por casi el 50% de las especies conocidas para el país, mientras las aves alcanzan el 42%, es decir el 6.5% del total mundial. Por otra parte, en el Parque se encuentra uno de los pasos migratorios de aves e insectos más importante del norte de Suramérica, conocido como Paso Portachuelo.

El Parque Nacional Henri Pittier, no sólo cumple una importante función de reservorio y protección de la diversidad biológica que allí habita, sino que también representa un laboratorio biológico al aire libre para los estudiosos e investigadores científicos cumpliendo también una función didáctica y conservacionista a través de diferentes actividades realizadas frecuentemente por instituciones regionales de docencia y grupos ambientalistas.

El Parque es rico en bellezas naturales, ofrociendo protección a las fuentes de agua potable de las ciudades que están en sus cercanías, brindando también un sitio ideal para la observación, la recreación y el esparcimiento espiritual de sus visitantes.

HISTORIA E IMPORTANCIA DE LA ESTACION

La predilección del General Juan Vicente Gómez, Presidente de Venezuela durante el período 1908–1935, por el ambiente silvestre que rodea a Maracay, originó la construcción de la carretera hacia Ocumare de la Costa y Turiamo, en la cima de la cual, conocido como Rancho Grande, hizo construir un gran edificio con la finalidad de asentar uno de los hoteles más lujosos del país. En 1935, con la muerte del General Gómez, se paraliza la obra, la cual se encontraba en su etapa final de construcción. En 1945, a través de una ayuda económica de la Creole Petroleum Corporation y el apoyo del gobierno venezolano, el célebre zoologo norteamericano William Beebe, logra acondicionar parte de las estructuras inconclusas como apoyo a un ambioioso proyecto para el estudio de la selvas tropicales. Así comienza su función de laboratorio biológico, hasta 1949, cuando finaliza el proyecto.

Posteriormente el botánico suizo Henri Pittier, comienza una campaña para lograr que esta edificación sea definitivamente acondicionada como centro de estudios biológicos y el así como en 1950, el Ministerio de Agricultura y Cría crea la Estación Biológica de Flora y Fauna de Rancho Grande. Para Organizar y poner en funcionamiento la Estación, son contratados los servicios del ornitólogo alemán Ernst Schaefer, quien junto con algunos técnicos encaminó la Estación Biológica de Rancho Grande como centro de investigación y sede de un magnifico museo didáctico de la fauna del Parque. La estación comenzó a recibir muchos otros científicos atraídos por la alta diversidad biológica del Parque, quienes ocupando sus húmedos laboratorios, han generade numerosas publicaciones. La estación pasa en 1977, al nuevo Ministerio del Ambiente y de los Recursos Naturales Renovables y años más tarde cesan sus actividades.

En 1966, por iniciativa del Dr. Alberto Fernández Yépez, comienza a funcionar otra estación biológica en el mismo edificio, perteneciente a la Facultad de Agronomía de la Universidad Central de Venezuela. Esta estación, conocida hoy día como Estación Biológica "Dr. Alberto Fernández Yépez," comienza a cumplir una importante labor de investigación, docencia y extensión conservacionista a favor del Parque y en la actualidad es la única institución que está encargada de estos aspectos, en colaboración con el Instituto Nacional de Parques (INPARQUES) y un organismo no gubernamental, la Sociedad Científica Amigos del Parque Nacional Henri Pittier, la cual ha sido factor de importancia en el logro de muchos objetivos.

El edificio de Rancho Grande está ubicado a unos 150 Km de Caracas, la capital del país, y sólo a 11 Km de la ciudad de Maracay. Esta ubicado en pleno ambiente de selva nublada tropical, a una altitud de 1,092 m, muy cerca del Paso Portachuelo, importante ruta migratoria de aves e insectos.

OBJETIVOS Y ADMINISTRACION DE LA ESTACION

La Estación Biológica "Dr. Alberto Fernández Yépez" ocupa el último piso, de los tres que tiene el edificio de Rancho Grande, funcionando, desde su creación en 1966, como una estación adscrita al Instituto de Zoología Agrícola de la Facultad de Agronomía de la Universidad Central de Venezuela, con sede en Maracay. Fue diseñada originalmente para brindar facilidades a los investigadores de la Facultad de Agronomía interesados en estudios de la flora y fauna del Parque, así como para brindar facilidades a investigadores visitantes nacionales y extranjeros con objetivos similares. También la Estación ofrece alojamiento a estudientes de diversos niveles educativos amparados por una institución, grupos ambientalistas y en general a todas aquellas personas cuyas actividades estén relacionadas con la docencia y extensión conservacionista a favor de la protección de los recursos naturales del Parque Nacional y así lo justifiquen en su solicitud.

La Estación ofrece facilidades, previa justificación, de alojamiento en dormitorios con baño, uso de cocina, áreas de trabajo como laboratorios y umbráculos, así como cualquier apoyo que pueda brindar la Facultad de Agronomía de la Universidad, tales como biblioteca, colecciones, herbarios, consultas, etc.

Gran parte de los conocimientos obtenidos en estudios sobre flora y fauna del Parque, han formado parte de proyectos individuales apoyados en las facilidades ofrecidas por la Estación. Además, en la Estación se lleva a cabo un registro permanente de flora y fauna del Parque. En la actualidad existen varios programas integrales en el área de la ciencia de la conservación, con apoyo de organismos gubernamentales y no gubernamentales.

Los ingresos de la Estación provienen de colaboraciones o cuotas de los visitantes y algunos insumos para la investigación y docencia son obtenidos a través de proyectos individuales, ayudas institucionales o donaciones.

La Estación es administrada por un jefe, miembro del personal docente y de investigación de la Facultad de Agronomía. Su personal está formado sólo por dos conserjes y un obrero, sin embargo, por ser una unidad ejecutora independiente de la Facultad de Agronomía, goza de todos los beneficios de los diferentes servicios de la Universidad.

CONVENIOS Y COOPERACION CIENTIFICA

Si bien la Estación ocupa sólo el último piso del edificio de Rancho Grande, tiene firmado un Contrato de Comodato con el Instituto Nacional de Parques (INPARQUES), organismo gubernamental que administra a los parques nacionales en Venezuela, con la finalidad de que ambas instituciones desarrollen en el edificio un Centro de Investigación y Docencia. De esta forma la estación es responsable directa de ejecutar o coordinar la investigación científica en sus instalaciones del último piso. En el piso intermedio, la Estación es co-responsable con INPARQUES, de desarrollar instalaciones adecuadas y organizar actividades docentes y de entrenamiento de personal en materia de conservación de los recursos naturales del país. De igual forma, en la planta baja, donde INPARQUES funciona a través de sus oficinas administrativas y puesto de Guardaparques, la Estación es co-responsable del desarrollo de un museo didáctico público conjuntamente con la Sociedad Científica Amigos del Parque Nacional Henri Pittier.

La Estación tamién ha establecido un convenio de ayuda mutua con la Sociedad Científica Amigos del Parque Nacional Henri Pittier, con sede en Maracay. Este convenio ha permitido el apoyo y/o ejecución por parte de la Sociedad de diversos proyectos de investigación y la obtención de algunos equipos y materiales necesarios para tal fin. Por otra parte, la estación viene colaborado activamente en el desarrollo de las actividades de investigación y docencia de instituciones públicas y privadas, nacionales o extranjeras.

LINEAS DE INVESTIGACION

La Estación coordina un proyecto de registro permanente de la flora y fauna del Parque Nacional Henri Pittier, donde además de las actividades desarrolladas por el personal y estudiantes de la Facultad de Agronomía, colaboran los investigadores que utilizan las instalaciones para desarrollar sus proyectos.

La mayoría de los estudios botanicos son realizados por investigadores del Instituto de Botánica Agrícola de la Facultad de Agronomía, en donde se encuentra el segundo Herbario en importancia del país y la mayor representación de la flora del Parque.

En cuanto a los estudios faunísticos la mayoría de los estudios son producto de estudiantes e investigadores del Museo del Instituto de Zoología Agrícola de la Facultad, el cual posee la colección entomológica más importante del país y una de las más importantes del Neotrópico, así como una buena representación de otros grupos animales del Parque. Otras investigaciones son llevadas a cabo por investigadores de otras instituciones nacionales o extranjeras. El Servicio Autónomo PRO-FAUNA, del Ministerio del Ambiente y de los Recursos Naturales Renovables, mantiene el Museo de Biología de Rancho Grande, ubicado en la entrada al Parque y considerado el más completo en representación de vertebrados del país. Este museo es de obligada consulta para los investigadores del área de vertebrados y presenta la mejor representación del Parque de este grupo animal.

En la actualidad se están ejecutando estudios en el área de la ciencia de la conservación, como son el diagnóstico de la problemática de los recursos naturales del Parque, impacto de los pobladores de los linderos sobre su medio ambiente y programas de monitoreo de aves migratorias. También se están planificando trabajos multidisciplinarios con el objetivo de realizar una base de datos de la diversidad biología del Parque, donde se puedan conocer la composición, importancia, problematica y conservación de sus recursos naturales.

De igual forma, la Estación, está participando en programas de educación ambiental en la búsqueda de un mejor uso del área por parte de los usuarios y visitantes. Estos programas están coordinados por la Sociedad Científica Amigos del Parque Nacional Henri Pittier y el Instituto Nacional de Parques con el apoyo de otras instituciones.

LOGROS OBTENIDOS MAS RESALTANTES

A continuación presentamos una lista de las investigaciones y logros más importantes, realizados desde la Estación Biológica:

- ✦ Descubrimiento del Paso Portachuelo como una de las rutas migratorias de aves e insectos más importante de Suramérica. Incluyendo investario de especies migratorias.
- ✦ Contribuciones al conocimiento a la biología y ecología de las selvas nubladas tropicales.
- ✦ Inventarios de flora en diversos ambientes del Parque.
- ✦ Inventario de los vertebrados del Parque.

- Inventario de muchos grupos de invertebrados del Parque.
- Fundación del Museo de Biología de Rancho Grande, hoy dependencia de PROFAUNA (Ministerio del Ambiente) y considerado la colección más completa de vertebrados del país.
- Contribución al enriquecimiento de la Colección de Insectos del Museo del Instituto de Zoología Agrícola de la Facultad de Agronomía de la U.C.V., uno de los más completos del Neotrópico.
- Descripciones de innumerables especies nuevas para la ciencia.
- Estudios de biología, ecología y comportamiento de muchas especies de las selvas tropicales.
- Estudios sobre distribución de flora y fauna en el Parque, como elemento importante en la zonificación de áreas para uso y manejo.
- Diagnóstico de algunas de las actividades humanas que se desarrollan en el parque y su importancia en la conservación.

PERSPECTIVAS Y FUTURO DE LA ESTACION

El edificio de Rancho Grande está siendo, en la actualidad, recuperado totalmente en su estruc-tura física, mediante financiamiento del Ministerio del Ambiente, el Instituto Nacional de Parques y la Universidad Central de Venezuela.

El edificio funcionará bajo tres objetivos fundamentales: Sede de laboratorios de estudios científicos y alojamiento para investigadores residentes y visitantes, coordinado por la Facultad de Agronomía de la Univesidad Central de Venezuela, en su Estación Biológica "Dr. Alberto Fernández Yépez," ubicada en el último piso del edificio. Una escuela para actividades docentes informales y formales, incluyendo talleres de entrenamiento para personal adscrito a áreas protegidas y cursos de Postgrado de las universidades nacionales, administrada por el Instituto Nacional de Parques y la Universidad Central de Venezuela. Por último, será sede de diversas oficinas administrativas del Instituto Nacional de Parques y otras instituciones gubernamentales y organizaciones no gubernamentales relacionadas con las actividades del edificio. Esta organización administrativa permitirá que el edificio de Rancho Grande sea un Centro de Investigación, Docencia y Extensión Conservacionista único en Suramérica, donde funcionarán:

- Laboratorios equipados para realizar estudios científicos por parte del personal de la Estación Biológica "Dr. Alberto Fernández Yépez" o de cualquier otra institución nacional o extranjera.
- Alojamiento con facilidades de dormitorios, baños, cocina y otras áreas que brinden comodidad a los investigadores visitantes y residentes; como también a grupos conservacionistas organizados.
- Herbario de referencia de la flora del Parque, adscrito al Herbario de la Facultad de Agronomía de la Universidad Central de Venezuela.
- Aulas para clases y conferencias y una biblioteca especializada en áreas protegidas y sus recursos naturales.
- Puesto de Guardaparques con funciones de guardería ambi-

ental y atención a los visitantes.

- ✦ Museo didáctico abierto al público.
- ✦ Oficianas para las instituciones que laboren en el edificio.

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The George Wright Society was founded in 1980 to serve as a professional association for people who work in protected areas and on public lands. Unlike other organizations, the GWS is not limited to a single discipline or one type of protected area. Our integrative approach cuts across academic fields, agency jurisdictions, and political boundaries.

The GWS organizes and co-sponsors a major U.S. conference on research and management of protected areas, held every two years. We offer the FORUM, a quarterly publication, as a venue for discussion of timely issues related to protected areas, including think-pieces that have a hard time finding a home in subject-oriented, peer-reviewed journals. The GWS also helps sponsor outside symposia and takes part in international initiatives, such as the Global Biodiversity Conservation Strategy.

Who was George Wright?

George Melendez Wright (1904-1936) was one of the first protected area professionals to argue for a holistic approach to solving research and management problems. In 1929 he founded (and funded out of his own pocket) the Wildlife Division of the U.S. National Park Service—the precursor to today's science and resource management programs in the agency. Although just a young man, he quickly became associated with the conservation luminaries of the day and, along with them, influenced planning for public parks and recreation areas nationwide. Even then, Wright realized that protected areas cannot be managed as if they are untouched by events outside their boundaries.

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