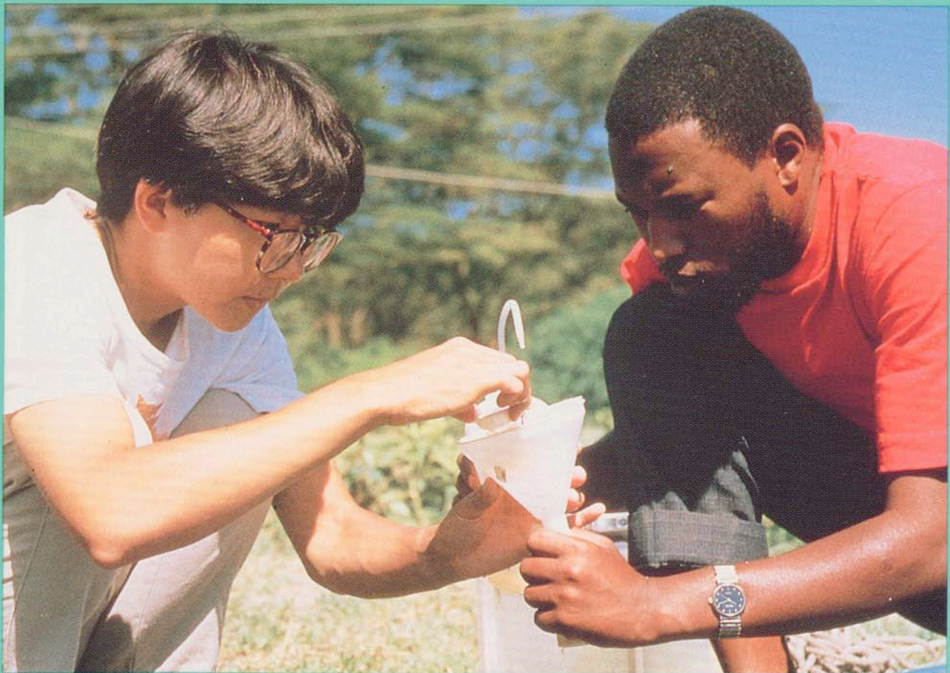
Protected Areas Programme

Coordinating Research and Management to Enhance Protected Areas

Edited by David Harmon



IVth World Congress on National Parks and Protected Areas
Caracas, Venezuela

IUCN
The World Conservation Union

THE GEORGE WRIGHT SOCIETY

SAMPAA

Commission of the European Communities

Coordinating Research and Management to Enhance Protected Areas

On the cover:
Volunteers on an Earthwatch expedition work with a water sample taken from Lake Naivasha, Hell's Gate National Park, Kenya.
Ron Kratzer photo, courtesy Earthwatch

Earthwatch, a nonprofit NGO, sponsors scientists, artists, teachers, and students on projects to improve human understanding of the planet, the diversity of its inhabitants, and the processes that affect the quality of life on Earth. To date, some 40,000 Earthwatch volunteers have supported 1,850 projects in 104 countries. For more information, write to Earthwatch, 680 Mount Auburn Street, Box 403, Watertown, Massachusetts 02272 USA.

Founded in 1948, **IUCN–The World Conservation Union** brings together States, government agencies, and a diverse range of nongovernmental organizations in a unique world partnership: over 800 members in all, spread across some 125 countries. As a Union, IUCN seeks to influence, encourage, and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable. The World Conservation Union builds on the strengths of its members, networks, and partners to enhance their capacity and to support global alliances to safeguard natural resources at local, regional, and global levels.

Since 1980, **The George Wright Society** has served as a multidisciplinary, international professional association for those who work in or are concerned with parks and other types of protected areas. The GWS's focus includes both natural areas and cultural sites. Through this cross-cutting emphasis, the GWS tries to promote innovative protected area leadership and problem-solving. To work toward its goals, the GWS organizes and is the primary sponsor of a biennial Conference on Research and Resource Management in Parks and on Public Lands. In addition, the GWS publishes *The George Wright Forum: A Journal of Cultural and Natural Parks and Reserves,* a quarterly venue for the discussion of timely issues related to protected areas. Membership in the GWS is open to anyone who wishes to support and further its objectives.

The **Science and Management of Protected Areas Association** originated in 1989 when a small group of scientists and managers from various government agencies and universities in the Canadian Maritime Provinces agreed there was a need to improve the quality of use of science in protected areas management. SAMPAA sponsored the 1991 International Conference on Science and the Management of Protected Areas; a second, with Ecosystem Monitoring as its theme, was held in the spring of 1994. The objectives of the society are to promote the effective use of science and technology, support research activities and scientific scholarship, provide a forum for consultation and education on issues related to the use of the science and technology, and promote cooperation and information interchange among land-use managers and specialists in the academic, public, and private sectors relating to the management of protected areas.

A **World Congress on National Parks and Protected Areas** has been held each decade since 1962. Its objective is to promote the development and most effective management of the world's natural habitats so they can make their optimal contribution to sustaining human society. The IVth World Congress, held in Caracas, Venezuela, 10-21 February 1992, aimed to reach out to influence numerous other sectors beyond those professionals directly concerned with protected areas.

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in collaboration with
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Contents

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Much of the remainder is based on previously published material. We have freely drawn from, combined, and recast parts of works listed in the "Sources" at the end of the book. Because this is a set of guidelines and not a scholarly text, citations have been omitted except for direct quotations. Nonetheless, certain sections draw so heavily upon one or two sources that we wish to acknowledge those debts here:

- The section in Chapter 2 on the politics of science is based upon Andresen and Østreng (1989).
- Chapter 3 is based upon Wade and Tavris (1990).
- Parts of Chapter 4 are based upon Jarvis (1991) and Thorsell (1992).
- The section in Chapter 4 on traditional environmental knowledge is based upon Cruickshank (1981) and Peepre (1992).
- Chapter 6 is mostly based upon Webb (1992) and Machlis (1993).
- Various sections of Chapter 7 are based upon Shelton (1992) and Jarvis (1991).

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We also wish to acknowledge the Bantam Doubleday Dell Publishing Group, Inc., New York, for granting permission to quote extensively from *Information Anxiety* by Richard Saul Wurman, copyright © 1989 by the author. Finally, our thanks go to Amy Shaw and Dee Robbins of Earthwatch for providing the cover photograph.

David Harmon
The George Wright Society
July 1994

A note on how to use this book

The purpose

This is a set of guidelines in the sense that it is filled with "shoulds" and even a few "musts," but we recognize that every protected area is unique. The book's value, we hope, will be as a source of ready-to-adapt ideas for coordinating research and management in your protected area. It can also be used by laypersons who desire an introduction to resource management and research planning.

The sequence

Although there is a logical progression to the chapters, they don't have to be read in order. Dip into the book as you like.

The marginalia

In the margins of some pages you will find, in shaded boxes, quotations from Richard Saul Wurman's book *Information Anxiety.* The author describes himself as being in the business of making information understandable. "My expertise," he writes, "has always been my ignorance, my admission and acceptance of not knowing." Wurman has published guidebooks to cities that try to look at them in the same way a curious first-time visitor does, has rewritten directories and reference books to make them easier to use, and has explored why people allow themselves to be inundated with information they cannot comprehend—and what can be done about it. Wurman's insights into information are valuable when juxtaposed against the special problems researchers, managers, and the public face when trying to build a working relationship.

We offer Wurman's thoughts in the margins much as one offers a spark to kindling. Some of his comments will challenge what is being said in the text on that page, others will echo it, while still others will act as reminders of concepts elsewhere in the book.

1. The research–management dynamic

Introduction

We live in a time of swirling environmental and societal change, and protected areas, like all other social institutions, are being transformed by the flow of modern events. As the world's political order continues to shift, and as the planet faces unprecedented strains from burgeoning material consumption and sheer population growth, people are *demanding* that protected areas take on broader and more complicated social and ecological functions. Gone are the days when parks and reserves were expected merely to safeguard a few popular wildlife species, or preserve a beauty spot or dramatic landscape feature, or embalm the site of some historic event. Now, protected areas are expected to help conserve entire ecosystems and ecological processes, contribute to the preservation of vanishing ways of life, spearhead local economic development, even solidify the cultural identity of whole groups of people.

In this uncertain atmosphere, establishing a partnership between researchers and managers has become crucial to the success of protected areas. Research in the natural and social sciences provides managers with vital information on the presence or absence of species and their needs, geophysical characteristics of the area, new interpretations of cultural resource material, trends in ecosystem change, social characteristics of resident and neighboring human communities, economic values of the protected area, tendencies in recreational use and tourism, the effectiveness of training programs—the list could go on and on. For their part, researchers are increasingly attracted to protected areas as "laboratories" for scientific and cultural work. To make optimal use of these laboratories, researchers need the logistical and political support only managers can give. Research also often gains in relevancy from the practical discipline imposed upon it by real-life management constraints.

A mutually supportive research–management partnership offers both sides valuable insights that can broaden their perspectives and make them more creative and flexible. This, in turn, translates into the protected area becoming more responsive to the changing needs of society.

So getting managers and researchers to work together is critical to the success of protected area conservation. Nor can the public interest be served unless research and management are coordinated. Nonetheless, researchers and managers working in protected areas don't always see eye-to-eye. Researchers and managers often have fundamentally different backgrounds and outlooks. And too often the roles research and management play are not clear to the public.

> As the novelist Henry Miller said, "We do not talk—we bludgeon one another with facts and theories gleaned from cursory readings of newspapers, magazines, and digests."

The purpose of this book is to suggest ways that researchers and managers can work more effectively with each other and with the public at large. The premise is that all research done in protected areas can enhance their management—even that which only peripherally addresses an immediate problem. Likewise, management of protected areas should accommodate rather than discourage research. And both researchers and managers should be willing to work with the public.

Let us take a look at two basic types of research as it relates to protected area management. Then we will move on to an overview of the different people involved in the equation.

Academic vs. applied research

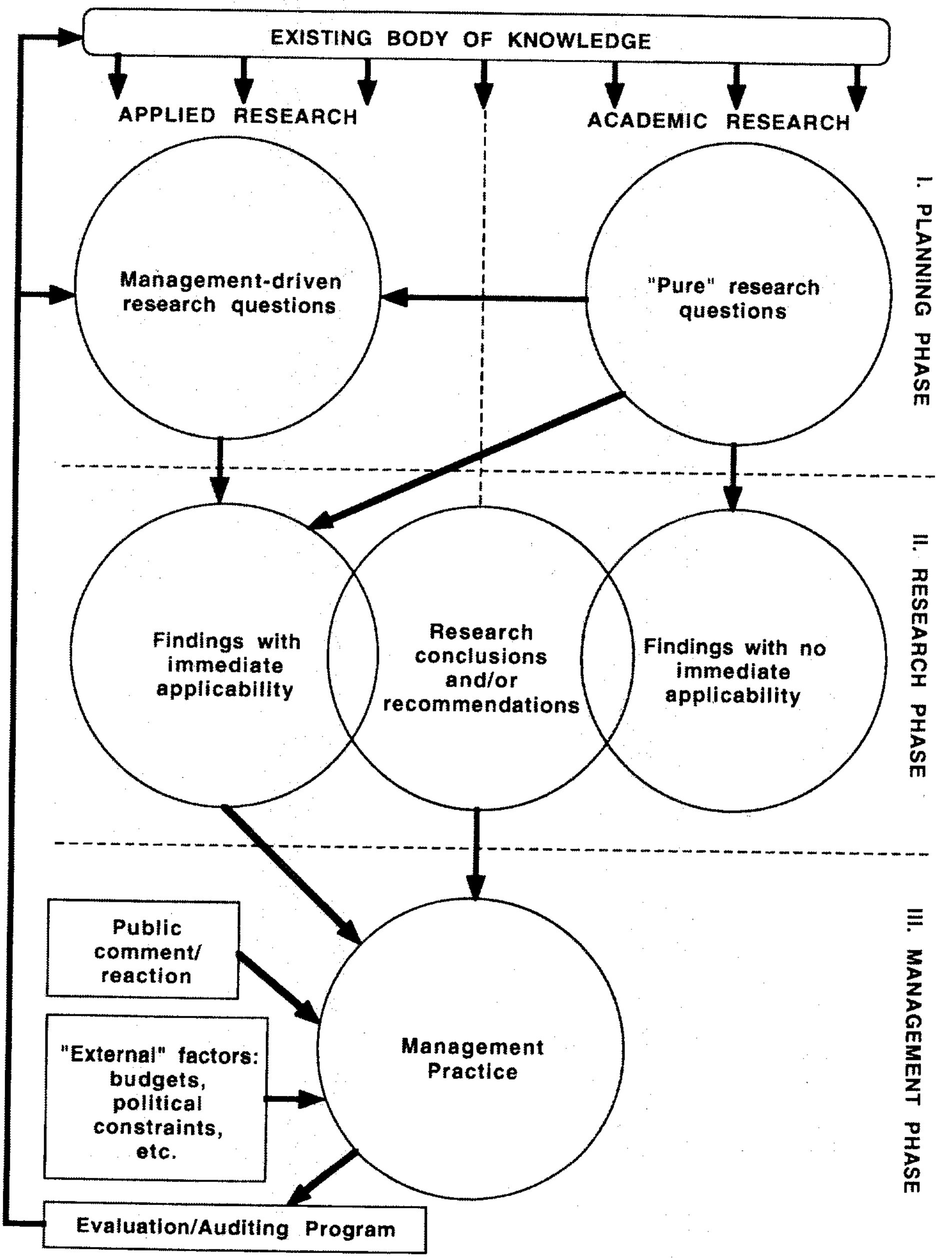
In terms of protected area conservation, *academic research* seeks to advance the frontier of knowledge for its own sake, while *applied research* is oriented toward or determined by managerial concerns. The latter is "management-driven," while the former is not. Applied research divides into three overlapping areas:

- Scientific and cultural research, which encompasses the natural sciences; history, archeology, and related fields; and technical disciplines such as historic preservation, curation, and data management.
- Social science research, which focuses on protected area conservation as a socioeconomic process revolving around the allocation of scarce resources and the management of human behavior.
- Operations research, which tries to make management more effective and efficient.

Given the financial constraints common to all park agencies, applied research must be given the highest priority, but even purely academic research should be welcomed as an added justification for having protected areas, as long as it is cost-effective and does not conflict with their objectives.

In practice, there is no absolute, stark division between applied and academic research: the two often grade into each other. However, the dichotomy is useful for visualizing (in simplified form) the research–management dynamic (Figure 1.1). The process falls into three phases:

Figure 1.1. The research–management dynamic



Source: adapted from Friedmann and Weaver 1979

(I) a planning phase, in which researchers, managers, and interested members of the public devise a range of possible research questions; (II) a research phase, in which the studies are actually done; and (III) a management phase, in which resource management activities are carried out in the field. During the planning phase, the questions will be broadly management-driven (aimed at addressing a pressing issue) or "pure" (aimed only at advancing knowledge). Research on management-driven questions will, during the second phase, yield findings with immediate applicability. "Pure" research may as well, though it is more likely to produce results not immediately applicable. Both types of findings can overlap into research conclusions and recommendations, which are then turned over to managers in the third phase. As we shall see, managers may not always use these conclusions or recommendations, but at least they are an additional source of information. Managers also may make direct use of findings that have immediate applicability, independent of any conclusions or recommendations from researchers. At the same time, managers take into account public reaction and other factors such as budgetary and political constraints. Finally, management practice is (or at least should be) filtered through a formal review program so that adjustments can be made and mistakes corrected. The results of the evaluation are then taken into account during the next round of formulating research questions.

Again, it is worth emphasizing that, in practice, the line between academic and applied research is frequently indistinct. Often, what appears to be "pure research" is in fact a prerequisite to developing an applied research program. For example, purely descriptive research to determine the biota of a region is required to form a basis for management-derived research at a later time. This sort of research could be called "basic"—it is basic to both academic and applied research. As such, it forms part of the "existing body of knowledge" (top, Figure 1.1) that informs both sides of the research–management dynamic.

The human equation: researchers, managers, and the public

A second way to categorize the research–management relationship is to look at differences between the groups of people involved. Researchers can be broadly classified into *scientists* and *cultural researchers,* while managers can be divided into field-level *resource managers* and senior-level *administrators.* The fifth group, the *public,* itself falls into a number of categories.

Scientists. The natural sciences (biology, ecology, geology, and many others) use the scientific method to try to understand natural phenomena. The social sciences (anthropology, economics, geography, psychology, political science, sociology, and others) apply the scientific method to understanding social behavior.

Although not the only means of advancing knowledge—the comparative method and systems analysis are two other techniques used in science—the scientific method is a long-standing and widely accepted process designed to impose objectivity on the solving of problems. Its goal is to uncover truths about the world in a never-ending process of examining testable hypotheses. As each new hypothesis is tested, new insights challenge currently accepted knowledge. These new insights may even eventually supplant the status quo if other scientists retest the theory and find it valid. Thus, through a rigorous and measurable process of consensus-building, a new set of truths emerge. (See Box 1.1, "Demystifying science," and Box 1.2, "The scientific method.")

For the scientific method to work, its practitioners must minimize subjectivity in their work. Opinions must be framed in the form of a testable hypothesis; otherwise they lie outside the bounds of the method. In addition, scientists must necessarily take a long view of their work because each new generation will challenge the truths of their predecessors. Because the process is never-ending, research is valued for its own sake. Whether the research has immediate utility may not be so important as whether it reveals some new insight into the subject. It should be noted, however, that some scientists are becoming more mission-oriented in the face of pressing environmental problems. This has led to the creation of subdisciplines which try to meld action and theory (e.g., conservation biology, ecological economics).

> Familiarity breeds confusion. Those afflicted are the experts in the world who, so bogged down by their own knowledge, regularly miss the key points as they try to explain what they know.

Cultural researchers. Cultural research (encompassing history, archeology, and related fields) differs from that in the natural and social sciences in several important ways. It proceeds by the continual reinterpretation of human activities, both past and present. The goal of cultural research is to generate many interpretations of events, often without the explicit use of hypotheses. Facts are collected as objectively as possible; once collected, the researcher derives an interpretation and a synthesis is developed. Subjectivity is not necessarily eschewed, though it must be supported by facts. In some disciplines the "personality" of the researcher may be much more evident than in the natural sciences. Nevertheless, the validity of cultural research is, like that of science, determined by the amount of consensus it commands among the researcher's peers. (It may take years for consensus to develop; thus, the value of research may not be immediately apparent.) Cultural researchers also take a long-term view

Box 1.1. Demystifying science

There is nothing magical about science. We practice the basic tenets of science in many of our everyday activities. For example, fixing a car that won't start requires the same approach as solving a problem with declining populations of rare species in a protected area.

Problem	
■ The car will not start.	■ The population of a rare species is declining.
Make initial observations to describe the present environment	
■ The gasoline tank is full.	■ There appears to be no increased number of predators.
■ The battery is not dead.	■ There has been no change in habitat.
■ The motor turns over.	
Develop testable hypotheses	
1. The spark plugs do not fire.	1. There is not enough food for nestlings.
2. Gasoline is not getting to the cylinders.	2. Eggs are not hatching due to thinning of the shells.
3. The timing is out.	3. Nest attendance by parents is poor.
Design experiments to test hypotheses	
1. Take the spark plugs out and test if they fire.	1. Increase the food through a food supplement experiment.
2. Check the fuel pump.	2. Compare the shell thickness of eggs in nests with those from museum collections.
3. Check the timing.	3. Conduct a study to determine nest attendance and hatching success.

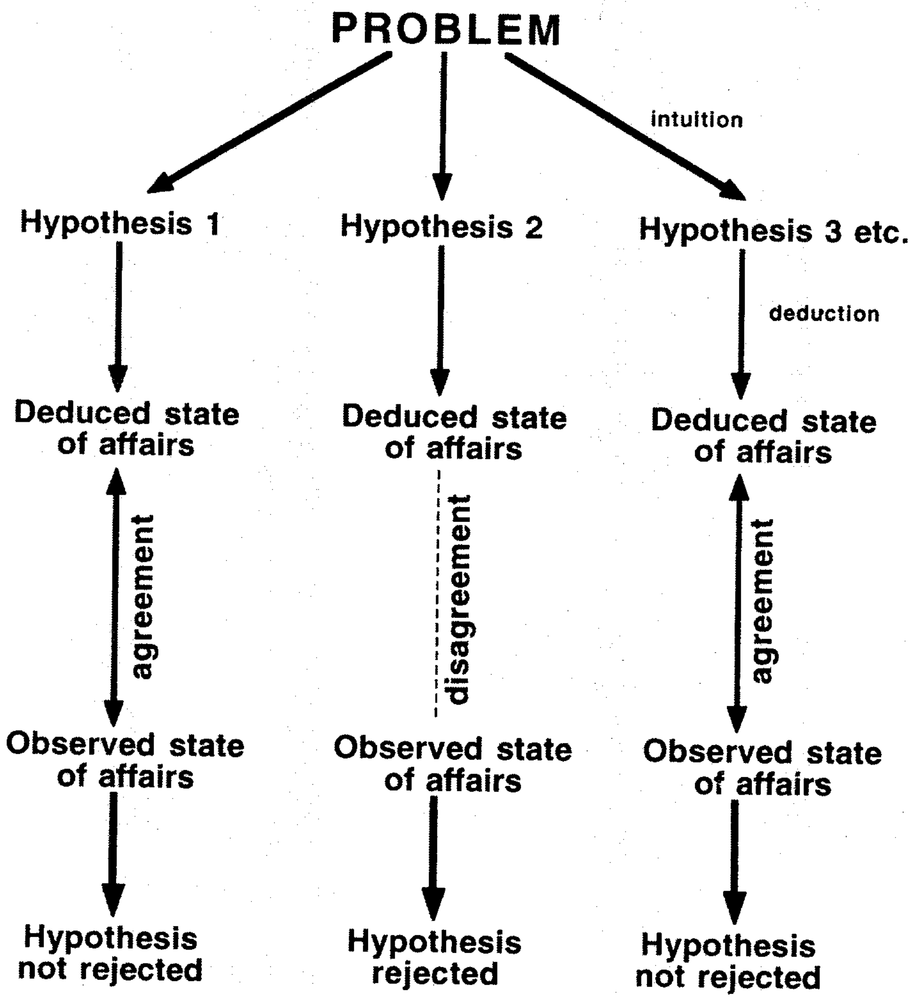
Conclusion

Hypotheses not rejected are the probable cause of the problem.
Remedying the cause should solve the problem.

Source: contributed by Søren Bondrup-Nielsen and Tom Herman

Box 1.2. The scientific method

The scientific method may be called the "hypothetico-deductive method," where deduction in logic refers to reaching a conclusion by reasoning from an assumption. It is important to keep in mind that we can never prove something; we can only disprove it.



We observe or conceive of a problem. Intuition and preliminary observations lead us to carefully articulated hypotheses. Hypotheses are rejected when there is not agreement with the observed and deduced state of affairs. It is important to develop several alternative hypotheses since hypotheses can only be rejected and not proved.

Source: contributed by Tom Herman and Søren Bondrup-Nielsen

and value research for its own sake, although, again, some are becoming more mission-oriented (e.g., historic preservation specialists).

Resource managers. In contrast to researchers, resource managers aim to solve problems as they arise—although the best plan ahead to avoid crises. Their goal is to manage one or more resources or activities (e.g., wildlife, historic properties, visitor use, etc.) to further a broad set of objectives that have been laid for their protected areas. Resource management is something of a hybrid, combining the intellectual detachment of the researcher with the hands-on involvement of the ranger/warden. This makes it a profession with unique challenges. Often resource managers are under pressure to produce solutions for a problem (or at least do *something* about it) in a short time. They strive for objectivity, but must respond daily to forces from within a very subjective arena: the world of politics. There is scarcely a protected area in the world today that is not, to some degree, controversial. Resource managers are on the firing line of the disputes. Consequently, they value research mostly as a tool to solve pressing problems.

Administrators. Upper-level managers and planners within the protected area agency differ from field-level resource managers in degree rather than in kind. Instead of focusing on individual resources, their goal is to carry out the entire set of objectives for a protected area or system of areas. More so than field managers, administrators are in closer contact with the political power structure. In the upper reaches of an agency, they may have regular interactions with ministers, members of national legislatures, and even heads of state. Administrators function as a conduit between the politicians and activities in the field. So it is that resource managers working in the field may well have everyday interests and concerns quite different from those of upper-level administrators. Even within the same protected area, one can find resource managers and superintendents with decidedly divergent perspectives.

The public. International experience over the past twenty years has made it abundantly clear that protected areas need the support of the public. Here we need to distinguish between the general public, short-term users of protected areas, and local people who live close by. Broad support from the general public, even those who have no direct contact with protected areas, is obviously important to maintain—if for nothing other than political considerations. Short-term users, such as tourists, can have tremendous direct impacts on the resources and attributes of a park. And time after time, the lack of local support has undermined the conservation objectives of particular protected areas.

A lack of public support on any level not only hinders the work of managers; it also affects research. Researchers are chronically short of funds, and this is ultimately caused by the low priority given to protected area research by governments and donor agencies. This situation is directly attributable to the fact that the public is not used to thinking about protected areas as sites for research. In the end, a large segment of the public takes a short view of protected areas, thinking of them as mere destinations for visits—or as hindrances to their livelihood. Neither management agencies nor research institutions have done nearly enough to change this. Both managers *and* researchers are the losers.

Why do rifts form between research and management?

Of course, all this is generalization—useful for sketching, in broad strokes, the outlines of the research and resource management professions and the public's interest in parks. Though there certainly will be individual exceptions to these sketches, the important point is that many researchers are vitally interested in the management implications of their work, just as many resource managers care deeply that their decisions have a solid research foundation.

There is no inherent chasm of intellect or temperament that separates researchers from managers, yet it would be less than honest not to acknowledge that important distinctions often exist between them. Differences in status, decision-making authority, financial support, and so on can drive a wedge between the two groups. For instance:

- In many cultures a higher status is associated with formal education. Researchers generally have more advanced degrees than managers, and thus may be tempted to look down upon them. Managers, on the other hand, tend to have more practical problem-solving experience than researchers, and thus might be disdainful of those who don't work daily in the field or are "overly specialized."
- Researchers and managers rarely share decision-making authority. When managers wield exclusive power, researchers are put into a subordinate position from which they must try to persuade managers of the value of their work.
- The two groups differ in salary, program funding, the size and quality of facilities made available, etc.
- Researchers and managers are trained to "perform" for their peers, not each other. This can lead to both groups tending to think of the other as a competitor—or, worse yet, an adversary—rather than as a partner.

In addition, the work of researchers can limit the discretion of managers (as when, for example, research reveals that a site slated for a visitor facility is critical habitat for a rare species), just as managers can limit the discretion of researchers by imposing restrictions on their field work.

Success in a research career is not won by making a manager's job easier. And no manager is going to advance by promoting research that has no recognizable bearing on a protected area's problems. The solution does not lie in creating a hybrid "researcher-manager," but rather in recognizing the advantage of having divergent approaches when dealing with protected area resources. Out of the tension and interplay between them come solutions that could not have come from either alone.

Let's say two people are talking about a project they are both working on, and Person A introduces new material. This will most likely set off a warning bell in Person B, who will start to worry: "Should I have known this? How did she find this out? What's wrong with me? How can I pretend that I knew this too?" While Person B is berating himself with these questions, he is likely to miss the chance to make the new material his own, to ask the questions born of a genuine desire to learn.

Bridging the gap by building respect

When rifts do form between research and management, poor communication is usually the reason. Too often, neither group understands the type of information the other can provide. This leads to a situation where managers fail to explain their needs to researchers, and vice versa. Often this occurs out of an inability to "listen." Communication skills are critically important.

Institutional mechanisms must nurture communication and reward researchers and managers for working in partnership rather than in opposition. In such a partnership, they would retain the responsibility to engage in reasoned debate with each other, as well as among themselves. This would foster mutual respect—the prerequisite for success in coordinating research and management. Building respect must begin on a one-to-one basis and then spread throughout the organization. The first step is to encourage the individual researcher and manager to understand one another.

2. Encouraging researchers and managers to understand each other

What researchers need to know about managers

First and foremost, researchers must keep in mind that managers primarily want information that relates directly to current concerns and issues in their park. Theoretical or long-term research, important as it is, does not serve management interests unless some component of it is relevant to what's happening now. For example, a theoretical model of predator-prey interactions in a park would certainly be valuable to wildlife managers, even if it were eventually disproved. On the other hand, a theoretical model of genetic variation among populations of a single abundant species might have little management relevance. (See also Box 2.1.) Researchers should acknowledge that the manager's need for relevance is a valid one, and try to envision components of their research that will accommodate it.

Box 2.1. Theory versus practice: the example of nature reserve design

In the management of protected areas, there will be many times when valid scientific theory has to yield to the exigencies of circumstance. For instance, the theory of island biogeography (MacArthur and Wilson 1967) posits a direct relationship between the size of an area and the number of species of a particular group of organisms to be found in it. The theory sparked a contentious debate about the optimal size and design of nature reserves for given regions: Does a single large reserve more effectively safeguard species, or do several small ones? There are strong arguments in favor of larger over smaller reserves, but many protected areas predate this research and expanding them to accommodate its findings is out of the question. Furthermore, smaller nature reserves may be important from the point of view of national or local biodiversity.

Small protected areas also have proven useful as sites for long-term research. Thailand's Sakaerat Environmental Research Station (7,458 ha in extent) is a case in point. Ecological and socioeconomic research at Sakaerat has provided insights into rehabilitating forest lands degraded by agriculture and mining. Sakaerat's easy access and facilities have enabled Thailand's National Research Council, its Institute of Scientific and Technological Research, and Kasetsart University to cooperate on research that has had direct implications for sustainable development. To cite another from many further examples, quite valuable botanical research has been carried forward at Ecuador's Rio Palenque Biological Station, which covers only about 0.1 sq km but contains over 1,000 plant species, many currently known only from a single living individual (Gentry 1982).

Source: contributed by Natarajan Ishwaran

Managers are usually generalists, not specialists. It is unlikely they will be familiar with the technical background of every subject they have to deal with. When working out the specifics of a project with managers, researchers should spend time making sure they understand the background. This is far more important than bombarding them with the details of the research process. Often, it will be enough for managers to be assured that sound practices are being followed.

Once again, the *conclusions* are what managers are most interested in. They must be clearly stated in readable language that avoids jargon. Where possible, graphics should be used to illustrate key points. Any statistical or other technical qualifications should be fully explained, and the significance of the results and their possible relevance to management should be laid out. Some notion of the relative importance of the conclusions should be given so that managers have an idea of how best to spend their time and money.

What managers need to know about researchers

For their part, managers must keep in mind that researchers are not necessarily trained to think in terms of immediacy. Research that seems to have no value today may be important tomorrow. A good example is the ethnographic work on Native Americans sponsored by the U.S. government in the 1800s. To many at the time, it seemed esoteric, a waste of money. Now it is proving an invaluable source of information for all kinds of cultural researchers and scientists who are trying to understand long-term social and environmental patterns. Managers should try to envision how components of research might be relevant in the years to come, not just right now.

Researchers are often specialists, not generalists. This is often a barricade to communication. The jargon that so confuses everyone else serves them well within their field because it is a valuable shorthand intelligible to their peers. Although they often use jargon to save words, researchers tend to shun other shortcuts through fear of being left open to criticism. Managers shouldn't be expected to master the jargon of every field, but they do need to be willing to work to understand how abstract research can be relevant to their jobs.

A long-standing source of misapprehension is the idea that research's primary function is to clear up uncertainties. In fact, scientists often simply exclude uncertainties by postulating theoretical models which are assumed to be correct. If uncertainties reach the point where the model itself is threatened, the model is changed. This is, practically speaking, the only way to deal with global phenomena such as climate change. Different principles govern cultural research, but the mode of operation is largely the same. Managers must therefore draw a distinction between uncertainty and ignorance. Both scientific and cultural research attempt to decrease ignorance—but, ironically, the more we know about the world, often the less certain we can be about how it really works. The theory of evolution is an example which leaps to mind: it tore down the prevailing shell of certainty even as it provided epochal insights into existence.

Unfortunately, there is a great deal of pressure on protected area managers to find certain resolutions to contentious issues. Unless it is understood beforehand that research may in fact *hinder* that search, then the relationship between researcher and manager can sour rapidly.

> "First, we need theories to live by. A theory is an intellectual armature which allows only certain facts in; other inconsequential facts can be screened out, untouched, not to be worried about. We will all die of word pollution if we allow our minds to become empirical dustbins where every fact is as salient as any other."
> — Warren Bennis

The politics of management

Such a widening of possibilities may or may not be welcome to the manager. This ambivalence comes naturally to those who work in a bureaucracy. Everyone knows that park bureaucracies can take on a life of their own, and that employees often succeed, at least in part, by furthering the bureaucracy rather than serving the needs of the parks themselves. So it is that some managers may be more comfortable operating within a narrow range of possibilities. For them, research can be threatening. While it is easy to condemn such an attitude as small-minded or careerist, it would be well to remember that the attitude is a logical response to the way the system is set up and that the system, for all its flaws, does at least tend to promote stability in the administration of protected areas.

The flaws endemic to park bureaucracies—chronic underfunding, political manipulation, the overemphasis on short-term actions, the tendency to hold field personnel exclusively responsible for failures and controversies, the unwillingness to tolerate uncertainty and ambiguity—all help explain certain management decisions. To a manager, saving 5% on the cost of getting a task done can be a more important consideration than paying full price for only a slightly better job. Under some circumstances, a decision that flies in the face of research findings makes sense if it represents the only politically feasible alternative. Likewise, in sensitive situations a reluctance to act on research recommendations makes sense if there is a strong likelihood that doing so will spark contention.

So politics intrude, and the conclusions of research—even those wholeheartedly welcomed by managers—will not always dictate management decisions. Is this necessarily bad? Unless we are to descend into a sterile cynicism, we must believe that scrupulous politicians who care about parks do exist, and that their decisions are taken with the best interests of society and the environment in mind. (See Box 2.2.)

The politics of science

It may not be so obvious, but scientists, like managers, work in a world ruled by politics—some of it internal, some external. It is considered a natural tendency of scientists to be extremely cautious in relating results of their study. Scientific tradition—which is just another way of saying the internal politics of science—favors those who do not overstate their conclusions. As noted, the scientific method seeks to impose discipline on inquiry, and tends to promote a conservative, incrementalist view.

The classical view of science is one of pure, disinterested inquiry driven solely by the thirst for knowledge, with scientists keeping their distance from the messy and vituperative world of politics. This view is, at best, naïve. Many scientists believe it their professional duty to stand aloof from the political process, but, as Young (1989) notes, "it is virtually impossible for the scientific community to avoid becoming—and being perceived by others as becoming—another interest group" in the political arena. Why? "The fact is that the scientific community, like other interest groups, is made up of human beings who have distinct values and policy preferences" which they try to promote. Scientists who sit on the sidelines are liable to have their conclusions manipulated by interest groups who do not abide by the scruples of the scientific method.

> The problem with interests is less one of making choices than one of distinguishing interests from obligations. Many people can't distinguish their genuine interests from the subjects they think would make them more interesting as individuals—true interest versus guilt or status.

Researchers are also just as liable to careerism as managers. They too must deal with bureaucracies, and, although academic institutions are markedly different from government agencies, they share some of the same flaws, particularly underfunding and political manipulation. In the real world, research is no more exalted than management.

Box 2.2. The politics of research and management: perspectives from two policy-makers

One hopes that a conscientious politician's wider view of events will serve protected areas well over the long haul. More specifically, such a person sometimes may be better able to tell what is needed for a successful research–management partnership than researchers or managers themselves. Here, John Leefe, a former Minister of Environment and Natural Resources for the Canadian province of Nova Scotia, offers his perspective, which emphasizes the need to achieve consensus.

> Researchers and managers live in a symbiotic relationship. Without management-initiated action, the researchers' endeavours are sterile. Without good service generated by researchers, managers will, only by the best of good fortune, make the right decisions. Most frequently their decisions will be at best inadequate, and at worst destructive.
>
> The last thing a manager needs is a staff captured by activism. While singular and highly focused activism can play an important and often positive role in society, it becomes entirely counter-productive in the internal formulation of public policy by governments. It breeds distrust, whereas mutual respect and the trust it engenders are absolutely essential to sound public policy creation and implementation.
>
> Good decision-making must be based on good science. The former will only occur where managers know they can trust the judgment and advice of their advisors. The latter will only occur where the researcher has the real sense that his toil will result in the right decisions being taken.
>
> Every successful partnership reflects a high level of trust, frank honesty, a joint sense of commitment, and an acceptance of accommodation in priority development—though certainly not compromise on matters of principle. The health of the symbiosis is entirely dependent on the will of the partners to make it work. The public interest is, in the short term, captive to the capacity of managers and researchers to team their abilities. When pushed beyond reasonable limits, patience exhausted, the public will remove the managers and hold up the researcher to ridicule—and all will lose.
>
> Paradise lost or paradise regained: the public interest is very much bound to the essential relationships between scientific and management functions. It is a wondrous responsibility not to be squandered in the morass of false principle and resultant lost hopes.

Exactly what constitutes "the public interest" is of course a matter of some debate, but it can be argued that one of its bedrock principles is *national security.* Protected areas, like all other important social institutions, must be ready to adapt to the new realities of the post-Cold War era. Writing about future scientific research agendas, a prominent national legislator from the USA, George E. Brown, Jr., puts it this way: "There is an emerging consensus that national security needs to be redefined to encompass a strong and growing economy; a healthier environment; a reduction of global tensions caused by economic disparities and ethnic, cultural and religious conflicts; and adaptive institutional structures (bureaucracies) able to respond to human needs promptly and efficiently" (Brown 1993). The economy, the environment, social justice, and flexible governance: four core concepts of the "new national security." All of them non-military, and all of them capable of being furthered by protected areas. Brown's message is clear: increasingly, governments "will not act to fund programs they perceive as unrelated to the evolving security goals" of the post-Cold War world. "As policymakers try to draft a blueprint for science that conforms with new global realities, many in the scientific community view this as a thinly veiled attempt to substitute the judgment of politicians for that of scientists in selecting the research agenda of the future. Those scientists seem genuinely unaware that political priorities have always dictated the general allocation of research funding. . . ." Brown's is writing of the USA, but his analysis applies equally well to many other countries, and to protected area management regimes as well as research.

The message to the research and management community is: if you want support, (1) make sure the public and politicians understand the role protected areas can play in fulfilling the "new national security"; and (2) learn to "reconcile these political standards with [your] own standards of excellence and political autonomy" (Brown 1993).

What researchers and managers need to understand about the public

The general public is largely uninterested in the administrative details of research and management. We should no more expect the average person to know about the ins and outs of a park bureaucracy than we expect a bank customer to understand the double-line accounting system. However, it is important to recognize that the public can be vitally interested in both the *process* and the *results* of research and management. *It is a fatal mistake to underestimate the public's intelligence or inquisitiveness.* Gearing all communications with the public to the lowest common denominator assures a self-fulfilling prophecy. Providing an occasional dollop of bland, mundane, self-serving information shows disdain or contempt for lay people. Instead, researchers and managers can work together to provide a stream of challenging in-depth information on how the park is administered, how resource management works, what the role of research is, what mistakes have been made, and how the public can help find solutions to problems. The advantage? For one, the public will know that it is being taken seriously, and that leads to more support for the park and its objectives.

As you learn about something, try to remember what it is like not to know. This will add immeasurably to your ability to explain things to other people.

The days are over when agencies can run protected areas by fiat without a murmur from the outside. Some countries have elaborate systems designed to encourage participation in and comment on important management decisions; where such systems exist, public participation is usually vigorous and (increasingly) contentious. Where they do not, there are many forms of *de facto* "input" available to the public: agricultural encroachment, poaching, illegal harvesting of plants, and vandalism, to name just a few. Either way, the public is having its say. Simply put, if park authorities want respect from the public, they have to give it first.

3. A blueprint for thinking about park problems

The first two chapters have tried to establish the basis for a common understanding between researchers and managers. By outlining differences between them—in philosophy, training, and method—it is hoped that practitioners in both camps will be able to recognize and set aside their own biases and (if nothing else) acknowledge the validity of the other's point of view. Once mutual respect is established, then the groundwork will have been laid for building an effective research and management team.

It is now something of a maxim to say that challenges facing the world's protected areas are complex, that solutions will come increasingly through cooperation, and that success ultimately depends on activities taking place outside park boundaries. Given this, we might ask ourselves whether there are any general principles to guide researchers and managers on how to think about these daunting challenges. Are there blueprints for good thinking?

The answer is "yes." Any number of psychologists, philosophers, and educators have sat down and thought about thinking: what separates reason from speculation, the elements of clear cogitation, the most common traps of faulty logic, the most tempting side-roads into illogic. What we'd like to do here is offer one blueprint from the many, based on the work of Wade and Tavris (1990). They lay out the principles of "critical thinking," which is "the ability and willingness to assess claims and make objective judgments on the basis of well-supported reasons." This is the key: researchers and managers must become critical thinkers—together.

As Wade and Tavris point out, the critical thinker is one who has developed "the ability to look for flaws in arguments and resist claims that have no supporting evidence." Critical thinking is not merely negative thinking; it "also fosters the ability to be creative and constructive—to generate possible explanations for findings, think of implications, and apply new knowledge to a broad range of . . . problems." *Critical thinking cannot be separated from creative thinking; only by questioning* "what is" *can one imagine* "what can be."

There are six steps to achieving critical thinking:

1. Be willing to wonder. The trigger for critical thinking is the willingness to ask "why?" Children ask "why" questions naturally (sometimes incessantly), but we seem to get this inquisitiveness drummed out of us as we pass into adolescence. By the time we reach adulthood, the fear of appearing to ask a dumb question is enough to paralyze most of us. Yet "why" questions typically uncover the *process* of the world around us, and so are especially valuable in shedding light on protected area research and management—which is, after all, a process itself. The worst situation for researchers and managers to find themselves in is one in which both groups think they know what the problem is—*especially* if they agree. Industrial engineers are taught to walk through a factory and question everything, even successful procedures that have been used for years. This would be a healthy attitude to bring to any research–management collaboration. At the start, managers should probe every research assumption, and vice versa. The first two questions on the table should be: "Why are things the way they are?" and "How did they get to be this way?" Working through this background together brings both sides closer to the same starting point in terms of agreed-upon knowledge. And, in the right atmosphere, a sense of camaraderie may emerge. The right atmosphere, needless to say, is one of collegiality, not hostility. Egos will have to be put on the shelf.

> **Most of us have been taught since childhood, at least implicitly, never to admit ignorance. We've all heard the parental admonition: "If you keep your mouth shut, the world can only suspect that you are a fool. If you open it, they will know for sure." This plays on an almost universal insecurity that we are somehow lesser human beings if we don't understand something. We live in fear of our ignorance being discovered and spend our lives trying to put one over on the world.**

> **You must always ask the question "What is?" before you ask the question "How to?"**

2. Analyze assumptions and lay them out. Critical thinkers evaluate the assumptions and biases that lurk beneath the veneer of reason. They ask how these assumptions influence claims and conclusions put forth in defense of a particular action or idea. They also are aware of their own assumptions and are willing to question them. Delving into assumptions is not easy work, and can require cultivating a new way of looking at things. Healthy skepticism is called for—without searching for an ulterior motive in every innocent utterance.

Be wary of research questions (and managerial reactions to proposed questions) with built-in, unexamined assumptions. Hard as it may be to do, both parties should try to communicate their assumptions and biases, and be aware of the outside political forces that shape them.

3. Examine and re-examine the evidence; then consider other interpretations. A truism? Maybe, but many popular beliefs hold sway even though there is only bad evidence, or none at all, to support them. The same goes in the field of protected area conservation. For years it was assumed that

Yellowstone-style national parks were the only worthwhile type of protected area and that anything else was a pale imitation. That value judgment went largely unexamined until the 1980s, when evidence from case studies began to mount showing that, in many places (and not exclusively in the developing world), an exclusive reliance upon strict reserves was hindering rather than helping conserve nature. Within scarcely a decade the groundwork of park planning has been dug up and recast, to the point that the major thrust in protected area conservation today is toward more flexible, nonexclusionary designations. Biosphere reserves, greenways, protected landscapes—these are some of the new types of protected areas designed to be integrated into the daily life of nearby communities. They are used as tools for sustainable rural development, urban revitalization, and even cultural preservation.

For many years, I had an idea in my mind of what the Pantheon in Rome looked like. Then, the instant I saw it, I forgot the picture of it that existed only in my imagination. It's as if there was a file in my mind under the heading "Pantheon." Once I saw the real thing, the image ran over or erased the original. Once you see or understand something, you cannot conceive of what it was like not to have seen or understand it. You lose the ability to identify with those who don't know.

Another example: Until quite recently, park interpretation treated native societies as dead history, relics, even impediments. Now there is increasing evidence that, far from being sterile curiosities, traditional lifeways may represent a vibrant and effective "back to the future" approach to environmental ethics—one which may turn out to be the key to humankind's making peace with the Earth. This evidence derives from a surging worldwide interest in native cultures on the part of nonnatives, and by the increasingly effective reassertion by native peoples of their own heritage and concomitant rights. Thus, park authorities are beginning to accept participatory management strategies designed to include natives, and even co-management arrangements where day-to-day authority is shared or given over. In both examples, through the examining and casting-anew of what was "known," protected area conservation has been fundamentally changed. Examining and re-examining evidence is what puts flesh on the bones of assumption.

Think about opposites. When you have a problem, think of one solution, then of its opposite.

Stubbornly accepting a conclusion without evidence ("Nothing you say will ever change my mind") is a sure sign of uncritical thinking. Uncritical thinkers attempt to marshal every conceivable argument in favour of their opinions, and let it go at that. Critical thinkers always rehearse the arguments *against* their opinions, and indeed try to shoot themselves down. They think, "What evidence supports *and* refutes this line of reasoning, as well as the opposing line? How reliable is the evidence?" The ultimate goal is to find an explanation that accounts for the most evidence and relies upon the fewest assumptions. The critical thinker also knows that merely because a strategy or technique has always been successful in the past does not indicate, let alone guarantee, that it will work in the future.

A note of caution. The *willingness* to abandon old assumptions should not be confused with a *readiness* to do so. You should embrace new paradigms (and new uncertainties) only after evidence demonstrates that a move is warranted.

4. Avoid reasoning based solely on emotions. Many people involved with protected areas are passionately devoted to their work. The very idea of creating a protected area, of committing an expanse of land or water to a special set of purposes—not for 25 or 50 or 100 years but for all time—is nothing less than an act of consecration. Someone willing to undertake such a profoundly serious task can well be expected to bring to it a sense of high purpose. It would be less than human for the conscientious park professional not to be emotionally involved.

Indeed, emotion plays a valuable role in critical thinking by tempering any tendency toward overly technical (and dehumanizing) calculation. After all, most research and management decisions must account for either (1) cultural resources that carry emotional as well as intellectual significance; or (2) associations of plants and animals that have differing status in the eyes of people. The strategy of focusing on "charismatic megafauna" as a lever to protect an entire ecosystem is a perfect example of using emotion to advance a reasonable aim. It can even be argued that, were it not for emotion, most protected areas would never have been created.

Still, the recognition that we are emotional beings (and rightfully so), and that there is a whole set of equally non-scientific moral and ethical judgments underpinning protected area conservation, does not negate the fact that feelings alone are not a reliable guide to the truth. Researchers and managers should try to pinpoint the technical and emotional aspects of an issue and then weigh them separately. Only in this way can it be determined which of the subjective aspects are appropriate for including in the decision. Many misunderstandings can be avoided if everyone is clear on this.

5. Don't oversimplify. A critical thinker sees through and then looks beyond the obvious, resists easy generalizations, and rejects "either/or" thinking. By grabbing the most obvious solution to a problem, you run the risk of missing fine details and implications that may be important in the long run. Generalizing from particulars to universals (i.e., using inductive reasoning) is a deceptively tough job; any answers that come easily are probably wrong. Likewise, casting a decision as "either/or" locks it into a false dichotomy and shuts out shadings and nuances that are vital to accurately reflect the complex issues surrounding protected areas.

Well-considered simplification is fine, even necessary, for dealing with these complexities. For example, computer-based simulations of natural systems can be very valuable tools. Similarly, social science models, and schools of thought in disciplines like history and anthropology, are indispensable to researching and managing cultural resources. Modeling must not displace fieldwork or research into primary materials, however.

> When you can admit that you don't know, you are more likely to ask the questions that will enable you to learn. When you don't have to filter your inquisitiveness through a smoke screen of intellectual posturing, you can genuinely receive or listen to new information. If you are always trying to disguise your ignorance of a subject, you will be distracted from understanding it.

6. Tolerate, even embrace, uncertainty. The desire for certainty is arguably one of the few truly universal human needs. All the world's great social institutions, from civil government to religion, are purposed on providing a measure of certainty to our all-too-often bewildering existence. The most basic premise behind protected areas—that they will exist in perpetuity—is a testament to the desire for certainty. Ironically, it is becoming more and more apparent that the path to perpetuity may wend its way across *terra incognita*. In the eyes of a U.S. park superintendent, "the job of a park manager has changed from a strict custodial and technical response to agency regulations, guidelines, and manuals, to a more wide-ranging, strategic profile pursuing stated but often vague public purposes, through programs whose outlines are rarely more than sketched" (Arnberger 1991).

Another U.S. park professional states flatly that "the most important skill for future [protected area] employees will be the ability to tolerate ambiguity" (Smith 1991). He goes on to list other necessary skills, all of which relate to that. Success will go to those who:

- Manage change rather than allow themselves to be engulfed by it.
- Take risks based on priorities that have been clearly communicated.
- Are comfortable with controversy, ready to negotiate, and able to resolve conflicts constructively using a thorough understanding of prevailing politics.
- Not only recognize and deal with cultural diversity, but value it as well.

- Focus on results rather than on the bureaucratic method that leads to decisions.
- Analyze complex issues and visualize solutions.

Never nod your head at something you don't understand. Practice saying "Could you clarify that?" or "I'm not sure I understand what you are talking about" in front of your mirror. This can be a disarming tactic. It speaks of a childlike innocence.

Researchers find themselves in a uniquely difficult position whenever they are considered to be "the experts" on a subject. People expect experts to be able to provide them with certain answers, not simply a range of plausible possibilities. Already we have noted that advances in scientific and cultural research tend, in a seeming paradox, to heighten rather than lessen uncertainty.

Critical thinkers can handle uncertainty and ambiguity because they are self-confident enough to be able to say "I don't know." The best thinkers actually relish their own ignorance. And they do not allow the fact that today's knowledge could be overthrown tomorrow to deter them from forming convictions; on the contrary, they seek to make new ideas their own. Yet they can relax their embrace, too. They don't become dogmatic or doctrinaire. How? By avoiding the common mistake of *defining themselves* in terms of their beliefs.

We tend to perceive the things that relate to our pre-existing interests and attitudes—either to support or refute them. People have a tendency to shun information that contradicts these, whether consciously or not.

These are the six steps, each of which implies extraordinary talent and flexibility. But in the end, say Wade and Tavris, "critical thinking is as much an attitude as it is a skill. All of us are much less open-minded than we think. We take comfort from believing that only *other* people are biased or need to think more clearly. Critical thinking requires you to be willing to submit even your most cherished beliefs to honest analysis."

4. Designing a coordinated research and management program

Before research begins

The research capacity of protected areas is far too limited to squander on ill-considered or haphazard projects. Money is short, personnel are few, and problems are many. All research in protected areas should fit into a larger, integrated research and management plan. The plan should identify research needs, rank them, lay out a schedule for meeting the most important needs first, and provide a framework for relating all research results to specific management actions. The plan should be co-designed by researchers, managers, and the public. Public participation is essential since research in protected areas often has ramifications for local people.

> The essential components of good directions are:
> *Time.* Directions should include the estimated time that the entire task should take.
> *Anticipation.* The sights you can expect to see along the way are reassuring checkpoints that you are on the right path.
> *Failure.* This is often missing from directions, yet is probably the most essential component. All directions should have in them the indications that you have gone too far, the warning lights to turn back.

It follows, then, that the development of the research and management plan must be an open process. It is largely up to managers to make sure the process is as inclusive as possible. It is not enough simply to issue a blanket invitation or publish a notice of a meeting. Everyone should be welcome at the initial organizing sessions, but key individuals who might reasonably be expected to make a substantial contribution to the process must be identified *and* courted. Managers should:

- Learn what research capabilities are available in the area. Contact universities, secondary schools, other government agencies, other protected areas, nongovernmental organizations (NGOs), and local community leaders to make a list of people with expertise in areas that might be helpful. Develop a roster of names sorted by subject. Begin building a network by opening up personal relations with as many of these contacts as possible.
- Contact political leaders and invite them or their representatives to the organizing sessions.
- Make a special point to personally invite local community leaders, elders, chiefs, and other important personages, as appropriate.
- Keep the news media abreast of the process by issuing press releases, giving interviews, and allowing news reports of meetings.

The initial organizing sessions should be devoted to a broad discussion of values as they relate to the protected area. Many people will hold strong feelings about the protected area, both positive and negative. It is just as important to know that local hunters resent the loss of access to bush meat (or some other resource) as to know that tourists revere the annual game migrations. People need to be given a chance to air their feelings in a non-coercive, non-judgmental atmosphere. Having this information will allow an honest evaluation of research needs—one which will accurately reflect the concerns of the protected area's constituency.

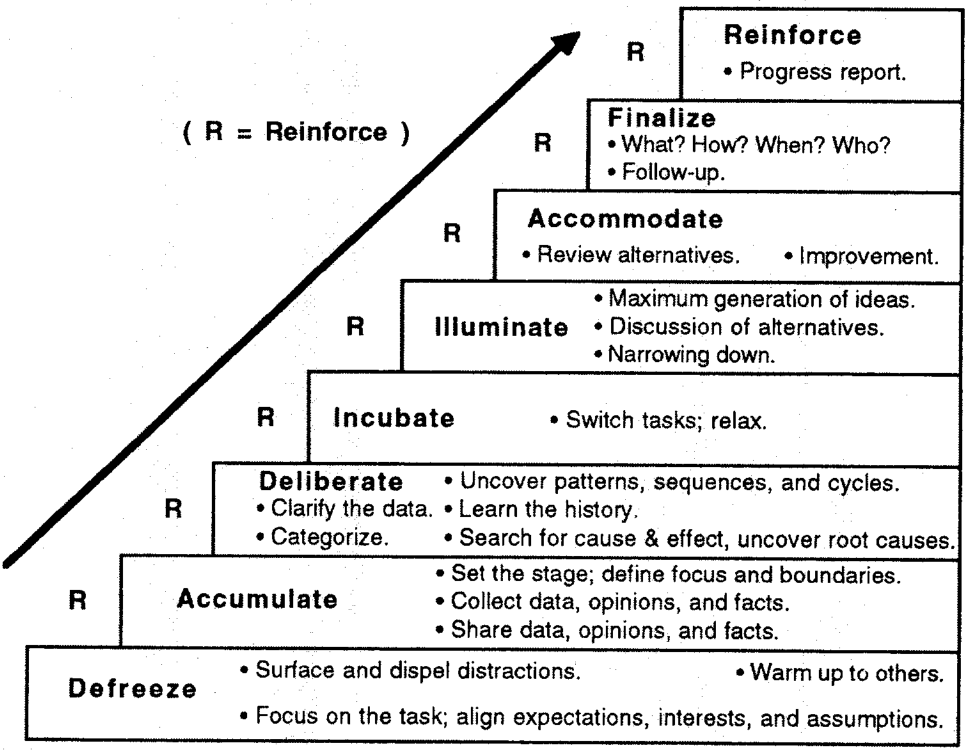
No one should be permitted to say anything negative about a new idea for at least five minutes after it is introduced. New ideas are fragile, no matter how brilliant or prophetic they are.

The organizing sessions are also a chance to educate local people about the protected area's national and international objectives. Every park operates on different scales, and this is a good time to introduce and reinforce this idea. That way no one "loses sight of the forest for the trees."

In planning the initial sessions, you may find it useful to dip into the large amount of literature that has been produced for business on "total quality management." This literature aims to teach businesses how to be keener competitors by building effective partnerships among employees. Figure 4.1 is an example. It envisions the decision-making process (in characteristic business terms) as a "stairway to success." The precepts undergirding the "steps" of the "stairway"—building familiarity and trust, being inclusive, encouraging new ideas, synthesizing different points of view—are applicable to putting together a coordinated research and management program.

Once the organizing sessions are completed, participants who are required or wish to be fully involved in the process can form a planning team. The team—which should be interdisciplinary and include representatives from research, management, and the public—can then begin working on identifying and ranking specific needs. Exactly how this is done will of course vary from park to park. The selected readings given at the end of this book contain many examples that walk you through the park planning process, so we will not offer a step-by-step recipe here. However, certain kinds of information are particularly relevant to designing a coordinated research and management program; they are highlighted below.

Figure 4.1. The decision-making process as a "stairway to success"



Source: Faust Management Corporation 1991

The information base

Park research and management is only as good as the base of information it generates and builds upon. Computer databases, bibliographies, and narrative descriptions are all desirable, but the best way to initially gather all the strands of resource information together is by making an annotated base map.

Nothing is more useful for planning than an accurate and complete resource map of the park area. This should illustrate or delineate geological formations, vegetation types, elevations, local climatic differences, location of major wildlife habitats, herd migration routes, colonial bird rookeries, and other wildlife information. It should also locate sites of historic and prehistoric structures and artifacts and all unique or special natural, historic, prehistoric, or cultural features. Usually it is necessary or desirable to accompany such a map or maps with text material and references to clarify or give more specific information (Linn 1976).

A base map is a starting-point for gathering more sophisticated data (such as trends in plant succession, or ecosystem disturbance patterns).

In drawing up this map—and, indeed, in building the information base as a whole—do not neglect the insights to be gleaned from the direct observations of local people. "Native tradition about landforms, geology, fluctuations in game and other natural cycles provide a view of the natural environment different from our own, and often at odds with our pre-conceived notions about how best to classify and manage" (Peepre 1992). Incorporating native and other local anecdotal environmental knowledge is not a matter of adding a dash of spice to the dull, white-lab-coat observations of science. Traditional environmental knowledge can contain highly technical information that is invaluable to enhancing protected area research and management. Through their long-standing familiarity, local people often develop fine-grained classifications of natural phenomena which, though informally recorded, are every bit as sophisticated as a professional taxonomist's.

> You cannot perceive anything without a map. A map provides people with the means to share in the perception of others. It is a pattern made understandable; it is a rigorous, accountable form that follows implicit principles, rules, and measures.

Local people can also often provide good information on long-term trends taking place in ecosystems. One researcher in Botswana used hundreds of strategically located interviews with old people to help determine major ecological changes throughout the eastern Kalahari. The informants helped trace the gradual disappearance of roan, sable, and tsessebe from a vast area as overgrazing by domestic cattle converted grassland habitats into thickets interspersed with grassy areas (G. Child, personal communication 1993).

While non-native people may regard science as the superior model of explanation, with oral tradition being useful only to the extent that it confirms the work of scientists, natives might consider scientists culturally impoverished because their views encompass only half of reality. As hard as this may be for those steeped in empirical rationality to accept, such open-mindedness is a key for getting the much-vaunted "support of local people." If park authorities just go through the motions with regard to public participation, if they refuse to recognize the validity of wholly different approaches to natural and cultural resources, then the ensuing research and management program will be hidebound. As Peepre (1992) points out, "we tend to plan and manage our parks in a single agency framework, using hierarchical organization and a linear development approach"—even though neither society nor the natural world works that way at all.

> We sometimes consult local native and non-native people, but may not always listen or comprehend. We press on with five-year plans, but don't make the effort to understand local community time frames. We want to cooperate but are reluctant to share decision making authority. It is not good enough to listen a little better, and try to glean a bit more information from local people. We need a complete restructuring of the way park planners and managers do business (Peepre 1992).

This is not to say that research and management should abandon national objectives and obligations in deference to local concerns. Most protected area managers and many people with traditional environmental knowledge would acknowledge the inadequacy of relying solely on oral tradition for resource information and management decisions. Yet the fact remains that if traditional knowledge has its limitations, so does science (see Box 4.1).

Box 4.1. Planning with traditional environmental knowledge

Accounting for oral tradition is a long-standing practice in the research and management of historical and other cultural sites, but not in that of protected natural areas. Here are some suggestions for what to do when traditional history and use are an integral part of the natural and cultural landscape:

- Ensure that information from both a scientific and oral perspective is gathered. Record the oral tradition before plans are completed. Note "invisible resources" such as spiritual landmarks.
- Prepare the management plan so that traditional knowledge and use do not stagnate. Many protected areas near native communities could go beyond interpreting "dead history" and relate park themes to present-day cultures. Even if management is to focus primarily on the non-human portion of the ecosystem, plan for a living cultural area.
- Involve local people in planning and management—and do it in a meaningful way. Listen to the local perspective, setting aside any preconceived ideas about what actions are best. Observe the rights of

local people to privacy, and respect the protocols for speaking with chiefs, elders, and other community leaders.

- Indigenous languages are the paramount expression of native cultures, but most are spoken by only a few hundred people and are not being passed onto the next generation. Most of the world's indigenous languages face extinction in the coming century unless decisive action to preserve them is taken soon. As part of the planning process, the protected area authority could adopt the local language's names for natural features (as happened at Denali National Park in the U.S. state of Alaska, which had been known as Mount McKinley, and Sagarmatha National Park in Nepal, previously known as Mount Everest).
- View co-management as an opportunity, not an obstacle. Include local people on a multi-disciplinary planning team, and encourage them to stay involved in day-to-day management after the plan is completed. Make sure local people review the text for all interpretive and educational materials, such as signs, museum displays, and brochures.

Source: adapted from Peepre (1992) and Harmon (1992).

As far as purely scientific information is concerned, what are the basic requirements? Here are some examples from the biophysical sciences:

- **Inventory.** What plants and animals are present—whether they be wild, naturalized/feral, or domesticated? How are they distributed, both spatially and temporally? Are there important medicinal plants or wild relatives of domestics? What is the hydrogeology, with run-off rates and amounts of measurable pollution? What is the geology and soil composition? What outside influences affect the protected area?
- **Trend data.** What changes are occurring in key ecological elements, such as water, soils, vegetation, air quality, and so on?
- **Species needs.** What is the status of species deemed to be of special management significance? What are their requirements for habitat, shelter, food, minerals, and water?
- **Ecological relationships.** What is the relationship between soils and vegetation? Between vegetation and key animal species? Which species or communities maintain the integrity and functioning of the ecosystem?
- **Monitoring and dynamics of change.** Are studies needed on colonization and restoration of disturbed areas, invasion by new species, changes of river flow and quality, population trends within species, and so forth?
- **Manipulation of ecosystems.** Are natural processes running contrary to the objectives of management? If so, does management want

to counter the processes or affect their direction? (This is perhaps the most complicated task protected area managers can undertake because it requires as full an understanding as possible of the dynamics of the processes in question.) On the other hand, managers often want to *protect* natural processes *from* change by manipulating human effects on the ecosystem; this too requires comprehensive information. Both tasks are easier if managers set criteria in key areas and include cross-checks to them in the management plan.

- **Indirect effects.** What are the existing and potential indirect effects on the reserve (e.g., poaching, urban encroachment, long-distance transport of air pollution) over which the manager has no immediate control?

In the social sciences:

- **Resident and neighboring populations.** How do local people perceive and use the reserve? What benefits do they receive and what are the direct costs to them? Has traditional knowledge of the reserve's resources been documented? What is the history of human occupation? Are there are economically important species migrating into and out of the reserve? If so, are they hunted by local people, and how important are they to their livelihood?
- **Economic valuation.** Are there estimates of the reserve's economic value in terms of protecting watersheds and fisheries, ensuring conservation of biodiversity, and tourism expenditures? What is its role in regional economic development and local employment? Are government pricing policies (for items such as entrance fees, safari permits, concessionaire licenses, and the like) having an adverse or positive impact on local economies? Are proceeds from the reserve distributed locally? Is compensation paid to local people for any economic disruptions attributable to the reserve?
- **Recreation and tourism.** What is the market area of the reserve? How many visitors use the reserve (where and when)? What impacts (environmental and economic) do they have? What are their attitudes and opinions before and after they visit? How can "ecotourism" or "cultural tourism" be encouraged?
- **Management and administration.** How effective is the legal basis for the reserve? What staff training methods are most effective? What are the links between the reserve and surrounding lands? What is the best means to obtain public participation? How could international programs and conventions be used to foster and support research and management?

Table 4.1 will give you an idea of the breadth of documentation that is desirable.

Table 4.1. Elements of a comprehensive information base

Biological Inventory
- Invertebrates
- Mammals
- Birds
- Nonvascular plants
- Vascular plants
- Vertebrates other than mammals
- Biological survey and collections

Resource Maps
- Geological
- Land use
- Soils
- Regional land tenure (ownership)
- Topographic
- Vegetation
- Geographic Information System

Research on Ecosystem Cycles, Processes, and Trends
- Biogeochemical cycles
- Comparative ecological research
- Ecological succession
- Ecosystem modeling
- Fire history effects
- Hydrological cycle
- Paleoecology
- Sedimentation & soil erosion
- Microgeomorphological changes
- Soil–plant relationships
- Plant–animal relationships

Research on Pollution
- Acidic deposition
- Atmospheric pollutants
- Pesticides
- Water pollutants

Research on Management Practices
- Agricultural
- Appropriate rural technology
- Assessment of resource production technologies
- Ecosystem restoration
- Genetic resource management
- Mining reclamation
- Rangeland management

Permanent Research Staff

Ecological Monitoring
- Air quality
- Climate
- Freshwater ecosystems
- Groundwater hydrology
- Marine ecosystems
- Precipitation chemistry
- Surface hydrology
- Vegetation data
- Water quality

Historical Records
- Aerial photography
- Bibliography
- Cultural landscape studies
- Historic architecture
- Historical ecology
- History of scientific study
- Primary materials
- Regional history

Research on Species Populations
- Pests and diseases
- Rare & endangered species
- Wildlife population dynamics

Research on Human Systems
- Archeology
- Cultural anthropology
- Demography & settlement patterns
- Ethnobiology
- Political science
- Psychology
- Sociology
- Resource economics
- Land tenure, use & management systems
- Traditional land use systems

Monitoring and Research Facilities
- Air pollution station
- Curatorial facility
- Laboratory
- Library
- Hydrological station
- Permanent plots (aquatic)
- Permanent plots (vegetation)
- Watershed research site
- Weather station

Infrastructure
- Conference facilities
- Lodging for scientists
- Road and air access
- Vehicle fleet

Source: adapted from Gregg, Serabian, and Ruggiero (1993)

Research data and resource monitoring information should be organized and stored so that they are retrievable and comparable. In the years to come managers will need to analyze increasingly large databases with a multitude of interrelated factors. The sheer volume of information will require that data be manipulated by computer. Already a backlog of information exists to be entered, one which seems almost insurmountable. Nonetheless, parks should begin to create and enlarge databases for analyzing resource trends. Small databases can be easily managed with "off-the-shelf" data management software. The most efficient process is to enter data at the time the information is collected. Field data sheets should be modified, if necessary, to facilitate entry of data into computer systems. Data that can be mapped should be collected at a specified standard and stored for entry and use in a Geographic Information System (GIS; see Box 5.2).

> I think there is a debilitating misconception that the shortest way from Point A to Point B is the best way and that order is the solution to all problems. . . . Order is no guarantee of understanding. Sometimes the opposite is true.

Identifying research needs

Once a reasonably complete information base is established, the planning team can begin identifying research needs. Good problem identification is essential, and the best way is through a series of dialogues among team members. As we saw in Chapter 3, research, management, and public representatives on the team must be willing to explain their assumptions and aspirations and have them examined by other team members.

In these meetings, researchers should be made aware of the needs of management. At bottom, managers need facts so they can make decisions capable of withstanding scrutiny by the public, politicians, and the legal system. Researchers should also be informed of expectations, rules, constraints, and the relevant management philosophy. Researchers are generally responsible individuals who will follow regulations if informed beforehand. But it is in their nature to want to know the *rationale* behind the regulations, and this should be explained too. In some instances, exceptions to regulations may be justified; these should be agreed upon beforehand.

For their part, managers must understand the limitations of research results. Scientific research rarely produces categorical conclusions. Rather, it is often circumscribed by qualifications which, if not understood, will seem wishy-washy. For example, managers of natural resources ought to know the difference between statistical and biological significance and why these concepts are important (see Box 4.2). Managers also must make sure their research aspirations are logical. Projects that require major time commitments and shifts in other operations are less likely to work. At the same time, however, the managers should identify research needs that support high-quality management. Accountability, tracking, follow-up, and periodic review of the actions are important in maintaining high standards; all should be built into the research needs articulated by managers.

To comprehend new information of any kind—be it financial reports, appliance manuals, or a new recipe—you must go through certain processes and meet certain conditions before understanding can take place. You must have some interest in receiving the information. You must uncover the structure or framework by which it is or should be organized. You must relate the information to ideas that you already understand. You must test the information against those ideas and examine it from different vantage points in order to "possess" or know it.

Ranking research needs

Once research needs have been identified, they must be prioritized so the research and management program doesn't become a scattershot affair. The most basic criteria for ranking is that research should relate to management objectives in some way. Given the universal constraints of limited funding and staff, research sponsored by the protected area authority itself should relate both directly and primarily to a specific management objective. If the primary knowledge to be derived is theoretical or distant from current concerns, and only secondarily relevant to management objectives, then the research should be funded by an outside entity. Following such ground rules will instill a greater desire by park staff to support the research operation and a higher chance that the results will be used.

Does this mean that applied research should always go to the top of the list? Not necessarily. It may be that such research is not currently feasible because there is no one qualified to do it, or because no money is available, or because the park doesn't yet have the capacity to absorb the anticipated data. In the meantime, carrying out "pure" academic research may make sense. The actual ranking of needs will depend on a host of subjective and extraneous factors, such as the political climate, public desires, bureaucratic demands on management, research vogues in academia, logistics, personalities, and so on.

Another way of deciding research needs does not assign numeric rankings to specific issues. Instead, a cluster of unranked priorities is chosen from a larger set of concerns. Time and money can then be channeled toward the priority areas according to the factors discussed in the above

Box 4.2. The concept of significance in the natural sciences and pitfalls to interpreting statistics

In all our activities we recognize patterns and are alert to changes in them. Whether an activity is simple, like lighting a cook stove in the morning, or complex, like managing a protected area, we automatically compare the present state or condition with our past experience of that system, and note any apparent change. But: Is this apparent change real? and, if so, Does this change require a management action?

In both of the above systems, a wide variety of changes can occur. If your stove blows up or a tornado hits your protected area, the change is obvious, and requires an immediate management decision. More subtle changes are harder to detect but may still require management decisions. The more complex the system, the more subtle the changes can be and the more difficult it is to separate the real from the apparent.

Nature is inherently variable! Population dynamics, age structure, timing of migration and reproduction, and temperature and precipitation regimes all vary from year to year. How does a manager know that a significant change has taken place? Further, is the change both statistically and biologically significant? Not all statistical change is biologically important. On the other hand, lack of statistical significance (if due to poor study design or low sample size) may not mean that an apparent change (biological or environmental) does not require a management action.

Sampling is the process whereby we obtain data to estimate the actual distribution of events or parameters. Unbiased sampling should result in an estimated distribution that closely reflects the actual distribution. The scientific method (see Box 1.2) often involves experiments where we ask if there is a difference between two or more sets of observations.

Below are hypothetical data from an aerial census of elephants sampled along fixed transects in a protected area before and after a major drought (Figure A). The manager is concerned that the drought may have had an adverse effect on the elephants. We can examine and describe the two distributions of counts of elephants before and after the drought (Figure B). Distributions can be characterized by their central tendency (mean, median, mode) and shape (variance, standard deviation, skewness, kurtosis), and those attributes can be compared statistically. Statistics can tell us if there has been a real change (although it requires a value judgment to determine if a management action is required). Distribution measures are affected by sample size. When samples are small, as frequently occurs in studies in protected areas, caution must be exercised in interpretation.

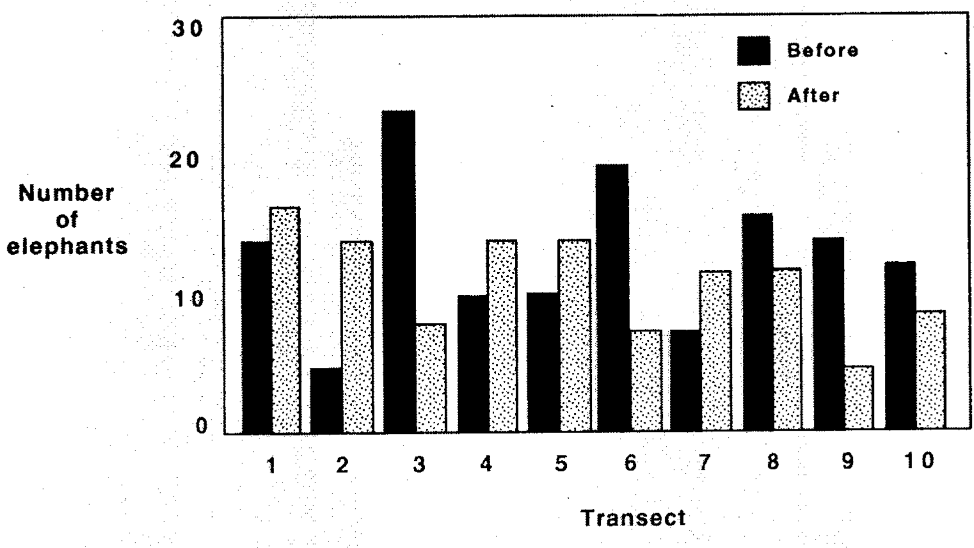


Figure A. Elephants censused along 10 fixed transects

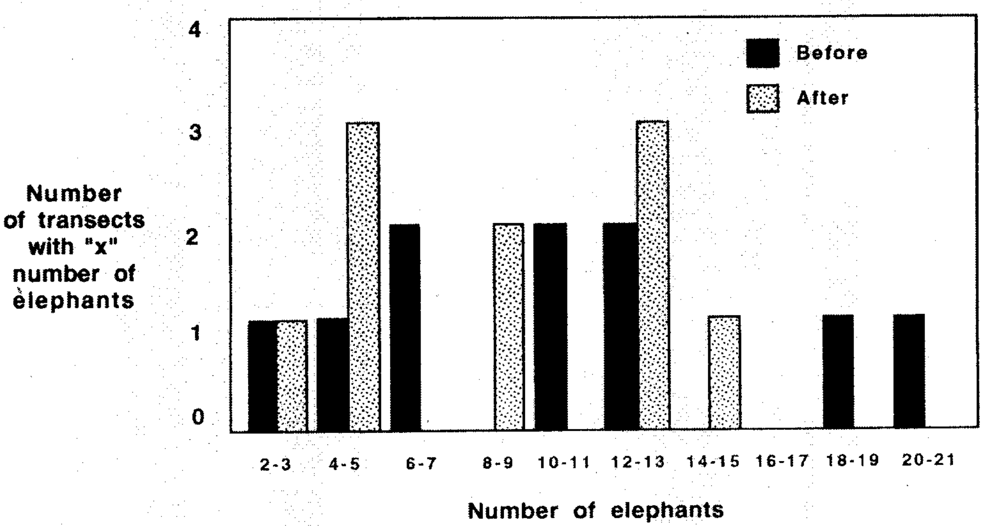


Figure B. Frequency distributions of counts of elephants before and after the drought

Statistical experiments

Note: It is essential to have a well-designed experiment. Before proceeding, always seek the advice of a professional statistician. Well-designed experiments are based on formulation of the Null Hypothesis, which states that there is no difference between two conditions. In the case of the elephants, the two conditions (before and after the drought) were determined by nature rather than by the researcher. In a more experimental study, in which the researcher has control, the two conditions would comprise an unmanipulated control and a manipulated experimental situation. Both conditions must be replicated (i.e., repeated), perhaps several times, in space. In the case of the elephants, the ten transects represent ten replicates. Replicated observations can then be compared.

Applying the proper statistical test leads to accepting or rejecting the Null Hypothesis with a particular certainty or probability. There are two types of errors that can be made when carrying out an experimental test: Type 1—Rejecting a true Null Hypothesis; or Type 2—Accepting a false Null Hypothesis.

The level of significance in biology is often 0.05. However, there is nothing magical about this level, and the one we choose depends on our willingness to make an error. For example, with the elephants we are concerned that the drought caused a decline. However, we may be able to make a Type 1 error (reject a true Null Hypothesis), since we want to make sure that we do not lose the species, and therefore choose a level of significance of 0.10.

Statistical pitfalls

■ *Lack of proper control.* Although we have sampled elephants before and after the drought (control and experimental, respectively), we have not controlled for other factors, such as seasonally related movements, that may have influenced elephant distributions.

■ *Lack of replicates.* Although we replicated the transects on which elephants were counted, we only sampled one drought. We can measure with a degree of certainty the response of the population to this particular drought, but we do not know if elephants will respond to future droughts in the same way. To determine this, we need to sample repeated droughts.

■ *Low sample size.* There are standard techniques for determining appropriate sample size, based on the variation among the samples and the acceptable probability of error.

■ *Use of improper statistical method.* The best advice here is to consult a statistician—*before* you begin to collect data.

■ *Improper use of statistics.* Lying with statistics is *still* lying.

Source: contributed by Søren Bondrup-Nielsen and Tom Herman

paragraph. Box 4.3 gives a real-life example for the Atlantic Maritime Ecozone. The issues marked "yes" were deemed priorities for further research through workshop discussions at a small conference on ecological research. Those marked "no" were not priorities for the group as a whole, but remain important to the individual researchers who suggested them.

Box 4.3. Atlantic Maritime Ecozone issues and priorities

Environmental Stressors and Ecological Issues	Priority?
Airborne pollutants	
• acid precipitation	YES
• toxins	no
• ground-level ozone	YES
• ozone depletion (UVB lichens)	YES
Climate change	YES
Eutrophication	YES
Identification of bio-indicators	no
Water quality	no
Encroachment on natural areas	no
Introduction of exotics	no
Habitat fragmentation	no
Fluvial habitat change	no
Waste management and disposal	no
Management of ecosystems	
• forestry	YES
• agriculture	YES
• fisheries	YES
• tourism	no
• transportation corridors	YES
• mining	no
• urban	no
• soil erosion & nutrient run-off	no
• coastal erosion	no
Public education	
• wildlife (migration)	no
• biodiversity	no
• exotic species	no
• marine spills (coastal sensitivity)	no
• landscape degradation	no

Source: Atlantic Maritime Ecozone Long-Term Monitoring and Research Workshop, March 1993

Once research needs have been ranked within a management plan, the next question becomes which ones to actually go after. Obviously it would be most desirable to go right down the list, taking on the applied projects first and starting in on others as budgets allow. This might be possible in wealthy countries with vast networks of universities, where it is not unusual for a specialist based at an institution thousands of kilometers away to come and study a particular problem in a protected area. In other countries, a more desirable way to choose which problems to tackle first is to select those for which there are trained nationals.

It is ironic that many countries have plenty of qualified graduates or promising students who might be inclined to take on conservation research, but are deterred because employment opportunities are not attractive enough. For example, outstanding students in biology are often drawn into medicine, veterinary science, or agricultural research rather than conservation. And sometimes there are simply not enough trained nationals to carry out important research and management tasks. Some countries are suffering "brain drains" because their best students and graduates go abroad for training or employment and never return home. In many countries, basic information about their protected areas is not available to local schools, and often unavailable in local languages.

One way to stretch scarce research–management funds would be to pair protected areas in developing and developed countries to make it easier to share information. A one-on-one relationship could benefit both areas. The established research–management program could donate subscriptions to professional journals, back issues of journals, internal research reports, textbooks, basic equipment, and so forth; the fledgling program could donate its own internal reports and possibly even wildlife specimens or artifacts. The established program could encourage faculty researchers and graduate students to fill research needs in its sister park in tandem with nationals from the host country. The overall goal would be to build research and management capacity in the fledgling program so self-reliance is achieved.

Managing research

Researchers need to understand that their work is not self-justifying; it has the potential to damage the resources of the protected area they are working in. For example, it is possible for researchers to over-collect specimens or needlessly interfere with visitor activities. The long-term impacts of research must be weighed as would any proposal affecting park resources. If necessary, alternative areas outside the park boundaries or alternative techniques may have to be employed or negotiated so research can be completed with minimum effect on park resources.

Exceptions to research regulations should be granted only with justification and prior permission. Parks should develop a written statement or checklist about conducting research in their park. The statement can accompany responses to research proposals and collecting permits. In addition, each research project should adhere to an agreed-upon timetable. Managers typically need information in relatively short time frames, so scheduling the reporting of interim results is helpful. This comes as part of regular reviews of the project to ensure it is on track and responding to the needs of management.

As new information becomes available, research may have to be adjusted. Changes in mid-project can be sensitive situations, and are best avoided altogether through open, early design discussions. Researchers should be able to contact a park-based liaison person who understands their needs, the value of their projects, and the management requirements, and who can help them deal with the park bureaucracy.

Thorsell (1992) has summarized the basic ideas behind managing research:

- **Require approval of all research projects before they commence.** The protected area management authority will first want to ensure that any unsolicited project is compatible with the objectives of the reserve. The manager may also request modifications to a project to make it more relevant to management needs, or to complement other research projects in the area. In assessing proposals, the management authority will want to confirm the adequacy of the research design and the credibility of the responsible investigator. Some countries require that researchers post a bond before a permit is granted.

> You don't have to know everything, you just need to know how to find it.

- **Monitor activities of researchers in the field.** The manager must retain control over all activities in the protected area, including those of researchers. This may mean that the reserve manager gives prior approval of researchers' travel and work schedules or may, for management reasons, place restrictions on such activities. Provision of a "Code of Ethics" for research in northern Canada is an example of another means of soliciting cooperation. Researchers should also be required to submit periodic written progress reports and make presentations of their findings to protected areas staff. The manager should also recognize that the presence of researchers in some parks can also assist management indirectly by keeping tracks open and acting as a deterrent to poachers. Research facilities must be maintained at the highest environmental standards and avoid situations such as in research centers in Antarctica where waste and local pollution are common.

- **Devote special attention to the collection of specimens.** Collection of plant and animal materials usually requires special permission and the managers may wish to require that duplicate specimens be deposited at the protected area facility or at a national museum. Taking material outside the country may require a special permit and in parks with valuable genetic resources regulations for collection of seeds and reproductive materials need to be formulated and strictly enforced. Removal of archeological specimens or any other rare materials should be limited to, at most, minimal amounts.
- **Minimize the disruptive effects of social and anthropological research.** Research on park users can involve intensive interviews and long questionnaires which may not be well-received by tourists and local residents. Maximum use should be made of non-obtrusive measures that are less noticeable but still are technically valid. In protected areas that have resident human populations, special care will have to be taken to avoid deleterious effects on the cultural integrity of people whose way of life the area is designed to protect.
- **Return financial benefits from research activities to local communities.** Expenditures by researchers (such as equipment or support staff) can be an additional factor in justifying a protected area. In Costa Rica's Guanacaste National Park, for example, scientists spend an estimated US$200,000 per year for local support services, and this figure is expected to reach US$1,000,000 as the research program expands. Researchers should, therefore, be encouraged to patronize businesses in the local region, thereby increasing public support for conservation.
- **Record all research undertaken in the reserve.** On completion of the study, the researcher should submit a full final report on his or her project with a compulsory section of the relevance of the findings to conservation of the area. Each researcher should be required to send the management authority copies of all publications that arise from the research and acknowledge assistance of the reserve management and relevant staff. Summaries written in a popular style can then be used in interpretive literature on the park and copies of all research reports and a bibliography of all research conducted in the park should be part of every park reference library.
- **Consider the appointment of a staff research scientist.** For many protected areas, particularly those that have been designated biosphere reserves and thus carry a special responsibility for scientific research, a full-time staff position of "park scientist" is warranted. (See Box 4.4.) The scientist should be free to criticize management activities when called for. He or she would act to support the above activities as well as coordinate the park's research and monitoring program. Another option would be to consider an agreement with a university to perform the same function.

One might make two amplifications to the list:

- **Determine and agree upon what research products will be provided during the course of the project, not just at the end.** Often an interim product or report is as valuable to management as a final one, and may be put to uses unrelated to the project which produces it. For example, in the North Cascades national park complex (USA), a doctoral candidate analyzed the relationship between standing dead snags and access roads in an area where firewood cutting was permitted. An interim product was a GIS (geographic information system) vegetation map. The park authority required that the map and raw vegetation data be turned over for further analysis unrelated to that research. Often the park will want to obtain raw data as a long-term record. This allows future replication of the study to determine trends.
- **Require that all specimens collected become part of a publicly accessible museum collection.** Ideally, specimens should be stored at the protected area, but of course most will not have proper facilities to do so and many specimens will of necessity go to universities, national museums, or other curatorial facilities. In such cases, it is essential that the specimens be catalogued so that park personnel can locate and consult them. The presence of accessible, documented collections also serves to guide managers in deciding whether a proposed collecting expedition has merit. Many parks with popular geological features suffer from over-collecting, since many researchers want their own private collections of specimens. By referring them to an existing collection, such over-collecting can be avoided.

For some ideas specifically on "pure" research (which is also known as "basic," "academic," or "curiosity-driven" research) and how it should be managed in protected areas, please refer to Appendix 2.

Box 4.4. Field organization: the protected area ecologist

To develop relevant and effective resource protection strategies for protected natural areas of significant size, it is desirable to permanently assign a scientist with ecological expertise to coordinate resource management activities on site. Duties should include responsibility for scientific and technical staff specifically dedicated to research, monitoring, and quality control. Unrestricted communication with managers and scientific peers in the region is essential. To bridge the gap between the manager and scientist, the latter must become part of the management team.

Modern protected area ecologists should possess broad knowledge extending beyond natural science. Understanding of economic principles, finance, political science, and personnel management can prove essential. Knowledge of the information management field is also important.

The microcomputer, coupled with development of the electronic "information superhighway," is revolutionizing the conduct of field science. Public speaking skills, use of mass media, and photography further support the effectiveness of a field scientist.

> There are several situations likely to induce information anxiety: not understanding information; feeling overwhelmed by the amount of information to be understood; not knowing if certain information exists; not knowing where to find information; and, perhaps the most frustrating, knowing exactly where to find the information, but not having the key to access it.

Because ecological management issues extend beyond protected area boundaries, the field ecologist should spend significant time developing professional affiliations with agencies, universities, and local land users. In times of decreased funding, cooperative relationships with other research and land management institutions can provide valuable assistance. Such networking also offers the opportunity for better public understanding and improved quality control.

The protected area scientist's role in the community should be a significant one. The tax-paying public must understand what science has been done and why. Collaboration should occur with volunteers and local schools, so that use of study information is optimized. In turn, these groups should be encouraged to assist with data collection and analysis when feasible. When the protected area scientist becomes an integral part of the community fabric, along with bankers, teachers, laborers, business owners, and other traditional vocations, knowledge associated with responsible ecological management will be better disseminated, respected, and, increasingly, applied.

Source: contributed by Cliff Drysdale

Monitoring and long-term research as part of the management routine

Each park should set a high priority for baseline monitoring of specific indicator species, resources, environmental trends, and so on. It is never too early to start a baseline monitoring program, but it can be too late.

Long-term monitoring is at once the best method to watch and interpret changing trends that may be human-caused, and the best way to develop a database for future decisions. Baseline monitoring programs should have periodic professional review to ensure that data are being collected so as to serve the purposes of the program and so that they can be statistically analyzed.

The key to success of long-term programs is linked to continuity in staff, yet in some parks staff come and go frequently. By working to institutionalize resource management and monitoring programs into day-to-day operations, there is greater assurance that they will be continued despite turnover. Important long-term resource programs should become such a part of the operation that they are as routine as fee collection or road patrol. This can be accomplished by establishing long-term monitoring within park management plans and as part of employee work-evaluation standards.

Promoting protected areas as research sites

If protected areas are to fully contribute to sustaining society, their roles as laboratories for research and as monitors of natural systems need to be actively pursued. This may mean building working relationships with local universities or arranging special agreements with research institutes (e.g., the Smithsonian Tropical Research Institute in Panamá). Working in a protected area has an intrinsic appeal that many scientists find irresistible. Encourage this by offering logistical support. Probably the best way to foster research in a protected natural area is to establish a field station (see Box 4.5). Special study zones also can be an incentive.

Making research usable to managers

There are several criteria for making research usable to protected area managers:

- The information must be provided at the proper point in the decision-making process. When is that? Usually, managers are working against a deadline and they have to make decisions based on the best information available. In this sense, management can be thought of as a series of separate decisions, with each decision being a goal that must be accomplished in a timely fashion. Contrast that with the open-ended, continual pursuit of knowledge that characterizes the research method and it becomes apparent that there is a potential for misunderstanding and conflicts.

  Thus, the proper point is after consultations between researchers, managers, and other interests have established the terms of the research, but well before the deadline for making a decision. This may seem self-evident, but research is routinely undertaken without any regard to managerial timelines. Flooding managers with indiscriminate information is counterproductive; missing a deadline renders the information irrelevant for a given decision (though of course potentially useful for future decisions).

Box 4.5. Desirable attributes of a field research and monitoring location

- Protected area status—provides security for long-term research and monitoring.
- Representative of a regional or national ecosystem.
- A resident scientific advisor/researcher, e.g., an ecologist.
- A core research and monitoring team (can be non-resident).
- *In situ* environmental monitoring infrastructure, such as atmospheric recording and calibrated watershed instrumentation.
- A basic field laboratory.
- Basic accommodations and transportation assistance on site.
- A comprehensive resource inventory and analysis in narrative, geographic (GIS), and data formats.
- An up-to-date research bibliography.
- Partnerships with other government departments, universities, and non-governmental organizations to engage in research and monitoring.
- Compatible working relationships with neighboring landowners.
- Provision for reception and teaching of students.
- Coordinating committee to review research and monitoring proposals and requirements.
- A means to distribute research findings, e.g., manuscripts, workshops.

Source: contributed by Neil Munro

- The information must address the manager's needs. These should not absolutely dictate what is researched, but all research should at least partially relate to them. Even purely theoretical research should point to some possible management implications.

- Research results should be reported at a level of detail appropriate to the decision. All research should be reported in three formats: in great detail for one's peers; in a summarized version for managers, which points out the limitations of the data, the degree to which they can be applied, and the certainty (or lack thereof) of successful application; and in a layperson's summary for the public.

- The manager must understand the authoritativeness of the researchers. Work done by young researchers or those without a solid reputation is obviously not perforce invalid, but managers should realize that such research may be scrutinized more carefully by the professional community. Managers should not be gun-shy about establishing the credentials of those proposing research. But neither should managers allow the reputation of a researcher dazzle them to the point that they accept results uncritically.

Managerial objectives must be matched with criteria to evaluate proposed research projects. A table similar to the following can help planning.

Table 4.2. Managerial objectives and criteria in assessing protected areas research projects

Managerial objective	Evaluation criteria
1) Enhance benchmark knowledge	■ enrich and/or expand the database and inventory ■ identify specific threats or stresses ■ improve field science (pure & applied)
2) Improve decision-making	■ provide better and more usable information for: (a) planning, (b) resource and land-use management, and (c) environmental assessment
3) Enhance ecological or cultural integrity of a protected area	■ maintain or improve biodiversity ■ stabilize a population or ecosystem ■ no permanent environmental impact
4) Reduce overall management costs and enhance benefits	■ cost-effective (shared funding or partnership proposal) ■ results-oriented proposal ■ interdisciplinary input—enhance objectivity
5) Improve sustainability	■ provide socioeconomic benefits ■ contribute to the development of an environmental ethic or attitude
6) Increase public awareness	■ contribute to environmental education ■ dissemination of research monitoring information to the public, e.g., exhibit, binder, video, pamphlet, article

7) Contribute to national or global environmental goals	■	contribute to: UNESCO World Heritage Convention Convention on Biological Diversity Agenda 21 Caring for the Earth National Conservation Strategies

Source: contributed by Neil Munro

Follow-up evaluations

Table 4.2 leads us to the final part of a coordinated research and management program—one which, unfortunately, can be easily overlooked. A method for evaluating the effectiveness of the program should be decided early on by the planning team. Protected areas need to demonstrate that they are in fact reaching their conservation goals if they are to justify their continued existence to governments, the public, and donor agencies. To draw an analogy with the world of business, protected areas need to do "quality assurance." One example of a follow-up system comes from the U.S. state of Florida, where the Department of Natural Resources has begun doing "resource management audits" of its protected areas (see Box 4.6).

Box 4.6. Evaluating the effectiveness of park management plans

Florida is one of the USA's most biologically diverse states. It is also one of the fastest-growing, and now the fourth most populous in the country. The state's Department of Natural Resources oversees some 178,000 hectares of state parks and natural areas. The Department has begun a system of "resource management audits" which brings a team of biologists together with the site manager to evaluate the effectiveness of management plans.

For each protected area, the Department assembles an audit team consisting of biologists and the site manager. Three Department biologists, representing different districts of Florida, visit each protected area and make subjective evaluations of 1) the condition of the biological communities, 2) effects of management programs, and 3) impacts of recreational development. The protected area manager accompanies them, supplying information and records, pointing out problem areas, offering interpretations of the effectiveness of resource management activities, and making suggestions for improvement based on personal, on-the-ground experience. In cases where the expertise of biologists from another agency would be useful, they are invited to join the audit team. For example, some of the Department's coastal parks have nesting colonies of least terns *(Sterna antillarum)* and black skimmers *(Rynchops niger)* as well as endemic subspecies of beach mice. In these cases, the Department asked the specialist biologist from the state wildlife agency (the Florida Game and Fresh Water Fish Commission) to assess habitat conditions and discuss potential options for improving the management program for these species.

During an audit, a general outline serves as a reminder of topics and features to examine in the field:

- **Geology,** under which prominent features (springs, streams, beaches, sinkholes, etc.) and trends (in water quality, erosion, and disturbances to features) are considered.
- **Biological resources,** under which the present condition of plant and animal communities are rated (according to standardized evaluation procedures) and discussed. Special note is taken of threatened, endangered, and distinctive (though non-listed) species.
- **Natural resource management**, under which techniques such as prescribed burning are reviewed.
- **Cultural resource management**, under which inadvertent disturbances to significant sites by natural resource management activities are noted and relayed to state archeologists.
- **Threats to natural and cultural resources**, under which such things as invasions of exotic species, looting of prehistoric objects, airborne pollution, and visitor impacts are considered.
- **Research and monitoring activities,** under which current activities and future needs are discussed.

Finally, **compliance with resource management documents** (including the recommendations of previous audits) is checked and a **ranked list of management programs and projects** is drawn up by consensus of the biologists. It is to guide the manager to programs most in need of attention.

When the audit is done, one of the biologists drafts a report, which is then reviewed and revised by team members. The park manager responds to the audit team's recommendations, and a final version is sent to senior Department administrators. The outline—indeed, the whole process—is dynamic and is refined with comments from the participants. Since the program began in 1987, all of the Department's 100 protected areas have been audited, and a second cycle is underway.

Source: MacLaren 1993

Some final thoughts

As the process of putting together a coordinated research and management program unfolds, there will be many unavoidable disagreements. Do not expect to get an absolute consensus. Scientists and cultural researchers are not trained to think of consensus as a worthy goal. Research is a competition among ideas (and even among personalities). Instead, strive for broad agreement while allowing dissenting views to be aired and debated.

Conflict in one area should not be allowed to prevent cooperation in another. A cooperative atmosphere can be created by taking time to work through non-controversial areas, such as enumerating indisputable facts about the issue at hand. Far from a being a waste of time, this exercise builds camaraderie and allows the planning team to get to know one another. The fragile interpersonal dynamics of a committee must be nurtured from the outset. If you are lucky, this spadework will result in team members being more tolerant of opposing views, and impasses can be avoided.

In a similar vein, the planning team should continue to solicit comments and suggestions from the entire community as the process rolls on. At no point should public access be cut off. Planners should cultivate open-mindedness and encourage genuine participation. Having the public involved in the design of research and management will not quell all opposition to decisions, but it will legitimize the decision-making process. Continual public review can actually insulate researchers and managers from political interference.

If the process goes well, a closer accord can be reached between the expectations of the public, the desires of management, and the capabilities of research. Neglecting to coordinate research and management will, on the other hand, almost certainly lead to failure. As Machlis (1993) concludes, "a research project completed too late, dealing with issues of only tangential relevance to a manager's decision-making needs, presented without limits or explanation, and by scientists of unknown credibility, will likely not produce usable knowledge. Note that such research could be excellent, even brilliant, science; it would still remain outside the boundaries of usable knowledge."

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5. Getting the most research and management for the least money

Many of the concepts we have been discussing are free for the doing. Changing attitudes, expanding the circle of communication, thinking critically, planning cooperatively—all of these require no cash outlays whatsoever, yet they can markedly improve a protected area's research and management program.

> The secret to processing information is narrowing your field of information to that which is relevant to your life, i.e., making careful choices about what kind of information merits your time and attention.

Even so, most protected areas in the world cannot afford to hire the personnel and buy the equipment needed to fully carry out the program detailed in Chapter 4. They can still do a lot with a basic, low-cost program. (Keep in mind that "low-cost" does not mean "low-quality." Having the most basic physiographic, biological, and cultural information is far better than having none at all, and raises the quality of management markedly.) Below we suggest four possible elements of a low-cost program, ranked according to importance.

Priority 1: Provide basic research facilities

Nothing is more attractive to researchers than the existence of research facilities. There seems to be a high correlation between the presence of at least basic facilities reserved for researchers and the amount of research that is done in a protected area. And certain desirable attributes of a research station (see Box 4.5) can be achieved for little money.

First and foremost, researchers need somewhere to stay in the park. Housing can be spartan as long as it is safe from the weather, quiet, reasonably accessible, and equipped with basic sanitary facilities. A cluster of sturdy tents (with waterproof walls and floors, or on platforms) may be all that's needed in many climates. As an alternative, it may make more sense to erect compact housing using indigenous building materials. Or, if any sound but disused buildings are available, they can be refurbished. A good example is the Rancho Grande Biological Station in Henri Pittier National Park, Venezuela, which makes use of a hotel that was abandoned unfinished years ago.

Along these same lines, researchers also require a separate sheltered workplace. Preferably it would be equipped with a basic field laboratory, but at the least it should provide a dry place with some tables and chairs to examine specimens, write up field notes, and so on.

Third, a basic reference collection should be established at the protected area's headquarters. The collection should encompass both printed reports and collected natural and cultural specimens. It should aim to include and catalogue every research reference to the park and at least one representative example of all specimens. (Many countries have restrictions on or prohibitions against exporting natural specimens and cultural objects, and of course these must be respected.) The printed reference collection (which is non-circulating) would form the nucleus of a larger park library. Ideally, individual park collections could then eventually be amalgamated into nationwide repositories of protected area information.

The receipt of a copy of all research reports and examples of specimens derived from the park should be required from researchers as a standard condition of the research permit. This is in fact already the rule in many places, but there still seems to be a widespread failure to lodge data with the host country. One way to ensure this is done would be to require visiting researchers to post a substantial bond.

Priority 2: Establish formal ties with at least one university or research facility

Every protected area should establish formal ties with an appropriate university, museum, or other research facility. Usually it is best to establish ties with the institution best able to address the research needs of the protected area. However, in smaller countries with a national (or single prominent) university or museum, the initial ties should be to them, regardless of whether that institution is currently strong in areas of expertise relevant to the protected area. This is because it is important for countries to build up their internal research capacities.

"Formal ties" to another institution means any mutually recognized means of cooperation. Low-cost ways of doing this include executing memoranda of understanding (see Box 5.1), bringing in professors or other specialists to the research and management planning team, hosting a series of lectures by university personnel, and so forth. Park budgets should allocate some funds for periodic visits by managers to cooperating research institutions.

Priority 3: Train wardens and other field staff as paraprofessional researchers

There are never enough people on staff to accomplish everything that needs to be done in a protected area. One way managers can stretch their

Box 5.1. Memoranda of understanding with universities

"Memoranda of understanding" are a type of agreement widely used to govern research in protected areas. Often they are executed between the protected area authority and a university. The purpose is to recognize the parties' common interests in improving research, education, and information exchange pertaining to the planning, management, and operation of protected areas. Such memoranda have two objectives:

Objective 1: To further shared goals in research by encouraging—

(a) Research in areas of mutual interest to identify, select, establish, protect, develop, plan, interpret, and manage protected areas;
(b) Research that will enhance individual or shared educational objectives designed to develop public understanding, appreciation, and enjoyment of protected areas; and
(c) Basic scientific research. (Such research may not be essential for management, yet it may expand knowledge and reinforce the role of protected areas as benchmarks.)

Objective 2: To further shared goals in education by encouraging—

(a) Protected areas to act as field extensions to university programs, where appropriate;
(b) University participation in the education and training of protected areas personnel and vice versa;
(c) Joint development and production of educational material and programs to enhance public and student awareness;
(d) Jointly sponsored lecture programs, workshops, and conferences;
(e) Staff and university personnel interchange;
(f) University staff to undertake relevant research or related work while on sabbatical or leave; and
(g) Private, corporate, government, or non-profit organization sponsorship for specific projects.

Source: contributed by Neil Munro

research capabilities is to invest a small amount of time and money in training wardens to perform basic research functions. Paraprofessionals are particularly well-suited to maintaining long-term monitoring routines and doing field identifications. A recent example of the latter is being carried forward by the Instituto Nacional de Biodiversidad (INBio) of Costa Rica. To pay for a national biodiversity survey, INBio proposes to broker naturally derived chemical substances to industry. Since many taxa in Costa Rica are unidentified, and there are not enough professional taxonomists to do the work, INBio trains local people as "parataxonomists" to do the initial field classifications (which are later checked and refined by professionals).

INBio does not restrict itself to protected areas, but the principle could easily be applied by park agencies to their own employees. Southern Africa provides several good examples. In Zimbabwe's Sengwa Wildlife Research Area, game populations have been monitored for about 30 years by junior technical staff, with Game Scouts following the movements of up to 50 radio-collared elephants every 3 hours, 300 days a year, for over a decade. Game Scouts walking transects collected animal population data in Tarangire National Park in Tanzania during the early 1960s (G. Child, personal communication, 1993).

> In the business community, millions of dollars are lost in hours and errors in the training of new employees because the trainers or seasoned employees can't remember what it was like not to know. If you could remember what it was like not to know, you could begin to communicate in terms that might be understood more readily by someone who doesn't know.

With a minimum of training, wardens and other field personnel could collect other basic data, such as weather observations and the reading of monitoring equipment, as part of their everyday work. Some compromise from optimal sampling locations may be in order to keep from overtaxing wardens. Locating sampling points along regularly traveled patrol routes provides a better opportunity for field staff to assist in data collection. A remote location may be slightly better in terms of representation of a particular resource, but it is wasted if too remote to allow regular access and data collection.

Priority 4: Obtain a low-cost computer

> The amount of available information now doubles every five years; soon it will be doubling every four.

Computers are all but essential for modern protected area management. Low-cost microcomputers (often referred to as personal computers, or PCs) have truly revolutionized research and management in the space of a decade. At their primary level of function, PCs can easily store vital protected area information, such as resource inventories and visitor statistics; perform analytical functions, such as statistical computations and budget management; and facilitate communications through word processing and desktop publishing. At a more sophisticated level, PCs can combine primary information with outside sources (by merging other databases or connecting to electronic bibliographies) to expand the manager's "knowledge reach." The signal example of such technology is GIS, which gives managers and researchers an unprecedented ability to manipulate information from a database by plotting it, quickly and repeatedly, on thematic maps (see Box 5.2).

The main job of the first PC to come into a park should be to compile and store baseline information, such as natural and cultural resource inventories, visitor-use statistics, land tenure records, and the like. A low-cost program could be based on selecting a handful of topics from the comprehensive list given in Table 4.1.

Box 5.2. Geographic Information Systems

The term "Geographic Information System," or GIS, refers to computer technology whereby software and hardware are designed to store, analyze, and display spatially referenced data. Sophisticated graphics programs handle digitized cartographic data and interface with database management systems containing data such as vegetation types, animal and plant distributions, topography, and so on.

A GIS constructs, displays, and analyzes maps and their associated attributes (data). All information in a GIS is referenced to a fixed point; that is, each point (e.g., water-well site), line (e.g., road, stream), or region (e.g., field, forest, lake) has a known geographic reference, such as longitude and latitude or universal transverse mercator (UTM).

GIS operates first by developing a computerized description of all the information contained on a map or drawing. Each point, line, and region on a map is translated into a series of code numbers (digits) and entered into the GIS computer software. This process is referred to as "digitizing." Digitizing can be done by typing on a computer keyboard; using electronic tracing tablets, called "digitizers"; or directly entering digital satellite data. The digitized media can be traditional maps or drawings, aerial photographs, satellite images, or digital descriptions of phenomena.

The second step is to manipulate the digitized map information in the computer. This is the power of the system. A GIS can automatically change a map's scale, its legends, its title, or the number of features it displays without having to redraw it. GIS allows new information to be generated from the base map with remarkable savings of time and effort. A major strength of GIS is the ability to combine maps and drawings of different scales and themes to create new maps. For example, GIS can automatically combine a historic vegetation map with a map of present conditions to produce a new map highlighting areas of similarity and dramatic change.

The final step in GIS application is the production of map documents (paper, mylar, video) for use in communication and management.

GIS is a tool with many variations. Ultimately it is only as useful as the ability of a person to use it. Important questions to consider when choosing a GIS are: (1) How can we obtain a database for the protected area? and (2) What are the questions we want to answer using GIS?

Of course, in many cases the overriding question will be one of money. The cost of GIS varies widely. The following list of selected systems suggests that most packages fall into the medium- and high-cost ranges.

LOW-COST (<US$1,000)

System (Maker/Originator)	Equipment (Operating System)
EPPL7 (Minnesota Land Mgmt. Center)	PC & compatible (DOS)
Geo/SQL (Generation 5 Technology, Inc.)	PC & compatible (DOS)
GRASS (GRASS Information Center)	PC & compatible (UNIX) Workstation, Mini/Mainframe (UNIX)
IDRISI IDRISI Project/Clark University)	PC & compatible (DOS)

MEDIUM-COST (US$1,000–$10,000)

System (Maker/Originator)	Equipment (Operating System)
pcARC/INFO (Environ. Systems Research Inst.)	PC & compatible (DOS)
Atlas GIS (Strategic Mapping, Inc.)	PC & compatible (DOS)
FMS/AC (Strategic Mapping Systems, Inc.)	PC & compatible (DOS & UNIX)
ILWIS (International Institute for Aerospace Survey & Earth Sciences)	PC & compatible (DOS)
MOSS (Autometric, Inc.)	Workstation, Mini/Mainframe (UNIX)
PAMAP GIS (PAMAP Technologies Corp.)	PC & compatible (DOS)
SPANS GIS (Tydac Technologies Corp.)	PC & compatible (DOS, OS/2)

TerraSoft (Digital Resource Systems, Ltd.)	PC & compatible (DOS) Workstation (UNIX)

HIGH-COST (>US$10,000)

System (Maker/Originator)	Equipment (Operating System)
ARC/INFO (Environ. Systems Research Inst.)	Workstation (UNIX) Mini/Mainframe (VMS etc.)
CARIS (Universal Systems, Ltd.)	PC & compatible (UNIX) Workstation (UNIX) Mini/Mainframe (VMS)
ERDAS IMAGINE (ERDAS, Inc.)	Workstation (UNIX)
GENAMAP/GENACELL (Genasys II, Inc.)	PC & compatible (UNIX) Workstation, Mini/Mainframe (UNIX)
Geo/SQL (Generation 5 Technology, Inc.)	Workstation, Mini/Mainframe (UNIX)
PAMAP GIS (PAMAP Technologies Corp.)	Workstation, Mini/Mainframe (UNIX)
SPANS GIS (Tydac Technologies Corp.)	Workstation (UNIX)
SYSTEM 9 (Computervision)	Workstation (UNIX)

Source: contributed by Søren Bondrup-Nielsen; partly based on Rafkind et al. 1993; table adapted from GIS World, Inc., *1993 International GIS Sourcebook*

How might budget-strapped agencies get hold of PCs for their parks? It appears that some sort of international brokering network should be set up to promote manufacturer donations or low-cost sales to protected areas. Here's one way this might work. A prominent PC maker in the USA has donated thousands of new computers to primary and secondary schools. This is more than just an act of charity; it is also a way to introduce the brand name to youngsters, thus solidifying the company's future base of customers. As PC sales in developed countries reach their saturation point, PC makers will look increasingly to the developing world for sales. Using an international conservation NGO as a broker, a similar giveaway program might be set up and aimed at protected areas in developing countries.

Another possibility would be to broker used computers. The PC industry and its consumer market are extremely volatile. Many perfectly good PCs are retired by their owners after three or four years of service merely because they are not as fast or have as much memory as the newest models. The same is true for peripheral equipment, such as printers. As the PC market matures, there will be more and more used computers available for a small fraction of their original cost. These might be a windfall for protected area agencies on tight budgets. Again, an international NGO could act as go-between.

> **We used to have to make a conscious decision to go looking for information, to take action to find it. Now, the equipment of the information age permits the transmission of information without the desire, or even the permission, of the receiver. We are increasingly vulnerable to the invasion of information; it intrudes in our lives, often uninvited, at inopportune times.**

The same techniques might be used to supply software. The minimum software requirement is a database management program and a word processing program. A statistics program, financial spreadsheet, and graphics program would be very desirable additions, as would one of the low- or medium-cost GIS packages, when funds permit.

6. Social science and cultural research—Important tools for management

The management of all protected areas—whether classified as primarily "cultural" or "natural"—is necessarily the management of people. To some extent, managing parks and reserves is a socioeconomic process—a means of allocating scarce resources. More broadly, there is a growing realization that biophysical and social systems are intertwined. In fact, research from areas as far afield as neotropical forests and the protected areas of Israel suggests that humans have had a hand in shaping some seemingly natural habitats, and that human use is sometimes a prerequisite for maintaining species diversity. Hence, the social sciences have emerged as a potential partner to conservation in general, and protected area management in particular.

> I am interested in failure because that is the moment of learning—the moment of jeopardy that is both interesting and enlightening. The fundamental means of teaching a course in structural engineering is to show the moment when a piece of wood breaks, when a piece of steel bends, when a piece of stone or concrete collapses. You learn by watching something fail to work.

In 1982, at the Third World Congress on National Parks and Protected Areas, the participants acknowledged a shift from the approach that parks should be protected *from* people, to the approach that they should be protected *for* people. Ten years later, at the Fourth World Congress, the entire theme of the conference was how to enhance the role of protected areas in sustaining society. This is a remarkable shift away from the view that the *summum bonum* of protected area conservation is an exclusionary national park, and it seems to poise the social sciences, cultural research, and protected area management for important cooperation.

What is meant by "social science?" By one definition, its key characteristic is the application of the scientific method to understanding social behavior. This gives us anthropology, economics, political and cultural geography, psychology, political science, and sociology as the social sciences. However, a broader definition would encompass fields of cultural research such as history and its applied branches (historic preservation, cultural landscape research, etc.), archeology and allied fields, museum collections research and curation, and other disciplines. Whatever distinctions may be made among these disciplines, they all center on the study of humans. And all have the potential to contribute to protected area conservation.

Cultural resources

Before moving on to an overview of the social sciences, let us take a moment to define what is meant by "cultural resources." They are those resources that represent aspects of culture (both tangible and intangible) with significance and integrity. Just as natural resources can be inventoried, so too can cultural resources. Social science can also evaluate the significance of cultural resources to local and national populations, examine the needs and values of the local communities and the visiting public, and offer data for planning and management decisions.

Cultural resources, like natural resources, occur in nearly every protected area in the world. Unlike many natural resources, they are nonrenewable: 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.

A description of the social sciences

So, how are social sciences relevant to protected areas? To begin to understand, it may be useful to compare where each discipline has traditionally concentrated intellect and effort.

Anthropology. Anthropology focuses primarily upon social groups that are intensely cultural: communities, subcultural groups, and even entire cultures themselves. The primary interest of anthropology is cultural change, with the role of tradition being a critical interest. 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, subsistence patterns or recreational uses can affect 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 and benefits from the protected area. The research assesses physical as well as spiritual use—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.

Archeology. Archeological resources can be any surviving physical evidence of past human activity, representing both prehistoric and historic time periods. They may be found above or below ground or even submerged under water. 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 the park and should precede any planning or development activity. While archeological resources should be left undisturbed if possible, on occasion excavation can be justified for protection, research, interpretation, or development.

Archeological sites provide unique information on past civilizations. 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 living cultures whose written or oral history did not or does not include details on how people dwelled together in individual houses and villages.

Economics. Economics treats markets, industries, and economies as key units of study; the driving force of change is economic value (broadly defined). Most managers find economic studies among the most valuable. Economic analyses demonstrate precisely how much, where, and in what ways protected areas contribute to business development, employment opportunities, the tax base, economic stability, and other aspects of the economy. Such studies, by assessing how protected areas affect local and regional economies, measure intrinsic economic values, and can help rate community values and a protected area's contribution to the quality of life. Economic studies also can be used to examine whether resources are being distributed equitably.

Economics helps discern regional tourism travel patterns and assess tourism's economic impacts. Many protected areas are trying to avoid exploitative tourism incursions and encourage more compatible forms of 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.

Geography. Geography (specifically human geography) treats regions, landscapes, and other spatial units (governmental, environmental, and so forth) as critical, and the spatial distribution of people, resources, and culture is seen as a significant driving force. While geography is an extremely broad field, one of its subdisciplines, cultural landscape research and management, is rapidly emerging as one of the "growth areas" in protected area conservation through the "protected landscape" designation.

Cultural landscape research and management draws on the increasing recognition that human influence on natural areas has been pervasive. As the clarity of the definition of "naturalness" continues to fade, insights gained from research on historical ecology can be particularly useful to managers. Cultural landscapes are complex resources that contain both cultural and natural resources. In many ways, the dynamic qualities inherent in natural systems are what differentiate cultural landscapes from other cultural resources. Plant and animal communities associated with human settlement and use in a particular landscape are "biotic cultural resources" and can reflect social, functional, economic, ornamental, or traditional uses of the land. In sum, 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. By identifying and preserving such landscapes, the traditions and customs that shaped them are recognized and valued.

Historical research. A fundamental way to learn about an area's cultural resources is through a comprehensive regional history. If none exists, one should be commissioned, because it provides a greater understanding of national events, human motivations, and cause-and-effect relationships. Equally important, it surveys, identifies, and evaluates the significance of many tangible cultural resources, such as buildings, structures, and landscapes. A 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—e.g., poaching, developmental intrusions, pollution—and evaluate the effectiveness of previous management actions in dealing with them. Environmental historians also can track changes in natural resources through time, allowing the manager to understand ecological processes more fully.

> "My thoughts," said the wanderer to his shadow, "should show me where I stand; but they should not betray to me where I am going. I love my ignorance of the future and do not wish to perish of impatience and of tasting promised things ahead of time."
> —Friedrich Nietzsche, *The Gay Science*

Historic architectural research. Research on and management of valued structures are the bases of historic preservation. Historic structures are works consciously created to serve some human activity that have been deemed valuable for their quality or importance to history. They include buildings, statues, dams, ships, tunnels, and roads. Historic architectural 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 displays or adapted to some other purpose.

Before 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 people skilled in historic crafts. These specialists have learned carpentry, masonry, ironworking, and other skills as they were taught in the past. They can duplicate in materials, design, and execution 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. Through the preservation of cultural structures of local significance, protected area managers can develop rapport with local populations and win their reciprocity.

Museum collections research and curation. Museum collections require continuous professional management or they quickly lose their value. Protected area collections typically comprise archeological artifacts; biological, geological, and paleontological specimens; and historic objects. Curatorial 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 catalogued and conserved if necessary. If objects are to be used in interpretive exhibits or furnished historical structures, appropriate plans should provide for their preservation and security. Through museum collections, researchers can study the details of everything from the ordinary life of a culture to the complexities of biodiversity.

> There should be a museum dedicated to human inventive failure. The only problem it would face would be its overnight success. In almost any scientific field, it would add enormously to the understanding of what does work by showing what doesn't work.

Political science. Political science focuses upon the institutions of state, at all levels; the primary research focus is on the nature of power and its use. It goes without saying that both researchers and managers will benefit from a sophisticated understanding of the political milieu in which they work. Politics and the struggle for power dictate much of what goes on in protected areas. A knowledge of relevant political institutions, and an understanding of how they interact with each other and with the populace at large, is a prerequisite for success.

Psychology. Psychology's key unit is the individual, and communication of meaning (within and between individuals) is a central tenet. Though the protected area manager will have little recourse to psychological research on a frequent basis, the underlying importance of individual motivations in determining behavior is self-evident. Certain studies profiling visitors or other users of protected areas may have psychological components.

Sociology. Sociology treats social groups, organizations, and communities as key units of analysis, with conflict and cohesion as the two main forces that drive change. Sociological studies help managers learn more about park visitors, nearby communities, and resident populations. In terms of these three groups, sociologists collect fundamental information on who they are and how they use the protected area. They explore their expectations, values, and interests. They address overcrowding issues. They examine special subpopulations, such as older people, foreign tourists, handicapped visitors, and minority groups. They assess what recreational opportunities should be provided, what constraints should be applied to protect the natural and cultural resources, and what should be done to avoid conflicts. They can conduct social impact analyses (SIAs) which are analogous to environmental impact assessments.

Why social science and cultural research are not used more often

Protected area managers are faced with an often bewildering and complex set of decisions, most of which must be made relatively quickly and without complete information. A majority of these decisions have a socioeconomic or sociopolitical component; actions will likely have important effects upon the wider social system. Hence there is an almost continual opportunity for social science to assist in making such decisions—assuming the information is usable, not arcane.

As you can see from the above list, social sciences overlap considerably as to their units of analysis: a protected area manager interested in learning about a local community's culture could reasonably employ an anthropologist, economist, political scientist, or sociologist. The social sciences reflect the complexity of human social behavior: tradition, value, power, and space are all considered critical to understanding the human condition. The decisions of protected area managers are made against a complex sociopolitical backdrop, but, ironically, they rarely use research from the social sciences. Information from the biophysical sciences is more likely to be employed: a water quality assessment or game population estimate is more likely to enter into a resource management decision than an employee survey is into an administrative one.

> **What you take for granted you cannot improve.**

Protected area managers often use common sense, folk knowledge, field experience, and ideological views to make decisions, while usable knowledge from the social sciences is frequently ignored or avoided. In many cases, managers may not be aware of or understand the potential advantage of using social science information. In some instances, protected area managers are uncomfortable integrating scientific information into their decision-making. It often limits the range of alternatives available to the manager, by identifying unacceptable consequences, prioritizing choices along scientific rather than political criteria, and creating the need for managers to defend their rationale for not following such delivered advice. For all these reasons, what occurs is *ad hoc* and fragmented use of social science information.

The potential contributions of social science

The potential of social science is much greater. Here are five ways it can contribute to management:

Assessment. However informal, most protected area managers attempt an assessment of conditions before making decisions, from the siting of new tourist facilities to the regulation of subsistence use. Managers need to build into their assessments a role for social science information. The more formal the assessment process, the more formal a role for social science is required. For example, protected area planning should include a significant level of scientific information on visitor, resident, and nearby population resource needs, and the planning process should be designed to make this possible.

Feedback. Managers need frequent comment on park conditions and their own management techniques to keep on top of the situation. Visitor surveys, monitoring of resident population resource needs, and reporting of socioeconomic trends are examples of important social science feedback that all managers can use. Such feedback must be timely, deal with trends important to managers, and have scientific integrity. Social scientists must therefore focus on adapting all aspects of their research techniques to the practical needs of managers, from study design to the final reporting of results.

Prediction. The simplistic criticism of managers—that they reel from problem to problem, reacting to events rather than anticipating them—has a kernel of truth to it, but in many cases there is no choice. Social scientists working on protected area issues have for too long avoided prediction for the safer realm of description—describing in social science terms what managers often see for themselves. The storehouse of theory and prediction available from the social sciences needs to be opened up to protected area managers. Social scientists have the ability, and should be pushed, to apply theories and make specific predictions. They can predict which activities are sustainable, whether visitors will be satisfied, whether the cost of a project will exceed its benefit, and so on. The most accurate predictions are based on tested theory, not ideology. The level of certainty assigned to each prediction must clearly be described. No doubt some predictions will be wrong, but those mistakes can be used to improve future predictions. When a protected area manager asks "What might happen?", the social sciences must attempt an answer.

Every time you come across a new idea, try to relate it to something else.

Mitigation. Protected area management decisions often have unintended social consequences: a new visitor road opens up an area for poaching, a new regulation leads to conflict between locals and tourists. Social science can provide useful strategies for dealing with the consequences of decisions. Examples include giving economic incentives to replace income lost through a new regulation, improving communication techniques between local people and authorities so concerns are mutually understood, and using formal techniques of conflict resolution to overcome disagreements. Social science research can also help determine the human "carrying capacity" of natural protected areas.

Acceptance. Many protected areas are designated because of their national (or global) significance, and consequently managers tend to downplay or ignore their regional and local significance. Yet a recent study of reported threats to World Heritage Sites (Paine 1992) found many with local origins, such as encroachments (farming, grazing, forestry, and poaching) and negative local attitudes. Obviously local people regard these World Heritage Sites in a very different light from those who see them as inviolate monuments to civilization or nature. Social science is especially attuned to problems of scale, and thus can help managers identify and understand questions of local significance. Armed with such knowledge, managers stand a better chance of being able to win support from local constituents and alleviate some of these problems, while at the same time adhering to national or international obligations.

Accept that there is much that you won't understand. Let what you don't know spark your curiosity.

Making social science and cultural research usable to managers

These functions are the core of a successful partnership between social science and protected area management. What changes are required to achieve it?

Institutional arrangements have a great influence on whether social science and protected area management will cooperate. Here are some institutional changes that could help.

- At each scale of protected area management—individual park, regional, national, and international—monitoring programs should be established. Systematic monitoring of socioeconomic trends as they relate to protected areas is not generally available. Social scientists should develop these programs, and managers should be involved in determining what data are collected. Feedback to managers should be regular and in easy-to-use form. Data collected at one level should, as much as is possible, be aggregated at the next. For example, national data can be combined to form indicators of realm-wide conditions. A major global assessment of key socioeconomic trends should be produced before each World Congress on National Parks and Protected Areas, beginning in 2001.
- An international network of cooperative research stations should be established. Whenever possible, they should be located at universities and funded by protected area agencies, and employ a mix of university and agency scientists. Such units are an efficient way of producing usable knowledge in both the social and natural sciences. The stations can be adapted to the particular needs of each region, country, and biogeographical realm. To staff such units, a generation of young, home-country social scientists must be nurtured and encouraged to apply their skills to protected area management.
- Social science research must be integrated with natural science research in the overall program. One of the barriers to the full use of social science by managers has been that it is often treated separately from the natural sciences in funding, staffing, and organizational structures. Since the problems faced by protected area managers are interdisciplinary, this artificial separation has led to a host of problems: lack of cooperation between biological and social scientists, inadequate and undependable funding for social science, excessive administration, lower standards of scientific rigor, and, most importantly, reduced usable knowledge for managers.

Individually, social scientists and cultural researchers can make their work more usable to managers if they take a few pragmatic steps.

- Research reports should be readable, avoiding social science jargon. Most likely it will be necessary to write one report for research peers and another for managers, emphasizing scientific accomplishments in one and managerial recommendations in the other, with a third for the public.
- All graphics and tables should be concise and meaningful. Figures with columns of numbers that require extensive statistical training for their interpretation are useless to the busy manager. It is often enough for managers to know which values are statistically significant and which are not. This distinction should be made clear in the figure.
- Researchers should provide frequent oral briefings to managers and their staffs. Managers need a constant flow of data—for them, some is better than none and sooner is better than later. Moreover, when managers are kept apprised of research results, they become participants in the project and more willing to apply the results and support funding.
- Researchers should also work with park interpreters and outside educators to ensure that current research results are funneled into educational programs for the public.
- Researchers should provide viable recommendations to managers. Pie-in-the-sky lists of "future research needs" that have no chance of getting funded are worthless in a final report. Managers need specifics: specific assessments of current conditions, specific feedback on current management strategies, specific predictions of future consequences, and specific suggestions on how to mitigate the effects of those consequences. While researchers should not alter professional findings to fit political needs, they must take into account the socioeconomic aspects and political realities of protected area management.

7. Communicating research findings and management decisions

As we noted in Chapter 1, the purpose of this book is to suggest ways that researchers, managers, and the public can work more effectively together. Now, as we near our close, you can look back and see that much of the book has been about communicating better. Fostering mutual understanding and respect between researchers and managers, getting these two groups to overcome their fear of letting the public in on the game, encouraging critical thinking, emphasizing coordination in developing a research and management program, including "people research" in management—all hinge on being able to communicate convincingly.

> **We read without comprehending, see without perceiving, hear without listening.**

So, if there is a single key to successful research and management, it is effective communication. Many protected area professionals now seem to recognize this. In a recent survey of 445 North American protected area managers, the respondents identified "ecosystem dynamics and management," "public relations and participation," and "education and interpretation" as the most important management concepts for the future (Einsiedel and Brown 1992). Two of the three are about communicating.

Researchers, on the whole, are less used to dealing with the general public. They are trained to communicate with their peers via technical or professional jargon which is presented in a highly structured format. The entire apparatus of documentation and annotation, laden with Latin or other obscure abbreviations, is designed as a shorthand to enable scholars to validate the work of other scholars. Researchers basically are trained to communicate in a self-contained, self-referential world. This tradition—essential to the scholarly method—is a barrier to communicating with managers and the public. Scientists (and, perhaps to a lesser degree, cultural researchers) who attempt to talk to the general public run the risk of being branded as "popularizers" by their peers and looked down upon.

Researchers must begin to realize that they have a vested interest in banishing this unfortunate and counterproductive attitude. Those doing research in protected areas ought to recognize that the root cause of the myriad threats to the long-term viability of these areas (and, by extension, to their own research) is a lack of public support. If the public doesn't understand what's going on in a protected area, they are much less likely to acknowledge its intrinsic importance and support its research and management aims. *It is worth re-emphasizing here that it is a fatal mistake to underestimate the intelligence of the public.* Popular accounts of scientific and cultural research can be every bit as rigorous and sophisticated as those written for scholarly journals; only the style and techniques of communication are different. It is up to researchers to inculcate this attitude among their peers.

Working through an intermediary: the research interpreter

In the meantime, many researchers will have a hard time expressing themselves in everyday language. One interim solution can be to appoint an intermediary from the protected area staff to translate research results into forms more amenable to other users.

> Raw data can be, but isn't necessarily, information, and, unless it can be made to inform, it has no inherent value. It must be imbued with form and applied to become meaningful information. Yet, in our information-hungry era, it is often allowed to masquerade as information.

This challenging task calls for a person who is conversant enough with the methods and procedure of scientific or cultural research to be able to distill the main findings of ongoing projects and translate them into language and graphics intelligible to the rest of the staff and to the public. Many protected areas have interpreters or educators on staff whose primary job is to communicate what is happening in the park to the rest of the world. A special effort should be made to connect interpreters with research projects and to encourage these individuals to be trained in scientific or cultural research. Yellowstone National Park in the USA has gone so far as to create a separate position called *research interpreter.* The research interpreter's job is to be a liaison between scientists working in the park, the rest of the park staff, and the public. The research interpreter makes sure that research reports reach those who should see them within management, and writes digests of research to distribute both within and outside of Yellowstone. In Zimbabwe, a similar type of liaison position, working between agricultural researchers and extension officers, is well established. While such liaisons will be beyond the budgets of most protected areas, perhaps it could be established at a higher level within the system.

Briefings on research-in-progress

Whether or not there is a research interpreter, every protected area should have a formal means for researchers to brief the staff and the public on the progress and management implications of research. Face-to-face discussions are probably more effective than circulating memos or newsletters. These briefings should include all relevant protected area personnel (including interpreters, naturalists, historians, resource managers, staff scientists, administrators, seasonal employees, and maintenance workers) as well as resident and neighboring populations. By including both protected area staff and local residents in the briefing, the paradigm of community-based management is reinforced. Holding such briefings in an informal and collegial atmosphere, such as over a meal, may be appropriate for reporting on research in lay terms. In-depth technical briefings may also be warranted for certain research projects, and these could be reserved for formal training sessions (which, again, should not exclude interested local residents). For protected area staffers, these sessions should be considered part of the protected area's employee development program as part of a continual in-service training scheme.

How often should briefings be held? For multi-year projects, at least three times yearly, and more often if circumstances warrant. For shorter projects, a single briefing at the end of on-site work may be enough, though it would be better to have done another prior to the start so people know what work is to be done. In no instance should a project go through an entire field season without holding a briefing. The timing of a minimum number of briefings should be specified in the official research schedule.

> What is accuracy? What is enough? How great is the need to know? Does it matter to me if they tell me that my flight time on the airplane is 4 hours 21 minutes and 13 seconds and 4 milliseconds or that we will be flying at an altitude of 31,331 feet?

For those researchers who are willing, there should be an opportunity to make at least one formal, well-advertised presentation to the general public during the project. Parks are perfect venues for this; many a subject which would sink like a lead weight if presented as a "lecture" can draw enthusiastic crowds if presented as a campfire program or an informal slide-talk at the headquarters building or visitor center. Getting researchers to present such talks is worth negotiating. For paid research, this requirement can be placed in the contract. For volunteer researchers, it can be requested in exchange for logistical or other staff assistance.

Reporting research results to management

Every research project should include the provision for a summary of the work in non-technical language. The summary should include a discussion of the management *implications* of the work, if not necessarily management *recommendations*. Not all research can appropriately provide management recommendations, and some researchers may be uncomfortable making them under any circumstances. It bears repeating that managers should not expect researchers to make their decisions for them. Conversely, researchers should not expect that their every recommendation will be adopted by managers; indeed, on occasion sound scientific recommendations are rejected for valid non-scientific reasons.

Even so, if researchers are provided with a clear understanding of management constraints, any management recommendations they do make will be more practical and therefore more likely to be accepted. Unfortunately, management recommendations arising from research are seldom in a form that can be easily or directly carried out. Converting research results into practical programs requires an understanding of management constraints and options, funding, and staffing limitations. As suggested above, it would help to have a research interpreter assigned specifically to translate the results into usable management feedback. In complex situations, interdisciplinary strategy teams can be used.

> This should be the approach to interpreting information. You should ask yourself, "How can I look at this from different or opposite vantage points?" and "How would reorganizing the information change its meaning?"

The importance of providing a truly concise summary can hardly be overstated. Sending out a 300-page dissertation with a routing slip ensures that the information would be read by few if any of the park staff. Circulating the document with a one- or two-page summary written in plain language and emphasizing implications for management ensures greater interest, which in turn improves future field support for research.

Marketing research to managers

Managers (and field staff, such as wardens and maintenance workers) may have to be continually convinced of the value of research. They may need incentives to support research, since, as we have noted, political and bureaucratic realities can make managers less than enthusiastic about controversial or inconvenient findings. In addition, park field staff already feel the burden of too much work and not enough time or money. A new research program should be designed to fit into other operational duties. Personnel who provide logistical support should receive comment on their efforts and benefit from the research project information. Field and logistical support from managers should be acknowledged in scholarly publications. Communicating research results should be made part of job-performance standards of all staff researchers and managers, and demonstrations of excellence in doing so should be rewarded.

Another way of getting managers to "buy into" research is to encourage them to co-author articles with researchers. Articles in popular magazines are useful, but exposing managers to the rigors of peer-reviewed publishing in traditional, single-discipline scholarly journals has more value: it sharpens their analytical skills and helps them understand the researcher's point of view. Best of all, there are also a growing number of intermediate publications (some peer-reviewed, some not), aimed at professional audiences, that stress cross-disciplinary applied research. These intermediate publications would be a good starting point for researcher–manager collaborations, who can branch out from there toward both the popular and traditional scholarly audiences.

Marketing management to researchers

Researchers also need some nurturing. They should not be allowed to think that their work has gone into a black hole once they turn in their final report. They should receive notice that their research is being applied, providing the framework necessary for future working relationships. If, on the other hand, their results or recommendations are not being used, they should be told the reasons why. Both kinds of feedback allows for evaluating the work's applicability and for refining future studies.

When specific applications of research results are envisioned beyond the scope of the original work, the researcher should be contacted for a discussion of applicability. Needless to say, any extensions of the results should not be attributed to the researcher without prior permission. A related potential misunderstanding centers on who "owns" the raw data derived from research. A discussion of the many questions surrounding intellectual property rights is beyond the scope of these guidelines; suffice it to say that data ownership can be the subject of fierce disagreements, particularly when the research has been partly or wholly funded by government. A mutual understanding should be arrived at with the researcher and put into writing before work begins.

Communicating directly with the public

The reasons for and the results of research projects should be communicated to the public through various means. Park visitors generally are interested and educated users. They are the grass-roots supporters of the protected area system and its programs. Their support becomes stronger and more effective to the degree they understand the varied resources. Short articles on resource projects should be presented in park newspapers or other visitor publications. Where possible, a research or resource management field team should be accompanied by someone with interpretive skills who can discuss the project on-site with interested visitors.

> **Learning can be defined as the process of remembering what you are interested in.**

An extra effort should be made by the protected area authorities to stay in touch with resident populations and nearby communities. As we have tried to stress, representatives of these groups ought to be involved in planning research and management activities (as well as presenting the results), and presumably will report back to their groups. Nonetheless, park personnel will do well to keep open direct lines of communication to community leaders. In these communications, observance of protocol is all-important. Local personages must be accorded respect and approached on terms that are comfortable to them. You may issue dozens of invitations to attend planning meetings or briefings that are declined or ignored, but never stop inviting local leaders. The fact that they are consistently approached is an important overture that may pay dividends some day. An "open-door" policy is vital to obtaining local support for a protected area.

Research needs should also be shared with local educational institutions. A list should be prepared of suggested research topics or projects and provided to universities, colleges, and even secondary schools. The list should include a contact person's name and the minimum logistical support the park can offer. Likewise, every park should try to present research results to local universities and schools down to the primary grade levels—perhaps *especially* in primary schools.

Using the news media

Another avenue to public understanding, one which can be of great value to both researchers and managers, is the news media. Protected areas are of enduring interest to journalists because they impart a sense of tangibility to complicated and often abstract resource issues. Parks and reserves are an easy "hook" for reporters to hang a story on. Of course, the drawback of trying to communicate research findings through the news media is the danger of having them oversimplified, sensationalized, or misinterpreted. Yet the potential number of people that can be reached is so large that no protected area can afford to ignore the press.

Both researchers and managers need to develop much more sophistication in their approach to using the news media. Rather than sitting back and reacting to interview requests as they come in, protected area staffs need to develop media outreach plans to actively pursue press contacts so stories can be molded and scheduled to fit the protected area's purposes, rather than the journalist's. Basic news stories require an eye-catching lead-in, a quick exposition of the facts, and an identifiable conclusion—preferably peppered throughout by snappy quotations.

Press releases thus become an important research and management tool. They must contain pre-packaged quotes and short clear phrases that can be used verbatim by the media. Reporters are in a perpetual rush and always under space or time limits. They may be allotted only a handful of short paragraphs or time for a few "sound bites" to get the story over. As deplorable as that is, it is the rule, not the exception, and protected area authorities will have to become adept at using the system as best they can.

Obviously, most research and management projects, considered in their entirety, cannot be boiled down to this formula—but key parts can. Do not try to cram the whole project into a single news story; plan instead to portion it out to the media in a logical fashion, so that over time and through a *series* of news stories, a more coherent picture emerges. To do this requires forethought, which is why a media outreach plan is a good idea. The series and media mix can be planned out before any oversimplifications or misrepresentations take hold.

The importance of good graphics

In today's visually oriented world, graphics are no longer an embellishment to the printed word, nor even a supplement: they are increasingly the most effective primary mode of printed communication. Charts, tables, maps, and drawings—many of them capable of being created on a personal computer—are often the fastest, most effective way of conveying spatial and numerical information. Words fail to do justice to many complex relationships that will arise from protected area data; a carefully thought-out graphic can bridge the communication gap between researchers and managers, and between them both and the public (see Box 7.1).

> Elevating the stature of statistical graphics has created two camps, and the mere mention of the words "diagram" or "chart" will likely produce strong reactions. They will set the statistically inclined all aquiver, but will evoke fear and loathing among the poor, angst-ridden verbal types who insist they can't understand numbers. Both reactions are based on a failure to understand or regard charts and diagrams as maps, in that they are all patterns made understandable.

Just as there are style books that advise authors on how to write well, there are certain principles that go into good graphics. What makes for graphical excellence? Whatever "gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space" (Tufte 1983). Because graphics can also distort, cover up, confuse, confound, and outright lie about the data being presented, Tufte has also put forth some principles of "graphical integrity":

> For many people the first word that comes to mind when they think about statistical charts is "lie."

- The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.
- Clear, detailed, and thorough labeling should be used. Write out explanations on the graphic itself. Label important events in the data.

Box 7.1. Tailoring a graphic to three audiences: researchers, managers, and the public

Many times a graphic will have to be customized for a particular audience. In the example below, the same data from the Canadian province of Nova Scotia are presented in three formats: a cluster analysis prepared for a manuscript submitted to a scientific journal, a histogram prepared for a management document, and a distribution map prepared for a fact sheet meant for the general public.

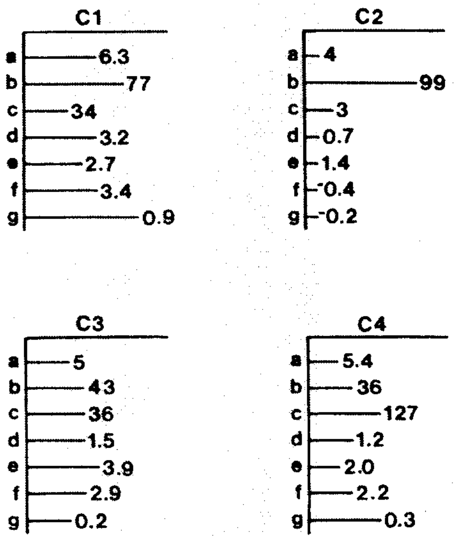
The cluster analysis is an example of a highly technical graphic aimed at a specialist audience. The emphasis is on statistical comparability rather than visual attractiveness, and indeed our example has virtually no visual impact. That does not matter, however; to the trained eye, the graphic allows comparison among many data points.

The histogram is a specialized type of bar chart in which the distribution of frequencies is shown by means of rectangles whose widths represent class intervals and whose areas are proportional to the corresponding frequencies. It can be understood, at least in its basics, by someone with no statistical training; to those who have some statistics, it yields a more sophisticated interpretation. The visual impact is much higher than that of a cluster analysis: in the example, one can see at a glance that certain pH values appear more frequently than others. The disadvantage is that such simple observations, if taken alone, may be misleading.

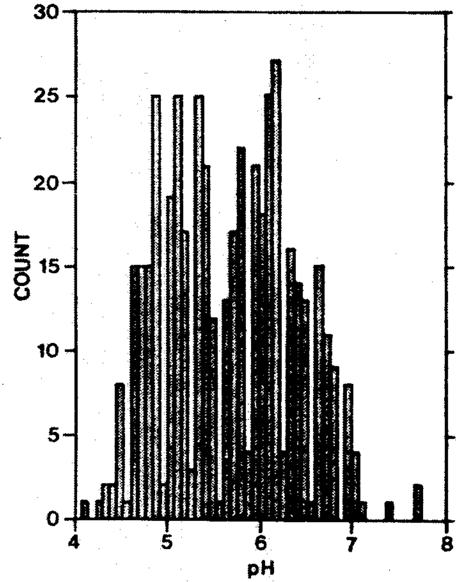
The distribution map has the highest visual impact because it uses an image with which many people are already familiar. Most of the public in Nova Scotia will have seen other maps of the province, will be able to place themselves and other locales on the map, and will be able to conjure up mental images of the landscape based on their travels. All of this contributes to understanding. The map conveys important, albeit generalized, information on pH values, though the significance of that information will have to be further explained (e.g., How does a pH of 4.5 compare with one of 6.5, and why is the difference important?). Further drawbacks are that almost all statistical comparability is lost; one gets no sense, for example, of the variations in pH within the subregions of Nova Scotia.

Our examples suggest an important corollary to using graphics: while graphics should not be considered merely a supplement to text, text *should* be used to supplement graphics. Very few, if any, graphics can stand alone.

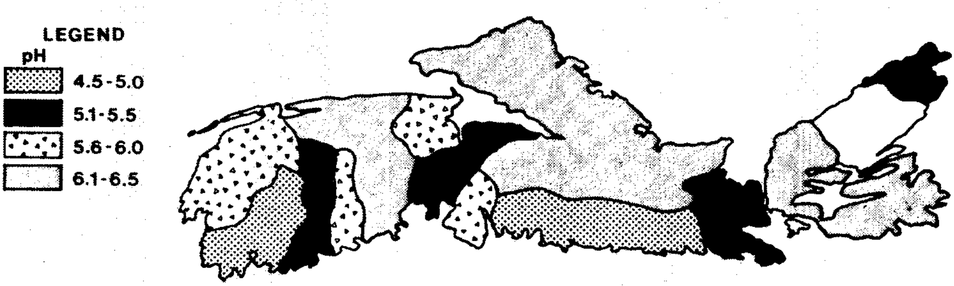
CLUSTER ANALYSIS OF
NOVA SCOTIA LAKES



HISTOGRAM OF pH FOR
600 NOVA SCOTIA LAKES



DISTRIBUTION OF pH FOR 600 NOVA SCOTIA LAKES



Source: graphics contributed by Tom Pollock

- Show data variation, not graphical design variation.
- Graphics must not quote data out of context.

Failure to respect these principles can produce graphics that either (1) lie, (2) use only the simplest designs, such as unstandardized time-series based on a handful of data points, or (3) miss the real news of the data. Such graphics are at best only decorations of numbers. Tufte (1983; 1989) gives numerous examples of shoddy and misleading charts, tables, and maps—as well as excellent ones.

There are also some general rules for which form to select. *Sentences* are a poor way to show more than two numbers because the linear flow of words, broken arbitrarily across the columns of a page, prevents quick comparisons among numbers. *Tables* are preferable to charts for small sets of data. They also work well with large data sets if they require many localized comparisons. In all cases, however, tables lack visual impact. *Bar charts* are good for comparing quantities but not volumes; *pie charts,* for comparing simple percentages but not complex ones. "*Fever charts*" are good for showing trends as long as the scale used is constant. Maps are unexcelled for showing spatial relationships, but can be misleading if their projections are too distorted.

A word here about projected graphics. Most presentations suffer from graphics that are either indistinct or far too detailed to be grasped by the audience. Transparencies (i.e., slides) intended for presentation, as well as overhead clear-film projections, should be custom-designed for the purpose at hand. Slides must exhibit crisp edge-to-edge focus or they will become blurry when projected. Photographs of specific objects must show them in sharp contrast to the background, and the objects must be large enough to be readily seen by the audience. Overheads must not be crammed with detail; each overhead should make two or three points in summary and no more. This will likely require breaking down tables and charts into highlights.

Building and preserving research capacity

Finally, some attention should be paid to nurturing the long-term capacity for parks to do research; without this, even the best communications scheme will eventually grind to a halt. The foundation of research capacity is having a responsive, integrated research and management plan which includes a monitoring program. The basic tools to build on the foundation are a solid park library and a good electronic database. Every protected area should have some space set aside for management documents, research reports, files of news clippings, collections of video and audio tapes, and any other documentation that relates to the park. Having computerized park bibliographies and catalogues, electronically with others throughout a protected area system, is an admirable goal, but for many protected areas a more realistic step is to make sure at least one hard copy of all relevant publications is on a shelf in the headquarters and that there is at least one PC on hand running a database with basic inventory information.

> As the economist Kenneth Boulding said, "The moral of evolution is that nothing fails like success because successful adaptation leads to the loss of adaptability. . . . This is why a purely technical education can be disastrous. It trains people only in thinking of things that have been thought of and this will eventually lead to disaster."

Without some kind of depository, the protected area loses its "institutional memory" as personnel come and go. Indeed, as Shelton (1992) notes, personalities play a big role in how effectively research results are communicated. Some people are good at it, some are not; but no matter who is on staff at a particular time, having a park library dampens the fluctuations caused by the "personality factor."

8. Conclusion

Our aim has been to present a forceful case for coordinating research and management. Without glossing over the differences between researchers and managers, or taking sides, we have tried to show that both their interests are better served when they work together rather than at cross-purposes. We have argued that genuine public involvement is essential to the success of protected area conservation as we near the new century. Since changes in traditional attitudes about research and management are called for, we have suggested a blueprint for thinking critically about park problems. Finally, we have laid out the elements of a coordinated research and management program, taking into account costs, the neglected area of social science research, and the need to communicate effectively.

The machines of the world's greatest inventor, Leonardo da Vinci, were never built, and many wouldn't have worked anyway—but he was trying solutions where no man knew there were even problems.

We hope you can use at least a few of the ideas offered here. Reshape them, turn them upside down, or use them "as is." The important thing is to realize, as Leonardo did, that the search for solutions can be just as meaningful as finding them.

Appendix 1: Case studies of coordinated research and management

Conserving Sinharaja: The evolution of a partnership between research and management

When IUCN and the government of Sri Lanka signed an agreement in 1988 to cooperate on forest conservation projects in the low-lying wet zone of Sri Lanka, Sinharaja was already being recognized as one of the world's better-documented tropical forests (IUCN 1988). Although threats to Sinharaja's future still linger around its borders, its conservation has drawn together scientists and managers, both within Sri Lanka and from the international community.

In the Sinhalese language spoken by 70% of Sri Lankans, Sinharaja literally means "lion king." The legendary origin of the Sinhalese, as the people of the "lion-race," perhaps contributed to Sinharaja's becoming the island's first natural site to be inscribed on UNESCO's World Heritage List. It is also Sri Lanka's first National Wilderness Heritage Area.

Sinharaja is located in the southwestern lowlands (Figure A1) and conserves the largest contiguous patch of lowland evergreen rainforest in Sri Lanka. In the past, Sinharaja's forests probably extended over 100,000 ha. The designated World Heritage Area, however, covers only 8,864 ha, of which 75-80% was thought to comprise undisturbed lowland evergreen rainforest (Ishwaran and Erdelen 1990). But a recent review (IUCN 1993a) estimates the extent of undisturbed forest cover to be around 66% of the World Heritage Area. Although most parts of the original Sinharaja forest outside the World Heritage Area have been managed for the production of timber, some natural forest patches still occur adjacent to the reserve (IUCN 1993b).

Annual rainfall in Sinharaja ranges from 3,000 to 5,100 mm, and even during February, the driest month, about 190 mm falls. The wet zone of Sri Lanka, and Sinharaja in particular, represent the only area of aseasonal climate between western Malesia (Sumatra, Malaya, Borneo, Philippines) and the western coast of Madagascar. Furthermore, the natural vegetation of Sinharaja and the surrounding lowlands include significant Godwanic elements and are quite distinct compared with that even of southern India (Ashton and Gunatilleke 1987). Endemism among the flora and fauna of Sinharaja is very high, exceeding 90% in some dipterocarp families. About 70% of the known species of woody trees

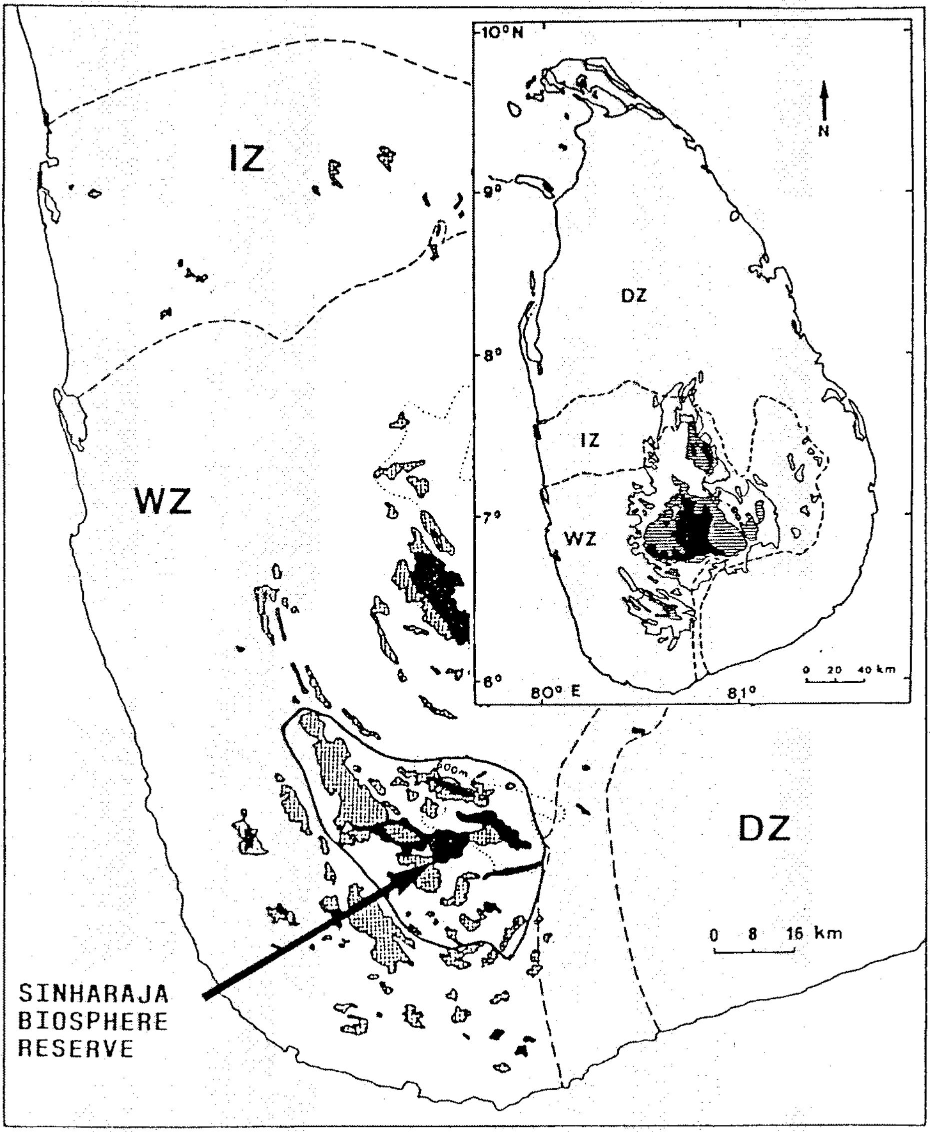


Figure A1. Location of Sinharaja and lowland wet-zone forests

DZ = dry zone; IZ = intermediate zone; WZ = wet zone. Approximate extent of Sinharaja group of forests encircled. Black areas = relatively undisturbed primary forests. Checkered areas = selectively logged and/or disturbed forests. Inset map: Lined areas = elevation between 900 and 1500 m. Black areas = elevation above 1500 m.

and lianas, ferns, and epiphytes are endemic, as are 90% of the birds seen in Sinharaja (Gunatilleke and Gunatilleke 1984; Balasubramaniam 1985; March for Conservation 1985).

The fact that Sinharaja contained an abundance of certain classes of merchantable timber was known through surveys undertaken during the 1950s. Yet Sinharaja remained largely undisturbed since its rolling terrain, a series of valleys and ridges, posed problems for mechanized logging operations. This natural security enjoyed by Sinharaja was threatened when a 1968 international study justified logging Sinharaja to supply raw materials for a plywood sawmill and chipwood factory in a nearby town.

The beginning of mechanized logging in Sinharaja, in 1971, led to the formation of an alliance of nature lovers, scientists, and academics who challenged the validity of the decision. A re-evaluation of costs and benefits made it clear that the site's topographic constraints on the efficiency of logging operations had been ignored—and the amount of timber Sinharaja could supply exaggerated—to justify the operations of the plywood sawmill and chipwood factory. Moreover, the reality of the difficulties of mechanized operations in Sinharaja soon became apparent, and logging had to be abandoned in 1972. The struggle between the pride of those who justified the logging in the first instance, and the commitment of others who clearly saw the senselessness of destroying Sri Lanka's last remaining patch of evergreen rainforest, continued for nearly five years. Although logging was reintroduced on a limited scale in 1974, it was permanently abandoned in 1977.

The Forest Department of Sri Lanka, which is responsible for the management of Sinharaja, recognized the scientific and conservation importance of the site and initiated a program of action which increasingly drew the attention and cooperation of scientists from Sri Lanka and elsewhere. In 1978, what was then the Sinharaja Forest Reserve was declared an International Biosphere Reserve as part of UNESCO's Man and the Biosphere (MAB) Program. Biosphere reserves are intended to be a category of protected areas where scientific research, training, and environmental education initiatives aid the manager in conserving ecosystems and the genetic resources they contain in cooperation with local people living within or near the reserve. In declaring Sinharaja to be the only biosphere reserve representing Sri Lanka's lowland wet zone, the managers and administrators in the Forest Department expressed their interest in Sinharaja becoming the focus of a research–management partnership to promote conservation of the rainforest and socioeconomic development of local people.

Interest in research on the flora and fauna of Sinharaja increased sharply during the 1980s and has continued to grow since. Studies of the flora were spearheaded by a team from the University of Peradeniya's Department of Botany. Research on the fauna became a main interest of a newly established nongovernmental organization called March for Conservation and of the University of Colombo's Department of Zoology. The Forest Department provided basic facilities to accommodate scientists and made available the time of its guards and other staff resident in the Sinharaja forest to assist field research. Publications from these research studies began to attract scientists from abroad, particularly from universities in the USA (e.g., Harvard University and the University of Massachusetts). At present, Sinharaja is one of the most important sites where long-term records on tropical forest ecology are being built up, primarily through the joint efforts of universities in Sri Lanka and the USA and with help from several bi- and multilateral donor agencies (U.S. Agency for International Development, Norwegian Agency for Development, UNESCO) and international nongovernmental organizations (IUCN, World Wide Fund for Nature).

In 1982 Sinharaja was nominated to be Sri Lanka's first natural site inscribed on the World Heritage List. The World Heritage Committee agreed that Sinharaja merited inclusion, but deferred action until the reserve's legal status was upgraded and a management plan prepared. At the time, Sinharaja was still nationally classified as a Forest Reserve by the Sri Lanka government, even though it had received the concurrent designation of International Biosphere Reserve. The Forest Reserve classification left open the possibility that Sinharaja could be managed for timber production. Although the biosphere reserve designation indicated the Forest Department's intention to manage for other objectives, the reserve lacked a management plan which put this intention into writing. The World Heritage Committee's deferral spurred the Forest Department to seek upgraded legislation and prepare a management plan.

The preparation of the plan (Sri Lanka Forest Department 1986) took the research–management partnership to new levels. The plan was readied through a two-step process. First, a workshop was held to bring together local and provincial authorities concerned with the conservation of Sinharaja. The constraints and opportunities for conserving Sinharaja made evident by these people, facing the day-to-day realities in the field, were then addressed during the second step, in which a five-day interdisciplinary workshop brought together scientists and important decision-makers to derive the basic concepts and strategies of the management plan. The strength of the plan and the support it received for its implementation came from the participatory mechanism that characterized its creation. The whole process was coordinated by the Forest Department, in cooperation with IUCN and WWF. The plan was adopted by the Sri

Lankan government and immediately attracted generous funding for its implementation from the Norwegian Agency for Development.

Parallel to this process, the Forest Department drafted a National Wilderness Heritage Act under which, in 1988, Sinharaja was declared the country's first National Wilderness Heritage Area. Both of its concerns addressed, the World Heritage Committee inscribed Sinharaja on the List later that year.

In the implementation of the management plan for Sinharaja, the hitherto neglected aspects of local people and their socioeconomic needs were given new emphasis. The research community grew to include social scientists, and the information they gathered began to cater to the short- and medium-term needs of Forest Department managers and administrators. Demographic and socioeconomic information such as the following were revealed (Silva 1985):

- There were two villages within Sinharaja, and twenty settlements along its periphery.
- Forty-nine percent of the households owned less than 1 ha of land, and 8% completely depended on rainforest resources for their livelihood. Extraction of these resources were carried out by those below the age of 40.
- Fifty-three percent of the families had more than five members.
- Alternative employment opportunities in the area were rare.

Although the main plant species used by people in and around Sinharaja were few (six; see Box A1), more than 200 species had known medicinal, commercial, or subsistence value. The halting of logging during the 1970s seems to have blinded the scientists, managers, and nature lovers to the persistent danger posed by the resource dependence of the local people. The implementation of the management plan, however, achieved the following (IUCN 1993b):

- Socioeconomic surveys were completed and the option of resettling several villages along the boundary of Sinharaja was investigated.
- Local people's awareness of the importance of Sinharaja was raised considerably. Conservation education workshops were held, teaching and extension materials were developed, some young people were recruited and trained to be visitor guides, and a voluntary society, *Sinharaja Sumithuro* (The Friends of Sinharaja) was set up.
- A buffer zone management program, including a rural renewal program, was developed.

Box A1. Sinharaja plant species most intensively used by local people

- "Kitul" palm *Caryota urens* (Palmae). The phlegm sap of the young inflorescence of this palm is used for preparing jaggery, a sugar substitute. Small pieces of the bark of the dipterocarps *Shorea stipularis* and *Vateria copallifera* are introduced while the sap is being heated to prevent fermentation. (The fermented sap, called "toddy," is a locally popular alcoholic beverage.)
- "Wewal" palm *Calamus* spp. (Palmae). This palm grows in open sites created by natural tree-falls or logging. It is the source of cane used for manufacturing baskets, chairs, and several other handicraft items for which there is a demand in both urban and international markets. Cane-ware is recognized as a craft product of Sri Lankan artisans which provides employment as well as foreign-exchange earnings.
- Wild cardamom *Elletaria ensal* (Zingiberaceae). Wild cardamom is used locally as a spice. The plant is found in the undergrowth of the rainforest.
- "Beraliya" and "dun" *Shorea* spp. (Dipterocarpaceae). Fruits of a species of *Shorea*, locally referred to as "beraliya," are used to produce a substitute for flour. Another species of the same genus, "dun," provides a resin which is used in preparing varnish and incense.
- "Weniwal" *Coscinium fenestratum* (Menispermaceae). The stem of this liana has recognized anti-tetanus properties and is used by people throughout Sri Lanka.

Despite these achievements, there were certain weaknesses in the management regime which derived from the 1986 plan. For example, rural renewal projects undertaken as part of buffer zones emphasized the welfare aspect, with activities such as the creation of a mobile eye clinic and the free distribution of spectacles. Laudable though these were, they did not reduce the dependence of local people on Sinharaja's resources. This has resulted in encroachments persisting as "an incremental threat to Sinharaja's integrity" (IUCN 1993a).

Nevertheless, the experience gained through the implementation of the plan and its review led to a revised management plan (IUCN 1993b). The research data compiled in elaborating this "Phase II" plan has made it possible to fine-tune management operations to address specific issues such as:

- Modifying the boundary to exclude old encroachments and private lands and include patches of natural forest lying adjacent to Sinharaja, including privately owned and estate lands and parts of some proposed reserves.

- Setting aside special sections of the Sinharaja Conservation Area (with modified boundaries to include all natural forest patches adjacent to the current National Wilderness Heritage Area) as core areas where all entry will be prohibited, except for scientific study.
- Issuing permits for tapping kitul (*Caryota urens;* see Box A1) inside as well as outside the Conservation Area, except in the core areas. This recommendation is particularly significant for the local economy, because from 1985 permits to tap the kitul palm have been restricted to lands outside Sinharaja. A recent study by Savithri Gunatilleke and Nimal Gunatilleke of the University of Peradeniya has indicated that this activity could bring substantial income to villagers (estimated at 2,000-3,000 Sri Lanka rupees per month, equivalent to US$40-50) from tapping a single inflorescence. Some villagers have begun planting the palm as a boundary marker or shade tree in their small plots of tea.
- Expanding the buffer zone program to include ecological restoration, forming and strengthening community-based organizations, and a schools program, apart from the existing rural renewal projects. The rural renewal activities will also give more emphasis to improving delivery of services provided by government agencies to local people and for developing cottage industries. Local and foreign expertise will be sought to shape rural development that is in harmony with the conservation objectives of Sinharaja.

The case of Sinharaja provides an example of the evolving partnership between research and management. It also highlights the need to prompt researchers and managers into having fresh insights by regularly reviewing management operations. A protected area without a management plan has no future—but having a plan is no eternal solution, either. Regular reviews of management plans and operations, and doing the surveys and studies essential to such reviews, are indispensable components of the research–management partnership. Strengthening the partnership must be a goal for both sides if the complex and diverse objectives of contemporary protected areas are to be realized.

Source: contributed by Natarajan Ishwaran

Ecological research and monitoring: The Kejimkujik model

To permit development of economically effective and ecologically sound resource management strategies, decision makers must have scientifically dependable information on both the limitations and opportunities associated with land use. Getting such information requires a long-term research and monitoring strategy which permits relational analysis of environmental variables. Sites chosen for long-term research and monitoring must be kept from uncontrolled disturbance, and provide the opportunity for a variety of studies both inside and outside protected areas.

Kejimkujik National Park, located in southwestern Nova Scotia, was chosen as one of Environment Canada's first ecological research and monitoring centers because it fit these criteria, as well as having a research and monitoring history associated with acid rain studies and a resource management program. The opportunity to provide the public with information through the park's interpretive program was an important additional asset.

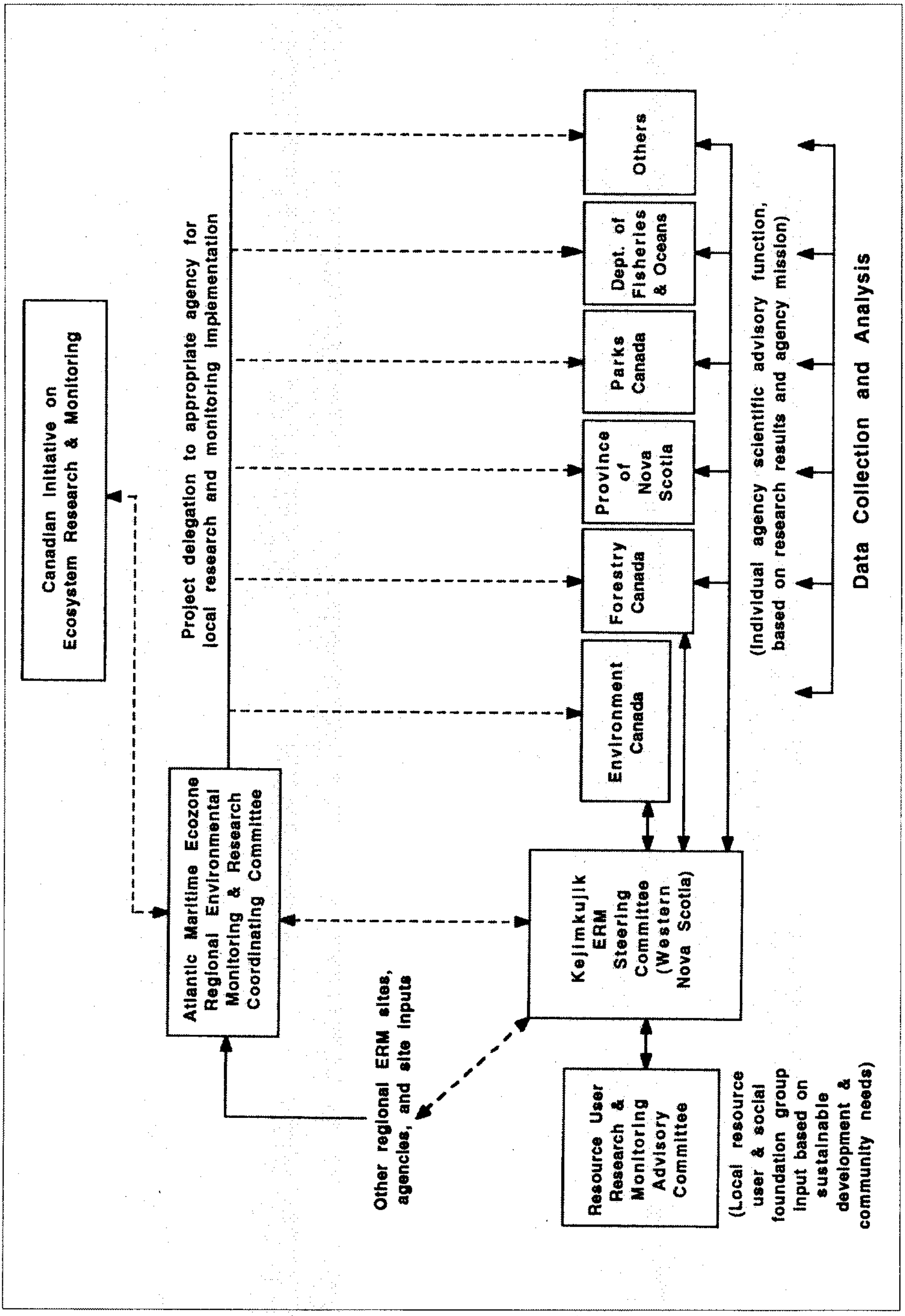
The Kejimkujik ecological research and monitoring center is still in its developmental stages. However, the following outline of the project's objectives and organizational framework reflects progress made thus far.

The general objectives are threefold. First, to develop the center as part of a national system intended to improve our understanding of ecological functions and processes. Second, to determine the causes and consequences of environmental change in appropriate ecosystem elements. Third, to provide an early warning system of environmental change. More particularly, the project aims to monitor ecological processes in the park and surrounding region in concert with a number of provincial, federal, and international partners, and to increase public awareness of the findings.

Figure A2 depicts the decision-making process and operational interrelationships as they apply to the center. Scientific strategy is developed and carried out primarily by the Kejimkujik Ecological Research and Monitoring (ERM) Steering Committee (Western Nova Scotia). This multidisciplinary group is composed of scientists from a variety of agencies, government levels, and academic institutions, all of whom are familiar with the Kejimkujik area. Its task is to develop research and monitoring objectives relevant to Environment Canada's needs, and those of other partners. It can direct recommendations for projects to relevant agencies and institutions for action, as feasible. The committee presents workshops on ecological research and monitoring activity and maintains quality assurance standards.

On an ecozone level, coordinating research and monitoring is the responsibility of the Atlantic Maritime Ecozone Regional Environmental Research and Monitoring Committee. It reviews and supports the strategy developed by the Kejimkujik ERM Steering Committee, while coordinating study priorities with other ERM sites in the Atlantic Region network and with nationwide or international initiatives. Membership in this committee is cross-sectoral, with participants from a variety of agencies and government levels.

Figure A2. The decision-making process for the Kejimkujik ERM center



At the field level, the Kejimkujik park ecologist serves as the on-site co-ordinator. This person serves on community and scientific committees; acts as a liaison with other researchers, agencies, park staff, schools, land owners, nongovernmental organizations, and businesses; plans and oversees initiatives to increase ecological understanding; updates the park-based ecological information management system for western Nova Scotia; develops cross-sectoral partnerships; and helps direct students. Finally, the ecologist develops opportunities for training and public education, and represents Parks Canada and Environment Canada to the public.

To optimize the relevance and utility of scientific study at the local level, a Resource User Research and Monitoring Advisory Committee has been created. It is composed of representatives from local forest-based businesses, educational institutions, government resource management agencies, citizen's groups, and health services. This group represents a primary point of contact with communities in the area, and permits opportunities for services-oriented studies, public education, and information exchange associated with the concept of sustainable development.

A coordinated information management system, operated by a skilled data management specialist, using microcomputer technology with GIS and database software, provides a critical element in the development of a research and monitoring network. At Kejimkujik, this system will include an up-to-date bibliography of studies carried out in western Nova Scotia, in addition to georeferenced thematic maps, selected study methodologies, and database files. Operation of the system will include development and maintenance of protocols for the regular updating of files and access by participating agencies and institutions through Internet, the global communications network. Consulting with researchers on optimizing data management systems will also be an important duty for the information management specialist.

Capabilities for integrated ecological research and monitoring can be strengthened through increased co-operation among various institutions, agencies, and businesses. This in turn requires an infrastructure which makes it easier to set common research and monitoring objectives, and to cooperate in the conduct of studies. A locally coordinated information management system provides the link to greater information networks. The entire system can also be used by schools for science and mathematics education, thus further enhancing the utility of ecological research and monitoring initiatives.

Source: based on Drysdale 1994

Toward ecosystem management: The Greater Fundy Ecosystem Project

The Greater Fundy Ecosystem (GFE) project is an attempt to design and implement a plan to manage a landscape on an ecologically sustainable basis. The overall aim is to protect ecological structures, functions, and processes while providing a sustainable flow of goods and services for people. A key element of the GFE project is the integration of a protected area into its regional landscape as a single greater ecosystem. At the core of the GFE project is Fundy National Park, covering 206 sq km on the upper Bay of Fundy in New Brunswick, Canada.

The GFE project grew out of concerns, mainly by park managers and academics, that the ecological values of the park were not being adequately protected by managing the park in isolation from surrounding lands. A study of the ecological integrity of the park documented a history of losses of native species, invasions by exotic species, habitat fragmentation and conversion, and significant doubts that species associated with old-growth coniferous forests would survive in the area.

The problems faced by Fundy National Park occur in many of the world's protected areas. Parks and equivalent reserves are often too small to protect viable populations of many species, especially large vertebrates and seasonal migrants. Most reserves are also too small to accommodate the dynamics of large-scale ecological processes, such as wildfire or insect epidemics. As a result, the integrity of many community types is at risk.

There is no absolutely determined size for the GFE. A detailed biophysical database exists for an area of 1,050 sq km, but this is a working area and does not define the size of the GFE. The project is an approach to integrating an ecological reserve into its larger surrounding landscape; the ecosystem approach is the context for it all. There is no attempt to draw a boundary around the 1,050-sq-km area that either limits institutional partnerships or ecological understanding.

The GFE project was established in 1991. From the beginning, the project was conceived of as being a research and monitoring effort to provide the science support necessary to manage an ecologically sustainable landscape. This early research focus was essential to bring all parties together under a common, non-threatening agenda. The project was always conceived of as being multidisciplinary, with members from industry, government, and academia. The aim of the GFE project is to be inclusive, and not to be interpreted as aligned with the aspirations of a particular group or agency.

The project is run on an *ad hoc* basis, without a formal constitution. Decisions are reached on a consensus basis, and management is accomplished by a chairperson and management committee. An office for organization and administration of the project was established in 1993 in the Faculty of Forestry at the University of New Brunswick. Funding for the office and a project coordinator comes from Parks Canada (the federal park agency) and the University. Research funds come from a variety of sources and granting agencies.

The GFE project was instrumental in applying for, and receiving, a "Model Forest" grant from the federal government of Canada. The Model Forest program is a large national and international effort by Canada to promote research and demonstrate sustainable forestry. The procurement of a Model Forest grant led the GFE project into a partnership with over 20 other groups to form the Fundy Model Forest. The other groups include forest products companies, private woodlot owners, federal and provincial government agencies, universities, and nongovernmental organizations such as environmental groups and clubs. The area of the Fundy Model Forest extends north and west of Fundy National Park to encompass approximately 500,000 ha. A key partner in the Fundy Model Forest is the Southern New Brunswick Wood Producers Co-op, a cooperative of small private woodlot owners who collectively own half of the forest lands in the Model Forest.

The ecological research agenda developed for the GFE project was adopted in full by the Fundy Model Forest. The Fundy Model Forest now acts as a key sponsor for research in the GFE and will use the results to develop a larger management plan, expected by 1996.

The GFE project is an attempt to manage a reserve as part of a larger ecosystem. Ecosystem management is a term applied to the activities of many different agencies, and has been interpreted in a variety of ways. The following principles of ecosystem management are thought to apply to the GFE project.

- *An integrated partnership.* Institutional boundaries are never the same as ecological boundaries. Thus, if management is to proceed on the basis of ecological boundaries, interagency co-operation is essential and not simply a desirable thing to do. The GFE project is explicitly organized to cross institutional boundaries and not let institutional frameworks influence ecological thinking.
- *The importance of scale.* All management issues vary with the scale on which they are considered. This is certainly true for biology, which is characterized by hierarchically related levels that include genes, organisms, populations, communities, and landscapes; it is

also true in the social sciences (see Machlis 1993). The choice of the appropriate scale at which an issue is to be managed is critical.

- *A range of land uses over a broad scale.* Over the longer term, ecosystem management must accommodate multiple uses at a regional scale, and restricted uses at a site or unit scale. Simply put, this implies that human activities may not be ecologically sustainable if spread over the entire landscape. Our best approach to conserving nature is to plan for a range of land uses, from concentrated human activity (such as towns or plantations) to large areas (such as ecological reserves) where humans have little impact. At the heart of the GFE project is a core protected area, Fundy National Park. The GFE project aims to ensure that management actions in the surrounding landscape are compatible with the protection of the ecological values of the park.
- *A systems context for decisions.* Social, political, and environmental issues must be viewed in a systems context and not as isolated issues. This is a basic principle of ecosystem management and it implies that actions, programs, and policies cannot be based on narrow sectoral perspectives.
- *Ecological boundaries are contextual.* Ecosystem boundaries are elastic over time. This characteristic can be seasonal, as is found in migratory ungulates moving from summer to winter range, or longer term, such as the distribution of mature-growth forest, beaver ponds, and retreating glacial outwashes. We have deliberately not drawn fixed boundaries around the GFE. Specific issues must be managed in their own dynamic context. For example, the park has two rivers with runs of Atlantic salmon *(Salmo salar)*. One of the rivers was subject to a salmon reintroduction program, in which an old logging dam was removed and juvenile salmon were introduced. For that issue, the spatial boundary is the river basin. However, the adult salmon runs are far smaller than historical levels, possibly due to a fishery by-catch. For this issue of low returns, the ecosystem management boundary is much larger. It includes the Bay of Fundy and Gulf of Maine, where Fundy salmon stock are known to spend time.
- *Integration of databases.* Decisions in the context of ecosystem management are best made from common, integrated databases. The term "database" is used in the largest sense and includes the commonly used spatial information on vegetation, geology, land form, soil, land use, animal movements, and rare features. However, the database should not be limited to biophysical data. It should also include information on cultural features, institutional arrangements, economics, and human living patterns. The use of an integrated database puts all partners in ecosystem management on an equal footing. For the GFE project, a common biophysical database exists in a geographic information system, to which all members have unlimited access. A detailed protocol for data storage, acquisition, and cata-

loguing is being developed. This database is housed in the GFE office at the University of New Brunswick.

- *Clear and appropriate goals are necessary.* Ecosystem management best develops where there are clear objectives for the ecosystem. The goals for the GFE project are to: (1) identify strategies to maintain viable populations of native species within the GFE by focusing on species whose population levels are perceived to be at risk; (2) quantify species–habitat relationships for selected species in the GFE so that the information can be used in land-management decisions; (3) examine environmental stresses in the GFE and understand how they affect valued resources; and (4) identify operational management options that will ensure the ongoing sustainability of the GFE.
- *Monitoring is necessary.* For ecosystem management to be successful in protected areas, a comprehensive monitoring plan must be established that examines the state of ecological integrity of the system on a regular basis. Results of the monitoring must be built into a management system so that management practices can be adapted. Despite a general call for monitoring in the recent literature, it is difficult to find ecosystem management projects, in protected areas or elsewhere, where good ecological monitoring programs are in place. The GFE project is part of a national program coordinated by Environment Canada to monitor the status of ecosystems on an ecozone basis. We hope that having an institutionalized requirement to prepare regular reports will provide the necessary impetus to conduct regular monitoring.
- *Management must be adaptive.* All management involving ecosystems is a long-term experiment that must be continually adapting to changing conditions and new knowledge. Our fundamental understanding of ecosystems is weak and our ability to predict cause and effect relationships in ecosystems is imprecise. Therefore, decisions regarding ecosystems must be open to modification on a short time horizon, and management structures must be designed to reflect this necessity.

This brings us to the GFE research agenda. It has three bases. First, the fundamental need to characterize the GFE. This includes describing past and possible future landscapes and the dynamics of change, at both the ecological-community and landscape levels. Second, the need for research on mitigation and avoidance of known stresses on the GFE, such as conversion of adjacent mixed-forest stands to monocultures, or the building of forestry roads. Some examples of this type of research include analyzing the effectiveness of buffer strips around watercourses, studying paleoecological evidence to determine past disturbance regimes, and determining which patterns of forest harvest best suit the maintenance of biodiversity. Third, the need to design a research program that accounts for the inherent hierarchical nature of ecosystems, as discussed above. The research agenda was designed through consensus, using a series of workshops.

Despite the widespread adoption of the ecosystem approach to management, it should be recognized there are problems associated with it. First and foremost is the very idea that ecosystems can or should be managed. Ecosystems are complex, self-organizing entities that are dynamic in time and space. They respond to external and internal forces in both predictable and unpredictable ways. To say that humans can manage something as complex as an ecosystem, something of which they are part, is an expression of human arrogance. Ecosystem management should be viewed as an effort to think holistically, understand a range of interactions and not be constrained by institutional boundaries. We can destroy ecosystems, or protect them from destruction, or even moderately influence them. However, managing ecosystems, in the sense of fully controlling them, is not possible.

The GFE project has been successful in bringing parties together that previously had little dialogue or an adversarial relationship. Most partners now agree that there has been an enormous increase in the common level of understanding and appreciation of one another's problems and contexts. The use of a research focus and an office in the non-aligned atmosphere of a university was an effective tool in bringing parties together. This accomplishment might have been impossible if left to bureaucracies to develop similar arrangements. The project has also been successful in bringing a research focus to the GFE and the Fundy Model Forest.

Because the GFE project is only three years old, there is little to report in actual changes to management actions. However, there is an expectation within the GFE and the Fundy Model Forest that the comprehensive management plan under preparation will result in significant changes in the nature of human use of the region. Ultimately, the success of ecosystem management and the GFE project will be judged by what happens on the ground. Most operating examples of ecosystem management have had a difficult time pointing to actual changes in land-based operations that have taken place. We are hopeful that our efforts will result in a long-term management strategy that is adaptive, ecosystem-based, and will provide a working example of humans living in harmony with the ecosystem that must sustain them forever.

Source: adapted from Woodley and Freedman 1994

Appendix 2: Managing "pure" research in protected areas: A practical guide

"Pure" research, which is also known as "basic" research, is the kind sometimes described as "curiosity-driven." Pure research is concerned with understanding natural or social phenomena, without consideration for whether the research will provide some tangible human benefit other than wisdom. In practice, this wisdom is put to many uses and the tangible benefits are great. Whether any particular pure research project is, or is not, appropriate in a protected area is a matter of judgment requiring the cooperation of the pure researcher and the protected area manager. The following is intended as a brief guide to the thinking of the pure researcher and provides some reflection on how the protected area manager might, in consultation with the pure researcher, select appropriate pure research.

It is important that there be a framework for making decisions about what kind of pure research is acceptable in protected areas. Scientists need to be informed about the protection objectives of an area within which they seek to work. Managers are responsible for ensuring that scientific investigation conducted within their protected area serves its interests (or those of protected areas in general) and will not compromise protection objectives. This must involve an assessment of environmental and cultural impacts in the context of potential long-term benefits. The objective is to work with the scientist to minimize undesirable impacts while maximizing benefits.

The major steps in a typical "curiosity-driven" research program are:

- Definition of a set of critical questions ("I wonder why . . . ?").
- Literature review ("Has someone discovered the answers to . . . ?").
- Definition of testable hypotheses ("What are the critical questions?").
- Designing experimental protocols to test hypotheses ("How can I answer these questions?").
- Application for funding, if necessary ("Please, can I have enough money to test the following hypotheses by the following methods for the following reasons?").
- Implementing research ("Let's get on with the fun stuff!").
- Analysis of results ("Were the original hypotheses valid?").
- Formulation of conclusions ("What did I really discover?").
- Publication of results and conclusions in a professional journal ("Can my conclusions stand the test of time?").

The formulation of conclusions usually leads to new questions and to the renewal of the cycle of hypothesis-testing and reporting (see Chapter 1). Granting agencies often provide funding by assessing productivity based on the number and quality of publications in professional journals (the "publish or perish" syndrome). For this reason, the pure scientist tends to be more interested in publishable science than in that which will provide useful but unoriginal results.

The manager might be aware of the skills of a cooperating pure scientist and be frustrated to find that useful assistance is not provided. To overcome this, a careful and thorough understanding needs to be established between the parties initially. Even if information of practical value is not obtained, pure science may provide fundamental information of immense value to the objectives of protection once the meaning of that science is fully appreciated. Full appreciation may take several years and the work of other scientists around the world who have been stimulated by the initial published work.

While the objectives of the pure scientist may have only indirect relevance to the protection objectives for a particular protected area, it may be easy for him or her to add some work which will provide useful information to the manager. This may be an acceptable price for both sides and should be worked out through communication and mutual understanding. Determining whether there is a net benefit to the protection of the area is the critical issue, and this requires that all involved take care to appreciate the issue.

The following practical steps may help to ensure that the benefits of both pure science and the protection of areas of natural or cultural significance are maximized.

1. Following first contact between the scientist and the manager, a meeting should be arranged at which both explain their objectives fully. If meeting is not feasible, written communication may suffice if it is something more than a simple exchange of forms. The establishment of interpersonal understanding and trust is important.
2. A statement of the objectives for protection of the area must be provided to the scientist and the primacy of protection over utilization emphasized. This could be described as a "statement of the purpose of the protected area." This statement of purpose is the benchmark against which the scientist's proposal for research will be judged.
3. The scientist should be asked to provide a statement of the benefits the research would bring to the protected area in particular and protection objectives in general. This statement becomes an objec-

tive reference for evaluating the actual research proposal and will itself be evaluated with reference to the protected area's statement of purpose. The scientist's statement of benefit could constitute the opening section of a standard application form used by management to approve proposed research.

4. The scientist should be asked to make a detailed statement of any scientific protocols to be followed that may have an environmental or cultural impact on the protected area. An assessment of these impacts should be made by the scientist and independently reviewed by the manager. The assessment process may include a proposal for impact monitoring during the scientific investigation. The process should permit the manager to request that proposed protocols be revised if the impacts are unnecessary or excessive. This is an iterative process and is best accomplished through consultation between the parties. Alternatively, it may be accomplished using a second section of an application form.
5. If the impacts are judged acceptable in relation to benefits to the objectives of protection of the area (or to protected areas in general), formal approval may be granted. It is at this stage that consideration should be given to revision of the proposal so as to provide special benefits to the management of the protected area in question. This must be done sensitively and with consideration for the needs of the pure scientist. Non-scientists often misjudge the amount of work that is required to answer questions scientifically. The pure scientist will probably happily provide advice and opinion, but is unlikely to compromise scientific methods if practical research is required.
6. The manager must insist upon giving approval before the researcher applies for funds, regardless of their source. If funding is secured before impacts on the protected area are considered, the impact evaluation will be compromised. To ensure that funding agencies become sensitive to protection needs, it should be required that the manger's written approval be provided to the funding agency even if it does not require this.
7. When work is in progress, actual impacts should be monitored in relation to the impact assessment statement initially approved. This should be done with a minimum of bureaucracy. The pure scientist is accustomed to bureaucracy in the proposal funding process, but most scientists work cooperatively and by consensus at the stage of practical research. If an understanding has been reached between scientist and manager before research begins, monitoring can be done by them both in a friendly and cooperative spirit. For example, if the scientific work involves a field study in which plots are monitored for changes in animal or plant abundance, the manager and scientist would visit the sites to be monitored at the time of their establishment. This could be done in the context of under-

standing the scientific methods being used rather than in the context of a formal inspection. As a general rule, the establishment of trust between manager and scientist should be such that most of the monitoring can be done by the scientist and his or her assistants. If a formal monitoring and inspection protocol other than that initially approved needs to be devised, this is an indication that the approval process itself needs to be reconsidered.

8. Reports of pure science are prepared when the questions of importance are answered, not on a defined schedule. Scientists are naturally strongly motivated to report their work in scientific journals, but this may take longer than expected. Nevertheless, scientists are often happy to give lectures about their work while it is in progress and will usually be pleased to be invited to give a presentation even to a small interested audience. The manager should maintain a file of all publications which relate to the pure science done in the protected area. These will usually be in the form of "reprints" (also known as "off-prints"). All publications which arise from the work should refer to approval having been granted by the protected area management. This is usually done in a section marked "Acknowledgments" at the end of the publication. If the manager takes a direct interest in the published science, the opportunity for further productive cooperation will be enhanced. Authorship of published work is determined by contribution to the ideas in the work reported. A manager may be invited to be included as an author of a scientific paper. There is a strong ethical code among scientists about authorship, and it should be respected.

Source: contributed by Martin Willison

Sources and other selected readings (in English)

Because these are guidelines and not a research text, citations were used only for direct quotations. Much of the information in this book comes from the list of sources below. Following that is a further list of selected readings, representing a cross-section only of the burgeoning literature on research and management in protected areas. A selection from the two lists would make a good English-language core for a park library.

Since biosphere reserves place special emphasis on research as a conjunct of management, you should also refer to the comprehensive *Bibliography on the International Network of Biosphere Reserves,* published by the U.S. MAB Coordinating Committee for Biosphere Reserves (Washington, D.C.: U.S. Department of State, 1990), which runs to 52 pages. Most of the entries in that book are relevant to the question of coordinating research and management; only the references to conference proceedings are included below.

There are also any number of excellent texts being produced in languages other than English. For example, the Food and Agriculture Organization of the United Nations (FAO) and IUCN–The World Conservation Union produce relevant publications in Spanish and French.

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