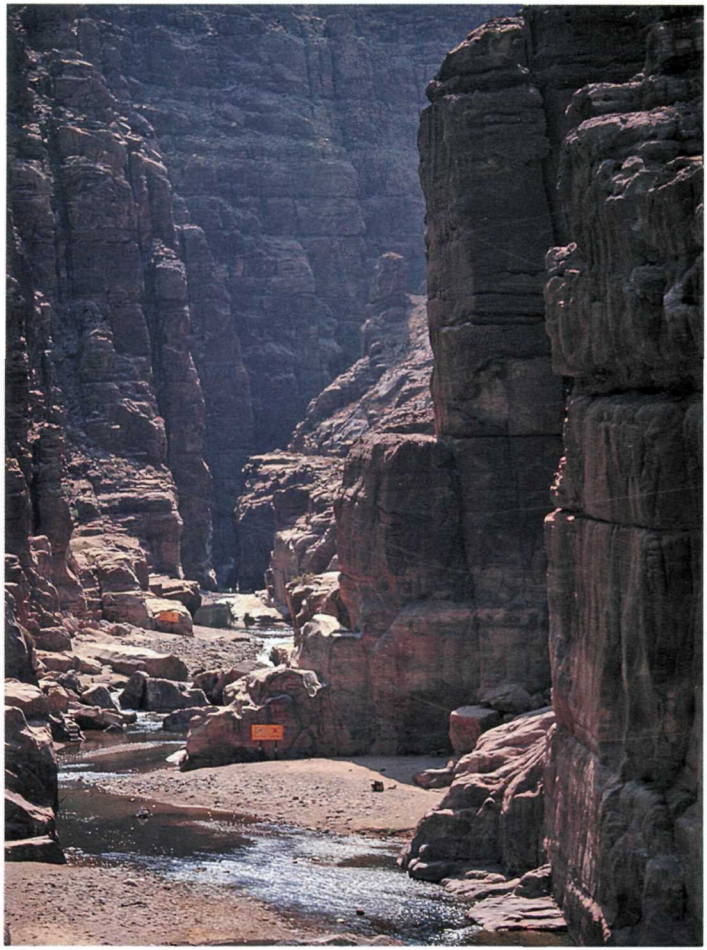
THE GEORGE WRIGHT

FORUM

Volume 16 ❖ 1999 ❖ Number 2



THE JOURNAL OF THE GEORGE WRIGHT SOCIETY

Dedicated to the Protection, Preservation and Management
of Cultural and Natural Parks and Reserves
Through Research and Education

The George Wright Society

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The George Wright Society is a member of
US/ICOMOS (International Council on Monuments and Sites—U.S. Committee),
IUCN—The World Conservation Union, and
The Natural Resources Council of America

ISSN 0732-4715

Editorial guidelines may be found on the inside back cover.
Text paper is made of 50% recycled fibers.
Printed by Book Concern Printers, Hancock, Michigan

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On the Cover: Wadi Mujib, Jordan, as it leaves its canyon and enters the Dead Sea. *Photo by G. W. Burnett.* Refer to *Burnett & Schneider*, page 75.

Society News, Notes & Mail

Asheville Conference Draws Big Crowd; Proceedings Due in September

The 1999 GWS meeting, the 10th Conference on Research and Resource Management in Parks and on Public Lands, was held March 22-26 in Asheville, North Carolina. A total of 599 people attended, the largest number since the GWS began organizing this series of conferences in 1982. It was a lively week of sessions, special events, and the all-important informal networking in the halls. The plenary sessions included presentations by Susan Flader, the biographer of Aldo Leopold, and Don Barry, the assistant secretary of the interior for fish, wildlife, and parks. There were also plenary panel discussions on preserving sites associated with the Civil Rights movement (with presenters Robert Weyeneth, Claudia Polley, and Gayle Hazelwood) and on resource management and science in the National Park Service and the U.S. Geological Survey Biological Resources Division (with panelists Michael Soukup, Dennis Fenn, and Denis Galvin). Sixty concurrent sessions, field trips, side meetings, and other special events rounded out the week. We received almost 100 evaluation questionnaires back, containing many useful suggestions for improvement that we will follow up on for the 2001 meeting in Denver. Finally, the conference proceedings—containing more than 90 papers—will be published in late September. Ordering information will appear in due course.

Award Winners Recognized at Asheville Conference

One of the highlights of the week in Asheville was the GWS Awards Banquet on March 25, at which the winners of the Society's four awards were honored.

- **Tim Davis,** a historian with the Historic American Buildings Survey / Historic American Engineering Record program in the NPS Washington office, won the inaugural GWS Communication Award for excellence in communicating highly technical and/or controversial subjects to other park professionals and to the general public. Davis was recognized for putting together the exhibition "Lying Lightly on the Land: Building America's National Park Roads and Parkways." This exhibit at the National Building Museum (June 1997 through January 1998) called attention to the unique characteristics of park roads, showed how they were

constructed, and traced their impact on the ways in which visitors have experienced America's national parks over the past 125 years. Davis was cited for his ability to present this complex and controversial material in a balanced and accessible manner.

- **Jerry L. Rogers,** superintendent of the NPS's Intermountain Support Office in Santa Fe, New Mexico, was the winner of the GWS Cultural Resource Management Award, given for outstanding overall contributions in that field. Rogers was cited by the GWS for his long and distinguished service to the cause of better cultural resource management over the course of more than 30 years with the Park Service. Aside from numerous publications and conference assignments, of particular note are Rogers's participation in the conception and development of National Register of Historic Places, the Advisory Council on Historic Preservation, and the supporting network of state historic preservation officers, federal preservation officers, tribal cultural heritage preservation officers, and private-sector activists. He was also cited for his contributions to the agency in the area of cultural landscapes and ethnography.

- **R. Gerald Wright** of the U.S. Geological Survey's Biological Resources Division, based at the University of Idaho in Moscow, won the GWS Natural Resource Management Award in recognition of his research related to identifying, selecting, designing, and managing protected natural areas. His ecological work was pivotal in establishing Wrangell-St. Elias and Gates of the Arctic national parks and in expanding Denali National Park and Preserve. Wright was also cited for creating a Systemwide resources database, as well as for authoring several important publications on biodiversity and wildlife management policies.

- **Bryan Harry,** superintendent of the NPS Pacific Islands Support Office in Honolulu, won the GWS's George Melendez Wright Award for Excellence, which honors career-long achievements in furthering the purposes of the Society. Harry was cited for his pivotal involvement in the creation of new National Park System units in Alaska and in the Pacific region, his assistance to Alaskan Native Regional Corporations in identifying historic places, and his role in creating the Cultural Resources Management Assessment Program. Harry's effectiveness in dealing with complicated and controversial issues was cited by the GWS Awards Committee as a key factor in his selection.

The four GWS Award winners (l to r): Gerry Wright, Bryan Harry, Jerry Rogers, and Tim Davis. *NPS photo by Charles D. Rafkind.*

As a special gift, Bryan Harry received a ceremonial Samoan woven mat from NPS colleagues in the Pacific Region. Epifania Suafoa of the National Park of American Samoa is pictured here. *NPS photo by Charles D. Rafkind.*

GWS Establishes Archive within National Trust Collection

After several years of searching for a suitable location, in April the Society signed an agreement with the University of Maryland's McKeldin Library to create a permanent repository for GWS materials within the library's National Trust for Historic Preservation Collection (NTL). Thanks to the interest and support of curator Sally Stokes, the NTL will house a complete collection of THE GEORGE WRIGHT FORUM, copies of our conference proceedings and other GWS publications, and other materials related to the GWS mission.

Out-of-Print GWS Publications Wanted

In line with the above news item, the GWS executive office is looking for good copies of several out-of-print issues of THE GEORGE WRIGHT FORUM to augment our existing reference and archival copies: Vol. 1, No. 2 (Autumn 1981), Vol. 2 No. 3 (Summer 1982), Vol. 3, No. 3 (Summer 1983), Vol. 3, No. 4 (Autumn 1983), Vol. 4, No. 1 (1984), Vol. 4, No. 2 (1985), Vol. 4, No. 4 (1986), Vol. 10, No. 2 (1993), and Vol. 11, No. 3 (1994), as well as copies of the program and abstract booklet from the 1995 (Portland) GWS conference. If you have any of these in your collection and are willing to donate them to us to retain as additional reference copies, please send them to the GWS at P.O. Box 65, Hancock, MI 49930-0065 USA. You can be assured of our thanks.

Box 65: Commentary from the GWS Office and Our Members

The Four R's as an Rx for the Andes ... and Elsewhere?

The Andean countries have done remarkably well in establishing systems of protected areas of various kinds in the Andean Cordillera. There are at least 23 million ha of mountain protected areas in 82 units in the Andes (Thorsell and Paine 1995). Brazil and the Central American countries have also protected non-Andean mountain environments, as has Venezuela. Many more protected areas are needed to give adequate coverage of representative ecosystems, to provide more continuous pathways for biological diversity shifts with climate change, and to conserve traditional cultural mountain landscapes and the cultures themselves. And of course, the level of management urgently needs to be improved. These protected areas are of various kinds and come under the six categories established by IUCN–The World Conservation Union: I–strict nature reserve/wilderness area; II–national park; III–natural monument; IV–habitat/species management area; V–protected landscape/seascape; and VI–managed resource protected area (IUCN 1994).

These existing mountain protected areas (and, it is to be hoped, others to come), plus what we can salvage in the usually more intensively developed lowlands, will be the only remnant wildlands in an increasingly populous Latin America, with commensurately larger needs and wants per capita. The increasing demands on land and water resources to meet these needs is of course tremendously exacerbated by export-related resource development associated with the global economy. Minerals and water development and use for export are currently the cause of much degradation of wild land (and traditional mountain cultures), and these show only greatly increasing trends. Fortunately, a reasonable compromise has been reached this year for the Antamina Mine affecting Perú's Huascarán National Park, but this was probably only achieved because it is also a World Heritage Site. Elsewhere in South America, unfortunately, governments seemingly welcome any and all mining with open arms, even in formally protected areas. Our best chances of conserving natural biodiversity, agrobiodiversity, and cultural biodiversity are being nibbled away and fragmented. Greater attention to the role of national parks and other kinds of conservation areas in the Andes is imperative, and is the theme of this essay. But, these areas need a new vision to replace the old one of drawing a line around the highest

and most scenic peaks and then promoting visitation by urban citizens and overseas tourists.

We are gaining a new appreciation of the values of conserved wildlands, even as we are losing them rapidly to development. There is, for instance, an increasing recognition of the important role of sacred mountains or of their sacred groves or springs; of wildland ceremonial, medicinal, and otherwise useful plants and animals; and of controlled traditional use of alpine grasslands, forests, puna, and water bodies as sustainers of valuable traditional livelihoods and cultures of mountain ethnic peoples. The protected landscape, natural monument, or managed resource (stewardship) area designations can help to conserve cultural diversity. Biological diversity is best conserved *in situ* by protected areas of various kinds, sometimes in Strictly Protected Areas if endangered species are involved. Nature-based ecotourism can be accommodated for direct economic gain in national parks or other types of community-based conservation areas.

But wildlands in general are finally being recognized for the economic value of their ecosystem services, as well as that of their direct products. New studies as to monetary value are directed at the "money counters" who understand only pesos, bolívares, and dollars, and these values are staggering. A recent economic study (Costanza et al. 1997) put dollar values on many of the hard-to-value ecosystem services such as maintaining water supplies and nutrient cycling, to pollination and recreation, and came up with an estimate of US$33 trillion per year (range between $16 and $54 trillion), a sum that equals two times the Gross Global Product. Even if we take only the lowest of the estimates, it is an impressive number. As a specific example, replacing the carbon storage function of tropical forests could cost US$3.7 trillion (Panayotou and Ashton 1992).

Unfortunately, as we alter or convert wildlands, we run up against the reality that many of their features are irreplaceable: there are no substitutes for the components and we have no spare parts, there are generally no substitutes for the functions performed, wild areas critical for ecological functions cannot be moved, and the resilience of wild areas is limited. How, then, can protected areas function in this situation? To make them work, we need to **reconceptualize, rescale, reform,** and **research**.

The Four R's

The role of protected areas must be **reconceptualized**. We have been prone to create mountain protected areas because of their spectacular scenery, or sometimes to try to safeguard a single endangered species such as the Andean spectacled bear, or because the high summits were not in demand for agriculture, forestry, or mining, and therefore there would be little objection. This has

led to the creation of isolated high mountain reserves—fragmented archipelagos. We need to establish new sites and to link and manage existing reserves so that they maintain ecosystem functions and biodiversity along with production of economic goods, especially water of high quality. Increasingly, we must also make creative use of IUCN's Category V, protected landscapes, "where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecologic and/or cultural value, and often with high biological diversity"; and creative use of Category VI, managed resource protected areas, whose purpose is to "to ensure long term protection and maintenance of biological diversity while providing at the same time a sustainable flow of natural products and services to meet community needs." Note an emphasis in this reconceptualization on biodiversity conservation. The Andean countries were signatories to the United Nations Convention on Biological Diversity, and in order to fulfill their commitments to this treaty, many more *in situ* areas are needed that safeguard this national and global treasury of genes, species, and ecosystems.

To carry out these expanded functions, we need to **rescale** our efforts. The size of most protected areas is too small. A single catastrophe can destroy a small protected area, or so disturb it that its resilience will not be sufficient to restore it to its original function and species complex within decades or even centuries. They are also too small to provide for the continued welfare of the full suite of the biological complement of the area, including large, wide-ranging species (especially predators), that we now know are essential to the well-being of the whole ecosystem. Even Yellowstone National Park, at just under 9,000 sq km, has its elk move seasonally out of the park,—as do the bison and the wolf. Areas that will conserve a minimum viable population (at least 500 individuals) of a species like the lion may have to be on the order of 6,250 sq km, and for Africa's endangered wild dog may be 100,000 sq km (Newmark 1992). The island biogeography studies of MacArthur and Wilson (1967) and Diamond (1975) showed us long ago the rates at which species are lost with respect to island size and distance from nearest source of replenishment. Conservation biology has shown us that nature protection areas surrounded by an "unfriendly" landscape from which recruitment (species migration and gene flow) cannot occur are similar to islands. In essence, the smaller the island, the more rapid and greater is species loss. *Larger is thus better than smaller* and one single area is generally better than several smaller areas aggregating the same size as the single area. There is not only less edge effect with its attendant problems, but a large area is less susceptible to being destroyed by natural or human-caused catastrophes. A transition or *buffer zone*

around a core protected area can make the surrounding area more "nature friendly." The *shape* of a protected area is also important, with circles and squarish areas being better than long narrow areas (again because of minimizing edge effect). *Connectivity* can provide for gene flow and species migration and recruitment, and this is especially important in view of climate change. Landscape linkages in the form of corridors that are managed in a nature-friendly way are needed to connect these island archipelagos of mountain protected areas. Along mountain ranges, large corridors are easy to conceptualize, and we need to work toward them. Also critical are altitudinal corridors or connections from the summit to lower elevations, and perhaps eventually to the sea and marine environment. These too provide for species movement and genetic flow in altitudinally zoned habitats—habitats that may shift with climate change. They also offer a watershed or basin approach that maximizes the ecosystem services that depend on the interaction of land and water in a hydrologic unit. Two good examples of this near Quito, Ecuador, are the Choco-Andean Corridor and Biosphere Reserve proposal of the Maquipucuna Foundation (Figure 1), and the Condor Bioreserve cluster of four protected areas fostered by the Autisana Foundation and The Nature Conservancy.

The third R is to **reform** institutions so that we can develop some needed changes in institutional arrangements. Those managing protected areas need to work with neighboring communities, residents, indigenous groups, corporations, or local levels of government that own or use the surrounding land. These need to become nature-friendly stewardship areas—ideally through voluntary cooperation in a bioregional program such as described by Miller (1996) and Saunier and Meganck (1995). These will be new partnerships for those dealing with protected areas, but very necessary ones. Many of them will hopefully become voluntarily dedicated and government-blessed as IUCN Category V protected landscape or Category VI managed resource protected areas. Each protected area should encourage the development of a local support group, a private voluntary organization—and develop good relations and real communication with existing community groups.

And fourth is **research**. Science and other types of information such as traditional knowledge are more important than ever. Particularly needed are greater appropriate use of the best that new GIS techniques have to offer, and more complete biodiversity inventory and location. In the United States, where the level of research knowledge and protected area management is relatively high, there is nonetheless an alarming ignorance of what biological diversity exists in most national parks, for instance. While species inventories for vertebrate species and the higher

plants may be relatively good, data on invertebrate, fungi, and lower plant species is inadequate for sound biodiversity and ecosystem management. The National Park Service in the USA has begun a 10-15 year project in 1998 that will improve the situation under a Natural Resources Initiative, and projects such as the All Taxa Biodiversity Inventory being carried out in Great Smoky Mountains National Park (Clarke 1998). Partnerships with research institutions need to be initiated or expanded greatly since the research component in most protected area agencies around the world is generally either lacking or not adequately supported. In addition, systematic and careful monitoring must be initiated if trends are to be accurately identified.

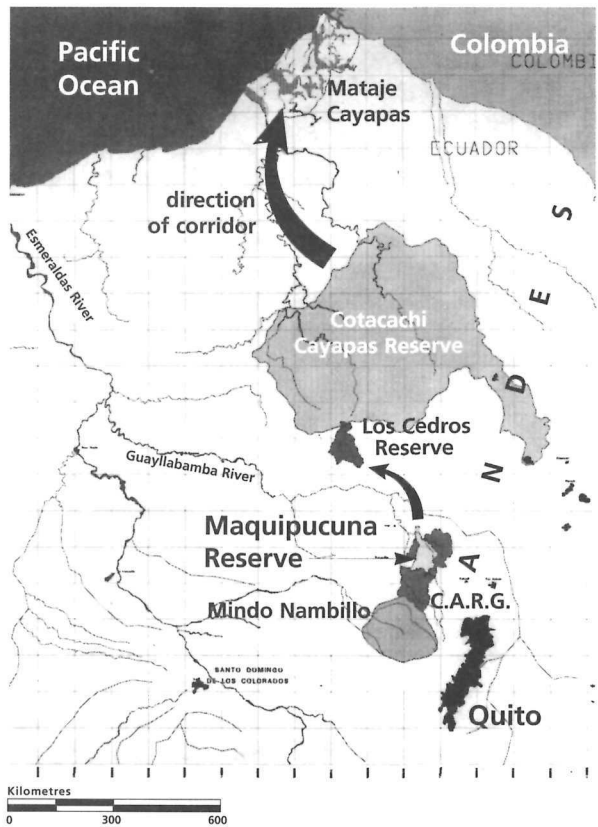

Figure 1. Proposed Choco-Andean Corridor, Ecuador.

Action on the Ground

A summary of the on-the-ground action for mountain protected areas would involve:

1. Identify, select, and establish *new core wild areas* using criteria of biodiversity conservation and capturing ecosystem services, rather than just spectacular summits and alpine scenery. Important headwaters should figure prominently in this.
2. Develop zones of conservation around both new and existing core protected areas where public, private, and communal landowners and users are invited, through legal means or incentive policies, to manage their resources in ways that minimize negative impacts on the protected cores. These transition areas of conservation have been referred to as *buffer zones* and may even be a heavier-use area within the same national park or legal protected area. Where the land is in private or communal ownership, they might be more appropriately called *stewardship lands*. Brown and Mitchell (1998) present a good discussion of the myriad aspects of incentives, policies, philosophy, requirements for success, and some case examples from around the world for stewardship lands. These areas can do much to help preserve traditional life styles and cultures. The classical model biosphere reserve of UNESCO's Man and the Biosphere program promoted the designation and management of buffer zones of this nature around core protected areas.
3. *Link* these cores and their buffer zones by corridors of wild or *nature-friendly landscapes,* both altitudinally to the lowlands and along the ranges. The need is to somehow achieve land and water management in these connectivity areas that will permit plant and animal migration. Currently these intervening lands are often in almost "nature-hostile" uses, such as monocrop agriculture with heavy fertilizer and pesticide use, or are overgrazed lands or heavily overcut forests. The challenge of converting these to a stewardship regime of management is formidable and demands creativity, patience, and hard work with local landowners and community groups. It demands new partnerships and the reforming of institutions referred to previously.
4. *Inventory* of biodiversity and *monitoring* are necessities in all protected areas, and in the buffer zones.

Is any of this practicable? Some progress is being achieved by agencies or organizations that have caught the vision of these large-landscape-level ecosystems or bioregions (described in Hamilton 1997). I am currently working with Kenton Miller of the World Resources Institute on a joint project with IUCN's World Commission on Protected Areas to identify and map the various proposed large ecoregion corridors or clusters around the world, and the number is substantial. They are mostly in mountain areas, where there are some 31 areas. In the Andes, in addition to those shown in Figures 1, there are the Naya River Watershed Corridor in Colombia, the Andean Bear Ecological Corridor in Venezuela, a corridor in Bolivia beginning near Cochabamba and extending north to and across the border with Perú, the Huascarán-Huayhuash corridor in Perú, and an exciting transborder corridor along the southern Andean spine between Chile and Argentina near Puerto Montt, recently given impetus by the

creation of Pumalin Park.

An ambitious and stirring proposal for a Yellowstone-to-Yukon Conservation Initiative is underway, and it has a full-time executive officer at the present time. This inspiring initiative causes one to dream of an Andean Mountain Conservation Corridor from Tierra del Fuego to the Isthmus of Panamá, and this was fostered by an Andean IUCN proposal for an Integrated Program of Environmental Conservation and Sustainable Development presented by José Pedro de Oliveira Costa and Danilo Silva at the 1995 Andean Mountain Association Symposium in Huarina, Bolivia. And those attending that meeting will recall also that Jim Thorsell and I introduced "our dream" of a Conservation Corridor of the Americas which would extend from Tierra del Fuego to the Bering Sea. This was given some realization when the governments of seven Central American countries signed a formal compact in 1997 proposing a Meso-American Biological Corridor of connected protected areas.

The Andes are what might be termed a "natural" for such a biotic corridor of conservation. Maps of protected areas elsewhere in the world show the potential, as in the European Alps, the Western Ghats, and many more. We need a vision, a dream. The Reverend Martin Luther King, Jr. would have had little impact if he had shouted "I have a small strategic plan!" instead of "I have a dream!"

This paper was originally presented at the Symposium on Sustainable Mountain Development: Understanding Interfaces of Andean Cultural Landscapes for Management, December 10-17, 1998, Quito, Ecuador.

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Reminder: this column is open to all GWS members. We welcome lively, provocative, informed opinion on anything in the world of parks and protected areas. The submission guidelines are the same as for other GEORGE WRIGHT FORUM *articles—please refer to the inside back cover of any issue. The views in "Box 65" are those of the author(s) and do not necessarily reflect the official position of The George Wright Society.*

The Importance and Principles of State of Ecosystem Reporting and Indicators

Introduction

The five papers in this section of THE GEORGE WRIGHT FORUM are linked by three common themes: state of the environment reporting, indicators, and protected areas. However, they differ in a number of important elements, such as the scales being used, the purposes being served, the interests being considered, and the clients being addressed.

This paper is intended to address the concepts and principles that underlie state of the environment reporting and indicators. The achievements in these two related fields of work vary from place to place, and from jurisdiction to jurisdiction. Overall, the work has not reached an even level of maturity, and innovations continue. Within North America, for example, these two fields of study have a more developed history at the national level. Such jurisdictions as provinces, states, and territories have less experience. For national jurisdictions, Canada has the most experience, having completed three major state of the environment reports (Government of Canada 1986; 1991; 1996) and numerous indicator bulletins. Protected areas have constituted an important part of all these publications and reviews. A previous paper in THE GEORGE WRIGHT FORUM (Wiken and Lawton 1995) touched upon some of the reporting topics.

The four papers that follow this introductory article serve as both case studies and discussion pieces. Protected area networks and systems plans have a strong connection to ecosystems. As ecosystems vary across spatial and temporal scales, so do reporting and indicator needs:

- The second paper describes a North American context. The Commission for Environmental Cooperation (created pursuant to the North American Free Trade Agreement) and an earlier Tri-Lateral Committee on Environmental Information initiated much of this work (NAEWG 1997).
- The third paper takes on a national perspective. The achievements

made in reporting on protected areas in Canada's state of the environment reports (referenced above) serve as the main basis for discussions.

- The fourth paper examines a continental macro-ecosystem: the Great Plains of North America. This is one of the continent's most heavily disturbed and altered ecosystems.
- The final paper describes needs in the context of a natural resource sector: forestry. The resource sector, and the character and distribution of productive forest ecosystems, are closely interwoven to further forest sustainability.

Decision-Making and Concerns

Decisions concerning natural resources and life-sustaining systems are becoming more crucial. Historically, the repercussions of using resources unwisely may have taken substantial time periods to affect our daily lives. This is no longer the case. Many factors have contributed to accelerating the pace of impacts:

- The resource demands of a rapidly growing population (6 billion globally) translate into an increasing number of stakeholders and interest groups.
- Technology has allowed us to see and detect more, and to do so more rapidly.
- Stocks of prime resources have commonly been depleted or subjected to wider demands. For instance, we have fewer forest wilderness areas, and those that remain that are competitively sought-after to meet biodiversity conservation, resource harvesting, recreation, and wildlife habitat goals.
- Stakeholders and interest groups have far greater access to decision-making bodies and processes.

Owing to their dearth, protected areas have increasingly become specialized warehouses holding the vestiges of disappearing assets. The ecological integrity of these places has become the focal points of many debates. Today, some people debate whether protected areas should occupy 10-20% of the landscape/ seascape. Others emphasize a different perspective and argue that protected areas are the 100% solution of tomorrow. Without some minimum having been retained, ecosystems can be degraded to the stage that restoration is impossible simply because many of the original assets have disappeared. From a purist's standpoint, how can we truly restore the prairies when historical ingredients like the passenger pigeon, plains grizzly, and wolves are no longer there? Will the reintroduction of the swift fox and black-footed ferret to parts of the prairies be successful now? In some cases, our history book has not only a few chapters with torn pages, but is missing entire chapters. When this stage is reached,

there is no longer a benchmark ecosystem type to act as a standard.

Some groups and individuals ponder over how protected areas can fit within the context of the greater landscape. How can protected areas survive and maintain their integrity given the types of land uses and human activities that surround them? In contrast to the more encompassing look, others adhere to mere cartographic "counts and measures" of particular types of protected areas. For instance, do we have 10-15% of each regional ecosystem protected as a national park? Protected areas should not be seen so much as boundary lines and percentages on a present-day map. Rather, they should be construed as lines to the future of sustainability.

What Do We Understand?

Across the continent, terms such as protected areas, reporting and indicators all seem to be familiar. Even particular types of conservation areas, such as national parks, IBPs (International Biological Program sites) and biosphere reserves, appear to be part of the everyday language. Many of the major ecosystems across North America in which protected areas exist, like the Canadian Arctic, the Central Grasslands, and the Sonoran Desert, are also seemingly well-known.

However, within the context of North America or any of its member nations, how well do we understand any of these terms specifically? What are the collective status, achievements, and gaps in wildlife areas or protected areas in general? Why is the reporting on the state of protected areas an important function for average citizens within each of the three countries, as well as for conservation specialists? Do indicators have any particular importance in a reporting process? Can strategic planning and comprehensive assessments emerge in the absence of authoritative reporting? Should the scope of reporting be based on jurisdictions or ecosystems alone, or should it embrace both?

Individual conservation organizations tend to reflect their particular interests and achievements fairly well. The wide knowledge that people have about national parks is an example. Areas that are less-frequented by people, such as wildlife areas, are well-known too but to a smaller range of people. In many nations, for instance, the term "protected area" is almost synonymous with "parks." In Canada, few people understand that the Canadian Wildlife Service has over 11,350,600 ha protected for wildlife purposes (Beric 1998)—an extent nearly as large as that of the country's national parks. If a national system of major wildlife areas is not well known, what about all the other contributions (e.g., forest reserves, wilderness areas, conservation areas) to the protected area estate? Are the possible

synergies underlying these separate endeavours capitalized on? How well do parks conserve wildlife habitats? And how well do wildlife areas protect representative ecosystems?

Changing Goals

For a long time, progress in establishing protected areas in any given field of conservation was largely seen as an "interesting announcement" occasionally reported in newspapers. The addition of new areas or the management of existing ones was not really viewed within the context of such mainstream ecosystem issues as acid rain impacts. Thus the success in the field of protected areas was welcome, but was largely seen as something happening in the background. Without obvious and ubiquitous evidence of ecosystems and species becoming endangered, there was little public unrest and few concerns shown by professional groups.

Our Common Future (WCED 1987), the World Conservation Strategy (IUCN, UNEP, and WWF 1980), and the Convention on Biological Diversity (UNEP 1992) are examples of global initiatives that started to markedly advance protected areas as a more visible issue. A more integrated conscientiousness was created about the disappearing legacy of natural areas. The need to further conserve native ecosystems and their inherent biological and physical resources was steadily being recognized at state, provincial, national, and regional levels (Wiken and Gauthier 1998). Encroaching land uses (e.g., forest harvesting, agriculture, urbanization), expanding exploitation of natural resources, and competing demands on prime lands and waters were all common stress factors. They were contributing to the erosion of opportunities to acquire areas and to the sense of urgency to complete individual protected area system plans. The increasing numbers of endangered ecosystems and species were also obvious signals of the inadequacy of conservation measures.

With protected areas, the new and elevated principles of sustainable development and ecosystem management drew attention to the need to be more inclusive in understanding the basics of conservation objectives. Parks, wildlife areas, marine sanctuaries, wilderness areas, ecological reserves and forest reserves have for a long time appeared to be very different enterprises. Notwithstanding their success in meeting older objectives, these protected areas have newer roles in achieving biodiversity protection and, in cases, in directly meeting the goals of other agencies (e.g., a wildlife organization may protect vital habitat and indirectly serve a park organization's goal of protecting a representative ecosystem). These commonalties in goals are benefits. Applying the principles of sustainable resource man-

agement or an ecosystem approach has also meant that managers and planners must be aware of the conditions that prevail within and around each protected area and the entire protected area network. Having knowledge of the entirety and dynamics of the landscapes/seascapes of which protected areas are a part is seen to be more vital to assess potential impacts and to maintain the integrity of ecosystems. The desire to understand land-use and land-cover changes is an example of a fairly common interest.

Using Reporting and Indicators as Strategic Devices

How do we establish a more collective and strategic view of achievements and goals? How do we improve the collection of important data and information? Canada's 1991 state of the environment report (Government of Canada 1991) is one of the first comprehensive assessments of protected areas undertaken in North America. A broad range of stakeholders and agencies contributed to its development. The document included a special chapter on protected areas. It used the national ecosystem framework (Wiken et al. 1996; NAEWG 1997) of 217 ecoregions to assess the progress that had been achieved by two of the nation's leading federal departments (Parks Canada, Environment Canada), the ten provincial and two territorial jurisdictions, and 125 non-governmental organizations (e.g., The Nature Conservancy–Canada, Ducks Unlimited, Island Nature Trust).

This 1991 report was the second concerted effort to develop principles of reporting. Based on feedback from the first state of the environment report (Government of Canada 1986), participants and contributors from across Canada and abroad agreed that the:

- Material should be *authoritative;*
- Scope of the work should be as *inclusive* as possible;
- Assessments and conclusions should be completed in an *objective* manner;
- Context should be *ecosystemic;* and
- Underlying yardsticks should further foster a *preventative and anticipatory* mode of sustainable resource use and management.

Each of these adjectives can be used in a parallel and extended way. For instance, "objectivity" is in many ways an equivalent word for "credibility." Also, objectivity means divorcing discussions from inordinate biases. From the selection of data through to discussions, reporting calls for a dispassionate view. Otherwise, how can things be "matter of fact" when the data and the information that comes from them are not?

The state of the environment analysis, conclusions, and reviews embraced varied stakeholders and interest groups involving different levels of governments industries, en-

vironmental groups, academics, etc. What did it do? It provided a:

- Means to measure progress on the status of protected areas;
- Way to communicate and monitor results;
- Chance to learn by presenting information and not propaganda;
- Method to assess gaps and set targets for the successful achievement of system plans;
- Mechanism to set priorities and adjust goals;
- Capacity to see the broader picture and improve linkages between protected areas initiatives;
- Means to create an understanding of the use and application of indicators;
- Basis to allocate resources and efforts;
- Vehicle to evaluate trends and conditions;
- a means to build synergies and integrate talents and expertise of different organizations;
- a basis to advance protected area science and research; and
- a vehicle to improve knowledge of state–pressure–response relationships.

Ironically, state of the environment reporting works most effectively when the core set of activities is rooted within ecosystems—here, meaning people *and* the environment (Wiken 1996). The condition of ecosystems and the status of their assets are the fundamental worries. What is the desired state for ecosystem health, social well-being, economic stability, etc.? The worries cover a range of ecosystems from small to large and time scales from the near- to the long-term. The state of the environment reporting process typically starts with a robust discussion of the issues and concerns. In a sense, they provide an initial measure of the impacts, the implications, and the goals. The problems as well as the perspectives of different groups must be clearly understood. The analysis of stressors is simply an analysis of causes (probable and known). An evaluation of trends determines the rate, consistency, and location of changes. Actions and policies become the means whereby governments, the public, industry, and businesses can enhance existing mechanisms to deal with issues or devise totally new approaches. Measures and indicators concern all of the basic inventory, monitoring, and research activities. They are the vital engines behind acquiring relevant information and indicators. Review and adjustment activities are associated with those stages in decision-making where periodically the current set of actions and policies are evaluated to see if they are effectively addressing the issues, or whether the measures and indicators are in need of refinement. The overall state of the environment reporting process is seldom strictly linear. It works most successfully when it capitalizes on

iterations between stages.

Moving Ahead

Reporting on the status of protected areas and using various indicators to measure progress appear to be quite simple endeavours. Environmental groups, governments, universities, individuals and industries typically want this information for doing strategic planning, meeting public accountability requirements, and fulfilling mandated responsibilities (Government of Canada 1986).

Information is crucial. If the questions are not properly sculptured at the outset, then the answers are of little value. If information does not reflect a comprehensive perspective, then the interests have not been fully represented. If the principles of reporting on the state of the environment are reduced to a single Confucian proverb, it might be:

If what was meant to be said remains unsaid,
then what was meant to be done remains undone.

In managing human activities that affect natural areas, decision-making is far more complicated and significant than ever before (Wiken 1999). How to protect the last of the least? How to judiciously manage the remnants? How to avoid reaching stages of paucity? How to manage protected areas within the realm of their surrounding modified landscapes? How to judge and compensate for long-term trends? How to appease the increasing numbers of stakeholders and interest groups? How effectively are we using and capitalizing on mechanisms like state of protected area reporting, state of the environment reporting, and ecological indicators? If mechanisms like these are not used, how can protected area achievements and gaps be fairly assessed and communicated? These questions illustrate the taxing nature of decision-making today.

Reporting is becoming more onerous, both as a responsibility and as a basis for decision-making. Why? Because the forums for decision-making are increasingly open and contentious, covering numerous jurisdictions, scales, and disciplines. The once-taught ideal that "this is mine" has swung about to "this is ours." The more inclusive nature of ownership is in part a reflection of the shrinking resources base, the shorter impact regimes and turnaround periods, and the appreciation of new principles: long-term equity, shared values and resources, and ecosystem integrity.

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Reporting on North America: Continental Connections

Introduction

Conservation of biodiversity at any level—genetics, species or ecosystems—is an issue of high priority today, since the level of our success will help to determine our own future and even that of nature itself. Evidently, we face enormous challenges. The numerous and complex difficulties inherent in how to protect our natural resources are matched by the variety of approaches that have been taken since the modern ecosystem crisis began. Events such as the toxic leaks from a chemical and plastics dump at Love Canal in 1978, the brown snow in Chesterfield Bay in 1988 (NAEWG 1997), the threat to Arctic ecosystems and marine species from distant pollutant emissions (Wiken 1996), and the dangers associated with ozone depletion are some examples among many that point to the global character of ecological problems. The numerous international agreements created in the five years since the Earth Summit in Rio de Janeiro testify to how the world's ecosystems and environmental resources have recently become of major importance in the eyes of governments, societies, and individuals.

Among the many problems related to changes in nature and the uncountable ecological problems that we face is the loss of biodiversity. Its effects in the short as well as the long term are not to be neglected. As one of the first responses to the loss of natural areas that are storehouses for biodiversity, protected areas were created in many places all over the world. Prevailing conditions and views determined the different criteria by which they were designated (Phillips 1998; IUCN 1985). The first protected areas in North America were of variable origin and purpose: the USA's Yellowstone National Park was created in 1872, Canada's Last Mountain Lake Wildlife Sanctuary in 1887, and Mexico's El Desierto de los Leones National Park in 1917 (Secretaría de Medio Ambiente Re-

cursos Naturales y Pesca 1996).

Ecosystem Approach

Ecology deals with several levels of complexity, all of which are equally important. However, as recognized by many scholars, ecosystems are the conceptual backbone of ecology (Evans 1956; McIntosh 1985; Wiken 1996). The ecological framework (Wiken 1996) is based on a holistic approach to defining ecosystems and is recognized as a standardized method for classifying and understanding landscapes as well as seascapes. Other "natural" means of organizing information, such as by watersheds, have also been used effectively (Master et al. 1998). From a spatial perspective, the organization, by ecosystems, of data on environmental and socio-economic conditions is useful for the analysis of complex interactions and linkages. These evaluations are not only useful to understanding nature; they are increasingly important to understanding people and the surroundings of which they are a part. In this sense, an ecosystem perspective is a powerful tool for the identification, establishment, monitoring, and management of protected areas.

The delimitation of natural ecosystems is a main element in the discipline of ecology and in the conservation of nature (Primack 1993). Techniques and concepts have varied through the years and have been influenced by many schools of thought, from natural sciences through economics. Ecological classifications were originally based on the result of the interaction and mix of biotic and abiotic components of a natural unit. However, human impacts can, and have been, so pronounced that in many instances it is simply impossible to describe an area without assessing the roles, effects, and risks of human activities (Hirvonen et al. 1995; Omernik 1995; Government of Canada 1996; NAEWG 1997). Indeed, this is the essence of the current-day ecological perspective.

North America: A Geographic, Ecological, Political, Commercial, and Environmental Entity

In many ways, North America is a keystone case for the comprehension and implementation of a holistic approach to conservation. It is a rich continent, in which most of the world's climatic types can be found. Furthermore, it has very complex topography that includes low valleys—one of which is the world's lowest elevation—and high mountain ridges and extended plateaus. Indeed, it possesses many unique natural features of worldwide significance, some of which are safeguarded in national parks and wildlife areas (NAEWG 1997; National Geographic Society 1995). A very high level of biodiversity is associated with its varied ecosystems and huge extent. Biodiversity generally increases as

one moves south from Canada to Mexico, reflecting an overall equatorial gradient in species distribution. The high level of biodiversity in Mexico reflects its unique geographic position, straddling Nearctic and Neotropical ecosystems, as well as the large number of ecosystems embedded within its highly varied topography. Mexico alone, as one of the world's twelve so-called megadiversity nations, contains 10% of planetary biodiversity (Instituto Nacional de Estadística Geografía e Informatica and Secretaría de Medio Ambiente Recursos Naturales y Pesca 1998). Endemism is also especially high in Mexico (Figure 1), where as many as 40-50% of flowering plants and more than half of the reptiles and amphibians are considered endemic (Flores-Villela and Gerez 1989).

The primary threat to North America's biodiversity is related to human activities and the loss and degradation of habitats they cause. It has been estimated that about half of the continent's most diverse ecosystems are now severely degraded (Ricketts et al. 1997). Habitat loss and degradation (Figure 2) particularly threaten freshwater fish.

North America's natural wealth is partially protected through wildlife areas, ecological reserves, parks, and many other types of protected areas. Because protected areas are often established to secure both representative and pristine portions of major ecosystems, it is appropriate to assess them against an ecological framework (Wiken and Gauthier 1997). Figure 3 shows a point form location of North America's national, provincial, and state parks, superimposed on a map portraying 15 major ecological regions. About two-thirds of these types of protected areas are located in three ecological regions: eastern temperate forests, Great Plains, and the northern forests. Although there are fewer parks in the northern quarter of the continent, given their size (which is not represented on the map), these form the bulk of North America's larger parks.

Mexico, the USA, and Canada are linked through common terrestrial and aquatic ecosystems. Working with this perspective, a tri-national team of scholars classified the continent's ecosystems in a project coordinated by the Commission for Environmental Cooperation (NAEWG 1997). The team sought a common ecological language for the continent.

In addition to their biophysical connections, the three countries are increasingly related through economic and cultural exchange. The 1994 North American Free Trade Agreement (NAFTA) is the first trade agreement to include environmental considerations. Its reference to sustainable development goals and the pronouncement that countries should work together to enhance the safety and protection of the environment provide a conceptual foundation for environmental cooperation

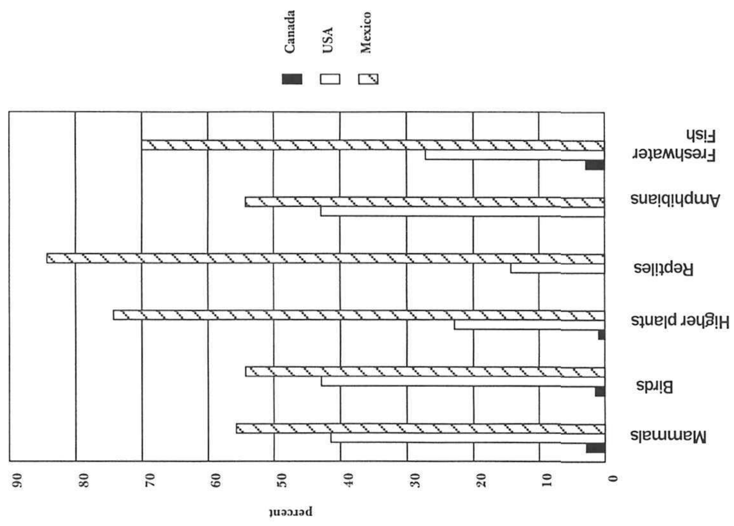

Figure 1. Percentage of endemic species in North America, by country.

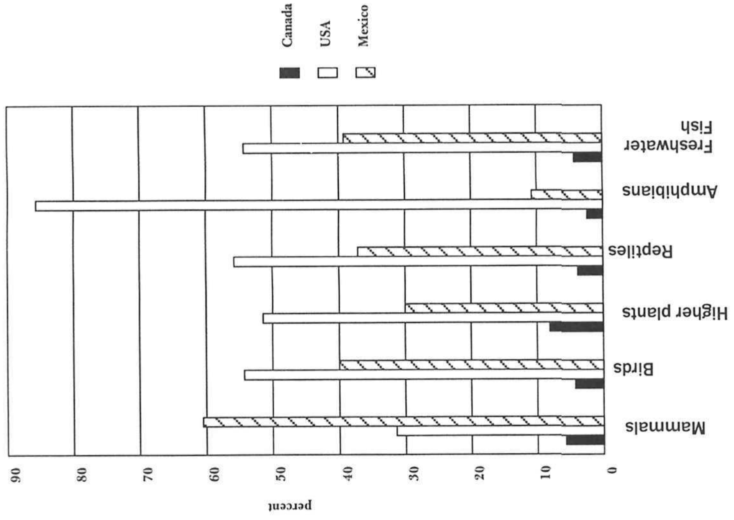

Figure 2. Percentage of threatened species in North America, by country.

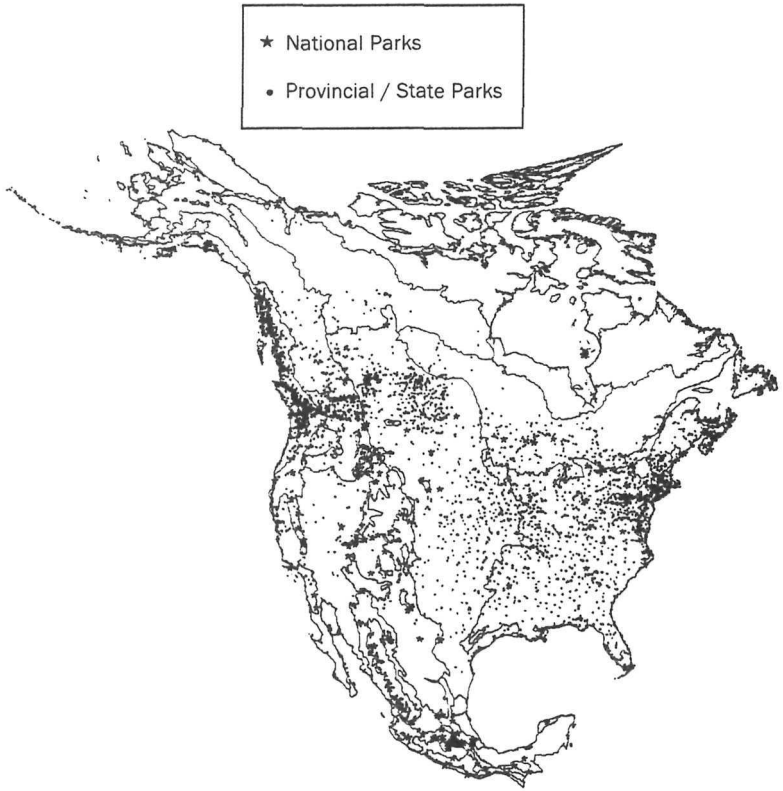

Figure 3. National, provincial/state parks, and Level I ecological regions.

(Johnson and Beaulieu 1996). The intensity and the relevance of the environmental debate during NAFTA negotiations prompted the governments of the three countries to sign a supplemental North American Agreement on Environmental Cooperation (NAAEC), which entered into force on 1 January 1994 (Johnson and Beaulieu 1996). The NAAEC can be considered the first document that establishes environmental commitments and responsibilities for countries participating in a commercial agreement, making it unique in this sense (Bustani and MacKay 1996; Ludwiszewsky and Seley 1996; Richardson and Beaulieu 1996). The NAAEC created an intergovernmental Commission for Environmental Cooperation (CEC), one of whose projects has been the investigation of the environmental effects of freer trade in North America (CEC 1999). The CEC has a very broad mandate, however, that does not limit it to dealing with trade-environment issues. Rather, the NAAEC confirms the goal of sustainable development and the essential role of cooperation in the conservation, protection, and enhancement of the environment in the territories of the three countries.

Migrations and Protected Areas: Birds, Butterflies, and Marine Species

Habitats, ecosystems, and migratory species all cross political boundaries—another illustration of how the three countries are connected. A number of species migrate within North America, including birds, bats, butterflies, fish, whales, and other marine mammals. For example, 14 land-based threatened species are shared by all three countries, 35 by Mexico and the USA, 15 by Canada and the USA, and 7 by Canada and Mexico (CEC, in press {a}). The significance of migrations for North American ecosystems is twofold. First, the loss or degradation of only one refuge—a staging, nesting, or wintering habitat, for example—in one of the three countries that is visited by a particular species can threaten its very survival. Second, local or national measures alone may be inadequate to protect the many forms of biodiversity that cross human-delineated borders.

Birds. Seasonal habitats create seasonal resources, but conservation needs are not restricted to any specific season. If migratory species are not to disappear, their habitats and ecosystems need to be preserved, even during their temporary absence. An estimated 2 to 5 billion birds pass from North America into the tropics each year (Greenberg 1990). Migration is most common among species that breed at high latitudes, including both landbirds and seabirds. In fact, virtually all landbird species in North America have at least some individuals that migrate during the course of the year. Conservation strategies to

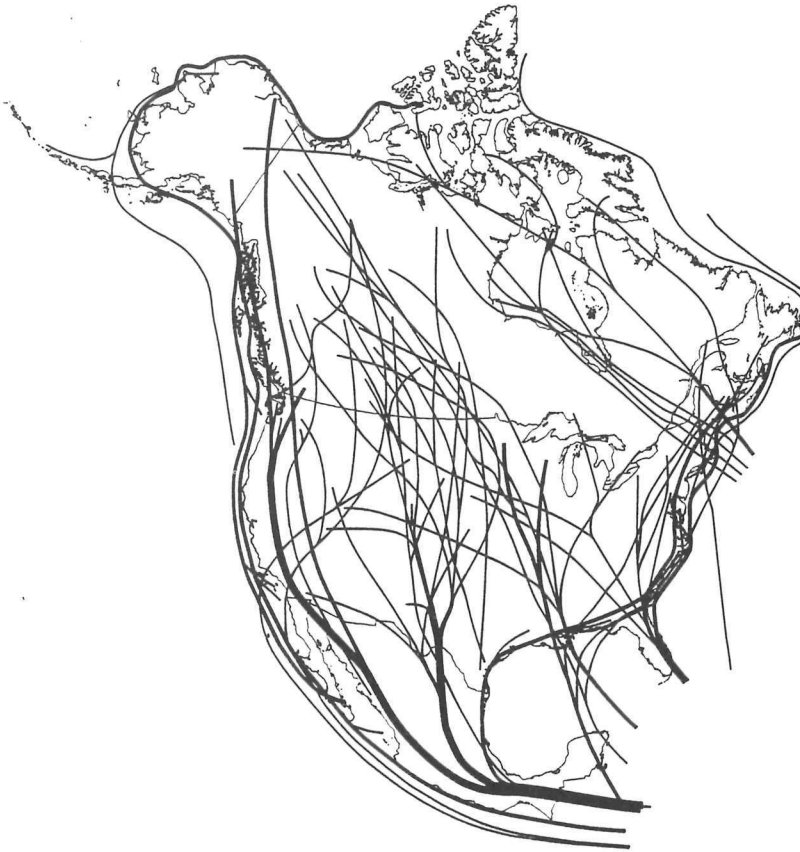

Figure 4. Main migratory bird routes in North America (after data produced by the National Geographic Society)

protect them and their homes throughout the year are significant challenges due to the complexity and distance of their routes (Figure 4).

Fortunately, the need to protect habitats and ecosystems of migratory species has been clearly understood by many activists, academics, and governmental representatives. Some successful initiatives are taking place. It is now understood that efforts made for the conservation of a particular species can fail completely if habitats are not protected and managed throughout the whole migratory range, no matter how many countries are involved.

The development of the North American Waterfowl Management Plan (NAWMP) is an example of how multilateral conservation strategies can be successful. It was signed by Canada and the United Sates in 1986. The addition of Mexico in 1988 further enhanced the potential for protecting migratory waterfowl and their critical habitats and ecosystems throughout the continent. The NAWMP is a continent-wide collaborative effort to secure, enhance, and manage wetlands across North America. Through the use of a wide range of conservation area types, from national wildlife areas through private land stewardship projects, it aims to reverse the alarming decline of ducks noted in the mid-1980s and to restore waterfowl populations in North America to 1970s levels (Environment Canada 1997). NAWMP features specific strategies to recover declining waterfowl populations and to reverse the decline in wetland surface (Graziano and Cross 1993). Wetland protection has significantly improved the recovery of unhealthy duck populations.

Another promising North American initiative is the Important Bird Areas (IBA) project. Initiated by BirdLife International, the IBA project has been widely supported and adopted in many places. It recognizes the need for a set of sites through the range of distribution of both resident and migratory birds. Thus, it aims to create an international network of key habitats and protected areas. It was designed more specifically for species whose characteristics and the particular threats to them are best addressed with an integrated approach. An important bird area can be a roosting, reproduction, nesting, or feeding place. It can aim to protect a few individuals of a very endangered species, or many individuals of a healthy population that could be endangered if a particular area is disrupted.

The first step of the project is the identification of IBAs according to the ecosystem approach. Conservation strategies are then designed locally, a process involving local inhabitants and all other stakeholders. In some cases, educational programs are needed and are enough to establish simple conservation measures that can protect an IBA. In other

cases, deep, radical measures, such as the creation of new protected areas, are required to protect habitats. Through the participation of many organizations in a regional, trilateral commitment, a network of North American IBAs has been identified (CEC, in press {b}).

The conservation and protection of IBAs needs to be based on sound ecological and scientific studies, on the active involvement of local inhabitants, and on international agreements and compromises. The three countries have different legislation for the conservation and protection of birds, and the way society participates in such issues differs widely within and among them. For example, bird watchers are very numerous in the USA and Canada, and millions of dollars are spent annually on bird-watching activities (field equipment, birdhouses, bird feeders, field guides, meetings, etc.). The same is not the case in Mexico, where there are no bird-watcher associations. In the USA and Canada, bird hunters are organized through multiple groups. Some, such as Ducks Unlimited, are also involved in the protection of birds and their habitats. In contrast, there are no national hunting societies in Mexico, where hunting birds still represents a way of obtaining food or animals for sale, and is not a popular, commercial sport. Despite these and many other deep differences, the general criteria adopted for the definition and identification of IBAs can be applied to the three countries and adapted to local, national, regional, and continental levels.

General agreements and common criteria and indicators can lead to a new and successful period of bird conservation. Protecting the habitat of endemic species also frequently includes the protection of migratory species. An ecosystem approach for the design of IBAs as protected areas that fall under different legal regimes is a very promising idea. It has the added advantage of protecting habitats of non-targeted species that would otherwise remain totally unprotected. Of course, an element in the conservation of any area or species is the necessary compromise between conservation strategies and the satisfaction of the local community's needs, which must be determined, established, and respected to make conservation viable.

Butterflies. The conservation of the emblematic North American monarch butterfly and its extraordinary migration routes (Figure 5) presents its own particular difficulties. The northern part of the monarch migratory range has been affected by the use of pesticides and by some reduction of the Aesclepias species populations on which the monarch larvae feed and from which they derive the chemical protection that defends them from bird predators. The monarch butterfly habitats in the USA and Canada that are frequented from late spring to early autumn are very

diverse, and include badly disturbed areas. The butterflies return to them regularly, year after year, after overwintering in warmer places. However, wintering sites are also badly degraded. The southern Californian landscape, where the western populations live during winter, has been severely altered from its original condition (Primack 1993). The establishment of monarch colonies in newly restored forests has been but partially successful in the best of cases (Leong 1997).

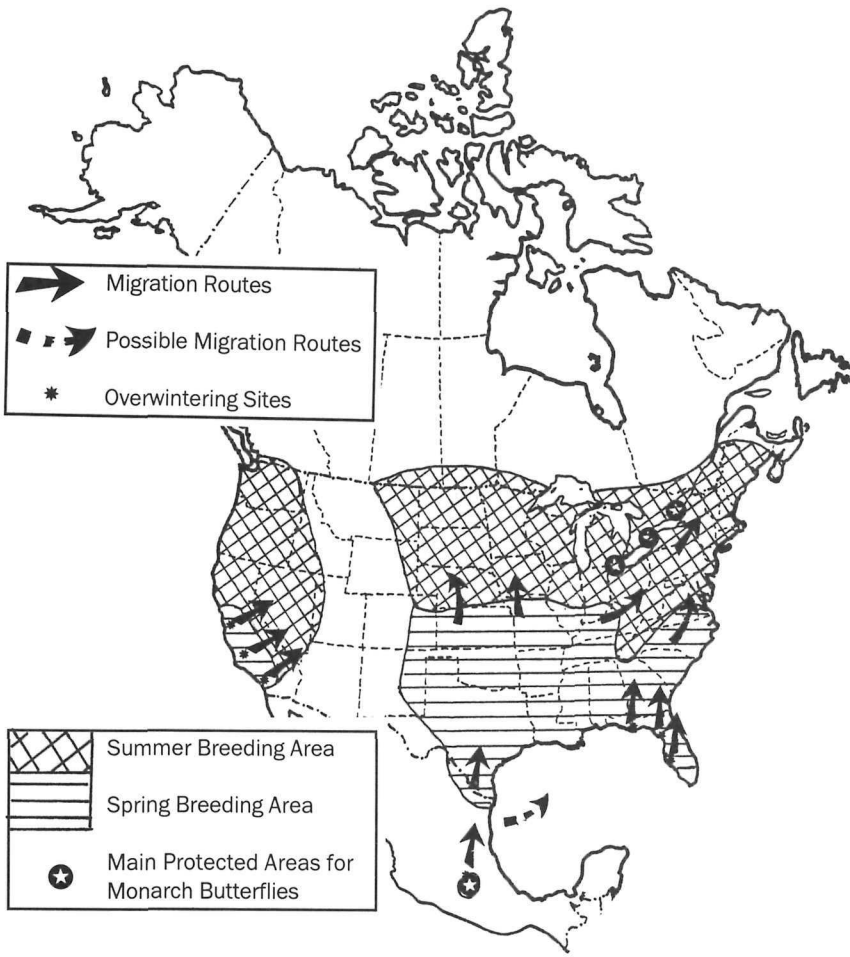

Figure 5. Migration routes of the monarch butterfly

All the eastern populations congregate in a very restricted area in central Mexico (Brower 1997; Hoth 1997; Merino 1997; Oberhauser 1997) and are only afforded a few protected areas in Mexico and Canada (Wiken and Gauthier 1998). Here, they form very numerous and dense colonies in the fir (Abies spp.) forests, but these habitats have been drastically reduced because of unsustainable forest practices. The overwintering region in Mexico is very densely populated (150 inhabitants per sq km) by impoverished, indigenous peasants who have lived there for centuries (Merino 1997). If the Mexican overwintering habitats disappear, we risk losing this migratory phenomenon forever.

The creation of protection and conservation strategies demands creativity and imagination as well as respect and compromise from the three countries interested in protecting monarchs and their migration. Until now, the highest social and financial costs of conservation have been borne by Mexico. Due to conservation policies established during the early eighties, overwintering habitats still receive millions of monarchs every November. Despite the huge efforts made, however, the region's characteristics have made success extremely difficult, and international concern is justified. New commitments to preserve the integrity of the ecosystems that harbour the winter populations, as well as a better awareness of the multiple risks monarchs face in their northern habitats, will lead to a real possibility of conserving this insect and its unique migration. New proposals based on an understanding of the importance of preserving ecosystem integrity are being considered in an effort to design a better conservation strategy than the one implemented eleven years ago (L. Bojórquez, personal communication). Legal caveats are also being reviewed to make conservation activities and protected areas more fair to the local communities than they have been in the past.

Marine species. Oceanic pelagics, including swordfish and a number of species of tuna, as well as salmon, migrate long distances and some species are of major importance to commercial fisheries and are harvested over broad areas of ocean. Marine mammals such as whales, dolphins, and porpoises also range the North American sides of the Atlantic and Pacific oceans and onward to the Arctic Ocean. National systems of protected areas have concentrated on terrestrial zones, but increasingly, the three North American countries are turning their attention to the designation of marine protected areas to protect these ecosystems, species, and habitats. Dwindling stocks or the endangered nature of a number of these species compound problems associated with managing them across international boundaries.

Invaded Habitats

Non-seasonal migrants are also an important transboundary issue for biodiversity conservation. Increased travel and trade have increased the chance of the intentional or accidental introduction of opportunistic species to natural areas. Exotic species can be extremely disruptive for the ecosystems and habitats they colonize. They pose serious threats to native biodiversity and ecosystem integrity due to competition, predation, disease, parasitism, and hybridization. Like extinction, successful biological invasions are irreversible (CEC, in press {a}).

Freshwater species are much more vulnerable to extinction than are their marine counterparts, and North America has witnessed the invasion of several species, including the zebra mussel, that have wreaked havoc in many freshwater habitats. Within North America, the USA is of global significance in its diversity of freshwater species. It once contained the world's greatest diversity of freshwater mussel species. More than 65% of these species are now extinct or threatened, however (Master et al. 1998). If we are to be successful in conserving biodiversity in protected areas, therefore, it is crucial to keep them free of exotic species.

Protecting Permanent Residents

Even though ecological principles for protected areas are well-known, the establishment, management, and evaluation of protected areas are biased by many factors. For example, North American forests are very important natural resources for all three countries, and the forest industry accounts for a considerable percentage of the Gross Domestic Product, approximately 2.4% in Canada in 1997 (Natural Resources Canada 1999) and 1% in Mexico in 1994 (Segura 1996).

Boreal, temperate, and tropical forests face different risks and pose different conservation challenges. If a regional strategy for the conservation of North American forests is to be designed, the different land ownership regimes must also be considered from the start. In Mexico, 80% of forest lands are communal property, 5% are federal, and 15% are privately owned (Segura 1996). By law, communal forest lands cannot be sold. This fact alone creates a unique condition for the design of conservation policies in Mexico. In addition, there exist significant differences in the public ownership of forest lands in Canada and the USA, where 94% and 2% of productive timber areas, respectively, are publicly owned (CEC, in press {a}). An additional difference of prime importance is that most of the Canadian forest lands are not inhabited, while Mexico's are densely populated. The USA has an intermediate general pattern.

Despite these and many other differences, conflicts such as those that developed between the Canadian province of British Columbia and the

American states of Washington and Oregon could probably be avoided if common transboundary sustainable-use practices and reporting prevailed instead of shorter-term commercial ventures. The prime role forests play in the long-term health of the biosphere and of societies and their economies should be a strong enough impetus to improve the way we manage them. This understanding has prompted different international agreements for habitat and biodiversity conservation and reporting, but many of these have yet to show marked success.

Reporting and Information: A Right and a Need

Any conservation strategy needs to be founded on as much information as is available. The computer revolution makes this easier than it was when databases and other information management systems were the only tools. The North American countries need to acquire and share information to make the right decisions for their shared ecosystems. One initiative that exemplifies this kind of cooperation is the North America Biodiversity Information Network (NABIN). A database for the protected areas of North America is being prepared by governmental, non-governmental, and academic organizations under the coordination of the CEC and the Canadian Council on Ecological Areas (CCEA 1999). Fair sharing of information and responsible reporting mechanisms can help to create an improved scenario for the conservation and protection of the natural richness of the North American continent.

A Final Comment

Common ecosystems, communities, and species represent common resources and common responsibilities. Birds that overwinter in Mexico are not Canadian or American birds any more than the monarchs that fly northwards at the onset of spring are Mexican butterflies. These are North American species, relying on North American ecosystems, and they all constitute a part of North America's heritage. Their protection, conservation, and use must be based on respect for individual sovereignties and comply with the local laws of each of the countries the migratory species visit. This does not exclude the need for compromise. Cooperative programs between the three North American countries can lead to a system of protected areas which ensures the survival of genes, species, and ecosystems throughout the continent. The protection of North American ecosystems and natural resources must be based on cooperative strategies built upon solid scientific knowledge and that respect national laws and policies at the same time as they enhance regional opportunities. This is a major ecological challenge set by globalization trends that cannot be postponed using

commercial or political arguments. Sharing resources implies sharing responsibilities, improving reporting capabilities, and selecting meaningful indicators.

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Reporting and Indicators for Protected Areas and Ecosystems: A National Perspective

Introduction

Like the United States, Canada is an immense country—nearly 10,000,000 sq km of land and freshwater, and over 5,500,000 sq km of oceans. It has the world's longest coastline (243,795 km) fronting three oceans, a diversity of temperate and northern ecosystems with globally significant representation of boreal forests, Arctic oceans, temperate rainforest, freshwater lakes, and wetlands, to name a few. Just as the ecosystems are highly diverse, so too are the resources which they contain. Resource extraction and harvesting have been the mainstay of the nation's economy. Canada's population, about 28 million, remains fairly low for its size, and much of the population centres are in the lower latitudes. There is much to conserve and protect for a small population administered under a decentralized federal system.

As across much of North America and elsewhere, the interests which Canadians have in protected areas are varied. From a national perspective, there are several federal agencies that are charged with specific protected area mandates. Reporting on the achievements under each mandate is increasingly critical to the public, other governments, and industry. Several national non-governmental organizations (NGOs) also have interests in ensuring the completion of a national network of protected areas or protecting special and vulnerable ecosystems. In addition, national players very often are concerned not only with the efforts of federal agencies but also the provincial, territorial, and regional protection efforts that add to the national family of protected areas (i.e. parks, wildlife areas, forest reserves, wilderness areas). Considering all the valuable contributions to protected areas in this country-wide setting, there is a fundamental requirement for coordinated approaches. This needs to be reflected in the process of reporting and the use of complementary indicators.

To measure, communicate, and ultimately understand the taxing enterprise of protecting a nation's ecological heritage requires the effective use of indicators and reporting. This

article provides a brief overview of the various ways that Canada has responded to this challenge, ranging from narrow fields of interests through to comprehensive and holistic interests. Each varies in its use of indicators and reporting mechanisms.

National Protected Areas Efforts

Different national agencies have different core responsibilities and perspectives on protected areas. Some federal agencies, e.g., the Canadian Wildlife Service and Parks Canada, have had a long history of administering particular designations such as national wildlife areas and national parks.

Despite selected efforts at coordination such as the Federal Provincial Parks Council, which provides a national perspective on provincial and federal parks programs, there is generally a lack of central leadership and coordination for all protected areas. In part this is because there is no one agency that has had a long-standing responsibility to both provide and oversee a comprehensive perspective on protected areas. The public, environmental NGOs, the industrial sector, as well as governments find it difficult to reasonably ascertain "How are we collectively doing and what is still missing?" with respect to protecting ecological assets.

National State of Environment Reporting. Perhaps the most comprehensive and integrated views taken on protected area interests have been through the *State of Canada's Environment* reports (Government of Canada 1986; 1991; 1996) prepared by the State of Environment Reporting organization within Environment Canada. The overall development and history of this work has been described previously (Wiken et al. 1997; Wiken 1997a, 1997b). While these reports were not solely devoted to protected areas, they had significant portions of the document aligned with this issue. The other information contained in these reports also provided a convenient way to approach the protected area from a total landscape/seascape view. Instead of assessing protected areas in isolation, the broader setting of ecological integrity could be evaluated. The State of Environment Reporting organization was eliminated in the mid-1990s and currently there is no federal government agency that has the mandate to provide comprehensive reporting on progress made in protected areas.

The first major national state of environment report (Government of Canada 1986) attempted to integrate a number of statistics on the environment, population, and other socio-economic factors. The general preponderance for analysis was to look at elements (i.e., land, water, climate, wildlife) of ecosystems in isolation and to report by jurisdictional units (i.e., provinces, territories) and standard census divisions. Some effort was directed at organiz-

ing information by Canada's major ecozones and watershed. Reporting on protected areas (i.e., forest reserves, ecological reserves, migratory bird sanctuaries, wilderness areas, parks) was limited to statistics on the number and area protected by each of these geographic frameworks. Reporting and analyzing in an ecosystematic manner was limited by a lack of data and of integrated data sources, and by inexperience in large-scope ecosystem evaluations.

In the 1991 *State of Canada's Environment* report, protected areas was treated as a separate chapter. By that time, the National Conservation Areas Data Base (now referred to as the Canadian Conservation Areas Database; see below) had enabled the collection of a national information base on federal, provincial, and territorial protected areas as well as on a large number of properties held by NGOs. The national ecosystem classification and integration of data according to that standard framework was further advanced (Wiken et al. 1996). Reporting on the status of protected areas shifted from simple counts and area measures to include a systematic analysis of ecosystem representation based on a national ecoregion classification. This approach was significant because all government-owned protected areas were reported on using a common and holistically defined ecosystem framework, rather than by thematic natural region maps (e.g., plant regions, physiographic regions) or those limited to selected areas of the country (Wiken 1998). Reporting on protected areas included reference to systems planning and targets, and introduced the topics of the ecological integrity and risks to protected areas.

Canada's signing of the Convention on Biological Diversity in 1992 raised the profile of the conservation of ecosystems, genetic resources, and species. Thus in the 1996 *State of Canada's Environment* report, Canadian protected areas were covered within several chapters, but most prominently with an international issues chapter on "Biodiversity Change." This chapter emphasized the importance of protected areas beyond Canadian borders in addition to reporting in the context of the country's major ecosystems – ecozones. This ecosystem approach, which was used in all chapters, enabled a more focused, integrated presentation of protected area trends and conditions and their relationship with land uses and human activities that were affecting each of these ecosystems. The approach to many ecozone chapters allowed a more holistic perspective to be taken on protected areas by describing the richness of Canada's ecological heritage and the threats to species and ecosystems, in addition to updating Canadians on progress made in representing Canada's ecosystems through protected areas. The chapters also included a glimpse of how Canada's resource sectors are addressing issues of spe-

cies and ecosystem conservation through ecosystem management.

Reporting on biodiversity risk and protected areas. Some aspects of the protected area analysis were innovative. Ecosystem representation in protected areas has been used as part of a national assessment of biodiversity risk at an ecosystem level (Turner et al. 1998). Thirteen themes representing various threats, conditions, and management responses (i.e., protected areas) were presented in an ecoregions of Canada framework using Geographic Information System (GIS) technology. Each parameter was assessed as an indicator and weighted by experts according to its relative contribution to placing the ecosystem more or less at risk to changes in its inherent biodiversity. The resultant map (Figure 1) is one product and shows the ecoregions aggregated according to degrees of risk. The highest-risk areas are in ecoregions in southern Canada dominated by combinations or factors such as high human population, extensive land-use modification (e.g., agriculture), high species richness, and the small area that is currently protected.

A National Assessment of Progress

From the above discussion on reporting, assessments of ecosystem conservation can have many perspectives. A comprehensive national approach is required. A central objective of the Canadian Council on Ecological Areas (CCEA) has been to provide a scientifically based national perspective on all protected areas. Beginning about 1985, CCEA prepared a hard-copy binder describing about 500 conservation areas. This list served as the first entries in a digital version stored in Environment Canada's Canada Land Data System. These files have grown into what is known today as the Canadian Conservation Areas Database (CCAD), a national database on protected areas supported by many of the federal agencies mentioned earlier. The CCEA's yearly jurisdictional reports and other official sources have been used to update this database.

The CCAD database currently includes over 3,500 federal, provincial, and territorial conservation areas. A related database contains information on about 10,000 NGO conservation areas. As well, most protected areas larger than 1,000 ha are stored as Geographic Information System (GIS) polygons. This has opened doors to much integrated analysis with other GIS databases.

CCAD has been used by the CCEA to undertake a national gap analysis study (Gauthier et al. 1995), and by the federal government to conduct state of environment reporting (Government of Canada 1991; 1996), biodiversity risk assessment (Turner et al. 1998), and protected forest area indicators (Environment Canada 1997) among

Table 1. Summary of foremost national agencies reporting on protected areas.

Agency	Principal report	Primary interest in protected areas	System framework
State of Environment Reporting Branch, Environment Canada	*State of Canada's Environment* reports	all IUCN category I-VI protected areas (IUCN 1994)	ecosystems of Canada
Parks Canada	*State of the Parks* report	national parks national marine conservation areas national historic parks	Parks Canada Natural Regions Parks Canada Natural Marine regions 15 priority socio-economic themes
Canadian Forest Service, Natural Resources Canada	*State of Canada's Forests* report	representative protected forests	ecosystems of Canada
Canadian Wildlife Service, Environment Canada	no official report	national wildlife areas migratory bird sanctuaries marine wildlife areas	ecosystems of Canada used as general reference; no official system plan framework
Department of Fisheries and Oceans	no official report	marine protected areas	no system plan framework
Ramsar	periodic international / national reports	wetlands of international significance	ecosystems of Canada used as general reference
Canadian Council on Ecological Areas	fact sheets; newsletter articles	representative ecosystems	ecosystems of Canada
World Wildlife Fund–Canada	*Endangered Spaces* report	highly protected areas	various frameworks used by national, provincial, and territorial agencies

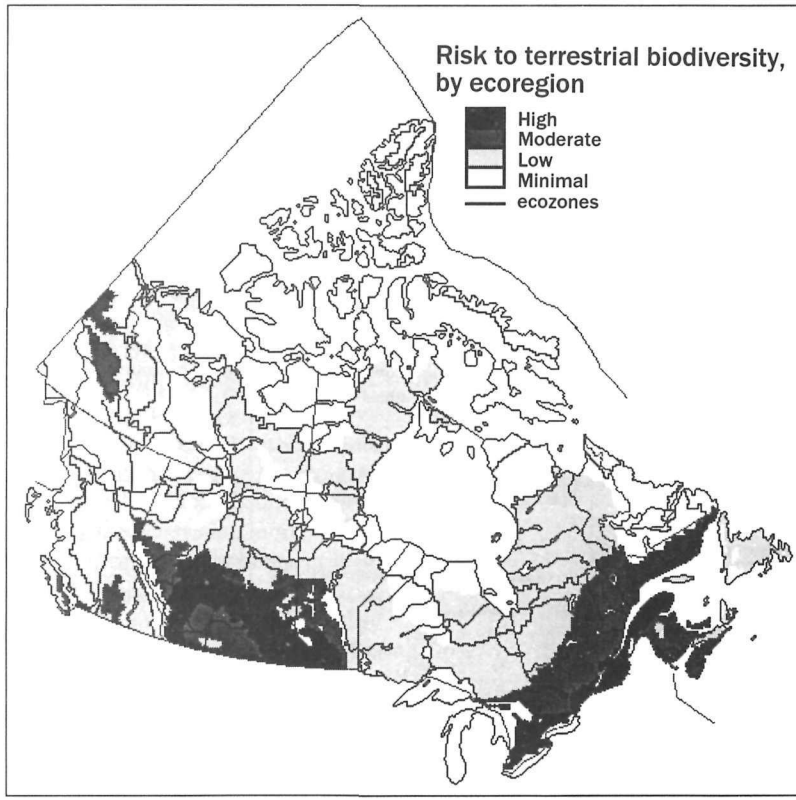

Figure 1. Relative degree of risk to biodiversity loss in Canada, by ecoregion. Source: Turner et al. 1998.

other specialized uses. Two key measures derived from CCAD and the ecoregions of Canada framework has been thegrowth in Canada's protected areas (Figure 2) and an objective assessment of ecosystem representation (Figure 3). The database has also contributed to assessments of North American-, global-, and provincial-level state of environment reports and indicators.

National Reporting by Specialized Sectors

Along with national state of environment reporting, there have been more recent efforts by others to highlight particular kinds of pro-

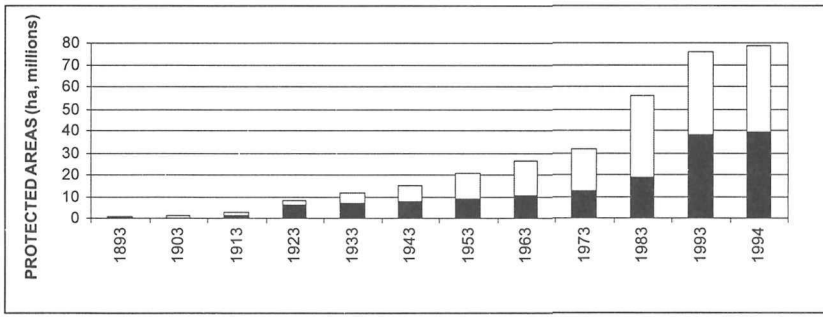

Figure 2. Growth in the establishment of Canadian protected areas, 1893-1994. Black indicates total protected area in IUCN categories I-III, while gray indicates area in IUCN categories IV-VI. Source: Government of Canada 1996.

tected areas. Many of these endeavours are responding to legal obligations, specific commitments, and specialized disciplines.

National parks. Since 1990, Parks Canada has produced three State of the Parks reports. The initial report focused on describing the components of the system of national parks and historic sites, the ongoing efforts dedicated to the maintenance of ecological integrity, and the progress on completing the system. Completion of the National Park System is reported on according to a framework of 39 natural regions, while national marine conservation areas are reported on according to the 29 marine natural regions. Subsequent reports also included results of questionnaires addressing the levels and sources of stress on park ecosystems. As well, the reports included an analysis of more global effects of landscape fragmentation on national parks. Future *State of the Parks* reports will not always be as comprehensive. They will focus on specific issues and be produced on a biannual basis.

Bird sanctuaries and wildlife areas. The Canadian Wildlife Service of Environment Canada, another federal agency, is responsible for three core protected area programs: the national network of migratory bird sanctuaries, national wildlife areas, and, most recently, marine wildlife areas (Wiken et al. 1998). These efforts are mainly aimed at conserving areas that are critical for wildlife. The key focus is on migratory species, but special areas have been created for polar bears, bowhead whales, and other fauna. While these areas are not designed to capture ecosystem representation, adopting an ecosystem approach is vital for maintaining wildlife habitat integrity. The Canadian Wildlife Service is also responsible for promoting the development of an

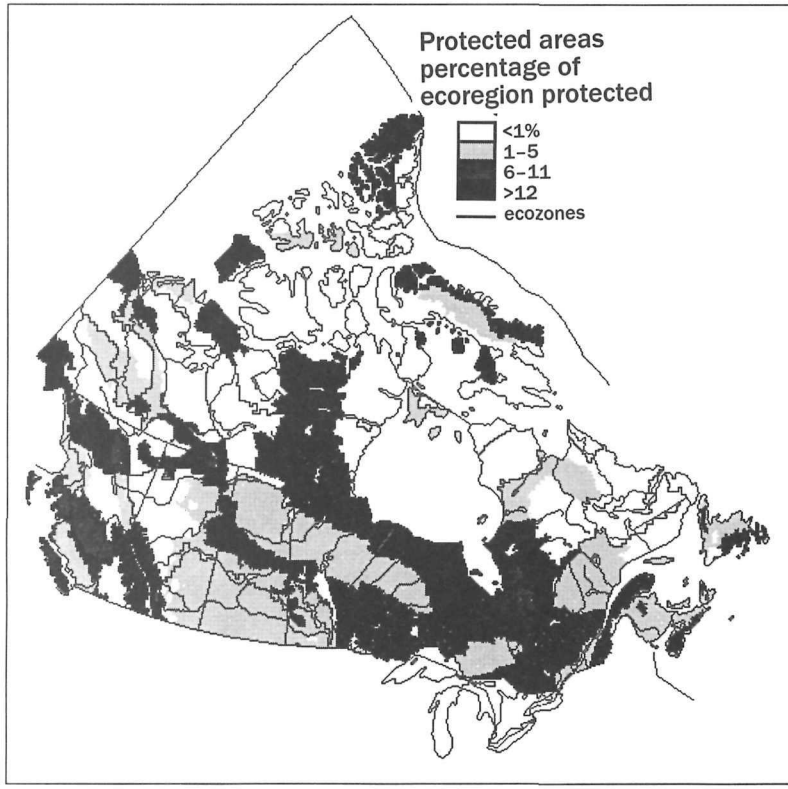

Figure 3. Percentage of each ecoregion area protected. This map includes those government-owned protected areas larger than 1,000 ha, which meet the criteria for IUCN management categories I-VI. Source: modified from Natural Resources Canada 1999.

international Ramsar wetland network within Canada and of an ecological land donation program. Ramsar achievements are reported on every three years (Rubec and Kerr-Upal 1996); ecological land donations, which largely occur in southern Canada, are reported on as required. Reporting on waterfowl conservation areas and sites under the North American Waterfowl Plan takes place about every five years.

Forests. The Canadian Forest Service also has a special interest in reporting on protected areas. Although the service doesn't own or

designate protected areas itself, it does have a requirement to report on progress in establishing protected forest reserves. This requirement is largely a response to the National Forest Strategy, which contains a shared objective for all members of the forest community to complete, by the year 2000, a network of protected areas representative of Canada's forests. Reporting on progress is done primarily through the annual *State of Canada's Forests* report (e.g., Canadian Forest Service 1998).

Biodiversity. Reporting on protected areas is also part of Canada's response to the Convention on Biological Diversity. The convention calls upon Parties to "establish a system of protected areas or areas need to be taken to conserve biodiversity" (Article 8). In addition, Parties are required to "present ... reports on measures which it has taken for the implementation of the provisions of this Convention and their effectiveness in meeting the objectives of this Convention" (Article 26). The Canadian Biodiversity Strategy, completed in 1995, restates Canada's intention to "complete Canada's networks of protected areas" (Strategic Direction 1.11) as well as "report periodically to Canadians and the international community on the status of Canada's biodiversity by appropriate means including state-of-the-environment reporting" (Strategic Direction 6.6). It is expected that progress in establishing a network of protected areas which help preserve species, genes, and ecosystems will be captured in future reports.

NGO reporting. Among NGOs, the World Wildlife Federation-Canada (WWF 1996) has the highest profile with respect to protected area reporting. Since 1989, WWF has produced a national progress report on the status of their "Endangered Spaces" program—a program designed to bring attention to both achievements and failures of the federal, provincial, and territorial governments to collectively protect representative examples of Canada's natural regions. The program recognizes only those protected areas that are permanent, do not permit industrial activities, and are large enough to sustain natural processes. As such, many provincial parks and wildlife sanctuaries as well as federal wildlife areas and migratory bird sanctuaries are excluded. The WWF report uses a report card method to assess the progress of each jurisdiction.

The Canadian Council on Ecological Areas has produced periodic fact sheets (e.g., CCEA 1995) and newsletter articles (Beric 1998) reporting on the progress of protected areas. The CCEA's strategy and efforts on promoting ecosystem representation are based on the standard and systematic national ecosystem classification that was initially developed by a host of national scientists and resource managers under the auspices of the Canada Committee on Ecological Land Classification.

The CCEA and other national agencies have promoted the extended development of this classification system to encourage a standardized and ecosystematic approach to sustainable resource use. The CCEA's assessments of representativity cover contributions that emerge from a variety of protected area designations and IUCN classes.

Marine ecosystems. Much of Canada's effort in protecting ecosystems and their resources has been devoted to terrestrial areas. The emphasis being placed on marine protected areas is relatively new. While reporting achievements and selection of indicators is not well developed yet, these items will become strategic yardsticks.

National wildlife areas and national migratory bird sanctuaries, administered under the authority of the Canadian Wildlife Service, are amongst the oldest marine protected areas (Zurbrigg 1996). National wildlife areas are designed to protected wildlife habitats up to the 12-nautical-mile statutory coastal limits. Revisions to the Canada Wildlife Act in 1994 have enabled the creation of marine wildlife areas which can be established for similar purposes as national wildlife areas (research, conservation, and interpretation) but will apply between the 12- and 200-nautical-mile statutory coastal limits. Currently no marine wildlife areas have been designated.

The national marine conservation areas program, led by Parks Canada, focuses on developing a national system of these areas which will be representative of each of Canada's 29 marine regions. As with terrestrial-based national parks, progress on national marine conservation areas is done through the biennial national *State of the Parks* report. Although marine region representation is the overriding selection criterion, a wide range of other ecological, environmental, and social criteria are also considered.

The Oceans Act authorizes the government of Canada to establish a national system of marine protected areas and to make regulations that allow them to be designated, zoned, and closed to certain activities. Briefly, an area can be designated as a marine protected area to conserve and protect one or more of the following:

- Commercial and non-commercial fishery resources, including marine mammals, and their habitats;
- Endangered or threatened marine species and their habitats;
- Unique habitats;
- Marine areas of high biodiversity or biological productivity; and
- Any other marine resource or habitat as is necessary to fulfill the mandate of the Minister.

Developing a comprehensive federal marine protected area program will require the cooperative efforts of a number of government agencies, NGOs, and other stakeholders. For

the federal Department of Fisheries and Oceans, it will be necessary to develop a strategic program framework in order that priorities and actions are clearly expressed.

Indicators and Protected Areas

Indicators are important means to assess ecosystems and protected areas. Ecosystem conditions, processes, and factors that influence or threaten both protected areas and ecosystems are extremely complex. Indicators can be used to help simplify the messages for scientists, the public, and decision-makers. An indicator can be defined as a statistic or parameter that, tracked over time, provides information on trends in the condition of the phenomenon and has significance beyond that of the statistic itself. Indicators have long been used to measure trends and simplify and communicate complex issues. For example, the Gross Domestic Product is a common indicator for the health of the economy; body temperature is often used as a simple indicator of the condition of a patient.

In Canada, indicators have been developed on threats and condition of ecosystems and protected areas. For example, tracking the growth in amount of area protected over time has been a commonly used indicator to communicate the rate at which the country is setting aside protected areas and whether that rate of progress is increasing or slowing down over time. Tracking figures such as the area protected is especially useful if there is a suitable ecosystem target.

Indicators of ecosystem representation. A more complex but useful indicator of protection is a measure of the degree of ecosystem representation of the national network of protected areas. Such a national gap analysis can determine ecosystems that are well-represented, poorly represented or have no representation at all. It can also help determine where protection efforts need to be placed in the future if a complete network is envisioned. A national gap analysis, such as was done by the CCEA (Gauthier et al. 1995), is also a useful way to include all protected areas managed by a diverse number of agencies.

Indicators of integrity. The current health or integrity of protected areas is a more complex measure that is continually being improved with new data. Parks Canada has included measurement of the integrity of national parks in its *State of the Parks* report. For national parks, ecological integrity is defined as the condition of an ecosystem where: 1) the structure and function of the ecosystem are unimpaired by stresses induced by human activity, and 2) the ecosystem's biological diversity and supporting processes are likely to persist. The ecological integrity of each national park will be measured using a number of indicators of threats and conditions. While the actual indicator components will

Biodiversity	Ecosystem functions	Stressors
Species richness • change in species richness • numbers and extent of exotics	**Succession/retrogression** • disturbance frequencies and size • vegetation age-class distribution	**Human land-use patterns** • land-use maps, roads, densities, population densities
Population Dynamics • mortality/natality rates of indicator species • immigration/emigration of indicator species • population viability of indicator species	**Productivity** • landscape or by site	**Habitat fragmentation** • patch size, interpatch distance for interior
Trophic structure • size class distribution of all taxa • predation levels	**Decomposition** • by site	**Pollutants** • sewage, petrochemicals, etc., • long distance transport of toxins
	Nutrient retention • Ca, N by site	**Climate** • weather data • frequency of extreme events
		Other • park-specific issues

Table 2. Indicator categories for assessing the ecological integrity of National Parks.

vary from site to site, the main areas for which data will be collected are listed in Table 2.

Forest ecosystem indicators. The forest sector has also developed indicators to address the need for conserving ecosystem diversity. To specifically address how forest protection will be tracked, in 1995 the Canadian Council of Forest Ministers developed an approach to criteria and indicators for the sustainable management of Canadian forests. Under the category of ecosystem diversity are indicators to protect forest types, age structure, and spatial patterns, as well as an indicator of area, percentage, and representativeness of forest types in protected areas. How these will be measured and presented is the subject of ongoing research.

A first attempt at developing indicators of forested ecosystems under the heading of forest biodiversity was coordinated by Environment Canada with advice from the Canadian Forest Service and other agencies. This bulletin (Environment Canada 1997) includes indicators of potential threats to forest (road access), forest condition (tree species mix, age-class distribution, population trends in

forest birds, and forest-dependent species at risk) and management response (protected forest area). In an effort to make the indicators more ecologically meaningful, many were presented according to the ecozones of Canada framework. The protected forest area indicator compared the area of protected forest in each of four forestry-dependent ecozones as a ratio of the area of total forest in the surrounding ecozone. This indicator did not distinguish between the type, structure, or quality of forest.

Outlook

Within countries like the USA, Canada, and Mexico, many of the strategic decisions that affect the nation as a whole are normally taken through national agencies. Those agencies need to be equipped with timely and objective information that is suitable for that role and perspective. They equally have to be guided by more regionally specific interests as well as global interests.

Much the progress that has been made to establish new protected areas and networks, and to manage existing areas, has been done by individual organizations. While protected areas may differ in names and specific goals, there are many commonalties in purpose between them. For example, parks protect wildlife habitats and wildlife areas serve to protect representative ecosystems.

It is strategic that organizations know what types of protected areas collectively exist and what is being planned to expand given networks. Using the ecosystems of Canada framework has proven to be a very useful way to objectively assess the collective progress of many agencies at a national scale, which not only helps to inform Canadians but also helps to communicate Canada's efforts to the rest of the world. Establishing protected areas is one important step, but managing them in a ecosystematic and sustainable manner is another. Couching reporting and indicators in the context of the national ecosystem framework is vital in this respect. It provides the means to measure and monitor the inherent characteristics of ecosystems and to assess current stressors.

The meaningful use and application of reporting and indicators relies on fairly simple principles. They do not start with selecting indicators or invoking a reporting process. Rather, they need to be based throughout on ecosystem knowledge:

- Understanding the inherent diversity and characteristics of ecosystems;
- Providing the capacity to monitor and research ecosystems;
- Tracking trends and conditions on how and where ecosystems are changing;
- Interpreting the significance and the basis of these changes; and
- Developing and implementing action plans and policies to address issues.

As nations continue to grow and de-

velop in the third millennium, there will be an even more pressing need to find innovative ways to objectively assess the collective progress and health of our protected area network and ecosystems.

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Reporting on Macro-Ecosystems: The Great Plains of North America

Introduction

Reporting and indicators concerning protected areas and other topics are intended to serve decision-makers. They commonly do so by providing both a context for the 'study area' and a comprehensive platform of basic ecological information. As decision-making increasingly takes place at all levels (e.g., including ranchers, academics, government officials, corporate organizations, resource developers, and environmental groups), the context-setting and information need to be robust to cover varied social, economic, and environmental considerations that stakeholders may have.

The process of state of the environment reporting and indicators has a fairly strong record at national levels and, in cases, at provincial levels. However, at the continental scale that is most suitable for the Great Plains, little exists (Wiken et al. 1997). Within the existing reports, some have had success in applying an ecosystem approach, but this is a recent innovation and an activity to which many organizations are unaccustomed. Attempting to do this for a macro-ecosystem such as the Great Plains is unprecedented even for a seemingly simple indicator such as protected areas.

State of the environment reporting and the use of ecological indicators are rather recent innovations put in place to document, track, and explain changes. The products ideally set a basis for sustainable resource use and living. While this type of venture would be most helpful in guiding actions and policies concerning the use and conservation of pristine areas, many of the world's macro-ecosystems have already been subject to a host of changes induced by human activity. The prairie ecozone of Canada and its natural extension—the Great Plains of North America—exemplify this situation very well.

The North American Great Plains Ecosystem Setting

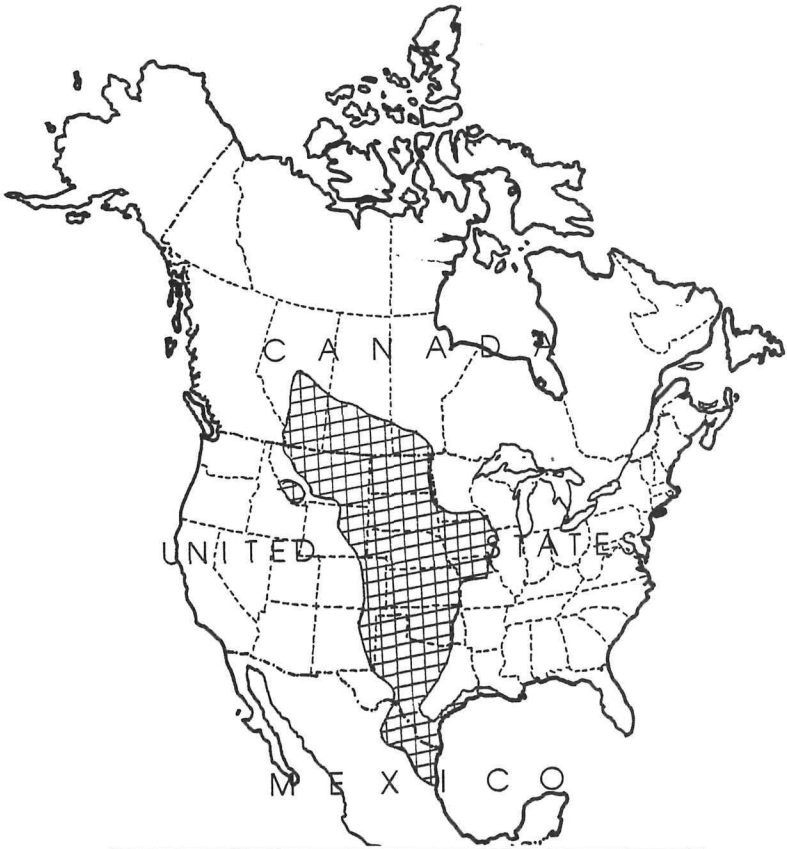
Initiatives like sustainable resource use, ecosystem management, and ecosystem integrity call for an

approach that goes beyond the confines of jurisdictions, whether they are country, state, or provincial borders (Gauthier 1992; Gauthier et al. 1995; Wiken and Gauthier 1997). The Great Plains is one of the best examples of a macro- and continental ecosystem, one that is shared amongst three countries, three provinces, and twenty-one states. Historically, the Great Plains' wealth of resources and productive landscapes has been the seed of its demise in respect to current-day conservation interests. As a result, much of the landscape has been altered, many native ecosystems and species have been lost, and little of what was natural remains.

The Great Plains ecological region (NAEWG 1997; Wiken and Gauthier 1998) is found in the central part of the continent and extends over the widest latitudinal range of any single North American ecological region. It is a relatively continuous and roughly triangular area covering about 3 million sq km (Figure 1). The North American prairies extend north to south about 1,500 km from Alberta, Saskatchewan, and Manitoba in Canada through the Great Plains of the USA to southern Texas and adjacent Mexico, and east to west approximately 600 km from western Indiana to the foothills of the Rockies and into northeastern Mexico. The majority of the Great Plains, approximately 80%, is found within the USA, with 16% in Canada and 4% in Mexico. This large ecological region is generally distinguished by the following characteristics: relatively little topographic relief, grasslands and a paucity of forests, and a climate ranging from subhumid to semi-arid.

The Great Plains is currently a culturally molded ecosystem. The first European settlers began moving westward into the northern and central Great Plains from the eastern forest regions. At first, settlers considered the prairies to be infertile, so they stayed where trees persisted. But the settlers soon realized that the prairie soil was one of the most productive in the world. Today, the prairie grasslands are among the largest farming and ranching areas of the Earth. Agriculture is the most important economic activity as well as the dominant land use and the main stressor for this ecological region. Crop types vary from north to south with differences in growing seasons and temperatures. While agricultural activities dominate the rural landscape, population is centered in urban areas and rural depopulation is a continuing trend in Canada and the USA. Overall, approximately 34 million people live within this ecological region, with some 32 million occupying the portion occurring within the USA.

The character of the Great Plains ecosystem is unlike many other North America ecosystems. For example, in stark contrast to the Great



Area of the Great Plains ecological region		
Canada	45,730,810.	ha
United States	228,748,630.	ha
Mexico	10,553,283.	ha
Total for North America	285,032,723.	ha

Figure 1. The Great Plains of North America.

Plains, the tundra ecosystem contains less than 30,000 people living in an area of 2.8million sq km and falling under only four main jurisdictions. The influence and impact of human activities and land uses in that region are, by contrast, minute. The Great Plains has some of the most extensive networks of roads. These types of factors ultimately affect the conditions of the ecosystems and the biases of decision-making. For example, in the Arctic managers may be able to adopt a stronger "prevent and anticipate" management focus, whereas those in the Great Plains may have to "restore and repair."

The Protected Area Situation

Within the Great Plains macro-ecosystem there are five major ecological regions (Figure 2). Figure 2

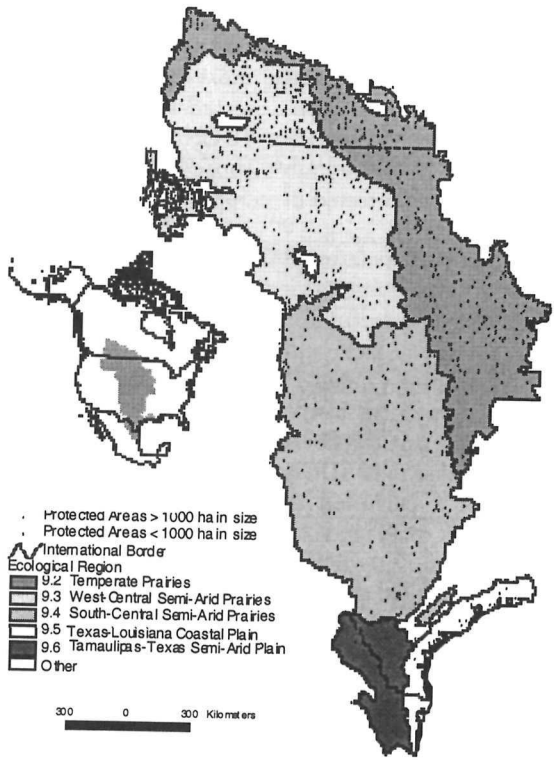


Figure 2. Ecological regions and protected areas of the Great Plains

also shows the distribution of protected areas according to those that are greater than 1,000 ha in size and those that are less. In the remainder of this paper, unless noted otherwise the term "protected areas" refers only to those areas greater than 1,000 ha.

There are 603 protected areas in the Great Plains. Table 1 shows that, in total, they occupy just under 6% of the Great Plains. Ninety-nine percent of the area protected occurs within only three of the five ecological regions. The majority (72%) of the area protected occurs in the west-central semi-arid prairie. The Texas - Louisiana coastal plain and the Tamaulipas–Texas semi-arid plain contain less than 1% of the area protected in the Great Plains.

The six-category international IUCN system for classifying protected natural areas is useful for comparisons across ecological and jurisdictional boundaries (Table 1) (IUCN 1994). Sixty percent of the area classed as protected in the Great Plains has been coded as to its IUCN status. Of that, 80% is coded as IUCN Category VI, managed resource protected area. Only 5% of the area protected in the Great Plains that has been coded as to its IUCN status falls into IUCN classes I to III (strict nature reserve/wilderness, national park, or natural monument), often considered to be managed for the highest degree of protection.

It is also useful to examine these data by country (Table 2). Canada contains 16% of the Great Plains in two ecological regions, the temperate prairies and the west-central semi-arid plains. Those two compose the prairie ecozone of Canada, which occupies 5% of the country's total land area. Twenty-six percent of the protected areas in the Great Plains occur in Canada.

Eighty percent of the Great Plains are found in the USA, and they occupy approximately 29% of the country's continental land area. Almost 75% of the Great Plains' protected areas are in the USA. When all IUCN categories are considered, those areas provide protection for approximately 7% of the Great Plains within the USA.

Five percent of Mexico's land area is prairie, representing 4% of the total area of the Great Plains of North America. While there are protected areas within the Mexican Great Plains, they are few and relatively small (less than 1,000 ha).

Table 3 provides a summary of protected area information for Canada and the USA according to ecological regions. While the USA and Canada are relatively similar in the proportionate representation of protected areas in the temperate prairies, the USA has substantially more proportionate representation in the west-central semi-arid plains.

Table 4 examines the distribution

Table 1. Number and extent of protected areas (>1,000 ha) for the ecological regions of the Great Plains, by IUCN category

	Temperate Prairies	West-Central Semi-Arid Prairies	South-Central Semi-Arid Prairies	Texas-Louisiana Coastal Plain	Tamaulipas-Texas Semi-Arid Plain	TOTAL
IUCN Cat. I						
Number	2	8	1	1	0	12
Area (ha)	6,253	46,492	5,526	50	0	58,321
% area	0.008	0.05	0.006	0.0005	0	0.02
IUCN Cat. II						
Number	8	10	1	0	0	19
Area (ha)	162,963	252,964	1,056	0	0	416,983
% area	0.21	0.29	0.001	0	0	0.14
IUCN Cat. III						
Number	4	6	4	0	0	14
Area (ha)	7,014	15,154	3,188	0	0	25,356
% area	0.009	0.02	0.003	0	0	0.008
IUCN Cat. IV						
Number	46	47	13	9	0	115
Area (ha)	307,459	647,741	76,484	118,124	0	1,149,808
% area	0.39	0.7	0.08	1.23	0	0.40
IUCN Cat. V						
Number	22	6	18	3	1	50
Area (ha)	128,529	29,445	49,924	36,233	7,563	251,694
% area	0.16	0.03	0.05	0.56	0.05	0.09
IUCN Cat. VI						
Number	31	78	3	0	0	112
Area (ha)	620,223	7,238,411	636,596	0	0	8,495,230
% area	0.80	7.9	0.65	0	0	2.93
Unclassified						
Number	107	97	71	8	1	284
Area (ha)	752,484	3,929,975	1,872,338	19,273	1,620	6,575,690
% area	0.97	4.6	1.93	0.29	0.01	2.27
TOTAL						
Number	220	252	111	21	2	606*
Area (ha)	1,984,925	12,160,182	2,645,112	173,680	9,183	16,973,082
% area protected, each ecological region	2.6	13.3	2.7	2.7	0.07	
% area protected, entire Great Plains	0.7	4.2	0.9	0.06	0.003	5.9

* Because of overlap of protected areas across ecological region boundaries, some are recorded as occurring in more than one region, yielding a total number higher than the actual count of 603.

IUCN Category I = strict nature reserve / wilderness area
IUCN Category II = national park
IUCN Category III = natural monument
IUCN Category IV = habitat/species management area
IUCN Category V = protected landscape/seascape
IUCN Category VI = managed resource protected area

Table 2. Number and extent of protected areas (>1,000 ha) in the Great Plains, by ecological region and country

Country	Total area (sq km)	Area (sq km) of prairie (%)	Percentage of Great Plains in each country	Number of protected areas (% of total)	Area (sq km) of protected areas (% of prairie protected)
Canada	9,970,610	457,308 (5%)	16%	159 (26%)	15,874 (3.5%)
Continental USA	7,825,161	2,287,486 (29%)	80%	444 (74%)	153,856 (6.7%)
Mexico	1,958,201	105,532 (5%)	4%	0 (0%)	0 (0%)
TOTAL	19,753,972	2,850,327 (14%)	100%	603 (100%)	169,730 (5.9%)

Table 3. Number and extent of protected areas (>1,000 ha) in the Great Plains of Canada and the USA, by ecological region and country

Ecological Region	Canada				USA			
	% of ecological region in Canada	# of PAs	Area (sq km) of PAs	% of ecological region protected	% of ecological region in USA	# of PAs	Area (sq km) of PAs	% of ecological region protected
Temperate Prairies	29	69	6,332	2.8	71	151	13,517	2.4
West-Central Semi-Arid Prairies	27	90	9,542	1.5	73	162	112,059	17.7
South-Central Semi-Arid Prairies	0	0	0	0	100	111	26,451	2.7
Texas-Louisiana Coastal Plain	0	0	0	0	82	21	1,736	2.2
Tamaulipas-Texas Semi-Arid Plain	0	0	0	0	37	2	91	0.2
TOTAL	16	159	15,874	2.1	80	447*	153,856	6.7

* Because of overlap of protected areas across ecological region boundaries, some are recorded as occurring in more than one region, yielding a total number higher than the actual count of 444.

of protected areas solely according to country and administrative jurisdiction (state or province). Three Canadian provinces, eighteen U.S. states, and three Mexican states contain portions of the Great Plains. When federal management agencies are included, these figures reflect the multiplicity and inherent complexity of attempting to achieve coordinated ecosystem management over such a large macro-ecosystem.

Most of Canada's Great Plains is found in Saskatchewan. It also has the greatest number of large protected areas and the largest percentage (5%) of prairie protected in Canada (Gauthier and Patino 1998;

Table 4. Number and extent of protected areas (>1,000 ha) in the Great Plains, by province and state

Country	State or Province	Area (sq km) containing portions of the Great Plains	Area (sq km) of prairie (% of Great Plains portion)	% of Great Plains Ecological Region in State or Province	# of PAs	Area (sq km) of PAs (%)
Canada	Alberta	660,457	152,295 (23)	5.3	19	1,150 (0.8)
	Manitoba	649,937	70,075 (10.8)	2.5	29	2,455 (3.5)
	Saskatchewan	649,187	234,938 (36.2)	8.2	111	12,269 (5.2)
USA	Arkansas	137,540	28 (0.02)	0.001	0	0
	Colorado	270,865	114,318 (42.2)	4	26	9,326 (8.2)
	Idaho	215,739	84 (0.04)	0.003	1	71 (86)
	Illinois	146,385	56 (0.04)	0.002	1	1 (2.4)
	Iowa	145,048	136,172 (93.9)	4.8	49	379 (0.3)
	Kansas	211,873	211,869 (100)	7.4	32	2,521 (1.2)
	Louisiana	121,909	16,330 (13.4)	0.6	7	361 (2.2)
	Minnesota	218,357	80,386 (36.8)	2.8	27	2,544 (3.2)
	Missouri	180,443	88,724 (49.2)	3.1	6	137 (0.2)
	Montana	380,100	280,260 (73.7)	9.8	91	43,514 (15.5)
	Nebraska	199,844	199,844 (100)	7	16	4,280 (2.1)
	New Mexico	315,155	67,390 (21.4)	2.4	14	1,662 (2.5)
	North Dakota	182,056	182,056 (100)	6.4	70	19,846 (10.9)
	Oklahoma	180,895	158,677 (87.7)	5.6	13	8,617 (5.4)
	South Dakota	198,282	193,432 (97.6)	6.8	40	47,558 (24.6)
	Texas	687,711	481,706 (70)	16.9	46	5,392 (1.1)
	Wisconsin	146,323	854 (0.6)	0.03	2	25 (3)
	Wyoming	252,996	75,295 (29.8)	2.6	12	7,620 (10.1)
Mexico	Coahuila	150,747	25,818 (17.1)	0.9	0	0
	Neuvo Leon	65,227	33,592 (51.5)	1.2	0	0
	Tamaulipas	78,178	46,127 (59)	1.6	0	0
TOTAL		6,445,256	2,850,327 (44.2)	.100	612*	169,730 (6)

* Because of overlap of protected areas across ecological region boundaries, some are recorded as occurring in more than one region, yielding a total number higher than the actual count of 603.

Gauthier et al. 1998, Patino and Gauthier 1997). Within the USA, those Great Plains states whose land area is at least 70% prairie (North Dakota, Nebraska, Kansas, Iowa, Montana, South Dakota, Texas, and Oklahoma) vary widely in the percentage of that prairie which is protected (ranging from less than 1% for Iowa to 25% for South Dakota).

Examining protected area data according to both ecosystems and administrative jurisdictions provides a useful means by which to evaluate those areas according to different perspectives and requirements (Wiken and Lawton 1995; Wiken et al. 1996). Across the Great Plains, the diversity of land forms, soils, hydrologic regimes, climate, vegetation, and wildlife species and communities—as shaped by human activities—has resulted in numerous ecosystems that require a multitude of management approaches to insure their protection. Jurisdictions can benefit in their coordination efforts by combining standardized ecosystem and protected area classification schemes.

The grasslands have been and remain productive areas for many resource sectors, such as agricultural, gas and oil, and mining. While these ecosystems have been widely supportive of human endeavours, that support has come at the cost of the systems' original assets. This analysis has provided an initial look at the presence and absence of conservation areas across the continent's core, once dominated by native grasslands. It is a general indication of where the assets remain. The pattern of protected areas shows a generally wide dispersal northwards from the Rio Grande. Success in establishing protected areas is lowest in Mexico and highest in the USA. In terms of designating additional protected areas, most of the larger, and therefore likely more viable, properties (those greater than 1,000 ha) are in the USA. The percentage of Great Plains protected within North America (5.9%) is relatively low, and is, by many worldwide standards, insufficient.

In North America, the "Old West" and the Great Plains are often thought of as synonymous terms. The Old West signified an era with hardy and colourful characters, a dynamic environment, and spectacular and vibrant landscapes. That era only survives as a legacy recorded in history books. The legacy of the natural grasslands is disappearing into history as well. The remnant and often-isolated spots of the former grasslands are now typically contained within protected areas. These areas scattered across the plains are the few remaining pages that have not yet been relegated to the natural history books. They are like a fleet of Noah's Arks moored in a sea of agricultural lands. Existing protected areas within the Great Plains appear as island vestiges of the past. Unlike

other areas such as the tundra, protected areas in the Great Plains are not entities within a larger landscape of wilderness. Their isolated, island pattern mediates against their likely effectiveness as clusters for migrating species. It also weighs heavily against their ability to, on their own, maintain their ecological integrity over the long term due to their small size and the surrounding land uses. It is becoming very clear that cooperative partnerships and reporting endeavours among individuals, organizations, and agencies throughout the Great Plains are essential to insure that conservation objectives are met.

Common Action and Partnerships

Numerous partnership programs to conserve prairie are in place across the Great Plains. Some are specific to particular resources, such as the North American Waterfowl Management Plan, and the High Plains Partnership for Species at Risk (Walsh 1997), while others are broader, encompassing many resource sectors and stakeholder interests. For example, the Great Plains Partnership (GPP) is an international program made up of "federal, state, and local agencies, tribes, non-governmental organizations and landowners who believe that through cooperation rather than conflict, economic and environmental interests can be compatible."

The Partnership's mission is to catalyze and empower the people of the Great Plains to define and create their own generationally sustainable future. To this end, the Partnership brings together individuals and groups who commit appropriate resources, work to remove institutional barriers, develop the necessary science and data, and enhance local, regional, and world-wide learning from these efforts (GPP 1999a).

Connected to the Great Plains Partnership is the Great Plains International Data Network (GPIDN). Membership in the data network is open to all parties interested in participating in a Great Plains program that facilitates access, exchange, and integration of databases relating to the region.

Members of the GPIDN are interested in exploring ways of cooperating with other agencies and jurisdictions to advance data activities and sustainable development within the Great Plains region. A framework document describes the components of the GPIDN. Over 120 U.S., Canadian, federal, non-governmental, nonprofit, state and local participants are represented on the data network. By working together, exchanging ideas and information, and pooling resources, it is anticipated that the GPIDN can develop mechanisms to facilitate Great Plains data access, exchange and integration. As a result, this will stimulate scientists in the Great Plains region to identify challenges and propose solutions, so that decision-makers and stakeholders can make wise decisions on the management of the region (GPP 1999b).

Regional conservation plans are also being developed. For example, in Canada, prairie conservation action plans have been developed for Saskatchewan (PCAP 1998), Alberta (Prairie Conservation Forum 1997),

and Manitoba (Manitoba Natural Resources 1998). These plans reflect agreements among representatives of numerous resource industry associations, government agencies, and nongovernmental organizations regarding the conservation of the Canadian prairies.

There are no standardized sets of indicators commonly used to report on the success of the wide range of conservation programs throughout the prairies. By their very existence, such conservation programs are an indicator of conservation activity useful for reporting purposes. However, measures of the success of such programs are essential to facilitate planning and policy needs. The criteria used by each conservation program as measures of their productivity and success in achieving their objectives can be useful reporting indicators. Such indicators would vary from measures of communication and education success to the amount of land conserved through land securement projects. The ultimate success of the various cooperative conservation partnerships on the prairies could be compromised by the absence of reporting and indicator items. Increasingly, planners, managers, investors, and the general public are calling for measures that document, track, and explain changes as a basis for sustainable living.

Implementing successful cooperative conservation programs in the prairies requires working with a large number of private owners; lessees; rural and urban municipalities; state, provincial, and federal governments; First Nations and other indigenous governments; and a host of interest groups. Such programs recognize and respect different cultural interests, the reality of substantially altered landscapes, the importance of agri-business and other economic interests, and the seriousness of biodiversity losses. They also recognize the need to extend conservation beyond the boundaries of existing protected areas to the entire working landscape. In these types of cooperative partnerships lie the best hope for the conservation of the Great Plains.

Acknowledgments

Special thanks for their assistance in data preparation and analysis to Rob Beric of Ottawa, Ontario, and to Sarah Gammell and Lorena Patino of the Canadian Plains Research Center in Regina, Saskatchewan. Also, the Canadian Council on Ecological Areas provided access to the Canadian Conservation Areas Database.

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Reporting and Indicators: Mechanisms in Ecologically Sustaining the Forested Sector

Introduction

The forests of North America are diverse, covering the spectrum of forested landscapes from the northern taiga of Canada and Alaska to the tropical humid forests of Mexico. The Commission for Environmental Cooperation has identified 15 broad ecosystems of North America (including Canada, USA, and Mexico) (NAEWG 1997). Twelve of these macro-ecosystems have a substantial forest cover. Canada, for example, includes all or portions of seven of these North American forested ecosystems covering a total forest area of 418 million hectares, or nearly half of the Canadian landscape. Although this chapter concentrates on the forests of Canada, there is an implicit understanding that the forests of one nation cannot be isolated from those of its neighbours. Equally, forests cannot be thought of in isolation of the continental and global cycles operating in the rest of the world community. Table 1 provides a comparison of forest land among Canada, United States and Mexico (Cantin et al. 1998).

Table 1. Area of forest within Canada, United States and Mexico

Country	Forested Area (million ha)	% of Total Land Area of Country	% of North American Forests	% of Global Forest
Canada	417.6	45	55	10
USA	298.1	33	39	7
Mexico	49.6	26	6	1

The national ecological classification of Canada (ESWG 1996; Wiken et al. 1996) stratifies Canada into 15 ecozones which meld with the North American ecosystem units (NAEWG 1997). Nine of these ecozones are considered as having a substantial forested component. The following section, extracted from the publication *Forest Health in Canada: An*

Overview (Forest Health Network 1999), provides a descriptive ecological and demographic synopsis of each of these forested ecozones.

The Forested Ecozones of Canada

The **Pacific maritime** ecozone occupies an area of 21.9 million ha (10.6 million ha of forest) and has a mostly urban population of 3 million people. Canada's most productive forests and its biggest and oldest trees, some attaining ages of 500 years and older and heights to 70 m and more, are found here. The forest ecosystems vary with elevation and precipitation. Major species include western hemlock, western red cedar, Douglas-fir, Sitka spruce and subalpine fir. The ecozone is dominated by a coastal temperate rainforest. Globally, these rainforests are scarce, with a worldwide distribution of only 40 million ha (Kellogg 1994). Overall, the forests have low endemic populations of tree-damaging insects and diseases. There is an infrequent fire history, although large burns have occurred in the past. Harvesting is the major human disturbance.

The **montane cordillera** ecozone occupies an area of 49.2 million ha (34.9 million ha of forest) and has a mostly urban population of one million people. It is the most diverse of all of the ecozones, consisting of alpine, forest, and grassland ecosystems. Major tree species include Douglas-fir, ponderosa pine, subalpine fir, Engelmann spruce, western white pine, and lodgepole pine. The major historical agent of disturbance has been fire. Insects and diseases, such as the western hemlock looper, mountain pine beetle, and Armillaria root rot, have also been primary agents of ecological change.

The **boreal cordillera** ecozone occupies an area of 46.5 million ha (28.8 million ha of forest) spanning northern British Columbia and the southern Yukon. The population of 31,000 people is mostly rural. There is less diversity in tree species than in the more southern ecozones, with subalpine fir, lodgepole pine, white spruce, and trembling aspen being dominant. The valley and lower-slope ecosystems historically have been fire-dominated. Within the ecozone, the tree line is reached at elevations of 1,000 to 1,400 m.

The **taiga plains** ecozone occupies an area of 64.7 million ha (50 million ha of forest) and has a population of 22,000 people spread among several settlements. The ecozone is characterized by poor soils and frequent fires. It comprises a transition forest between mixed forest–tundra and dense coniferous forest. Black spruce is predominant. Within the ecozone, it generally grows slowly under open forest conditions. A vigorous forest, however, characterizes the Mackenzie River valley and its tributary valleys, containing some of Canada's largest white spruce and balsam poplar trees.

The **taiga shield** ecozone occupies 136.6 million ha (52.7 million ha of forest), covering much of the Canadian Shield from Labrador to as far west and north as Great Bear Lake in the Northwest Territories. It has a population of 34,000 people. This ecozone is an ecological crossroads where climates, soils, plants, birds, and mammals from two biomes—the boreal and the Arctic—meet. Permafrost is prevalent. The open, stunted forests are dominated by a few highly adaptable tree species, such as black spruce and tamarack. These forests are characterized by innumerable surface waters, wetlands, and lichen rock outcrops.

The **boreal plains** ecozone occupies an area of 73.8 million ha (49.8 million ha of forest) and has a population of 710,000 people. The Peace River area is predominantly agricultural with ongoing forest clearing. White and black spruce, balsam fir, lodgepole, and jack pine and trembling aspen are the dominant tree species. Much of the forest area is dissected by seismic lines associated with oil and gas exploration.

The **boreal shield** is the largest ecozone in Canada, covering 194.6 million ha (151.1 million ha of forest) and stretching from Newfoundland to northeastern Alberta. The largely urban population numbers 3 million people. Balsam fir predominates in the east; elsewhere, black spruce, white spruce, jack pine, and balsam fir are common. The forests are typically mixed with wetlands, lakes, and major rivers that contribute to the landscape diversity of the ecozone. Major natural ecological influences are fire, insects, and diseases.

The **mixedwood plains** ecozone covers the lower Great Lakes–St. Lawrence River Valley, occupying 24.4 million ha (3.7 million ha of forest). This industrial and urban heartland of Canada has a population over 14 million people and the smallest forest land area of all the forested ecozones. Before the arrival of Europeans, this ecozone was forested and supported a greater diversity of trees and plants than any other part of Canada. Today, only small pockets of the Carolinian forest, the basswood–sugar maple forest, and the hickory–sugar maple forest remain. Most of these forests have been cleared for farms, orchards, highways, and cities.

The **Atlantic maritime** ecozone covers an area of 20.4 million ha (16 million ha of forest). The largely rural population exceeds 2.6 million people. Centuries of forestry and agriculture have left few pockets of old-growth forest. The typical Acadian forest is characterized by a mix of softwood and hardwood species, including red spruce, sugar maple, beech, yellow birch, balsam fir, and white pine. Fire suppression has reduced the role of fire in ecosystem development. Insects and diseases, particularly the spruce budworm,

remain a major ecological influence. Introduced insects and diseases pose an increasing threat to native plant species.

Most of the country's forests are publicly owned, with 71% controlled by the provinces. Twenty-three percent are federally owned; some are managed by, or in cooperation with, the territorial governments; and the balance is in private hands. Export products from Canada's forest sector contribute over $31 billion to the country's net balance of trade—almost as much as energy, fishing, mining, and agriculture combined. These forests also support industries providing billions of dollars in sales, including tourism, recreation, wild foods, fur trade, Christmas trees, and maple products (CCFM 1998).

Protected Forests versus Commercial Forests

Of the forest land base, 23 million ha are recognized as heritage forests and, as such, are by law to be left in their natural state. Another 28 million ha are considered protection forest, where timber harvesting is excluded or modified by policy. In total, of the 418 million ha, some 235 million ha are considered capable of producing timber. Currently, 119 million ha are managed primarily for timber production.

Terms such as "heritage forest," "protection forest," "national parks," "provincial parks," "wildlife sanctuaries," etc., all conjure up some notion of protection. The problem is that all these notions tend to confuse the definition of protected area rather than clarify it. For example, most of the Canadian national parks can be equated, with confidence, to IUCN Category II (IUCN 1994). Provincial parks cannot; some allow resource extraction and some are not intended to be there for purposes of ecosystem representation. What of protection forest? In commercial forests, not all of the areas can be freely harvested as they may have importance as wintering grounds for certain wildlife or as erosion control zones. These sensitive ecosystems are as important to identify and protect as is the sustainability of the timber surrounding these areas. However, having a policy rather than regulatory basis, these "protected areas" are not considered as protected by many. Indeed, in at least one province, such areas are simply given longer rotation lengths or harvesting must be conducted as partial cuts rather than the usual clearcuts.

The problem is amplified when comparisons of protected areas are made among countries. IUCN Categories V and VI are particularly open to interpretation among countries, to such a degree that one may not be able to readily compare these areas. Canada has a strong environmental and protected area lobby. As such, in most cases, when provinces report areas under protection, they tend to equate protected lands to those that

meet the requirements of IUCN categories I and II—those that are legislated to prohibit resource extraction.

Reporting and Indicator Initiatives

Canada has emphasized the need for criteria and indicators of sustainable forest management over the past several years. Two similar processes have resulted in comparable sets of criteria and indicators: the international Montreal Process and the domestic Canadian Council of Forest Ministers (CCFM) process. The CCFM set has been adopted nationally for reporting on an array of ecological, economic, and social indicators of forest sustainability (CCFM 1997). One of the ecological indicators tracks the representativeness of forest types in protected areas. Others are intended to track various aspects of ecosystem, species, and genetic diversity trends in forest landscapes, including commercial and protected forest. In the United States, researchers have indicated similar needs for scientifically sound and defensible indicators and assessments (Gillespie 1996).

Canada recognizes the need to integrate protected areas with the working forest, meaning that the biodiversity values that government agencies and other organizations seek to protect cannot be maintained without consideration of surrounding landscapes. Likewise, the protected areas should contribute environmentally and economically, if possible, to the surrounding area. There is also recognition that static preservation of protected areas is impossible. Ecosystems, by nature, are dynamic and constantly changing due to a myriad of ecological factors. The term "islandization" is being used to describe existing protected areas that have become isolated from their surroundings, to a degree that their own viability is questioned. For example, in several regions, logging has occurred up to the boundaries of national parks. These parks have become refugia of landscapes that were once much larger, and may be too small and isolated to maintain ecological functions and processes essential to sustain desirable ecosystems. Several initiatives, both provincial and federal, are under way looking at options and opportunities to enhance this integration. One such initiative is embodied by Canada's Model Forest Program.

Model forests were initiated in Canada in 1991, as part of the federal "Green Plan" program. The intention was to establish examples of sustainable forest management in a "working-sized" forest with multiple stakeholders. The examples were intended to represent each forest region in the country, as defined by Rowe (1959). Model forests are administered differently in different parts of the country depending on their membership and the important issues in the area. All were expected

to address biodiversity and other environmental issues. Most model forests contain protected areas within their boundaries, commonly provincial parks or ecological reserves, and, in one case, a national park. This provided an opportunity for development of management approaches that would treat protected areas as part of an integrated landscape. The work conducted by the Greater Fundy Ecosystem Research Group, for example, culminated in a set of management guidelines to protect native biodiversity in the Fundy Model Forest, in the context of maintaining and enhancing the protective role of Fundy National Park (Woodley and Forbes 1997).

In addition to the protected areas contained within the boundaries of the model forests at the beginning of the program, researchers conducted gap analyses in several of the model forests to identify and fill gaps in representation of ecological diversity. The purpose was two-fold: to develop and promote methods to be applied in the rest of the forest region, and to take advantage of model forest objectives to achieve increased protection of elements within the model forests. Gap analyses were conducted at different scales, and resulted in a number of initiatives to protect or develop stewardship approaches to maintain ecologically significant features.

The Model Forest Program focuses most attention on the rest of the forest; in maintaining the natural mix of community types across the landscape, and developing and demonstrating management practices that aim to sustain all native biodiversity. Protected areas are generally recognized as an important component of a larger strategy in the model forests, aimed at maintaining sustainable forest ecosystems into the future.

The Canadian Model Forest Program has spawned interest from other countries. Today, as part of the international model forest network, these working forests have been established in Mexico (two such forests exist and a third one is being considered) and Russia. The United States has integrated three adaptive management areas along the Pacific coast as part of the international network. Discussions are under way to include Malaysia as part of the network (Natural Resources Canada 1996).

Forest Ecosystem Classification

Another Canadian initiative addresses the need for a unified system for ecosystem classification across the country. The existing national ecological land classification (ESWG 1996) is most useful at relatively coarse scales, but the scale of information required for reporting and planning purposes is often finer. For example, in the absence of a national forest type nomenclature, it is difficult to answer basic questions such as that posed by the CCFM indicator on "Area, percentage and represen-

tativeness of forest types in protected areas." In contrast to the USA, Canada does not have a national forest type classification system. The Canadian Forest Service is developing such a classification system in collaboration with the provinces and territories. Its approach is to build on work that has been done by provinces using vegetation and site attributes to develop a hierarchical system. Wherever possible, structural or taxonomic conventions from existing provincial or territorial ecosystem classification systems will be used. This work has been given high priority nationally, in part to facilitate reporting on national criteria and indicators of sustainable forest management. Several CCFM indicators, in addition to the one cited above, require reporting at the level of forest type. In the absence of a recognized classification system for forest ecosystems, such reporting is difficult and imprecise, at best.

British Columbia Protected Areas Strategy

In Canada, responsibility for land management lies at the provincial government level, so responses to calls for expanding systems of protected areas have been inconsistent across Canada. British Columbia is an example of a province that made a substantial commitment and has been steadily working toward that goal. There, protected areas are seen as an important means of preventing loss of biodiversity. A protected areas strategy was released in 1993, with a stated goal to protect 12% of the province by the year 2000 (Morrison and Turner 1994). Between 1992 and 1996, the provincial protected area percentage grew from 6% to just over 9%, and it continues to increase.

The strategy encompasses steps all the way from identifying study areas through the eventual management of areas that are designated. A comprehensive set of criteria was developed to identify and evaluate the study areas, including: representativeness, naturalness, viability, diversity, and vulnerability. From the socio-economic perspective, two additional criteria were added: opportunity for public use and appreciation, and opportunity for scientific research. After areas were recommended, the strategy called for Cabinet approval before going to a land-use planning exercise which involved consultation with all interests at the regional and sub-regional levels, with assurances of that principles of planning and public participation be followed. The decision to designate particular protected areas is taken by Cabinet.

Threatened Major Forest Ecosystems within Canada

Several of the forested ecozones have forests that are under continuing threat from land-use activities. The following table describes the

Table 2. Threatened forest ecosystems by ecozone		
Ecozone	**Forest Ecosystem**	**Concern**
Pacific maritime	Coastal temperate rain forest	Old-growth component from harvesting
	Garry oak–Arbutus forest	Entire ecosystem from urbanization and land conversion
	Coastal Douglas-fir forest	Conversion to urban and agricultural uses
Montane cordillera	Ponderosa pine forest	Fire suppression, non-forest land use activities
Boreal plains	Southern aspen forest	Conversion to agricultural use
Boreal shield	White pine forest	Old-growth component from harvesting
	Red pine forest	
Mixedwood plains	Carolinian forest	Urbanization and conversion to agriculture
	Hickory–sugar maple forest	Urbanization and conversion to agriculture
	Basswood–sugar maple forest	Urbanization and conversion to agriculture
Atlantic maritime	Wet cedar forest	Over-harvest with poor regeneration
	Rich, tolerant hardwood forest	Old-growth component to harvesting and conversion to agriculture

major threatened forest ecosystems by ecozone.

All these forest ecosystems, except for the aspen forests of the southern portion of the boreal plains ecozone, extend into the USA. All have a key role to play as habitat, source of food and shelter for various North American migratory wildlife species. Each represents a unique assemblage of gene pools, critical for the survival of North American forest ecosystems as environmental conditions change.

In response to concerns about the old-growth pine forests in Ontario, a conservation strategy has been developed for red and white pine ecosystems. The goal is "to ensure that red and white pine forest ecosystems, including old growth stands are present on the landscape of Ontario now and into the future, while permitting a sustainable harvest of red and white pine" (Ontario Ministry of Natural Resources 1998). The strategy will include protected areas and sensitive forest management.

One function of protected areas is to protect genetic diversity of natural populations. Genetic diversity is that portion of biodiversity that is probably the least easily measured and most often ignored. Global change renders genetic diversity especially important today. Maintaining genetic diversity means maintaining the potential for evolutionary change, thus ensuring the potential of a species to adapt to environmental change. Genetic diversity of most forest species may be adequately maintained under commercial forest management conditions. However, opportunities for genetic processes to occur under conditions that are as natural as possible, are important to avoid modifying species by imposing inadvertent selection pressures.

Any forest-harvesting regime has potential effects on species occupying the site. For example, it is clear to all forest managers that the forest can be changed in commercially detrimental ways by harvesting only the best trees of a particular species over a wide area and a long time. But removing only the (commercially) worst can result in changes as well, that are good in the short term from a commercial perspective, but may not be so beneficial in the long run. To maximize the probability of our forest species surviving ecosystem change, large diverse populations must be maintained.

Butternut provides an example of the importance of maintaining large diverse populations. A devastating new disease has swept the range of the species and left many trees dead in its wake (Ostry et al. 1994). The disease is efficient, rapidly spreading through entire stands and killing the trees. If genes are not available in existing populations, which are already adapted to survive the disease, the species is doomed. There is no particular reason for such pre-adapted variants to exist before the

disease struck, but, given large and diverse enough populations, experience has demonstrated that there is a reasonable possibility of the existence of such resistant variants. The butternut is just one example of a species experiencing catastrophic impacts of introduced pathogens.

The best safeguard against losses due to ecological change, regardless of the cause, is maintenance of large populations of native species that are free to evolve under conditions that are as natural as possible. This is an important function of representative protected areas.

Conclusion

Protection of forest biodiversity is especially challenging in Canada, where the federal government makes international commitments but the provincial or territorial governments are responsible for land management. There remains a very high degree of interest in protecting and reporting on forests at the international level. Canada has been called upon by the G8 Action Programme on Forests (May 1998) to identify key forest types that are insufficiently represented within the existing network of protected areas. Canada also faces significant challenges in defining forest types, identifying those that are insufficiently represented in protected areas, and then filling the gaps. At present, government agencies lack the tools to accomplish these things. Continuing initiatives to co-ordinate efforts among the levels of government, First Nations groups, non-governmental organizations, and industry are crucial to meeting the challenges.

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A Private Affair: Nature Reserves in the Hashemite Kingdom of Jordan

...and God has made the earth a wide expanse,
that you may traverse its open ways.
— *Qur'an: Surat Nuh (71), ayahs 19-20*

There is not an animal on earth, nor any being that wings its flight,
but is a people like unto you.
— *Qur'an: Surat al-An'am (6), ayahs 38*

The Qur'an asserts an exceptionally demanding environmental ethic, one the West has only begun to explore (Bagader et al. 1994; Forward and Alam 1994; al-Faruqi 1995, 53-56; Khalid and O'Brien 1992). Humankind is given the earth but is warned that all creatures are a "people like unto you" with the function to bear witness to God's majesty. Reality in much of the Middle East and North Africa, however, seems to mock Islam's environmental scruples. Forests, woodlands, and wetlands are gone along with their wildlife, while places that once supported pastures and fields are now entirely de-vegetated. There is silence where hunters once stalked their prey. Explanations for environmental degradation are many, but of greater concern is the seeming indifference of many Islamic countries to possibly calamitous environmental degradation. Nature, and its conservation, has been neglected in the face of nation-building, economic development, and regional geopolitical realities.

There are, however, encouraging signs of change in the Arab World's approach to nature conservation. In Jordan, this change is both obvious and dramatic. This paper reviews the origin, objectives and status of Jordan's nature reserves. Jordan has a rich and diverse natural and cultural environment which offers exceptional opportunities for conservation through the establishment of nature reserves. The origin of Jordan's reserves are typically British-colonial, but the reserves and their administration have uniquely evolved to give major responsibility for conservation to a private organization. A policy context and administrative structure offering a secure management environment in which representative reserves can prosper along with allied conservation activities is

developing. As a result, Jordan is able to marshal an unusual mix of natural and institutional resources for accomplishing its goals, and is consequently becoming a regional leader in nature conservation.

Our discussion is based on eight weeks of field work in the summer of 1996 facilitated by the American Center for Oriental Research in Amman. During this time, we investigated the historical geography of Jordan's nature reserves as well as contemporary conservation and tourism policy. We systematically reviewed Jordanian planning documents, conducted structured interviews with both governmental and non-governmental personnel, and made site visits to the majority of Jordan's nature reserves. In the summers of 1997 and 1998, the senior author followed up on the data obtained in 1996 while he was engaged in archaeological excavations in Jordan.

The Country

Though having a long history of human occupation, modern Jordan was declared in 1946 upon termination of the British mandate established after World War I. King Hussein assumed the throne in 1952 and remained in power until his death in early 1999. His wife, Queen Noor, is a Princeton-educated architect. A large part of Jordan's progress in conservation is directly attributable to the active interest and strong support of the royal family, particularly King Hussein and Queen Noor.

Comparable in size to Indiana, the biological importance of the 89,411-sq-km country rests in its topography and climate (al-Eisawi 1985; Feinbrun and Zohary 1955; Atkinson and Beaumont 1981; Hadidi 1985). From the eastern portion of the Dead Sea Rift Valley at 100 to 300 m below sea level, there is a steep and dramatic ascent to between 1,250 and 1,650 m and then a plateau descending gradually toward Iraq and Saudi Arabia. The climate of the most densely settled portions of Jordan, the western fringe of the plateau, is typically Mediterranean but of the driest type, with precipitation concentrated in cool winter months while the summers are hot and dry. Much of the Jordan Valley is subtropical, but 86% of Jordan is steppe and desert while only 14% is capable of supporting Mediterranean shrub and woodland, the majority of which is devoted to agriculture and settlement. Significantly, Jordan's topographic and climatic variety rests solidly in a transitional zone between three of the world's major biomes—Mediterranean, Irano-Turanian, and Saharo-Indian (Feinbrun and Zohary 1955, 5). The result of this location is a close proximity of species generally thought of as separated by continents. Cheetah and wolf, fox and hyena have hunted deer and gazelle in the same field, while birds from Europe, Asia, and Africa have soared above.

Several characteristics of Jordan's history and sociopolitical condition profoundly affect its ability to create and care for nature reserves. First, significant archaeological sites are practically ubiquitous and coincide predictably with biologically important sites. An oasis or wadi (i.e., watercourse) important to fauna and flora was undoubtedly important to Paleolithic and Neolithic man, to Ammonites, to Greeks and Romans, and Umayyad Arabs. Biological conservation is inseparable from the management of antiquities, and both are vital to Jordan's embryonic tourist industry. Second, Jordan has had to steer a difficult, and sometimes unsuccessful, course among powerful and frequently hostile neighbors. Geopolitical realities, most notably the 1967 Arab-Israeli War and the 1991 Persian Gulf War, have often distracted Jordan's attention away from important domestic issues, including conservation, while flooding it with refugees that give it a de facto population growth far in excess of its natural growth (Jordan Department of the Environment 1991, 149).

Foundation of Nature Reserves

Hatough et al. (1986) and Hatough-Bouran and Disi (1991) have reviewed the historical presence of megafauna in Jordan as well as its demise, but only a few studies have detailed the demise of individual species (e.g. the ostrich, Jennings 1986). The causes for environmental degradation are obvious, if complex and incompletely understood. Overgrazing, which has literally de-vegetated large areas, is clearly the main culprit. Concentrations of stock supported now by watering and feeding programs have long exceeded carrying capacity, resulting in the virtual denudation of the eastern and southern steppe and desert to the extent that Jordan can no longer provide livestock for local markets cheaper than carcasses can be imported from Romania, Turkey, and Australia (Burnett et al., in press).

By the 1960s, the decline of natural conditions in Jordan had provoked environmental anxiety—a realization of the possibility of environmental catastrophe (Grove 1987). In reaction, the Royal Jordanian Hunting and Shooting Club, formed in the 1930s as an elite hunting and environmental club with restricted membership, reorganized itself as the Royal Society for the Conservation of Nature (RSCN) and began a career that would make it the leading advocate for, and administrator of, Jordan's nature reserves. Among its patrons was King Hussein. In 1963, the King invited an Englishman, Guy Mountfort, to conduct a survey of Jordan's biological resources (Mountfort 1965, 1974). The selection of Mountfort was fortuitous. A distinguished soldier with World War II service in North Africa, Italy, Burma, the Pacific, and Germany, he was also a successful and wealthy businessman as well as an avid amateur ornithologist. During his later life, he led eight expeditions to other

countries that would result in the founding of protected areas, and he was a founding member of the World Wildlife Fund. Mountfort's Jordan expedition, which included such distinguished personages as Julian Huxley, resulted in a proposal to create five national parks. Had these materialized, a large system embracing about 8.5% of Jordan would have resulted (Clarke 1979a, 7).

Clearly the highest priority among Mountfort's suggestions was Azraq, a 12,000-sq-km internal drainage basin centered on the Azraq Oasis and wetland. Here Mountfort envisioned a national park in excess of 4,000 sq km consisting of oasis, wetland, playa, and limestone and basalt desert, devoted to tourism, conservation, research, education, and demonstration and extension work among the Bedouin. Clearly its greatest importance, however, is as a watering point on the flyways linking Asia and Europe to Africa (Wallace 1982; 1983). On July 26, 1965, King Hussein proclaimed his intent to declare the Azraq National Park, and work began on creation of an Azraq Biological Station to be headed by a Scotsman, Bryan Nelson (Boyd 1966; Nelson 1985a).

Then Jordan was plunged into the brutal 1967 Arab-Israeli War, diverting it from domestic issues, including conservation, well into the next decade. Iraqi intervention in eastern Jordan stopped the creation of Azraq National Park, closed the Azraq Biological Station, and sent Bryan Nelson packing back to Scotland (Nelson 1996) and a distinguished career as a seabird ornithologist at University of Aberdeen. However, the station survived long enough for Nelson to complete research for a beautiful and authoritative book (1974) on the Azraq Oasis.

Post-war Conservation

In its initial conservation efforts, Jordan demonstrated a pattern like that encountered in other areas of British colonial influence (Grove 1987; MacKenzie 1987). Environmental anxiety based on the disappearance of game species developed, followed by a realization that action could and should be taken to relieve this anxiety. Local leadership turned to the imperial authority for scientific and administrative expertise, advice, and direction. In this case, the roles of the RSCN and King Hussein, and the imperial representatives, Mountfort and Nelson, are archetypal examples of the colonial approaches to conservation.

As the chaos of 1967 subsided, this pre-war pattern repeated itself, only in broader outline. With the continued patronage of King Hussein, the RSCN emerged as Jordan's leading advocate for conservation. Too, while Jordan still depended on leadership and technical assistance from the United Kingdom, imperial influence became indirect and legitimized by being channeled through an international organization, the International Union for the Conservation of Nature (IUCN). Under its sponsorship, the English-

man John Clarke inventoried Jordan for potential biological reserves. He brought to the task exceptional experience in Africa and the Middle East which he eventually (1981) turned into a doctorate in forestry at the University of Georgia. His report on Jordan (1979a) identified both potential areas for protection as well as a general outline of priorities for action, and it constitutes official policy of both the RSCN and the government of Jordan to this day (Table 1, Figure 1).

Clarke (1979a) prioritized this list in descending importance: Azraq Wetland, Shaumari, Zubia, Mujib, Burqu, Rajil, Dana, Jabel Masadi, Rum, Abu Rukbah, Bayir, Jarba. The priorities were determined by

Table 1. Proposed nature reserves of Jordan.

Map Location	Name	Status	Area (sq km)	Land Type
1	Burqu	1, 4	950	eastern desert
2	Zubiya	2	12	Mediterranean Forest
3	Wadi Rajil	1	860	eastern desert
4	Azraq Wetlands	2, 5	12	oasis
5	Shaumari	2	342	eastern desert
6	Wadi Mujib	2	212	escarpment
7	Abu Rukbah	1	410	steppe
8	Wadi Bayir	1	440	eastern desert
9	Wadi Dana	2	150	escarpment
10	Jarba	1	40	steppe
11	Jebel Masadi	2	460	escarpment
12	Wadi Rum	3	560	southern desert

Conservation status: 1 = No action; 2 = Administered by the RSCN; 3 = Administered by several state and local agencies including the RSCN; 4 = Proposed biosphere reserve; 5 = Ramsar wetland

Sources: Clarke 1979a; Hatough-Bouran and Disi 1991; Jordan Department of Environment 1991.

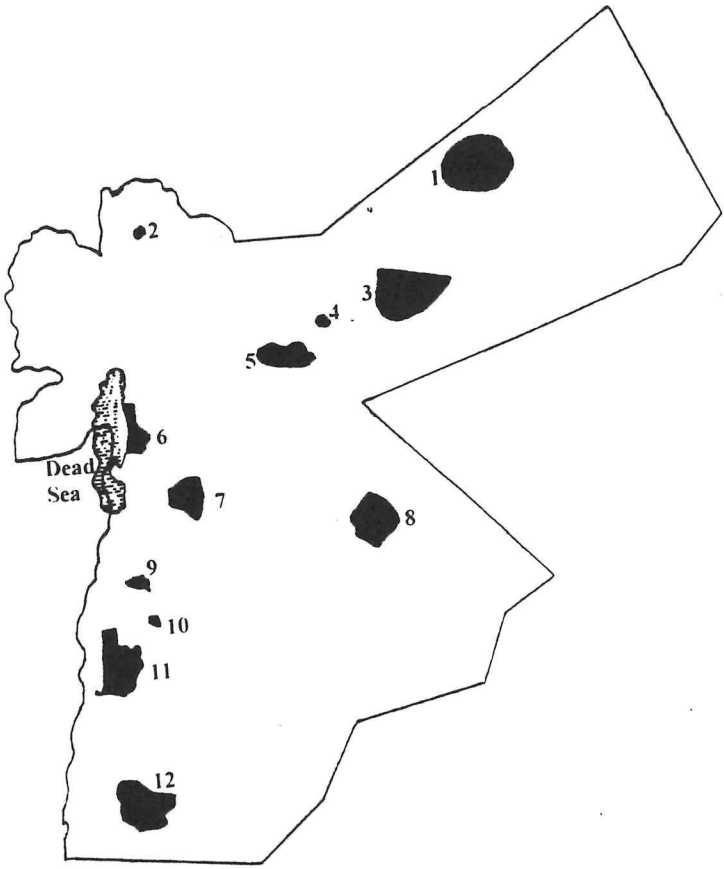

Figure 1. Location map of the proposed protected areas of Jordan. Map numbers are keyed to Table 1.

perceived risk to each area and by the perception of what would be the maximum conservation accomplishments achievable at a minimum of effort and costs. The RSCN has stayed close to the priorities but not slavishly. The Azraq Wetland has remained a high priority, while Shaumari, Zubia, and Mujib are under RSCN management. Burqu and Rajil are both so far removed geographically from the threat of either development or tourist interests that they have not merited action. Burqu is, however, a proposed Biosphere Reserve and Rajil is a likely site for

wild release of part of the Arabian oryx herd now at Shaumari. Dana and Rum took on priority by virtue of opportunity, proximity to the tourist market, and social issues well beyond ecological consideration. Several of the areas are no longer realistic candidates for conservation. For example, significant oil shale deposits underlie Abu Rukbah, test drilling has been done, and production early in the next century is a virtual certainty (Shawabkeh 1991). Consequently, investment in the area for the purposes of conservation is pointless.

Clarke's list, reflecting the British enthusiasm for the hunt as well as the RSCN's history as a hunting club, gives preference to areas that provide habitat for game species, and Jordan has accomplished much in this arena. It has established a large herd of Arabian oryx at Shaumari (Figure 2) (Clarke 1977; 1979b; Nelson 1985b). Extinct in the wild, the 200-member herd is breeding successfully and animals have been given to Syria. The RSCN has plans to release oryx in the wild, probably in Wadi Rajil, an area almost inaccessible by motor vehicle and where straying animals would most likely drift into Saudi Arabia which has effective game protection programs. At Shaumari, experiments with breeding and re-introduction of ostrich are underway, while a large herd of Nubian ibex (Figure 3) has been established at Wadi Mujib and release experiments are underway. Clarke's list, however, needs to be reconsidered with the objective of protecting Jordan's biological diver-

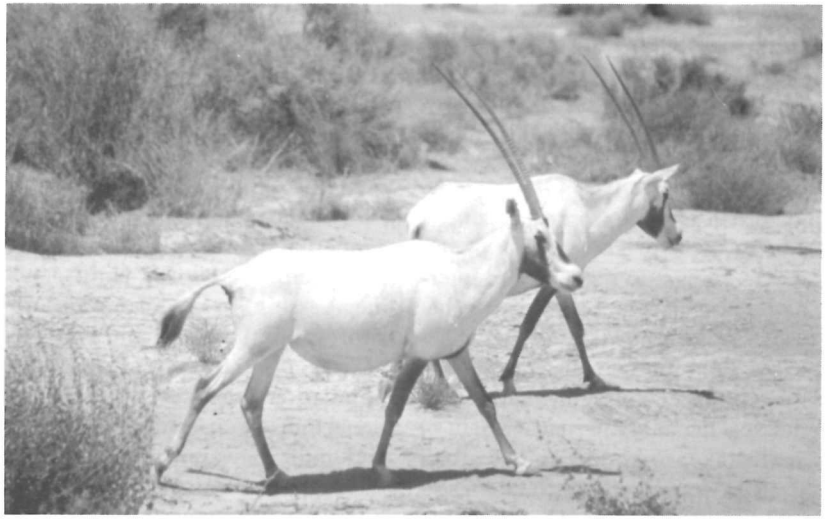

Figure 2. Arabian oryx at Shaumari Reserve. *Photo: G. W. Burnett*

Figure 3. Nubian ibex at Mujib Reserve. *Photo: G. W. Burnett*

sity, most notably its vegetation and smaller creatures. Realizing this, the RSCN has initiated, predictably under the auspices of the IUCN, a process of re-inventorying Jordan for potential reserves.

Organizational Changes

Jordan's journey toward creating a system of nature reserves is of immense interest to regional and international conservationists partly because of its success and partly because of its unique structure. With the IUCN encouraging nations to develop flexibility in management of protected areas, Jordan's distinctively privatized approach to conservation certainly demands attention. Jordan's Ministry of Agriculture is responsible for, among other things, protecting, conserving and managing wildlife. In 1966 the Ministry recognized RSCN as being primarily responsible for Jordan's wildlife protection, and in 1975 vested it with the authority to enforce hunting regulations. As a private organization, the RSCN is governed by an elected board of directors and is supported by committees advisory to its specific activities. Until 1993, membership was available only by approval of the board and consisted of less than 0.05% of the adult population. Structured into operational units—conservation, education and public awareness, wildlife reserves, research and scientific affairs, hunting control, and heritage—the staff reported directly to the board's general director.

International recognition of the RSCN as critical in Jordan's conservation efforts has required review and reform of the RSCN's structure and administration, again under supervision of the IUCN. The resulting strategic plan (RSCN 1996) adopted this mission statement: "[T]o conserve and enhance wildlife and wildlife habitat whilst actively promoting an understanding of the natural environment, its protection and interdependence with people." To accomplish the mission, its organization was streamlined and decentralized. The RSCN was reorganized in six sections—research and surveys, reserves, wildlife enforcement, administration, awareness, and fund raising—under the direction of a full-time executive director accountable to the board of directors. The plan also set ambitious goals for membership expansion and public education.

Because of the strategic planning, two reserves have absorbed most of RSCN's time in recent years. The first is Dana Reserve. Extending from the Wadi Araba up to the crest of the escarpment, the rugged terrain shelters ibex, mountain gazelle, red foxes, badgers, rock hyrax, hare, and porcupine. At Dana, the RSCN has initiated research projects, improved its trails and provided a campground. But the crux of RSCN activity at Dana Reserve has been restoration of Dana village (Figure 4). Because of its springs, the village has certainly been occupied for thousands of years, but the current village was built and occupied during the Ottoman Period. Floundering in snow at the broken crest of the escarpment, T. E. Lawrence describes "looking down across the chessboard houses of Dana village, into sunny Arabah, fresh and green thousands of feet below" (1991, 498). Unfortunately, this most charming hill village with its spectacular panorama had become derelict, a situation the RSCN set out to correct. The mosque was rebuilt, a guest house built, the irrigation works restored, village women taught new handcrafts from jewelry to soap-making, and their products marketed in Amman as well as Dana. The rejuvenated Dana village is a lesson in the natural environment's interdependence with people.

The second reserve that the RSCN has focused on is the Azraq Wetlands (Figure 5). At the end of the 1967 Arab-Israeli war, the Azraq Oasis opened to settlement and hundreds of wells were dug to irrigate crops as varied as olives and prickly-pear cactus. The water table fell from near the surface to 12 meters below and springs at the oasis dried up. At the Azraq wetlands, ʿAin Soda, the spring and pool that feeds the Dashsha Marsh, the 12-sq-km wetland, had reversed itself and become a drain. When water from geological sources was pumped into the pool, the pool developed leaks and would not hold water, even with the spring sealed. The Azraq wetlands, it was assumed, were no more.

Figure 4. Dana Village. *Photo: G. W. Burnett*

A reasonable, if not entirely satisfactory, design is being attempted to save the wetland. The ʿAin Soda spring and pool is admittedly sacrificed. Geological water is being pumped directly into the wetlands, a series of channels that weave their way toward the center of the playa. Along its way, new pools to provide for bird habitat are being con-

Figure 5. Archaeological excavation, Dashsha Marsh pool, Azraq Wetlands. ***Photo: G. W. Burnett***

structed. To rid the wetland of the plague of rank grass which now chokes it, and to restore something of its naturally grazed variety, a small herd of feral water buffalo imported from Syria is being introduced. The plan, well along its way to implementation, is subject to criticism in that an artificial wetland will replace a natural wetland. The alternative, however, is no wetland at all, and its disappearance would mean the destruction of hundreds of thousands of migrating birds that depend on it. In implementing this project, the RSCN is transferring lessons learned at Dana by carefully integrating local economic and educational interests

into the project. The intended lesson, as at Dana, is that people are the ultimate beneficiaries of conservation.

Conclusions

Over the past 30 years, Jordan has engaged in attempts to conserve its biological resources through the establishment of nature reserves. In so doing, it has evolved an unusual approach by empowering and relying on a private conservation organization to do many of those things government generally does in other countries. Though unorthodox, the approach seems to be working and has much to commend it. Possibly the most surprising effect of Jordan's arrangement is the RSCN's almost obsessive desire to link its projects and activities to advancing the local social, economic, and educational welfare. While many government conservation agencies profess concern for their neighbors, many of these confessions seem to lack sincerity. It is discouragingly difficult, though not impossible, to find examples of government-sponsored conservation actually benefiting local populations in substantial ways. The RSCN and its employees are not protected by automatic appropriations and civil service status. Accomplishing its mission, conservation, and indeed its survival as an institution, is directly dependent on its ability to relate conservation to human welfare. The result is a lean organization with a "fire in its belly," intent on conservation and bettering its neighbor's lives.

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Why Don't Parks and Sanctuaries Protect Marine Fish Too?

Introduction

Many people believe that marine wilderness—i.e., areas of the sea where human influences are minimized and no extractive uses are allowed—protects biodiversity, restores and sustains fisheries, provides insurance for management errors, and produces tourism industries. In spite of the apparent benefits, and in stark contrast to the proliferation of wilderness designations in the terrestrial environment, very little marine wilderness has been designated worldwide. Marine protected areas (MPAs) abound, but we afford few portions of the sea enough protection from fisheries harvest and other extractive activities to function as wilderness. Why?

The title of this essay may seem facetious or cynical. It is not. Serious, thoughtful people still ask, "Why should parks and sanctuaries protect marine fish?" Many believe the sea is inexhaustible and deny that human activities, particularly fishing, damage ocean resources. These people believe that wilderness designations in the sea unnecessarily restrict economic development and reduce profitability of fisheries.

Conflicts between competing beliefs such as these cannot be resolved without additional knowledge and understanding. Science can provide the required knowledge and facilitate understanding. Here, I will explore the role of science in marine protected area designation and management, identify the theoretical values of marine wilderness, describe scientific documentation of these potential values, and discuss why we need new approaches to marine conservation.

Science, as a way of knowing, began challenging people's beliefs about their environment and natural resources as early as the 16th century, when Galileo, to his detriment at the hands of church inquisitors, championed Copernicus' heliocentric description of the universe in defiance of prevailing Ptolemaic beliefs. Beliefs still dominate resource allocation and management issues, but we have made some progress in the intervening 400 years, most of it in the last century. When Yellowstone National Park was designated in 1872, people came to the park to see forests and herds of elk and deer, and to catch trout. Virtually everyone believed fires threatened the forests, wolves and coyotes threatened the elk and deer, and white pelicans threat-

ened cutthroat trout populations in Yellowstone Lake. Appropriate management of these situations therefore required fire suppression and predator control, i.e. killing wolves, coyotes, and pelicans. Today those beliefs seem remarkably naïve because, during the past 75 years, science has elucidated the essential role of fire in forest ecosystems and the vital importance of predator–prey relationships in maintaining healthy fish and wildlife populations. If science similarly shows essential functions of unimpaired, untrammeled, marine ecosystems, perhaps those holding beliefs of the sea's inexhaustibility and denying human culpability for collapsed fished populations can embrace new knowledge and modify their beliefs to everyone's benefit. Simply challenging one set of untestable beliefs with another is futile. Only new information, knowledge, can break the deadlock. Science as a process for learning can do that. Science as a source of light in the darkness of ignorance can help us change the way we allocate, restore, maintain, and protect marine resources to assure that future generations will still have options to exercise.

Conservation of Marine Resources

People have little empathy for fishes, invertebrates, and algae, even in national parks. More than 30 units of the United States National Park System and the 12 national marine sanctuaries contain some of the nation's finest marine resources, 85 park units support salmonid fisheries, and many more harbor warm-water aquatic ecosystems of national and international significance. All of these places, widely recognized as the nation's heritage and most protected, allow and even encourage killing and removal of marine and aquatic plants and animals from within their 'protected' boundaries. The difference in treatment of aquatic and marine resources from terrestrial resources in these special places is not an accident. I found that simply informing people of the disparity didn't change their beliefs. Early in my career I naïvely thought, "If the public knew what I did about the policies and practices and what they did to native populations and ecosystems, they'd agree with me that we need to change how parks are managed." That is not true.

In the 1970s, with many colleagues, I explored ways to enhance the integrity of park ecosystems by showing the contributions no-take areas in parks could make to adjacent fisheries. We labored in the coral reefs, seagrass meadows, and mangrove-lined estuaries of Everglades, Biscayne, Virgin Islands, and Dry Tortugas National Parks. We sought to discover how spiny lobsters, stone crabs, snappers, seatrout, drum, and shrimp fisheries depended on these parks, and to determine the fishery benefits of creating no-take areas in the parks (Jones et al. 1978; Costello and Davis 1979; Davis 1977, 1979, 1981, 1982a, 1982b; Davis and Dodrill 1980, 1989).

In the 1980s I returned to my home in California to discover that some coastal fisheries could not be sustained without no-take areas to act as refugia, de facto or designated (Davis 1989). The many long-lived, slow-growing, late-maturing residents of kelp forests and deep rocky reefs were particularly susceptible. Now in the 1990s, we must not only discover new models to sustain fishery harvests, we must first stop exhausting populations and find ways to rebuild depleted populations (Davis in press). Research into refugia design needed to discover optimum sizes, shapes, and distributions to protect ecosystem integrity and to sustain fisheries takes on a real sense of urgency as some fished populations slouch toward extinction (Davis et al. 1998).

Why Create Marine Wilderness?

I can think of at least three reasons to set aside, or restore to natural conditions, areas of the sea. First, it's simply the right thing to do—to save some unimpaired marine areas as wilderness for future generations. As Aldo Leopold told us in *Round River* (1953), the first rule of intelligent tinkering is to save all the pieces. We are beginning to lose pieces, both habitats and species, of coastal marine ecosystems and have no way to recover them, once lost. Second, we need to protect biodiversity and ecosystem structure to serve as control areas for the numerous environmental management experiments we conduct, such as fishing. Finally, adequately protected marine wilderness can serve as refugia to rebuild and sustain fished populations by assuring survival of adequate spawning stock and enough habitat to perpetuate harvests.

If marine wilderness is such a good idea and essential for human well-being, why aren't the coasts littered with it? Tradition, denial, and apathy are powerful impediments to creating marine wilderness. Traditionally, everyone has had unrestricted access to the sea. This open access, combined with a frontier approach to management, led to serial depletions that sustained fisheries, but not fished populations. Denial that fishing alters populations and ecosystem structure or threatens future productivity produced a general euphoria and impression that everything's fine. Public apathy, confusion, and ignorance regarding the status of fished populations and other publicly owned resources allowed fishing industries to profitably deplete the ecological equivalent of capital assets needed to generate annual yields. Now the public must invest in rebuilding depleted populations before they can again produce any yield.

Serial depletion is a natural strategy for hunter-gatherers with unlimited resources. Human societies have practiced this strategy successfully for millennia. It is a short-term solution for sustaining economic development of virgin resources, and it is a common resource management practice worldwide. Unfortunately, because

humans have now saturated the Earth for the first time, we need a new strategy. Without new territories or new resources, the serial depletion strategy is fatally flawed.

The California diving fleet provides a good example of the serial depletion problem. Commercial abalone landings increased and appeared stable for 30 years after World War II, and then declined dramatically in the 1970s. A common industry explanation for the 1970s landings decline is sea otter predation and a shift of harvest effort to more profitable red sea urchins. An examination of the evidence reveals a different story for southern California, where otters have played no significant role in the twentieth century. Here we see a sequence of five abalone species supplying the apparently stable landings. First the harvest consisted primarily of pink abalone, the most common southern California species. When pink abalone landings began to decline, the difference was made up by red abalone, a large, valuable, species more common to the north. When both pink and red abalone landings began to decline, harvest efforts shifted to shallower regions for green abalone, and for a short time to deep reefs for white abalone. By the early 1970s, even adding new species and habitats was not sufficient to sustain abalone landings, so the fleet shifted some effort to red sea urchins and began harvesting intertidal black abalone, previously considered undesirable in the market. In the 1980s, red sea urchins replaced abalone as California's most valuable coastal fishery. But southern California reefs could not sustain the annual 20,000 mt harvest required to replace the value of 2,000 mt of abalone, and the fishing effort expanded into new territory in northern California to sustain the fleet's income. The income to the diving fleet remained roughly the same through this transition from abalone to urchin, which obscured the severely depleted condition of abalone populations. The ecological cost of serial depletion was high. It left abalone populations collapsed, with white abalone on the brink of extinction, and will require expensive and risky rebuilding to restore abalone populations to productive levels again. The lower market value of red sea urchins required removal of ten times the biomass to secure the same financial income.

This story also reveals the danger of relying entirely on fishery landings data to understand the status and trends in populations. Fishery-independent surveys and ecological monitoring were needed to interpret resource status, and to separate the influences of natural environmental factors, such as El Niño events, and fishing-induced depletion. Only with independent data could fishery managers confirm population status with enough certainty to close fisheries, as they finally did in the mid-1990s.

The consequences of serial depletion and the general lack of fishery-independent resource assessments may be catastrophic. As populations collapse, fisheries remain open and

stocks may never recover. The abalone fishery along the Orange County coast of southern California was closed in 1977, and abalone populations there show no signs of recovery more than 20 years later.

Refugia as Fishery Management Strategies

Searching for resource management strategies that would avoid the consequences of serial depletion and recruitment overfishing led to a review of fisheries-related experiences with marine protected areas. This revealed a burgeoning literature that identified several potential refugia effects on target species and on ecosystem structure and function. Briefly summarized, these hypotheses suggest:

- Abundance in no-take MPAs increases
- Individual size and age in no-take MPAs increases
- Reproductive output from no-take MPAs increases
- Recruitment in and adjacent to no-take MPAs is enhanced
- Genetic diversity of stocks is maintained
- Fishery yields are enhanced in areas adjacent to no-take MPAs
- Species diversity increases in no-take MPAs
- Habitat complexity and quality is enhanced in no-take MPAs
- Community stability increases in no-take MPAs

Several years ago, we found 31 studies that actually tested some of these hypotheses (Dugan and Davis 1993). The best-documented effect was an increase in abundance of target species in no-take MPAs. Fisheries-targeted species were 2 to 25 times more abundant in no-take MPAs than in surrounding areas for fish, crustaceans, and mollusks on coral and temperate reefs in Australia, New Zealand, the Philippines, Japan, Kenya, South Africa, the Mediterranean Sea, Venezuela, Chile, and the United States (California, Florida, Rhode Island). Mean sizes of fished species protected in no-take MPAs were 12-200% larger than those in surrounding areas for all fishes studied and in 75-78% of the invertebrates. Increases in size in MPAs is best documented in large predators, e.g., serranids, lobsters and crabs. Only 4 of the 31 studies measured reproductive output from no-take MPAs. All four studies found increased reproductive output for lobster, conch, and abalone. The well-documented increases in sizes of individuals is strong evidence that reproductive products must also increase, even though few empirical data exist. We found little empirical evidence that no-take MPAs increased juvenile or adult recruitment outside the protected area, only 3 studies attempted to measure recruitment adjacent to the MPA. Only one found evidence of increased recruitment (Shepherd 1990). Recruitment is clearly a key parameter to measure empirically to demonstrate

the efficacy of no-take MPAs and to determine optimum no-take MPA design. This topic needs more research before conclusions can be reached.

We found no studies that attempted to compare genetic diversity in no-take MPAs and equivalent fished areas. Nevertheless, the circumstantial evidence of fishing as a selection pressure favoring small, early-maturing, slow-growing fish and invertebrates is intriguing, e.g., the size of lobster maturity is smaller in the heavily fished Florida Keys than in adjacent unfished Dry Tortugas (Davis 1975). The theoretical mechanisms for no-take MPAs to protect larger, faster growing individuals are clear. Clearly, we need more empirical research on this topic.

The "bottom line" for fishery managers is whether fishery yields increase near no-take MPAs. Empirical evidence of this is scarce, but consistent. Nearly all (86%) of the studies that tested fishery yields found catches within 3 km of the MPAs were 46-50% higher than before no-take MPAs were created. It is clear that fishers all over the world believe no-take MPAs increase yields, because they fish as close to no-take MPA boundaries as they can. Perhaps the best example of an effective fisheries refugium is Sumilon Island in the Philippines (Russ and Alcala 1996). Mean catch was 0.8 kg per day before a small no-take MPA was designated. Catch rate tripled within five years of MPA creation, and remained high for nearly ten years. Harvest in the no-take MPA rapidly reduced catch rate to the original subsistence low level.

Another example demonstrates the odd relationship of belief-based management and knowledge-based management. Research predicted that protection of juvenile lobster in nursery habitats would increase fishery yield on adjacent reefs (Davis 1980). While fishers, both sport and commercial, supported MPA creation, they would not invest in research to measure the increase or test the prediction (hypothesis). Once the fishers accepted the research results (knowledge) they *believed* the MPA would work, therefore testing their belief would have been a waste of time and money. The concepts of adaptive management and the scientific method are not widely known or used outside the scientific community, not even in many natural resource-based industries.

Measuring ecological effects of no-take MPAs is even more complex than detecting population-level effects. Ecological theory predicts that key species—especially top consumers and species providing habitat for others—maintain diversity and community structure, at least in some kinds of ecosystems (Dayton et al. 1995). Evidence of this effect was reported for fishes in New Zealand, Corsica, and the Philippines, and with invertebrates in Chile and Kenya (Dugan and Davis 1993). In California, fisheries removal of urchin predators and competitors has allowed unharvested urchin populations to increase and create urchin-

barrens.

As we explore the limits of MPAs as refugia and search for evidence of their efficacy to restore and sustain fisheries and to protect biodiversity, we do well to remember the late Carl Sagan's admonition that "absence of evidence is not evidence of absence." Many no-take areas are too small to effectively protect wide-ranging species. California waters contain no less than 104 MPAs that collectively include 46% of the state's coastal ocean. Nevertheless, only 11 of them contain no-take areas, which total only 0.1% of the coastal ocean. The mean size of each no-take area is less than 300 ha, four of them are less than 40 ha, and the largest by far is only 845 ha. This is in a coastal ocean of 3.7 million hectares (see Table 1). Many no-take MPAs were estab-ished in marginal habitat for most fished species, the result of a 'not-in-my-back-yard' political selection process. Some no-take areas were established on historical fishing grounds in hopes that depleted populations would spontaneously recover. Most studies of ecology and MPAs are less than three years in duration, not long enough to detect changes in long-lived species or capture infrequent recruitment events. Rarely have designed systems of MPAs been created, let alone tested or evaluated to see if they met design criteria or expectations (Balantine 1995).

Conclusions

Humans dominate coastal ecosystems and threaten their stability and continued productivity (Vitousek et al. 1997). Many coastal fisheries are unsustainable with current management strategies. We are simply taking more from them than can be replaced by natural reproduction. Designated no-take MPAs can protect fished populations from recruitment and ecosystem over-fishing. No-take MPAs may protect genetic diversity and high reproductive capacity of fished populations. Existing no-take MPAs are generally too small to test their conservation efficacy.

Table 1. California's marine protected areas: Are they?

- Total fishing area = 9.2 million acres
- Number of MPAs = 104
- Extent of MPAs = ~ 4.4 million acres (46% of total fishing area)
- No fishing is allowed in parts of 11 MPAs, totaling 10,000 acres (<0.1% of total fishing area)
- The basic discrepancy: less than one-tenth of one percent (0.1%) of California's ocean is truly protected, yet nearly half of California's ocean *appears* protected by being under MPA status

Machiavelli (1525) described the dangers of advocating change in social systems. He warned that those profiting by the *status quo* would defend it vigorously, whereas those who might benefit from a new order would only defend the changes with lukewarm enthusiasm until they had personal experience that it would benefit them. In such situations advocates of change will find themselves in great peril, opposed by zealots and supported by skeptics. The information age has perversely given new respectability to uninformed opinion.

As a society, we need to get past the denial that fishing has caused problems and accept that traditional marine conservation has not worked as well as we need it to. Moving beyond denial toward acceptance and commitment to new ways of managing marine resources is a long and difficult passage. We need to start soon. Persistence is essential for success.

We need unharvested marine wilderness as insurance against our collective ignorance and the uncertainty of untested management schemes. We need such areas to protect the integrity of marine ecosystems so we can learn how they work and how to make them more productive for people. Finally, we need them to rebuild depleted populations, restore the productivity of coastal fisheries, and sustain that productivity into the future.

We are entering a new era— humans dominate the Earth for the first time. We have no new frontiers left—only the last frontier in the Far North. Can we learn from the past, or must we repeat it and wait until fished populations collapse before we initiate a new order of business? The cost of restoration is much greater than that required to sustain extant populations. Can we save that cost? Only if we act now and recognize this as a new beginning, with new rules.

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