Anthony M. Turner
Ed B. Wiken
Nikita Lopoukhine

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

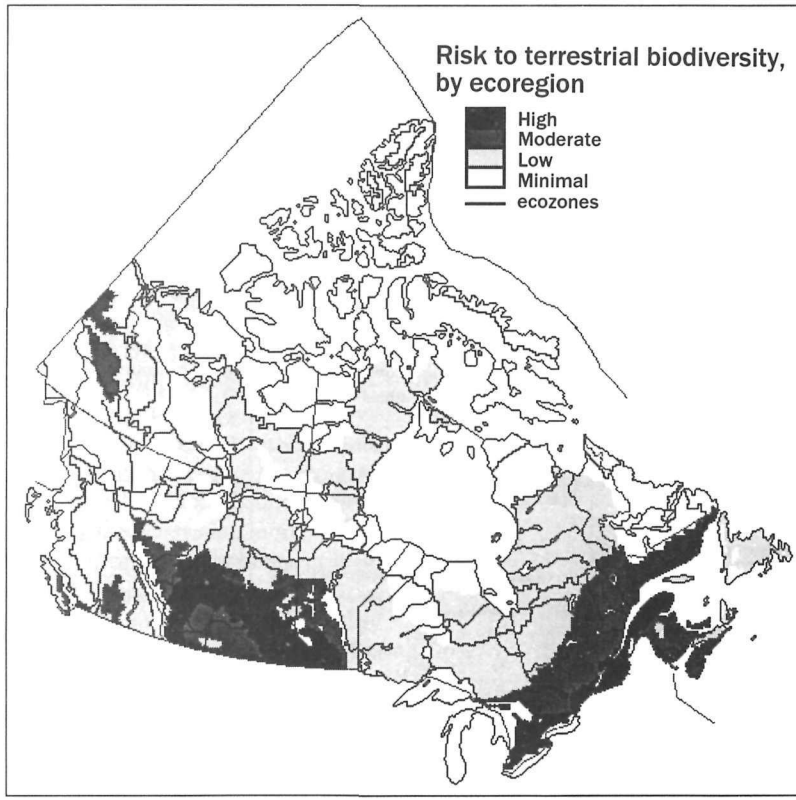

Figure 1. Relative degree of risk to biodiversity loss in Canada, by ecoregion. Source: Turner et al. 1998.

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-

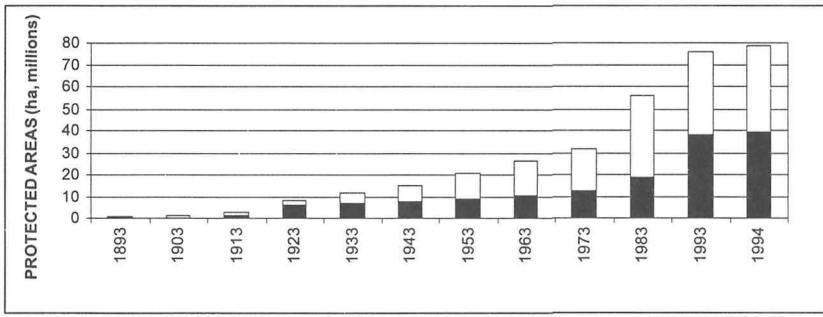

Figure 2. Growth in the establishment of Canadian protected areas, 1893-1994. Black indicates total protected area in IUCN categories I-III, while gray indicates area in IUCN categories IV-VI. Source: Government of Canada 1996.

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

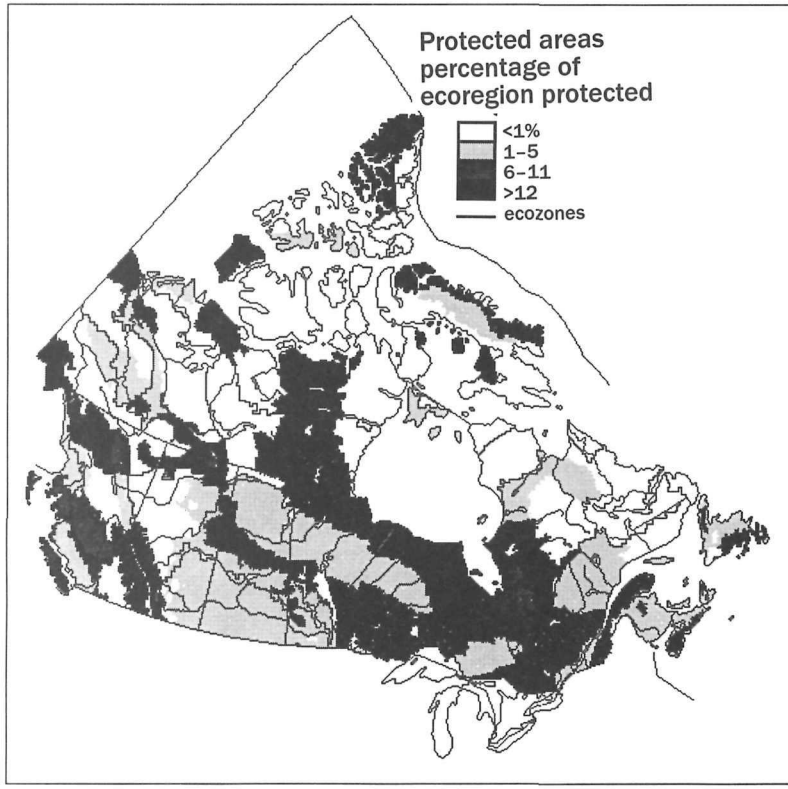

Figure 3. Percentage of each ecoregion area protected. This map includes those government-owned protected areas larger than 1,000 ha, which meet the criteria for IUCN management categories I-VI. Source: modified from Natural Resources Canada 1999.

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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Anthony M. Turner, A. M. Turner and Associates, 87 Java Street, Ottawa, Ontario K1Y 3L5 Canada; tturner@cyberus.ca

Ed B. Wiken, Canadian Council on Ecological Areas, 2067 Fairbanks Avenue, Ottawa, Ontario K1H 5Y9 Canada; ecologic@istar.ca

Nikita Lopoukhine, Natural Resources Branch, Parks Canada, 25 Eddy Street, Hull, Québec K1A 0M5 Canada; nik_lopoukhine@pch.gc.ca