PROTECTED AREAS AND THE BOTTOM LINE
ZONES PROTÉGÉES : PRUDENCE

Proceedings of the 1997 Conference of the Canadian Council on Ecological Areas

September 14-16, 1997
Sheraton Hotel
Fredericton, New Brunswick

Canadian Council on Ecological Areas
Conseil canadien des aires écologiques

Conférence 1997
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Zones protégées : prudence

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1999

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PREFACE

In September, 1997, we welcomed the 16th Annual General Meeting and Conference of the Canadian Council of Ecological Areas (CCEA) to the province of New Brunswick. This provice has a diverse array of landforms, overlying a complex geological base and supporting a rich and varied complement of flora and fauna. The forests of the north central part of the province are boreal in character, while those of the extreme northwest are dominated by tolerant hardwoods and much of the rest is transitional Acadian forest composed of species such as red spruce, sugar maple, white pine, and yellow birch. The hydrology and underlying parent materials result in a wide variety of wetland types and rivers, each supporting a characteristic suite of wild life. The coastline is extensive and varies from sand dunes to high rocky cliffs and outcrops, while the ocean is home to a diversity of marine life.

The theme of the Conference was "Protected Areas and the Bottom Line", a phrase which seems to preoccupy much of our thinking these days, whether we are making personal decisions, formulating public policy or creating marketable products. Although the "bottom line" in these situations usually refers to financial considerations, we believe that our individual and collective well-being requires a more elaborate accounting of the ecological processes and life forms that support us. The conference logo is the Greek symbol for *oikos*, which is the origin of word "ecology" (*oecology*), meaning the study of the household. This figure surrounds or embodies a stylized image of the Earth, representing the dynamic interplay of air, land and water. In another sense, then, the conference theme inspires us to contemplate the idea of a multi-faceted "bottom line" that integrates ecological, societal, and economic values.

We believe that the conference provoked a few moments of thoughtful reflection, respectful dialogue, and, perhaps, a few innovative solutions to the real and imagined problems associated with decisions to set aside land for conservation purposes. It should come as no surprise that there are consequences resulting from our actions in terms of development options, but the converse is also true. Land should never be regarded as so plentiful or so cheap that we can afford to give it all away. A more prudent response, akin to saving a portion of our income as insurance for a rainy day or as a bequest to our children, would be to ensure that we make reasonable decisions now, while we still can. Future generations will appreciate our foresight, just as we must thank the wisdom of our forebears in preserving the expanses of what we now recognize as many of our last remaining wildlands.

Martha Gorman and Judy Loo
Directors, Canadian Council on Ecological Areas

PRÉFACE

En septembre 1997, la province du Nouveau-Brunswick était l'hôte de la 16e assemblée générale annuelle et conférence du Conseil canadien des aires écologiques (CCAE). La province possède un vaste éventail de paysages topographiques, qui recouvrent une base géologique complexe et abritent une gamme riche et diversifiée de spécimens de flore et de faune. Les forêts du centre nord de la province sont de type boréal, alors que celles qui sont situées à l'extrême nord-ouest sont essentiellement constituées de feuillus tolérants et que la majorité du reste du territoire est recouvert d'une forêt acadienne de transition composée d'essences comme l'épinette rouge, l'érable à sucre, le pin blanc et le bouleau jaune. L'hydrologie et les matériaux originels sous-jacents justifient la présance d'une grande diversité de types de terres humides et de cours d'eau, dont chacun abrite un ensemble caractéristique d'espèces fauniques. La longueur des côtes est importante et celles-ci incluent autant des dunes de sable que des falaises rocheuses élevées et des affleurements, alors que l'océan est riche en espèces marines.

Le thème de la conférence était « Zones protégées : prudence », phrase qui semble au cœur de nos préoccupations actuelles, tant dans notre vie personnelle que lorsque nous devons formuler la politique publique ou créer des produits vendables. Même dans les situations financières où la « prudence » est généralement de mise, nous estimons que notre bien-être individuel et collectif nécessite qu'on accorde une plus grande importance aux processus écologiques et aux fomes de vie qui permettent notre survie. Le logo de la conférence était le symbole grec qui représente l'*oikos*, soit l'origine du mot « écologie » (oecologie) qui signifie l'étude de la maison. Ce symbole entoure ou renferme une image stylisée de la terre, ce qui représente l'interaction dynamique de l'air, de la terre et de l'eau. Vu sous un autre angle, le thème de la conférence nous a donc incités à nous pencher sur la notion de « prudence » sous des angles multiples qui intègrent les valeurs écologiques, sociales et économiques.

Nous sommes d'avis que les travaux de la conférence nous ont amenés à de rares moments de réflexion profonde, dans une atmosphère de dialogue respectueux, qui ont permis l'élaboration d'un certain nombre de solutions innovatrices aux problèmes réels et imaginés associés aux décisions de réserver des terres à des fins de conservation. Comme on devait s'y attendre, nos actions entraînent des conséquences sur le plan des options de développement, mais l'inverse est également vrai. Les terres ne doivent jamais être considérées comme si abondantes ou si bon marché que nous pouvons nous permettre de les céder en totalité. Une position plus prudente, qui s'apparente à l'épargne d'une partie de nos revenus en prévision des jours de pluie ou pour l'héritage de nos enfants, consiste à garantir que nous prenons des décisions sensées à l'heure actuelle, alors qu'il nous est encore possible de le faire. Les futures générations apprécieront notre prévoyance, tout comme nous devons rendre hommage à la sagesse de nos ancêtres, qui ont préservé les terres que nous considérons aujourd'hui en majorité comme nos dernières terres vierges.

Martha Gorman et Judy Loo
Directrices, Conseil canadien des aires écologiques

What is the Canadian Council on Ecological Areas?

The Canadian Council on Ecological Areas (CCEA) is a national, non-profit, multi-stakeholder organization incorporated in 1982 to facilitate and assist Canadians with the establishment and maintenance of a comprehensive network of protected areas that are representative of Canada's terrestrial and aquatic diversity. The goals of the CCEA are achieved by:

- guiding the design and completion of a Canada-wide protected areas network
- determining the ecological requirements and institutional arrangements for securing a protected areas network
- advancing sound ecological approaches for and stewardship of protected areas
- promoting the environmental and economic value of protected areas
- facilitating interchange among members and interested partners through regional and national fora.

The Council draws its membership and support from federal, provincial, and territorial governments, non-governmental organizations, private industry, universities, and the general public. In fostering dialogue and exchange of information among researchers, managers, and the general public, the CCEA acts as a catalyst in the development of scientific and ecologically based approaches to the selection and management of protected areas. It also performs an educational role by providing training, assistance and information to members and interested partners on matters relevant to the CCEA mandate. This includes:

- maintaining a national registry of ecological areas
- operating a website
- producing an information brochure, bi-annual newsletter, and a video
- sponsoring the Annual General Meeting and Meetings of the Board of Directors
- facilitating jurisdictional communication and reporting on protected area initietives
- serving as a liaison among member organizations and with international agencies with similar interests
- commissioning task forces, managing special projects, and publishing technical documents

The CCEA also presents a series of awards at the AGM Banquet acknowledging the efforts of individuals, agencies, organizations, corporations and institutions that have fostered protection of Canada's terrestrial and aquatic diversity. These special achievements involve acquiring, designating and managing protected areas, advancing scientific understanding of natural processes that sustain their ecological integrity, and educating the public about the importance of ecosystem conservation Past recipients include: the Island Nature Trust for its activities as a non-governmental organization in securing conservation lands on Prince Edward Island, Bowater Mersey Paper Company Limited for its support in establishing Panuke Lake Nature Reserve, Dr. Stan Rowe for his contribution to forest ecology, the British Columbia Ecological Reserve Program for its special achievements, Ducks Unlimited, Nature Saskatchewan, and Saskatchewan Wildlife Federation, in recognition of their cooperative efforts to further conservation in Saskatchewan, Mr Hal Hinds, for his achievements in documenting the flora of New Brunswick, and the World Conservation Monitoring Centre for its international work on data gathering for protected areas.

For information on the Canadian Council on Ecological Areas, its interests, activities or publications, please contact:

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Qu'est-ce que le Conseil canadien des aires écologiques?

Le Conseil canadien des aires écologiques (CCAE) est un organisme national à but non lucratif qui regroupe des intervenants multiples. Il a été créé en 1982 pour aider les Canadiens à créer et à maintenir un réseau complet de zones protégées qui soit représentatif de la diversité terrestre et aquatique du Canada. Pour atteindre ses objectifs, le CCAE :

- oriente la conception et la constitution d'un réseau canadien de zones protégées;
- détermine les besoins écologiques et les dispositions institutionnelles requises pour créer un réseeu de zones protégées;
- propose des stratégies écologiques judicieuses pour la gérance des zones protégées;
- effectue la promotion de la valeur environnementale et économique des zones protégées;
- facilite les échanges entre les membres et les parties intéressées dans le cadre de forums nationaux et régionaux.

Les membres et le soutien du Conseil proviennent du gouvernement fédéral ainsi que des gouvernements des provinces et des territoires, des organismes non gouvernementaux, du secteur privé, des universités et du grand public. En favorisant le dialogue et l'échange d'information entre les chercheurs, les aménagistes et le grand public, le CCAE joue le rôle de catalyseur de la mise au point de méthodes de sélection et d'aménagement des zones protégées qui soient basées sur des critères scientifiques et écologiques. Il joue également un rôle éducatif en offrant une formation, une aide et de l'information aux membres et aux parties intéressées sur les questions qui relèvent du mandat du CCAE. Cela inclut :

- La gestion d'un inventaire national des terres écologiques;
- l'exploitation d'un site web;
- la production d'une brochure d'information, d'un bulletin semestriel et d'un vidéo;
- le parrainage de l'assemblée générale annuelle et des réunions du conseil d'administration;
- la facilitation de la communication entre les administrations et un compte rendu sur les initiativas relatives aux zones protégées;
- le maintien de la liaison entre les organismes membres ainsi que les organismes internationaux qui possèdent des intérêts similaires;
- l'organisation de groupes de travail, la gestion de projets spéciaux et la publication de documents techniques.

Le CCAE présente également une série de prix lors du banquet de l'assemblée générale annuelle, afin de remercier particuliers, organismes, organisations, sociétés et institutions pour les efforts déployés dans le but de promouvoir la diversité terrestre et aquatique du Canada. Ces interventions spéciales incluent l'acquisition, la désignation et l'aménagement de zones protégées, l'amélioration des connaissances scientifiques relatives aux processus naturels qui appuient leur intégrité écologique et la sensibilisation du public à l'importance de la conservation de l'écosystème. Ont déjà été récipiendaires l'Island Nature Trust pour ses activités en tant qu'organisme non gouvernemental chargé de la conservation des terres de l'Île-du-Prince-Édouard, Bowater Mersey Paper Company Limited pour sa contribution à la création de la réserve naturelle du lac Panuke, M. Stan Rowe, Ph D., pour sa contribution à l'écologie forestière, le British Columbia Ecological Reserve Program pour ses réalisations spéciales, Canards Illimités, Nature Saskatchewan et Saskatchewan Wildlife Federation pour les efforts de coopération qu'ils ont déployés pour promouvoir la conservation en Saskatchewan, M. Hal Hinds pour ses réalisations dans le domaine de la documentation de la flore du Nouveau-Brunswick et le World Conservation Monitoring Centre pour les travaux internationaux qu'il a consacrés à la collecte de données relatives aux zones protégées.

Pour obtenir des précisions sur le Conseil canadien des aires écologiques, ses intérêts, activités ou publications, veuillez communiquer avec :

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OPENING REMARKS

CASTING THE BOTTOM LINE ON THE BLUE PLANET

Ed B. Wiken, Chairman,
Canadian Council on Ecological Areas (CCEA)
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In search of a safe passage........

A ship's supremacy on the sea is not always set
By the might of her cannons,
Or by the mass of her sails,
But by the skills of those who guide
her through.

The Blue Planet

It isn't until you stand back and view the world from space that you understand why so many people call the Earth the *Blue Planet*. The Seven Seas of antiquity embrace much of the world's surface. Canada's land mass ends at the margins of three of these great seas: the Atlantic Ocean in the east; the Pacific Ocean in the west, and the Arctic Ocean in the north.

The coasts, islands, fjords, and inlets against which these ancient seas roll are enormous. At over 243,000 kilometers, no other country in the world has more coastlines. As a result, Canada is known the world over as a Maritime Nation. But large numbers of Canadians have never seen the oceans, smelled the salt air, nor dealt with the fortunes and perils of a maritime navigation.

500 years ago, brothers John and Sebastian Cabot, sailed across the North Atlantic for King Henry VII of England. They didn't know that the Vikings had already abandoned these shores 500 years before them. Equally, they did not know that many European nations would come after them to further explore and exploit the bays, rivers, coves, and channels that surround Canada. And yet it was the navigational skill of the Cabot brothers — their ability to sail the seas and sound the shoals in uncharted waters — that set the stage for 500 years of settlement, exploration, and exploitation of the very land so many of us take for granted today.

Charting a Different Course

The theme of this year's conference of the Canadian Council on Ecological Areas is "Protected Areas and the Ecological Bottom Line." We all know that the bottom line is commonly thought of as an accounting term. It essentially means the real cost of producing something — after we subtract the expenses. But there is another meaning to the bottom line that has some significance as a metaphor for what we do at this conference.

Casting a bottom line was a common practice on early sailing ships. An ordinary seaman would go to the forward position on the ship's bow. From there, he would be responsible for looking ahead for obstacles as well as casting his lead-weighted line into the depths. Soundings from his bottom-line combined with his intuition and observations were vital forms of information that were conveyed to the ship's captain and helmsman to direct the ship's course through unknown waters, reefs, and shoals.

The use and understanding of that information kept the ship off the rocks, ensured the safety of the crew and delivery of the cargo goods. The water's depth, the occurrence of shoals, and the location of sandbars were features of nature that needed to be recognized and acted upon. They were fundamental characteristics of navigation that had to be considered. Ignoring them often meant trouble or disaster — from a hole in the ship to a lost ship.

Land and Sea

Although the Seas of Antiquity were the "information superhighways" of their day, TERRA FIRMA — the land that we live on — is what captures and keeps most people's day-to-day attention. For centuries, we have been exploring and exploiting our ecosystems, soils, forests, wildlife, and natural resources. In recent years, we have started to understand how our behavior over the decades has affected terrestrial and aquatic ecosystems, sometimes for better and sometimes for worse.

But we have yet to discover a bottom line — a depth sounder if you like — that will help us find safe passage to a haven of sustainable resources and life sustaining systems.

What is the bottom-line reading on our scientific knowledge and assessment skills? What is the bottom-line reading on resource use, protection, and conservation? What is the bottom-line reading on ecosystem health and integrity? These questions are complex and progress in answering them is tasking and burdensome on us all.

For centuries, we believed that the wilderness, seascapes, landscapes, and resources of Canada or, indeed, elsewhere were inexhaustible. It was admittedly a comfortable thought for most but perhaps lucrative conceit as well. In Canada, we saw land and forests that stretched beyond imagination. Incomprehensible amounts of fresh water. Fish we could scoop out of the sea in baskets. People could not believe that too many trees could be cut, too many fish could be harvested, too much land could be converted to farms and urban areas or too much water could be diverted! After all, we literally had more natural resources than we knew what to do with.

Today, Canada is still acknowledged for its magnitude and diversity. But we Canadians can no longer take this wealth for granted. Our one-time conceit and confidence about the boundlessness of resources, natural areas, and healthy ecosystems are unravelling.

The Horizon and Beyond

Many agreements have been reached and principles set on less restrictive approaches to bottom lines. Dialogues, critiques, and assessments have been important in this process. Progress has been achieved not by conservation groups alone nor by industry or governments alone. Governments, non-governmental organizations (NGOs), and industry have merged more closely owing to common needs and ground. In the last decade, this has been exemplified by the principles behind agreements such as:

- the National Forest Accord;
- World Conservation Strategies;
- Protected Area Systems Plans;
- North American Waterfowl Management Plan; and
- Biodiversity Conventions

They have all pointed to the growing realization that some other form of harmony must be reached.

Finding the ecological bottom line is a challenge. It can:

- help us understand the diversity of ecosystems that we have;
- show us where and how to establish limits; and
- guide us as to how we can be more careful about what we do.

Perhaps most importantly, understanding the bottom line in the realm of ecology can help us prevent problems that we might not wish to live with either today or in the future.

Often, an overriding concern is the impact on "future generations." This is not restricted to people. It applies to impending generations of other species, of existing and emerging types of ecosystems, and of basic resources like air, water, and soils. By studying how we interact within and rely on natural and human-modified ecosystems — we can help predict what our ecological impacts may be. Understanding the bottom line in ecology can help us understand what we must do to attain and retain sustainability.

With sustainable resource use, ecosystem integrity, and ecosystem management, many organizations and people currently see the attraction behind these notions but not the achievements. The passageways for them have not been mapped that clearly. We do not have charts showing every reef and rock nor every safe channel. **So welcome to the CCEA's New Brunswick conference!**

Seamen, Helmsmen and Captains

Seamen, helmsmen and captains — these are orders of rank but not of importance. This is a subtlety that many have missed. We have expected the CEOs of industry, the ADMs of government departments and Chancellors of universities to be the captains of the fleet and command ships like HMS Ecology and HMS Sustainable Development. This is an odd expectation when we intuitively know that the success of a voyage is very much dependent on the entire crew. Many of us attending the conference, in effect, fulfil the roles of seamen—some ordinary seaman and some leading seamen.

We have all been exposed to different experiences. Assessing and reporting on ecosystem degradation and depletion in Canada's oceans, arctic, grasslands, and forests have been essentially negative experiences. We have seen parallels in countries like the United States, Mexico, and Africa. A refreshing counterbalance of sorts has been initiatives like model forests, new commitments to protected area plans, ecological science centers, state-of-the-environment reporting, and integrated regional planning. They have provided a better foundation for applying and ensuring an ecological approach. Unfortunately while resource/ecosystem degradation and depletion continue in both different and rather widespread forms, the positive initiatives 'come and go' without any sustained and widespread application. This situation is a problem!

Finding the ecological bottom line is of mutual interest. It isn't a case of just setting aside protected areas but rather acknowledging the total value and importance of our ecosystems, terrestrial or aquatic. Some view protected areas as the anchoring points or safe havens of the ecosphere. Between these spots are the seaways of commerce, the ports providing traditional goods and services, the tour boats and recreation ventures, and everything else necessary for our well being.

"How good are our navigational skills, the charts we employ, and the directions we set?"— that is the ecological bottom line.

Canada's Marine Ecosystems: Basic Geographical Measurements and Protected Area Considerations

By Ed B. Wiken, Chair, CCEA, Ottawa, Ontario H1H 5Y9 *and* Harold Moore, President, Gregory Geoscience, Kanata, Ontario

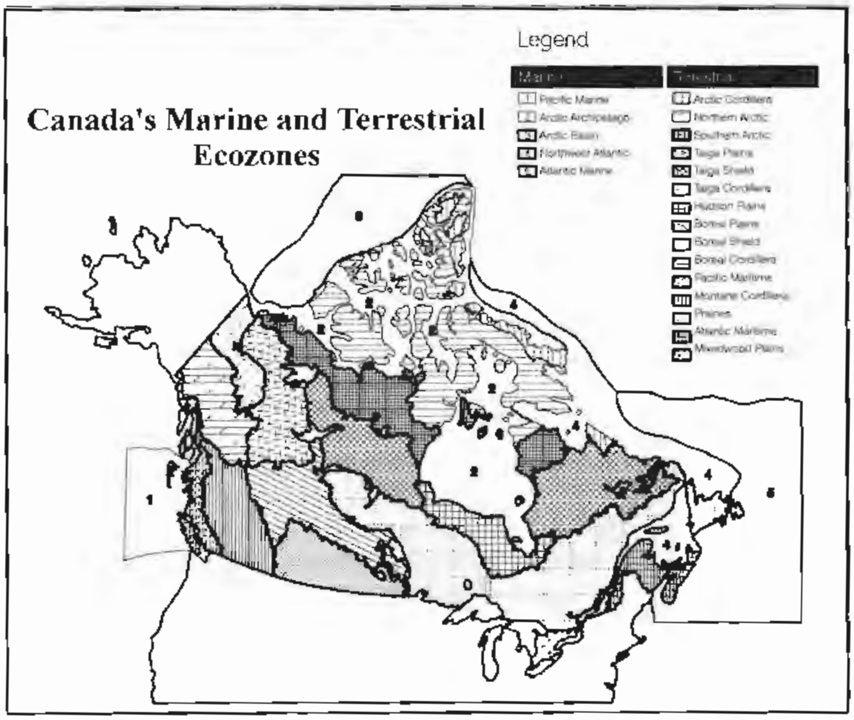
Marine and Terrestrial Ecosystems in Canada

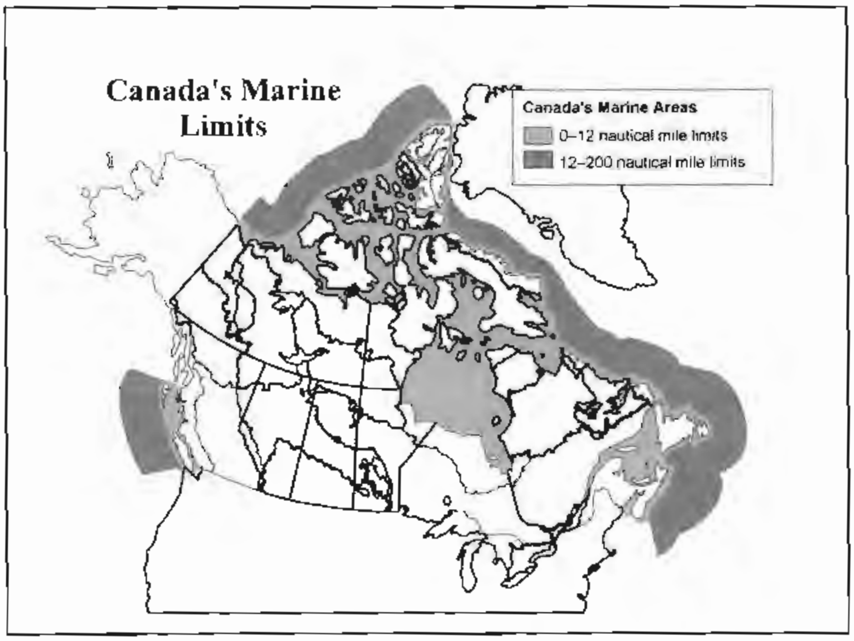
Usually, we speak of 'land' or 'sea' rather than 'land and sea'. Land is far easier to understand as it is typically all around us and we can more readily view the parts and differences of terrestrial ecosystems. For the sea, this is not so. There are many barriers to scientific investigations. The vastness of Canada's sea areas makes it inconvenient for most of us to travel to different surface locations. Our ability to study and monitor the basic ecological character of marine systems is obscured by the fathoms of water which mask the depths. Beyond obstacles like this, however, what are some of the fundamental land/sea differences?

At the macro scale, we have 20 major ecosystems in Canada. Fifteen are associated with the land and five with the sea (Figure 1). In a legal and territorial sense, Canada's land area is 9 215 430 km² (Table 1); this is in effect a figure that really covers land as well as freshwater bodies like rivers, ponds, and lakes. How large is the seascape in comparison? It is surprisingly about 60% as large, being 5 543 913 km². This marine area is over ten times the size of France or five and a half times the size of the province of Ontario.

Table 1. Comparison of land and sea areas within Canada's ecozones

Ecozone Name	Area (sq. kms)	% of Canada	% of Land	% of Marine
1-Arctic Cordillera	230 873	1.6	2.3	NA
2-Northern Arctic	1 361 433	9.2	13.7	NA
3-Southern Arctic	773 01	5.2	7.8	NA
4-Taiga Plains	580 139	3.9	5.8	NA
5-Taiga Shield	1 253 887	8.5	12.6	NA
6-Taiga Cordillera	264 480	1.8	2.7	NA
7-Hudson Plains	353 364	2.4	3.5	NA
8-Boreal Plains	679 969	4.6	6.8	NA
9-Boreal Shield	1 782 252	12.2	17.9	NA
10-Boreal Cordillera	459 680	3.1	4.6	NA
11-Pacific Maritime	205 175	1.4	2.1	NA
12-Montane Cordillera	459 680	3.1	4.6	NA
13-Prairies	469 681	3.2	4.7	NA
14-Atlantic Maritime	183 978	1.2	1.8	NA
15-Mixedwoods Plains	138 421	0.9	1.4	NA
Sub-total	**9 215 430**	—	**100.0**	NA
16-Pacific Marine	457 646	3.1	NA	8.3
17-Arctic Archipelago	2 178 998	14.8	NA	39.3
18-Arctic Basin	704 849	4.8	NA	12.7
19-Northwest Atlantic	1 205 981	8.2	NA	21.8
20-Atlantic Marine	996 439	6.8	NA	17.9
Sub-total	**5 543 913**	—	NA	**100.0**
TOTAL	**14 759 34**	**100.0**	—	—


Canada's Marine and Terrestrial Ecozones
Legend
Pacific Marine
Arctic Archipelago
Arctic Basin
Northwest Atlantic
Atlantic Marine
Arctic Cordillera
Northern Arctic
Southern Arctic
Taiga Plains
Taiga Shield
Taiga Cordillera
Hudson Plains
Boreal Plains
Boreal Shield
Boreal Cordillera
Pacific Maritime
Montane Cordillera
Prairies
Atlantic Maritime
Mixedwood Plains


Canada's Marine Limits
Canada's Marine Areas
0–12 nautical mile limits
12–200 nautical mile limits

Some of the marine area figures are striking. For instance, the Pacific Marine Ecozone or B.C.'s Pacific Ocean system adds up to 8.3% — a figure that is much lower than most people expect. What is often forgotten is that only the lower half of British Columbia has ocean access and the upper portion of the province is really cut off by the protrusion of the Alaskan Panhandle. In contrast to the West Coast, the arctic-based marine ecosystems (*i.e.*, #17 & #18) are overwhelmingly high. The Arctic Archipelago Ecozone surrounding the main set of arctic islands alone amounts to nearly 40% of the nation's oceanic territory. In addition to being large, it is rather unique in the entire arctic ecosystem setting. Unlike anywhere else in the circumpolar arctic. the marine waters here form an extensive lattice of aquatic ecosystems in and amongst the largest set of arctic islands in the north. This land/water interface provides a favored habitat for species like polar bears. The Arctic Basin Ecozone comprises the icefast oceanic barrens in Canada's far northeast. As a wetland often represents a transition between true water bodies and land, this marine ecozone is a hybrid, having attributes of landscapes and seascapes.

About 8% of the 15 terrestrial ecozones has been protected in IUCN classes 1-6. In comparison, work to protect and conserve marine ecosystems has been rather negligible to date. Heritage Canada (Parks) and the government of British Columbia have been quite successful in initiating a variety of actions in the Pacific Marine Ecozone. Elsewhere, Environment Canada - Canadian Wildlife Service (CWS) has been the most progressive organization, conserving over 2 918 891 ha through Migratory Bird Sanctuaries and 174 673 hectares as National Wild Areas. Many of the protected areas lie within arctic ecozones. The new legislation (*i.e.*, Oceans Act) under the Department of Fisheries and Oceans offers further opportunities for expanding a network of marine protected areas.

Twelve and Two Hundred Mile Limits

Perhaps the two most commonly cited jurisdictional areas in marine literature are the 12- and 200-nautical-mile limits. These two areas have specific implications with regard to the mechanisms that are available to encourage the establishment and regulation of marine protected areas. Owing to historical settlements on international borders, to resolution of boundaries through recent international disputes, and to peculiar interpretations of legal definitions, the resulting tabulations according to these two jurisdictions are rather different than might be anticipated.

The split between the 12- and 200-mile limit is almost exactly 50:50 (Table 2). How can this be so? Hudson Bay, a circular body of marine water in the heart of Canada, is over 500 miles in diameter. Parts of this Bay you would assume would fall within the 12- and 200-nautical-mile limits. Areas like this are considered to be part of Canada's 'internal marine waters' and thus, legally and technically, within the 12-mile limit.

Under the Canadian Wildlife Act, **National Wildlife Areas (NWA)** can be established on land and marine (within the 12-mile limit) areas. Under the same act, within the 12- to 200-nautical-mile limits, a different mechanism comes into place — **Marine Wildlife Areas (MWA).** In about half of Canada's marine waters, the CWS could consider protecting special and endangered wildlife areas under the designation of a NWA and as a MWA in the other half. As the 12- to 200-mile ratios indicate, the NWA mechanism likely has less importance in the Atlantic Marine and Arctic Basin Ecozones.

Table 2. The jurisdictional areas and coastline lengths of marine ecozones

Ecozone Name	Area (sq. kms + %) in 12 mile limit		Area (sq.kms + %) in 200 mile limit		12 to 200 ratio	Coastline length (kms + %)	
16-Pacific Marine	102 920	3.7	457 646	8.3	1:4	13 342	5.4
17-Arctic Archipelago	2 051 393	73.5	2 178 998	39.3	1:1	157 535	64.6
18-Arctic Basin	24 997	0.9	704 849	12.7	1:28	NA	NA
19-Northwest Atlantic	536 895	19.3	1 205 981	21.8	1:2	47 193	19.4
20-Atlantic Marine	72 144	2.6	996 439	17.9	1:14	25 725	10.6
TOTAL	**2 788 349**	**100.0**	**5 543 913**	**100.0**	1:2	**243 795**	**100.0**

Coastlines

Measuring coastlines is always dependent upon factors like the scale of the base map and the physical geography. The more detailed the map base becomes, the more likely it is that coastline details can be properly measured and represented. In coastal areas like Labrador, eastern Baffin Island and British Columbia, moving from 1:1 000 000 to 1:250 000 baseline maps makes a marked difference. Values measured in Labrador would increase by a factor of three. On smooth, lined coasts that have few islands like southern coastline of Hudson Bay, the differences in coastline measurement may jump by just an increment of 1.5.

Measured at intermediate scales like 1:500 000 / 1:250 000, Canada has over 243 795 kilometers of coastline. The earth's circumference is a mere 12, 756 kilometers or 19 times smaller than the nation's coastline. About 65% of the coastline is connected to the Arctic Archipelago Ecozone; another 19.4% is included in the Northwest Atlantic Ecozone. The tortuous fjords and myriad islands provide for a diverse range of coastlines in these two ecozones.

The mesh of land and freshwater bodies is an integral part of both landscape ecosystems and terrestrially based conservation areas. In the ocean setting, the coastlines and open seas are the interwoven and vital elements of marine ecosystems and protected areas. The sea cliffs, coastal islands, bays, fjords, nearshore areas, and beaches are indirect synonyms for 'coastline'. They are important in the overall life cycle of many marine organisms (*e.g.*, birds, mammals, crustaceans) and systems. They act as sites for colonies, perching, denning, rearing of young, foraging, resting, and refuge.

Ecosystems and Jurisdictions

The traditional protected area programs throughout Canada are built upon different forms of intellectual scaffolding. Some emphasize ecosystem representation, some productive wildlife habitats, some forest types, some scientific reserves, and so on. However, in common, they tend to work through windows based on jurisdictional frameworks that are driven by legal mandates or by provincial, territorial or national boundaries. For the newer efforts which will be devoted to marine areas, the breakdown by political jurisdictions is interesting (Table 3).

Table 3. Jurisdictional breakdown of coastlines

Province Name	Length of coast	(km) % of Total Coastline
British Columbia	25 725	10.6
Manitoba	917	0.4
New Brunswick	2 269	0.9
Newfoundland/Labrador	28 956	11.9
Northwest Territories	161 762	66.3
Nova Scotia	7 579	3.1
Ontario	1 210	0.5
Prince Edward Island	1 260	0.5
Ouebec	13 774	5.7
Yukon Territory	343	0.1
Total	**243 795**	**100.0**

The coastline span of the Northwest Territories dominates the figures. The largest length of coastline, the largest amount of marine waters and the relatively weak understanding of marine systems overall, places a great deal of responsibility on northern jurisdictions and ecosystems. Newfoundland and British Columbia are also tasked by their wealth of shorelines. At the federal level, departments such as Environment (Canadian Wildlife Service), Heritage Canada (Parks) and Fisheries and Oceans Canada have responsibilities that transcend all of these coastal areas.

Moving Ahead

"It used to be green side up!" This expression is sometimes used to describe the state of Canada's terrestrial ecosystems. In the southern latitudes, the expression has some sense of truth. The Prairie Ecozone, for example, has undergone extensive alteration because of agricultural activities (*e.g.*, farming, ranching, feedlots) to the point that native greenery is all but gone. Unfortunately ecosystems like this were highly valued as a farmscape long before protected areas gained wider currency as a value of equivalent status. What quote will eventually summarize our progress with marine areas?

Some of the earliest work on promoting a national and inclusive system of marine protected areas was done in the late 1980s and reported in the Council's Occasional Paper No. 9. As little has been done to strategize a system for establishing a comprehensive network of marine protected areas until recently, the diversity in organizations with capabilities to implement such a system is opportune. With the downsizing and resource reductions that seem to be universally applied across governments, a great deal of synergy will be required to have timely and meaningful actions. The CCEA as well as many other environmental non-government organizations (ENGOs), scientific groups, and concerned individuals welcome the initiatives and leadership that federal and provincial departments/ministries have undertaken.

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CCEA home page http://www.cprc.uregina.ca/ccea/

OBSERVATIONS PRÉLIMINAIRES

LANCER LA LIGNE DE FOND SUR LA PLANÈTE BLEUE

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À la recherche d'un passage sûr...

La suprématie d'un navire sur la mer ne dépend pas toujours
de la force de ses canons,
ou de la taille de ses voiles,
mais également des compétences de ceux
qui le manoeuvrent.

La planète bleue

Ce n'est qu'une fois dans l'espace qu'on possède un recul suffisant pour comprendre pour quelle raison tant de gens qualifient notre planète de « planète bleue ». Les sept mers de l'Antiquité recouvraient la plus grande partie de la surface du monde. Les terres du Canada s'arrêtent aux confins de trois de ces grandes mers : l'océan Atlantique à l'est, l'ocean Pacifique à l'ouest et l'océan Arctique au nord.

Les côtes, les îles, les fjords et les bras de mer que baignent ces mers antiques représentent un territoire gigantesque. Mesurant plus de 243 000 kilomèters, les côtes du Canada sont les plus longues du monde. C'est pourquoi le Canada est considéré dans le monde entier comme une nation maritime. Toutefois, un grand nombre de Canadiens n'ont jamais vu l'océan, respiré l'air salin ou connu les aléas de la navigation maritime.

Il y a 500 ans, les freres Jean et Sébastien Cabot traversaient à la voile l'Atlantique Nord pour le compte du roi Henri VII d'Angleterre. Ils ignoraient que les Vikings avaient déjà abandonné ces côtes 500 ans plus tôt. Ils ignoraient également que nombre de nations européennes leur succéderaient et viendraient explorer et exploiter les baies, les cours d'eau, les anses et les canaux du Canada. Pourtant, ce sont les qualités de navigateurs des frères Cabot et leur capacité de repérer les hauts-fonds dans des eaux inconnues qui pavèrent la voie à 500 ans de colonisation, d'exploration et d'exploitation de cette terre que nombre de Canadiens considèrent aujourd'hui comme la leur.

Trouver une autre voie

Le thème de la conférence du Conseil canadien des aires écologiques de cette année est « Zones protegées : prudence du point de vue écologique ». **Du point de vue des activités de notre conférence, l'expression « ligne de fond » est employée dans un sens métaphorique et rappelle la prudence.**

Les premiers navigateurs avaient coutume de jeter une ligne de fond. Un simple matelot se plaçait à l'extrémité de la proue du navire et guettait les obstacles tout en jetant sa ligne lestée de plomb au fond de l'eau. Les relevés de profondeur effectués au moyen de cette ligne combinés à l'intuition et aux observations du marin constituaient de l'information essentielle, qui était transmise au capitaine du navire et à l'homme de barre pour convoyer le navire dans des eaux inconnues, au milieu des récifs et des hauts-fonds.

L'utilisation et la compréhension de cette information permettaient d'éviter que le navire ne heurte des rochers, tout en garantissant la sécurité de l'équipage et l'arrivée des marchandises à bon port. La profondeur des eaux, la fréquence des hauts fonds et l'emplacement des bancs de sable étaient des caractéristiques naturelles qu'il convenait de reconnaître et de prendre en compte. Ces facteurs constituaient des paramètres fondamentaux de la navigation qui devaient être pris en compte. Faute de ce faire, le navire courait à l'incident ou au désastre, depuis une simple voie d'eau jusqu'au naufrage pur et simple.

La terre et la mer

Même si les mers de l'Antiquité étaient l'équivalent des « super autoroutes de l'information » d'aujourd'hui, la TERRA FIRMA, la terre sur laquelle nous vivons, est celle qui capte l'attention de la majorité des populations de nos jours. Durant des siècles, nous avons exploré et exploité nos écosystèmes, nos sols, nos forêts, notre faune et nos ressources naturelles. Au cours des dernières années, nous avons commencé à comprendre sous quelle forme notre comportement durant des décennies avait eu une incidence sur les écosystèmes terrestres et aquatiques, parfois pour le meilleur et parfois pour le pire.

Toutefois, nous n'avons pas encore découvert une ligne de fond, ou une sonde de profondeur si vous préférez, susceptible de nous aider à trouver un passage sécuritaire jusqu'à un havre de ressources durables et de systèmes garantissant la survie. Qu'indique notre ligne de fond quant à nos connaissances scientifiques et à nos qualités d'évaluation? Qu'indique notre ligne de fond quant à l'utilisation, la protection et la conservation de nos ressources? Qu'indique notre ligne de fond quant à la santé et à l'intégrité des écosystèmes? Il s'agit de questions complexes et pour y répondre, il est nécessaire d'obtenir la contribution et les efforts de chacun d'entre nous.

Durant des siècles, nous avons pris pour hypothèse que la nature, les paysages marins et terrestres, et les ressources du Canada, voire du monde entier, étaient inépuisables. Il faut reconnaître que cette façon de voir convenait à la plupart d'entre nous, mais qu'elle était également probablement inspirée par l'appât du gain. Au Canada, nous avions devant nous des terres et des forêts qui s'étendaient au-delà de l'imagination. Nous disposions de réserves inimaginables en eau douce. La mer nous fournissait du poisson en quantités inépuisables. Personne ne pensait qu'il était possible de couper trop d'arbres, de pêcher trop, de convertir trop de terres à l'agriculture ou à l'urbanisation ou de détourner un trop grand nombre de cours d'eau. Après tout, nous avions littéralement tellement de ressources naturelles que nous ne savions qu'en faire.

À l'heure actuelle, le Canada demeure réputé pour son immensité et sa diversité. Toutefois, nous ne pouvons plus considérer cette richesse comme un acquis. Les préjugés et les certitudes que nous avions quant au caractère inépuisable des ressources et des sites naturels et de la santé de nos écosystèmes sont sérieusement remis en question.

Le présent et l'au-delà

Nombre d'accords ont été conclus et des principes ont été énoncés de manière à assouplir la notion de ligne de fond. Dialogues, critiques et évaluations ont constitué des volets importants de ce processus. Les progrès ne sont pas le fruit de l'intervention isolée des groupes de conservation eux-mêmes pas plus que de l'industrie ou des pouvoirs publics. Ces derniers, les ONG et l'industrie ont déployé des efforts plus concertés sur la base de besoins et d'intérêts communs. Au cours de la dernière décennie, cette évolution a été illustrée par les principes qui sous-tendent notamment les accords suivants :

- Accord national sur les forêts
- Stratégies mondiales de la conservation

- plans de gestion des zones protégées (Protected Area Systems Plans)
- Plan nord-américain de gestion de la sauvagine, et
- conventions sur la biodiversité.

Toutes ces ententes ont mis l'accent sur la nécessité croissante de parvenir à une certaine forme d'harmonie.

Trouver la ligne de fond d'un point de vue écologique est un défi. Cette ligne de fond peut :

- nous aider à comprendre la diversité des écosystèmes dont nous disposons;
- nous indiquer où et sous quelle forme fixer des limites; et
- nous indiquer sous quelle forme nous pouvons être plus prudents dans nos interventions.

Peut-être plus important encore, la compréhension de la ligne de fond d'un point de vue ecologique peut nous aider à éviter des problèmes auxquels nous souhaiterions probablement ne pas être confrontés tant aujourd'hui que dans l'avenir. Les répercussions sur les " générations futures " sont fréquemment au centre de nos préoccupations. Cette notion ne se limite pas aux populations humaines. Elle s'applique aux générations à venir d'autres espèces, aux types d'écosystèmes existants et en émergence, ainsi qu'aux ressources de base comme l'air, l'eau et les sols. En étudiant sous quelle forme nous interagissons au sein des écosystèmes naturels et modifiés par l'homme, et sous quelle forme nous les exploitons, nous pouvons contribuer à prévoir quelle peut être notre influence sur l'écologie. Comprendre la ligne de fond d'un point de vue écologique peut nous faire réaliser ce que nous devons faire pour parvenir à la viabilité et la préserver.

Nombre d'organismes et de particuliers saisissent aujourd'hui l'importance des notions d'exploitation durable des ressources ainsi que d'intégrité de la gestion des écosystèmes, sans toutefois voir comment elles peuvent être réalisées concrètement. Les voies de navigation pour y parvenir n'ont pas encore été précisément cartographiées. Nous ne possédons pas de cartes qui nous indiquent les écueils et les récifs pas plus que les itinéraires sûrs. Aussi, bienvenue à la conférence du CCAE au Nouveau-Brunswick.

Marins, hommes de barre et capitaines

Marins, hommes de barre et capitaines; ces dénominations purement hiérarchiques n'ont rien à voir avec l'importance des fonctions qu'exercent ces hommes. Nombre d'entre nous ont perdu de vue cette subtilité. Nous nous attendions à ce que les dirigeants de l'industrie, les SMA des ministères et les recteurs des universités jouent le rôle de capitaines de la flotte et commandent des navires comme le NSM Écologie et le NSM Développement durable. Il s'agissait d'une attente irréaliste, lorsque nous savons de manière intuitive que le succès d'un voyage repose fondamentalement sur la contribution de l'ensemble de l'équipage. Nombre d'entre nous, participants à la conférence, sommes dans les faits de simples matelots, certains sans qualifications et d'autres de première classe.

Nous avons tous vécu notre propre expérience. L'évaluation et le compte rendu de la dégradation et de l'épuisement des écosystèmes dans les océans, les terres arctiques, les prairies et les forêts du Canada ont constitué essentiellement des expériences négatives. Nous avons tracé des parallèles avec la situation de pays comme les États-Unis, le Mexique et l'Afrique. Des initiatives comme les forêts modèles, les nouveaux engagements à l'égard des plans de zones protégées, les centres de science écologique, la planification régionale intégrée et les rapports sur l'environnement ont constitué à l'inverse des expériences positives. Elles ont permis de constituer des fondements plus solides à partir desquels nous pouvons mettre en oeuvre et conserver une approche ecologique. Malheureusement, alors que la dégradation des ressources ou de l'écosystème se poursuit sous des formes à la fois différentes et passablement généralisées, les initiatives positives sont ponctuelles et ne s'inscrivent dans aucune démarche durable et généralisée. Nous sommes confrontés à un réel problème!

Il est d'un interêt mutuel de trouver la ligne de fond d'un point de vue écologique. Il ne s'agit pas simplement de réserver des zones protégées mais plutôt de reconnaitre la valeur et l'importance globales de nos écosystèmes terrestres ou aquatiques. Certains considèrent les zones protégées comme les garde-fous de l'écosphère, dont ils constituent les havres sûrs. Entre ces îlots fleurissent les voies maritimes commerciales, les ports où transitent les biens et services traditionnels, les croisières et excursions récreatives et toutes les autres activités nécessaires à notre bien-être.

« Dans quelle mesure nos compétences en navigation sont-elles suffisantes, dans quelle mesure les cartes et les voies que nous empruntons sont-elles sûres? » C'est là que se situe la ligne de fond d'un point de vue écologique.

Écosystèmes marins du Canada : Mesures géographiques de base et enjeux liés aux zones protégées

Par Ed B. Wiken, Président, CCAE, Ottawa (Ontario) H1H 5Y9 *et* Harold Moore, président, Gregory Geoscience, Kanata (Ontario)

Écosystèmes marins et terrestres au Canada

Généralement, nous faisons une distinction entre la « terre » et la « mer » au lieu de parler de « terre et mer ». Il est sensiblement plus facile de comprendre la terre, étant donné qu'elle constitue généralement notre cadre de vie et qu'il est plus facile de constater les caractéristiques et différences des écosystèmes terrestres. Ce n'est pas le cas des écosystèmes maritimes. Les enquêtes scientifiques se heurtent à de nombreux obstacles. L'immensité des mers du Canada est telle qu'il est difficile pour la plupart d'entre nous de rallier divers emplacements terrestres par la voie maritime. Notre capacité d'etudier et de superviser le caractère écologique fondamental des systemes marins est affaiblie par l'opacité des eaux, qui masque les profondeurs. Hormis de tels obstacles, pouvons-nous toutefois préciser quelles sont certaines des différences fondamentales entre la terre et la mer?

D'un point de vue global, on recense 20 écosystèmes de première importance au Canada. Quinze sont reliés à la terre et cinq à la mer (figure 1). D'un point de vue légal et territorial, la superficie terrestre du Canada est de 9 215 430 kilomètres carrés (tableau 1); il s'agit concrètement d'un chiffre qui inclut non seulement les terres mais également les étendues d'eau douce comme les cours d'eau, les étangs et les lacs. Quelle est la superficie de la mer en comparaison? De manière surprenante, elle represente environ 60 % de la superficie terrestre, soit 5 543 913 kilomètres carrés. La superficie maritime représente plus de dix fois celle du territoire de la France ou cinq fois et demie celle de la province de l'Ontario.

Tableau 1 Comparaison des superficies terrestre et maritime au sein des écozones du Canada

Nom de l'écozone	Superficie (km²)	Pourcentage du Canada	Pourcentage superficie terrestre	Pourcentage de superficie maritime
1-Cordillère arctique	230 873	1,6	2,3	S/O
2-Nord arctique	1 361 433	9,2	13,7	S/O
3-Sud arctique	773 041	5,2	7,8	S/O
4-Plaines de la Taïga	580 139	3.9	5,8	S/O
5-Bouclier de la Taïga	1 253 887	8,5	12.6	S/O
6-Cordillère de la Taïga	264 480	1,8	2,7	S/O
7-Plaines d'Hudson	353 364	2,4	3,5	S/O
8-Plaines boréales	679 969	4,6	6,8	S/O
9-Bouclier boréal	1 782 252	12.2	17.9	S/O
11-Pacifique maritime	205 175	1,4	2,1	S/O
12-Cordillère sub-alpine	459 680	3,1	4,6	S/O
13-Prairies	469 681	3,2	4,7	S/O
14-Atlantique maritime	183 978	1.2	1,8	S/O
15-Plaines mixtes	138 421	0.9	1,4	S/O
Sous-total	**9 215 430**	—	**100,0**	S/O
16-Pacifique-littoral	457 646	3,1	S/O	8,3
17-Archipel arctique	2 178 998	14,8	S/O	39,3
18-Bassin arctique	704 849	4.8	S/O	12,7
19-Atlantique Nord-Ouest	1 205 981	8,2	S/O	21,8
20-Atlantique-littoral	996 439	6,8	S/O	17,9
Sous-total	**5 543 913**	—	S/O	**100,0**
TOTAL	**14 759 343**	**100,0**	—	—

Certains chiffres relatifs aux superficies maritimes sont surprenants. Par exemple, l'écozone pacifique-maritime ou système de l'océan Pacifique de la Colombie-Britannique constitue 8,3 % du total, chiffre nettement inférieur à ce que prévoiraient la plupart d'entre nous. On oublie souvent que seule la moitié inférieure de la Colombie-Britannique a accès à l'océan et que la partie supérieure de la province est concrètement isolée par l'avancée de l'enclave alaskienne. Par opposition à la côte Ouest, les écosystèmes maritimes centrés sur la région arctique (c.-à-d. n^{os} 17 et 18) représentent un pourcentage énorme de la superficie totale. L'écozone de l'Archipel arctique qui entoure le principal groupe d'îles arctiques représente à elle seule près de 40 % du territoire océanique du pays. En complément de son immensité, cet écosystème est passablement unique en comparaison du reste de l'écosystème arctique. Contrairement au reste de la région arctique polaire, les eaux marines de cette région constituent un vaste réseau d'écosystèmes aquatiques qui inclut le plus important groupe d'îles arctiques du Nord. Cette interface terre/eau constitue un habitat privilégié pour des espèces comme l'ours polaire. L'écozone du Bassin arctique est constituée des marais océaniques qui glacent rapidement de l'extrême nord-est du Canada. Étant donné que les terres humides constituent souvent une transition entre les véritables étendues d'eau et la terre, cet écosystème maritime constitue un système hybride qui possède les caractéristiques des paysages terrestres et marins.

Environ 8 % des quinze écosystèmes terrestres ont été protégés en vertu des catégories 1 à 6 de l'UICN. En comparaison, les efforts de protection et de conservation des écosystèmes marins ont été plutôt négligeables à ce jour. Patrimoine canadien (Parcs) et le gouvernement de la Colombie-Britannique ont entrepris avec passablement de succès une série d'interventions dans l'écozone Pacifique littoral. Dans les autres zones, Environnement Canada (Service canadien de la faune) s'est avéré l'organisme le plus efficace, assurant la conservation de plus de 2 918 891 hectares en constituant des refuges d'oiseaux migrateurs et de 174 673 hectares en créant des réserves nationales de faune. Nombre de zones protégées se situent dans des écozones arctiques. La nouvelle législation (c.-à-d. la *Loi sur les océans*) qui relève du ministère des Pêches et des Océans offre des possibilités complémentaires d'élargir le réseau des zones protégées du littoral.

Limites des 12 et des 200 milles

Les limites des 12 et des 200 milles nautiques constituent les deux délimitations territoriales les plus fréquemment citées dans les ouvrages consacrés au domaine maritime. Ces deux limites ont des répercussions précises en ce qui a trait aux mécanismes disponibles pour favoriser la création et la réglementation de zones maritimes protégées. En raison des règlements historiques relatifs aux frontières internationales, et compte tenu du règlement des litiges internationaux récents à propos des frontières ainsi que de l'interprétation précise des définitions juridiques, les chiffres obtenus lorsqu'on utilise l'une ou l'autre de ces deux limites sont plus éloignés qu'on pourrait le prévoir.

Le pourcentage de territoire correspondant aux limites des 12 et des 200 milles est pratiquement identique (tableau 2). Comment cela est-il possible? La Baie d'Hudson, baie maritime de forme circulaire située au cœur du Canada, a plus de 500 milles de diamètre. On pourrait s'attendre à ce que certaines parties de la Baie se situent entre les limites des 12 et des 200 milles nautiques. De tels secteurs sont considérés comme faisant partie des eaux maritimes intérieures du Canada et donc, d'un point de vue juridique et théoriquement, en deçà de la limite des 12 milles.

En vertu de la *Loi sur la faune du Canada*, des **réserves nationales de faune (RNF)** peuvent être créées dans les espaces terrestres et maritimes (en deçà de la limite des 12 milles). En vertu de la même loi, un mécanisme distinct s'applique entre les limites des 12 et des 200 milles nautiques, soit la constitution de **zones de protection marine (ZPM)**. Au sein de pratiquement la moitié des zones maritimes du Canada, le SCF peut envisager de protéger des secteurs fauniques pour des espèces particulières ou menacées, en vertu de la désignation des RNF, ou des ZPM au sein de l'autre moitié. Comme les ratios relatifs aux limites des 12 et 200 milles l'indiquent, le mécanisme des RNF revêt vraisemblablement moins d'importance dans les écozones Atlantique littoral et Bassin arctique.

Tableau 2. Zones territoriales et longueur de côtes des écozones maritimes

Nom de l'écozone	Superficie (sq. kms + %) à l'intérieur de la limite des 12 milles		Superficie (sq. kms + %) à l'intérieur de la limite des 200 milles		Ratio 12 - 200	Londueur de côtes (kms + %)	
16-Pacifque-littoral	102 920	3.7	457 646	8.3	1:4	13 342	5.4
17-Archipel arctique	2 051 393	73.5	2 178 998	39.3	1:1	157 535	64.6
18-Bassin arctique	24 997	0.9	704 849	12.7	1:28	NA	NA
19-Nord-Ouest atlantique	536 895	19.3	1 205 981	21.8	1.2	47 193	19.4
20-Atlantique-littoral	72 144	2.6	996 439	17.9	1:14	25 725	10.6
TOTAL	**2 788 349**	**100.0**	**5 543 913**	**100.0**	1:2	**243 795**	**100.0**

Longueur des côtes

La longueur des côtes dépend toujours de facteurs comme l'échelle de la carte de référence ou la géographie physique. Plus la carte de référence est détaillée, plus il est probable que les détails de la côte puissent être convenablement mesurés et représentés. Dans des régions côtières comme le Labrador, l'est de l'Île de Baffin et la Colombie-Britannique, on constate une nette différence lorsqu'on passe de cartes de référence au 1:1 000 000 à l'échelle 1:250 000. Les valeurs mesurées au Labrador sont multipliées par trois. Dans le cas des côtes peu accidentées et pratiquement rectilignes où figurent un faible nombre d'îles comme c'est le cas au sud de la Baie d'Hudson, les relevés de longueur des côtes peuvent être multipliés par 1,5.

Mesurée à des échelles intermédiaires comme le 1:500 000 ou le 1:250 000, la longueur en kilomètres des côtes du Canada est de plus de 243 795 kilomètres. La circonférence terrestre est d'à peine 12 756 kilomètres, soit 19 fois moins. Environ 65 % des côtes se situent dans l'écozone de l'Archipel arctique, alors que 19,4 % font partie de l'écozone Nord-ouest atlantique. Une longueur importante de côtes correspond aux fjords tortueux et à la myriade d'îles.

Le canevas des terres et des eaux douces fait partie intégrante tant des écosystèmes terrestres que des zones de conservation terrestres. En milieu océanique, les côtes et la mer elle-même constituent des éléments indissociables et indispensables des écosystèmes maritimes et des zones protégées. Les falaises maritimes, les îles côtières, les baies, les fjords, les secteurs situés à proximité du rivage et les plages sont synonymes indirects de " côtas ". Ces secteurs jouent un rôle important dans le cycle de vie global de nombreux organismes (c.-à-d. oiseaux, mammifères, crustacés) et systèmes marins. Ils abritent des colonies, tout en constituant des sites où les espèces peuvent se percher, pondre ou mettre bas, élever leur progéniture, se nourrir, se reposer et se réfugier.

Écosystèmes et limites administratives

Les principes sur lesquels reposent les programmes de zones protégées traditionnels différents selon les régions du Canada. Si certains mettent l'accent sur la représentation de l'écosystème, d'autres le mettent sur la productivité des habitats fauniques, sur les types de forêt, sur les réserves scientifiques ou sur d'autres critères. Toutefois, tous ces programmes s'inscrivent généralement dans des cadres basés sur des limites territoriales fixées par des mandats officiels ou correspondant à des frontières provinciales, territoriales ou nationales. Étant donné que les futurs programmes seront consacrés aux secteurs maritimes, la répartition entre les zones de compétence politique est intéressante (tableau 3).

Tableau 3 Répartition de la longueur des côtes entre les provinces

Nom de la province	Longueur de cotes (km)	Pourcentage de la longueur totale des cotes
Colombie-Britannique	25 725	106
Île-du-Prince-Édouard	1 260	5
Manitoba	917	4
Nouveau-Brunswick	2 269	9
Nouvelle-Écosse	7 579	31
Ontario	1 210	5
Québec	13 774	57
Terre-Neuve/Labrador	28 956	119
Territoire du Yukon	343	1
Territoires du Nord-Ouest	161 762	663
Total	243 795	100.0

C'est aux Territoires du Nord-Ouest que correspond la longueur de côtes la plus importante. Compte tenu de ce facteur, ainsi de que de la superficie importante des eaux marines et de la relative faiblesse des connaissances relatives aux systèmes marins d'un point de vue global, les provinces et les territoires dont relèvent les écosystèmes du Nord font face à des responsabilités importantes. Terre-Neuve et la Colombie-Britannique doivent également relever le défi associé à la longueur de leurs côtes. A l'échelon fédéral, des ministères comme l'Environnement (Service canadien de la faune), Patrimoine canadien (Parcs) et Pêches et Océans, assument des responsabilités qui transcendent l'ensemble de ces régions côtières.

Aller de l'avant

« Il fut un temps où le pays était recouvert d'espaces verts! » On utilise parfois cette expression pour décrire l'état des écosystèmes terrestres du Canada. Dans les régions situées plus au sud, l'expression a un certain degré de verité. L'écozone des Prairies, par exemple, a fait l'objet de transformations si radicales du fait des activités agricoles (c.-à-d. agriculture, élevage, parcs d'engraissement) que les espaces verts d'origine ont totalement disparu. Malheureusement, l'exploitation de ces écosystèmes en raison de leur richesse du point de vue de l'agriculture remonte bien avant la sensibilisation à l'importance des zones protégées. Quelle citation finirons-nous par utiliser pour résumer les progrès que nous aurons réalisés à l'échelon de nos zones marines?

Certains des travaux récents consacrés à la promotion d'un système national et complet de zones marines protégées ont été effectués à la fin des années 1980 et ils ont fait l'objet d'un compte rendu dans le cahier hors série n°9 du Conseil. Étant donné que jusqu'à récemment, les efforts concrets déployés pour mettre sur pied un système permettant la création d'un réseau complet de zones marines protégées demeuraient modestes, il convient de recenser les organismes possédant la capacité de mettre en œuvre un tel système. Compte tenu de la réduction des effectifs et des ressources qui semble généralisée à l'échelle des pouvoirs publics, il conviendra de mobiliser un volume important de synergie pour que des mesures significatives puissent se concrétiser en temps opportun. Le CCAE ainsi que nombre d'autres ONG, groupes scientifiques et particuliers concernés saluent les initiatives déployées par les ministeres fédéraux et provinciaux ainsi que le rôle de chef de file qu'ils assument.

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INVITED PRESENTATIONS

THE BIOLOGICAL BOTTOM LINE

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The situation for nature (biodiversity, habitat, creation) is grim. Prominent biologists claim that we are now midway into an unprecedented global extinction of species. Evolution is ending for most large species. The major, ultimate causes of the contemporary wave of habitat destruction and species loss are human population growth, technological innovation (*e.g.*, mechanized forestry and fisheries), and the globalization of commerce. For tropical nations, the correlation between population size (density) and the destruction of habitat is high.

Population growth, technology, and the new global marketplace contribute to the "evil quintet of destruction": (1) habitat loss and fragmentation, (2) pollution, (3) overexploitation (such as over-fishing), (4) the introduction of invasive species, and (5) global climate change.

How has society responded? Governments and the conservation establishment, encouraged by traditional economists, have said that we can "develop out" of environmental problems (sustainable development), but recent analyses have shown that sustainable development is not happening. Recently, the conservation establishment has responded by setting targets for the amount of habitat to be protected, such as the 10 to 12% guidelines. These guidelines may be justifiable politically, though this has not been established. It is clear, however, that in the tropics, the "success" of campaigns to set aside 10% may contribute to the extinction of, perhaps, 50% of Earth's species.

Can science come to the rescue? Conservation biology is a synthetic field that merges many traditional biological disciplines. Like the fields of forestry, agricultural science, and medicine, conservation biology is applied. The mission of conservation biology (or ecological sustainability in the broad sense) is to provide the theory and technology to accomplish the following five major objectives in all regions of the world:

1. Protect viable populations of all native species throughout their historical distributions;

2. Represent all native ecosystem types and seral stages;

3. abMaintain all ecological processes such as disturbance regimes, hydrological processes, biotic

   interactions (including predation), and ecosystem processes;

4. Allow for evolutionary processes, including natural selection and speciation;

5. Design and manage wildlands and waters to accommodate natural and anthropogenic environmental change.

Habitat destruction is the major problem. Its causes include farming, industrial forestry, livestock grazing, mining, urbanization, water projects, and road construction. These forms of habitat destruction also cause fragmentation of habitats — the creation of island-like remnants. The loss of species from habitat fragments (from small patches to large national parks) obeys certain rules. Conservation biologists have proposed guidelines for the maintenance of species diversity in such remnants.

1. Maximize the size of the habitat remnants, including reserves (management effort and expense per hectare must be intensified in inverse relation to the size of the remnant);

2. Minimize edge effects (*e.g.*, including those caused by roads);

3. Minimize the distance between remnant islands (nature reserves);
4. Protect large predators; they maintain ecological diversity;

5. Maintain or restore connectivity (landscape linkages);

6. Maintain the optimum scale, intensity, and frequency of disturbance;

Search out and destroy accidentally introduced alien species before they become invasive and destructive.

These guidelines may slow the rate of attrition, but they are no cure for massive habitat loss and fragmentation.

It is like coping with HIV. The immediate problem is biological (morbidity and death), but the fashioning of an effective strategy is social — changing people's behavior. Just so extinction. The science is necessary but not sufficient. What we need now is a compelling vision that inspires nations to protect ecological diversity and species richness within their boundaries.

The Wildlands Project is one example of such a vision. Inspired by such conservation heroes as Monte Hummel, Harvey Locke, and Dave Foreman, TWP challenges conservationists to embrace science while articulating a positive alternative to business as usual. The Yellowstone to Yukon project is one example.

LA LIGNE DE FOND SUR LE PLAN BIOLOGIQUE.

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L'état de notre nature (biodiversité, habitat, création) est inquiétant. Des biologistes de renom soutiennent que nous sommes rendus à mi-chemin sur la voie d'une extinction totale d'espèces sans précédent. Pour la plupart des espèces importantes, l'évolution est terminée. La croissance démographique, l'innovation technologique (p. ex., la mécanisation de la pêche et de la sylviculture) et la mondialisation du commerce constituent les causes principales et fondamentales de la vague contemporaine de destruction des habitats et de perte d'espèces. Dans les pays tropicaux, la corrélation entre la taille de la population (densité) et la destruction des habitats est importante.

La croissance démographique, la technologie et le nouveau marché mondial d'aujourd'hui contribuent aux « cinq volets irrémédiables de la destruction » : 1) perte des habitats et fragmentation; 2) pollution; 3) surexploitation (notamment surpêche); 4) réduction d'espèces parasites et 5) changement du climat global.

Comment la société a-t-elle réagi? Les pouvoirs publics et les spécialistes de la conservation, encouragés par les économistes traditionnels, ont affirmé qu'il était possible de se développer en surmontant les problèmes environnementaux (développement durable); toutefois, les analyses récentes ont prouvé que le développement durable est une illusion. Récemment, les spécialistes de la conservation ont réagi en fixant des objectifs en matière de pourcentage du territoire consacré aux habitats à protéger, notamment des normes de 10 à 12 %. Ces normes peuvent s'avérer justifiables d'un point de vue politique, même si cela n'a pas encore été prouvé. Il est clair toutefois que sous les tropiques, le « succès » des campagnes visant la « mise en réserve de 10 % du territoire » pourrait contribuer à l'extinction éventuelle de 50 % des espèces mondiales.

La science peut-elle venir à la rescousse? La biologie de la conservation constitue une synthèse de domaines qui recoupent nombre de disciplines biologiques traditionnelles. La biologie de la conservation s'applique en complément des domaines de la foresterie, de la science agricole et de la médecine. La mission de la biologie de la conservation (ou de la viabilité sur le plan écologique dans son sens large) consiste à fournir la théorie et la technologie requises pour accomplir les cinq grands objectifs suivants dans toutes les régions du monde :

1. Protéger les populations viables de toutes les espèces indigènes, sur l'ensemble de leur répartition historique;

2. Représenter tous les types d'écosystèmes indigènes ainsi que plusieurs étapes de ces écosystèmes;

3. Maintenir tous les processus écologiques, notamment les régimes de perturbation, les processus hydrologiques, les interactions biotiques, ce qui inclut la prédation, et les processus de l'écosystème;

4. Permettre les processus d'évolution, ce qui inclut la sélection naturelle et la différenciation des espèces;

5. Concevoir et aménager les terres vierges et les eaux de manière à permettre un changement environnemental naturel et anthropique.

La destruction des habitats constitue le problème essentiel. Au nombre des causes de cette destruction figurent l'agriculture, l'exploitation industrielle de la forêt, le pâturage du bétail, l'exploitation minière, l'urbanisation, les projets d'eau et la construction de routes. Ces formes de destruction des habitats provoquent également leur fragmentation, soit la création de reliquats des habitats semblables à des îlots de survie. La perte d'espèces provenant de ces habitats fragmentaires (depuis les îlots de taille modeste jusqu'aux parc nationaux de grande superficie) obéit à certaines règles. Les biologistes de la conservation ont proposé des normes en matière de maintien de la diversité des espèces dans ces fragments d'habitats résiduels.

1. Maximiser la dimension des habitats restants, ce qui inclut les réserves (l'effort d'aménagement et les dépenses à l'hectare doivent être augmentés en proportion inverse de la dimension de l'habitat);

2. Minimiser les effets lisière (p. ex., l'impact des routes);

3. Minimiser la distance entre les îlots restants (réserves naturelles),

4. Protéger les grands prédateurs; ils maintiennent la diversité écologique;

5. Maintenir ou restituer la connectivité (capacité de se déplacer d'un paysage à l'autre);

6. Maintenir une échelle, une intensité et une fréquence optimales des perturbations;

7. Rechercher et détruire les espèces non indigènes introduites par accident avant qu'elles ne deviennent envahissantes et nuisibles.

Ces normes sont susceptibles de ralentir le taux d'attrition, mais elles ne constituent aucunement une solution en cas de perte et de fragmentation massives des habitants.

Le problème s'apparente à celui du VIH. Le problème immédiat est biologique (morbidité et mort); toutefois, la mise sur pied d'une stratégie efficace repose sur des facteurs sociaux, soit un changement de comportement de la population. Le problème de l'extinction est similaire. La science est nécessaire mais elle ne suffit pas. À l'heure actuelle, cette vision incontournable incite les nations à protéger la diversité écologique et la diversité des espèces sur leur territoire.

Le projet Wildlands illustre cette vision. Inspiré par des chefs de file de la conservation comme Monte Hummel, Harvey Locke et Dave Foreman, le projet Wildlands met au défi les spécialistes de la conservation de se rallier aux scientifiques tout en concevant également d'autres options positives de remplacement du statu quo. Le projet Yellowstone to Yukon en constitue un exemple.

CONSERVATION OF ECOLOGICAL AREAS: THE ECONOMIC BOTTOM LINE

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Abstract

This paper suggests that there are no such things as economic benefits of Ecological Areas. There are only benefits, ecological, social, cultural, scientific, etc., that can sometimes be measured in economic terms. As a corollary to this, when someone talks about economic benefits, by which they generally mean jobs, spending in the local community, increased tax earnings to the government, what they are really talking about is economic activity that has been redistributed from somewhere else. And this can only be considered a benefit under some very restrictive assumptions.

The paper discusses these two propositions by examining the process by which the private sector and the public sector make the decision to invest. Basically, the private sector entrepreneur weighs the costs against the benefits (revenues) likely to occur from the investment. The public sector investor should do the same. However, for a variety of wrong reasons, the public sector entrepreneur has preferred in the past to use economic impact and visitor or tourist spending to justify the investment, not true benefits. The reason why this choice is wrong is discussed in theoretical terms.

It is, however, possible to measure true benefits (use benefits, existence benefits, ecological benefits, etc) in economic terms and use them to balance against costs in a way exactly equivalent to the decision-making process of the private sector investor. The paper gives empirical examples, particularly drawn from recent work done for Parks Canada, of studies that estimate an economic value for protected areas. This serves to demonstrate that true benefits can be estimated, and that the argument for protection is thereby strengthened.

Sommaire

Les auteurs du présent document affirment que les avantages économiques des secteurs écologiques n'existent pas. Ces secteurs n'ont que des avantages, écologiques, sociaux, culturels, scientifiques ou autres, qu'il est parfois possible de mesurer en termes economiques. En corollaire, lorsqu'on parle d'avantages économiques, ce qui signifie généralement des emplois, des investissements au sein de la collectivité locale et l'accroissement des recettes fiscales pour le gouvernement, on parle concrètement d'activité économique qui a été redistribuée à partir d'autres domaines. Cette redistribution ne peut être considérée comme un avantage que selon certaines hypothèses très restrictives.

Les auteurs du document analysent ces deux propositions en étudiant les processus mis à profit par le secteur privé et le secteur public pour prendre des décisions d'investissement. Essentiellement, l'entrepreneur du secteur privé compare les coûts aux avantages (recettes) susceptibles de découler de l'investissement. L'investisseur du secteur public devrait l'imiter. Toutefois, pour une diversité de motifs contestables, l'entrepreneur du secteur public a préféré jusqu'ici invoquer l'argument de l'incidence économique et des dépenses des visiteurs ou des touristes pour justifier l'investissement, en négligeant les véritables avantages. Le motif pour lequel ce choix est contestable fait l'objet d'une analyse théorique.

Il est toutefois possible de mesurer les vrais avantages (avantages liés à l'utilisation ou à l'existence, avantages écologiques, etc.) en termes économiques et d'en tenir compte pour effectuer une analyse comparative des coûts, exactement à l'image du processus de décision suivi par les investisseurs du secteur privé. Les auteurs du document fournissent des exemples empiriques d'études consacrées à l'estimation de la valeur économique des secteurs protégés, particulièrement des exemples tirés des travaux récents effectués par Parcs Canada. Ils font ainsi la preuve que les véritables avantages peuvent être estimés, ce qui renforce les arguments de ceux qui prônent la protection.

I'm here today to talk about the economic bottom line in the protection of ecological areas. Now, there are many people who would say that the phrase was redundant: that there is only the economic bottom line. If we are to prosper, all investment must be judged on the economic benefits it creates: jobs, revenue, contribution to gross domestic product. All this other stuff: ecological benefits, social benefits, pristine wilderness, biodiversity, are just luxuries that we indulge in at the expense of productive jobs. It is all very well to conserve ecological areas in times of prosperity, but when there are 1.3 million people unemployed in Canada, we need the jobs that exploiting these areas will create, or at least, we should not be diverting productive investment toward them.

You can generally recognize these people by the chain saws.

What I'd like to propose for your consideration today is quite a different view. I'd like to suggest to you that there is no such thing as economic benefits. There are only benefits, ecological, social, cultural, scientific and so on, that can sometimes be measured in economic terms. There is a corollary to this: when someone talks to you about economic benefits, by which they generally mean jobs, spending in the local community, increased tax earnings to the government, what they are really talking about is economic activity that has been redistributed from somewhere else. And this can only be considered a benefit under some very restrictive assumptions.

Let me explain what I mean. And let me start with the second statement: what we usually call economic benefits is really only redistributed economic activity.

Consider the case of a private sector entrepreneur who wants to invest in some money-making enterprise. The entrepreneur has to make a decision as to whether the enterprise will be profitable; in other words, whether it will return a net benefit. You can consider the decision as a balance. On one side of the balance, the entrepreneur puts the costs that the enterprise will entail, say 10 million dollars. Against this cost, the entrepreneur estimates, based on some combination of market research, experience, and gut feeling, revenue, or total benefit, will come to 15 million dollars. On this basis, the entrepreneur proceeds with the enterprise If things turn out as expected, what has really happened is that the market (meaning you and me as consumers) has judged that the 10 million dollars worth of plant, materials, wages and capitalist energy that the entrepreneur has combined into a product is now worth 15 million dollars to us collectively. In other words, 15 million dollars worth of benefits have been created out of 10 million dollars worth of materials. The entrepreneur has added 5 million dollars worth of value.

If, of course, revenues are only estimated to come to 8 million dollars, however, the entrepreneur won't make the investment.

In deciding to protect an ecological area by, for example, setting up a park, we face a very similar investment decision. Generally we know with some precision how much it will cost: say, 10 million dollars. But what do we put on the benefits side?

Well, to the extent that we market the park, that is, charga admission, camping fees and the like, we know we will make some revenue: about 2 million dollars. This is roughly the proportion of costs that Parks Canada receives in revenues. This is the equivalent of the entrepreneur's benefits. But we know that the park is worth more than this: we don't charge anything like what the experience is worth, and this is not the consumers' collective judgement about what the park is worth. So what else can we add to the benefits side of the balance to justify our decision to operate the park?

Typically, we add economic impact: the number of jobs and the amount of local spending that will take place when we operate the park. Economic impact occurs because we take some of the 10 million dollars that the park spends and we buy local goods and services. We hire some local people as employees and use some of the 10 million to pay their salaries. All our employees, locally hired or imported, spend some of their salaries in the local area on the necessities of life. This makes revenue for the local merchants and suppliers. They, in turn, spend some of this revenue in the local area when they buy goods and services from their local suppliers to supply the park. And so this spending percolates through the local economy, being spent over and over again and generating a whole chain of local benefits. This is the very familiar multiplier effect.

Any spending, by anyone, however — even our entrepreneur of a few minutes ago — has this percolating effect. So why didn't the entrepreneur take this into account when faced with expected revenues of only 8 million and decided not to invest? Because the entrepreneur wouldn't get any of this benefit. The local residents and merchants would, but all the money that goes to local people from the entrepreneur is viewed by the entrepreneur as a cost. The entrepreneur's return comes from the value added, not from the amount of money other people receive.

So why should we, as public sector entrepreneurs, be able to count this as a benefit, if the entrepreneur can't? The usual reason given is that the government, federal or provincial, is only investing on behalf of its constituents. Since the local people are constituents of the government, they are the «true» investors. Therefore, when they get a return on their investment in the form of additional jobs or spending, it is legitimate to count it as a benefit.

Now it is true that if a government jurisdiction pours public money into some region of Canada, the people of that region get something they would not otherwise have had. But, that money came from somewhere: in fact, it had to come from somewhere else in the jurisdiction. If the federal government is doing the spending, then the money came from somewhere else in Canada. If the New Brunswick government is doing the spending, then the money came from somewhere else in New Brunswick. And every dollar the government takes from elsewhere in its jurisdiction is destroying jobs through the exact reverse of the multiplier effect. So, if payments to local people as constituents count as a positive return on the investment made on their behalf by their government, then losses to other constituents of the same government in other parts of the jurisdiction must reduce that benefit, as they too are «true» investors. And the losses will always more or less equal the gains: immediately, if the jurisdiction is running a balanced budget; later, if the jurisdiction is deficit financing. All the government is doing through its spending and the multiplier effect is redistributing economic activity, not creating new benefits.

The reason the argument is compelling, however, is that the economic activity redistributed is all concentrated in one place and can be seen, while the economic activity that is lost is very diffuse. 10 million dollars poured into a small community of 500 people who happen to have the good fortune to live beside an area of ecological importance to us will have a very large effect: $20,000 per head. The loss, spread over 20 million Canadian taxpayers is half a dollar per head. It is well worthwhile for the 500 to lobby furiously for the expenditure and to extol its benefits to anyone who will listen, a politician looking for votes, for example. It is not worth it for the losers to get involved. So we have a proliferation of economic impact studies which purport to quantify an economic benefit, when really all they are saying is «My name is Paul and I am here to tell you that you should rob Peter for me.»

If we cannot use economic impact, we generally fall back on tourism. Can tourism spending tip the balance? The protected and developed ecological area will attract visitors who will come and spend money, not only on park fees, but on food, transport, accommodation, and souvenirs. They are spending their own money, not tax dollars, so surely they count.

Well, no, not really. Tourists come from somewhere too. And wherever they come from, they would have spent their money there if they hadn't come here. So again we see that tourists too are merely a redistribution of economic activity. If Paul is here visiting you, he is not visiting Peter.

Tourism is a bit more complicated, however. If people who would have visited some other part of Canada, come to the park, all we are doing is redistributing. If people from the United States visit the park instead of visiting some other part of Canada, all we are doing is redistributing. But, if people came from the United States to visit the park who would otherwise not have come to Canada at all, that could count as a net benefit. Furthermore, if people stay in Canada to visit the park, when they would otherwise have gone south for their vacation, that would seem to be a net benefit too. From the point of view of the taxpayer/entrepreneurs of Canada, it is okay to rob the American Peter to pay the Canadian Paul. It is still redistribution, but that's fair game as long as it does not hurt other Canadians. Of course, that is just because there is no North American jurisdiction. The Tourism Departments of Maine, New Hampshire, Vermont, New York, and Pennsylvania are plenty steamed. They view it as theft. The same thing would apply to a New Brunswick operated park robbing tourists from Quebec or Nova Scotia. From the point of view of the New Brunswick taxpayers, it is justified to consider that tourism spending a benefit.

That is what I meant when I said that we can only consider redistribution of economic activity as a benefit under very restrictive assumptions.

So is this all we get, a few paltry revenues, and the few tourists I'll allow you to count? It hardly seems enough to tip the balance.

Remember my first statement, «There are only benefits, ecological, social, cultural, scientific, *etc.* that can sometimes be expressed in economic terms.» This is where we see the real economic «bottom line.» We have already been told about some of the benefits in the previous presentation and I think we are going to be told more in the next presentation. I do not want to repeat or anticipate what my colleagues on this panel are going to say more clearly and intelligibly than I ever could, but I do want to make superficial reference to the whole range of benefits of conservation of ecological areas which has appeared in the literature, in order to talk about how we can measure some of these benefits in economic terms, and so show a more favorable balance.

There are lots of lists of benefits, classified in different ways, that identify the ecological, social, scientific, cultura, and other benefits that are created by an ecological area, especially when it is conserved and some form of managed access is provided to it. Peter Whiting (1996) recently developed such a list for Parks Canada, shown as Appendix 1 Here you can see that there are benefits produced by both direct and indirect use, by the sheer existence of the protected area, and by a variety of other uses to which the area can be put. Whiting has put the redistributive economic effects of ecological area operations into a special category called Business Benefits, and he stresses that they are only benefits under a very limited set of assumptions by calling them «economic impact of spending originating outside the area» (italics mine). I too developed, some time ago, a benefits framework (Stanley 1997) that identified much the same values, but clearly stuck those redistributive effects in a different column. See Appendix 2.

Recently as well, the IUCN undertook two parallel initiatives to articulate the benefits of protected ecological areas, one (IUCN 1996) called "Economic Assessment of Protected Areas," and the other Barbier *et al.* 1997) called "Economic Valuation of Wetlands." The first, on protected areas (Appendix 3), I have argued elsewhere is badly flawed (Stanley 1997), because it does not differentiate between redistributive effects and real benefits, but it does point to some very interesting and correct economic benefits that protected areas can produce. Tourism and Operating Costs are the redistributive items that I think are not clearly dealt with, but the other items are what is of interest. These benefits (and costs) have been picked by the authors because they all have direct market equivalents that can be used to estimate their value, and so, in the authors' view, will be highly credible in defending protected areas from pressures to develop them. An example will suffice to make this clear. In Australia, a very dry country, the majority of the population of the country gets its water from watersheds that happen to be protected in National Parks. These parks constitute natural dams, reservoirs and filtration plants, which would have to be replaced by vast capital works at great expense if the natural processes inherent in the parks were not left to work by themselves. Now many places in the world have built dams, reservoirs and filtration plants to provide a water supply to their populations, and water is sold to people through municipal and other governments. I get a water bill every month. So it is a fairly easy thing to determine what a public supply of water costs and what the public is willing to pay for it. Applying this to the Australian situation, it is possible to estimate credibly the benefits that the Australian National Parks produce for free: a clear benefit expressed in economic terms.

Wade Locke, an economist at Memorial University in St. John's, is in the process of completing a preliminary assessment of this list at Gros Morne National Park (Locke 1997). He has examined each of the categories the IUCN proposes, and tried to determine if such benefits are produced by the existence of the park, and how to go about measuring them (Appendix 4). He has found a number of different types of potential benefits that could be measured in economic terms. Unfortunately, this is just a feasibility study, so he did not have the scope to actually conduct quantification. We are hoping to find financing in the near future to actually undertake some of these studies.

The second IUCN paper is a more satisfactory benefits framework than the first (Appendix 5), in my view, because it is more comprehensive and does not mention redistributive effects at all. This list contains, I think, all the major benefits that have been identified in the literature. You will see here some categories such as use benefits (direct and indirect), non-use benefits, such as existence benefits, and some of the commercial benefits that the previous IUCN guideline identified.

Let us look at examples of some of the benefits identified in these frameworks and see how they could be measured in economic terms.

Use benefits are produced when someone uses a protected area for recreational purposes. Most campers or canoeists will admit, when questioned, that the true value of the benefits they experience in the wilds far exceeds the paltry admission price they pay. There are two main ways in which this true benefit has been measured: revealed preference and contingent valuation. Revealed preference consists of observing the spending behavior of people as they visit parks, and imputing that spending to their experience. For example, if I spend hundreds of dollars to travel a great distance to canoe in Quetico Park, I obviously think that the experience was worth the money. Just because you live near the park and have to spend much less to get the same experience doesn't mean that you get anything less out of it than I do. All it means is that you got some consumer surplus that I did not. We can measure how much people actually spend to enjoy a benefit, impute those expenditures to others who, throught fortunate circumstances, did not have to pay the full costs, and so derive an economic measure of the total benefits received. The other main method, contingent valuation is a very fancy name for asking people directly what they would be willing to pay to do something, or what compensation they would be willing to accept to forego the possibility of doing it.

Walsh *et al.* (1992) have extensively documented studies in which contingent valuation was used to measure the economic benefits of recreational experiences. Coopers and Lybrand (1995) recently updated these values and adjusted them to Canada when they studied the value of use benefits for British Columbia parks. Tables 1 and 2 are adapted from the Coopers and Lybrand report. Table 1 lists some of the values Walsh found. To get the numbers in Table 2, Coopers and Lybrand used a weighted average of the values of each activity for day users and for campers and used Walsh's value directly for boaters. They adjusted the U.S. dollars to Canadian equivalents for 1993. As you can see, the values are quite impressive. They estimated that the BC Parks system as a whole produced a user benefit of $716 million in 1993. This amount is made up of the amount they paid in revenues, and the amount of consumer surplus that they received that they did not have to pay for. So we can certainly put use benefits into the balance to help us boost our economic bottom line.

Table 1. Walsh's Estimates of Benefits of a Day of Activity

Activity	Benefit to Visitor of One Day of that Activity in Dollar Terms (1993 $U.S.)
Picnic	17.33
Beach	17.33
Swimming	22.97
Fishing	30.62
Bicycling	18.82
Long Hike	29.08
Short Hike	18.82
Use Visitor Centre	22.20

Table 2. Use Benefits Produced by B.C. Parks, 1993

Activity Grouping	Weighted Average User Day Benefit in Dollar Terms (Cdn $, 1993)	Number of User Days (millions)	Total Benefit ($ milions)
Day Users	30.90	19.7	609
Campers	33.17	2.6	86
Boaters	49.84	0.4	21
Total			716

The most interesting and, I think, significant non-use benefit is existence benefit. This is the benefit that, for example, we all receive as citizens of Canada because of the existence of a system of National Parks, whether we use them or not. I am certainly happier that we live in a country that has preserved significant parts of our natural heritage and that they will be there for future generations to appreciate. This is a source of pride for me and, I am sure, for you as well. Public opinion surveys (Environics 1996; EKOS 1996) have documented that far more Canadians take great pride in their National Parks system than will ever visit them and that National Parks are an important reason they feel an attachment to Canada. This pride and satisfaction has an economic value. Kimberly Rollins of Guelph University undertook a study, partially funded by Parks Canada, (Gunning-Trent and Rollins 1995) in which she conducted a contingent valuation study of the amount Canadians would be willing to pay to see the establishment of four National Parks in the north. She estimated the worth to Canadians of those parks at between one and two billion dollars. Lest you think this number exaggerated, put it in this context. If there are 20 million Canadians over the age of 15 and if only half of them are interested in paying for the establishment of the parks, and they were asked to contribute each year in a door-to-door campaign over their working lifetimes, say 30 years, then one to two billion dollars would only amount to an annual contribution of between $3 and $7. How much do you contribute annually to the Cancer Society or the Heart Fund? How much do you contribute to Greenpeace, a much more controversial and less popular cause, or to the World Wildlife Fund? I would not suggest that one billion was a hard number which I would take to the bank. But it does indicate that existence benefits represent a significant value that can be expressed, albeit more or less well, in economic terms.

Continent valuation has been used in the United States to determine the amount that oil companies must pay in compensation for oil spills (see, for example, Rowe *et al.* 1991). In the case of the Nestucca oil spill in Washington State in 1988, Rowe *et al.* estimated that the residents of Oregon, Washington, and British Columbia put a value of $3.000 on each bird that had to be cleaned up. A panel of distinguished social scientists put together by the National Oceanographic and Atmospheric Administration and led by Robert Solow, the so called NOAA panel (NOAA 1993), did an extensive review of contingent valuation methodologies, and judged that they were a legitimate technique for assigning economic values to hitherto intangible environmental benefits. This has had some considerable effect in the courts in the United States, in enabling them to reach hard dollars-and-cents judgements on compensation for environmental damage. So I think it is fair to add the economic value of existence benefits to our balance.

I have already given an example of the measurement of commercial benefits such as water production by protected areas. These were amply documented by the IUCN, and by Wade Locke, so we can add these benefits to the balance as well.

I don't think I need to go on and deal with every one of the benefits that the IUCN or Peter Whiting or others have documented. Many can be estimated in economic terms, more or less well. They can be legitimately included in the balance to help us construct an economic bottom line. But most important, I think they confirm in empirical, economically quantified terms, what most ecological area managers and planners knew already: that the benefits of ecological areas are substantial. They can often be measured in economic terms, which means they produce real economic benefits. This is the real economic bottom line.

Now I'm not advocating that every time we want to establish or operate a park or establish a protection program for an ecological area that we have to or ought to conduct a whole series of contingent valuation studies to estimate consumer surplus, or existence values, or measure the extent of water production. I think a few case studies, such as the one we are trying to do in Gros Morne, and like Coopers and Lybrand's BC study will suffice to illustrate the point and provide the evidence that planners need to make their case. There may be occasions when the preservation decision is so controversial that special studies will have to be done. The Temagami forest might be a case in point. But in general, a recognition that these benefits have substantial economic value, and this value has been unambiguously demonstrated throughout North

America in situations not dissimilar to the ones that face you every day should be sufficient. They have certainly convinced me, an economist and a cynic, that there are a variety of benefits, ecological, social, cultural, and scientific that can be measured in economic terms, so that we do not have to rely on the questionable "economic benefits" of redistributed economic activity

And that is my bottom line.

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Appendix 1

Benefits of Protected Areas as Identified by Whiting

Personal Benefits
- Use Benefits
  - direct
  - indirect
  - future
- Non-Use Benefits
  - option
  - existence

Business Benefits
- Economic impact of spending originating outside of the area

Societal Benefits
- Health
- Resource Integrity
- Worker Productivity
- Ecological Functions
  - Natural Services
  - Water Production
  - Mitigation of Natural Disasters
  - Fish Spawning and Breeding

Educational Benefits
Scientific Benefits
International Responsibilities

Appendix 2

Benefits of Protected Areas as Identified by Stanley

	True Incremental Benefits	Redistributed Economic Effects
Direct Use of Area for Primary Purpose (protection, understanding, and enjoyment of resource)	Paid Use (= revenues) Unpaid Use (= consumer surplus)	
Indirect Use of Area for Primary Purpose	Indirect Use (books, TV) Existence Benefits Option Benefits Bequest Benefits	
Use for Collateral Purposes	Natural Services Water Production Ecological Functions Health Effects	Tourism Spending Protected Area Operations Spending (economic impact)
Externalities	Worker Productivity Biodiversity Scientific, Education Benefits Amenity Benefits	

Appendix 3.

Economic Benefits and Costs of Protected Areas that have Direct Market Equivalents as Identified by the IUCN

BENEFITS

1. Tourism
2. Natural Services
3. Water Production
4. Mitigation of Natural Disasters
5. Fish Breeding
6. Hunting and Gathering
7. Commercial Activities

COSTS

8. Operating Costs
9. Natural Damage
10. Displaced Economic Activities

Appendix 4.

Detailed Benefits of Gros Morne National Park

Category of Benefits	Examples	Measurement Suggestions
PERSONAL BENEFITS		
Use Values		
direct	domestic timber, snaring fishing	transfer market values; ensure that these uses do not conflict with other uses
indirect	hiking, boating, cross-country skiing, kayaking, and swimming	actual payments associated with activity combined with estimation of consumer surplus (reveales market information or contingent-valuation/stated-preference surveys)
future	direct and indirect uses enjoyed by future generations	estimate future use value based on present use value; social discount rate required
Non-Use Values		
option	willingness to pay to preserve the option of enjoying personal use of Gros Morne National Park in the future	contingent-valuation/stated-preference survey required for nonmarket valuation
existence	value to Canadians associated with knowing that Gros Morne National Park is available for future generations to enjoy	contingent-valuation/stated-preference survey required for nonmarket valuation
bequest		contingent-valuation/stated-preference survey required for nonmarket valuation
BUSINESS BENEFITS		
Economic Benefits	tourism spending from non-residents of Canada (maybe even smaller regional issues) on camping, co-op bookstore	values can be derived from economic impact studies performed previously (care taken to determine the true benefits - not redistribution); also ensure that there is no double counting associated with personal benefits

Appendix 4.

Detailed Benefits of Gros Morne National Park (continued ...)

Category of Benefits	Examples	Measurement Suggestions
SOCIETAL BENEFITS		
Ecological integrity		
Ecological processes		
Primary productivity	energy captured by the 'base' of the food web	published values for different land uses; determine the total energy capture and compare to adjacent or other land use - leterature survey required
Energy flow	energy flows through the food web	determine the upper level carnivore biomass in thepark versus alternative land uses - literature survey required
Fixing of nutrients	fixing nutrients calcium, carbon, nitrogen, phosphorus	amount fixed by forest/land use multiplied by the area within that forest/land use and compare to adjacent or other land use - literature survey required
Cycling of nutrients Nutrient	cycling of nutrients within a system	leaching/losses from commercial versus natural forests - literature survey required
Soil information	biological activity which creates productive soils	soil productivity of natural versus commercial forests - literature survey required
Watershed protection		
Groundwater recharge	annual groundwater recharge	estimate groundwater recharge and compare to alternative land uses; data to be obtained from government sources - soil types, land uses/cover and annual rainfall
Water quality	filtration as water moves through soils	using soil types and scientific data to estimate the amounts of pollutants that can be filtered by the park - literature survey required
Erosion/flood control	prevention of erosion and flood	estimate erosion/runoff and compare to alternative land uses; data to be obtained from government sources - soil types, land uses/cover and annual rainfall

Appendix 4.

Detailed Benefits of Gros Morne National Park (continued ...)

Category of Benefits	Examples	Measurement Suggestions
Biodiversity		
community structure	natural species composition	examples of plant/animal species and relative abundance; current list needs to be updated
rare species protection	protection of species that are rare or found only within the area	itemize rare species - compare to species lists for alternative land uses outside park; more research needed to identify threatened species
genetic conservation	interaction between	genetic conservation improves fitness and allows for continued survival in the face of stress; more research need for measurement
keystone species	species/services provided by one species to others	use examples to demonstrate the importance of some 'key' species in Gros Morne National Park - Woodland caribou a likely candidate for keystone species
Health and Worker Productivity Effects		
health	activities such as hiking and cross-country skiing contribute to reduced hospitalization	trail counter combined with length of trails and transferred estimations of the health care savings - overestimate of the contribution provided by Gros Morne National Park specificially; benefits may overlap with personal
productivity	recreational activities also contribute to reduced absenteeism and improved productivity	visitor information and transfer of benefit values - over estimation of the contribution provided by Gros Morne National Park specifically; benefits may over with personal

Appendix 4.

Detailed Benefits of Gros Morne National Park (continued ...)

Category of Benefits	Examples	Measurement Suggestions
Education and Scientific Benefits		
education	interactive program and educational visits	number of visitors - estimate willingness to pay for educational services; benefits may overlap with non-use personal benefits
scientific	ongoing research within Gros Morne National Park is encouraged; particularly thatwhich leads to a better understanding of the functioning of the ecosystem and the determination of species richness, abundance, and so on	numbers/types of research projects; a significant finding has been the verification of the theory of plate techtonics
Business Location		
quality of life, community cohesion	proximity to Gros Morne National Park important to location decision for business and quality of life	number of doctors per capita; also survey local businesses to determine this impact - may conflict with productivity and health effects

Appendix 5.

Benefits of Wetlands as Identified by IUCN

Use Values			Non-Use Values
Direct Use	**Indirect Use**	**Option and Quasi-Option**	**Existence**
- fish - agriculture - fuelwood - recreation - transport - wildlife harvesting - peat/energy	- nutrient retention - flood control - storm protection - groundwater discharge - external ecosystem support - micro-climate stabilization - shoreline stabilization	- potential future uses - future value information	- biodiversity - culture, heritage - bequest values

WHY PARKS MATTER: THE FUTURE ROLE OF PROTECTED AREAS IN LOCAL, NATIONAL, AND GLOBAL CULTURE

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Abstract

As the new century begins, the issues surrounding national parks and protected areas make their final shift from allocation (how many hectares and where) to stewardship (how to sustain those hectares). Challenges facing the world park movement are extraordinary and difficult. The future role of protected areas in local, national, and global culture is unlikely to remain static in the face of inexhaustible demands, constrained fiscal resources, entrenched regimes of power, and emerging new sciences. The dilemma of sustaining a 19th century idea in the 21st century is a central concern for those (like the CCEA) who would "protect biodiversity in perpetuity."

Sommaire

À l'aube du prochain siècle, les enjeux associés aux parcs nationaux et aux zones protégées évoluent de manière définitive; après avoir été préoccupés par la question de la répartition (nombre d'hectares et emplacements), les responsables se soucient de gérance (comment assurer la conservation de ces hectares). Le défi auquel est confronté le mouvement mondial des parcs est extraordinaire et complexe. Le rôle futur des zones protégées au sein de la culture locale, nationale et mondiale ne devrait pas demeurer statique compte tenu des exigences sans cesse renouvelées, de la restriction des ressources financières, de l'immobilisme des régimes de pouvoir et de l'apparition des nouvelles sciences. Le dilemme du développement durable, concept du XIX^e siècle appliqué au XXI^e siècle, constitue une préoccupation cruciale pour ceux, à l'image du CCAE, qui souhaitent « protéger la diversité à perpétuité .»

In the heart of Nanging, China is a large and traditional park. In its interior, it has an expansive, broad lake. On the shore of Schuanwuhu there is a small boat rental where you can rent small wooden boats with lanterns. So I went down to the shore one night; one beautiful evening like last night here in Fredericton, to rent a boat. The dock was empty. All boats rented. And I looked out on the lake at Schuanwuhu and it was dark, just sighs and whispers. Schuanwuhu, that night, was used for courtship.

There is a lesson there for us experts: conservationists, park managers, interpreters, environmental education specialists, GIS operators, research biologists, economists, and sociologists. Parks matter for lots of reasons and one of them is love.

What I would like to share with you is relatively straight forward. Parks have a wide range of values and their future role locally, nationally, and globally largely depends on protecting the full range of those values. It has become fashionable to speak of parks in metaphors, parks are a zoo or parks are not a zoo, *etc.* and I will be occasionally guilty of that fashion. In addition, my views are mine and not those of the US Parks Service, as you will soon find.

First, as Michael elegantly stated, parks matter for ecosystem values. They provide habitat, edge, context, refuge. Their services, ecosystem services which is a carefully defined piece of rhetoric, can be measured: kilocalories of energy, liters of fresh water, meters of wood, kilograms of biomass, numbers of species — all in various recipes of output. It's as if nature is some kind of cook and parks are elaborate gourmet kitchens where certain treats are served up. At the local level, the services are often modest except for flood control and a source of food or local sustenance. Kenyan National Park is a source of meat for locals. We know that flood control matters For example, in the 1960s, when the dam blew at Grand Teton and the community downriver was harmed. And Schuanwuhu is a source of fish during the day. At the regional level, these services are actually critical and as development plunders Asia, South America, and Africa and suburbanization pauperizes much of North America and Europe, parks, as nature's unique kitchens, are likely to stand in stark contrast to what can only be described as zones of plunder.

At the global level, the contributions of protected areas to ecosystem services becomes modest again. Empirical estimates of the contributions of parks to carbon storage, erosion control, water quality or even biological diversity at global levels are difficult to come by and require immense assumptions.

Second, as Dick described, there are values that can be rethought as economic values. Parks can be economic engines for local economies, creating jobs, wealth, capital, debt, credit, profit, economic competition, unemployment, inequality, and rampant inflation.

Ecotourism is still tourism, and tourism stripped of its Victorian concern with self improvement is stark. At its core, it is rich people going to where poorer people live to have fun. It doesn't usually work the opposite way.

Some of these economic values can be measured: dollar costs and dollar benefits, number of jobs created, inferred dollars of existence, option values, continent valuation, willingness to pay, and so forth. It's as if nature is an investment councillor known for taking bad risks And parks are an investment opportunity. This argument increases at all levels as local agencies seek jobs, regional entities seek rural development, and nations seek balance of payments in the Olympics.

"User pays" has become fashionable and rents can be created for almost anything. In South Africa's National Parks, like Kruger National Park, visitors must pay in advance for their water and energy, receiving a small button that they put into a meter that gives them only so much to teach them conservation

In the US Forest Service, they are now renting out abandoned fire-watching towers for romantic trysts, suggesting that what I saw in Schuanwuhu is repeated in culture after culture.

At Grand Canyon National Park, using one of the great euphemisms of economic benefits of parks: cost recovery, you must not only pay for getting your name on a list to float the Colorado, not only for the permit to actually float on the Colorado, not only for the back country permit, but now you must pay an annual fee to stay on the computer list to have the chance to pay for the permits. Twenty-five dollars a year cost recovery to stay on a computer list.

A third kind of value is social value. Mark Sagof wrote an insightful response to Costanza's research group's effort to price out global ecosystem services. Costanza *et al.* calculated the current economic value his term of the entire biosphere was worth between 16 and 54 trillion dollars with an average year of about 33 trillion. Mark Sagof argues that there are problems with that calculation and that not all values can be so commodified and priced. Fine and good.

But what caught my eye was the way he started his article with the Drifters — their 1962 song, remember?

"At night the stars put on a show for free
And darling you can share it all with me
Up on the roof whoowee."

That caught my attention because I knew the Drifters definitely knew what was happening.

Parks have values to society beyond ecological services and beyond economic values. They are some of our most important common ground. We need them as common ground for our communities, our neighborhoods, our cities, our provinces, our cultures, our nations. We need them for play, for release, for relaxation, for competition, for laughter, for love, for patriotism, for commemoration — and we make decisions in non-economic terms.

The British government during the height of the air war over London, decided that the giant panda at the London Zoo would stay because to evacuate the panda would harm morale and it was one of the few mammals left at the London zoo to go through the blitz. It lost its hair in the air raids, it got sick, and it became a hero of the battle.

In 1942, the US, faced with a set of defeats the Pacific, had to decide if they would log Olympic National Park for spruce to build wing gliders. In Congress, the debate raged while the US was not victorious in the darkest days of the war in the Pacific: Should we log Olympic to save the republic? The answer was no, for that is what we are fighting for. The decision was not economic.

Central Park in New York City recently hosted thousands and thousands of people to listen to Garth Brooks. No matter what you think of Garth Brooks' music, the fact that you could get more than 100,000 New Yorkers together with low levels of violence to enjoy one single thing, makes Central Park critical.

You could measure all this. One way we could measure it is the percentage points of popularity decline to politicians who want to shut parks down; or the number of hours of exercise and skill, and socialization making us good citizens by walking and recreating and enjoying nature. When we do that we drift toward prudishness, nature is some kind of stern teacher, and parks as playgounds for approved activities, so that Yellowstone becomes just a pilgrimage and Galapagos Islands becomes an ecotourism trophy for the elite. But in an era of growing tribalism, where we wear our identities on our sleeves and on our t-shirts and in our attitudes toward others, parks as common ground will become more and more important and sometimes, as the Drifters told us, "nature puts on a show for free" if we can only enjoy it.

Fourth are spiritual values. Spiritual values associated with parks and nature have a historical cycle in North America and we currently live in a veritable cafeteria of spiritual values. Go to a contemporary bookstore. The new age section is three times as long as history and science combined. There is argument that parks and the nature they contain embody sacred values of harmony, of beauty, of goodness, and while there is something disconcerting with conflating the beauty of Grand Canyon with personal spirituality, for a select and growing few it is real and it is heartfelt. Can it be measured? Perhaps, but not necessarily with insight.

In the future, I would not be surprised to see a heightened spirituality associated with nature and protected areas. It will come from select groups at national and global levels and in the 21st century selected parks may well become shrines; park visits holy pilgrimages; those that would oppose parks treated as blasphemers, antichrist or worse. The thin line between reverence and fetish can and will be blurred with uncomfortable results; uncivil and smug self-righteousness.

I argue that parks matter for all those values. They are a kind of kitchen and they do provide ecosystem services. They are economic engines and they do provide jobs and wealth. They are social glue, a common ground, and they do provide for communitas and sharing. They are spiritual sanctuary and they do provide for religious fervor.

They have all those values, and here is the crux of my argument. A protected area is only as protected as its weakest value. In other words a robust park or a well-protected protected area requires the demonstration of all values. It cannot be bereft of ecosystem value, it must in fact be bountiful. It must provide for economic opportunity, it must provide for common ground for shared social values and it cannot be bereft of spiritual values. If parks have all these values they are likely to survive in the 21st century, with vigilance and care. If parks don't have these values or if their keepers refuse them or are ignorant of them, the parks are doomed. And that's my answer for the bottom line. So what? What has this to do with contemporary effort, with this meeting? Or your theme?

Here are a few practical suggestions. First be cautious of single-factor explanations or excuses; making the conservation argument on one kind of value alone is risky business. Second, the role of protected areas in the near future will depend on all these values: ecosystem, economic, social, and spiritual; hence the struggle must proceed on all fronts and that means the fate of parks and protected areas is not just in the hands of scientists, but interpreters, maintenance workers, secretaries, administrators, friends groups, teachers, ministers, citizens, visitors.

I know of no significant park management problem that can be solved by one division within an agency. I know of no one significant management problem in a park that can be solved by one scientific discipline.

A brief conclusion — as you go about the rest of the meeting — useful, creative and important, I urge you all to reflect on the range of values discussed this morning, and if tonight is as pretty as night as last night in Fredericton, go up on the roof, do what the Drifters say and watch those stars put on a show for free.

PLANNING FOR BIOLOGICAL CONSERVATION

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Abstract

Biological conservation refers to the protection of indigenous biodiversity at the levels of population, species, community, and landscape (or seascape). Biological conservation requires an integration of : (1) ex situ approaches, including laboratory research into the biology of species-at-risk, captive-breeding programs, gene banking, and other work occurring outside of wild habitats, and (2) in situ approaches, such as the designation of protected areas, and integrated efforts to conserve biodiversity in "working areas" that are used more intensively.

A broader goal of planning for in situ conservation is to protect ecological structures, functions, and dynamics that may be required to sustain indigenous biodiversity in wild habitats. If this goal is to be realized, certain kinds of knowledge must be obtained by undertaking programs of monitoring and research relevant to: (1) changes in environmental stressors, including disturbance dynamics, (2) ecological responses to environmental change, and (3) conservation biology. This knowledge is required to support effective planning for the conservation of biodiversity in both protected and working areas. Planning for biological conservation also requires that gap analyses be undertaken to identify which elements of indigenous biodiversity are adequately protected in the management region, and which are at risk because of anthropogenic or natural stressors. Information from gap analyses is crucial for setting objective priorities for conservation actions.

Sommaire

La conservation biologique renvoie à la protection de la biodiversité indigène aux échelons de la population, des espèces, de la collectivité et des paysages terrestres ou marins. La conservation biologique nécessite l'intégration des volets suivants : 1) approches ex situ, ce qui inclut la recherche en laboratoire portant sur la biologie des espèces à risque, les programmes de reproduction en captivité, les banques génomiques et d'autres travaux effectués à l'extérieur des habitats sauvages et 2) approches in situ, notamment la désignation des secteurs protégés et les efforts intégrés en vue de maintenir la biodiversité dans les « secteurs d'activités. » qui sont exploités de plus en plus intensivement.

La protection des structures, des fonctions et de la dynamique écologiques susceptible d'être requise pour maintenir la biodiversité indigène dans les habitats sauvages constitue un objectif élargi de la planification de la conservation in situ. Pour que cet objectif se concrétise, il convient d'obtenir certains types de données en entreprenant des programmes de suivi et de recherche en rapport avec les facteurs suivants : 1) changements des facteurs de stress environnementaux, ce qui inclut la dynamique des perturbations; 2) réactions écologiques aux changements environnementaux et 3) biologie de la conservation. Ces connaissances sont requises pour appuyer une planification efficace en vue de la conservation de la biodiversité tant dans les secteurs protégés que dans les secteurs d'activités. La planification de la conservation biologique nécessite egalement des analyses des faiblesses afin de préciser quels sont les éléments de la biodiversité indigène qui sont convenablement protégés dans la région qui fait l'objet d'un programme de gestion et quels sont ceux qui sont à risque en raison de facteurs de stress naturels et anthropiques. L'information tirée des indices de faiblesse est essentielle à la fixation des objectifs prioritaires des mesures de conservation.

Much data relevant to planning for the conservation of biodiversity has a spatial context. Conservation Data Centers (CDCs) are an extremely powerful tool used for planning for biological conservation. CDCs have been developed by The Nature Conservancy (U.S.), and are based on a geographic information system that is specifically designed for the collection, storage, analysis, and portrayal of spatially based biodiversity data. In addition to this information system, CDCs include a systematic process of prospecting for existing and new field data of conservation interest. CDCs are organized as an integrated network of sites using compatible methods and technology. They are operational in all American States, in various countries in Latin America, and in all major Canadian jurisdictions except the Atlantic Region. Efforts are being undertaken to address the latter deficiency.

Une grande partie des données reliées à la planification en vue du maintien de la biodiversité ont un contexte délimité dans l'espace. Les centres de données sur la conservation (CDC) constituent un outil extrêmement puissant de planification de la conservation biologique. Ces CDC ont été conçus par The Nature Conservancy (É.-U.); ils reposent sur un système d'information géographique spécialement conçu pour la collecte, la mémorisation, l'analyse et la description de données sur la biodiversité, qui est axé sur un cadre délimité dans l'espace. En complément de ce système d'information, les CDC incluent un processus systématique de recherche sur le terrain de données existantes et nouvelles qui présentent un intérêt du point de vue de la conservation. Les CDC sont structurés sous forme d'un réseau intégré de sites qui utilisent des méthodes et une technologie compatibles. Ils sont opérationnels dans tous les États américains, dans divers pays d'Amérique latine et dans toutes les grandes régions canadiennes à l'exception de la région de l'Atlantique. Des efforts sont entrepris pour combler cette dernière lacune.

Introduction

The term biological conservation, in its use here, refers to the protection of indigenous biodiversity values at the levels of population (including genetic variations), species, community, and landscape or seascape. This is rather different from another possible interpretation of the term, which could refer to the conservation of biological resources, in the sense of the "wise" or sustainable use of potentially renewable natural resources.

Biological conservation requires an integration of *ex situ* and *in situ* approaches. *Ex situ* approaches include: captive-breeding programs, gene and seed banking, laboratory research on the biology of endangered species, and other actions occurring outside of wild habitats. *In situ* approaches, which are the focus of the present analysis, include: the designation of ecological reserves and other kinds of protected areas, integrated efforts to conserve indigenous biodiversity in "working areas," and other means of protecting biodiversity in its wild habitats. Ultimately, a broader goal of both *ex situ* and *in situ* approaches is the conservation of those ecological structures, functions, and dynamics that are required to sustain all elements of indigenous biodiversity in wild, unmanaged, self-organizing habitats.

Key Elements of Effective Planning for Biological Conservation

Comprehensive planning for biological conservation involves the design and application of various strategies, in an integrated manner. The most important elements of planning are intended to deal with the following requirements for effective conservation of indigenous biodiversity:

(1) **Development of a conservation ethic.** This is a societal-level action, and is required to develop support for the comprehensive conservation of indigenous biodiversity.

(2) **Specific planning to conserve indigenous genotypes, species, communities, and self-organizing ecoscapes** (*i.e.*, landscapes and seascapes). Conservation of these elements should be undertaken at various spatial scales, including global, bioregional (or ecoregional), and more local scales.

(3) **Monitoring and research relevant to knowledge required for biological conservation**. The particular focus is on determination of:

   (a) changes in the intensity and spatial distribution of environmental stressors, including disturbance dynamics (again, geographic scale is an important consideration),
   (b) ecological responses to environmental changes, including species-level indicators,
   (c) the design of ecologically sustainable systems of resource harvesting and management, and
   (d) work in applied conservation biology.

(4) **Legislative tools** must be developed or strengthened, and implemented, to effectively conserve biodiversity. Legislation must govern land-use practices, endangered species, the establishment and management of protected areas, and any commercial exploitation of endangered biodiversity.

Developing a Conservation Ethic

A conservation ethic is an integrated component of a more encompassing environmental ethic, which is itself related to environmental literacy. The essence of a conservation ethic is: respect for indigenous elements of biodiversity, and recognition of their intrinsic value.

Achieving an appropriate, societal-level conservation ethic is essential if there is to be broad-based social and political support for comprehensive programs of biological conservation. If this support does not exist, the best intentions and efforts of conservation biologists are likely to fail. Conservation biologists do not work in a socio-political vacuum, and therefore a key element of planning for biological conservation involves designing a strategy that will result in support for their issues. This is a crucial, but extra-disciplinary role for specialists who are concerned about the protection of biodiversity values.

A sufficient degree of environmental and conservation literacy must be developed. This can be approached in various ways. Within the educational system, environmental learning can be integrated across the curriculum, while also offering focused classes in environmental studies and environmental science, and specialized classes in conservation biology, environmental ecology, and natural-areas management, among others. Environmental literacy is also fostered by the activities of advocacy non-governmental organizations, such as the World Wildlife Fund, Canadian Nature Federation, Sierra Club, and provincial and local organizations. The popular media also has an important role to play in environmental education, particularly through relatively sympathetic vehicles such as The Nature of Things of the Canadian Broadcasting Corporation, other nature-oriented programs of television and radio, and articles in the print media.

Among their other responsibilities, biodiversity specialists should contribute to the development of societal-level environmental literacy. This can be done by making presentations to schools and public interest groups, by writing their articles and opinion pieces for the print media, and by being available for interviews by reporters and science writers interested in conservation-related issues.

It is also important to recognize that people who have had direct experiences with wild nature also tend to develop a greater respect and empathy for indigenous biodiversity values. Many people fondly remember mind's-eye images of magnificent wilderness vistas, or of howling wolves or yodelling loons. Such memories can elicit passionate defences against threats to those personal linkages to charismatic elements of indigenous biodiversity. Biodiversity specialists can bolster their larger conservation agenda by helping people to realize such epiphanic experiences, for instance, by making time available to lead interpretive nature walks.

Planning to Conserve Populations, Species, Communities, and Self-organizing Landscapes & Seascapes

Effective planning must be undertaken to conserve each of the hierarchical levels of indigenous biodiversity. At each level, a gap analysis should be undertaken to identify those elements of indigenous biodiversity that: (1) occur within the management region, (2) are presently conserved in protected areas, in working areas, or in the integration of these, and (3) are at risk within the management region because of anthropogenic or natural stressors (this element of the gap analysis is analogous to an analysis of conservation risk). Often, the management region is defined on a jurisdictional or political basis. However, from the ecological perspective, the gap analysis should integrate both global or bioregional spatial perspectives.

Because gap analyses can help to identify those elements of indigenous biodiversity that are most at risk, information derived from this planning tool is crucial to setting objective priorities for conservation actions. Such information is required for designing comprehensive systems of protected areas that: (1) protect all indigenous biodiversity values; (2) include sufficient redundancy within the system to ensure against catastrophic losses at particular sites: (3) are sufficiently connected within a permeable matrix, and (4) are managed effectively within the context of "greater ecosystems." Incorporated in the latter consideration is the need to design and implement ecologically appropriate methods of resource harvesting and land use on the working areas of the landscape and seascape.

Conservation Data Centers

Much data relevant to planning for the conservation of biodiversity has a spatial context. Conservation data centers (CDCs) are specifically designed for the collection, storage, analysis, and portrayal of spatially referenced biodiversity data. CDCs are an extremely useful tool in planning for biological conservation, and in conducting environmental impact assessments.

CDCs have been developed by The Nature Conservancy (U.S.), and are based on a geographic information system specifically designed (and continuously refined and upgraded) to handle data relevant to biodiversity. In addition to the information system, CDCs include a systematic process of prospecting for existing and new field data of conservation interest.

CDCs are organized as an integrated network of sites using compatible methods and technology. They exist in all American States, in various countries in Latin America, and in major Canadian jurisdictions (Alberta, British Columbia, Manitoba, Ontario, Quebec, and Saskatchewan). In the Atlantic Region, an effort is being made to establish a conservation data center through a pilot phase. The Atlantic Canada Data Centre (ACDC) is a partnership involving the Nature Conservancy (U.S.), the government of Prince Edward Island, agencies of the federal government (Canadian Forest Service, Canadian Wildlife Service, Parks Canada), and The Nature Conservancy of Canada. Unfortunately, the governments of Nova Scotia, New Brunswick, and Newfoundland have so far declined to participate fully in this regional integration.

Once the network of provincial/regional CDCs is complete (or as it is being completed), it would be extremely useful to undertake the following: (1) a national CDC is the logical next step in the development of the Canadian network of CDCs; (2) developing CDC capability to handle the Northwest Territories, Nunavut, and the Yukon; (3) fostering greater integration among the Canadian CDCs, particularly by developing joint projects (such as national biodiversity assessments); and (4) building CDC-sustainability by generating stronger support within government, among biodiversity specialists, and within the community of environmental consultants, utilities, large-industry, and other CDC "customers" relevant to environmental impact assessment and planning.

Monitoring & Research for Biological Conservation

Another central element of planning for biological conservation is the need to undertake appropriate programs of monitoring and research. This is particularly necessary because anthropogenic environmental influences are becoming increasingly intense. Unless anthropogenic influences can be controlled or mitigated through management, indigenous biodiversity values must either adapt to these challenges or become degraded.

Scientifically sound management decisions require adequate, well designed, integrated programs of research and monitoring. Important components of environmental change include: (1) **global changes** in climate, exposure to ultraviolet radiation, and distributions of species; (2) **regional changes** in climate, certain kinds of pollution (*e.g.*, the deposition of acidifying substances from the atmosphere), and distributions of species and ecosystems; and (3) **more local** conversions of natural ecosystems, including insularization and fragmentation. Appropriately designed programs that monitor key ecological indicators over time are essential if these elements of environmental change, and their natural and/or anthropogenic causes, are to be quantified and understood.

In addition, appropriate research programs are necessary if the ecological consequences of environmental changes are to be understood. Such ecological responses include effects on the distribution and abundance of species and communities at various levels (local, regional, global), and changes in the structure and function of ecosystems, many of which are relevant to indigenous biodiversity values. Determining the ecological responses to environmental change requires integrated programs of: (1) monitoring ecological indicators over time; and (2) conducting strategic research to develop an understanding of the specific causes and consequences of ecological changes. This knowledge is required if the potential ecological damages of environmental change are to be effectively avoided or mitigated, and if the consequences of not taking effective actions are to be understood by decision makers.

Much of the necessary research involves work on:

(1) the biology of endangered species, such as protocols for captive breeding, ecotoxicological risks of environmental pollution, and specific habitat requirements);
(2) the ecology of endangered communities, including responses to changes in disturbance regimes and ecotoxicological threats, and restoration ecology;
(3) landscape and seascape dynamics and their implications for other biodiversity values, such as understanding the importance of the size and shape of protected areas and the influences of insularization, connectedness, and redundancy for the ecological integrity of networks of ecological reserves;
(4) management strategies to cope with threats to biodiversity values, such as mitigation of damages by habitat management or restoration.

Planning for Biological Conservation by the Nature Conservancy of Canada

The Nature Conservancy of Canada (NCC) is a national-level, non-governmental organization (NGO). The mandate of NCC focuses on the acquisition of land and land-use interests for the purposes of conserving indigenous biodiversity. Although NCC has this unique mandate within the Canadian community of national biodiversity ENGOs, it seeks partnerships and integrates with the activities of other national and more local ENGOs, such as: World Wildlife Fund, Canadian Nature Federation, Ducks Unlimited, Wildlife Habitat Canada, The Nature Conservancy (U.S.), and provincial and local land trusts. In fact, almost all NCC projects are highly cooperative, typically including partnerships involving private-sector companies, government agencies at national, provincial/territorial, or municipal levels, individual donors, and other NGOs in the conservation community.

The Nature Conservancy of Canada is not an advocacy organization. Rather, it pursues its mandate through: (1) the purchase or donation of land, (2) purchase or donation of land-use rights, (3) negotiating conservation easements and covenants for privately held land, and (4) funding the development of sound arrangements for property management and stewardship of areas it has helped protect NCC has been pursuing its mandate since 1962, and has completed more than 650 projects, helping to conserve more than 460 thousand hectares of natural habitat.

Priorities for NCC activities and projects are based on advice and suggestions from: (1) a Scientific Advisory Network of about 40 biodiversity specialists, (2) biodiversity agencies and specialists in government (including Parks Canada, Canadian Wildlife Service, and relevant provincial and territorial agencies), (3) conservation data centers (this is becoming increasingly important), and (4) staff and key volunteers at NCC. The choices of some NCC projects have been, to some degree, opportunistic. However, NCC staff and trustees are committed to increasing the influence of more science-based planning on its activities (including planning on a bioregional basis). This is being done because: it is appropriate, smart, and the best way for NCC to pursue its mandate more effectively.

Conclusions

The planning elements discussed in this presentation are necessary at all levels in a hierarchical system of biological conservation. The major geographical and political levels of this hierarchy are: global, continental, national, provincial/state/territory, and local (including municipal). The major institutional and organizational levels of the hierarchy are the various levels of government, environmental non-governmental organizations, the private sector, and individual owners of property land and land-use rights. Ideally, planning at all of these levels would involve tools and processes that allow partnerships and mutually beneficial integrations to be developed. One such example could be a fully functional Canadian network of conservation data centers, each using mutually compatible technology and freely sharing information about the threatened biodiversity of Canada.

As biodiversity specialists we must all pursue science-based planning in our endeavors, if we are to most effectively contribute to managing the biodiversity crisis. This is good sense, and good practice. Even more crucial, however, will be more dedicated actions by each of us, and deeper commitments by the larger societies and economies of which we are a part.

Our actions must be invigorated and prioritized by the awareness that, in spite of recent progress by governments, non-governmental organizations, and other partners in conservation, **the prospects for Canadian and global biodiversity are steadily becoming worse, not better.** Because the state of biodiversity is descending into a rapidly deepening crisis, we clearly have not yet done enough to protect these values. In fact, we have only begun to become effective at executing our mandate of helping to preserve and/or conserve Canada's indigenous species and natural places.

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MITIGATING STRATEGIES FOR THE EFFECT OF REPRESENTATIVE PROTECTED AREAS ON WOOD SUPPLY IN A TOTALLY ALLOCATED LANDSCAPE: A NEW BRUNSWICK CASE STUDY

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Abstract

An analysis was carried out on two simulated but realistic management areas in New Brunswick. Representative protected areas were designed for each area based on a set of defined criteria. Three maximum sustainable harvests were calculated for each area using the 1997 management planning requirements of the Department of Natural Resources and Energy. These harvests were based on: first, a benchmark run including the potential protected areas in the harvest schedule; second, a run excluding all the protected areas; and third, a run that examined the inclusion of each protected area individually. The impacts were measured as a reduction in cubic meters of wood fiber, and as a percentage of the benchmark wood supply. Three broad mitigating strategies were then applied: 1) an adjustment to the even-flow constraint to allow for variations in harvest between limits set by the maximum sustainable harvest calculated with and without allocations to other values: 2) varying the timing of implementation of protected areas (i.e., by allowing a one-pass harvest; and 3) integration and trade-offs among land allocations to other values including riparian zones, deer wintering areas, mature coniferous forest habitat, and protected areas. While additive, non-integrated, and rigid land allocations to other values will cause an increasing and significant reduction in wood supply, integrated, compensatory design of these allocations can reduce significantly the impact on wood supply, and facilitate a flexible planning response.

Sommaire

Deux secteurs d'aménagement simulés mais réalistes ont fait l'objet d'une analyse au Nouveau-Brunswick. Des zones protégées représentatives étaient conçues pour chaque secteur, selon une série de critères définis. Trois récoltes maximums durables ont été calculées pour chaque secteur en utilisant les critères de planification de l'aménagement de 1997 du ministere des Ressources naturelles et de l'Énergie. Ces récoltes étaient basées sur les critères suivants : en premier lieu, une récolte de base, incluant les secteurs susceptibles d'être protégés dans le cadre du programme d'exploitation; en second lieu, une récolte excluant toutes les zones protégées; et en troisième lieu, une récolte dans le cadre de laquelle était envisagée l'inclusion individuelle de chaque secteur protégé. On a effectué la mesure des répercussions d'une part du point de vue de la réduction du nombre de mètres cubes de fibre de bois, et d'autre part, en pourcentage de l'approvisionnement en bois de la récolte de base. Trois stratégies généreles d'atténuation ont été appliquées . 1) ajustement de la contrainte d'uniformité afin de permettre des variations de la récolte entre les limites fixées par la récolte maximum durable avec et sans affectation aux autres valeurs; 2) variation du moment de l'entrée en vigueur des secteurs protégés (c.-à-d. en permettant une récolte complète préalable) et 3) intégration et compromis entre les affectations de terrain à d'autres valeurs, ce qui inclut les zones riveraines, les secteurs d'hivernage du chevreuil, les habitats des forêts de conifères adultes et les secteurs protégés. Même si des affectations supplémentaires non intégrées et fixes de terrains à d'autres valeurs provoqueraient une réduction croissante et importante de l'approvisionnement en bois, la conception intégrée et compensatoire de ces répartitions pourrait réduire de manière importante les répercussions sur l'approvisionnement en bois et améliorer la souplesse de la planification.

CONTRIBUTED PAPERS

VALUING BIODIVERSITY AND PROTECTED AREAS

SMOKEY THE BEAR MEETS PAUL BUNYAN: CAN PROTECTED AREAS SURVIVE DOLLAR-DRIVEN DEVELOPMENT IN AN AGE OF ECONOMIC TOTALISM?

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Abstract

The intensification of the globally competitive, capital-driven, market economy now casts serious doubt over the security of protected natural areas. As the drive to maximize the economic potential of the Earth is continually notched up, the market economy will, quite logically, have less and less tolerance for protected areas.

This problem has arisen because of a fundamental misunderstanding of Earth's biophysical process in relation to human settlement and adaptation. Our market society is proceeding as if ecology were a subset of economics. The result is a pattern of human adaptation to Earth process characterized by consumption and aggrandizement. Human economic activity is, in fact, a subsidiary of Earth ecology. Adaptation keyed to an adequate understanding of this reality would be characterized by conservation and nurturing.

The basic question before us is not whether a realm of "intangible" or "spiritual" values can supersede or, at least, act as a brake on the "tangible" and "material" values of the market society. The critical question is whether conservation and nurturing can become values that are as powerful and as compellingly tangible as consumption and aggrandizement.

The resolution of this cultural dilemma in favor of conservation and nurturing depends on a shift in world-view from domination to participation. Do Western cultural traditions have any substantial roots that can nourish an ethos of ecological participation as a replacement for economic domination? Our address to human development and human adaptation to Earth process must undertake a comprehensive scrutiny of both spiritual and scientific consciousness.

Sommaire

L'intensification de l'économie de marché capitalistique et compétitive à l'échelle mondiale remet sérieusement en question la sécurité des secteurs naturels protégés. Alors que les efforts de maximisation des possibilités économiques à l'échelon planétaire ne cessent de s'intensifier, il faut s'attendre à ce que l'économie de marché, de manière parfaitement logique, tolère de moins en moins l'existence des secteurs protégés.

L'apparition de ce problème est due à un malentendu fondamental à propos des processus biophysiques de la planète associés à l'établissement et à l'adaptation des populations humaines. Notre société de marché se comporte comme si l'écologie était un sous-produit de l'économie. Il en découle un modèle d'adaptation humaine aux processus planétaires caractérisé par la consommation et l'expansion. Or, l'activité économique est en fait dépendante de l'écologie de la planète. Une adaptation fondée sur une compréhension adéquate de cette réalité serait caractérisée par des mesures de conservation et de protection de la nature.

La question fondamentale à laquelle il nous faut répondre est la suivante : une série de valeurs « intangibles » ou « spirituelles » peuvent-elles remplacer ou, au minimum, atténuer les valeurs « tangibles » et « matérielles » de la société de marché. La question cruciale est la suivante : les mesures de conservation et de protection peuvent-elles devenir des valeurs aussi convaincantes et aussi irrémédiablement tangibles que la consommation et l'expansion.

La résolution de ce dilemme culturel en faveur de la conservation et de la protection repose sur un changement de priorités à l'échelon de la planète en faveur de la participation et au détriment de la domination. Les traditions culturelles occidentales possèdent-elles des racines suffisamment solides susceptibles d'alimenter un ethos de participation écologique qui puisse remplacer les valeurs axées sur la domination économique? Notre façon de concevoir le développement et l'adaptation de la population humaine aux processus de la planète doit être axée sur une analyse approfondie et exhaustive des valeurs à la fois spirituelles et scientifiques.

Human betterment, in our global context, depends on a growing and increasingly accurate sense of our interactive participation within the whole spectrum of Earth's biophysical processes. Without this sense of ecological embeddedness, the movement to define and establish protected areas runs the risk of being confineo to a marginal concession, which, logically, allows the rest of the environment to be considered and used as a legitimately "unprotected" area.

The market economy, as presently driven by the imperative of capital accumulation, will inexorably process as mucn of the Earth's substance as it can into tradable commodities and products. Within this world-view and the behavior which flows from it, protected areas will be under continual siege and the unremitting threat of elimination. The protection of protected areas depends on a shift in cultural orientation from accumulation to adaptation, from consumption to conservation, from aggrandizement to nurturing; and on the invention of an economy that embodies this shift.

The future of human development, with regard to ecologically sound adaptation, is an open question. Spiritual autism, with regard to the human-Earth relationship, is a persistent characteristic of Western culture, a characteristic that has become one of its most widely distributed exports. It is a disability factor of critical importance. We face the real possibility of adaptive failure. Subsidiary enterprises (human economies) that become a drag on the parent company (Earth ecology) are eliminated.

Making the values of conservation and nurturing powerfully tangible, and fostering a cultural ethos of ecological participation and biospheric communion, is important countervailing work most effectively accomplished in early childhood experiences. The security of protected areas and the creation of a sustainable economy that supports them, depends, to a great extent, on whether a sufficient number of the young have the kinds of childhood experiences that bring the values of conservation and nurturing into eventual political prominence.

L'amélioration de notre comportement en tant qu'êtres humains, dans le contexte planétaire actuel, repose sur une sensibilisation croissante et de plus en plus aiguë à la nécessité d'une participation interactive dans le cadre global des processus biophysiques de la planète. Sans une telle prise de conscience de l'intégration des valeurs écologiques, les efforts de définition et de création de secteurs protégés risquent d'être limités à des concessions marginales, ce qui, dans l'ordre des choses, permettrait l'exploitation du reste de l'environnement considéré comme un secteur légitimement « non protégé ».

L'économie de marché, actuellement motivée par la recherche impérative de l'accumulation du capital, se traduira inexorablement par la transformation du maximum de « substances » terrestres en marchandises et en produits négociables. Dans une telle optique mondiale, et compte tenu des comportements qui en découlent, les secteurs protégés seront constamment en état de siège et inexorablement menacés d'élimination. La protection des secteurs réservés repose sur un changement des valeurs culturelles de manière à prôner l'adaptation plutôt que l'accumulation, la conservation plutôt que la consommation et l'entretien plutôt que l'agrandissement, ainsi que sur l'invention d'une économie qui intègre ces changements de valeur.

L'avenir du développement humain, sous l'angle de sa capacité de s'adapter de manière à ne pas nuire à l'environnement, est une question controversée. L'autisme spirituel, du point de vue des relations entre l'homme et la planète, est l'une des caractéristiques immuables de la culture occidentale, caractéristique qui a déteint sur un nombre sans précédent de pays à l'échelon planétaire. Il s'agit là d'un facteur d'incapacité d'importance cruciale. Nous sommes confrontés à la possibilité concrète d'un échec de nos efforts d'adaptation. Les entreprises-filiales (économie humaine) qui deviennent une charge pour la société-mère (écologie terrestre) seront éliminées.

La promotion de valeurs de conservation et d'entretien incontestablement tangibles, ainsi que d'un ethos culturel de participation écologique et de communication à l'échelle de la biosphère, constitue une activité de compensation importante qui est avant tout efficace lorsqu'elle est effectuée au cours de la petite enfance. La sécurité des secteurs protégés et la création d'une économie susceptible de les appuyer dépend, dans une grande mesure, de la sensibilisation en bas âge d'un nombre suffisant de jeunes, de manière à ce que les valeurs de conservation et d'entretien finissent par revêtir un poids politique.

A few miles upriver from where we are meeting, the town of Nackawic has a small park in which the municipal authority has erected a curious symbol — the world's largest axe. On a hill overlooking the town and its gigantic axe is the Saint Anne-Nackawic pulp mill. This mill, when first built, was touted as a great industrial advance; it was the first mill in the region that could turn hardwood species into pulp and paper. The mill has now been in operation for close to 30 years and the extensive hardwood ridges of western of New Brunswick are being steadily reduced to splintered, rutted and eroded hillsides.

Of course, it has been the chainsaw and skidder, not the axe that have been the instruments of this destruction. Now, I could have said "that have been the instruments of this employment," for that, too, along with the destruction of the watershed cover, is a reality of regional economics. It is this "necessary" twining of economics with environmental degradation, this binding of employment to watershed destruction that has been, and is, the logic of "development."

The world's largest axe stands at a rakish angle in its quiet park reminding us of the machinery and dollar-driven economics that are rapidly rendering our hopes for protected areas obsolete. Smokey Bear meets Paul Bunyan! Paul Bunyan is still swinging the monstrous corporate axe of industrial "development" while Smokey Bear applies the citizen's shovel of ecological protection. This historic confrontation is in full tilt and it is not at all clear what the outcome will be.

A recent event in Nova Scotia is an ominous sign of what the outcome may be. The government of has "delisted" a wilderness area in Cape Breton Island that had been designated as "protected." It seems the Jim Campbell Barrens has become of interest to gold mining interests and the government of Nova Scotia has, without consultation or legislative process, simply removed it from the list of protected areas.

It seems to me this conference stands in the ominous shadow of the economic logic that has been applied to the Jim Campbell Barrens. Protected areas and the bottom line — are any protected areas really protected, really safe from disruption and destruction, if it can be shown that significant capital accumulation can be generated from their industrial development? Industrial development is often disguised as the carrot of job creation, but we should never forget that it is the stick of capital that drives development. We know this is true because industrial operations of all sorts will choose machines over jobs if it means an enhancement of capital accumulation.

Will the designation of protected areas always exist under threat of reversal if it can be shown that industrial utilization has the monetary cost/benefit analysis on its side? Is mastering monetary cost/benefit analysis the most significant and effective approach for conservationists in the struggle to preserve natural areas? Or have we essentially given the game away by even agreeing to these terms of reference? In accepting this framework for decision making on protecting natural areas, are we submitting to what Raymond Rogers calls "the tyranny of value," the automatic habit of placing everything within a hierarchical scale of values, even the constituent elements of the intricate, holistic mantle of biotic process which encircles the planet - the biosphere! (See Raymond Rogers, *Nature and the Crisis of Modernity: A Critique of Contemporary Discourse on Managing the Earth*, Montreal, Black Rose Books, 1994)

Now it may be argued that hierarchical ranking is a more-or-less innate characteristic of human mental process and, with regard to so-called advanced cultures, this is probably true. If our predilection for ranking were applied, for example, to the various forms and elements of Earth process with regard to homage and veneration, our valuation would be relatively benign. But the almost unbelievably bizarre fact is that in the capital-driven, market society it is routine and automatic to rank the various forms and elements of Earth process in terms of the dollar value and the degree of capital accumulation that can be realized by their expropriation, disruption, and conversion into marketable products. I am not suggesting that we can live on the Earth without using its various forms and elements, but I would argue that the evidence before us clearly shows that when use value is eclipsed by monetary value, a vortex of ecological destruction is created that is very difficult to limit.

Is there any chance that protected areas can be regarded as secure as long as money works the way it now works in our society and monetary cost/benefit analysis continues to be the principle decision-making tool? I suggest it will be very difficult, under these conditions, to build up the range of protected areas needed to ensure the preservation of Earth's remaining biodiversity. Now if you ask me for a short answer on what I mean by "the way money works," I would say this: It is often the case, with regard to Earth's biotic integrity, that the way money works causes good people to do bad things for good reasons; for example, the way the monetary system now functions, it is generally financially rewarding to advance production, consumption, and aggrandizement without taking into account the effects of this behavior on the geophysical and biotic integrity of Earth's environments. Unless and until monetary reforms are introduced which reward conservation as an expanding social ethos, protected areas and biodiversity will exist under a cloud of insecurity. (See Paul Hawken, *The Ecology of Commerce: A Declaration of Sustainability*, New York, Harper Collins, 1995)

I know that many people at this conference are working in good faith within the context of the monetary cost/ benefit analysis and I have nothing but admiration and praise for their efforts. Nothing I have to say should be seen as devaluing this approach to establishing protected areas and protecting biodiversity. It should certainly be advanced to the full extent of its effectiveness. I have raised the limitations of the current monetary system with regard to its support of conservation because I wish to emphasize additional and parallel approaches, that should be brought strongly into play around this issue. In particular, there is a context of aesthetic experience and moral response that can and should be rigorously advanced in our quest for a rational approach to the human/Earth relationship.

Before going directly into to this, I would like to talk a bit about language and call your attention to several expressions that, I think, provide a useful perspective and help sharpen conceptually what it is we are talking about when we talk about Earth's biotic environments and human adaptation within these environments. These expression are, "Earth process", "human/Earth relationship" and "developing sustainability." The context of their use will become clear as I proceed.

It is my sense that the concept of Nature is becoming an increasingly ineffective tool with regard to communication about the integrity of Earth's geophysical and biotic environments. There is a whole range of reasons, which I cannot go into here. for why this is the case. Suffice it to say, the concept of Nature is a cultural construction that has grown from our wish for coherence and our narrative skill in story telling. Our concept of Nature is a story we have been telling about Earth, but like previous theological stories that offered comprehensive explanations of the way things are, the Nature story now seems less and less able to cover either the information which is emerging about Earth's behavior, or the complexities of relationships which are involved. The Nature story and its ability to provide overarching guidance with regard to human adaptation, is fetching up on the rocks of cultural deconstruction and is being battered by the upheavals of information concerning Earth process.

One of the principle reasons why the concept of Nature is a narrative of receding effectiveness is the irreconcilable contradiction of human behavior within the Nature story, and, at the same time, the impossibility of understanding the human story except within the context of Earth's organic expression. It is probably true that very few citizens, except for a few eccentric philosophers, lie awake at night worrying over this problem, but it is, I submit, a significant factor of mental and spiritual life in modern societies that is undercutting the motivation for ecological preservation.

There is a nagging undertow of confusion and quiet despair growing from this conflict which says, in effect, if Nature itself cannot get it right, why should we struggle to correct the problem. Why not just get on with creating the most convenience, security, and affluence for ourselves as possible and let whatever is left of Nature take care of itself. There is both a social and an ecological answer to this view.

The social answer is that, with regard to the relationship between wealth and poverty. we are not likely to get away with it in the long run, although, at the moment, those who control capital — both monetary and material — seem to be very effectively extending and consolidating their control. The ecological answer is, of course, that while the stance of modern human cultures, vis-à-vis Nature, is contradictory, there is simply no question of an irreducible human/Earth relationship within the context of Earth process, and that a diminishing biotic environment means the increasing fragility of human adaptation.

While it may be increasingly difficult to say just what Nature is, there is no doubt at all about what Earth is and the fact that our functional information about its processes is convincing and expanding. I am suggesting that our communication about ecological issues will be improved if we can get clear of the dichotomous conceptual confusion and the reactive static that always seems to emerge around the protection of Nature. I am suggesting that, in addition to the protection and renewal of biodiversity, the conservation movement should focus on the holistic development of ecologically appropriate human/Earth relationships.

It is my sense that the impact of economic totalism is so great that an enclave strategy with regard to Earth's biotic integrity will not work. I would argue that in order to ensure Earth's geophysical and biotic integrity we must have a shift in the culture of economics from "sustainable development" to the socially determined goal of "developing sustainability," a shift from economic growth to ecological adaptation. I suspect that conceptualizing and working on ecological reformation in terms of the functional details of Earth process and the human/Earth relationship, rather than in terms of a Nature/Culture conflict, would go some way toward advancing the conservation dialogue and creating a broader and more accurate understanding of the ecological realities in which all species are embedded.

Now, back to the question of valuing biodiversity. It seems to me there is a sense in which we should refuse to place Earth process in general and biodiversity in particular under any scheme of valuation. There is a sense in which the ecological reality of Earth stands prior to all valuation and is, in fact, the ground out of which consciousness and all processes of valuation take their rise. For human consciousness to rise up, turn around, and abstractly chop up the biosphere into categories of more and less valuable components is an act of amazing ecological myopia and sensual ignorance. To then consider that some parts of the living Earth's body can be summarily dispensed with, and that a steadily increasing amount of biotic material can be benignly obliterated is surely madness. the peculiar madness of modernity.

Fortunately, the primal human tradition of Earth-based culture, a tradition that comes to us from before the earliest mists of history, has not been obliterated. In fact, this cultural stream, this holistic valuation of the organic, this recognition of biospheric integrity and human embeddedness within it, is in resurgence. The recognition that sustainable human cultures can only flourish within the organic integrity of the larger Earth culture is being manifested around the world in many forms. This organization and this conference are certainly two of those forms.

My sense of this resurgence, this commitment to preserving the biotic environments of Earth and the re-connecting of human communities with the biotic culture of Earth, is a certain common approach to living — living with a sense of Earth in an open, non-judgmental way, living lightly among the full range of plant and animal beings, land-forms, skyscapes, and various unseen energies. It is like having an amazingly diverse and interesting peer group. Never a dull moment. And neither is there the need to rank or justify in terms of value. Things are just what they are. The vision is whole. The Earth is just the Earth — our home place, our larger body. The connection is direct. The heart becomes radiant, the mind luminous and, like the dew-spangled spider web on the grass in the sunrise, no part of the scene can be altered without disrupting the magic of the whole. Such are the moments in which we are spiritually grounded, the moments that inform ecological consciousness and enable us to take up our various tasks and vocations with a sense of calling, a sense of vision.

There is, of course, a level of functioning, a level of consciousness, in which it is necessary and important to articulate "ecological values" over and above money's "tyranny of value." The ecological consciousness that comes into play in valuing biodiversity is generated along a continuum of aesthetic experience which grows into moral feeling and ethical conviction. This growth is critically important for the work of protecting Earth's biotic integrity. We have long understood the power of aesthetic experience in valuing natural areas, but it is the growth of aesthetic experience into a coherent morality, into a comprehensive ecological ethic that can speak most effectively for the enlargement and security of protected areas. (See Herbert Read, *Education Through Art*, New York, Pantheon, 1945; Edith Cobb, *The Ecology of Imagination in Childhood*, New York, Columbia University Press, 1965.) It is this question of aesthetic experience and the growth of moral feeling to which, in conclusion, I now turn.

Among those concerned with the health of Earth's natural environment, there is a growing sense of moral initiative, a sense that destroying Earth's biotic integrity to satisfy a bottomless hunger for money and money's aggrandizement of life is simply wrong.

This is not the first time Western economic development has come to loggerheads with morality. In 1791, a discussion of the slave trade was brought before a Select Committee of the British House of Commons which argued as follows: "A trade which disgraces the national character, which is productive of unexampled misery to the human race and which must soon or later bring down the vengeance of God on the nation that pursues it, must be impolitick indeed, if it has not the plea of necessity for its continuance." (Quoted by Reginald Reynolds in *The Wisdom of John Woolman*, London, George, Allen & Unwin, 1948.)

We may not see the environmental crisis as the "vengeance of God," but this reasoning expresses precisely our relationship to the capital-driven, market economy. There seems to be a tacit agreement between political, industrial, business, and financial leaders on one side, and consumers on the other, that in order to maintain and advance our money-based standard of living it will be necessary to disable more and more of the biosphere. When I make this point in public discussion I often get the reaction, "But that's absurd!" Of course it's absurd. It is also true. The capital-driven, market economy has no built-in limitation on its use of the Earth. Its primary focus is the production of money. It is based on the idea that the more money produced the better off we will all be. And the way to produce money is to turn an ever-increasing amount of Earth's substance into marketable commodities. This is called the production of wealth. It is also the destruction of Earth.

Why is this issue so clear for some — like a bell ringing over the roof tops — and so out of sight for others? Why do some people have a sense of the integrity of Creation, while others are oblivious to this fundamental context of life? Why do some people care intensely about stopping wild-land destruction or the bulldozing of farmland into suburbia, while others think only of board feet per acre or the profits of condominium development? It is, I suggest, the experience of having formed a deep bond with some aspect of the natural world, or the lack of such experience, that accounts for this great divergence in world-views and values.

I am convinced that early childhood experience of a particular kind is critical to the sense of the transcendent - the sense of feeling most fully alive when you are drawn out of yourself into communion with some aspect of the greater Creation. This communion is the context — the nourishing soil — that enables us to remain open to the mystery of presence in Creation.

This communion, this sense of presence, structures a certain down-in-the-soul moral knowledge which is not easily obtained in any other way.

When we think of this communion we often think of rural and wilderness environments. But I would not argue for the rustic or the wild as the only, or even the most favored, environments of communion. Much depends on the opportunities parents create with children for contact with the natural world. The critical point is not necessarily where one lives — though that can be a great advantage — but that at sometime before the age of ten, children have the experience of bonding with some aspect of Earth not of human origin. For example, now that released falcons are colonizing the upper reaches of Manhattan, I can imagine a child who gazes from the window of a New York high-rise at this elegant and graceful bird and gets "carried away."

Consider the experience of being drawn into communion with wild or domestic animals, with a special grove of trees or a rocky outcrop, with the flight of birds or the passing forms of clouds, with a mountain waterfall or a meadow of wildflowers, with moonlight over quiet water or with any of the other endlessly arising, spontaneous patterns and forms of Creation — this kind of experience is the seed bed of ecological consciousness, of the mature ability to cherish and protect the Earth.Those who grow up encapsulated in a fabricated world, a world that excludes contemplative contact with natural forms and process, are at a great disadvantage with respect to the maturing of their sensory potential. They simply do not get the sensory information required for balanced and effective participation in the real world of Earth process. Awakening to this deprivation is now drawing many persons into a re-education in the natural world and a growing allegiance to the Earth and its integrity.

This, I believe, is a movement that can effectively counter the destructive dogma of unlimited economic growth. It is a kind of moral insight born of aesthetic/spiritual experience, that enables us to say: "This destruction of the natural world is not right."

Geographer Bret Wallach, in his fascinating book *At Odds With Progress* (Tucson, University of Arizona Press, 1991), shows that it has not been the scientific, economic or social arguments that have put the ethic of conservation and environmental protection into a position of growing prominence, but rather key persons and community groups, working from a base of moral and aesthetic values. When the discussion moves to this level, people who previously felt excluded by the technical language of cost/benefit analysis can confidently and legitimately speak for the integrity of cherished environments. The experience of communion powerfully informs the moral voice. Speak with feeling!

Only, thus, I suspect, will Smokey Bear's mindfulness and his spade work of ecological protection be able to quell the greed and calm the consumption that keeps Paul Bunyan swinging his corporate axe.

PROTECTED AREAS AND ENLIGHTENED SOCIETY

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Abstract

While protected areas are important in providing uninterrupted space for plants and animals to live in the absence of human disturbance, they also provide a critical reference point from which humans can discover the essential connectedness of life, a connectedness in which human society must participate if it is to be sustained. If there is still magic in this world, powerful enough to change the complexion of human society, "protected places" will be one of the essential catalysts.

The desire to protect parts of the world from the ravages of an exploding and unnecessarily destructive human population is a manifestation of the fundamental human condition, which is basically good. From this point of view, provision of such protection is an interim measure, necessary only until society "wakes up" to the real possibilities of sustainability, and the real necessities of minimizing the size of the slice of the pie each of us consumes and that our entire species consumes. In other words, the establishment of protected areas is a manifestation of the vision of sustainable society; the process of allowing these protected areas to inspire the restoration of the rest of the world is the path of bringing basic human goodness to its natural fruition.

Enlightened human society, or sustainable society in the current jargon, exists within the context of the fully functioning "natural" world. It could be said that a "sustainable society" and the "natural world" are interdependent, but, more accurately, it is one inseparable world in which basic goodness is expressed as caring for the welfare of all beings. Enlightened society manifests as families and communities living gently in the land, consuming as little as possible to meet their real needs, and sharing a mutual commitment to "wake up" and wake each other up. The role of government is to assist in providing maximum benefit for all members of society while minimizing the disruption of the lives of other beings. This is accomplished through example and encouragement rather than regulation, as much as possible.

Sommaire

Alors que les secteurs protégés constituent des habitats non fragmentés importants pour les plantes et les animaux qui peuvent y vivre à l'abri de toute perturbation provoquée par l'activité humaine, ils jouent également un rôle d'exemple crucial en permettant à nos populations de prendre conscience de la dépendance fondamentale entre toutes formes de vie, valeur que doit assimiler la société humaine pour garantir sa survie. Si le monde actuel recèle encore des forces inconnues suffisamment puissantes pour changer la physionomie de la société humaine, les « secteurs protégés » constitueront l'un des catalyseurs essentiels de ce changement.

Le désir de protéger certaines parties de la planète contre les ravages de l'explosion démographique d'une population humaine qui provoque des destructions inutiles illustre l'une des caractéristiques fondamentales de la nature humaine, car l'homme est foncièrement bon. De ce point de vue, une telle protection constitue une mesure provisoire, qui ne s'impose qu'en attendant que la société « s'éveille » aux possibilités concrètes qu'offre la durabilité et aux nécessités réelles de minimiser la « part du gâteau » que chacun d'entre nous consomme et que consomme globalement notre espèce. En d'autres termes, la création de secteurs protégés illustre la vision d'une société durable; la constitution de ces secteurs protégés de manière à promouvoir la remise en état du reste du monde constitue la voie qui permettra à la bonté fondamentale de l'homme de s'exprimer pleinement de manière naturelle.

Une société humaine conscientisée, ou une société viable dans le jargon actuel, existe dans le contexte d'un monde « naturel » qui fonctionne parfaitement. On peut affirmer que la « société viable » et le « monde naturel » sont des notions interdépendantes, mais il est plus exact d'affirmer qu'il s'agit d'un tout inséparable au sein duquel la bonté fondamentale de l'homme s'exprime sous forme de souci du bien-être de tous les êtres vivants. Une société conscientisée est caractérisée par l'existence de familles et de collectivités vivant dans le respect de l'environnement, en consommant le moins possible pour satisfaire leurs besoins réels et en partageant un engagement mutuel de « s'éveiller » individuellement et mutuellement. Le rôle des pouvoirs publics consiste à contribuer à améliorer la condition de tous les membres de la société tout en minimisant la perturbation des autres êtres vivants. Pour ce faire, il convient de donner l'exemple et de prodiguer des encouragements plutôt que de réglementer, dans la mesure du possible.

Is enlightened society an ancient myth or a real possibility? On the one hand, if we examine the reality of our world, there seems no possibility of averting extensive catastrophe for most species, including humans. On the other hand, the reality of enlightened society, as myth or realistic vision, is alive in the hearts of all people. It springs as a natural flow from the intrinsic nature of being human. Gentleness, fearlessness and intelligence are the fundamental resources of human beings. The development of these resources results in sustainable wealth. The clouds of confusion, which we call anger, pride, greed, desire, ambition, jealousy, stupidity and so on are merely that, a thin or thick overlay obscuring our basic goodness. Superficial though they may be, it is these clouds of confusion that are resulting in the destruction of the incredible variety and abundance of life on earth.

So, what kind of magic would have to happen to alter the destructive course we are on? Ordinary magic. The magic of individuals, one at a time, rediscovering open mind, open heart, and their natural connections with the phenomenal world. One of the most effective means of developing an intimate personal connection with the miraculous complexity of life is hanging out in, and fully sensing, the natural world, especially in its protected places. The logical extension of this heart connection is working toward the restoration of the natural world beyond the bounds of protected places and beyond the exclusion of human habitation. Enlightened society is the only human context in which protected areas, and the complexity of life which they preserve, can reinvade the world.

While protected areas are important in providing uninterrupted space for plants and animals to live in the absence of human disturbance, they also provide a critical reference point from which humans can discover the essential connectedness of life, a connectedness in which human society must participate if it is to be sustained. If there is still magic in this world, powerful enough to change the complexion of human society, "protected places" will be one of the essential catalysts.

Most of us do not have to be reminded that the quality of life in this world is deteriorating rapidly. On the economic front, an increasing percentage of people are poor; there has been a dramatic loss of regional sufficiency; economic security is tenuous for most people. Socially things are no better, with tragic loss of cultural diversity and widespread loss of local communities. The ecologically minded decry global deforestation, habitat loss, and species extinction, as well as crises in water resources and ozone layer protection; that the earth's climate is changing rapidly is beyond reasonable debate. One could go on and on, but you have heard a lot of this already in this conference in, of all places, the Sheraton Hotel.

Is all this suffering of so many beings a reasonable exchange for the benefit of the rich and powerful? Perhaps this is the intent or the perception, but even for the few who appear to "benefit", happiness is illusory. Quality of life is deteriorating at an accelerating rate.

It could be said, with considerable evidence, that the cause of the problems is human greed or arrogance or stupidity or whatever. Because of this indictment, we feel guilty about being human, implicated as co-conspirators in the destruction of life on earth. We might blame ourselves for what is happening, for being human.

However, ladies and gentlemen, we should not be afraid of ourselves at all. In fact, in spite of the apparent irony, we can afford to celebrate our humanness. At the core of our being is basic goodness, which is even more fundamental than the dichotomy of good and bad; it is the goodness that comes before that, the goodness that is evidenced by the feeling evoked by warm sun on your neck or a fresh breeze across your face. It is the pure joy of seeing and smelling a clump of chanterelle mushrooms under the hemlocks, or our capacity to fall in love.

Gentleness, fearlessness, and intelligence are the natural resources of human beings. It is the development of these resources that results in sustainable wealth. The problem is the clouds of confusion, which we call anger, greed, arrogance, desire, jealousy, ambition, envy, stupidity, and so on. These clouds obscure the underlying goodness and, in fact, are causing the destruction of the incredible variety and abundance of life on earth.

On the other hand, the motivation to protect ecological areas is a manifestation of basic goodness, evidence of our compassion for other life forms. Ideally, this motivation is not only wanting to preserve them for the archives, which could become merely a collectors game, but more importantly, as a recovery fund which will be needed when the time comes to restore the rest of the world. Protecting ecological areas now is a tangible example of the vision of sustainable society. Allowing these natural areas to inspire the restoration of the entire world is the path of bringing basic goodness to fruition. This dream is not too big or too far-fetched, in fact it is an ordinary and uniquely human dream.

Enlightened society (sustainable society) can only exist in the context of the natural world. It cannot exist in a degraded environment created by the selfishness of the strongest individuals and corporations, or even all of human society. This degradation, which usually is a result of regarding nature as primarily a resource for the use of our little group, will become a massive restoration project for enlightened society. Although it has been said that enlightened society and the natural world are interdependent, they are more than that; they are aspects of one inseparable world, in which basic goodness is expressed as caring for all beings and where waking up means going beyond aggression.

Enlightened society manifests as individuals, families, and communities living gently in the land, consuming as little as possible to meet their real needs and sharing a commitment to wake up, and to wake each other up, to the fundamental nature of what it is to be human. You might ask "Isn't enlightened society merely an ancient myth? After all, catastrophe, due to human aggression, greed and stupidity seems inevitable. Can anyone come to any other logical prediction? When one examines, dispassionately, the state and the direction of change, of this world, is it possibkle to imagine another possibility than extensive and pervasive disaster?"

Reasonable cynicism. On the other hand the vision of a truly sustainable society, whether as myth or realistic vision, is alive in the hearts of all human beings. It springs as a natural flow from the intrinsic nature of being human and leads to belief in some kind of magic that will change the course of events. This will require some powerful magic. What can you imagine?

I have been taught, and experienced, that looking outside for a "magic bullet" is worse than a waste of time. It is a cruel illusion which leads one into a blind alley. Any other quest leads back to ourselves,. And this seems to offer real possibility. In fact, this is ordinary magic, the magic of individuals, one at a time, rediscovering open mind, open heart, and natural connections within the phenomenal world.

So, how do we do that? One of the most effective means is hanging out in, and fully sensing, the natural world, especially in its untrammeled protected places. The logical extension of this sensual connection is working toward the restoration of the natural world beyond the boundaries of protected places, and beyond the exclusion of human habitation.

Fellow human beings, enlightened society is the only human context in which protected areas, and the complexity of life which they can protect, can reinvade the world. The prerequisite for the creation of enlightened society is individual people waking up, and encouraging others to rediscover their own gentleness, fearlessness, and intelligence. A most effective way to begin is to spend more time in the forest, in the prairie, in the desert, in the tundra, in the ocean ... doing as close to nothing as possible. The discoveries that can result from this form the only foundation on which successful individual and evolutionary journeys can proceed. This is the practicality of creating enlightened society, and the ultimate benefit of creating protected places.

This is not a riddle. This is the truth as I have been taught and as I have experienced it.

RETHINKING THE VALUE OF BIODIVERSITY AND THE PRIORITY OF ITS CONSERVATION

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Abstract

Two commonplace assumptions in society are that (a) biodiversity should be valued in economic terms, and (b) the short-term economic benefits of biodiversity-depleting development activities should somehow be balanced against biodiversity losses. This paper argues that these assumptions are misguided. Instead, biodiversity in total is better conceived as an essential environmental condition, and the conservation of biodiversity, therefore, should take priority over any one generation's collective interests. Two broad policy goals stem from this conception of biodiversity and its value as an essential environmental condition. First, conservation goals need to be established regardless of the opportunity costs of doing so, and second, conservation should be recognized as a constraint on the public interest, not a goal in service of the public interest.

Sommaire

Deux préjugés sont largement répandus au sein de notre société : a) la biodiversite doit être évaluée selon des critères économiques et b) les avantages économiques à court terme des activités de développement qui épuisent la biodiversité doivent d'une certaine façon compenser les pertes de cette biodiversité. Les auteurs du présent document soutiennent que ces hypothèses sont erronées. Globalement, la biodiversité est plutôt considérée comme une condition environnementale essentielle et la conservation de cette biodiversité doit donc avoir préséance sur les intérêts collectifs de toutes les générations. Deux objectifs de politique généraux découlent de cette conception de la biodiversité et de son importance en tant que condition environnementale essentielle. Tout d'abord, il convient de fixer des objectifs de conservation, peu importe les coûts d'opportunité qui en découlent et, en second lieu, la conservation doit être considérée comme l'une des exigences auxquelles l'intérêt public doit satisfaire et non comme un objectif au service de l'intérêt public.

The need to conserve biodiversity is now receiving attention worldwide, and protected areas are the cornerstone of any credible strategy aimed at conserving biodiversity. Yet how often do we hear that biodiversity values need to be balanced against economic values? The idea that biodiversity and economic values need to be balanced is a common premise that governments tend to accept without question. It is my purpose in this paper to challenge that notion and to suggest that biodiversity needs to be conserved, for the sake of future generations, regardless of the economic opportunity costs of doing so. A practical implication is that sufficient protected areas should be designated to conserve biodiversity, even if it is not in the collective interests of society to do so.

In natural resource management, the notion of balancing one set of values against another stems from a central economic assumption: that the goal of resource management is to maximize the overall value society captures from natural resources. And this is achieved by trading off one resource for another so as to produce a mixture of natural resources that will maximize society's net realization of value — a little less of this for a little more of that.

The value of biodiversity has been included in this mixing and trading-off process because we have tended to conceive of biodiversity as simply another set of resources. This is an incorrect conception in my opinion. Both the idea of biodiversity, and especially its value to society, are some of the most misunderstood concepts in environmental management. Biodiversity is often defined as the diversity of life forms, and includes the diversity of genes, species, and ecosystems. And the value of biodiversity is usually expressed in terms of the potential value of future resources that we might discover if biodiversity is conserved.

Unfortunately, these concepts fail to convey the full reasons for the urgent need to conserve biodiversity. If biodiversity is perceived as a pool of potential resources, then it will be treated as such. Increments of biodiversity — a species here, an ecosystem there — will be out-competed by land-use and land-management practices that displace and deplete elements of biodiversity. Potential resources are no match for resources that have current economic value; in fact, most of the world's species are currently, and probably always will be, useless in the limited sense of having direct market value. In the trade-off process, biodiversity is usually considered dispensable.

Nowhere is this dilemma more apparent than in attempts to designate protected areas. The very reason that protected areas are a hard sell is because the lands and waters they could potentially occupy are usually seen as more valuable to society if used for the production of resources with more immediate economic value.

The central problem is the tendency to confuse biodiversity with biological resources. I suggest that biodiversity can be seen as a concept on a higher logical plane than biological resources.

To appreciate this difference, it is necessary to determine the root meaning of the term. Biodiversity is not simply the sum total of genes, species, and ecosystems. Rather it can be defined more cogently (albeit more abstractly) as the *differences* among biological phenomena. It is an *emergent property* of collections of biological entities. Or we can say that it is *an environmental condition* that emphasizes the differences among these biological entities.

Take other environmental conditions for example: the rate of solar influx, the world's average temperature, the Earth's rate of rotation around its axis, and the trajectory of the world's orbit around the Sun. A sudden and large change in any one of these conditions would spell disaster for humankind. But we don't need to worry about such changes; we can safely presume that they will remain much the same from year to year — with the possible exception of global warming. Biodiversity differs from these other environmental conditions precisely because humans, quite inadvertently but insidiously, are eroding its structure.

What is the value of biodiversity? It is far from simply representing the chance of discovering a few new medicines or useful new resources. On the contrary — as I have argued elsewhere, it is the *source* of biological resources.[1] Its value therefore is on a higher logical plane than the value of biological resources themselves. The condition we call biodiversity is an absolute necessity for the long-term maintenance of the biological resources upon which humans depend. Or to express this differently, humans are of necessity dependent in the long term on the current conservation of biodiversity.

Biodiversity, therefore, is an *essential* environmental condition, and is not something to be traded-off against more attractive, short-term opportunities. If an environmental condition really is essential, then it needs to be maintained. Land-use and land-management decisions should be made with this constraint in mind. Put simply, this means that each generation needs to live within its ecological limits. Each generation should be free to make whatever environmental trade-offs are appropriate for promoting the public interest, provided that biodiversity is not depleted. This can be expressed as an ethical principle, which I call the Priority-of-Biodiversity Principle: *the conservation of biodiversity should take priority over any one generation's collective interests.*

Recasting biodiversity as an environmental condition, and re-evaluating it as an essential environmental condition, carries strong policy implications. The first implication is general: we need to establish conservation goals first, and then later determine cost-effective means of implementing them. This represents a marked departure from the current tendency for society to allow market forces and cost-benefit analyses to determine our goals for us.

The second implication is also general, and stems directly from the above-mentioned Priority-of-Biodiversity Principle: for the sake of future generations, we must conserve biodiversity even if it is not in the best interests of society to do so. Arguably, it may be in our collective interests in contemporary society to allow for biodiversity loss — to accept the extinction of seemingly useless species, for example. After all, we get the benefits of the development projects that displace biodiversity. So biodiversity conservation should be recognized as a constraint on the public interest, not a goal in service of the public interest.

This constraint is especially needed in the design of an adequate network of protected areas. These should be designated even if the opportunity costs to current society outweigh the apparent benefits.

The third policy implication is that the discretionary authority of governments themselves may need to be curtailed in order to implement conservation projects. This is where the plot thickens. The *purpose* of western governments is to promote the public interest, and the public interest is usually interpreted as the collective interests of extant individuals, not future individuals, within the relevant government's jurisdiction. But the Priority-of-Biodiversity Principle suggests a constraint on the public interest and, therefore, implies a limit on governmental authority.

In constitutional democracies, limits on state authority are recognized in one area only: constitutional provisions, including the basic civil rights and freedoms. These rights and freedoms are the individual's safeguard against a "tyranny of the majority." It is a self-limiting feature of liberal democracies that prevents the majority of citizens from unjustly persecuting minority groups. Borovoy expresses the system this way:

> *Majority rule is democracy's safeguard against minority dictatorship. And the fundamental rights such as freedom of speech, freedom of assembly, and due process of law are democracy's safeguard against majority rule itself from becoming a dictatorship.*[2]

There is a connection between this self-limiting feature of constitutional democracies and the conservation of biodiversity. Valuing biodiversity as a necessary precondition for the long term maintenance of biological resources allows us to see biodiversity not as one more value to be traded off against competing values, but rather as an essential environmental condition. Fulfilling our obligations to future generations, therefore, implies that no one government should permit itself to be persuaded by contemporary collective desires for resource extraction to the extent that biodiversity would be depleted. But as the *purpose* of any one government is precisely to promote these contemporary collective desires, the conservation of biodiversity needs to be placed beyond the immediate reach of governmental discretion. The legal mechanism in constitutional democracies is to limit state authority itself by constitutional decree. Constitutions prescribe the legitimate jurisdiction of state authority. Government actions in violation of constitutional limits are *ultra vires* — literally "beyond jurisdiction."

In effect, there is a strong parallel between the individual in contemporary western societies and future generations: both need to be protected against a "tyranny of the majority."[4] Limits to state authority are required in both cases. In the specific case of biodiversity conservation, constitutional limits to state authority are needed in order to prevent the present generation from exerting the equivalent of a "tyranny of the majority" over future generations by way of pre-emptive environmental decisions.

[1] Wood, P.M. 1997. Biodiversity as the source of biological resources: a new look at biodiversity value. Environmental Values 6(3) 251 - 268.

[2] Borovoy, A. 1988. When freedoms collide. Lester & Orpen Dennys. Toronto. 200 p.

[3] While the term "tyranny of the majority" is usually interpreted literally in the sense of a majority outnumbering a minority, the term can also apply to a minority exercising unjust power over the interests of *disadvantaged* groups, even if the latter constitute a majority. South Africa's apartheid regime is an example in the recent past. The issue at stake here is the exercise of power, not numbers of people *per se*. For the topic at hand, it is likely that the number of people in the near future will outnumber extant individuals, despite the current rate of biodiversity loss. So, in this case, I am referring to the ability of the present generation to exercise power over future generations by way of unjustly usurping the ability of the environment to support them, and this is one form of tyranny of the majority.

WHAT IS GOOD FORESTRY?
An Ethical Examination of Forest Policy and Practice in New Brunswick

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Abstract

Public concern for ecological and environmental values is making the job of forest management increasingly complex and uncertain and is gradually undermining the domination of timber value as the primary organizing goal of forest policy. The key question is how to balance the pursuit of short-term economic self-interests with the long-term public good. I articulate a moral theory that affirms the existence of a public good that is understood teleologically as an objective purpose to be pursued. I argue that there is a connection between philosophical and moral concept of creativity and the scientific concept of biological diversity. I suggest that these concepts are both linked to the political question of the public good. The maximization of the ethical good of creativity according to this theory is linked to the maximization of the public good. In forestry, the management of forest ecosystems in order to maximize their creative good is linked to the maximization of the public good and vice versa. The ethical theory is essentially a religious one in the neo-classical theistic tradition, in which authentic human existence is defined in terms of our relationship to reality and metaphysically and cosmologically informed world view.

Sommaire

Les préoccupations du public à l'égard des valeurs écologiques et environnementales rendent la tâche des aménagistes forestiers de plus en plus complexe et incertaine, et elles provoquent une remise en question progressive de la priorité accordée à l'exploitation du bois en tant que principal objectif sur lequel s'appuient les politiques forestières. La question essentielle consiste à trouver un équilibre entre la poursuite des intérêts économiques individuels à court terme et le bien public à long terme. J'avance une théorie morale qui affirme l'existence d'un intérêt public qui soit considéré d'un point de vue téléologique comme une fin objective à poursuivre. Je soutiens qu'il existe un lien entre le concept philosophique et moral de la créativité et le concept scientifique de diversité biologique. Selon moi, ces concepts sont tous deux liés à la notion politique d'intérêt public. La maximisation de l'intérêt éthique de la créativité selon cette théorie est liée à la maximisation de l'intérêt public. Dans le domaine de la foresterie, la gestion de nos écosystèmes forestiers pour maximiser leur intérêt créatif est liée à la maximisation de l'intérêt public et vice versa. La théorie ethique est essentiellement une théorie religieuse selon la tradition théiste néoclassique, qui affirme que l'existence authentique de l'homme est définie en fonction de nos rapports à la réalité et d'une vision du monde informée d'un point de vue métaphysique et cosmologique.

PROTECTED AREAS AND OTHER LAND USES — A SPATIALLY EXPLICIT EVALUATION METHOD

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Abstract

We will present the conceptual framework and associated methods for a generic land-use planning tool which will allow resource managers, decision makers, and/or stakeholders to estimate the effects of proposed management initiatives on land use values for a defined area, such as a planning unit. The resulting decision support system will be based on the concept of trade-offs, will be spatially explicit, will consider the production capabilities, the net economic values, social preferences, and relationships between ecological processes, for a selected set of natural resources

Implementation of the project would involve the following components: development of a framework for estimating the values of the major natural resources; development of a framework for estimating production capabilities; development of an activity/use interaction matrix; development of a balance sheet to illustrate how the total value of the natural resources of a landbase change under different management scenarios; and development of a spatially explicit decision support system tied to existing GIS databases. The proposed approach will also ensure that the decision support tool is as generic as possible for easy transferability to other management units.

Sommaire

Nous allons présenter le cadre théorique d'un outil de planification générique de l'utilisation des terres susceptible de permettre aux gestionnaires des ressources, aux décideurs ou aux parties intéressées d'estimer les conséquences des initiatives de gestion proposées sur les valeurs de l'utilisation des terres dans un secteur défini, notamment en tant qu'unités de planification, ainsi que les méthodes associées. Le système de soutien de la prise de décisions qui en résulte sera basé sur le principe des compromis, qui seront explicites sur le plan spatial, en tenant compte des capacités de production, des valeurs économiques nettes, des préférences sociales et des rapports entre les processus écologiques pour un ensemble choisi de ressources naturelles.

La mise en œuvre du projet inclura les composantes suivantes : élaboration d'un cadre d'estimation des valeurs relatives aux principales ressources naturelles; élaboration d'un cadre d'estimation des capacités de production; élaboration d'une matrice d'interaction entre les activités et l'utilisation; élaboration d'un bilan afin d'illustrer sous quelle forme la valeur totale des ressources naturelles d'un territoire change selon les scénarios d'aménagement pris en compte; et élaboration d'un système explicite sur le plan spatial de soutien de la prise de décisions qui soit lié aux bases de données du SIG existantes. La stratégie proposée garantira également que l'outil de soutien de la prise de décisions soit le plus générique possible de manière à pouvoir être facilement transféré à d'autres unités d'aménagement

ÉVALUATION DE LA DIVERSITÉ ÉCOLOGIQUE RÉGIONALE À PETITE ÉCHELLE : LE CAS DU PROJET DE PARC DE CONSERVATION DE HARRINGTON-HARBOUR (BASSE-CÔTE-NORD DU SAINT-LAURENT, QUÉBEC)

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Résumé

Le gouvernement du Québec envisage la création d'un parc de conservation sur la Basse-Côte-Nord du Saint-Laurent, à proximité du village de Harrington-Harbour. Depuis 1991, diverses superficies ont été envisagées et ont fait l'objet de discussions avec les communautés locales. En vue de retenir un territoire optimal, le ministère de l'Environnement et de la Faune a entrepris de faire une évaluation sommaire de la diversité écologique des différentes options envisagées. Cette évaluation repose sur l'analyse d'informations tirées des niveaux de perception supérieurs du cadre écologique de référence des écosystèmes du Québec et, plus particulièrement, du niveau 4, les districts écologiques. La diversité écologique est exprimée à travers la notion d'unité de paysage. Appliquée, dans un premier temps au milieu terrestre, elle a permis de suggérer, qu'après certaines modifications mineures, la plus petite superficie proposée pouvait inclure la totalité des unités de paysage régionales.

Abstract

The Government of Quebec is exploring the possibility of creating a conservation park on the Lower North Shore of the St. Lawrence near the village of Harrington Harbour. Since 1991, various tracts of land have been considered and discussed with local communities. In order to select the most suitable lands, the Department of Environment and Wildlife has conducted a general evaluation of the ecological diversity of the various options being studied. The evaluation is based on an analysis of information derived from the upper perception levels of the ecological reference framework for Quebec ecosystems, in particular Level 4, ecological districts. Ecological diversity is expressed through the concept of the landscape unit. Applied initially to the land environment, it suggested that with a few minor changes, the smaller proposed land area could encompass all of the regional landscape units.

Introduction

Le cadre écologique de référence (CER) est une méthode de cartographie et de classification écologiques du territoire qui s'inscrit dans une approche holistique, multiscalaire et hiérarchique du haut vers le bas (*top to bottom*). Il cartographie, en premier lieu, des unités écologiques en s'appuyant sur des variables stables du milieu physique, et, en second lieu, les décrit en faisant appel à une gamme élargie de variables écologiques. Le Québec présente 13 polygones de niveau 1, le niveau de perception le plus élevé nommé province naturelle, et 81 polygones de niveau 2 (Li *et al.* 1994 ; Ducruc *et al.* 1995). La cartographie du niveau 3 a été réalisée dans 14 unités de niveau 2 limitrophes du Saint-Laurent et leur description s'est faite à l'aide de la notion de Grand Type Écologique (GTE) (Li *et al.* 1997).

Dans cette communication, nous faisons d'abord une brève revue des concepts du CER et des principes qui en découlent, et présentons les niveaux de perception. Ensuite, nous montrons une application toute recente du CER (niveau 4) à l'évaluation de la diversité écologique régionale dans le cadre d'un projet de parc de conservation du gouvernement du Québec sur la Basse-Côte-Nord du Saint-Laurent.

Cadre écologique de référence : concepts, PRINCIPES et niveaux de perception

Le CER est une méthode de cartographie et de classification écologiques dans laquelle la représentation cartographique est primordiale.

L'essentiel des principes de base du CER était déjà clairement établi dès la fin des années 1960, aussi bien au Canada (Lacate 1969), qu'au Québec (Jurdant 1968 ; Jurdant *et al.* 1972). Au Québec, cette méthode a depuis lors constamment évolué au travers d'une série de grands travaux (Jurdant *et al.* 1977 ; Jurdant et Ducruc 1980 ; Ducruc et Bérubé 1980 ; Ducruc 1985) et s'est modernisée par des applications diverses (Gerardin et Ducruc 1990 ; Ducruc *et al.* 1993 ; Ducruc *et al.* 1995 ; Gerardin *et al.* 1995 ; Pâquet et Ducruc 1995 ; Beauchesne *et al.* 1996 ; Ducruc et Gerardin 1996 ; Gerardin et Ducruc 1996 ; Li *et al.* 1997).

Le CER repose sur deux concepts fondamentaux :

1) l'écosystème est considéré comme une entité spatiale cartographiable de dimensions variables ;
2) able territoire est abordé selon une approche holistique, hiérarchique et multiscalaire.

Une série de principes découlent de ces deux concepts fondamentaux et président à la réalisation du CER:

1. La cartographie écologique est dressée à plusieurs niveaux de perception emboîtés les uns dans les autres ; l'emboîtement se fait du haut vers le bas ;
2. Quel que soit le niveau de perception, on considère d'abord le territoire à cartographier dans son ensemble, puis on le découpe en sous-ensembles spatiaux ;
3. Le découpage cartographique s'appuie sur des assemblages plus ou moins complexes, selon le niveau de perception, de formes de terrain ; ces formes sont, pour l'essentiel, héritées de l'histoire géologique et paléoclimatique qui a façonné la surface du globe au travers d'orogénèses, de cycles d'érosion-sédimentation, de modifications tectoniques, de variations climatiques, *etc.* ;
4. Les contours des unités cartographiques sont permanents : végétation, faune, occupation du territoire sont ultérieurement cartographiées à l'intérieur de ces limites stables ;
5. Le contenu des unités cartographiques est hétérogène et chaque niveau de perception génère sa propre hétérogénéité (à rapprocher de la théorie des fractales). C'est l'objet de la classification écologique d'exprimer cette hétérogénéité au travers de diverse typologies (sol, végétation, capacités de support, sensibilités, *etc.*) ;
6. Le climat actuel n'intervient pas dans le découpage cartographique car il n'est pas facteur génétique de l'organisation spatiale des éléments permanents du milieu (les assemblages plus ou moins complexes des formes de terrain). Par contre, il est une variable écologique primordiale et il intervient lors de la caractérisation des unités cartographiques, c'est-à-dire lors de l'élaboration des diverses typologies qui en découlent.

Huit niveaux de perception sont actuellement définis dans le CER pour la partie terrestre (tableau 1 et figure 1).

Évaluation de la diversité écologique à petite échelle pour le projet du parc de conservation de Harrington-Harbour

En 1991, le gouvernement du Québec mettait en réserve 3000 km² de territoire sur la Basse-Côte-Nord du Saint-Laurent en vue de créer un parc de conservation (projet de parc de Harrington-Harbour, ci-après nommé P3000 ; figure 2). En 1995, un comité interministériel-régional proposait un nouveau territoire de 1000 km² de superficie (ci-après nommé P1000 ; figure 2).

L'objectif de l'étude est d'évaluer la diversité écologique naturelle régionale à l'aide du CER et sa répartition dans les deux propositions, P3000 et P1000. L'étude complète porte à la fois sur la partie terrestre du territoire et sur sa façade littorale (Li *et al.*, en préparation) ; nous ne présentons ici que les résultats concernant la partie terrestre.

Méthode et outils de travail

Après des discussions avec les promoteurs du projet de parc, nous avons convenu que l'évaluation de la diversité écologique régionale serait optimale au travers du niveau 4 du CER, le niveau des districts écologiques. Cependant, avant d'arriver au niveau 4, le découpage cartographique du territoire a été réalisé selon les principes du CER, c'est-à-dire en niveaux de perception successifs emboîtés les uns dans les autres. Ainsi, à partir du niveau 1, nous avons successivement découpé le niveau 2 du CER (E3) à l'échelle de 1 : 1 000 000, le niveau 3 (les ensembles physiographiques) à l'échelle de 1 : 500 000, et enfin, le niveau 4 (les districts écologiques) à l'échelle de 1 : 250 000 (figure 3).

Le découpage cartographique repose essentiellement sur des variables physiques permanentes du milieu : la physiographie, la structure géologique, la nature pétrographique des roches, les dépôts de surface, la nature, la configuration et la densité du réseau hydrographique.

Modèle numérique d'altitude (MNA), images satellitaires, photos aériennes, cartes géologiques, cartes topographiques et les cartes de l'Inventaire du Capital-Nature de la Moyenne-et-Basse-Côte-Nord (Ducruc 1985) constituent la panoplie des outils avec lesquels nous avons travaillé.

La description écologique s'est aussi réalisée selon les principes proposés pour décrire les niveaux de perception élevés du CER : à l'aide des grands types écologiques (GTE) intégrant les variables écologiques suivantes (Li *et al.* 1997) :

- une forme générale de terrain (colline, fond de vallée, *etc.*)
- la nature géologique du socle rocheux
- le dépôts de surface
- le régime hydrique dominant des sols
- le couvert végétal

Pour qualifier les formes de terrain les outils de travail ont à nouveau été les MNA, les images satellitaires et les photographies aériennes. L'information sur les autres variables proviennent de cartes thématiques ou de résultats d'études régionales.

Les deux étapes décrites ci-dessus établissent le CER du territoire. L'analyse de la diversité écologique régionale et l'évaluation de la représentativité des périmètres proposés sont basées sur le concept soutenu par plusieurs auteurs dont Rowe (1993 et 1997) qui veut que les paysages soient une clé très efficiente pour capter la diversité écologique du territoire (notion de filtre grossier) (Hunter *et al.* 1988 ; Kavanagh et Iacobelli 1995).

Le niveau 4 du CER (les districts écologiques) a été décrit en terme de GTE à partir desquels nous avons bâti une typologie qui prend en compte les trois variables écologiques suivantes : la forme de terrain, le dépôt de surface et la végétation. Elle aboutit à une notion du paysage très proche de la notion d'unité de paysage proposée par Genest et Moisan (1995).

Résultats et discussion

Le CER du territoire : cartographie et description

La figure 3 présente les unités écologiques de niveau 2 (E3), de niveau 3 (ensembles physiographiques : EP#1 à EP#8) et de niveau 4 (districts ecologiques ; 1-1 à 8-4) du territoire.

Le territoire du niveau 2 du CER, E3, est dominé par des collines dont l'élévation varie de 0 à 300 m. Il est bordé au nord par un plateau de 300 à 600 m d'altitude (E6). Une série de fractures de direction NE-SO sépare E3 en deux parties. Les vallées profondes de trois rivières principales, creusées dans des fractures du socle rocheux, divisent la partie nord en quatre ensembles physiographiques correspondant au niveau 3 du CER (EP #5, #6, #7 et #8). EP #8 est caractérisé par une abondance de grands lacs alors que les trois autres EP ont une configuration similaire composée d'un système de vallée en forme de Y et de deux blocs de collines séparés par une forte rupture de pente. Cette configuration particulière permet de définir trois unités de niveau 4 (les districts écologiques ; DE) dans chaque EP. La partie sud de E3 présente une alternance de terrains bas et plats avec des dépôts epais (EP #1 et #3) et de terrains élevés et rocheux (EP #2 et #4). Ils se divisent, à leur tour, en districts écologiques (de 3 à 5 selon les EP considérés).

Nous avons décrit 13 districts écologiques en terme de GTE . 11 qui sont compris en totalité ou en partie dans les territoires P3000 et P1000, et deux situés à proximité immédiate. Leur description a amené la définition de 32 GTE pour lesquels est évaluée l'importance relative de chacun d'eux dans les différents territoires a l'étude (tableau 2).

Unités de paysage

La typologie des 32 GTE bâtie avec les trois variables retenues (forme de terrain, dépôt, végétation) aboutit à la définition de 12 unités de paysage (tableau 3) dont l'importance relative a à nouveau été calculée pour les différentes superficies à l'étude (tableau 4). Remarquons que l'importance relative des unités de paysage #2 et #3 qui occupent, à elles seules, 66% de la superficie des 13 DE tandis que les unités de paysage #8 et #12 représentent moins de 1%.

P3000 compte 9 des 12 unités de paysage régionales en des proportions différentes de celles observées dans les 13 districts écologiques : l'unité de paysage #1 (5% contre 2%), l'unité de paysage #2 (47% contre 31%) et l'unité de paysage #5 (11% contre 5%) sont sur-représentées tandis que l'unité de paysage #3 est sous-représentée (10% contre 35%).

Une seule unité de paysage de P3000 (#4) ne se retrouve pas dans P1000, ce qui veut dire que huit unités de paysage sur neuf de P3000 sont conservées dans P1000. Notons aussi que les proportions relatives de trois unités de paysage diminuent dans P1000 par rapport à P3000 (#1, #2 et #5) et que celles de cinq autres, augmentent (#3, #6, #8, #9 et #10). Certains changements sont assez importants, en particulier pour les unités de paysage #2, #3 et #5 ; ils sont cependant très intéressants car ils réduisent les écarts qui existaient entre les 13 DE et P3000. De façon générale, les proportions des unités de paysage régionales dans P1000 sont plus proches de celles des 13 DE que ne l'étaient celles de P3000, à l'exception des unités #9 et #10.

La limite nord-ouest de P1000 s'enfonce loin à l'intérieur de E3 par rapport à P3000. incorporant ainsi une partie de la zone bioclimatique du boréal inférieur (Gerardin et Ducruc 1983). Cette inclusion permet d'ajouter une nouvelle unité de paysage de paysage (#7 - vallées en argile marine avec des tourbières et des sapinières à mousses) dans P1000. Le périmètre de P1000 comprend ainsi 9 des 12 unités de paysage régionales.

Modifications proposées pour inclure toutes les unités de paysage régionales dans P1000

L'unité de paysage #4 (collines rocheuses dénudées ou avec krummholz ; figure 4), régionalement peu abondante, se retrouve surtout dans les DE 2-4 et 4-3 (tableau 3) ; le DE 4-3 est très proche de la limite orientale de P1000. Il a, de plus, une assise géologique particulière pour la région : c'est un complexe syénitique d'âge Cambrien , beaucoup plus récent que le socle rocheux régional qui date de l'orogénèse grenvillienne (Davies 1965 ; Lalonde 1981). Il serait possible de modifier légèrement le périmètre de P1000 pour inclure une superficie de 20 km² de cette unité de paysage dans le projet de parc Cette superficie ne représente que un neuvième de la superficie du DE 4-3, ce qui ne devrait pas affecter une éventuelle mise en valeur minière (figure 5).

Le CER a mis en évidence la structure similaire des EP #5, #6 et #7 : une succession de vallées et de collines. La limite nord actuelle de P1000 coïncide avec la limite septentrionale du DE 5-3. En tenant compte de cette structure spatiale, nous proposons de pousser la limite de P1000 un peu plus vers le nord dans les DE 5-1 et 5-2 ; ceci permettrait d'ajouter les deux unités de paysage régionales manquantes : l'unité de paysage #11 (fonds de vallées en alluvions fluviatiles avec des sapinières à mousses) et l'unité de paysage #12 (versants escarpés en colluvions avec des sapinières à mousses ; tableau 4 et figure 4) Pour contrebalancer l'augmentation de la superficie totale, il est possible d'enlever une petite partie de P1000 dans le DE 5-3, sans que cela n'en affecte sa représentativité (figure 5). La superficie de P1000 avec les modifications proposées atteindrait ainsi 1115 km².

Conclusion

Le terme de « cadre écologique de référence », proposé initialement par Veillette et Ducruc en 1983 a depuis fait beaucoup de chemin. Il s'est successivement enrichi grâce aux nombreux travaux réalisés un peu partout sur le territoire québécois et il s'est aussi inspiré des derniers développements conceptuels et méthodologiques de l'écologie du paysage (Naveh et Lieberman 1994 ; Forman 1995). En particulier, il intègre bien aujourd'hui les dimensions terrestres et les dimensions aquatiques dans un spectre très complet de niveaux de perception hierarchisés. En général, les niveaux de perception élevés du CER conviennent bien à des problématiques d'envergure provinciale ou régionale comme l'établissement de réseaux de conservation ou encore l'évaluation du bilan sur l'état de l'environnement ; en contre partie, les CER réalisés à des niveaux inférieurs plus détaillés répondent bien à des problématiques régionales ou locales comme les schémas d'aménagement des MRC (Gerardin 1996), la gestion par bassin versant (Lajeunesse *et al.* 1997) et la gestion intégrée des ressources (Bissonnette *et al.* 1997 ; Gerardin et Lachance 1997).

L'application présentée ici, quoique préliminaire et incomplète, souligne les avantages qu'un CER de haut niveau de perception offre pour cerner rapidement la diversité écologique régionale. C'est certainement une voie à privilégier à l'avenir car elle donne rapidement une information plus complète et plus pertinente que les traditionnelles spatio-cartes. En comprenant mieux la structure et l'organisation du milieu naturel, le choix de sites et de territoires à conserver sont rendus plus objectifs et considèrent la diversité écologique régionale du territoire étudié. Au fur et à mesure que la cartographie et la description des hauts niveaux de perception du CER avanceront pour l'ensemble du Québec, l'approche méthodologique proposée ici pourra être reprise et améliorée et la planification des réseaux d'aires protégées au Québec n'en sera que facilitée.

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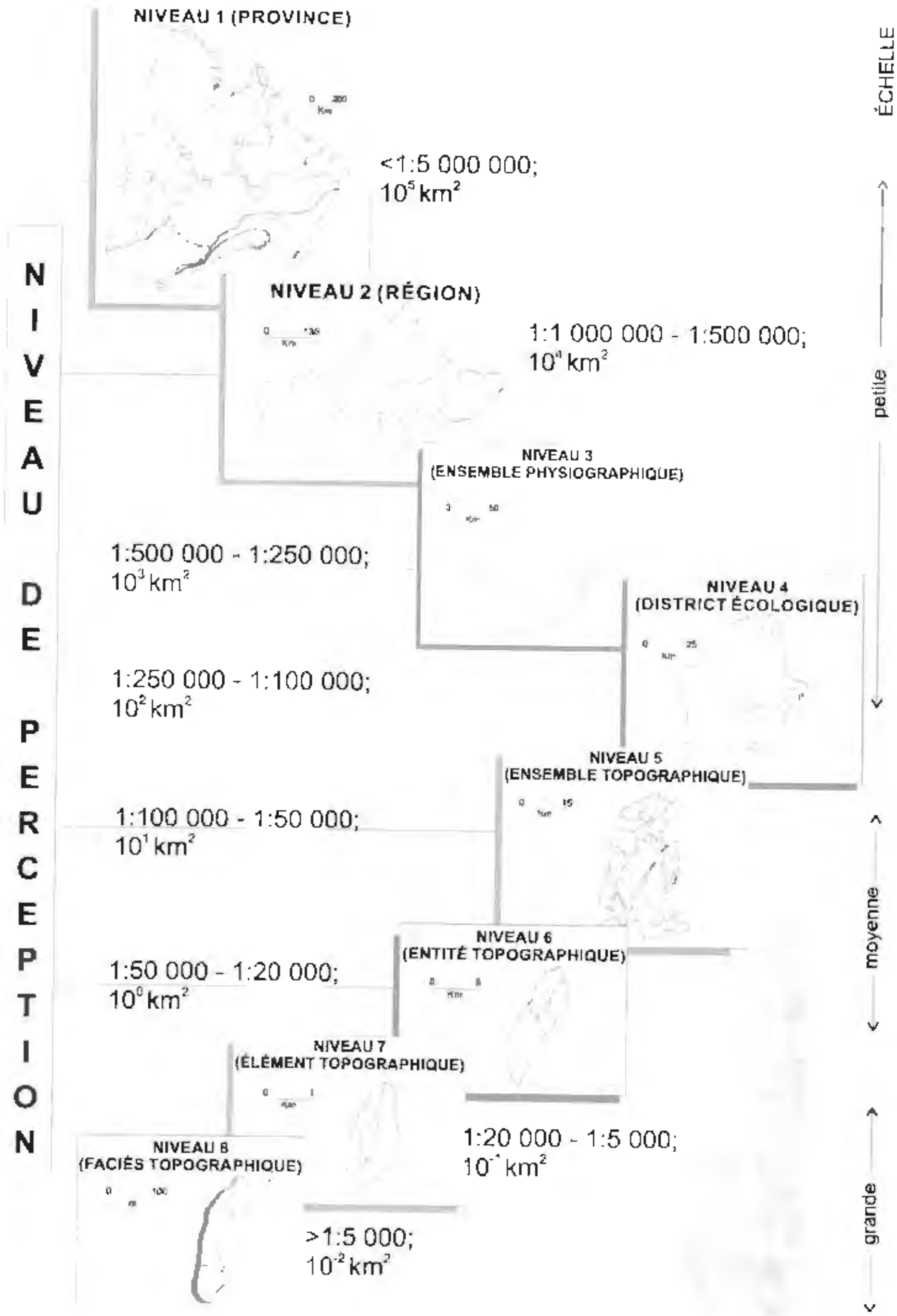

Figure 1 Les niveaux de perception du cadre écologique de référence des écosystèmes du Québec (partie terrestre)

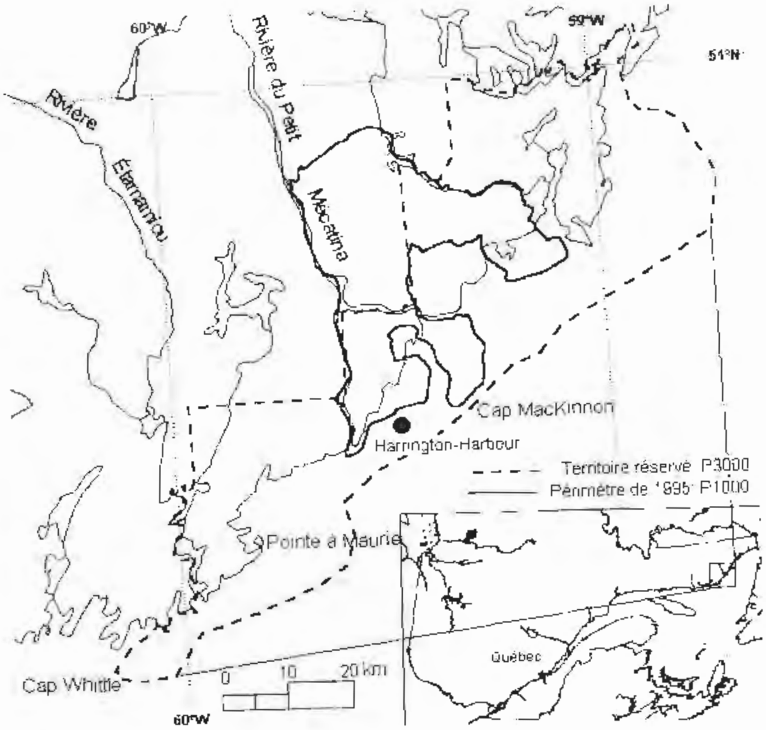

Figure 2 Localisation du projet de parc de conservation de Harrington-Habour (Basse-Côte-Nord du Saint-Laurent, Québec)

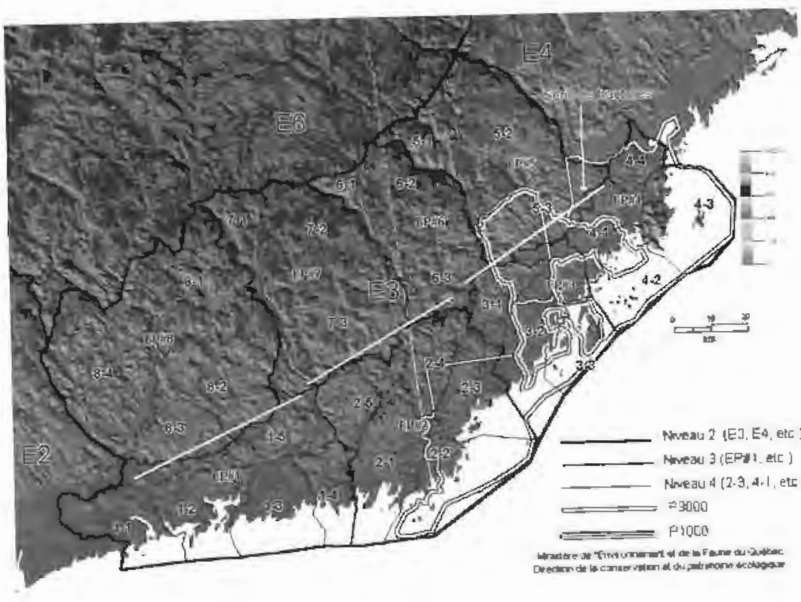

Figure 3 Les unités écologiques du territoire (niveaux de perception 2 à 4). Image du fond : relief ombragé généré à partir d'un modèle numérique d'altitude de Géomatique Canada

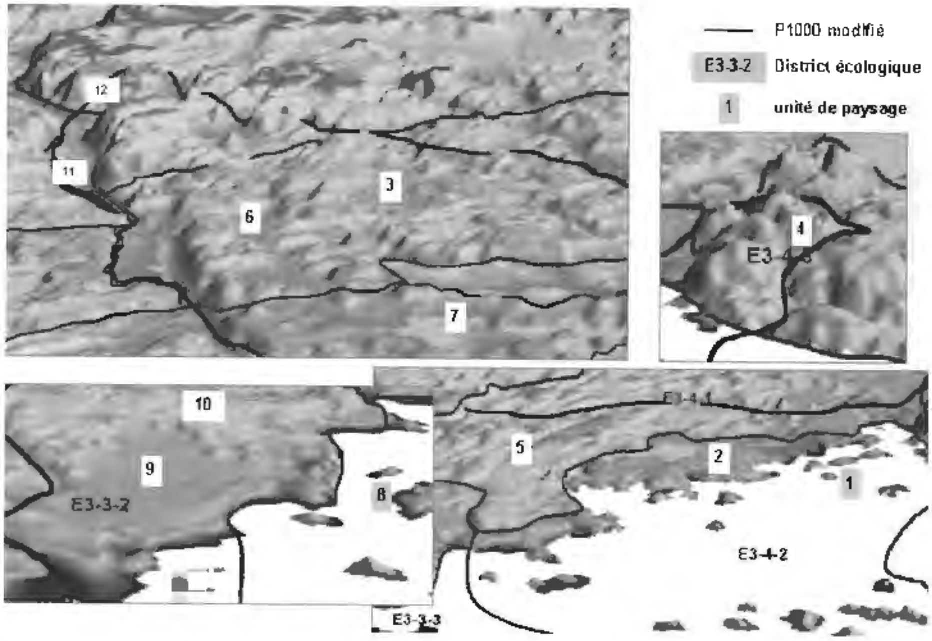

Figure 4 Localisation typique des 12 unités de paysage

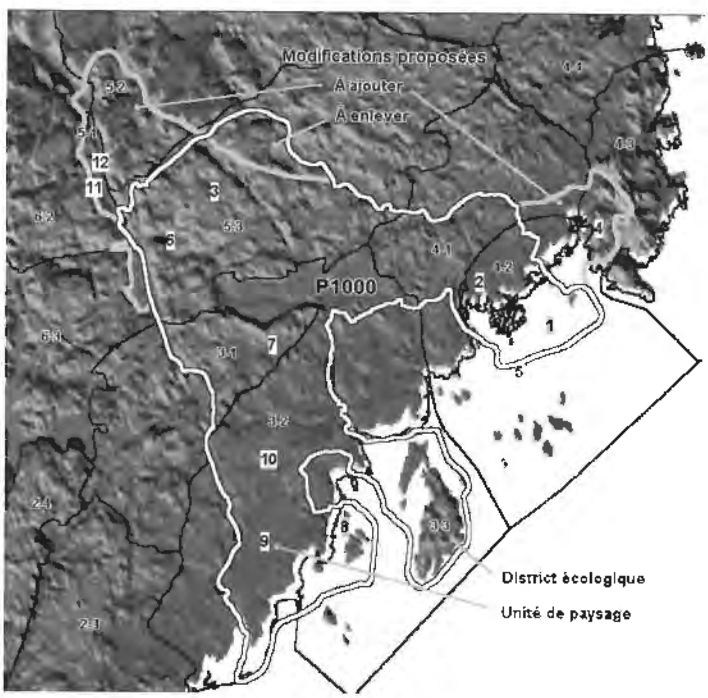

Figure 5 Les modifications proposées aux limites initiales de P1000

Tableau 1 Les niveaux de perception du cadre écologique de référence des écosystèmes du Québec (partie terrestre)

Définition générale : Les niveaux de perception du cadre écologique de référence correspondent à des ensembles spatiaux de superficie de plus en plus restreinte, se traduisant par des assemblages de plus en plus simples de formes de relief génétiquement emboîtés les uns dans les autres.

Niveau de perception	Échelle d'analyse (superficie: ordre de grandeur)	Facteurs génétiques prépondérants	Variables intrinsèques de description[1]	Exemples
Niveau 1 (province)	1:5 000 000 (10^5 km²)	Tectonique des plaques (craton, marge continentale, bassin océanique, orogène, etc.)	Géologie, Relief, Hydrographie, Climat	Les Appalaches Les Laurentides méridionales
Niveau 2 (région)	1:5 000 000 à 1:1 000 000 (10^4 km²)	Géologie régionale (domaine structural, terrane, bassin de sédimentation, graben, etc.) Formation géomorphologique majeure (invasion marine, glacio-lacustre, etc.)	Géologie, Relief, Géomorphologie, Hydrographie, Climat	Massif du Lac Jacques-Cartier Massif du mont Tremblant Plaine du Haut St-Laurent (plaine de Montréal)
Niveau 3 Ensemble physiographique (EP)	1:1 000 000 à 1:500 000 (10^3 km²)	Géologie régionale (zone de cisaillement, batholite, nappe de charriage, dôme, faille, etc.), / Formation géomorphologique régionale (delta, plaine alluviale, moraine de décrépitude, etc.)	Géologie, Relief, Géomorphologie, Hydrographie, Climat	Monts Chic-Chocs Astroblème de Charlevoix Basses-terres du moyen Outaouais
Niveau 4 District écologique (DE)	1:500 000 à 1:250 000 (10^2 km²)		Géologie, Relief, Géomorphologie, Hydrographie, Climat	Delta de la rivière Assomption Colline de Québec Terrasse de Charlesbourg
Niveau 5 Ensemble topographique (ES)	1:500 000 à 1:250 000 (10^2 km²)	Cellule de la structure du socle (cassante, ductile, etc.) / Processus géomorphologique local (érosion, transport, accumulation)	Géologie, Relief, Géomorphologie, Hydrographie, Climat	Un ensemble de basses collines moutonnées Un ensemble de buttes ondulées Un ensemble de ravins
Niveau 6 Entité topographique (ET)	1:50 000 à 1:20 000 (10^0 km²)		Géologie, Relief, Géomorphologie, Climat	Une colline Une terrasse Un fond de vallée
Niveau 7 Élément topographique (EL)	1:20 000 à 1:5 000 (10^{-1} km²)	Position topographique[2]	Relief, Géomorphologie, Climat	Un sommet Un bas de pente Un replat
Niveau 8 Faciès topographique (FT)	1:5 000 (10^{-2} km²)	Micro-relief[2]	Relief, Géomorphologie	Une levée alluviale

1. Ces variables deviennent de plus en plus précises spatialement et typologiquement au fur et à mesure que l'on descend dans les niveaux de perception. À ces variables s'ajoutent généralement des descripteurs portant sur l'occupation et l'utilisation actuelle du territoire et des données socio-économiques.
2. Ce ne sont plus des facteurs génétiques *sensu stricto*.

Tableau 2 Description des 13 districts écologiques par les GTE

District écologique		GTE						Importance relative (%)		
DE #	Superficie (km²)	#	Forme de terrain	Roche du socle	Dépôt de surface	Régime hydrique	Végétation	DE	P3000	P1000
2-2	206	1	BT	PA	0	X	D	50	50	0
		2	VA	PA	5-6	M	Sm	35	25	0
		3	AP	PA-SY	0	X	D	15	25	0
2-3	359	4	BT	PA	0	X	D	80	70	0
		5	VA	PA	5-0	MX	Sm	20	30	0
2-4	336	6	BU	PA	1-0	MX	ESm-K	60	60	0
		7	VA	PA	5-2	M	Sm	30	40	0
		8	CO	PA	0-1	XM	D-K	10	0	0
3-1	250	9	BU	PA	0-1	XM	D-K	60	0	30
		10	FV	PA	5-7	MH	Sm-T	40	0	70
3-2	531	11	PL	PA-SY	7	H	T	40	40	40
		12	RV	PA-SY	5	M	Sm	40	40	40
		13	BT	PA-SY	0-1	XM	D-K	20	20	20
3-3	73	14	BU	PA	0	X	D	40	40	40
		15	BT	PA	0-6	XM	D-K	30	30	30
		16	PL	PA	6	H	F	30	30	30
4-1	248	17	BU	PA-SY	0	X	D	70	70	70
		18	FV	PA-SY	5-0	MX	Sm	30	30	30
4-2	103	19	BT	PA	0-6	XM	D-K	60	60	80
		20	AP	PA	0	X	D	40	40	20
4-3	156	21	CO	SY	0	X	D	50	50	0
		22	BU	SY	0-1	XM	D-K	40	40	0
		23	AP	SY	0	X	D	10	10	0
4-4	159	24	BU	PA	0	X	D	80	80	0
		25	VA	PA	0-5	XM	Sm	20	20	0
5-3	370	26	BU	PA-SY	1-0	MX	ESm-K	90	100	85
		27	VA	PA-SY	5-3	MH	Sm	10	0	15
5-1	196	28	BU	GN	1	MX	ESm	60	0	0
		29	FV	GN	3	M	Sm	30	0	0
		30	ES	GN	8	M	Sm	10	0	0
5-2	588	31	BU	GN-RA	1-0	MX	Esm	90	0	0
		32	CO	GN-RA	0-1	XM	ESm	10	0	0

Forme de terrain
- AP - Archipel
- BT - Button (<50m)
- BU - Butte (50-100m)
- CO - Colline (>100m)
- ES - Escarpement
- FV - Fond de vallée
- PL - Plaine
- RV - Ravin
- VA - Vallée

Roche du socle
- GN - Gneiss (y compris migmatites)
- PA - Paragneiss
- RA - Roches acides (roche charnockitique, granite
- SY - Roches intermediaires (syénite)

Dépôt de surface
- 0 - Roc
- 1 - Till
- 2 - Fluvio-glaciaire
- 3 - Fluviatile
- 4 - Lacustre
- 5 - Marin
- 6 - Littoral
- 7 - Organique
- 8 - Colluvion

Régime hydrique
- M - Mésique
- H - Hydrique
- X - Xérique

Végétation
- D - Dénudé
- Esm - Pessière à épinette noire à sapin et mousse
- F - Tourbière minérotrophe (fen)
- K - Krummholz d'épinette noire
- Sm - Sapinière à mousse
- T - Tourbière ombrotrophe (bog)

Tableau 3 La typologie des GTE : les unités de paysage

#	Unité de paysage Appelation	District écologique #	GTE #	Forme de terrain	Dépôt de surface	Végétation
1	Archipel rocheux dénudé	4-2	20	AP	0	D
		2-2	3	AP	0	D
		4-3	23	AP	0	D
2	Buttes ou buttons rocheux avec placages de till, dénudées ou avec krummholz	2-2	1	BT	0	D
		2-3	4	BT	0	D
		3-3	14	BU	0	D
		4-4	24	BU	0	D
		4-1	17	BU	0	D
		3-1	9	BU	0-1	D-K
		3-2	13	BT	0-1	D-K
		4-3	22	BU	0-1	D-K
		3-3	15	BT	0-6	D-K
		4-2	19	BT	0-6	D-K
3	Buttes ou collines de till mince avec pessière à sapin et mousses	2-4	6	BU	1-0	ESm-K
		5-3	26	BU	1-0	ESm-K
		5-2	31	BU	1-0	Esm
		5-1	28	BU	1	ESm
		5-2	32	CO	0-1	ESm
4	Collines rocheuse, dénudées ou avec krummholz	4-3	21	CO	0	D
		2-4	8	CO	0-1	D-K
5	Vallées ou fonds de vallées d'argile et roc avec sapinière à mousses	2-3	5	VA	5-0	Sm
		4-4	25	VA	0-5	Sm
		4-1	18	FV	5-0	Sm
6	Vallées d'argile et sable, avec sapinière à mousses	2-4	7	VA	5-2	Sm
		2-2	2	VA	5-6	Sm
		5-3	27	VA	5-3	Sm
7	Fonds de vallée d'argile avec des tourbières ombrotrophes avec sapinière à mousses	3-1	10	FV	5-7	Sm-T
8	Terrain plat littoral avec des tourbières minérotrophes (fen)	3-3	16	PL	6	F
9	Terrain plat avec des tourbières ombrotrophes structurées	3-2	11	PL	7	T
10	Ravins d'argile avec sapinière à mousses	3-2	12	RV	5	Sm
11	Fonds de vallées d'alluvions avec sapinière à mousses	5-1	29	FV	3	Sm
12	Versants escarpés de colluvion avec sapinière à mousses	5-1	12	ES	8	Sm

Tableau 4 Superficies absolues et relatives occupées par les unités de paysage

#	Unité de paysage	Superficie Régionale km²	%	P3000 km²	%	P1000 km²	%	P1000 modifié km²	%
1	Archipel rocheux dénudé	88	2	92	5	11	1	15	2
2	Buttes ou buttons rocheux avec placages de till, dénudées ou avec krummholz	1123	31	789	47	234	29	264	29
3	Buttes ou collines de till mince avec pessière à sapin et mousses	1240	35	175	10	178	22	218	24
4	Collines rocheuse, dénudées ou avec krummholz	112	3	78	5	0	0	20	2
5	Vallées ou fonds de vallées d'argile et roc avec sapinière à mousses	178	5	182	11	25	3	29	3
6	Vallées d'argile et sable, avec sapinière à mousses	210	6	52	3	31	4	38	4
7	Fonds de vallée d'argile avec des tourbières ombrotrophes avec sapinière à mousses	100	3	0	0	53	7	53	6
8	Terrain plat littoral avec des tourbières minérotrophes (fen)	22	1	22	1	20	3	20	2
9	Terrain plat avec des tourbières ombrotrophes structurées	212	6	153	9	124	16	124	13
10	Ravins d'argile avec sapinière à mousses	212	6	153	9	124	16	124	13
11	Fonds de vallées d'alluvions avec sapinière à mousses	59	2	0	0	0	0	11	1
12	Versants escarpés de colluvion avec sapinière à mousses	20	1	0	0	0	0	7	1
	Total (partie terrestre)	3575	100	1697	100	800	100	923	100
	Total (terre + eau du Golfe)			3000		1000		1115	

THE ROLE OF ADAPTIVE MANAGEMENT IN PROTECTED AREAS

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Abstract

Protection of many species, especially the less commonly occurring, often involves reserving some lands for habitat. Another important conservation strategy involves the ability and willingness to adapt to new information. Adaptive management deliberately seeks both new information and action based on that new information.

This presentation gives preliminary results of a 24.3-million-acre experiment where reconciliation of the two conservation strategies is being tried. That area is within the range of the northern spotted owl in western Washington and Oregon and northwestern California. The area included in the experiment is on the federally administered lands,which is but 42% of the entire range.

Not surprisingly, many conservationists readily accept the reserves but do not want management "experiments" where threatened or uncommon species are involved. Also not surprisingly, other conservationists want the active search for and use of new information to be a mainstay of the conservation strategy. One implementation solution being tried is to identify areas where we are piloting Adaptive Management. The consensus of scientists is that the known populations of threatened species in these areas would not be affected, even if the habitat were mismanaged. The second part of implementing this strategy is to permit an adaptive management approach everywhere but be more passive in its pursuit until more is learned from the pilot areas. The third and fourth elements of this strategy are to focus on landscape scales and to use models.

Sommaire

La protection de nombreuses espèces, particulièrement les espèces les plus rares, passe fréquemment par la constitution de certaines réserves pour les habitats. Une autre stratégie importante de conservation suppose la capacité et le désir de s'adapter aux nouvelles données. La gestion adaptative recherche délibérément à la fois de nouvelles données et des interventions basées sur cette nouvelle information.

Ce document présente les résultats préliminaires d'une expérience réalisée sur 24,3 millions d'acres, dans le cadre de laquelle on a tenté la conciliation de deux stratégies de conservation. Le secteur en question est situé sur l'aire de répartition de la chouette tachetée nordique, dans l'ouest des États de Washington et d'Oregon et dans le nord-ouest de la Californie. Le secteur faisant l'objet de l'expérience est constitué de terres gérées à l'échelon fédéral, qui représentent presque 42 % de l'ensemble de l'aire de répartition.

De manière non surprenante, nombre de spécialistes de la conservation acceptent facilement les réserves, mais sont opposés aux « expériences » de gestion, lorsque des espèces menacées ou rares sont concernées. De manière également non surprenante, d'autres spécialistes de la conservation soutiennent que la recherche et l'utilisation active de nouvelles données doivent être l'une des priorités des stratégies de conservation. L'une des options de mise en œuvre faisant l'objet d'expériences consiste à préciser les secteurs où sont réalisées des expériences pilotes de gestion adaptative. Les scientifiques s'entendent tous sur le fait que les populations connues d'espèces menacées dans ces secteurs ne seront pas touchées, même si l'habitat n'a pas été convenablement géré. Le second volet de la mise en œuvre de cette stratégie consiste à permettre une stratégie de gestion adaptative dans tous les cas, mais de procéder de manière plus passive, en attendant qu'augmentent les leçons tirées des secteurs pilotes. Les troisième et quatrième volets de cette stratégie consistent à mettre l'accent sur des échelles de paysage terrestre ainsi qu'à utiliser des modèles.

CAN OUTSTANDING NATURAL WATERS CONTRIBUTE?

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Abstract

A major initiative under the Clean Water Act will be the development of a River Classification System which will provide a framework for water quality management in New Brunswick. Under Classification, goals for water quality will be set using community participation. Water bodies will be placed in one of six classes, and water quality and benthic invertebrate standards, in combination with other water management tools, will be put in place to achieve the water quality goals. One of the Classes, Outstanding Natural Waters, will be managed to protect special lakes and rivers that still show natural water quality and that are representative of unique water bodies.

This paper will explain the criteria for designating an Outstanding Natural Water and the process for nominating a water body to the Class. It will examine the Outstanding Natural Waters Class in the context of its relevance for contributing to the conservation and protection of the natural resources of the province. The purpose for protecting outstanding waters will be outlined and its benefits to water quality and habitat protection and ecotourism will be explored.

The outstanding class is presented as contributing towards the filling of an important gap in protection of New Brunswick ecosystems, that of the aquatic ecosystem. By protecting these beautiful, special waters, downstream water quality will be maintained or improved, and additional educational and scientific opportunities will be provided for future generations. There may also be opportunities to pool resources and together protect different components of our important freshwater and estuarine ecosystems and their surrounding drainage basins.

Sommaire

L'élaboration d'un système de planification des cours d'eau susceptible de constituer un cadre directeur de la gestion de la qualité des eaux au Nouveau-Brunswick constitue l'une des principales initiatives entreprises en vertu de la Loi sur l'assainissement de l'eau. Dans le cadre du système de classification, les objectifs en matière de qualité des eaux seront fixés en consultation avec la collectivité. Les étendues d'eau seront placées dans l'une de six catégories, et des normes en matière de qualité des eaux et d'invertébrés benthiques, en combinaison avec d'autres outils de gestion des eaux, seront mises en place dans le but de réaliser les objectifs en matière de qualité de l'eau. L'une des catégories, les eaux naturelles exceptionnelles, sera gérée de manière à protéger les lacs et les cours d'eau spéciaux dont la qualité naturelle des eaux demeure exceptionnelle et qui sont représentatifs des étendues d'eau uniques.

Le présent document explique les critères de désignation des eaux naturelles exceptionnelles et le processus de nomination d'une étendue d'eau dans cette catégorie. Les auteurs examinent la catégorie des eaux naturelles exceptionnelles sous l'angle de sa pertinence du point de vue de sa contribution à la conservation et à la protection des ressources naturelles de la province. L'objectif de la protection des eaux exceptionnelles est souligné et ses avantages du point de vue de la qualité des eaux, de la protection des habitats et de l'écotourisme sont évalués.

La catégorie exceptionnelle est considérée comme susceptible de contribuer à combler une lacune importante sur le plan de la protection des écosystèmes du Nouveau-Brunswick, à savoir les écosystèmes aquatiques. En protégeant ces eaux particulières et majestueuses, la qualité des eaux situées en aval sera maintenue ou améliorée et les futures générations accéderont à des possibilités supplémentaires sur le plan éducatif et scientifique. Il devrait également être possible de mettre en commun des ressources et, ainsi, de protéger différents volets de nos écosystèmes importants d'eau douce et d'estuaires ainsi que leurs bassins de drainage environnants.

GREATER ECOSYSTEM PLANNING FOR GEORGIAN BAY ISLANDS NATIONAL PARK, ONTARIO

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Abstract

An Ecosystem Conservation Plan (ECP) for a national park represents Parks Canada's approach to identifying and addressing ecological integrity related problems, issues and concerns for a park and its Greater Park Ecosystem (GPE). The ECP recognizes that a high level of understanding about the stresses and problems facing a national park is required from all stakeholders. Strategies and techniques that will facilitate a high level of cooperation in addressing these issues will be promoted.

In 1995-96, the Heritage Resources Centre conducted a study that assembled background information on Georgian Bay Islands National Park (GBINP) (25 km²) and its GPE. The information was used to place the Park within a regional context, to identify its significant values compared to surrounding areas and to identify and prioritize the problems, issues, and concerns facing both the Park and its GPE. This information, in combination with public consultations and meetings, was used to develop an ECP.

Using maps and other visual aids, the ECP proposed the delineation of a Core Area, Near-core Area, and Area of Cooperation and Communication (ACC) for the GPE. The Core Area would be managed through the national park's internal Management Plan. Management goals for the Core Area would focus on maintaining a high level of ecological integrity and human disturbances and land uses would be kept to a minimum. The Near-core Area would be managed within the ACC. Within the ACC, a Greater Park Ecosystem Forum would be established. The Forum would be made up of area stakeholders who would meet annually to exchange information about the GPE. The Forum would communicate with the public and provide a means for promoting education, monitoring, and research on land-use changes and environmental quality in the GPE. Established as part of the Forum would be a Consultative Committee comprising the key actors involved in the Near-core Area. The Consultative Committee would coordinate the linking and sharing of resources and programs within the Near-core Area and other significant natural and cultural areas in the GPE (e.g., Cooperative Heritage Areas (CHAs) and Key Ecological Areas (KEAs))

Sommaire

Le recensement et le traitement des problèmes, des enjeux et des préoccupations reliés à l'intégrité écologique d'un parc et de son écosystème élargi constituent la stratégie mise en œuvre par Parcs Canada pour protéger ses parcs nationaux et qu'on appelle plan de conservation des écosystèmes (PCE). Le PCE est basé sur l'hypothèse que toutes les parties intéressées doivent être fortement sensibilisées aux stress et aux problèmes auxquels est confronté un parc national. Il vise à promouvoir les stratégies et techniques susceptibles de faciliter un degré élevé de coopération dans le but de résoudre ces questions.

En 1995-1996, le Centre des ressources du patrimoine a réalisé une étude afin de réunir de l'information de référence sur la parc national des Îles-de-la-Baie-Georgienne (PNIBG) (25 km²) ainsi que son écosystème élargi. L'information a servi à situer le parc dans un contexte régional, à préciser l'importance de ses valeurs en comparaison des secteurs environnants ainsi qu'à recenser et à classer par ordre de priorité les problèmes, questions et préoccupations auxquels sont confrontés les gestionnaires du parc et de son écosystème élargi. Combinée aux résultats des consultations et des assemblées du public, cette information a été utilisée pour élaborer un PCE.

En mettant à profit des cartes et d'autres aides visuelles, le PCE a proposé la délimitation d'une zone de base, d'une zone périphérique et d'une zone de coopération et de communication (ZCC) de l'écosystème élargi. La zone de base serait gérée selon le plan de gestion interne du parc national. Les objectifs de gestion de cette première zone seraient axés sur le maintien d'un degré élevé d'intégrité écologique et les perturbations provoquées par l'activité humaine et les utilisations du terrain seraient limitées au minimum. La zone périphérique serait gérée dans le cadre de la ZCC, au sein de laquelle un forum de l'écosystème élargi du parc serait créé. Ce forum serait composé des parties intéressées, qui se réuniraient tous les ans pour échanger des informations sur l'écosystème élargi. Le forum serait l'occasion de communiquer avec le public et de promouvoir la sensibilisation, d'effectuer le suivi et des recherches sur les changements de l'utilisation du terrain

The development of an ECP for GBINP, as outlined above, was very much grounded in a civics approach. The recommendations that were set out were designed to bring a number of agencies and groups to the table in the common interest while respecting the efforts of these agencies and groups to meet their own needs and responsibilities. It will be difficult to develop a relatively comprehensive and effective ECP without using such civic processes.

ainsi que la qualité de l'environnement au sein de l'écosystème élargi. Un comité consultatif serait créé dans le cadre du forum; il serait composé des principaux intervenants concernés par la zone périphérique. Le comité consultatif coordonnerait la liaison et les échanges entre les ressources et les programmes au sein de cette zone et d'autres domaines naturels et culturels importants de l'écosystème élargi (p. ex. aires du patrimoine à gestion conjointe et aires écologiques essentielles).

L'élaboration d'un PCE pour le PNIBG, comme nous l'avons souligné ci-dessus, a été essentiellement axée sur une stratégie faisant appel à la population. Les recommandations énoncées visaient à amener un certain nombre d'organismes et de groupes à se concerter dans un intérêt commun, tout en respectant les efforts déployés par ces groupes et organismes pour faire face à leurs propres besoins et responsabilités. Il sera difficile d'élaborer un PCE relativement exhaustif et efficace, sans mettre en œuvre ces processus de concertation.

GUIDELINES FOR DRAWING ECOLOGICAL RESERVE BOUNDARIES - GETTING DOWN TO SPECIFICS. A CASE STUDY FROM MAINE

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Abstract

The Maine Forest Biodiversity Project is exploring a proposal for a statewide ecological reserves system designed to represent all native ecosystem types across their natural range of variation in Maine in a permanently protected system of reserves. These reserves would serve as: 1) benchmarks against which biological and environmental changes in both managed and unmanaged ecosystems could be measured; 2) habitats adequate to maintain viable populations of species whose habitat needs are unlikely to be met on managed land; and 3) sites for scientific research, long-term environmental monitoring, and education. Through landscape analysis and field inventory, 66 areas on private conservation and public lands were identified as having potential as ecological reserves. Reserve design principles and guidelines relating to size, natural disturbance regime, water and watersheds, physiographic and ecological diversity, naturalness, fragmentation, connectivity, and shape are being appliad to aach of these areas to delineate preliminary reserve boundaries. The set of rulas applied depends on the scale of the ecosystems that are the focal point at a given site. Reserves centered around ecosystems that occur as small patches on the landscape will typically be smaller than those that center around the mosaic of ecosystem types that make up the matrix forest of a region. In Maine, we are finding that an average size of 2,400 to 5,000 hectares incorporates most of the reserve design principles and guidelines being applied.

Sommaire

Les responsables du Maine Forest Biodiversity Project étudient une proposition prévoyant un système de réserves écologiques à l'échelon de l'État dans le but de représenter tous les types de systèmes indigènes recensés à l'état naturel dans le Maine, dans le cadre d'un système de réserves protégées sur une base permanente. Ces réserves joueraient le rôle suivant : 1) secteurs de référence en fonction desquels les changements de la biologie et de l'environnement des écosystèmes gérés et non gérás pourraient être mesurés; 2) habitats adéquats permettant le maintien de la viabilité des populations d'espèces dont les besoins en matière d'habitat ne peuvent être comblés sur les terres faisant l'objet d'un aménagement; et 3) sites dont la vocation serait la suivante : recherche scientifique, contrôle environnemental à long terme et éducation. Au moyen d'une analyse des paysages et d'un inventaire des terrains, 66 terres situées dans des secteurs publics et privés ont été considérées comme susceptibles d'être transformées en réserves écologiques. Les principes régissant la mise sur pied de ces réserves et les normes en matière de superficie, de régime de perturbations naturelles, d'eau et de bassins hydrographiques, de diversités écologique et géomorphologique, de caractéristiques naturelles, de fragmentation, de continuité et da forme sont appliqués à chacun de ces secteurs afin de délimiter les frontières préliminaires des réserves. L'ensemble des règles qui s'appliquent est fonction de l'échelle des écosystèmes qui constituent le centre d'intérêt d'un site donné. Les réserves axées sur un écosystème constitué d'îlots de faible superficie au sein du paysage seront généralement de taille inférieure a celles qui sont axées sur la mosaïque des types d'écosystèmes qui composent la forêt caractéristique d'une région. Dans le Maine, nous avons constaté qu'en moyenne, les secteurs qui incorporent la plupart des principes et normes de conception appliqués aux réserves ont une taille moyenne se situant entre 2 400 et 5 000 hactares.

PARKS AND PROTECTED AREAS AS A COMMUNITY DEVELOPMENT RESOURCE IN NOVA SCOTIA

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Abstract

Nova Scotia's Protected Areas Strategy was announced in February, 1997, as the culmination of a multi-year planning and consultation process dating back to 1990. The strategy provides direction for the establishment of a comprehensive system of parks and protected areas, the purposes of which are: (1) to protect natural areas that serve as representative examples of the province's typical landscapes and ecosystems, or natural sites, features or phenomena that are unique, rare or of otherwise outstanding interest; and (2) to provide quality outdoor environments that are attractive for wilderness recreation and eco-tourism. Community development interests in Nova Scotia have been quick to recognize the potential significance of a quality system of parks and protected areas as an important primary resource in support of community development. Perceived benefits at the community level are many and varied, and range from environmental to cultural, social, and economic. This presentation provides a brief overview of the Protected Areas Strategy, highlights its relevance and significance in the context of community development, identifies directly-related community-based initiatives that are either underway or in the planning stages, and considers important opportunities and challenges that lie ahead in the future.

Sommaire

La stratégie sur les secteurs protégés de la Nouvelle-Écosse a été annoncée en février 1997; elle constitue l'aboutissement d'un processus de planification et de consultation semestriel qui remonte à 1990. La stratégie fournit les orientations relatives à la création d'un système exhaustif de parcs et de secteurs protégés, qui répond aux objectifs suivants : 1) protéger les secteurs naturels qui constituent des exemples représentatifs des paysages et des écosystèmes typiques de la province ou des sites naturels, des caractéristiques ou des phénomènes uniques, rares ou présentant un intérêt remarquable d'un autre type; et 2) constituer des cadres extérieurs de qualité qui soient attrayants tant pour les loisirs en milieu naturel sauvage que pour l'écotourisme. Les parties intéressées par le développement communautaire de la Nouvelle-Écosse ont rapidement pris conscience de l'importance potentielle d'un système de qualité de parcs et de secteurs protégés, en tant que ressources primaires importantes susceptibles de favoriser le développement communautaire. Les avantages perçus à l'échelon de la communauté sont nombreux et diversifiés et ils sont, entre autres, environnementaux, culturels, sociaux et économiques. Le présent document constitue un bref aperçu de la stratégie relative aux secteurs protégés; il souligne l'importance et la pertinence de cette stratégie dans le contexte du développement communautaire, précise les initiatives directement reliées qui se déroulent actuellement à l'échelon de la collectivité ou sont en cours de planification et il analyse les possibilités et les défis importants à venir.

ECOLOGICAL LAND CLASSIFICATION FOR NEW BRUNSWICK: A FOUNDATION FOR CONSERVATION PLANNING

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Abstract

Ecological land classification (ELC) is a method of identifying and mapping terrestrial ecosystems by defining the framework of factors, both biotic and abiotic, that have influenced their distribution spatially and through time. Digital maps from a geographical information system (GIS) of climate, landform, geology, hydrology, soils, and vegetation were used to delineate the ecoregion, ecodistrict, ecosection, and ecosite levels of the Canadian Ecological Land Classification System (CELCS). Each of these maps was assessed and compared, to evaluate the factors most important in controlling the distribution of ecosystems at each level of the classification.

The ELC has been used as a tool to identify areas of greatest ecosystem diversity within each ecoregion. It has also been used to assess the extent to which existing protected areas capture the ecosystem diversity of a particular level of the ELC. At a finer scale, it has acted as a starting point in identifying areas with high plant diversity. As the ELC has provan capable in each of these endeavors to assess diversity in a systematic and objective manner, the potential uses of this classification show much promise.

Sommaire

La classification écologique des terres (CET) constitue une méthode de recensement et de cartographie des écosystèmes terrestres; elle définit le cadre des facteurs, à la fois biotiques et abiotiques, qui ont influé sur la répartition dans l'espace et dans le temps de ces écosystèmes. Les cartes digitales du système d'information géographique (SIG) qui représentent le climat, la topographie, la géologie, l'hydrologie, les sols et la végétation ont été utilisées pour délimiter les frontières de l'écorégion, de l'écodistrict, de l'écosection et de l'écosite de la Classification écologique des terres - système canadien (CETSC). Chacune de ces cartes a été étudiée et comparée, afin d'évaluer les facteurs les plus importants sur le plan du contrôle de la répartition des écosystèmes à chacun des échelons de cette classification.

La CET a servi d'outil de recensement des secteurs qui affichent la plus grande diversité d'écosystèmes au sein de chaque écorégion. Elle a également servi à évaluer dans quelle mesure les secteurs protégés existants incluaient l'ensemble des écosystèmes recensés à un échelon précis de la CET. À une échelle plus précise, la classification a servi de point de départ de la mise en évidence des secteurs affichant une grande diversité d'especes végétales. Étant donné que la CET s'est avérée un outil valable d'évaluation de la diversité de manière systématique et objective à chacun de ces échelons, l'utilité potentielle de cette classification s'avère très prometteuse.

CONSERVING BIODIVERSITY & ECOSYSTEM INTEGRITY:

THE ROLE OF PROTECTED AREAS

WOLVES KNOW NO BOUNDARIES

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Abstract

RESTORE: The North Woods and the Greater Laurentian Wildlands Project aim to restore and protect the ecological integrity of the North Woods of the United States and Canada. Restoring native wildlife, such as the Eastern Timber Wolf (Cants lupus tycoon), is central to this goal. Today, the possible dispersal of pioneer wolves across political boundaries is a powerful reminder of the need for US-Canadian cooperation in eastern timber wolf recovery. This paper outlines central challenges and opportunities for a bi-national approach to wolf restoration.

Ecological: Recent studies have identified millions of acres of potential wolf habitat in northern New England and New York, and possible wolf migration corridors between Canada and US. Suitable wolf habitat and migratory corridors are jeopardized by settlements, industrial logging, road building, and development pressures. Research is necessary to determine what land use patterns must change to encourage connectivity between core wolf habitat, and how a system of connected refugia might ensure long-term wolf protection.

Social: Public support for wolf recovery is increasing in the US and wolf advocates are working to establish a formal protection and recovery program. In Canada, wolf populations are declining due to hunting pressures and lack of habitat. Negative attitudes towards wolves persist in both countries. Through advocacy and education, activists and government officials can promote tolerance of wolves and enhance their protection. This change in attitudes will affect wolf populations

Sommaire

RESTORE : Les projets North Woods et Greater Laurentian Wildlands visent à restituer et à protéger l'intégrité écologique de la région des boisés du nord (North Woods) aux États-Unis et au Canada. La reconstitution des populations de la faune indigène, notamment le loup ordinaire de l'Est (Canis lupus lycaon), constitue une condition essentielle à cet objectif. À l'heure actuelle, l'éparpillement possible des loups reproducteurs sur plusieurs territoires politiques rappelle la nécessité cruciale d'une coopération entre le Canada et les États-Unis pour permettre la reconstitution des populations de cette espèce. Ce document souligne les défis et les possibilités essentiels associés à une stratégie concertée de reconstitution de ces populations entre deux États.

Dimension écologique : Les études ont permis de recenser des millions d'acres d'habitats potentiels du loup dans le Nord des États de la Nouvelle-Angleterre et de New York, ainsi que des couloirs de migration possible du loup entre le Canada et les États-Unis. Les couloirs de migration et les habitats qui conviennent au loup sont menacés par l'implantation humaine, l'exploitation industrielle du bois, la construction des routes et les pressions liées au développement. Des recherches s'avèrent nécessaires pour déterminer quels sont les modes d'utilisation du terrain qui doivent changer afin d'améliorer les connexions possibles entre les habitats essentiels du loup, ainsi que la façon dont un système de refuges reliés par des couloirs de migration pourrait garantir la protection à long terme de l'espèce.

Protecting core wolf habitat and corridors combined with decreased persecution should encourage populations of healthy wild wolves to roam freely across their native ranges. Natural wolf dispersal across political boundaries provides a unique opportunity for the cooperation of US and Canada wildlife advocates, and serves as a reminder that we share the same ecosystems.

Dimension sociale : L'appui manifesté par le public à l'égard de la reconstitution des populations de loups s'accroît aux États-Unis et les défenseurs de l'espèce collaborent à la mise sur pied d'un programme officiel de protection et de reconstitution. Au Canada, les populations de loups déclinent en raison de la chasse et de la perte d'habitats. Le loup conserve une image négative dans les deux pays. En se faisant les défenseurs de l'espèce et en éduquant la population, activistes et représentants des pouvoirs publics peuvent promouvoir la tolérance à l'égard du loup et améliorer sa protection. Ce changement d'attitude aura une incidence sur les populations de l'espèce.

La protection des habitats et des corridors essentiels du loup combinée à une baisse de sa persécution devrait encourager les populations de loups sauvages en santé à errer librement sur leur aire de distribution d'origine. L'éparpillement des loups sauvages entre les frontières politiques offre aux défenseurs de la faune des États-Unis et du Canada des possibilités uniques de coopération et nous rappelle que nous partageons les mêmes écosystèmes.

LEAFHOPPERS (INSECTA: HOMOPTERA: CICADELLIDAE): INDICATORS OF ENDANGERED ECOSYSTEMS

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Abstract

Over 100 species of "short-horned" bugs (Insecta: Homoptera; Auchenorrhyncha) in Canada are very localized. The majority of these are leafhoppers which (excepting the wind-dispersing "microleafhoppers" subfamily Typhlocybinae) are mostly slow dispersers associated with particular specialized habitats or very limited numbers of host plants and, therefore, potentially threatened by habitat destruction. Suites of endemic species constituting characteristic faunal assemblies can be used to identify habitats of particular significance, and when these habitats are limited in size the potential for total destruction is high. Leafhopper assemblies indicate the need for habitat preservation in four parts of Canada not usually considered as endangered habitats: (1) bogs of Newfoundland; (2) LaCloche islands in Lake Huron; (3) interlake grasslands of Manitoba, (4) Seton Lake Valley, west of Lillooet, British Columbia.

Sommaire

Plus de 100 espèces de « criquets » du Canada (Insecte : Homoptera; Auchenorrhyncha) sont très localisés. Il s'agit en majorité de cicadelles qui (à l'exception des microcicadelles, sous-famille des Typhlocybinae) sont essentiellement des insectes de dispersion lente associés à des habitats spécialisés ou à un nombre très limité de plantes hôtes; ils sont donc vraisemblablement menacés par la destruction des habitats. Les familles d'espèces endémiques qui constituent des ensembles de spécimens fauniques caractéristiques peuvent servir à recenser les habitats qui revêtent une importance particulière et, lorsque la superficie de ces habitats est limitée, le risque de destruction totale est élevé. Le recensement des familles de cicadelles souligne la nécessité de préserver ces habitats dans quatre régions du Canada qui ne sont pas considérées généralement comme des habitats menacés : 1) marais de Terre-Neuve; 2) îles LaCloche sur le lac Huron; 3) prairies de la région des lacs du Manitoba; et 4) vallée du lac Seton à l'ouest de Lillooet, en Colombie-Britannique.

Introduction

Canada is a huge land mass with extensive areas of seemingly uniform biota. Only 21 of the 52 ecological regions of North America are represented in Canada compared with 24 in the much smaller area of Mexico (CCEA, draft document). On a finer scale, however, the picture is much more complex. There are at least 45 vegetation regions (*Atlas of Canada* 1974) and when soils and topography are considered, there are 217 ecoregions divided into over 1000 ecodistricts, with literally thousands of possible subdivisions. How to represent these with a network of ecological preserves is a daunting task. Even the job of deciding on priorities among sites available for conservation is a massive undertaking.

This paper introduces a neglected analytical tool that can be used efficiently to help determine which ecodistricts have unique or at least rare ecosystems in need of preservation. This tool is the fauna of leafhoppers (Fig. 1), the insect family Cicadellidae.

Leafhoppers as environmental indicators

Insects make good environmental indicators of even small sites. Their faunal assemblies are apparently little influenced by patch size. Furthermore, distance from other such sites is often not a significant factor provided that the community has been in continuous existence since human activities began to fragment landscapes. Populations can survive for years on few plants and thus persist even in very small, isolated sites. For example, five prairie-endemic species of leafhoppers were taken on a 10-m² square patch of grassland behind a warehouse in the city of Winnipeg, Manitoba; this species richness is equivalent to that of an average managed prairie site of over 10 hectares (Hamilton 1996). Likewise, the same study found 25 prairie-endemic species (the highest number recorded for any eastern prairie site) along a railway grade within the village of Grosse Isle, Manitoba far from any other prairie remnant.

Why should you have to study minute insects like leafhoppers? Various other groups of larger, better known insects have been used as a source of information to categorize ecological areas, or for monitoring environmental changes, or assessing the quality of site preservation. Ground beetles (Carabidae) are especially good indicators of microhabitat conditions (Ball and Currie 1979) and have been used in formulating hypotheses about prehistorical conditions (*e.g.* Kavanaugh 1979). Butterflies are useful indicators of forb community types (*e.g.* Swengel and Swengel 1997). Leafhoppers make a good «fit» in environmental studies along with ground beetles and butterflies, because they feed mainly on other plants (trees, grasses, and sedges) and appear little influenced by microhabitat. Leafhoppers are well represented in both forested and grassland areas; in fact, they are one of the few insect families with numerous grassland-endemic species (Ross 1970).

Leafhoppers are highly suitable for use as indicators of ecological areas, being diverse enough to be found in many different ecosystems, individually numerous, and easily sampled. The very slow dispersal rate of many species is also an important consideration in their usefulness as environmental indicators.

Diversity. Leafhoppers are the most common and diverse family of the «short-horned» bugs (Homoptera: Auchenorrhyncha), a group of sap-sucking insects that include cicadas (Cicadidae), spittlebugs (Cercopidae), treehoppers (Membracidae) and planthoppers (Fulgoroidea). There are 1,500 species of «short-horned» bugs known to occur in Canada (unpublished checklist, 1997), which I estimate to represent about 85% of the total fauna; of these, 1200 species are leafhoppers of which perhaps 95% of the species are now known. The fauna is, therefore, diverse enough to provide meaningful differences throughout the large number of Canadian ecodistricts. It is sparse only in the far north where the leafhopper fauna falls rapidly in high boreal areas to just 15 species by treeline (Hamilton 1997). Most other «short-horned» bugs show similar or even steeper declines northward; for example, only one cicada, two treehoppers (Beirne 1961), and a single spittlebug (Hamilton 1982) are found in the most temperate part of the Northwest Territories. Delphacid planthoppers have a sizeable northern Canadian fauna of 30 species (Wilson 1997) but this is only a fifth of the number of leafhopper species in the same area.

Abundance. Leafhoppers can attain astounding numbers without apparent damage to their host plants. Samples from ungrazed temperate-zone grasslands based on vacuum collecting (which does not pick up nymphal spittlebugs or cicadas) yielded nearly 1000 individuals per 8 m² in July (Morris 1971). Even neglecting probable sampling error, this shows that «short-homed» bug populations can rise to well over 1 million individuals per hectare in midsummer. Artifically concentrated populations of leafhoppers disperse rapidly to about 28/m² (Andrzejewska 1961) or 280,000 per hectare but, in doing so, probably do not displace other bugs.

Sampling. About a third of all insects sampled by suction traps in grasslands may be leafhoppers and delphacid planthoppers, and these may be represented in nearly equal proportions (Heikinheimo and Raatikainen 1962). These insects are collected differentially by sweep nets as planthoppers tend to live lower on the plant and are less likely to be caught. Leafhoppers on the other hand are caught readily in this manner and are sometimes most reliably sampled this way. They are more easily collected using pan traps although the sampling time is greatly extended. Flight intercept traps are usually ineffective in collecting most leafhoppers. Light trapping is productive although selective as not all species come to light, but leafhoppers usually are able to avoid falling into such traps. A suction device must be included (as in a New Jersey light trap) or specimens must be hand-picked by aspirator from a sheet behind a light source.

Dispersal. Leafhoppers and their relatives are jumping insects with powerful hind legs. They disperse largely by running and jumping, but they also disperse by flight even when most of the population are short-winged («brachypterous») and flightless. They have been known to migrate over thousands of kilometers (Medler 1962; Cheng *et al.* 1979; Ghauri 1983) when aided by strong winds. Yet many species have very restricted distributions: over 90 species of leafhoppers plus 35 planthoppers, 8 treehoppers, 7 spittlebugs, and 4 cicadas are known from only very small areas of Canada (unpublished checklist, 1997). This seeming contradiction apparently reflects the diversity of life styles found in these insects.

Most migratory bugs are light-bodied insects not more than 4 mm long that are easily carried by air currents. They usually show modifications for flight: their wings are usually more than four times as long as wide, and (in planthoppers) their eyes are very large compared to the width of the head. These migratory insects apparently include most «microleafhoppers» (subfamily Typhlocybinae) and many of the common delphacid planthoppers. Thus, in the following discussion, the term «hoppers» is used to denote mainly non-migratory bugs, the «short-horned» bugs exclusive of both Delphacidae and Typhlocybinae.

A great number of species of «hoppers» fly, but only few individuals of most species are found in flight intercept traps. The main exception to this rule is the genus *Xestocephalus* which are believed to be ant-guest insects; apparently adults fly actively near ground level in search of ant nests. Traps more than 1 m above the ground collect few «hoppers,» mainly long-winged species of *Macrosteles* (Waloff 1973), at least some of which are known to be migratory (Chiykowski and Chapman 1965). Otherwise, tree canopy species are more commonly collected in such traps than species from low vegetation, as the usual flight path of «hoppers» is obliquely downwards. The exception seems to be sexually immature individuals (Waloff 1973): possibly these actively disperse over short distances to prevent inbreeding. By the time females become gravid, they usually lose the power of flight.

The rate at which «hopper» populations spread is best observed in species imported by human activity. The ranges of such «exotics» expand at rates between 10 and 100 km/year (Hamilton 1983). These figures may be taken to be upward extremes for «hoppers» as introduced species are often the most aggressive ones, and their habitats are usually linked through transportation corridors that typically have introduced floras suitable for these non-native insects. Native species or ones with fragmented habitats appear to spread at much slower rates. Northern leafhoppers often do not occupy the entire width of the boreal forest zone, and half the arctic leafhoppers that were restricted to Alaska and the Yukon during the ice age show even slower rates of migration (Hamilton 1997): 20% reached Hudson Bay after the boreal forest did, thus travelling less than 1 km/year, and 30% never even crossed the 10-km-wide Mackenzie valley (Fig. 2). Only one arctic species out of 24 has been able to invade islands across major water channels.

Thus, the majority of leafhoppers are slow dispersers associated with particular specialized habitats or very limited numbers of host plants and are potentially threatened by habitat destruction.

Habitats of significance

Only a small fraction of the Canadian ecodistricts have been intensively sampled for leafhoppers. It is therefore premature to give an accounting of comparative leafhopper faunas. However, preliminary sampling on selected parts of Canada thought most likely to have interesting faunas has turned up some unexpected habitat restrictions. When these habitats are limited in size the potential for total destruction is high and the need for conservation should become a priority.

Thirty-two leafhopper species are known from *only* one ecodistrict, and nowhere else in the world (Table 1). This partly reflects lack of collecting elsewhere, or lack of life-history knowledge needed to sample effectively for these insects. Some exceptions are notable:

(A) Species restricted by ecology. A large proportion of leafhopper species are monophagous or oligophagous, feeding either on just a single plant species or on closely related species even in speciose groups of plants such as willows (*Salix*). Some of their host species were once widespread and abundant but are now found only in small, isolated stands or as scattered individuals incapable of providing a reliable food source for leafhoppers. An example is an undescribed species of *Flexamia* that feeds only on mat muhly, *Muhlenbergia richardsonis* (Trin.) Rydb., a prairie grass that is rare in eastern Canada. The leafhopper is known only from a single alkaline fen in Michigan, one of the few such sites where this grass occurs in sufficient numbers to support its leafhopper host.

Another case is *Rosenus decurvus* Hamilton & Ross (1975) which occurs in tremendous numbers on wheatgrass (*Agropyron* sp.) growing on south-facing bluffs along the Peace River in Ecodistrict 591. This apparently isolated grassland is maintained in this northerly location by the local buildup of heat on sun-warmed slopes. Sampling on similar sites further north has failed to find additional populations of this species.

(B) Species restricted by geography. Mountaintop species are, in effect, on islands in a sea of inhospitable territory. One such leafhopper, *Psammotettix beirnei* Greene (1971) occurs on two adjacent mountains in Ecodistrict 985; its sister species is known only from Mount Washington and adjacent peaks in New Hampshire.
An endemic spittlebug (*Philaenarcys* sp.nov.) has been found on the unglaciated Magdalen Islands in the Gulf of St. Lawrence (Ecodistrict 539). Due to the very isolated situation of these islands, it is unlikely that the spittlebug will be found on mainland coastal sites. An endemic species of grasshopper is also found there (Vickery and Kevan 1985, p. 395).

(C) Unique species co-existing. When more than one species of «hopper» is found in the same ecodistrict and nowhere else in the world, this ecodistrict is probably something special. The only such ecodistricts known to date are 521 (Cape Breton Highlands), where *Colladonus balius* Hamilton coexists with *Cribrus micmac* Hamilton (Hamilton and Langor 1987), and in the adjacent lowlands (Ecodistrict 522) where *Idiocerus cabbottii* Hamilton (1985) coexists with a typhlocybine leafhopper *Typhlocyba hollandi* Hamilton (Hamilton and Langor 1987).

Suites of endemic species, even if not uniqua to one ecodistrict, constitute characteristic faunal assemblies that can be used to identify habitats of particular significance. Such leafhopper assemblies have been found in four parts of Canada not usually considered as endangered habitats.

(1) Bogs of Newfoundland have been very inadequately sampled, but the little we know has yielded unexpected riches (Hamilton and Langor 1987). These include two endemic leafhopper species from unique sites, *Cosmotettix unica* Hamilton and *Typhlocyba unicorn* Hamilton, plus two widespread endemic taxa, *Oncopsis speciosa* Hamilton and *O. minor terranovae* Hamilton that feed on birches including the Newfoundland and Labrador-endemic dwarf birch *Betula michauxii* Spach (Fig. 3). At present no correlations with ecodistricts are possible.

(2) The LaCloche Islands near Manitoulin Island in Lake Huron have an extensive limestone plain or «alvar» similar to those extending from Belleville to Kingston, Ontario. Unlike the more southerly alvars, this northern alvar has a suite of 11 widely disjunct prairie leafhoppers (Hamilton 1994). These leafhoppers occur only on a tiny corner of Ecodistrict 411 (Sudbury) but some species are also found on Manitoulin Island itself and on suitable sites on the Bruce Peninsula (Ecodistrict 550).

(3) Interlake grasslands of Manitoba in Ecodistrict 846 (Lundar), are usually considered a mere extension of the tall-grass prairie (Ecodistricts 849, 852, 853). However its prairie-endemic leafhopper fauna is the richest in northeastern North America (Hamilton 1996) and includes three undescribed species apparently unique to this area: one each in *Attenuipyga*, *Flexamia* and *Macrosteles*. The first of these (Fig. 1) has been found in most of the Interlake sites sampled; its sister species is extremely rare, ranging from southern Wisconsin to Kansas.

(4) Seton Lake valley west of Lillooet, British Columbia (Ecodistrict 1002) is home to a number of highly disjunct arid-zone species not represented in the much richer arid-adapted fauna of the Okanagan. The most surprising of these is the large, black and orange cicada *Okanagana ornata* (Van Duzee), a Californian species that is also known from Mount Hood in Oregon. Other local disjuncts include the leafhopper *Colladonus aureolus* (Van Duzee) and the planthoppers *Pissonotus rubrilatus* Morgan and Beamer (Delphacidae) and *Oliarus coconinus* Ball (Cixiidae). Two other disjuct planthopper species occur in the Lower Fraser Valley (Ecodistricts 1002 and 1005): *Oeclidius brickellus* Ball and *Oliarus beirnei* Meade & Kramer. Most of these species are characteristic of the southwestern U.S.A. and have scattered populations throughout the western parts of Oregon and Washington (Fig. 4A). The pattern of these disjunct populations strongly suggests that Ecodistrict 1002 received its distinctive faunal elements during some postglacial period when the coastal valleys were drier than at present, allowing northward migration of Californian species (Fig. 4B).

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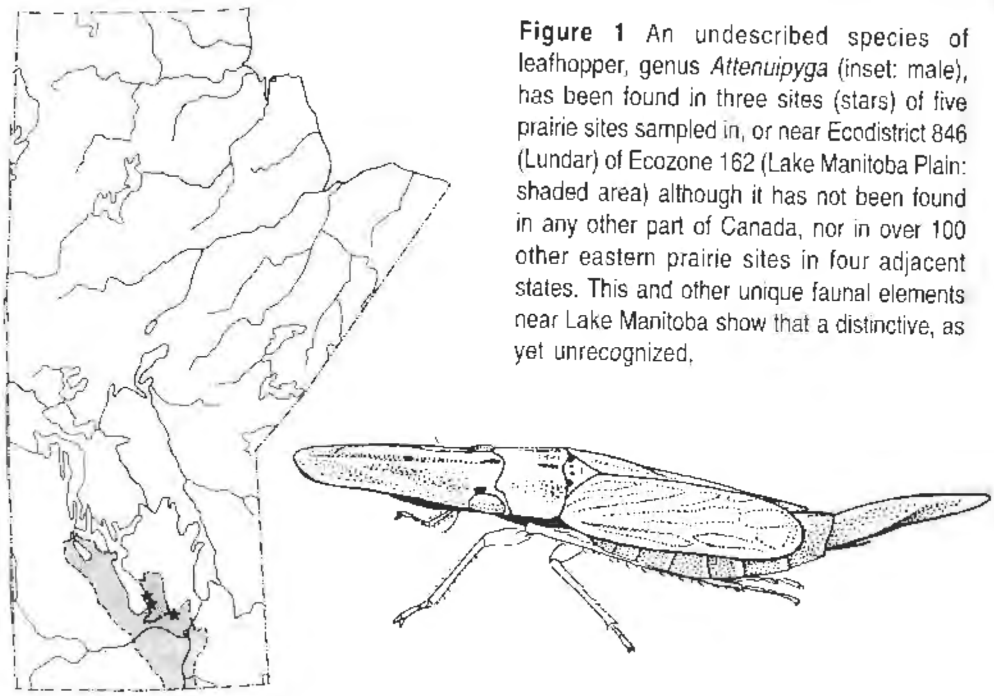

Figure 1 An undescribed species of leafhopper, genus *Attenuipyga* (inset: male), has been found in three sites (stars) of five prairie sites sampled in, or near Ecodistrict 846 (Lundar) of Ecozone 162 (Lake Manitoba Plain: shaded area) although it has not been found in any other part of Canada, nor in over 100 other eastern prairie sites in four adjacent states. This and other unique faunal elements near Lake Manitoba show that a distinctive, as yet unrecognized,

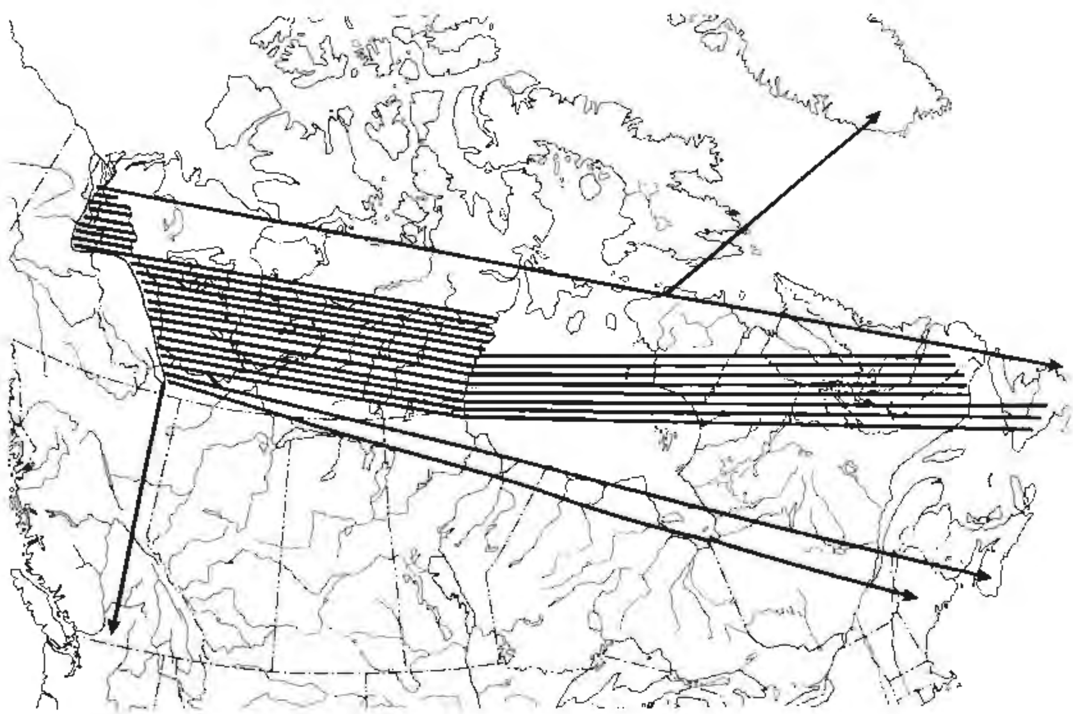

Figure 2. A "natural experiment" performed by glaciation. 24 arctic leafhopper species probably confined to unglaciated parts of Alaska and the Yukon show varying abilities to invade deglaciated territory over the last 12,000 years. Only *Psammotettix lividellus* Zetterstedt (top line) has been able to cross large bodies of water, establishing colonies on Baffin Island and Greenland. Seven species (30%) have not crossed the Mackenzie River valley; five (20%) reached Hudson's Bay, but after its lower shore became boreal (not later than 5000 years ago); five were able to cross to the far side of the bay but (being restricted to high latitudes) did not reach insular Newfoundland; the others are widely distributed into the boreal zone, with three (lowest lines) also occuring in the hemiboreal zone.

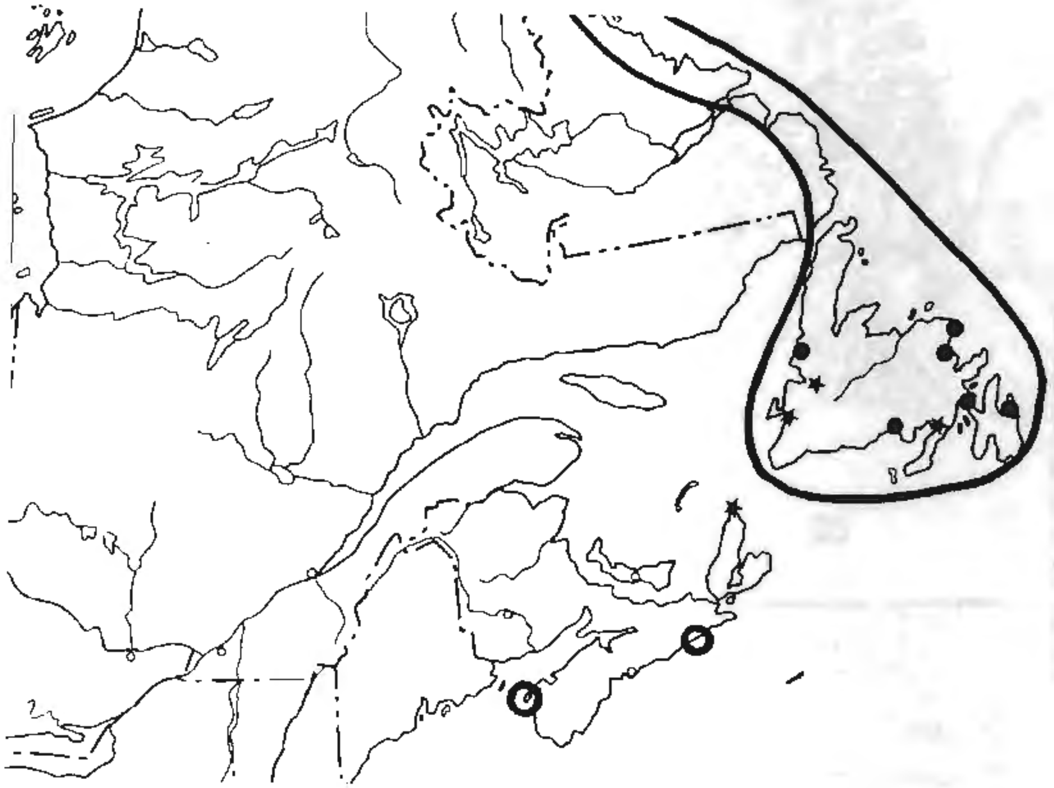

Figure 3. Distribution of a Newfoundland-endemic dwarf birch, Betula michauxii Spach (outline; circles indicate outlier populations in Nova Scotia) and a Newfoundland-endemic leafhopper that feeds upon it. Oncopsis minor terranovae Hamilton (dots) plus a related birch-feeding leafhopper, Oncopsis speciosa Hamilton (stars) that has spread to Nova Scotia.

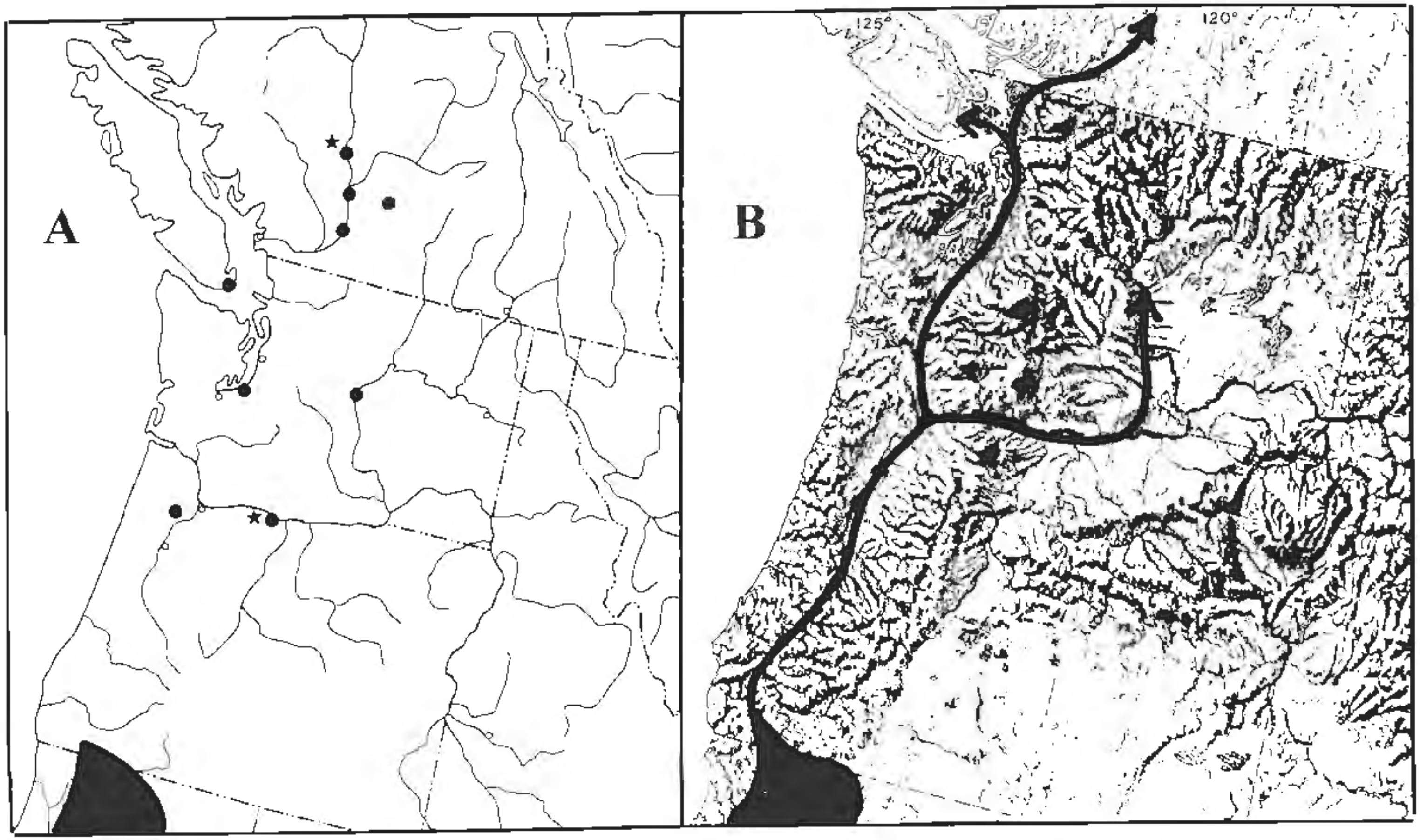

Figure 4. Origin of the distinctive fauna of Seton Lake valley (Ecodistrict 1002, Lillooet) in British Columbia. A, distribution of a cicada, *Okanagana ornata* Van Duzee (stars) and a leafhopper, *Colladonus aureolus* Van Duzee (dots) north of their common range in California (black area); B, probable migration route of these species during a drier postglacial, prehistorical period.

Table 1. Non-typhlocybine leafhoppers restricted to a single ecodistrict

NEWFOUNDLAND

1. *Cosmotettix unica* Hamilton - Valleyfield

NOVA SCOTIA

2. *Colladonus balius* Hamilton - Cape Breton Highlands Nt Pk.
3. *Cribrus micmac* Hamilton - Cape Breton Highlands Nt Pk.
4. *Idiocerus cabbottii* Hamilton - Cape Breton Highlands NtPk.

QUEBEC

5. *Deltocephalus* sp.nov. - Louvricourt
6. *Scaphoideus flavidus* Barnett - Kazabazua
7. *Scaphoideus incognitus* - Rigaud

ONTARIO

8. *Amplicephalus* sp.nov. - Lakeview
9. *Chlorotettix* sp.nov. - Windsor
10. *Colladonus* sp.nov. - Kirkwood Township
11. *Eutettix* sp.nov. - One Sided Lk.
12. *Limotettix nigristriatus* Hamilton - Savoff
13. *Macrosteles* sp.nov. - Rutter

MANITOBA

14. *Macrosteles.* sp.nov. - The Narrows

SASKATCHEWAN

15. *Cuerna nielsoni* Hamilton - Indian Head
16. *Limotettix medleri* Hamilton - Hudson Bay

ALBERTA

17. *Idiocerus canae* Hamilton - Medicine Hat
18. *Idiocerus taiga* Hamilton - Galloway

BRITISH COLUMBIA

19. *Aceratagallia* sp.nov. - Osoyoos
20. *Athysanella* sp.nov. - Similkameen Valley
21. *Colladonus* sp.nov. - Carmanah Valley
22. *Destria* sp.nov. - Sparwood
23. *Hebecephalus* sp.nov. - Douglas Lake
24. *Idiocerus indistinctus* Hamilton - Quilchena
25. *Limotettix xanthus* Hamilton - south of Revelstoke
26. *Limotettix obesura* Hamilton - Ladysmith & Victoria
27. *Macrosteles* sp.nov. - Cranbrook
28. *Norvellina* sp.nov. - Victoria
29. *Psammotettix beirnei* Greene - east of Revelstoke
30. *Rosenus decurvus* Hamilton & Ross - Taylor
31. *Unoka* sp.nov. - Oliver & Osoyoos

YUKON

32. *Limotettix scudderi* Hamilton - Lapie Canyon

EFFECTS OF FORESTRY PRACTICES ON HERBACEOUS LAYER DIVERSITY AND COMPOSITION: IMPLICATIONS FOR PROTECTED AREAS

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Abstract

Little information exists on the effects of forestry practices on herbaceous layer plants for any forest, especially the Acadian Forest. Herbaceous layer composition and diversity were assessed in three spruce plantations in each of three age classes (3-6, 10-14, 14-16 yrs) and three natural spruce-fir stands (ca. 90 yrs) in southeastern New Brunswick, Canada. All stands had pre-harvest composition of 70% spruce-fir and occurred on relatively infertile, imperfectly to moderately well-drained sites. Percent cover of all vascular plants <1 m tall and many common bryophytes was recorded by species in 52 1-m^3 quadrats and additional species were listed within 1300 m^3 in each stand. There were no significant differences among the four stand age groups in species richness, reciprocal Simpson index, Shannon-Weiner index, Shannon-Weiner evenness or Magalef index. Stands on slightly richer sites had significantly higher species richness, Shannon-Weiner and Margalef indices than stands on less fertile sites. Fifteen species had lower abundance in plantations than natural stands, suggesting that they may be adversely affected by harvesting and plantation management. These species along with several others identified in two related studies should be the focus of conservation efforts. It is unlikely that traditional protected areas will adequately conserve these species. Our results indicate that alternative forms of protected areas such as riparian buffer strips and small reserved areas within harvest blocks may help maintain viable populations of these species in forested landscapes subjected to harvesting.

Sommaire

On possède peu d'information sur les répercussions des pratiques forestières sur les plantes de la couche herbacée des forêts, particulièrement la Forêt acadienne. La composition et la diversité de la couche herbacée ont été évaluées au sein de trois plantations d'épinette de chacune de trois classes d'âge (3-6, 10-14, 14-16 ans) et de trois peuplements naturels d'épinettes-sapins (environ 90 ans) dans le sud-est du Nouveau-Brunswick au Canada. La composition de tous les peuplements avant la récolte était de 70 % d'épinettes-sapins et les sites étaient relativement stériles, imparfaits ou relativement bien drainés. Le pourcentage de couvert de toutes les plantes vasculaires de moins de un mètre de hauteur et nombre de bryophytes communs ont été consignés par espèce sur 52 quadrats de 1 m^3 et une liste d'espèces complémentaires a été dressée pour des secteurs de 1 300 m^3 au sein de chaque peuplement. On n'a constaté aucune différence importante entre les quatre groupes d'âge des peuplements, sur le plan de richesse, de l'indice réciproque de Simpson, de l'indice Shannon-Weiner, de l'homogénéité Shannon-Weiner ou de l'indice Margalef. Les peuplements situés sur des sites légèrement plus fertiles étaient nettement plus riches du point de vue de la diversité des espèces, et des indices Shannon-Weiner et Margalef, que les peuplements situés sur des sites moins fertiles. Quinze espèces étaient moins abondantes dans les plantations que dans les peuplements naturels, ce qui semble indiquer que la récolte et la gestion des plantations pourraient avoir une incidence négative. Ces espèces ainsi que plusieurs autres espèces recensées dans le cadre de deux études connexes devraient être au centre des efforts de conservation. Il est peu probable que les secteurs protégés traditionnels assurent une conservation adéquate de ces espèces. Selon les résultats, les types alternatifs de secteurs protégés comme les bandes tampons riveraines et les secteurs réservés de faible superficie au sein des blocs de récolte pourraient contribuer à maintenir la viabilité des populations de ces espèces dans les paysages boisés qui font l'objet d'une récolte.

Introduction

Biological diversity has been the focus of much attention in recent years, both within the scientific community and among the public. In spite of numerous studies, there is little agreement concerning the effects of human-caused disturbance, such as forest harvesting, on biological diversity. To illustrate, a paper was recently published in Conservation Biology (Duffy and Meier 1992) in which the authors argued that herbaceous understorey communities would not recover within 40-150 years after clearcutting in mixed-mesophytic forests of the southern Appalachians. The paper raised considerable controversy, with arguments supporting both sides of the issue.

We initiated a study in 1992 to determine the effects of intensive forestry practices on species composition and diversity in spruce-fir forests in New Brunswick.

Study Area and Methods

The study area includes Fundy National Park and surrounding industrial freehold and Crown lands in southeastern New Brunswick (Fig. 1). In this region, ridgetops support tolerant hardwoodsand valley bottoms and flat areas may support stands of spruce (*Picea* spp.) and balsam fir (*Abies balsamea*). Mixed-wood communities of *Picea rubens*, *Abies balsamea*, *Betula papyrifera*, *Betula alleghaniensis*, and *Acer rubrum* are widespread throughout the area.

Because our study was directed towards the commercial softwood stands, we sought stands with pre-harvest composition of at least 70% spruce-fir. To control for variations in stand composition due to site differences, we selected stands with similar nutrient and drainage conditions using the New Brunswick Forest Site Classification System (Zelazny *et al.* 1989). These were relatively infertile, imperfectly to moderately well-drained sites with < 10% slope.

We sampled a chronosequence of *Picea mariana*, *Picea glauca*, or *Picea abies* plantations, ranging in age from 5 to 16 years (Table 1). The plantations were established after commercial clearcutting and mechanical site preparation. Herbicide was applied 1-4 years after planting in all but two of the plantations, which were both in the oldest age class.

Three natural stands within Fundy National Park were selected as controls. These stands contained several age cohorts which probably originated from spruce budworm outbreaks in 1910-20, 1940-50 and 1974-76. The oldest cohort was approximately 90 years old (Table 1).

Our original intent was to include another chronosequence of naturally regenerated clearcuts, but we could find only two such stands that met our stand selection criteria. These were included for comparison only and are not described in this paper.

A 120-m^2 (1.44-ha) plot was set up in a representative portion of each stand. The herbaceous layer was sampled in 13 10-m^2 subplots, uniformly distributed in a grid pattern within each plot (shaded areas in Fig. 1).

A 0.5 X 2 m quadrat was placed in each corner of the subplots and percent cover of all vascular plants < 1 m tall, including many bryophytes, was estimated by species. The total sample area was 52 m^2 for each plot (stand). A species list was made for the 10-m^2 subplot and any new species not sampled in the quadrats were added to the sample with a token cover value.

Hill's (1973) diversity indices were calculated to represent different components of diversity. This series of diversity indices (N0, N1, and N2) progressively downweights rare species. N0 is species richness (total # species/stand). N1 is the exponential Shannon-Wiener index and N2 is the reciprocal Simpson index.

Analysis of variance (ANOVA) was used to test for differences in diversity indices using stand type (four levels represented by three age classes of plantations and natural stands) and vegetation type (2 levels) as the main factors.

Some differences in site conditions occurred among the sample stands in spite of our best efforts to control for site differences. These differences are indicated by the Vegetation Type (VT; Zelazny *et al.* 1989). VT-6 or 7 indicates moderately fertile and moist conditions whereas VT-2 indicates less fertile and drier conditions (Table 2).

Results

Species diversity: There were no obvious differences in diversity indices among any stand groups (Table 2). Indeed, variability within each type was quite high, especially within the young plantations where the highest and lowest N1 and N2 values occurred.

Vegetation type had an obvious effect on diversity indices, however. Stands on VT 6-7 sites as a group had significantly higher values than stands on VT-2 sites. The ANOVA results confirmed that there were statistically significant differences between vegetation types, particularly for species richness (N0), but no differences among stand types (Table 3).

Species composition: Most of the 198 taxa found in the 14 stands occurred infrequently and at low abundance. Only 15 species were found in all of the stands; 38 species occurred in only one stand.

Differences in species composition among stand groups reveals influences of harvesting not seen in the diversity indices. Fifteen species appeared to be negatively affected by harvesting (Table 4). *Aster lanceolatus* was the only species that occurred in the natural stands and that did not occur in the plantations, suggesting that it could have been eliminated by intensive management. Alternatively, it could have been missed in our relatively small sample of three plantations. *Bazzania trilobata* and *Oxalis montana* illustrate this pattern of reduced percent cover in plantations (Fig. 2).

Fifty-five species were invaders; that is, they appeared in the plantations but were not present in the natural stands. Some of these species are shown in Table 5. Most of these species are typical of disturbed sites. This pattern is illustrated by *Epilobium angustifolium* (Fig. 3).

Finally, nine taxa were present in the natural stands and showed greatly increased abundance in the plantations (Table 6). *Polytrichum* spp. typified this pattern (Fig. 3).

Overall community similarity patterns among stand types was compared using Sorensen's community coefficient. The values shown in Table 7 are the averages of the pairwise comparisons of the three stands within each group (n=3; top diagonal) or the six stands between two groups (n=9). The plantations became slightly more similar to the natural stands with increasing age. This pattern is expected as invader species die out and species that were reduced by harvesting reinvade the plantations. A similar pattern was also observed by Schoonmaker and McKee (1988) inDouglas-fir forests. The natural stands had the greatest similarity within a stand group. This may be because it is the only group with all three stands in the same vegetation type.

The following conclusions can be drawn from the chronosequence study:

1. Harvesting and intensive plantation management had no significant effects on species diversity as measured by standard diversity indices.

2. Site conditions had a greater effect on species diversity than management treatments, suggesting that diversity studies should carefully account for site differences.

3. Relatively large changes in species' abundances occurred as a result of harvesting, but only one species was totally eliminated in our plantations.

4. The herbaceous layer in plantations showed a slight tendency to become more similar to the natural stands with increasing plantation age.

5. Additional work is needed to identify the mechanisms underlying the patterns that we have described in this study.

With the chronosequence study, we identified general trends in species' abundances and identified species that are susceptible to harvesting disturbance, but we still do not know how variations in the harvesting disturbance itself affect the loss or reduction of certain species.

We recently initiated a new study in the Hayward Brook Watershed in the Fundy Model Forest to specifically address the effects of variations in harvesting disturbance on species populations. In this study, we are looking at recovery of herbaceous-layer species in relation to severity of forest floor disturbance and slash cover.

Permanent plots were established before harvesting and will be monitored after harvesting. Results from our pre-harvest sampling indicate that there are diversity "hot-spots" within the watershed. For example, stands G and H stand out as having unusually species richness compared to stands A-F (Fig. 4). These two stands contained a seepage area surrounding an intermittent stream.

There are important implications of these two studies for protected areas. First, small areas with unique species or high species diversity should be protected in individual cut blocks. Riparian buffer strips represent one example of this type of protected area. Second, it is also important to protect the full range of species present within the cut block because some of these species may be dramatically reduced by harvesting. In addition to riparian buffer strips, other leave strips or patches within the cut block may be required to protect viable populations of all species. Additional work is needed to understand the effects of forestry practices on herbaceous-layer species and in designing harvesting strategies that will protect vulnerable species.

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PERMEABLE BOUNDARIES: INDICATOR SPECIES FOR TRANS-BOUNDARY BIODIVERSITY MONITORING AT KEJIMKUJIK NATIONAL PARK

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Abstract

Ecological integrity and biodiversity monitoring should focus on critical indicator species; the challenge is in identifying the most appropriate indicator species for assessment (Noss 1990; Woodley 1996). A framework for identifying potential indicator species for broad monitoring objectives such as biodiversity has been developed and tested, integrating a "focus-species" approach (Hunter 1990; Noss 1990; 1991) with a scheme for ecological monitoring in national parks and protected areas (Woodley 1996), making it operational. The framework serves to identify critical indicator species for monitoring population dynamics et the species-population level, including measures such as population viability. Types of indicator species groups include vulnerable, keystone, flagship, and umbrella species and special populations as well as ecological indicator species.

Preliminary assessments suggest that species warranting special consideration as potential indicator species for biodiversity monitoring in Kejimkujik National Park are: fisher, American marten, American moose, Blanding's turtle, snapping turtle, yellow perch and brook trout. Several other species warrant further consideration, including: coyote, river otter, bobcat, white-tailed deer, southern flying squirrel, northern spring peeper, bullfrog, and lake whitefish. The framework may be adapted for application in other protected areas, as well as for broader biodiversity, wildlife or resource management purposes. The identified species can provide a focus for ecosystem management, monitoring, and research, habitat and ecosystem conservation initiatives, partnership and co-operative arrangements with adjacent land owners and other agencies, and education, interpretation, and communication.

Sommaire

Le suivi de l'intégrité écologique et de la biodiversité doit être axé sur des espèces indicatrices cruciales; la difficulté consiste à préciser les espèces indicatrices les plus appropriées aux fins de l'évaluation (Noss 1990; Woodley 1996). Un cadre de recensement des espèces indicatrices possibles, en fonction d'objectifs de suivi généraux, notamment la biodiversité, a été conçu et vérifié en intégrant une approche dite d'« espèces essentielles » (Hunter 1990; Noss 1990; 1991) à un programme de surveillance écologique au sein des parcs nationaux et des secteurs protégés (Woodley 1996), de manière à le rendre opérationnel. Ce cadre sert à recenser les espèces indicatrices cruciales pour effectuer le suivi de la dynamique à l'échelon des populations d'espèces, ce qui inclut des mesures comme la viabilité de ces populations. Les types de groupes d'espèces indicatrices incluent les espèces vulnérables, les espèces pivots, les espèces pilotes et les espèces « parapluie » ainsi que certaines populations spéciales et les espèces indicatrices d'un point de vue écologique.

Les évaluations préliminaires semblent indiquer que les espèces qui méritent sérieusement d'être considérées comme des espèces indicatrices possibles pour le supervision de la biodiversité dans le parc national de Kejimkujik sont : le pécan, la martre d'Amérique, l'orignal, la tortue de Blanding, la tortue-alligator, la perchaude et la truite mouchetée. Plusieurs autres espèces méritent également d'être prises en compte, parmi lesquelles : le coyote, la loutre de rivière, le lynx roux, le cerf de Virginie, le petit polatouche, la rainette crucifère, le ouaouaron et le grand corégone. Le cadre pourrait être adapté pour des applications relatives à d'autres secteurs protégés, ainsi qu'à des fins de gestion plus globale de la biodiversité, de la faune ou des ressources. Les espèces recensées pourraient être au centre des initiatives de gestion, de supervision et d'étude des écosystèmes, ainsi que de conservation de ces écosystèmes et des habitats, des accords de coopération et des partenariats avec les propriétaires de boisés adjacents et d'autres organismes, ainsi que des activités de sensibilisation, d'interprétation et de communication.

Introduction

Protected areas play a critical role in maintaining biodiversity; protected areas as life-supporting systems are essential components of the larger landscape. It is important that ecological integrity of protected areas be maintained; therefore, monitoring for ecological integrity and biodiversity objectives is a key part of ecosystem management. This paper examines the concepts of indicator species and focus-species and their potential utility as part of a larger composite suite of indicators to provide an index of ecological integrity. It focuses on the biodiversity sphere of ecological integrity monitoring and on measures of population dynamics at the species-population level as described by Woodley in a *Scheme for Ecological Monitoring in National Parks and Protected Areas* (1996).
A framework for identifying potential indicator species for monitoring biodiversity measures of ecological integrity is developed and tested, integrating a focus-species approach with Woodley's criteria for selecting indicator species. A matrix process is used to identify potential mammal, reptile, and amphibian, and freshwater fish indicator species for biodiversity monitoring at Kejimkujik National Park. Preliminary assessment results are discussed and interpreted and species that warrant further consideration as potential indicator species are identified and ranked. The potential usefulness, limitations, and benefits of the focus-species approach and framework are discussed.

Indicator species

An indicator species is an organism whose characteristics (*e.g.*, presence or absence, population density, dispersion, reproductive success) are used as an index of ecological attributes that are too difficult, inconvenient or expensive to otherwise measure (Landres *et al.* 1988 in Woodley 1993).

The use of indicator species to monitor or assess environmental conditions is a firmly established tradition, however, it has encountered many conceptual and procedural problems. Criticisms of the traditional concept and use of indicator species are valid and recommend the use of indicators as part of a comprehensive strategy of risk analysis that focuses on key habitats as well as species (Landres *et al.* 1988 in Noss 1990 and in Woodley 1993). Recent frameworks for ecological or biodiversity monitoring consider multiple levels of organization (regional landscape; community-ecosystem; population-species; and, genetic), and compositional, structural, and functional aspects (Noss 1990; 1995; Woodley 1993). They also include selection criteria for different categories of indicator species that consider vulnerable, keystone, and umbrella species as well as ecological indicator species (Noss 1990; Woodley 1993; 1996).

The term "indicator species" has often been used in a generic or ambiguous way. Operational definitions are quite varied depending upon the characteristics of the phenomenon they are meant to indicate. Consequently, indicator species are discussed at a variety of ecological and conceptual or management levels, ranging from specific localized stresses to ecological integrity or biodiversity. Indicator species may also be one group of focus — "feature" or "special" — species for management (Table 1) (Holbrook 1974 in Hunter 1990; Hunter 1990; Noss 1990; Millsap *et al.* 1990; Theberge 1995). These focus-species groups can be used to focus biodiversity management at the species-population level in order to maintain integrity at the ecosystem level (Noss 1991). For biodiversity or ecosystem management, each focus-species group should be considered in selecting the most suitable species for detailed monitoring and assessment; a species that falls into several groups would warrant extra attention.

Approaches Using Indicator Species

A proposed Scheme for ecological monitoring in national parks and protected areas is based on a two-tiered approach: 1) to assess known threats; and 2) to monitor a suite of indicators to assess overall ecosystem integrity (Woodley 1996). When choosing a biological indicator for a specific stress, it is important to ensure the response prediction model for the specific stress has been developed and the relationships are as clear as possible. No single biological indicator or indicator species has been found that will provide all the information necessary to reflect the behavior of an ecological system. Ideal indicator species should be: sufficiently sensitive to the particular stressor to provide an early warning of change; easy and cost-effective to measure, collect, assay, and/or calculate; able to differentiate between natural cycles or trends and those induced by anthropogenic stress; a population that will not be harmed by sampling for assay purposes; and, one which will not die out easily as stress progresses, but show response tiers (Cook 1976, Sheehan 1984, Munn 1988 in Noss 1990; Woodley 1993). Ideal indicator species will rarely be found, but these factors should be involved in indicator species selection (Woodley 1993). Good examples are the use of spotted salamander reproduction and tree ring widths as biological indicators of effects of acid precipitation (Portnoy 1990 and Munn 1988 cited in Woodley 1993).

Indicator species may also be used to evaluate the effects of management practices. Species types to consider as management indicator species may include: 1) threatened and endangered species; 2) species sensitive to intended management practices; 3) game and commercial species; 4) non-game species of special interest; and 5) ecological indicator species that suggest the effects of management practices on a broad set of species (Salwasser *et al.* 1983 and Wilcove 1988 in Noss 1991).

Using a suite of indicators to assess overall ecosystem integrity poses a significant challenge, especially in choosing the most appropriate indicators. An overall strategy must integrate indicators and measures at various scales and levels of organization. Woodley's Framework for assessing ecological integrity in national parks and protected areas consists of three major spheres: 1) biodiversity; 2) ecosystem function; and, 3) stressors. Key measures for monitoring ecological integrity within the biodiversity sphere include species richness (changes in species richness, and numbers and extent of exotics) and population dynamics (mortality/natality rates of indicator species; immigration/emigration of indicator species; and, population viability of indicator species) (Woodley 1996).

These measures are derived from conservation biology (Table 2). Population viability analyses include estimations of minimum viable population size and minimum critical area required to sustain the target — or focus — population over time, and are based on species-specific population dynamics such as mortality and natality and emigration/immigration rates. Woodley's species-population measures of biodiversity reflect these recommendations from conservation biology. Noss also outlines a range of measures for assessing and monitoring biodiversity at the species-population level (1990; 1995). Assessment at the species-population level is important in and of itself; however, it also provides necessary information for assessment and monitoring at the community-ecosystem and regional landscape levels. Variables at the landscape level such as connectivity and fragmentation cannot be meaningfully interpreted without reference to the requirements of particular species or suites of species. The challenge remains to select the most appropriate indicator species for these measures.

Selecting Indicator Species

There are many considerations in using and selecting indicator species (Table 3). The primary consideration is the purpose of the assessment and monitoring. Goals and objectives must be clearly defined. What is to be monitored and why? This question is fundamental to the selection of appropriate indicators.

The purpose of selecting indicator species for Kejimkujik National Park is primarily to assess change, such as changes in population structure and health (Munro, *pers. comm.* 1997). This paper will focus on selecting indicators for assessing and monitoring biodiversity at the species-population level. This is consistent with the use of indicators and measures of biodiversity, particularly population dynamics, for assessing ecological integrity as described by Woodley (1996).

Criteria for identifying indicator species vary depending on the phenomenon to be assessed. Selection criteria for categories of indicator species for assessing ecological integrity have been compiled by Woodley (Table 4). These criteria are used as the basis of the proposed framework for identifying indicator species described below. The framework assesses various species for their suitability as indicator species for population dynamic measures of biological integrity at the species-population level. The proposed framework integrates and attempts to operationalize Woodley's selection criteria for different categories of indicator species and *Scheme for Ecological Monitoring in National Parks and Protected Areas* (Woodley 1996).

Framework for identifying indicator species

A framework for identifying indicator species is proposed that integrates a focus-species approach (Hunter 1990; Noss 1990; Beazley 1997) with criteria for selecting indicator species for population dynamics and viability measures of biodiversity (Woodley 1996). Woodley's selection criteria for different categories of indicator species are defined and supplemented by sub-criteria (Table 5). Interpretation and judgment have been exercised in choosing appropriate sub-criteria to reflect Woodley's intent or meaning. Some criteria may require further definition and refinement in order to identify the most appropriate species, such as keystone, k-selected, and non-disturbance species. Critical review is required, with subsequent revision or refinement.

Woodley's first two criteria, 1) "Species vulnerable to identified indirect or distant threats", and 2) "Species vulnerable to identifiable direct or local threats" are somewhat ambiguous. It is not clear whether the criteria refer to vulnerability *per se*, such as resulting from biological traits or habitat requirements that make them susceptible to the threats (vulnerable species), or to particular sensitivity to the specific threat such that it may signal the effects of perturbations (ecological indicator species). For this reason, both aspects are explicitly incorporated into the proposed range of selection criteria and the identification matrix, under vulnerable species and ecological indicator species criteria.

The criteria are organized into a matrix that is structured by categories of focus-species types (Table 6). Each focus-species type should be considered in selecting the most suitable indicator species for biodiversity or ecological integrity monitoring. The selection criteria, sub-categories, and matrix are presented in the spirit of demonstrating the potential usefulness of a focus-species approach and data set in identifying indicator species for monitoring biodiversity at the species-population level. The criteria and data set are demonstrated and tested in the matrix format using native species existing or possibly existing in Kejimkujik National Park.

Considerations used to identify species fulfilling each criterion could be incorporated into the matrix and comprise a more-detailed level of sub-criteria for identification or information purposes. Alternatively the information could be recorded or attached in memo fields. This information could be used for management planning.

Sources of information used to complete the matrix include "expert consensus" from ecologists, biologists, and wildlife managers (Beazley 1997), and provincial wildlife agency and Nova Scotia Museum of Natural History documents (NBDNRE 1997; NSDNR 1996; Scott 1996). Park-specific information was obtained from Kejimkujik National Park (Drysdale 1986; Underwood, *pers. comm.* 1997). Further information from these sources and others could be used to identify potential indicator species for Cape Breton Highlands National Park and other protected areas.

Preliminary Assessment and Interpretation of Results

The information compiled within the matrix framework was assessed in four different ways (Table 7). The total number of criteria satisfied by each species was calculated as: 1) a simple number; and, 2) a percentage of the total number of known or consensus responses. The purpose of calculating the number of criteria satisfied as a percentage of total responses was to compensate for or take into account the varying levels of knowledge about different species. A third type of assessment counted the number of sub-categories that each species fulfilled (level 1.1, 1.2, 1.3, *etc.*). This assessment is considered to be informative because it compensates for a possible scoring bias towards species that satisfy several criteria within one sub-category but not in other sub-categories. Some sub-categories, such as "1.1 Endangered, threatened and vulnerable species / rare species of all kinds", contain more criteria than others, thereby resulting in an inherent bias in the weighting among sub-categories and categories. A fourth and final assessment was done to determine the number of focus-species groups represented by each species (vulnerable, keystone/dominant, ecological indicator, flagship/umbrella, and special population). This assessment is important because the first three types of assessments, based on number and percentage of criteria and sub-categories satisfied, generally favor or result in higher scores being received by "vulnerable species" because this category contains a higher number of criteria and sub-categories. However, vulnerable species are just one of five types of focus-species or species warranting special management attention, including monitoring.

It is important to note that not all criteria and sub-criteria could be assessed for all species due to deficiencies or lack of expert consensus in the data set, partially arising from the current status of knowledge of species and distributions in Nova Scotia. Additional information regarding, for example, population susceptibility, sensitivity to acidification, accumulator species, and non-native species is required to complete the matrix and provide a consistent level of information across criteria and across species.

Many criteria, such as large-bodied, large area requirements, non-disturbance species, and dietary, reproductive, and habitat specialization need to be interpreted in a relative sense. Refinements in these and other definitions could also improve the reliability of the matrix process. It may take some experimentation to determine how strictly to apply the criteria in order to produce an optimum suite of potential indicator species. Furthermore, it is likely to require several tests of the definitions, sub-criteria, and matrix format to develop the most effective process for identifying the most appropriate indicator species. Interpretations of the various assessment results and recommendations are made regarding species with the most potential as indicator species for monitoring biodiversity at Kejimkujik National Park. Several species fulfill several criteria and represent more than one type of focus-species. Many species fulfill at least one criteria. Only four mammal and two reptile species existing or possibly existing in Kejimkujik National Park fulfill no criteria (water shrew, striped skunk, northern flying squirrel, meadow jumping mouse, Maritime garter snake, and northern redbelly snake). All fresh water fish species fulfill at least one criteria. Preliminary results are summarized in Table 7 and are further discussed on a class basis.

Mammals

Mammal species that receive high scores in all four types of assessments are fisher, lynx, American marten, southern flying squirrel, eastern cougar and American moose. These species are generally more vulnerable than the others and represent at least three types of focus-species. When the number of criteria satisfied by the species is calculated as a percentage of total responses, eastern pipistrelle and silver-haired bat also receive high scores. This reflects a relative vulnerability coupled with a lack of knowledge about these species and their status; uncertainty or lack of data may be a factor in keeping these species from receiving higher scores in the other assessments. Only three species represent every type of focus-species: American marten, fisher, and American moose. Other species that represent three or more types of focus-species are coyote, river otter, bobcat, Arctic shrew, American black bear, white-tailed deer, American beaver, muskrat, American porcupine, and snowshoe hare.

Eastern cougar is not a suitable indicator species given arguments over its status; it is probably extirpated from Nova Scotia. Lynx may not be a suitable indicator species in mainland Nova Scotia because of their extremely low numbers and probable extirpation from the mainland, a small localized population persists in the highlands of Cape Breton Island. Any remaining individuals or populations of these species on the mainland would not be easy or cost-effective to assess, and may be further harmed by assessment. However, the identification of these extirpated or vulnerable species through the matrix framework process does support the position that focus-species warrant special management attention. It may also confirm or substantiate the choice of criteria and usefulness of the framework process for identifying focus-species and potential indicator species.

Although American moose populations may be considered relatively healthy in some parts of Nova Scotia and elsewhere, the local Kejimkujik-Tobeatic population is the only remaining and recovering population of the original indigenous herd. American moose and white-tailed deer are also potentially important indicator species because of the particular ecological requirements of ungulates (Theberge 1989) and their role as major herbivores. American marten, fisher, and white-tailed deer were all extirpated from Nova Scotia and were re-introduced or re-invaded with varying degrees of success. Status and health of the re-introduced American marten population in the Park and region is uncertain. The presence of Arctic shrew and silver-haired bat within the Park is also uncertain.

Eighteen mammal species fulfill at least one criterion in the ecological indicator species category. Coyote may be a potentially useful and interesting indicator species because it represents three types of focus-species, including ecological indicator species, and is an invading, possibly successful, non-native species. Non-native species were generally excluded from the mammal species list; however, coyote was assessed because there is evidence that coyote was historically present in New Brunswick and probably existed previously in Nova Scotia (Scott 1996). Furthermore, the wolf has been extirpated from Nova Scotia and the coyote may be perceived as fulfilling the role of summit predator.

Based on an overall interpretation of the assessment results, potential mammal indicator species with the highest overall scores for Kejimkujik National Park include: American marten, fisher, American moose, coyote, river otter, bobcat, white-tailed deer, and southern flying squirrel. Other species that warrant further consideration are lynx, eastern pipistrelle, and silver-haired bat, due to their uncertain status and potential vulnerability. American black bear also warrants further consideration because it is a relatively common, large-bodied species, representing three focus-species types. Arctic shrew, muskrat, American beaver, American porcupine, and snowshoe hare may also warrant further consideration as species that represent three focus-species types.

Reptiles and Amphibians

Blanding's turtle and snapping turtle receive high scores in every assessment type, fulfilling a relatively large number and percentage of criteria as well as several sub-categories, and representing four types of focus-species. Northern ribbon snake, blue-spotted salamander and four-toed salamander fulfill several criteria and sub-categories; therefore, warranting further consideration as indicator species due to their potential vulnerability. Northern spring peeper and all frogs represent three focus-species groups, along with red-backed salamander. Bullfrog in particular may represent a useful indicator species for frogs because it represents fiva sub-categories, whereas other frog species represent three or four sub-categories. All frog species are vulnerable to indirect or distant threat, and represent important prey and stress-related ecological indicator species. Bullfrog, northern leopard frog and pickerel frog also possess biological characteristics related to vulnerability. However, bullfrog is the only frog species that represents a management-related indicator species as a game species legally harvested in Nova Scotia.

As a result of these assessments, it would appear tnat Blanding's turtle and snapping turtle warrant further consideration as potential indicator species along with northern ribbon snake, blue-spotted salamander and four-toed salamander. The status or occurrence of four-toed salamander in Kejimkujik National Park is uncertain at present; therefore, some initial survey work may be warranted. Northern spring peeper and all frogs generally warrant further consideration; however, bullfrog in particular may represent a useful indicator species for frogs.

Freshwater Fishes

Brook trout and lake whitefish receive high scores in every assessment type, thus indicating a relative vulnerability and potential to represent various sub-categories and types of focus-species groups. Lake whitefish may not be considered an appropriate indicator species for Kejimkujik National Park because it was introduced to the Park. However, it was assessed because of uncertainty regarding its origin in Nova Scotia (Gilhen 1974). Yellow perch represented the highest number of focus-species groups (four) for freshwater fishes; however, it did not satisfy a relatively high number or percentage of criteria overall. This would indicate that yellow perch has several characteristics that make it suitable as a potential indicator species although it is not particularly vulnerable at the present time in this area. Other species that are not particularly vulnerable but which represent three focus-species groups are American eel, golden shiner, white sucker, and white perch.

Generally, yellow perch, brook trout, and lake whitefish warrant further consideration as potential indicator species because they represent a relatively large number of focus-species types and/or relative vulnerability. American eel, golden shiner, and white sucker may warrant further consideration because they represent three types of focus-species. White perch may also deserve some attention because it satisfies a relatively high number of sub-categories.

Conclusions

Methods for selecting indicator species are evolving along with definitions of monitoring goals. Integration of a focus-species approach with selection criteria for indicator species is possible in an assessment framework such as the one described. The framework appears to be useful for identifying potential mammal, reptile and amphibian, and freshwater fish indicator species for monitoring population dynamics measures of biodiversity at the species-population level. These measures include natality/ mortality, emigration/ immigration, and population viability of indicator species. A focus-species approach is compatible with *A Scheme for Ecological Monitoring in National Parks and Protected Areas*, including selection criteria for different categories of indicator species and a framework for assessing ecological integrity (Woodley 1996). The focus-species framework and data set could be adapted for use elsewhere, such as in Cape Breton Highlands and other national parks, Nova Scotia's and other provincial parks and protected areas, and more generally for regional ecological integrity and biodiversity management or integrated resource management.

Preliminary assessments suggest that priority species warranting special consideration as potential indicator species are: fisher, American marten, American moose, Blanding's turtle, snapping turtle, yellow perch, and brook trout. Several other species warrant further consideration, including, but not limited to, coyote, river otter, bobcat, white-tailed deer, southern flying squirrel, northern spring peeper, bullfrog, and lake whitefish. Eastern cougar and lynx also receive high scores in all assessments; however, they are not recommended as potential indicator species because they are probably extirpated from the Park and from the mainland of Nova Scotia. Atlantic salmon probably would also have received high score; however, the species has been confirmed as extirpated from the Park, along with gaspereau/alewife and, therefore, was not assessed. Species of uncertain status or unconfirmed presence in Kejimkujik National Park warranting further consideration are Arctic shrew, silver-haired bat, and four-toed salamander. Other species with relatively high scores include eastern pipistrelle, American black bear, muskrat, snowshoe hare, northern ribbon snake, blue-spotted salamander, American eel, golden shiner, white sucker, and white perch (Table 8).

Many species fulfilled several criteria and represented more than one type of focus-species. Few species fulfilled no criteria. There may be some justification to be more rigorous in application of the criteria in order to limit the number of potential indicator species. However, all potential indicator species need to be reviewed in terms of other selection considerations such as cost-effectiveness and ability of the population to withstand assessment; this additional assessment is likely to further limit the potential indicator species (Table 9).

Critical review and refinement of the criteria, definitions, and process of assessment are required. Additional data and knowledge are also required to improve reliability and consistency across species and criteria. Extension and adaption of the process and criteria to identify potential bird, invertebrate, and plant indicator species is also necessary to round out the suite of indicator species.

There are several benefits of a focus-species approach. It provides a focus for research, monitoring, and management with limited resources, as well as for broad goals such as maintaining ecological integrity or biodiversity. It provides an immediate focus within a longer term and broader regional context, and for partnerships and cooperative arrangements with adjacent landowners and other agencies in terms that are relatively easily understood. Focus-species may also serve as a "multi-species umbrella" for conservation initiatives at the landscape-level such as defining critical habitat for species with the most demanding requirements (Lambeck 1997). They may also provide a focus for interpretive programs and education, as well as for broader "social marketing" of ecosystem and species preservation and habitat conservation.

The approach integrates science, management, and policy in a way that is operational at national/regional and individual park levels. It is also strategic in that it is issue and goal driven; it is responsive and appropriate for adaptive management; and, it is contextual in that it may be adapted to particular regional, historical, and bio-geographical situations. However, a focus-species approach to monitoring biodiversity at the species-population level represents only one aspect of a monitoring and management program, which should include a suite of indicators and measures at various levels.

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Table 1. Types of focus species for biodiversity management

1. Vulnerable or endangered species: rare species or species with small population size, genetic impoverishment, poor dispersal powers, wide-ranges or large area requirements, low fecundity, dependence on patchy or unpredictable resources, extreme variability in population density, or are persecuted or prone to extinction in human-dominated landscapes (may also be estimated by extent of decline since Euro-American settlement);
2. Keystone: pivotal species upon which a large part of a community depends;
3. Ecological indicator: species that signal the effects of perturbations on a number of other species with similar habitat requirements;
4. Flagship: popular, charismatic species that serve as symbols or rallying points for conservation;
5. Umbrella: species with large area requirements which, if given sufficient habitat protection, will protect many other species; and,
6. Special populations: species where the population is a special gene pool.

(Source: Compiled from Hunter 1990 and Noss 1990; 1991)
Note: Groups of species for management attention have been variously referred to as "feature", "special", "selected", "focus", "priority", or "significant".

Table 2. Measures for monitoring and assessment recommended by conservation biology

1. Population dynamics of selected species: information required to determine population viability and minimum viable population size; specifically, an accurate measure of recruitment to the population, and an estimate of total population size; at the individual level, reproductive rates of selected indicator species;
2. Minimum viable population (MVP) sizes of selected species: species should include top predators, rare species, and large body size organisms (Theberge, *pers. comm.* 1990 *in* Woodley 1996); MVP to be determined by population viability analysis using knowledge of population dynamics; birth and death rates should be assessed for each distinct population of the selected species; and,
3. Minimum area requirements of selected species: especially for those with large territories, rare species or species with sparse distribution; calculation of minimum critical area should be done without regard to park boundaries.

(Source: Woodley 1993)

Table 3. Considerations for the use of indicator species

1. Goals must be clearly defined, including criteria to be used to determine when those goals have been achieved;
2. Selection of indicators depends on formulating specific questions relevant to management or policy that are to be answered through the monitoring process;
3. Indicators should be used only when necessary and appropriate (when direct measures cannot or should not be made);
4. Indicator species should be chosen using criteria that are unambiguously defined, and assumptions should be clearly stated;
5. The biology of selected species should be known in as much detail as possible;
6. Sources of subjectivity should be listed wherever possible;
7. Assessment design, methods of data collection and statistical analysis should be submitted to external peer review;
8. Research should be directed toward developing an overall monitoring and assessment strategy that accounts for the natural variability in population attributes and that incorporates concepts from landscape ecology; and,
9. Indicators for the level of organization one wishes to monitor may be selected from levels at, above or below that level. For example, to monitor at the species-population level, one might choose indicators from the landscape level (corridors for dispersal), population level (size, fecundity, sex ratios), level of individuals (physiological parameters), or genetic level (heterozygosity).

(Sources: Landres *et al.* 1988 *in* Woodley 1993; Noss 1990)

Table 4. Selection criteria for different categories of indicator species*

1. Species vulnerable to identified indirect or distant threats such as acid precipitation or climatic shifts;
2. Species vulnerable to identifiable direct or local threats such as disturbance from visitor use;
3. Rare species of all kinds (with defensible definitions of rarity: COSEWIC, rare in natural region, or rare in park);
4. Dominant species such as summit predators or keystone species;
5. Old-growth or non-disturbance species;
6. K-selected species such as extreme habitat specialists or species with low fecundity or low capability for compensatory recruitment;
7. Species with large body size;
8. Exotic or non-native species that are successfully living and reproducing in a given ecosystem;
9. Accumulator species or those that have a tendency to accumulate toxins

(Source: Woodley 1993; 1996)

Note: * Selection criteria should be applied for each broad ecosystem type in a monitoring and assessment program

Table 5. Focus-species categories and criteria for selecting indicator species for monitoring biodiversity

1. Vulnerable species:
- 1.1 Endangered, threatened and vulnerable species / Rare species of all kinds (Woodley 1993; 1996):
  - 1- Internationally rare (IUCN; WWF; TNC)
  - 2- Nationally rare (COSEWIC)
  - 3- Provincial Species of Concern (NSDNR):
    - - at risk of extinction (Red)
    - - particularly sensitive to human activities or natural events (Yellow)
  - 4- Rare in Park or region
  - 5- Genetically rare/distinct or impoverished
  - 6- Small population size (NSDNR)
  - 7- Small number of occurrences (NSDNR)
  - 8- Small geographic distribution (NSDNR)
- 1.2 Species vulnerable to indirect or distant threats (Woodley 1993; 1996):
  - 1- Sensitive to acid precipitation or climate change (Woodley 1993; 1996)
  - 2- Pollution susceptible, accumulator or tendency to accumulate toxins (Woodley 1993; 1996)
- 1.3 Species vulnerable to local or direct threats (Woodley 1993; 1996):
  - 1- Species that concentrate spatially
  - 2- Decline in range/distribution (NSDNR)
  - 3- Decline in population size (NSDNR)
  - 4- Population threatened by direct exploitation, harassment or interactions (NSDNR)
  - 5- Habitat threatened by loss, conversion, degradation, or fragmentation (NSDNR)
- 1.4 Biological characteristic-related vulnerability:
  - 1-K-selected species such as extreme habitat specialists or species with low fecundity or low capability for compensatory recruitment (Woodley 1993; 1996)
  - 2- Relatively large body size (Woodley 1993; 1996)
  - 3- Limited powers of dispersal
  - 4- Large area requirements / wide-ranging
  - 5- Extremely variable in population density
- 1.5 Old-growth or non-disturbance species (Woodley 1993; 1996)

2. Keystone or dominant species (Woodley 1993; 1996):
- 2.1 Important prey
- 2.2 Summit predator
- 2.3 Major herbivore / Pivotal species in the community

3. Ecological indicator species:
- 3.1 Stress-related indicator species:
  - - Sensitive to stresses: Acid precipitation or climate change; Pollution susceptible, accumulator or tendency to accumulate toxins; Non-disturbance or old-growth dependent (Woodley 1993; 1996)
  - - Species that indicate effects of stress on a broad set of species
- 3.2 Management-related indicator species:
  - - Sensitive to intended management practices; Game species; Non-game species of special interest; Species that indicate effects of management practices on a broad set of species
- 3.3 Exotic, non-native or invading r-strategist/generalist/opportunistic species successfully living and reproducing in a given ecosystem (Woodley 1993; 1996)

4. Flagship and Umbrella species:
- 4.1 Popular or charismatic species
- 4.2 Large-area requirements / wide-ranging

5. Special Populations:
- 5.1 Population is a special gene pool

(Source: Compiled from Holbrook 1974; Hunter 1990; Noss 1990, 1991; Millsap *et al.* 1990; Theberge 1993, 1995; Woodley 1993, 1996; Herman and Scott 1992; 1994; Harper *et al.* 1996; Elderkin and Boates 1996; Beazley 1997)
Note: Criteria vary slightly for freshwater fishes

Table 6. Focus-species selection criteria framework for indicator species in Kejimkujik National Park Mammals

Species group	1. Vulnerable species																					2. Keystone/ Dominant			3. Ecological Indicator			4. Flagship/ Umbrella		5. Special population
Criteria Native Mammals (existing / possibly existing in Park)	1.1 Endangered, threatened, vulnerable/ rare species of all kinds								1.2 Vulnerable to indirect or distant thr.		1.3 Species vulnerable to local or direct threat					1.4 Biological characteristic-related vulnerability					1.5 Old-growth/ non-disturbance	2 .1	2 .2	2 .3	3 .1	3 .2	3 .3	4.1 Flag-ship	4.2 Um-brella	
	1	2	3	4	5	6	7	8	1	2	1	2	3	4	5	1	2	3	4	5										
Arctic shrew*	X	X	X		√	X			√		X	X	X	X			X		X				X	X	√		X		X	√
Common shrew	X	X	X	X	X	X	X	X			X	X	X	X			X		X	√	X	√	X	X			X		X	
Smokey shrew	X	X	X	√	X	X	X	X			X	X	X				X		X				X	X			X		X	
Water shrew	X	X	X		X					X	X	X	X	X	X				X		X	X	X	X			X		X	
Pygmy shrew	X	X	X		X		√	√	X		X	X	X	X	X		X		X		X	X	X	X			X		X	
Short-tailed shrew	X	X	X		X	X					X	X	X	X					X	√	X	X	X	X			X		X	
Star-nosed mole	X	X	X	X	√	X					X		X	X		√			X			X	X	X			X		X	√
Little brown bat	X	X	X	X	X	X	X	X	X		√	X	X			√	X	X				X	X	X			X			
N. long-eared bat	X	X	√	X			√				√	X	X		√	√	X	X	X			X	X	X			X		X	
Eastern pipistrelle	X	X	√	√	X	√	√	√			√	X				√	X	X				X	X	X			X			
Silver-haired bat*	X	X	√	√	√	√	√					X			X		X	X			X	X	X	X			X			√
Red bat*	X	X	√	√	X	√	√		X		X	X			X			X			X	X	X	X			X			
Hoary bat*	X	X	√	√			√		X		X	X			X			X			X	X	X	X			X			
Coyote*	X	X	X		X	X	X	X	X	X	X	X	X	X	X		√	X	√		X	X	√	X	X	√	√		√	
Red fox	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	√	X	X	√	X		X	
Am. black bear	X	X	X	X	X		X	X	X	X	X	X	X	X	X	√	√	X	√			X		X		√	X	√	√	
Racoon	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	√	X	X	X	X	X	√	X		X	
American marten*	X	X	√	√		√		√	X	X	X				√	√	X	X	X			X	√	X		√		√	X	√
Fisher*	X	X	√	√		√		√		X	X	√					X	X	√	X		X	√	X		√		√	√	√
Ermine/Weasel	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X		X	X	√	X		√	X		X	
American mink	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	√	X		√	X		X	
Striped skunk*	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X		X		X	
River otter	X	X	X	X	X		X		X		X			√			X	X	√	X	X	X	√	X		√	X	√	√	
Eastern cougar *	X	√	√		X	√		X	X	X	X					√	√	X	√		X	X	√	X	X		X	√	√	
Lynx*	X	X	√		X	√	√	√	X	X	X	√		√	√	√	√	X	√			X	√	X	X		X	√	√	
Bobcat	X	X	X	X	X	X	X	X	X		X		X				√	X	√		X	X	√	X		√	X	√	√	
White-tailed deer*	X	X	X	X	X	X	X	X	X	X		X	X		X	√	√	X			X		X	√	X	√	√	√		
American moose*	X	X	X	√			X	X	X	X	X					√	√	X	√		X	X	X	√	X	√	X	√	√	√
Eastern chipmunk	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	√	X	X	X	X			X		X	
Woodchuck	X	X	X	√	X	X	X	X	X		X	X	X	X	X				X		X		X	X			X		X	
Am. red squirrel	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	√			X	X		√	X		X	
S. flying squirrel	X	√	√	√	√	√	√				X			X	X	√	X		X			X	X	X		√	X	√	X	√
N. flying squirrel	X	X	X	X	X	X	X	X	X		X	X	X	X					X				X	X			X		X	
American beaver	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	√	X	√	X	√	X	√	X	

Table 6. Continued.

Deer mouse	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	√	X	√	X	X			X		X	
White-footed mouse	X	X	X	X	√	X	X	X			X	X	X						X		X		X	X			X		X	√
Red-backed vole	X	X	X	X	X	X	X	X			X	X	X	X	X		X	X	X	√	X	√	X	X			X		X	
S. bog lemming	X	X	X	*	X	X	X		X	X	X	X	X	X					X	√			X	X	X		X		X	
Muskrat	X	X	X	X	√	X	X	X	X		X	X	X					X	X		X		X	X		√	X		X	√
Meadow vole	X	X	X	X	X	X	X	X		X	X	X	X	X	X				X	√	X	√	X	X			X		X	
Wood. jump. mouse	X	X	X	X	√	X	X		X		X	X	X	X	X		X	X	X		X		X	X			X		X	√
Mead. jump. mouse	X	X	X	X	X	X	X		X		X	X	X	X	X		X	X	X		X		X	X			X		X	
American porcupine	X	X	X	X		X	X		X	X	X	X	X	X	X	√			X				X	√			X	√	X	
Snowshoe hare	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	√	X	√	X	√	X	√	X		X	

1. *Coyote has invaded N.S. (probably prehistorically present); American marten, fisher, and white-tailed deer were extirpated and re-introduced/re-invaded (Scott 1996). Eastern cougar status is uncertain — probably extirpated; lynx is extremely rare on mainland — probably extirpated (Scott 1996). American moose in this case refers to a localized remnant population of indigenous moose. Presence of arctic shrew, silver-haired bat, red bat, hoary bat and striped skunk uncertain/unconfirmed (Drysdale 1986; Underwood 1997, *pers. comm.*); these species may not exist in Kejimkujik N.P.
2. Criteria include Selection criteria for different categories of indicator species (Woodley 1993; 1996), and are organized according to focus-species groups (Noss 1990; Hunter 1990) Considerations used to identify species fulfilling each criterion could be incorporated into the table and comprise a more-detailed level of sub-criteria for information purposes. Alternatively the information could be recorded or attached in memo fields.
3. Sources of information used to complete the matrix include consensus from experts (Beazley 1997), park specific information from Kejimkujik National Park (Drysdale 1986; Underwood 1997), and draft provincial wildlife agency and other documents (NBDNRE 1997; NSDNR 1996; Groombridge [IUCN] 1993; COSEWIC 1996).
4. Old growth or non-disturbance species includes Dependent upon provincially rare habitat
5. Flagship species: subjective opinion of K. Beazley
6. Toned areas indicate sub-categories (1.1, 1.2, 1.3, *etc.*) considered fulfilled by various species.

Table 7. Summary of assessment results for potential indicator species for Kejimkujik N.P.

Highest rankings in total number of criteria satisfied (total no. of √)	**Highest rankings in criteria satisfied (√) as a percentage of total responses (√ and X)**	**Highest rankings in number of sub-categories of focus-species types satisfied** (1.1, 1.2, 1.3, etc.)	**Highest rankings in number of focus-species types satisfied** (Vulnerable; Keystone; Ecological indicator; Flagship/Umbrella; Special population)
Mammals			
Lynx (13) **Fisher (11)**	**Fisher (55)** **Lynx (54)**	**Fisher (8)** **American marten (7)** **American moose (7)**	**Fisher (5)** **American marten (5)** **American moose (5)**
American marten (10) **S. flying squirrel (10)**	**American marten (48)** **S. flying squirrel (48)**	River otter (6) **Lynx (6)**	Coyote (4) River otter (4) Bobcat (4) White-tailed deer (4) **S. flying squirrel (4)**
Eastern cougar (9) **American moose (9)**	**Eastern cougar (43)** Eastern pipistrelle (41) **American moose (39)** Silver-haired bat (35)	Coyote (5) **Eastern cougar (5)** Bobcat (5) White-tailed deer (5) **S. flying squirrel (5)**	Arctic shrew (3) American black bear (3) **Eastern cougar (3)** **Lynx (3)** American beaver (3) Muskrat (3) American porcupine (3) Snowshoe hare (3)
Reptiles and Amphibians			
Blanding's turtle (21)	**Blanding's turtle (72)**	**Blanding's turtle (10)** **Snapping turtle (8)**	**Blanding's turtle (4)** **Snapping turtle (4)**
Blue-spot. salamander (12) **Snapping turtle (11)** N. ribbon snake (10) Four-toed salamander (10)	Blue-spot. salamander (55) N. ribbon snake (50) Four-toed samander (45) **Snapping turtle (42)**	Four-toed salamander (6) Bullfrog (5) Blue-spot. salamander (5)	N. spring peeper (3) Bull frog (3) Green frog (3) Mink frog (3) N. leopard frog (3) Pickerel frog (3) Wood frog (3) Red-back. salamander (3)
Freshwater Fishes			
Brook trout (11)	**Lake whitefish (53)**	**Brook trout (8)**	Yellow perch (4)
Lake whitefish (10)	**Brook trout (48)**	White sucker (6) White perch (6) **Lake whitefish (5)** Yellow perch (5)	American eel (3) **Lake whitefish (3)** **Brook trout (3)** Golden shiner (3) White sucker (3)

1. Numbers in brackets ( ) indicate scores: number or percentage of criteria, sub-categories or focus-species types satisfied.
2. Horizontal lines between groups of species indicate a preliminary cluster analysis of relative scoring.
3. Bold type indicates species receiving relatively high scores in every assessment.

Table 8. Species warranting further consideration as potential indicator species in Kejimkujik N.P.

Mammals	Reptiles and Amphibians	Freshwater fishes
Fisher American marten American moose	Blanding's turtle Snapping turtle	Yellow perch Brook trout
Coyote River otter Bobcat White-tailed deer Southern flying squirrel	Northern spring peeper All frog species, or bullfrog (as a potential indicator species for frogs)	Lake whitefish
Lynx* Eastern pipestrelle Silver-haired bat* American black bear Arctic shrew* Muskrat Snowshoe hare	Northern ribbon snake Blue-spotted salamander Four-toed salamander*	American eel Golden shiner White sucker White perch

1. Species indicated by asterisk (*) are of uncertain status in Kejimkujik National Park and/or region
2. Groups of species delineated by table cells represent a preliminary cluster analysis based on interpretation of combined relative scores in the various assessments of number and percentage of criteria and sub-categories satisfied and number of focus-species groups represented by each species

Table 9. Other considerations for selecting indicator species

1. Sufficiently sensitive to provide an early warning of change;
2. Distributed over a broad geographical range;
3. Capable of providing a continuous assessment over a wide range of stresses;
4. Relatively independent of sample size;
5. Easy and cost-effective to measure, collect, assay, and/or calculate;
6. Population will not be harmed by sampling for assay purposes;
7. Population will not die out easily as stress progresses, but show response tiers;
8. Able to differentiate between natural cycles or trends and those induced by anthropogenic stress; and,
9. Relevant to ecologically significant phenomena.

(Sources: Cook 1976, Sheehan 1984, Munn 1988 in Noss 1990; Woodley 1993)

THE GREATER KOUCHIBOUGUAC ECOSYSTEM PROJECT

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Abstract

The Greater Ecosystem concept, developed in the 1980s by Yellowstone National Park, allows resource managers to determine which critical habitat goes beyond the imposed administrative boundaries. To preserve biodiversity following this concept, we need to build an adequate integrated system. But the elaboration of this protection strategy is complex, and several things have to be considered. First, the definition of ecosystem has to be reviewed to determine the best assessment criteria for our Greater Ecosystem. Availability of information and financing is another problem to solve. Differing opinions and interests between managers, groups and industries are not a simple problem; negotiations are very complex when money and jobs are discussed. Finally, when the acceptable limits are found, efforts must be oriented on multiple data collecting and integration in the database. Ultimately, the monitoring system will help managers to understand ecosystem components, patterns and processes and point out elements of biodiversity that are more endangered than others. This way, actions can be taken, either to develop measures of protection or to reduce the risks at their source.

Sommaire

Le concept d'écosystème élargi, élaboré au cours des années 1980 par le parc national de Yellowstone, permet aux gestionnaires de la ressource de déterminer quels sont les habitats cruciaux dont les limites dépassent les frontières administratives imposées. Afin de préserver la biodiversité selon ce concept, il convient d'élaborer un système intégré adéquat. Toutefois, l'élaboration de cette stratégie de protection est complexe et divers éléments doivent être pris en compte. Tout d'abord, la définition de l'écosystème doit être analysée afin de déterminer les meilleurs critères d'évaluation de notre écosystème élargi. La disponibilité de l'information et du financement constitue un autre problème à résoudre. La divergence des opinions et des intérêts entre les gestionnaires, les groupes et les industries ne constitue pas un problème simple; les négociations sont très complexes lorsque des intérêts financiers et des emplois sont en jeu. Enfin, une fois des limites acceptables trouvées, les efforts doivent être orientés sur la collecte et l'intégration de données multiples à la base d'information. En fin de compte, le système de suivi aidera les gestionnaires à comprendre les composantes, les modèles et les processus de l'écosystème, ainsi qu'à souligner les éléments de la biodiversité qui sont plus menacés que d'autres. Ainsi, des interventions pourront être effectuées, soit pour élaborer des mesures de protection, soit pour réduire les risques à la source.

The Greater Ecosystem Notion

Protected areas, like parks, natural reserves or sanctuaries, were established to preserve the biodiversity of certain regions or to protect particular species. Numerous studies have been carried out inside protected areas, but they hardly ever investigated beyond their imposed territorial limits.
Unfortunately, those administrative boundaries are not, or are almost never, representative of primary habitats, of watersheds and of all the natural factors that define an ecosystem. That is why we have to monitor outside existing protected areas.

To achieve that goal, we need to understand the interactions inside and outside the system in order to protect habitats and species at risk. Protected areas depend on outside material or energy and they are frequently subject to many threats. These threats may sometimes be internal but they are mostly external because of human disturbance and pollution: they can originate from natural sources too like storms and floods.

To be effective, the preservation of biological diversity has to be done on a larger scale to ensure a better resilience of the protection area. We need a broader approach that recognizes the need to manage an entire ecologically whole and coherent region that usually extends beyond the protection area boundaries to include the whole ecosystem (Slocombe 1993).

The concept of Greater Ecosystem management, developed in the 1980s by Yellowstone National Park, is a good conservation strategy. It allows for managing resources and habitats, which go beyond the imposed administrative limits. However, there are a lot of things we have to consider for the development of a monitoring system. The major problem with the Greater Ecosystem concept is its delimitation. It can vary considerably depending on the point of view, on the goal of the study, on the approach. and on the scale or the species we study. There are many ways to delineate boundaries for an ecosystem. It depends mainly on the kind of management adopted, on what is going to be preserved or protected, and the kind of procedure taken to achieve it.

Definition of Ecosystem

This whole delimitation problem arises from the ecosystem definition problem. We all understand the concept of what is an ecosystem but the meaning varies depending on the user, and its application in the field is often not easy. To be efficient, we require a practical definition because the delimitation criterion that we use is coming from this definition (Gonzalez 1996).

We don't need a vague concept, we have to consider an ecosystem as a place. There are numerous definitions with species or organism-centered views. With this concept, boundaries are drawn around the area used by the organism (usually an animal), but if the needs and habits of the animal were to change, so would the boundaries of the ecosystem (Gonzalez 1996). This concept was used to create the Greater Yellowstone ecosystem. They based their delimitation mainly on the grizzly bear (*Ursus arctos*) habitat. For us, the organism-centered view is not really reliable; we can't modify our boundaries every year. Moreover, we believe that it is impossible to rely on one indicator only for such a large region.

That is why we adopted a view that is more global. The landscape-centered view seems to be a better solution. This way, ecosystems are fixed places with a definite location; consequently boundaries can be delimited in the field and on maps (Gonzalez 1996). This "geoecologist" view includes human occupancy and the natural aspects that constitute a landscape. It doesn't need to be abstract or too complex to be effective. A global view can adequately represent the reality. We have to adapt theories to our realities.

Another problem that we have to face in the elaboration of a Greater Ecosystem management is the availability of information and its coordination. Field surveys are expensive and available information is often expensive too. In addition we are not sure of its quality and the format may sometimes be incompatible with our information system. Besides, we have software and application program dilemmas concerning availability, efficiency, compatibility, and reliability. Finally, the problem of financing. who will pay for the research? That is a big question.

In the negotiation aspect, we have the problem of opinions and interest contrast between participants. Researchers, in general, customers, and industries have different points of view when trying to reach an agreement. Negotiations are not simple when money and jobs are discussed. We have to solve environmental problems and we have to reduce the impacts today before it is too late. The loss of biodiversity and extinction of certain species is a very serious problem. If people in general are not as concerned as they should be, it's because they don't really know what is going on. It is time to explain in detail the risks we are facing now, with the help of media like television and newspapers. Extinction is one of the major threats we have to deal with nowadays, we all have to do something before it is too late.

The Limits

Finally, when the best acceptable limits for the Greater Ecosystem are found, efforts must be oriented on a monitoring perspective. We need to provide qualitative and quantitative description of the area, like localization and identification of all the possible risks and targets that may be affected. We have to keep in mind that there will always be divided opinions on the acceptable limits depending on what is being studied.

Another thing to remember is that Greater Ecosystem limits have to be permeable, a kind of dotted line, where interactions are possible because there is some trade-off between ecosystems. Let's think about air pollution or bird migration and the regulations and policies that exist to regulate these aspects.

The Application of Greater Ecosystem at Kouchibouguac National Park

The influences of the park in the region are numerous; for example, to improve the accessibility of the park, roads were built. The park increased the tourism, improved the business on different levels, and created jobs. These influences led to an increasing number of threats that are coming directly from the establishment of the park but some already existed and were coming from other sources, like transport in the Northumberland Strait, pulp and paper production on the border of Miramichi River, *etc.* The need for protection is there; that is why, in the last 4 years, we worked to establish a Greater Ecosystem management program to reduce the impacts on the park's habitat and to protect its biodiversity.

For the Greater Kouchibouguac Ecosystem (GKE) project, the first thing we did was identify the ecosystems present inside the park and those that extend beyond its boundaries: forest, peat bogs, fallow lands, river systems, estuarine system, lagoons, salt marches, dunes, ground installations, *etc.*
After knowing what we were dealing with, we based the Greater Kouchibouguac Ecosystem delimitation on these criteria:

a) Watersheds — they are the basis of delimitation because they are natural boundaries and they represent a large regional ecosystem;

b) Land use and land cover, like urban areas, forest, agriculture, wetlands, *etc.*;

c) Marine flow, because a part of GKE is on the Northumberland Strait;

d) Municipality and county limits, were considered mostly for statistics or legal aspects.

We know that the last aspect used can be in contradiction with the Greater Ecosystem concept but it is necessary for statistical information. Usually, natural boundaries should be used for most delineations of ecosystem. Nevertheless, sometimes artificial boundaries, like political borders and county lines, must be used to bound ecosystems into administratively practical units (Gonzalez 1996). Humans are major actors in ecosystems; we can't ignore them, their beliefs or their socioeconomic activities. We can't rely only on an animal-based definition. We believe that it is impossible to manage efficiently an entire ecosystem. Rather, we manage human activities within ecosystems in order to minimize the impacts on natural processes and resources.

Finally, the limits we have are large enough for viable populations of all native species in the region, large enough to accommodate natural disturbance regimes, to include a time line of centuries within which species and ecosystem structures and processes may evolve and, to integrate human occupancy and land use at levels that do not result in ecological degradation (Grumbine 1990). In our view, it is small enough to be biogeographically distinct, to be mapped in detail and to be managed by people who know the land well.

For now we have a general approach, because our goal is a general level of protection. It is not oriented on specific species or habitat. We are collecting data on different subjects like:

1. Environmental risks: possible pollution sources, to build an environmental protection system (Martine Ruel, Université de Sherbrooke)

2. Socioeconomic features: land use evolution, to examine the trends and predict future developments (Denis Giroux and Nancy Maillet, Université de Sherbrooke)

3. Biophysical information: resource inventory — fauna and flora studies. Coyotes: research on lifestyle and habitat (Mathieu Dumond, Université de Moncton and Nadine Thébeau, Université de Sherbrooke)

We need more studies at the greater ecosystem level in order to understand natural processes such as forest fires and insect infestations. We also need more studies on socioeconomic factors such as forest production, estuarine commercial fisheries and more. This information will be gradually integrated in the database.

The Monitoring System and the Necessity of Cooperation

The monitoring system we are building has to be flexible, adaptable, and easily upgradable. Designed to detect environmental problems, it needs to be scale specific; that is why we use geographic information system (GIS) technology. At time of writing, efforts are focused on data collection, organization, and synthesis. The monitoring system will help managers understand ecosystem components, patterns, and processes (Grumbine 1990). Ultimately, the monitoring project will point out the elements of biodiversity that are more at risk than others.

This way, decision makers will develop administrative rearrangements, diverse research projects and monitoring plans, protection priorities, restoration of degraded lands and will promote citizen participation in decision making (Grumbine 1990). Ecosystem-based management requires not only the Greater Ecosystem concept, it also requires an interdisciplinary framework to integrate research, planning and management (Slocombe 1993). That is why cooperation has to be developed between park managers, government, municipalities, citizens and non-governmental agencies to develop agreements and measures of protection. We have to acquire some knowledge to reduce the risks at their sources and to adequately manage the Greater Ecosystem of Kouchibouguac.

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Gonzalez, O.J. 1996. Formulating an ecosystem approach to environmental protection. Environmental Management 20(5): 597-605.CANADA'S ECOLOGICAL MONITORING AND ASSESSMENT NETWORK:

A MECHANISM TO RESPOND TO BIODIVERSITY ISSUES

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Abstract

There are numerous stresses affecting ecozones in Canada, such as increased UV-B radiation from stratospheric ozone depletion, increasing average annual air temperatures, increasing atmospheric CO_2, acid rain, tropospheric ozone, toxic chemicals, etc. These stresses overlap geographically and, as a result, the changes in ecosystems are a result of their individual and collective effects. There will be numerous ecological responses to these stresses including changes in biodiversity.

Canada is organizing a National Ecological Monitoring and Assessment Network (EMAN) with the overall objective of being able to understand what changes are occurring in the environment and why those changes are occurring. Detailed objectives are to understand the nature of ecological change in response to these stresses, design scientifically defensible pollution control and management programs, evaluate the effectiveness of these control and management programs and define new issues. An ideal ecological monitoring and assessment site will have long-term, multidisciplinary studies. There are currently over 80 sites across Canada that have become part of the Network and while all are conducting long-term studies, not all have a complete suite of multidisciplinary measurements. However, all of the sites within a given ecozone are considered as an Ecological Science Cooperative (ESC), so that all of the available information may be pooled, thereby adding benefit to the individual sites and developing a collective understanding of changes within the ecozone.

Protected areas provide ideal locations for conducting the long-term multi-disciplinary studies needed to meet the four EMAN objectives. In turn, the information from the EMAN sites puts the public and decision-makers in a strong position to understand the needs for protection and how it might be accomplished. The presentation will include examples of the ecological changes that are occurring

Sommaire

De nombreux facteurs de stress influent sur l'écozone du Canada, notamment l'augmentation des radiations UV-B en raison de l'appauvrissement de la couche d'ozone stratosphérique, l'augmentation des températures moyennes annuelle de l'air, ainsi que l'accroissement de la concentration de dioxyde de carbone dans l'atmosphère, des pluies acides, de l'ozone troposphérique, des produits chimiques toxiques, etc. Ces facteurs de stress se combinent sur un même territoire et il en découle que les changements des écosystèmes sont le résultat de leurs effets individuels et collectifs. Ces facteurs de stress provoqueront de nombreuses perturbations sur le plan écologique, ce qui inclut des changements de la biodiversité.

Le Canada met sur pied un réseau national d'évaluation et de surveillance écologiques (RESE) ayant pour objectif général la compréhension des changements de l'environnement et leurs causes. Les objectifs détaillés consistent à comprendre la nature du changement écologique en réaction à ces facteurs de stress, à concevoir des programmes de gestion et de contrôle de la pollution valables d'un point de vue scientifique, à évaluer l'efficacité de ces programmes de contrôle et de gestion ainsi qu'à définir les nouveaux enjeux. Dans l'hypothèse idéale, un site d'évaluation et de surveillance écologiques fera l'objet d'études multidisciplinaires à long terme. On recense à l'heure actuelle plus de 80 sites à l'échelle du Canada, qui ont été intégrés au réseau; toutefois, alors que tous effectuent des études à long terme, la mise en œuvre d'une série exhaustive de mesures multidisciplinaires n'est pas généralisée. Cependant, l'ensemble des sites d'une écozone donnée est considéré comme une coopérative de sciences écologiques (CSE), de manière à regrouper toute l'information disponible et, ainsi, à augmenter les retombées positives à l'échelon des sites individuels et à acquérir une compréhension collective des changements au sein de l'écozone.

Les secteurs protégés constituent des emplacements idéals pour les études multidisciplinaires à long terme requises pour satisfaire aux quatre objectifs du RESE. En contrepartie, l'information des sites du RESE aide de manière notable le public et les décideurs à comprendre les besoins de protection et les modalités possibles pour les combler. Le présent document inclut des exemples de changements écologiques en cours.

MEASURING PROGRESS TOWARD SUSTAINABLE DEVELOPMENT IN THE PRAIRIE ECOZONE: THE MANITOBAN EXPERIENCE

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Abstract

The focus on sustainable development performance and on an ecozone represents a more holistic and integrated approach in assessment than the traditional. jurisdiction-focused State of the Environment (SOE) reports around the world. Although numerous SOE initiatives establish a link between ecological and socio-economic factors, elaborate efforts to integrate them into the context of sustainable development are still lacking.

Manitoba's 1997 SOE report represents a transition between SOE and integrated sustainable development reporting. While most of the report is still focused primarily on ecological conditions in Manitoba's six ecozones, the chapter on Manitoba's Prairie Ecozone was designed from the beginning to cover issues in the context of sustainable development. Indicators in the pilot chapter were selected in an iterative multi-stakeholder process covering the four broad categories of natural resources, human-made capital, community assets, and human life.

Special focus is given on examples of indicators used to describe Manitoba's natural lands and special places, including its protected areas, and the impact of human activities and land use on their state. Through these examples, the paper provides an analysis of the following issues:

* How to identify what should be measured
* How to prioritize the identified issues of sustainable development
* The search for data to measure these issues
* Data availability and alternative solutions (use of proxy data)
* Aggregation of indicators into indices and the evaluation of temporal and spacial trends

Experience from the project is analyzed based on the Bellagio Principles for Assessment, developed by the Institute. The analysis deals with the linkage of the report to the provincial vision of sustainable development, its content and preparation process, and the capacity of the Province to continue and improve reporting in the future.

Sommaire

L'accent mis sur le developpement durable ainsi que sur le concept de l'écozone constitue une stratégie d'évaluation plus holistique et intégrée que les rapports sur l'État de l'environnement (RIE) consacrés individuellement à chaque pays à l'échelle internationale. Même si nombre d'initiatives du RIE font le lien entre les facteurs écologiques et socio-économiques, des efforts approfondis n'ont pas encore été déployés pour les intégrer dans le contexte du développement durable.

Le rapport RIE 1997 du Manitoba représente une formule intermédiaire entre le RIE et les rapports intégrés sur le développement durable. Même si une grande partie du rapport demeure axée essentiellement sur les conditions écologiques des six écozones du Manitoba, le chapitre consacré à l'écozone des Prairies du Manitoba traite dès le début les enjeux dans le contexte du développement durable. Les indicateurs du chapitre pilote ont été sélactionnés dans le cadre d'un processus itératif faisant appel à de multiples parties intéressées et qui couvre les quatre grandes catégories suivantes : ressources naturelles, capitaux constitués par l'homme, actifs communautaires et vie humaine.

Une attention particulière a été consacrée à des exemples d'indicateurs utilisés pour décrire les terres naturelles et les sites spéciaux du Manitoba, ce qui inclut les secteurs protégés, ainsi que l'incidence des activités de l'homme et de l'utilisation des terres sur leur état. Mettant à profit ces exemples, les auteurs du document analysent les questions suivantes :

* Comment préciser les éléments qu'il convient de mesurer
* Comment classer par ordre de priorité les enjeux du développement durable mis en évidenca
* Recherche de données afin de quantifier ces enjeux
* Données disponibles et solutions de remplacement (utilisation de données indirectes)
* Regroupement des indicateurs en indices et évaluation des tendances temporelles et géographiques

L'expérience tirée du projet est analysée en fonction des principes d'évaluation de Bellagio, qui ont été élaborés par l'Institut. L'analyse porte sur les liens entre le rapport, son contenu et son processus de préparation avec le maintien du développement durable au sein de la province, ainsi que la capacité de celle-ci de poursuivre et d'améliorer le compte rendu dans l'avenir.

MARINE AND FRESH WATER PROTECTED AREAS

STRATEGY TO ASSESS AND MONITOR LAKE AND STREAM ECOSYSTEM HEALTH IN NEW BRUNSWICK

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"A river is only as healthy as the valley through which it flows" - *H.B.N. Hynes, 1975.*

Abstract

A hierarchial classification system is suggested to understand what a stream or lake ecosystem should contain in the presence or absence of important human impacts. Limnological habitat, fish assemblage and socio-cultural categories provide an ecotrophic structure necessary for qualification of ecosystem type and for biomonitoring lakes, streams and stream reaches. The classification system objectively scores important ecological social use attributes using a simple rating system. Attributes are weighted according to their judged relative importance and a total numerical score (maximum 100) is determined.

Classification (1) requires the natural resources manager to objectively evaluate waters, (2) encourages environmental agencies to consolidate and share data, (3) priorizes waters for protection/restoration, and (4) indicates limiting factors for fish production and recreational use.

Sommaire

Un système de classification hiérarchique est proposé afin de préciser ce que doit renfermer un écosystème de cours d'eau ou de lac lorsque l'activité humaine a ou non des répercussions importantes. Les habitats limnologiques, les familles d'espèces de poissons et les catégories socioculturelles constituent une structure écotrophique nécessaire à la détermination du type d'écosystème ainsi qu'à la survie écologique des lacs, des cours d'eau et des tronçons de cours d'eau. Le système de classification effectue une cotation objective des caractéristiques importantes sur le plan de l'utilisation sociale écologique, en utilisant un système de cotation simple. Ces caractéristiques sont pondérées en fonction de l'importance relative qui leur est accordée et une note chiffrée globale (maximum 100) est fixée.

La classification 1) repose sur une évaluation objective des eaux par le gestionnaire des ressources naturelles; 2) incite les organismes environnementaux à regrouper et à échanger leurs données; 3) classe les eaux par ordre de priorité en matière de protection ou de remise en état; et 4) indique les facteurs limitatifs des usages récréatifs et de la production piscicole.

Executive Summary

An ecosystem classification and scoring strategy is proposed to assess and monitor waterbody environmental health and to (1) understand what a particular ecosystem should contain considering the presence or absence of human impacts, (2) determine the outcome of management activities (logging, stream improvement, etc.) And (3) suggest how ecosystem management for fisheries may be implemented.

Lakes encompass their own ecosystem within a valley segment. Stream reach ecosystems are contained within valley segments and are identified by breaks in channel slope, channel sideslopes, channel width, substrate composition, and/or afternoon summer temperature. Lake and stream reach ecosystems represent natural, ecological units with distinct aquafauna that require specific aquatic, land-use management and sampling practices within the drainage basin.

Ecological, fluvial, geomorphic and social principles require integration at the drainage basin or watershed level to appreciate how anthropogenic influence may fragment, simplify or degrade aquatic resources. The fishery biologist's water inventory approach is a sound approach to understand the spatial and temporal geomorphic and ecological status of riparian and aquatic systems. The biologist's land, fish and habitat inventories form the basis for ecosystem classification and scoring when coupled with public collaboration and geographic information system (GIS) technology.

Aquatic ecosystems are unlike terrestrial ecosystem, they do not account for discrete, geomorphological areas of the streams or lake continuum. A stream basin usually straddles several terrestrial ecoregions. Stream and lake ecosystems can only be recognized from "the bottom up" by inventorying aquatic habitat; land ecosystems are identified from "the top down" by drawing boundaries around areas with similar landscape characteristics, such as topography and vegetation. New Brunswick's ecosection and ecodistrict boundaries are, however, often useful when indicating valley segments, stream reaches, and water quality.

Stream reach and lake classifications are scored within four categories: fish assemblage and biomass, environmental features, land-use features and special features. Pristine and productive reaches are assigned high scores (maximum 100) whereas disturbed and/or naturally unproductive ecosystems are assigned lower scores. The scoring attributes utilized are often collected by environmental or fishery agencies involved in lake and stream inventory programs.

Atlantic salmon and brook trout (or where these species are not present, perch, pickerel or bass) are the most important indicators to assess environmental health of lakes and streams. Species presence and abundance attributes comprise up to 30 points of the 100 point scoring system. Stream reach environmental features include flows, substrate embeddedness, alkalinity, pool and riffle ratio and stream thermal stability and can also comprise up to 30 points. The most important land use features include angling quality, angler access, riparian buffer strip and industrial or agricultural impacts. There are four special features that must be considered when assessing the health of a stream reach: rare/unique/exceptionally-sized fish, exceptional habitat, fish biointegrity, and stocking status. Lake environmental features are scored differently than those for streams as their primary production supports most the biotic community present. Lake land use and special features utilized to score ecosystem health are similar to those for stream reaches.

Ecosystem health is exemplified by scoring for 12 stream reaches within four different valley segments to illustrate the scoring process; scores range from 14 to 98, depending on environmental and anthropogenic influences. Stream ecosystem reaches within a particular valley segment and with a similar temperature stratum (cold or cool) should be compared, managed and sampled in a similar manner. Four oligotrophic, mesotrophic and eutrophic lakes, within specific valley segments, are also scored to assess ecosystem health.

The major users, impactors and benefactors or stream basin resources, i.e., logging, mining, and agricultural interests, should be responsible for lake and stream inventories, monitoring programs, or associated costs. Organized basin interests, led by fisheries managers working with other resource agencies and community environmentalists, should understand and be involved in ecosystem health monitoring strategy. Only by working together can everyone understand how individual ecosystem health can be preserved or rehabilitated the next generation.

Introduction

This paper proposes a classification and scoring methodology to assess and monitor lake or stream reach ecosystem health using selected biogeochemistry and land use attributes. Resource management agencies and, in particular, the primary users or impactors of the stream basin, need to identify and monitor key features of lakes or stream reaches that indicate resource viability and aquatic resource integrity in protected areas as well as in other wilderness and non-wilderness aquatic systems. Ecosystem management entails the understanding, use and preservation of a stream basin's resources to meet peoples' needs while maintaining healthy ecosystems. Lakes encompass their own ecosystem. A stream reach ecosystem is defined as a section of a stream lying between breaks in channel slope, channel sideslopes, channel width, geology, and/or temperature change. Stream reaches contain distinct aquafauna. Ecosystem classification and scoring is intended to provide clear, objective criteria to assess ecological integrity and waterbody environmental health, and, in particular, an understanding of what an aquatic ecosystem should contain considering the presence or absence of human impacts.

The water classification and scoring method proposed considers the variability and health (condition) of habitat and fish for a stream reach or lake ecosystem within individual geomorphic valley segments. This allows a homogenous comparison of "waters" of similar size and their ecological linkages according to biogeoclimatic attributes at a site-specific level. From a management perspective, waters that are similar can be expected to respond to management and restoration efforts in a more predictable fashion. Similar waters or reaches within various valley segments also represent natural units on which to base management practices such as forest road construction, silvicultural and buffer strip applications, and angling regulations. Classifying and scoring similar waters assists resource managers in priorizing or ranking waterbodies, as well as in the selection of sampling and monitoring stations.

Many past assessment and management efforts have usually focused on site specific habitat rehabilitation or production enhancement techniques such as stocking. We must instead understand what happens upstream to cause the problem, as well as appreciate how natural or anthropogenic events within the water body and drainage basin affect downstream ecosystems.

Importance of Managing Aquatic Ecosystems

Only recently have streams become recognized as hierarchically organized ecosystems influenced by terrestrial settings (Hynes 1975) and within the longitudinal gradient of a river (Vannote 1980). Stream ecosystem diversity and connectivity was subsequently classified using biogeoclimatic attributes including valley slope, substrate, and channel patters by Frissell *et al.* (1986) and Cupp *et al.* (1989).

Management objectives to maintain ecosystems in a sustainable and nearly natural state are often compromised by man's use of the stream basin involving land, water, forest, and recreational activities. Understanding ecosystem components and their interaction is fundamental in evaluating the potential or realized impacts of man-made or natural impacts. Leopold's conservation ethic describes how we should manage an ecosystem: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 1949). Leopold's insight that an ecosystem was an assemblage of related physical, biological, and social (people) components and that each component should be used with regard to each other provides a universal ethic that "we must not abuse the ecosystems we are part of, but rather, reconcile with ecosystem functions and structures. "Our 21st century conservation ethic responsibility to future generations requires that we accurately identify our healthy and degraded ecosystems, monitoring their health, conserving them, and, where possible, rehabilitating integral components (Callicott 1991).

Need and Opportunity to Manage Watershed Systems

Many of our aquatic resource problems are caused by anthropogenic influences that fragment and simplify habitat, degrade water quality, introduce non-native competitors or predators and overexploit the fisheries. Ecological and social principles require integration on a broad geographic scale at the watershed level to understand and resolve these problems. Lake and stream ecosystem dynamics are coupled to fluvial geomorphic conditions; these conditions must be characterized if individual stream reaches or lakes are to be representatively identified and managed from a temporal and spatial perspective.

Encouragingly, government resource management agencies and watershed-based organizations, *e.g.*, the Miramichi Watershed Committee, Fundy Model Forest, and the St. Croix International Waterway Commission, are partnering to protect and manage lakes and streams and resolve resource use conflicts. New Brunswick is fortunate to have numerous aquatic ecosystems that require only "preventative management" to minimize fishery and habitat damage. Other ecosystems, especially those near urban, agricultural or industrial areas, have been degraded over the past 50 to 100 years. It is imperative to communicate to resource and public organizations and elected officials that watersheds requiring only preventative management should not be subjected to the rehabilitative management practices prescribed for degraded waters.

Fundamental to protected area and watershed resource management is a spatial and temporal inventory of geomorphic and environmental status of existing riparian and aquatic systems. This approach identifies resource physical structure supply and often indicates causes of habitat or fish population abundance or degradation. For example, many third or larger order streams possessed driving dams, had their channels straightened and woody debris removed from the 1800s until the 1960s. Aquatic habitat diversity was substantially reduced, but improvement can only be appreciated by thorough stream habitat inventories. The inventory approach led by fisheries biologists, involving inter-agency collaboration, should encourage active involvement in watershed management by private landowners, community groups, industry, anglers, and other conservation interests. Resource managers (biologists, hydrologists, foresters, geomorphologists, and landscape planners) need to integrate their work for mutual understanding and improved community group decision making. The Catamaran Brook research study (Cunjak, and Fundy Model Forest study are excellent examples of the need for various science disciplines required to understand the temporal and spatial dynamics of a stream system. New Brunswick is fortunate to possess an advanced GIS repository of spatial data, including hydrography, forestry, land use, elevation, and ecological classification layers. Moreover, federal and provincial environmental agencies, and some large landowners continue to collect temporal and spatial aquatic resource and riparian data for incorporation into the New Brunswick Aquatic Resources Data Warehouse (NBARDW) (Cowie 1996; Cowie and Hooper 1997). The purpose of the NBARDW is to facilitate the consolidation and exchange of aquatic resource information between all watershed management interests to collectively develop and apply drainage basin management prescriptions.

Classifying Watershed Components and Scoring Ecosystem Health

Classification is used by resource scientists and managers to organize and simplify information about ecological systems, *i.e.*, the complex linkages between fish communities, habitat and humans by grouping objects with similar attributes. This allows aquatic ecosystems to be compared and scored, identifying degraded unproductive to exceptional aquatic habitats.

The terrestrial setting of a drainage basin is closely linked to water body physical and chemical conditions (Leopold and Wolman 1957; Platts 1979; Hankin 1984; Kellerhals and Church 1989; Clarkson and Wilso, 1995) and fish distribution and abundance (Bisson *et al.* 1988; Morin and Naiman 1990). Many resource managers organize habitat components within watershed or drainage systems. A stream basin contains valley segments according to geomorphic similarities (Cupp 1989; Naiman *et al.* 1992) and valley segments contain stream reach or lake ecoregions (Whittier *et al.* 1988) containing similar geology, topography, and site conditions (Figure 1). Streams and lakes can be highly variable, but similar biotic communities often occupy similar ecosystem reaches. Ecosystem reaches are identified by temperature, geology and gradient features, entrance of larger tributaries, and substrate type. Stream reaches determine the physical structure for all aquatic habitat units (Hynes 1975; Kellerhals and Church 1989), such as pools, riffles and runs, and associated microhabitat features (Bisson *et al.* 1982; O'Neill and Abrahams 1987; Hawking *et al.* 1993).

Once a stream ecosystem reach or lake is identified and classified, key physical, chemical, biological, and social components can be scored, allowing resource managers and stakeholder interests to assess and monitor ecosystem health for the purposes of identifying.

- Biotic integrity
- exceptional, degraded or pristine waters
- whether resource management objectives are being met by a rehabilitative project
- limiting factors degrading the ecosystem and whether these warrant mitigation
- how land management practices are affecting, over time, habitat or fish assemblages
- inventory data gaps required for decision making
- whether fish productivity is near potential.

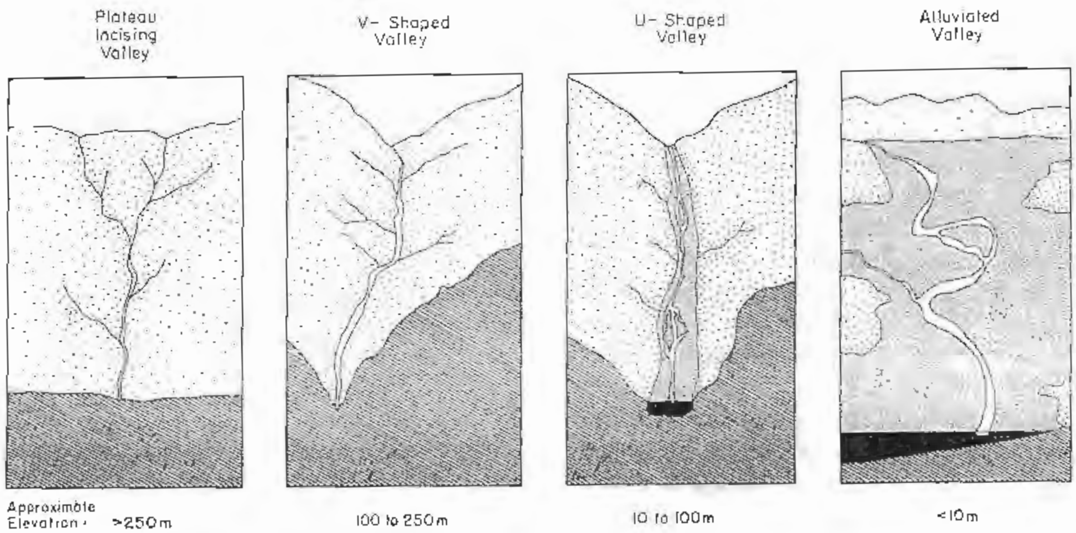

Figure 1. Valley segment types contained within a stream basin (modified from Cupp (1989) and Naiman *et al.* (1992).

Methods

Drainage Basin Hierarchy: Valley Segments, Reach Ecosystems and Habitat Types

The overview of stream basin ecosystem hierarchy presented in Figure 2 demonstrates the successively lower levels of habitat resolution in the drainage. Drainages, subdrainages, and streams and lakes in New Brunswick have been spatially identified with primary, stream water routes and stream orders digitized. Although topographic maps and aerial photographs can be utilized to determine stream basin boundaries and major elevation features, digital elevation data is now available to identify watercourse boundaries, valley segments, valley slope, stream gradient, and to perform *ad hoc* drainage area/discharge calculations (Table 1). Bedrock compositions have also been digitized, facilitating an understanding of the province's stream geology (Figure 3).

Four primary valley segment types are recognized within the drainage or stream basin: incising plateau, "V"-shaped, "U"-shaped, and alluviated (Figure 4). Each segment may contain two or more subsegments based on:

4. Valley bottom gradient (measured in length ca. 300 m or more)
5. sideslope or upland gradient (hill slopes within 200 m horizontal and 20 m vertical distance from the active channel)
6. valley bottom width to active channel width ratio
7. channel pattern
8. landform and geomorphic features.

Valley segments are identified prioi to field work from physical features including valley bottom and side slope geomorphological characteristics. These segments often account for lithology, climate, and land-use differences within the stream basin. Valley segments may or may not overlap New Brunswick terrestrial ecoregions that only partially recognize stream topography and lithology, but do recognize patterns in vegetation, soils, landforms, and land use. The Ecological and Land Classification System for New Brunswick (1996) provides "ecoregion", "ecodistrict", and "ecosection" digitized boundary layers that can be superimposed over the hydrography and topographic layers. Ecoregion boundaries often straddle several drainage basins and cannot be used to identify valley segments. Ecodistrict or ecosection boundaries may encompass or cross streams and often provide some indication of valley segments and may explain some environmental variation (Figure 5). Ecoregions do stratify landforms, vegetation and soil characteristics that exist across drainage basins that can be useful for sampling or monitoring studies or understanding stream water quality characteristics for example (Omernik and Griffith 1991). Hence both drainage basins and ecoregions should be employed to understand drainage landscape spatial patterns and develop management options. The primary problem with applying land ecoregions is that these ecoregions were developed by drawing boundaries around areas with similar landscape characteristics, but do not recognize discrete, geomorphological areas of the stream continuum and associated basin (Bryce and Clarke 1996).

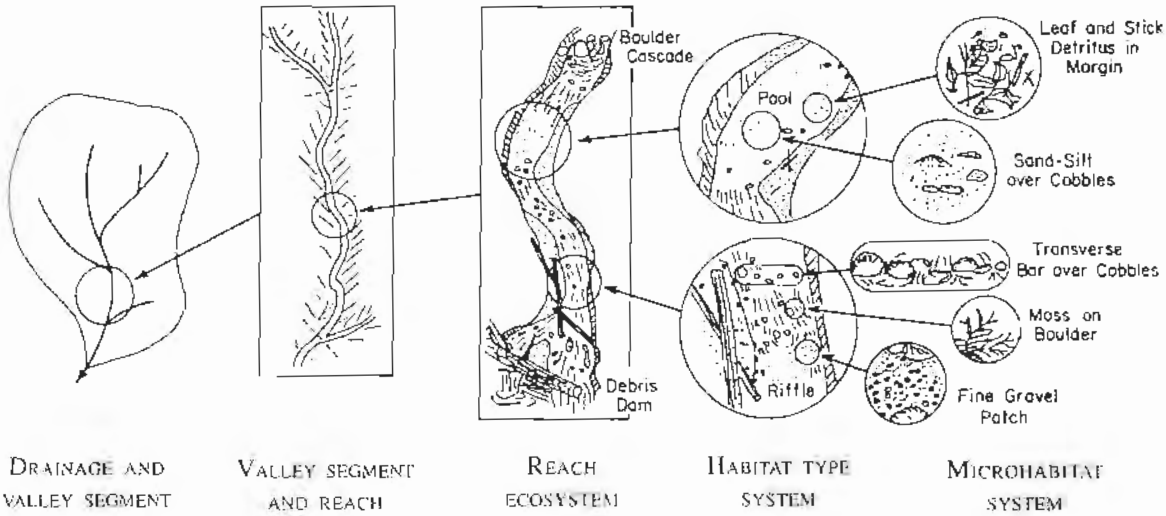

Figure 2. Hierarchical organization of a stream basin with an example of an ecosystem reach and associated habitat components (from Frissell et al. 1986).

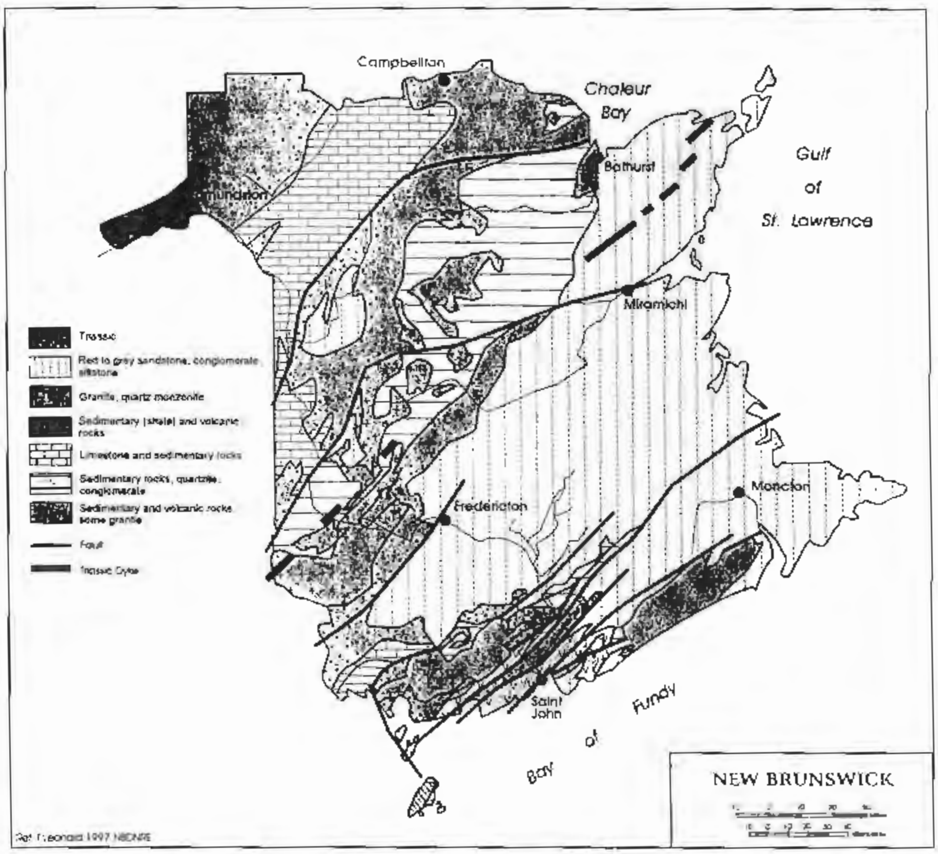

Figure 3. Bedrock geology of New Brunswick.

Table 1. Valley bottom and side slope characteristics utilized to identify valley segment types for six New Brunswick river reaches. Valley segments are distinguished by average channel gradient and valley form, adapted from Cupp (1989). Stream reaches or lake ecosystems are comparable within similar valley segments.

Valley Segment		Valley Bottom Gradient	Sideslope Gradient	Valley Bottom to Active Channel Width Ratio	Channel Pattern	Stream Orders	Landform and Geomorphic Features	Typical Valley Segment	Bedrock Geology
Type	Code								
Plateau Incising Valley	P_1	<3%	<10%	1-2x	Moderately constrained low sinuosity	1-3	Incised into flat or gently sloping landscape; narrow active floodplains	Upper Big Salmon River above Scholes Dam	Precambrian (volcanic and granite rock)
V-Shaped Valley	V_1	>5%	10-30%	<2x	Constrained	>2	Deeply incised drainage with steep sideslope	Rocky Brook (Jacquet River tributary)	Silurian - Devonian (silt stone and volcanic rocks)
	V_2	3-11%	70%'	<2x	Highly Constrained	>2	Canyon-like stream corridors with bedrock outcrops; stair-steped profile	Nepisiguit River below Grand Falls	Sedimentary and volcanic rocks
	V_3	1-5%	30-50%	<2x	Constrained	>2	Deeply incised drainage with steep sideslopes; pronounced stair-step characteristics	Lower SW. Miramichi below Baily Bridge to Lower North Branch Lower SW Miramichi	Silurian - Devonian (granite rock)
	V_4 Alluviated Mountain Valley	1-4%	<10-30%	<2-4x	Occasionally constrained high sinuosity, side channels, braided	>4	Deeply incised drainage with relatively wide floodplain	Middle Restigouche from Patapedia confluence to Upsalquitch confluence	Upper Devonian (limestone
U-shaped Valley	U_1	1-5%	>5% increase to 30%	>2x	Unconstrained by rock and boulders; occasional braiding	3-5	Drainage way in mid to upper watershed with history of glaciation	SW Miramichi from Taxis River to Cains River confluence	Upper Devonian (sandstone, siltstone)
Alluviated	A_1 (lowland valley)	<2%	<5%	>5x	Unconstrained sinous	Any	Wide floodplain within flat gentle rollinglowland landforms	Lower Kennebecasis	Upper Devonian (sandstone)

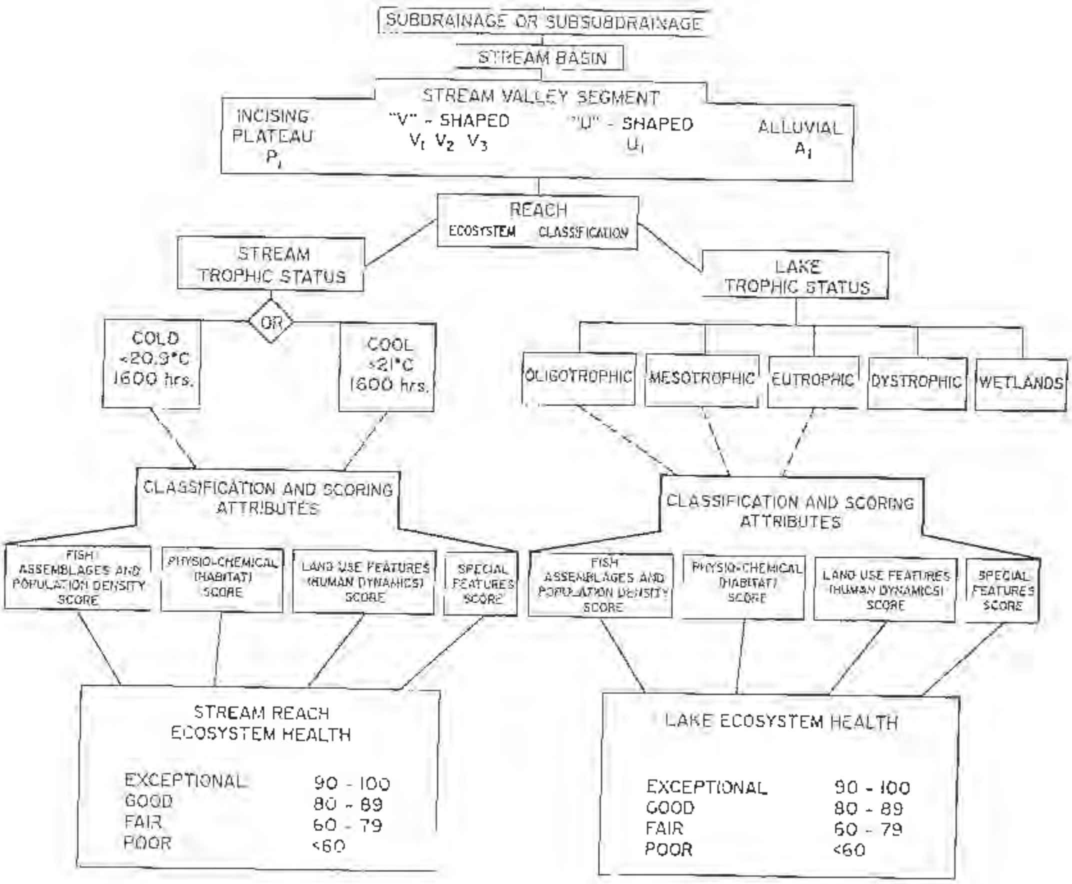

Figure 4. Overview of stream and lake ecosystem reach classification and associated scoring system within a drainage basin's valley segments.

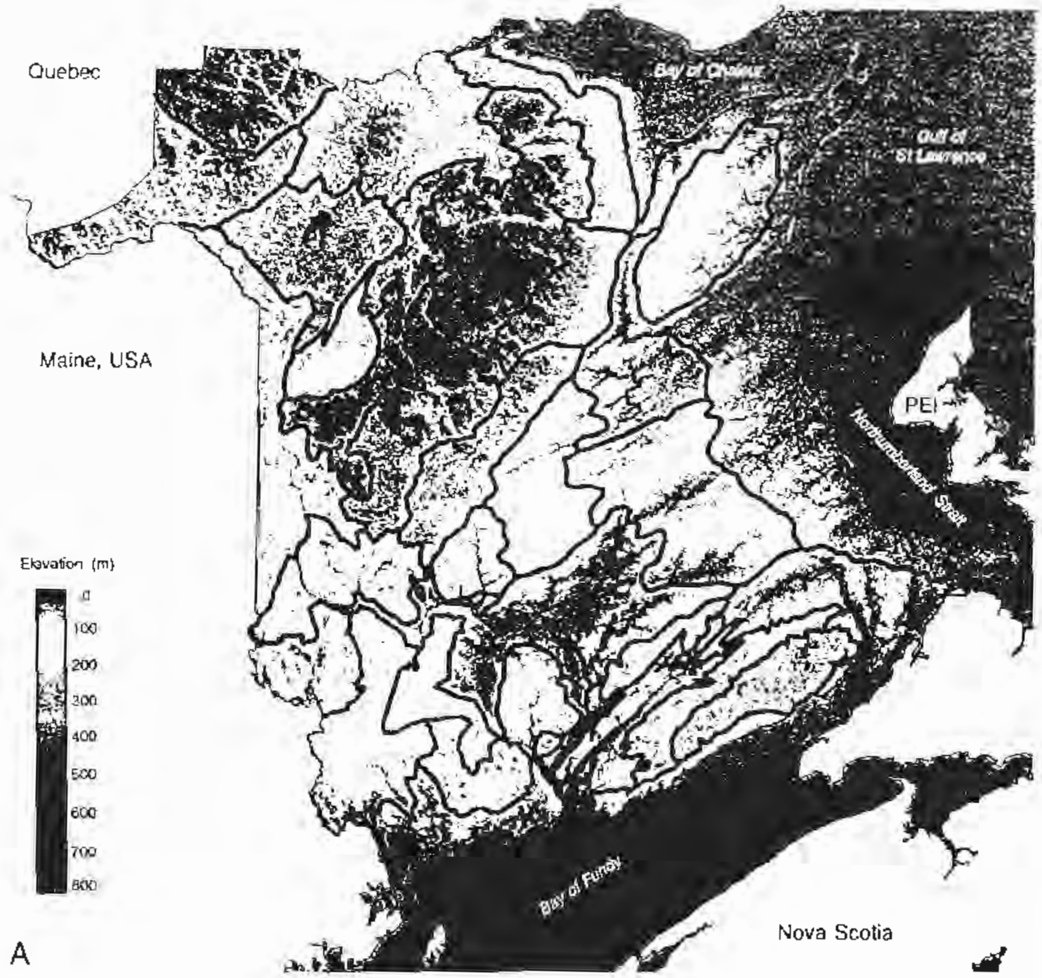

Figure 5. Elevation map of New Brunswick with terrestrial ecoregion and ecodistrict boundaries.

There may be one or more stream reach ecosystems within a valley segment. A reach ecosystem can only be determined through a field survey that identifies common in-channel features (*e.g.*, gradient, elevation, lithology, and discharge) controlling the physical state of the stream (*e.g.*, temperature, depth, substrate composition and embeddedness, and velocity); these components influence the character of biotic resources (Naiman *et al.* 1992; Nelson *et al.* 1992). Briefly, stream ecosystem reaches are defined by stream habitat characteristics that are relatively homogeneous and fit into the geomorphic structure of the valley segment. Stream order may identify a reach, particularly if there is a substantial temperature, gradient or substrate change. A stream reach is defined as a stream section lying between breaks in channel slope, sideslopes, channel width, substrate composition, and having either cold (<21°C) or cool afternoon temperatures. Stream and lake ecosystems represent natural, ecological units with distinct aquafauna that require specific sampling protocols and management prescriptions. Stream individual reach ecosystems are an integrated continuum influenced by riparian interactions that occur throughout the drainage basin (Figure 6). Lakes are considered an individual reach ecosystem within a particular valley segment

Habitat units within the ecosystem reach are the next spatial boundary components within the stream basin hierarchy. Field surveys identify and locate pool/riffle/run/rapid and other habitat unit types as well as microhabitat attributes within the habitat units (Appendix A). Hooper et al. (1996) provide habitat unit inventory methodology as well as habitat unit analysis. Hankin (1984), Hankin and Reeves (1988), and Dolloff *et al.* (1997) suggest how stream sections (ecosystems) should be sampled according to natural habitat units to estimate total numbers of fish.

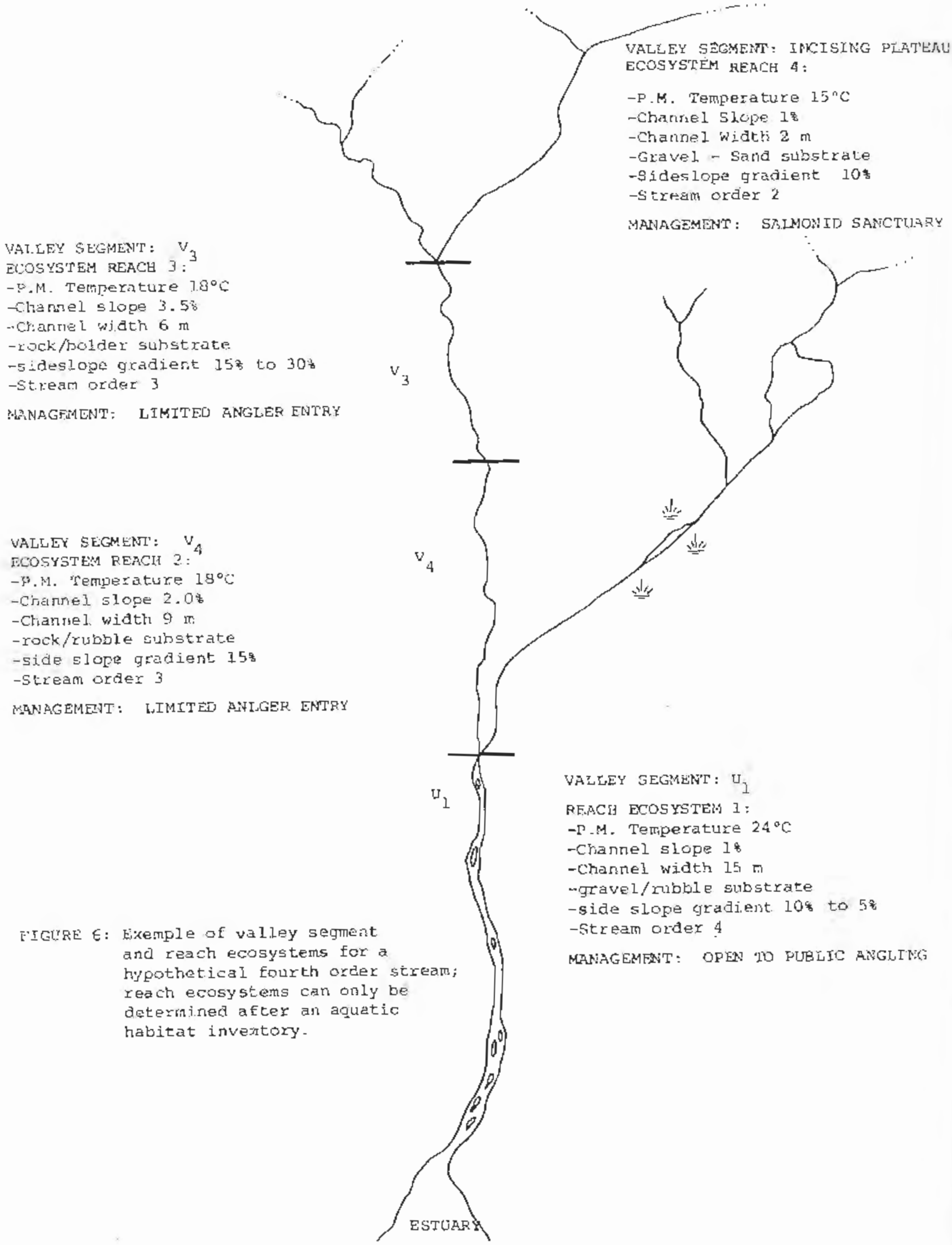

Figure 6. Example of valley segment and reach ecosystems for a hypothetical fourth-order stream; reach ecosystems can only be determined after an aquatic habitat inventory.

Cool and Cold Ecosystem Classification

Afternoon stream reach temperatures or lake thermal stratification dictate cold or cool ecosystem classification and usually species assemblages and fishery management strategy.

Two stream (cold and cool) and five lake (oligotrophic, mesotrophic, eutrophic, dystrophic, and wetlands) primary ecosystem classifications are recognized within the valley segment types (Figure 6). Dystrophic (shallow, acid bog) lakes and wetland lakes are not included in this ecosystem scoring strategy, as wildlife classifications are more appropriate to describe and assess ecosystem health and condition. Coldwater streams with substantial groundwater inflows or high elevation streams with extensive overhanging vegetation tend to remain cold during the summer months. Cool-water streams with little groundwater inflow or lower elevations with overhanging vegetation often have afternoon temperatures near ambient air temperatures. Coldwater streams are those where the afternoon daily maximum water temperature during the warm summer months does not exceed 20.9°C (Stoneman and Jones 1996). Cassie (1998) presents data for 11 New Brunswick streams that support this cold and cool ecosystem classification where the maximum recorded summer temperature is less than 21°C for only 3 streams; brook trout are known to thrive in these "cold" streams, but are not abundant in the eight warmer or "cool" streams identified. Only marginal brook trout populations should be expected in stream ecosystems where summer temperatures exceed 20°C (*e.g.*, Elson 1942; Barton *et al.* 1985; Meisner 1990). Marginal streams, with an afternoon summer temperature of 21°C + 1°C, are the most vulnerable to land-use impacts; they may require more intensive or special monitoring practices. Atlantic salmon can tolerate cold, but prefer cool water environments. Trout species and/or Atlantic salmon are present in most New Brunswick streams and can usually be used as indicator species for cold and cool water habitats; they are remarkably versatile fish behaviorally and physiologically, with a broad genetic repertoire favoring adaptation to a broad range of physical circumstances (Thorpe 1994). Slimy sculpins, blacknose dace, and lake chub are also potential indicator species for cold and cool ecosystems. Bass, pickerel, perch, and various minnow species have a low tolerance to cold water environment.

Lake bottom temperatures exceeding 18°C during summer usually preclude trout or salmon presence, instead favoring cool-water species.

Scoring Ecosystem Attributes

There are numerous differences in the biotic and abiotic structure between streams and lakes (Ryder and Pesendorfer 1989). Streams, particularly headwater streams, are heterotrophic, depending on allochthonous detritus as sources of energy. Lakes are autotrophic, their primary production supporting most of the biotic community present. Stream reach environmental features, because of their close association with the terrestrial environment and inherent trophic variety, require a somewhat different scoring approach than lake environmental features.

Management biologists have collected extensive physical, chemical, and biological data for lakes, but have less information for streams. Lake and stream attributes important to waterbody classification are cited and reviewed in the literature (*e.g.*, Bisson *et al.* 1982; Busch and Sly 1992; Naiman 1992; Born *et al.* 1990; Hubert *et al.* 1996). I have selected key aquatic resource, riparian, and land use attributes to identify ecosystem health from literature cited and from habitat and fishery data sets for New Brunswick waters surveyed by the New Brunswick Department of Natural Resources & Energy and Fisheries & Oceans Canada. Sample stream reaches and lakes have also been scored to demonstrate the classification and scoring strategy to determine ecosystem health.

Stream reach and lake classifications are scored within four categories: fish assemblages and biomass, environmental features, land use, and special features (Tables 2 and 3). The natural and land use attributes selected for scoring were selected to reflect ecosystem health, relative productivity, and land use disturbances. Pristine and productive reach ecosystems have high scores whereas disturbed and/or naturally unproductive ecosystems have low scores due to limiting factors identified by the scoring system. Some waters may be naturally unproductive for aquatic biota, *e.g.*, low alkalinity streams with low gradient. The species assemblages, environmental features, and land use features selected to score ecosystem health should reflect whether waters are naturally unproductive or are degraded for anthropogenic reasons.

The attributes selected for scoring are routinely collected by most environmental or fishery agencies through lake and stream inventory or monitoring programs. Resource managers may find the scoring system directly applicable to familiar waterbodies where background data is available, thereby requiring little additional field data collection.

Table 2. Attributes used to score stream reach ecosystem health within a specified valley segment; cold (<20°C) and cool (>20°C) reaches are considered separate ecosystem types.

Stream Attributes	Points	Maximum Score
1. Fish Assemblages and Biomass		
% Wild salmonids	10	30
% Cool-water non-salmonids	10	
Salmonid biomass in riffle areas	10	
2. Environmental Features		
Flow	5	30
Channel width discharge	5	
Substrate sedimentation	5	
Total alkalinity	5	
Pool : riffle ratio	5	
Afternoon temperature stability	5	
3. Land Use Features		
Angling	5	20
Angler access	5	
Riparian buffer	5	
Agriculture/mining/industrial discharge	5	
4. Special Features		
Rarity/uniqueness/exceptional fish or stock	5	20
Exceptional habitat feature or adult sanctuary	5	
Fish biointegrity intact	5	
No stocking	5	
Potential Score		100

Table 3. Lake attributes to score lake ecosystem health within a specified valley segment; lake scoring is comparable only for similar lake trophic status within a similar valley segment.

Lake Attributes	Points	Maximum Score
1. Fish Assemblages		
Primary piscivors -		
wild salmonids and/or bass or pickerel	10	30
% Perch or suckers in biomass	10	
Salmonid/bass/pickerel biomass	10	
2. Environmental Features		
Discovered oxygen at bottom #18EC	5	20
Dissolved oxygen at mid-depth	5	
Alkalinity (total)	5	
Water level fluctuation	5	
3. Land Use Features		
Angling quality	5	20
Angler access	5	
Riparian buffers	5	
Agriculture/mining/industrial impacts	5	
4. Special Features		
Rarity/scarcity/uniqueness/exceptional fish	5	30
Exceptional habitat	5	
Fish biointegrity intact	10	
No stocking required	10	
Potential Score		100

Stream Reach Ecosystems

1. Fish Assemblage/Biomass (Table 5)

Wild salmonid presence and biomass are the most important indicators in identifying the environmental health of streams (Born *et al.* 1990; Lyons and Wang 1996; Faush *et al.* 1990). Slimy sculpins, blacknose dace, and lake chub are also possible cool and cold stream indicators, but are not sensitive to angling impacts. These species, especially sculpins, could be considered as indicators of stream health for small first- and second-order streams that do not contain salmonids during summer base flows. Atlantic salmon and/or trout species inhabit most New Brunswick cold and cool streams and are, together or separately, excellent indicators of environmental health. The Atlantic salmon's temperature tolerance and density-dependent behavior (Allen 1969; Grant and Kramer 1990) result in widespread habitat utilization throughout cold or cool stream reaches, making the fish an especially good indicator species. The presence and relative abundance of Atlantic salmon juveniles in proportion to other cool water species indicates ecosystem health and the well-being of this very important game fish. Fish assemblage and salmonid biomass attributes can score up to 30 points where salmonids predominate and biomass is considered high. A mark and recapture or removal population estimate or single electrofishing pass in a 50-m riffle section(s) should be used to measure fish assemblage and biomass. Measurements should be performed in riffle habitat types, the preferred habitat for juvenile salmonids. Fish assemblage or biomass capacity alone cannot explain ecosystem health since environmental and land use factors are also integrated ecosystem components.

Table 5. Fish assemblage and biomass criteria and scoring range to evaluate health of a stream reach ecosystem

1. Fish Assemblage and Biomass (riffle areas)	**Scoring Range**		
	Good 10	**Fair 5**	**Poor 0**
% Wild salmonids	60-100%	11-59%	<10%
% Biomass of cool-water non-salmonids *(e.g.,* dace, chub, suckers) excluding sculpins	0-10%	11-22%	23-100%
Salmonid biomass or	>3 g/m^2	0.5 - 2.9 g/m^2	<0.5 g/m^2
Salmonids per 50 m or	>30	36461	<10
Salmonids per $100m^2$	>70	20-69	<20
Potential Score	30 points		

2. Environmental Features (Table 6)

Stream reach flows unmodified by anthropogenic factors receive maximum score whereas modified flows receive a lesser score (Table 6). Stream reach width-discharge relationship receives a maximum score if the bankfull channel width and mean annual stream flows within riffle habitat types are within the range of most Canadian rivers (Kellerhals and Church 1989) (Appendix B). The bankfull width is the distance between the edges of the floodplains or, for more entrenched channels, the width is measured between the scoured channel banks where rooted vegetation begins (Newbury *et al.* 1997). Stream channels may be too wide or too narrow (due to sedimentation) due to flow regulation. Substrate sedimentation in riffle areas should be less than 10% (Chapman 1988; Weaver and Fraley 1993) for salmonid species to spawn successfully. Streams flowing through sandstone bedrocks are especially susceptible to siltation from easily erodible slopes and associated low stream gradient that tend to retain sediments. Salmonid production is usually ... and environmental forces. *e.g.*, stream warming and floods. A high pool to riffle ration (≥0.70:1) throughout a stream reach receives maximum points.

Table 6. Environmental features and scoring ranges suggested to evaluate health of a stream reach ecosystem

Environmental Features	**Scoring Range**		
	Good 5	**Fair 3**	**Poor 0**
Row modification	None	Modified flow, excessive runoff, habitat loss, fluctuating flows due to anthropogenic factors, downstream recruitment loss over dams	Migration bottle-neck, dams, major habitat loss
$W = 4.5\ Q^{0.5}$ Channel width-discharge relationship	Normal	<10%	>10%
Substrate embeddedness (riffle areas)	<10%	11-19%	>20%
Total alkalinity (mg/L)	>20 m/100 mg/L	4-19 mg/L	4 mg/L
Pool : riffle ration	>0.70 : 1	0.40 : 1 - 0.69 : 1	<0.49 : 1
Stream thermal stability @ 1600 h on warm summer days	% always cold or cool	Marginal (21° + 1° C) cool or cold stream	Cold stream has degraded to marginal or cool stream
Potential Score	30 points		

Land Use Features (Table 7)

Human activities within the basin usually determine the health and sustainability of aquatic resources within a stream reach or a lake. Angling overexploitation, agricultural, mining or other industrial impacts all have potential to detrimentally affect fish populations and ecosystem habitat. Ideally, stream reaches should support a sustainable recreational fishery and contain aesthetically pleasing riparian buffers to non-logging interests.

Logging activities, in particular, can potentially alter stream reach or lake landscape components that affect fish habitat as well as food chains upon which fish depend. Adequate forest buffer strips are key to ensure logging does not degrade water temperature, bank vegetation and stability, suspended solids, fine and coarse woody debris contributions, channel morphology, substrate sediments, stream bed stability, nutrient inputs, and stream flows. For example, stream channels are profoundly influenced by the addition of large woody debris that provides variable channel habitat and flow conditions depending on the size and gradient of a stream (Keller and Swanson 1979). Stream slopes within sandstone regions are especially vulnerable to erosion by logging practices; full buffer strips are required to top of the stream valley to prevent stream siltation. Ideally full buffer strips should be retained to the top of all stream valleys to ensure against erosion, and provide wildlife corridors and riparian species well being. Stream reaches without a forested riparian zone are especially vulnerable to agriculture or urban damage. Mining or other industrial activities within the reach or valley sideslopes also can have substantial impact on the aquatic community by degrading water quality and flows, especially where the bedrock is composed of sandstone.

Table 7. Land use features and scoring range used to evaluate environmental health of a reach in a stream ecosystem.

3. Land Use Features	Scoring Range		
	Good 5	Fair 3	Poor 0
Angling Quality	Sustainable wild sport	Angling disappointing	Little or no angling
Angler access	Full or limited or closed	Difficult or uncertain access or reach provides public socio-economic benefits	None
riparian buffer strip	Streams immediate sideslope has uncut buffers	Riparian sideslope buffer has been partially logged outside of 30 or 60 m buffer adjacent to the floodplain channel where the slideslope is <25% and bedrock is not sandstaone	Logging within the 30 or 60 m of the floodplain channel or within the stream valley segment with sandstone bedrock geology
Agriculture, mining impacts; industrial discharge	No landscape impact	Minimum impact but potential to ocur	Inappropriately controlled; detrimental effect to stream environment
Potential Score	20 points		

4. Special Features (Table 8)

Rare, unique or exceptionally sized wild fish (*e.g.*, abundance of three sea-winter Atlantic salmon in the Kedgwick River) receive special feature points. Points are also given to stream reaches where exceptional habitat, *e.g.*, a large, cold-water holding pool or natural or regulated adult sanctuaries, exists and where native fish biointegrity is intact, *i.e.*, non-native species have not been introduced. Stream reaches where no stocking is required receive special feature points as hatchery fish stocking is not required.

Lake Ecosystems

Lake ecosystems are only comparable where lakes are within common valley segments, i.e., elevation areas where climate determines lake thermal stratification patterns and surface temperature and hence the presence or absence of indicator salmonids or cool-water species. As with streams, lake ecosystem evaluation, comparison or sampling strategy is possible only within a particular valley segment.

Oligotrophic lakes are deep and have complete thermal stratification during summer. They can be expected to have different fish assemblages than mesotrophic (shallower, partially thermally stratified) lakes or eutrophic (unstratified) lakes that are shallow and rarely thermally stratified. Eutrophic lakes at higher elevations ($250 m) usually contain trout populations, whereas lower elevation lakes contain primarily cool-water species such as bass, perch or pickerel. Oligotrophic and some mesotrophic lakes are capable of supporting cold or cool-water fish species regardless of elevation or climate.

Table 8. Special features that benefit the environmental health of a stream reach

4. Special Features	Scoring (Bonus Points)
Rarity/uniqueness/exceptional sized fish or stock	5
Exceptional habitat feature or sanctuary/homing area for adult salmonids	5
Fish biointegrity intact	5
No stocking required	5
Potential Score	20

1. Fish Assemblage /Biomass (Table 9)

Species assemblages favoring recognized game fish (salmonids and/or smallmouth bass or chain pickerel) identify lakes with good ecosystem health and conservation potential. Perch and/or sucker populations are undesirable species in New Brunswick and, at present, are of little social or economic value to humans, the exception being a few lakes where perch growth is good to exceptional. A few lakes support only white or yellow perch as game fish; fish assemblage/biomass for these lakes should be scored similarly as for salmonid, bass or pickerel lakes.

Lakes containing biomasses ≥10 kg/ha of salmonids, pickerel or bass are scored highest. Since many New Brunswick lakes do not have facilities for salmonid natural reproduction, but have facilities for good salmonid growth and survival, stocked fish populations are included in assemblage and biomass ratings.

Table 9. Fish assemblages and biomass criteria to score the health of a lake ecosystem

1. Fish Assemblage	Scoring Range		
	Good 10	Fair 5	Poor 0
Primary piscivors - salmonids and/or bass/pickerel	60-100%	11-59%	<10%
% Biomass composed of sunfish/perch and/or suckers	0%	1-19%	>20%
Salmonids or bass/pickerel biomas	>10 kg/ha	2-9.9 kg/ha	2 kg/ha
Potential Score	30 points		

2. Environmental Features (Table 10)

Lake bottom and mid-depth dissolved oxygen concentrations at ≥6 mg/L at temperatures ≤18EC are key attributes that determine whether abundant salmonid populations are possible. Pickerel and bass populations are also more abundant during the summer months in cooler lakes. As with streams, higher total alkalinity values are correlated with higher salmonid production (Ryder 1965). Lakes influenced by limestone bedrock areas have highest alkalinities. Water fluctuations, *e.g.*, reservoir drawdowns, are detrimental to fish and other aquatic production and sustainability; lakes without fluctuations receive highest scores.

Table 10. Environmental features scoring range utilized to evaluate a lake ecosystem

1. Environmental Features	**Scoring Range**		
	Good 5	**Fair 3**	**Poor 0**
Bottom oxygen if temperature is<18° C	>6 mg/L	3.0-5.9 mg/L	<3.0 mg/L
Mid-depth oxygen if temperature is <18° C	>6 mg/L	3.0-5.9 mg/L	<3.5 mg/L
Total alkalinity	>20 mg/L	4-19 mg/L	4 mg/L
Water level fluctuations	None	0.3-0.6 m	>0.6 m
Total Potential Score	20 points		

3. **Land Use Features** (Table 11)

Lakes with wild, sustainable sport fisheries are scored highest; stocked lakes are assigned a lower score because they are expensive to manage. Lakes with little or no angling receive a zero score.

Lakes with full or limited public access or closed to all angling are scored highest as are lakes that provide indirect public benefits from outfitting or operate as guest lodges. Lakes with difficult or uncertain access include those that have public water but only private access or remote lakes. Riparian buffer strips provide important supplies of woody debris to lakes for fish shelter and invertebrate shelter and food. Forest harvesting within the buffer or campsite shoreline development can minimize woody debris recruitment to the lakes and hence reduce aquatic resource production; where this occurs, a lower score is assigned. Moreover, buffer zones are important to preserve ground water recharge and discharge zones associated with trout spawning and incubation habitats in lakes (Curry and Devito 1996). Lakes are especially vulnerable to agricultural or industrial discharge impacts due to their long water retention time. Lakes within stream basins that supply no discharge impacts receive the highest score, whereas lakes receiving agricultural or industrial impact or potential for impacts receive a lesser score.

Table 11. Land use features and scoring range utilized to evaluate lake ecosystem health

3. Land Use Features	Scoring Range		
	Good 5	Fair 3	Poor 0
Anglingfishery sustainable	Sustainable wild sport fishery	Angling supported by supplemental stocking	Little or no angling
Angler access	Full or limited or closed	Difficult or uncertain access due to remote streams or access to Crown waters via private lands	None
Riparian buffer strip	Uncut, natural buffers around the lake basin or, full buffer maintenance for the lake basin area that supplies groundwater to trout spawning areas	lakes with a 60-m buffer strip that has not been logged	Lakes with less than a 60-m buffer strip or with a 60-m buffer strip that has been selectively cut
Agriculture or industrial discharge impacts	No landscape impact	Minimum impact but potential to ocur	Inappropriately controlled; adversely affects fish or fish habitat
Potential Score	20 points		

4. Special Features (Table 12)

Rare or unique fish (*e.g.*, Arctic char) and/or exceptional habitat (*e.g.*, a thermally stratified eutrophic lake) are included as special feature points to lake scoring (Table 12). Lakes containing their original fish assemblages (unless stocked through an approved management program) receive higher scores as their natural biointegrity has been maintained. Lakes that do not require stocking receive scoring points due to their self-sustainability and non-reliance on hatchery stocking.

Table 12. Special features that help define the environmental health of a lake ecosystem.

4. Special Features	Scoring
Exceptional size or rare/unique game fish	5
Exceptional habitat	5
Fish biointegrity intact	10
No stocking required	10
Potential Score	30 points

Scoring Ecosystem Health: Example Application (Table 13).

Once the stream reach or lake ecosystem has been identified within a valley segment, it can be identified as having exceptional, good, fair or poor ecosystem health.

1. Stream Reach Ecosystems

Three reach ecosystems are scored for each of four valley segment types (Table 13). The North Branch Southwest Miramichi has an ecosystem rating of 96, an exceptional health rating; only low alkalinity and substrate sedimentation are identified as limiting. Conversely, Upper Forty Mile Brook has a very low rating of 14; this stream is perhaps the Province's most polluted stream from mining activities near its headwaters. The Right Hand Branch Green River has an ecosystem rating of 75; this stream has a salmonid biomass limitation, a fish migration bottleneck downstream, disappointing angling and insufficient shoreline buffers.

Within the "V" shaped valley segment, the lower Rocky Brook (Miramichi) reach has a rating 88. This stream has a unique early run of Atlantic salmon. Angling access is difficult and the stream pool : riffle ratio is less than 0.49:1. The Upper Patapedia (N.B.) Has an exceptional rating of 98; angling access is difficult. The lower Serpentine reach has only a fair rating of 55; key limiting factors to ecosystem health include low salmonid biomass, flow regulation, marginal afternoon temperatures and poor angling quality. Management strategies to improve salmonid biomass and ensure controlled flows are required. The mid-Tabusintac reach is within a "V"-shaped alluvial valley; this reach has some limiting aquatic habitat features, but overall exhibits good environmental health. Past logging practices and forest fires have slightly degraded habitat in the stream reach which is very vulnerable to sedimentation problems given the sandstone bedrock type. This reach is a natural sanctuary area for adult sea-run trout and excellent habitat conditions for salmon juveniles.

The lower Bartholomew River is within a "U"-shaped valley segment. This reach has only a fair ecosystem health rating of 68. Aquatic habitat features could be improved by allowing the riparian buffer zone to regenerate to decrease marginal water temperatures and siltation. The lower Mamozekel has good ecosystem health (83) that could be further improved if riparian buffer strips were improved and siltation/embeddedness controlled.

The mid-Pokemouche reach has an exceptional ecosystem health rating of 98. The stream is especially vulnerable to siltation from land use practices given the region's sandstone bedrock formation. The lower Big Hole Brook reach has a salmonid biomass limitation, marginal cool-cold temperature and substrate embeddedness. As well, angling is disappointing and the shoreline buffers are inadequate due to fields and residential properties. The lower Kennebecasis River reach is deficient in salmonid biomass, has moderate substrate embeddedness, and has inadequate riparian buffers. Agriculture practices in the stream's upper and lower reaches adversely impacts on aquatic habitat. In the lower reach, angling is generally disappointing on this stream reach.

Table 13. Example of scoring aquatic ecosystem attributes to determine environmental health of a stream reach

Reach Temp. Type	Reach	FISH ASSEMBLAGES			ENVIRONMENTAL FEATURES						SOCIO-CULTURAL FEATURES				SPECIAL FEATURES				
		% Wild Salmonid	% Coolwater non-salmonids except sculpins	Salmonid Biomass	Flow	Channel Width to Discharge	Substrate Sediment	Total Alkalinity	Pool-Riffle Ratio	P.M. Temp.	Angling	Angling Access	Shoreline Buffer	Industrial Discharge	Rare, Exceptional Fish	Rare Habitat	Fish Integrity	No Stocking Required	Total Score
Incising Plateau Valley																			
Cold	North Branch S.W. Miramichi	10	10	10	5	5	3	3	5	5	5	5	5	5	5	5	5	5	96
Cool	Upper 40 Mile Brook	0	0	0	0	0	0	0	3	3	0	3	5	0	0	0	0	0	14
Cold	Upper R.H. branch Green River	10	10	5	3	5	3	5	5	3	3	5	3	5	0	0	5	5	75
"V" Shaped Valley																			
Cold	Lower Rocky Brook	10	10	10	5	5	5	5	3	5	5	3	5	5	5	0	5	5	88
Cold	Upper Patapedia - N.B.	10	10	10	5	5	5	5	5	3	5	3	5	5	5	5	5	5	96
Cool	Lower Serpentine	10	10	5	0	3	3	3	3	3	0	5	5	5	5	0	0	0	55
Cool	Mid-Tabusintac	10	10	10	5	3	0	5	3	3	5	5	5	5	5	0	5	5	84
"U" Shaped Valley																			
Cool	Lower Bartholomew	10	10	5	5	5	3	3	5	3	3	3	3	5	0	0	5	0	69
Cold	Lower Mamozeakle	10	10	10	5	5	0	5	5	5	5	5	3	5	0	0	5	5	83
Alluvial Valley																			
Cold	Mid Pokemouche	10	10	10	5	5	3	5	5	5	5	5	5	5	5	5	5	5	98
Cold	Lower big Hole Brook	10	10	5	5	5	3	3	5	3	3	5	3	3	0	0	0	0	63
Cool	Lower Kennebecasis	10	10	5	5	5	3	5	5	3	3	5	3	3	5	0	0	0	70

Stream Ecosystem Health Rating

Exceptional	90-100	(maintain conservation strategies)
Good	80-90	(continue management strategy, improvements may be possible)
Fair	60-79	(improve management strategy unless naturally unproductive waters)
Poor	<60	(Re-engineer management strategy)

2. Lake Ecosystems (Table 14)

Four oligotrophic lakes are assessed for ecosystem health: Big Nictau, Seven Mile (a reservoir), States, and Walton (Table 14). Big Nictau is scored 72, having been overfished since the mid-1970s, its low salmonid biomass providing disappointing angling (Hooper 1995). Water level fluctuations could also be mitigated by removal of the outlet dam debris. Seven Mile Lake, like Big Nictau, has a high biomass of perch and suckers. The lake's thermocline is a summer refuge for a sustaining brook trout population. Seven Mile has generally unsatisfactory environmental features including low dissolved oxygen, low alkalinity, and substantial water level fluctuation and is scored only 58. States Lake has ideal environmental health; in particular, this classically oligotrophic lake has unusually large salmonids including lake trout. Walton Lake, scored only 76, has a low salmonid biomass, only fair environmental features. Regenerative stocking may be required to prevent Arctic char extinction and to improve brook trout populations to an acceptable biomass.

Bolton Lake is a mesotrophic lake that contains a small brook trout biomass, but a large biomass of white perch and smallmouth bass (introduced species). Bolton's ecosystem health score is 69,but due to the lake's size and introduced species, it is unlikely management efforts could improve its score. California Lake's ecosystem limitations include riparian buffer and native fish biointegrity, but it has other ecosystem attributes and has a good health rating of 80. Killarney and Davidson Lakes ecosystems have been extensively modified by human activity and hence receive low health scores of 26 and 28, respectively. Douglas Lake has fair ecosystem health because of its healthy brown trout population, which is also considered a unique species, although introduced, in New Brunswick.

Eutrophic lake examples include Catamaran, Gulquac, Pabineau, and Wild Goose. Catamaran is an exceptional lake, scoring 86, given its fish assemblage and biomass as well as exceptional, thermally stratified habitat. Gulquac Lake has sufficient elevation to support a brook trout population, but perch and sucker populations and angling exploitation preclude brook trout presence. Gulquac Lake has insufficient dissolved oxygen, inadequate buffers, and requires stocking to maintain an angling fishery; ecosystem health score is only 33. Similarly, Pabineau Lake and Wild Goose Lake do not have a self-sustaining salmonid population and, like Gulquac, require stocking to generate angling. Pabineau Lake ecosystem health could be improved from 59 to 70 (fair) if regulations were implemented to allow only hook and release angling of stocked fish and if the riparian buffer were enhanced. Wild Goose Lake's score could be increased from 33 to at least 60 by annual stocking of salmonids (given its high elevation) or, if feasible, a sucker/perch reclamation program followed by regenerative or put-grow-and-take stocking.

Table 14. Example of scoring aquatic ecosystem attributes to determine environmental health for lakes

Lake	FISH ASSEMBLAGES			ENVIRONMENTAL FEATURES				LAND USE FEATURES				SPECIAL FEATURES				
	%Primary Piscivors	%Perch or Suckers biomass	Salmonid/Bass /Pickerel Biomass	Botom Oxygen at ≤18°C	Mid-depth Oxygen	Total Alkalinity	Water Level Fluct.	Angling Quality	Angling Access	Riparian Buffer.	Indust. Discharge	Rare Fish	Habitat Exceptional	Fish Bio. Integrity.	No Stocking Required	TOTAL
OLIGOTROPHIC TYPE																
Big Nictau	10	0	5	3	5	5	3	5	5	5	5	0	5	0	0	53
Seven Mill	10	0	5	0	5	0	0	5	3	5	5	0	0	10	10	59
States	10	10	10	5	5	5	5	5	5	5	5	5	5	10	10	100
Walton	10	10	0	3	5	3	3	5	5	5	5	5	5	10	0	76
MESOTROPHIC TYPE																
Bolton	0	0	0	3	5	3	5	5	5	5	5	0	0	0	10	46
California	10	10	10	3	5	5	5	5	5	5	5	0	5	0	10	83
Killarney	0	0	0	3	5	3	5	3	5	3	5	0	0	0	0	29
Davidson	0	0	5	3	5	0	5	0	5	3	5	0	0	0	70	31
Douglas	10	10	5	0	5	5	3	5	3	3	5	5	0	0	10	66
EUTROPHIC TYPE																
Catamaran	10	10	5	5	5	3	5	5	5	5	5	0	5	10	10	89
Gulquac	0	0	0	0	5	3	5	3	5	5	5	0	0	10	0	38
Pabineau	10	10	0	0	5	3	5	3	5	3	5	0	0	0	0	43
Wild Goose	0	0	0	0	5	5	3	0	5	5	5	0	0	10	0	38

Lake Ecosystem Health Rating:

Exceptional	90-100	(maintain conservation strategies)
Good	80-90	(continue present management strategy, improvements may be possible)
Fair	60-79	(improve management strategy unless naturally unproductive waters)
Poor	<60	(re-engineer management strategy)

Discussion

The classification system presented was designed to provide resource managers with an assessment and monitoring methodology for measuring stream reach and lake ecosystem health for conservation or ecosystem management. Productive states for lakes and streams are highly variable, with or without the influence of man's activities. It is therefore important to identify whether aquatic ecosystem scores are the result of natural or man-made attributes. Waters with high ecosystem scores should be preserved (*e.g.*, barring road building or avoiding timber harvest and road access) whereas waters with low scores caused by human activities should be the focus of management activities such as regulations, fish stocking, habitat rehabilitation, and public information-education-participation programs.

Once understood by resource stakeholders, the public and elected officials' ecosystem health assessment can be subsequently used as a monitoring tool to assess the improvement or degradation of a stream ecosystem reach or lake. Resource managers and resource users will have a benchmark to measure how well aquatic resources for all connected ecosystems are responding to natural and, in particular, human disturbance events within the stream basin. Wherever possible, stream basin residents and users have a similar goal: to provide and, where necessary, rehabilitate biotic and habitat resources in terrestrial and aquatic ecosystems for the present and next generation. The major users and impactors of stream basin resources, *i.e.*, logging, mining and agricultural interests, should be primarily responsible for collecting lake and stream inventory data, monitoring programs, and associated costs. Alternatively, Crown licensees and large private landowners should apply stumpage royalties in support of provincial government assessment and monitoring programs. Crown forest licensees and large private landowners need to recognize ecosystem complexity and connectivity working through an interdisciplinary team of biologists, hydrologists, and forest scientists. Fisheries, not forestry or stakeholder leadership is required for effective ecosystem management. Bryant (1995) has suggested a "pulsed" monitoring strategy to document ecosystem change or stability strategy involving a series of 3- to 5-year studies separated by longer periods (10-15 years) of reconnaissance data collecting. Once implemented and subjected to on-going management practices, ecosystem health assessments should become an important tool for resource decision making as well as for environmental impact studies.

Finally, users and benefactors of the watershed should consider a conservation fund to be used for preservation or rehabilitation of ecosystems within the watershed.

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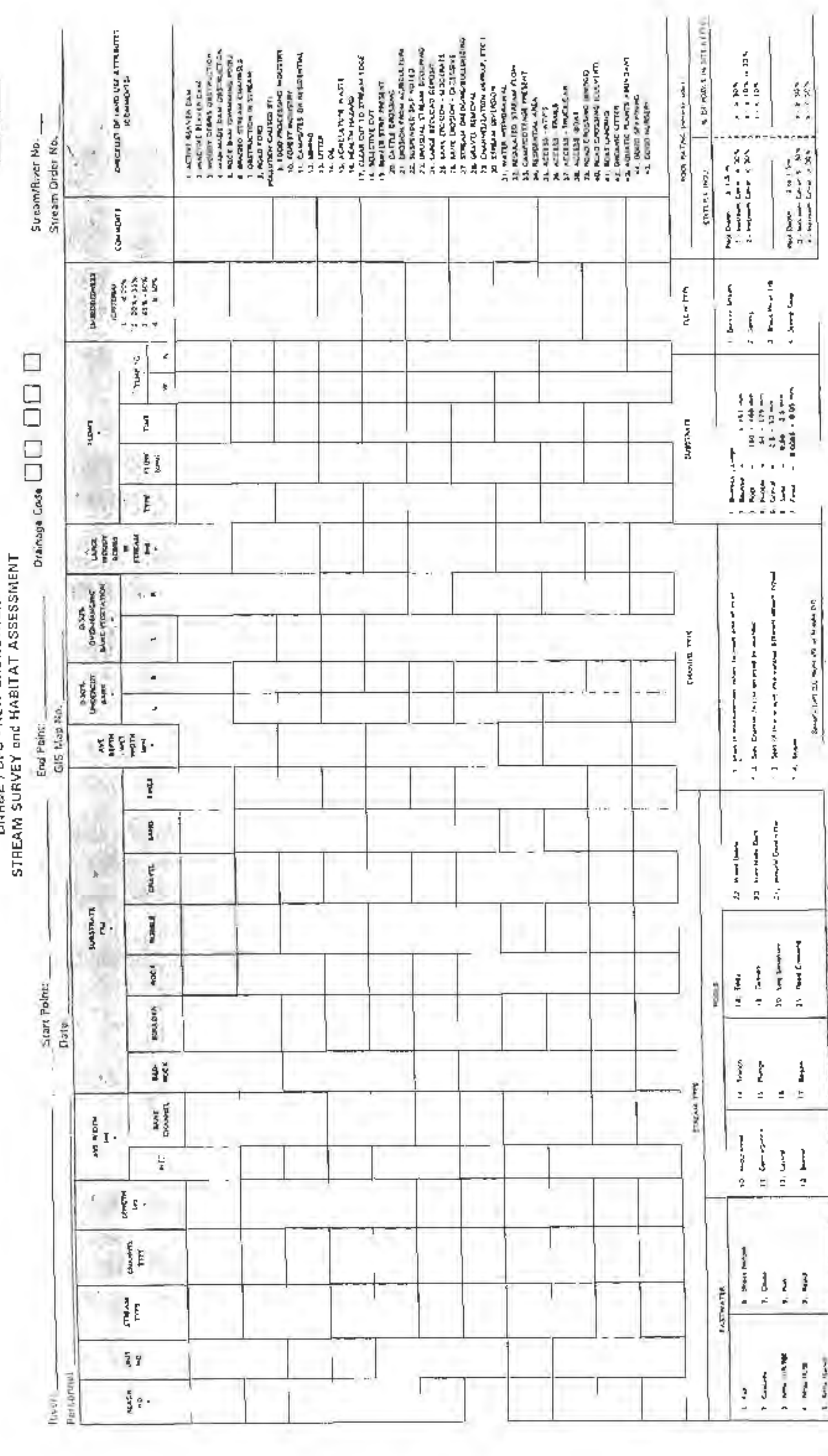
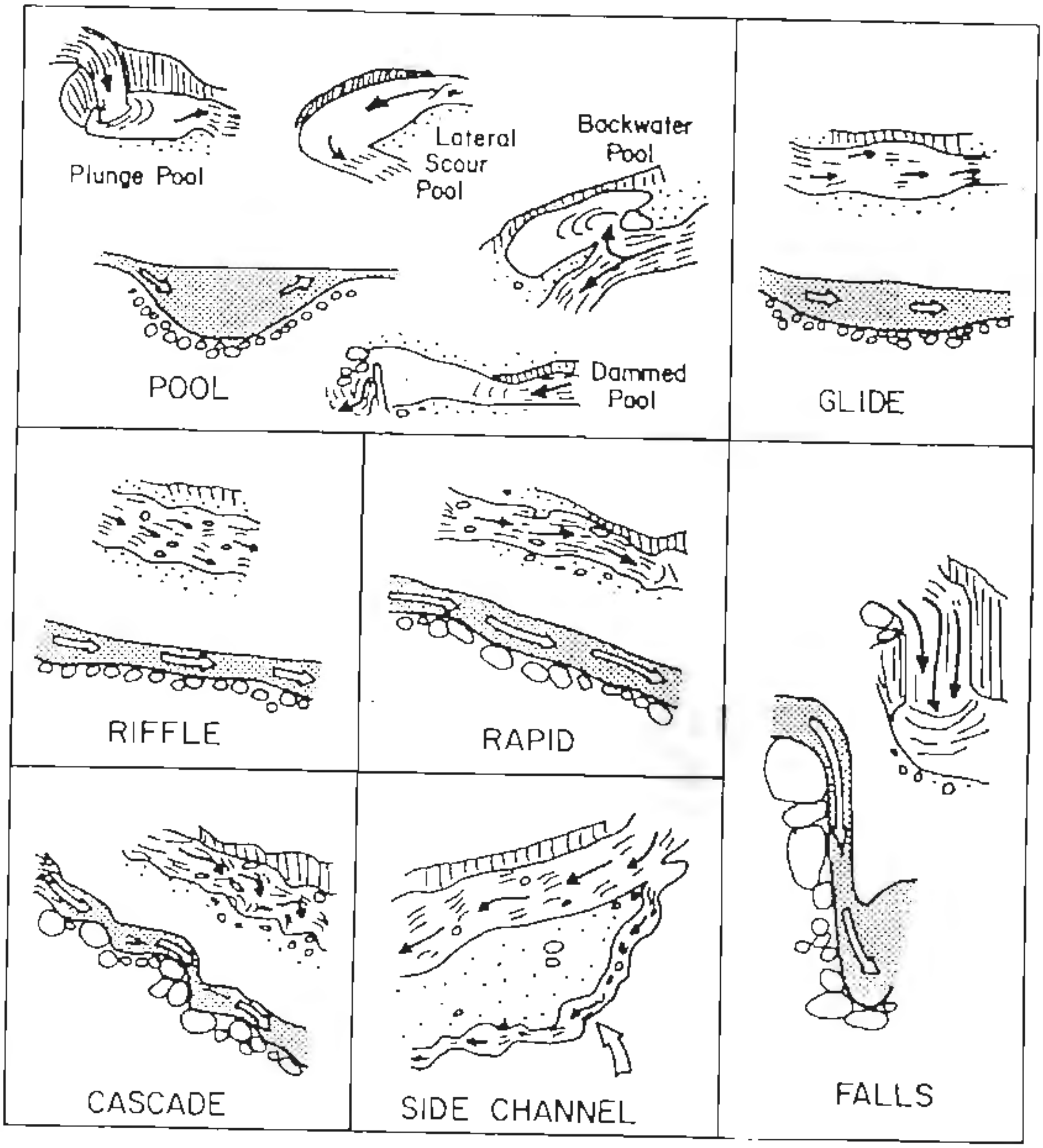
Appendix A

Physical, Chemical, and Land Use Attributes Measured for Each Habitat Unit Within A Stream Reach



DNR&E / DFO - NEW BRUNSWICK
STREAM SURVEY and HABITAT ASSESSMENT

River: ____ Personnel: ____ Start Point: ____ Date: ____ End Point: ____ GIS Map No. ____ Drainage Code □□ □□ □□ □ Stream/River No. ____ Stream Order No. ____ ___ of ___



Fundamental pool/riffle forms, reflecting bed topography. low water surface slope, hydrodynamic pattern and position in relation to the main channel. Longitudinal profile (*shaded*) and oblique views are shown. Modified from Bisson *et al.* (1982).

Appendix B

Relationship Between Bankfull Width and Discharge (Reproduced from Newbury *et al.* 1997)

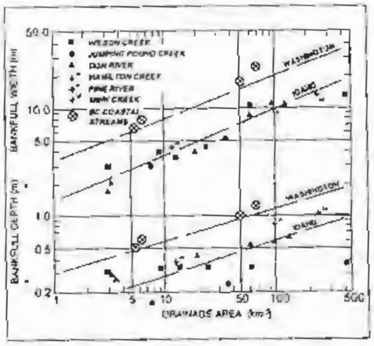


Figure 12-2 In regions with similar hydrologic regimes, the average bankfull width and depth are related to the drainage basin area in fluxvial channels. The points shown were derived from channel reference surveys in western Canada.

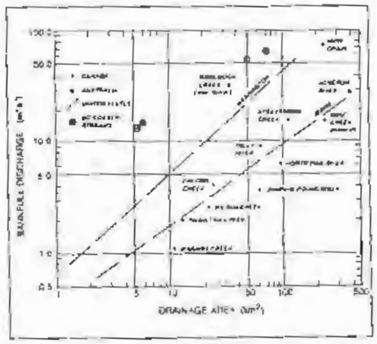


Figure 12-3 The bankfull channel discharge vs. drainage basin area relationship may be estimated from channel reference surveys using the survey data and a slope-velocity relationship such as Manning's equation (*Chow 1959*).

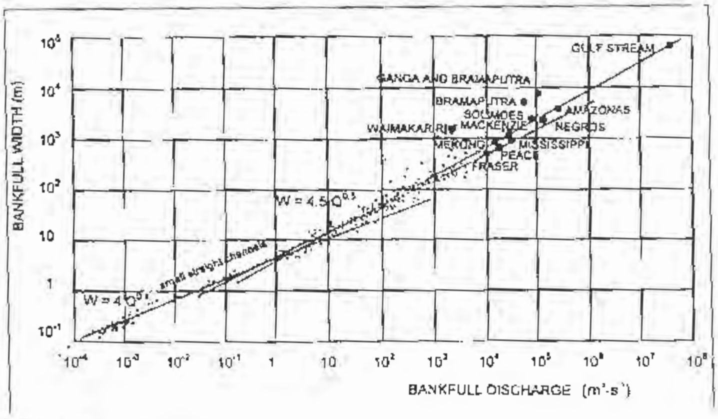


Figure 12-4 The relationship between bankfull width and discharge has been compiled for all ranges of river size by Kellerhals and Church (1989). For streams with bankfull discharges between 1 and 1,000 m^3 sec^{-1}, the relationship was estimated to be width = 4.5 bankfull discharge$^{0.5}$.

The **bankfull width** of the channel is used as the base unit for other plan and profile dimensions of the river (Fig. 12-5). The bankfull width is defined as the distance between the edges of the floodplains if they are present. In many channels that are entrenched, the equivalent width is obtained by measuring between the upper limits of the regularly scoured channel banks where rooted perennial vegetation begins.

TOWARDS A SCOTIAN COASTAL PLAIN BIOSPHERE RESERVE FOR SOUTHWESTERN NOVA SCOTIA

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Abstract

Canada has six functioning UNESCO/MAB biosphere reserves distributed from the Rocky Mountains to southern Quebec. There is a gap, however, in the Atlantic region. To correct this deficiency, we propose a cluster biosphere reserve be established in the coastal zone of southwestern Nova Scotia based upon an aggregate of existing protected sites. The proposed region is exceptionally well endowed with protected natural areas in all three of its constituent sub-zones (terrestrial, coastal, and marine). Forestry and fishing are the economic mainstays of the region, and thus these natural resource extractive industries would be the focus of the research in the proposed biosphere reserve. Development of the tourism potential of the region would also be an important undertaking. In this context. the designation of the town of Lunenburg as a UNESCO World Heritage Site greatly enhances this biosphere reserve proposal.

The existing terrestrial protected areas include Kejimkujik National Park, the Tobeatic Wilderness Area (and three other wilderness areas of the Nova Scotia systems plan of parks and protected areas), several nature reserves, and the Shelburne River which has recently been proclaimed as a Canadian Heritage River. Protected areas in the coastal zone include the Seaside Adjunct of Kejimkujik National Park, migratory bird sanctuaries, provincial parks, and several protected beaches. The existing marine conservation areas include two long-term fishery closures on offshore banks (Western/Emerald and Browns) and three whale sanctuaries (Grand Manan, Sable Island Gully, and Roseway Basin). An additional nearshore marine protected area in the vicinity of Port Joli is also proposed. In the terrestrial component of the proposed biosphere reserve, existing protected areas would comprise the core areas, provincial Crown land would form the buffer zones, and privately owned land would constitute the transition zone, or "area of cooperation". The concept of a buffer zone, however, is more difficult to apply in the marine environment.

Sommaire

Le Canada possède six réserves UNESCO/PHB en activité, qui sont réparties sur le territoire qui va des Rocheuses au sud du Québec. Toutefois, il n'en existe pas dans la région de l'Atlantique. Afin de corriger cette lacune, nous proposons la création d'une réserve de la biosphère constituée en fusionnant les sites protégés existants de la zone côtière du sud-ouest de la Nouvelle-Écosse. La région proposée est exceptionnellement riche en sites naturels protégés, dans les trois sous-zones qui la constituent (terrestre, côtière et maritime). La foresterie et la pêche constituent les principales activités économiques de la région et, de ce fait, les recherches relatives à la réserve de la biosphère proposée seront axées sur ces industries d'extraction des ressources. La mise en valeur du potentiel touristique de la région serait également importante. Dans ce contexte, la désignation de la ville de Lunenburg en tant que Site du patrimoine mondial de l'UNESCO accroît sensiblement l'intérêt de la proposition de réserve de la biosphère.

Les secteurs terrestres protégés existants incluent le parc national Kejimkujik, la zone naturelle Tobeatic (et trois autres zones naturelles du plan de parcs et de secteurs protégés des systèmes de la Nouvelle-Écosse), plusieurs réserves naturelles et la rivière Shelburne, qui a récemment été déclarée rivière du patrimoine canadien. Les secteurs protégés de la zone côtière incluent l'Annexe côtière du parc national Kejimkujik, les réserves naturelles d'oiseaux migrateurs, les parcs provinciaux et plusieurs plages protégées. Les secteurs de conservation maritimes existants incluent deux secteurs où la pêche est interdite à long terme sur les bancs situés au large (Western/Emerald et Browns) ainsi que trois réserves de baleines (Grand Manan, Gully de l'île de Sable et bassin Roseway). Un secteur maritime protégé supplémentaire situé à proximité du rivage près de Port Joli est également proposé. En ce qui trait à la composante terrestre de la réserve de biosphère proposée, les secteurs protégés existents

The UNESCO/MAB "people-in" approach to conservation is outlined in this paper and potential cooperating agencies and communities for our proposal are identified. Although further research is required before this proposal can be formally considered, its discussion among those living and working within the communities of southwestern Nova Scotia is considered a worthwhile step toward achieving sustainability. Since people living in the region have already experienced a wide range of habitat-based conservation tools, and have voluntarily encouraged the use of marine protected areas in fisheries management, the region is considered unusually well suited for research in sustainable living, for which the MAB biosphere reserve approach was designed.

It is proposed that the site be named the "Scotian Coastal Plain Biosphere Reserve" in recognition of the region's intrinsic natural and cultural connections between the land and the ocean. The coastal plain (the continental margin of North America) symbolizes this connection because it has long been subjected to changes in sea levels brought about by past glaciations. Places that are marine today, for example, were often terrestrial in the past. This seamless continuity between the land and the sea shapes not only the landscapes of Atlantic Canada, but its people. A representative biosphere reserve in this region should, therefore, reflect this deep-rooted connection with the ocean. The proposed Scotian Coastal Plain Biosphere Reserve would be a means of facilitating this goal.

comprendraient les secteurs centraux, les terres de la Couronne provinciales constitueraient les zones tampons et les boisés privés constitueraient la zone de transition ou « secteur de coopération ». Le concept de zone tampon, toutefois, est plus difficile à appliquer dans le contexte maritime.

La stratégie de conservation de l'UNESCO/PHB axée sur la participation des communautés est soulignée dans le présent document et les organismes et collectivités susceptibles de coopérer à notre proposition sont également précisés. Même si d'autres études devront être effectuées avant que cette proposition ne soit officiellement étudiée, on estime qu'en débattre avec les collectivités qui résident dans le sud-ouest de la Nouvelle-Écosse ou qui y travaillent constituerait un progrès sur la voie de l'objectif de durabilité. Étant donné que les personnes qui résident dans la région ont déjà fait l'expérience d'une vaste gamme d'outils de conservation axés sur les habitats et qu'elles ont volontairement prôné la création de zones de protection marine dans le cadre de la gestion des pêches, la région est considérée comme convenant particulièrement bien aux recherches sur la viabilité des espèces, pour laquelle la formule de réserve de la biosphère du PHB a été conçue.

Nous proposons que le site soit nommé « Réserve de la biosphère de la plaine côtière Scotian » compte tenu de l'interdépendance naturelle et culturelle intrinsèque entre les terres et l'océan dans la région. La plaine côtière (frange continentale de l'Amérique du Nord) symbolise cette interdépendance, étant donné la succession des changements du niveau de l'eau provoqués par les glaciations, depuis des temps très anciens. Par exemple, nombre de secteurs recouverts par la mer à l'heure actuelle étaient terrestres dans le passé. Cette continuité entre la terre et la mer façonne non seulement les paysages de l'Atlantique du Canada, mais également leurs populations. Une réserve de la biosphère représentative de cette région devrait donc refléter ces liens de dépendance profonds avec l'océan. La réserve de la biosphère de la plaine côtière Scotian proposée constituerait un outil susceptible de faciliter l'atteinte de cet objectif.

Introduction

The UNESCO biosphere reserve concept focuses on the idea that experiments in sustainable living are a necessary prerequisite for human adaptation to natural limits of growth, particularly in regions where local economies are dependent upon the development of natural resources. Although Atlantic Canada is just such a place, no biosphere reserve has yet been established in the region. The living resources of the ocean and the forests are central to Atlantic Canadian economies, providing the basis for a variety of industries related to marine fisheries, and to the harvesting of wood fiber. We have, therefore, examined the relevance and application of the biosphere reserve concept to Atlantic Canada and have explored how such a concept could integrate both the fishing and forestry sectors of the economy. The southwestern portion of Nova Scotia has been selected as the focus of our study.

In this paper we list and discuss the attributes that make southwestern Nova Scotia an excellent candidate for UNESCO biosphere reserve designation, and identify some of the likely partners in this conceived cooperative venture. We also recognize that tourism is a developing industry in the region, and we discuss briefly the role that a biosphere reserve would have in assisting the growth of this potentially sustainable industry.

UNESCO/MAB and Biosphere Reserves

The biosphere reserve concept was initiated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 1971 with the creation of the Man and the Biosphere (MAB) Programme (UNESCO 1984), and has been evolving ever since (Di Castri *et al.* 1981). MAB is an international endeavor that seeks to balance the conservation of biological diversity with the economic and cultural survival of local peoples (Batisse 1997; Laserre and Hadley 1997) by promoting the notion that man is an integral component of, and not isolated from, the natural world (Batisse 1982). A further intention of the MAB Programme is to develop models that demonstrate how to conserve the ecological integrity of a region, while still allowing for sustainable resource use, and to better understand the structure and function of the environment in which we all live (Herrmann 1990).

Biosphere reserves are multifunctional terrestrial, coastal, and/or marine geographical regions where the above objectives are developed, refined, and demonstrated. They are administered to facilitate conservation, research, education, and sustainable development through cooperative agreements between universities, governments, industry, and local communities (Batisse 1986). To date, 337 biosphere reserves in 85 countries have been officially established by UNESCO/MAB (Laserre and Hadley 1997) and many more are likely to be nominated in the near future (Agardy 1997). Together, they form the World Network of Biosphere Reserves (UNESCO 1996).

Biosphere Reserve Concept

The biosphere reserve concept is based upon three complementary roles: (1) *conservation* [protecting and maintaining landscapes, ecosystems, habitats, species, and genetic diversity], (2) *development* [fostering socio-culturally and ecologically sustainable economic development], and (3) *logistic* [providing an operational framework for research, monitoring, education, training, and exchange of information related to global, national, and local conservation and development issues] (Batisse 1986; UNESCO 1996).

In order to meet the global conservation objective, biosphere reserves are to be established in all 193 of the earth's terrestrial biogeographical provinces (von Droste 1988) to protect representative examples of the planet's unmodified natural ecosystems and landscapes (Dyer and Holland 1991). Furthermore, some biosphere reserves target areas of endemism, genetic richness, and unique natural features (UNESCO 1984). Since biosphere reserves are designed to contain a mosaic of undisturbed natural areas and those modified by human activities, these reserves are often ideal for studying the degree to which humans are altering the environment through resource extraction, and for measuring how natural spaces and ecological processes respond to anthropogenic perturbations of environmental regimes (von Droste 1988). Collaboration between peoples, organizations, and communities participating in the biosphere reserve, and between reserves themselves, is expected to lead to the emergence of sustainable management and economic development initiatives.

Biosphere Reserve Design

In order to facilitate conservation, research, education, and sustainable development, biosphere reserves are spatially divided into zones of varying degrees of anthropogenic disturbance, notably: core areas, buffer zones, and transition areas (see: Batisse 1986).

The core areas of a biosphere reserve promote the conservation role of UNESCO/MAB by protecting unmodified natural ecosystems and processes of significant ecological value. In essence, core areas conserve representative examples of landscapes and 'hotspots' of biodiversity, and are often established in pre-existing protected areas. These sites strictly control, and often prohibit, local anthropogenic stresses (Batisse 1982) often making them valuable areas for the collection of baseline scientific data for monitoring human impacts on a region (Herrmann 1990). The global system of biosphere reserves will therefore, in theory, facilitate global evaluation of human impacts on the biosphere (van Droste 1988).

Buffer zones surround the core areas to protect the most valuable ecological sites from environmental degradation (Wells and Brandon 1993) associated with human activities elsewhere within the biosphere reserve. These areas permit some low impact anthropogenic use, such as education, research, and tourism, but only if the ecological integrity of the core areas are not compromised by these activities (Kastenholz and Erdmann 1994).

The transition area, also known as the 'area of cooperation' (Batisse 1986) or 'zone of influence' (UNESCO 1984), is the region of the biosphere reserve that contains human settlements and allows for a wide range of anthropogenic activities. It is often vast in area, with no fixed outer boundary (Francis and Munro 1994), and will provide the opportunity for local landowners, communities, organizations, industry, and municipalities to participate in the functionings of the biosphere reserve (Agardy 1997). The purpose of the transition area is to develop sustainable resource management practices, and to promote local cooperation for sustainable livelihoods.

The idea of 'clustering' emerged at a joint USA-USSR Symposium on biosphere reserves and was endorsed by the MAB Programme in 1977 (Batisse 1986). Clustering occurs when a group of core areas and associated buffer zones are utilized within a single region identified as a biosphere reserve. This strategy has proven quite successful, especially in areas that have been highly fragmented by human activities. Efforts may be undertaken within a clustered biosphere reserve to plan for integrated conservation, such as connecting isolated core areas through wilderness corridors (von Droste 1988) to mitigate the ecological problems often associated with habitat fragmentation (Russell 1994). The 'cluster' approach is thought to be particularly appropriate when applying the biosphere reserve idea to a large geographical region (Francis 1993). It seems to be similarly ideal for application in the coastal zone, where the integration of management and conservation efforts in both terrestrial and marine environments introduces significant new challenges.

Coastal and Marine Biosphere Reserves

UNESCO/MAB has made the implementation of coastal biosphere reserves (including both terrestrial and marine components) one of its highest priorities (Batisse 1990). Given that two thirds of the world's population live along the coast, and that this zone is experiencing the highest rate of population growth (Agardy 1997), conservation within coastal areas requires our immediate attention. Unfortunately, establishing coastal biosphere reserves has proven to be a long, slow process (Ray and Gregg 1991). Slower still has been the promotion of conservation and sustainable development in the marine realm. Establishing marine biosphere reserves has been a particularly difficult undertaking because, until recently, the world's oceans have been considered so vast as to be beyond the human capacity to transform.

Difficulties

Effective marine protected areas tend to be more difficult to establish than their terrestrial counterparts because marine systems are often larger and more dynamic than those on land. Whereas most of the primary production on land comes from plants that are firmly rooted to the ground, most of the primary producers of the ocean realm are microscopic organisms that lie in the upper layer of the fluid water column and, therefore, move around with the ocean currents. The fluid nature of the marine environment poses a challenging dilemma for conserving oceanic resources.

Kenchington and Agardy (1990) refer to terrestrial protected areas as 'closed cells' and marine protected areas as 'open cells'. Marine areas are 'open' in that the fluid nature of the oceanic water column allows for relatively free exchange of nutrients, sediments, and pelagic species across the boundaries of a marine protected area. Even benthic communities can be linked to nutrient sources many kilometers away. Therefore, protecting a marine site by drawing a line on a two-dimensional map may not ensure the continued survival of the communities and processes targeted for conservation. There are, however, obvious exceptions to this rule. Marine protected areas can be effective tools for conserving sites such as coral reefs, deep sea vents, unique geologic features, narrow upwelling zones, marine mammal breeding sites, concentrations of benthic organisms, and communities of fish with strong attachments to specific sites.

Compounding the problem of conservation in coastal environments, terrestrial biologists have a tendency to forget the marine component of the coastal zone, while marine biologists often forget the terrestrial component (Batisse 1990). As a result, very few coastal protected areas conserve both the land and the sea. The MAB Programme recognizes this problem and is trying to overcome it by encouraging the creation of biosphere reserves that have both terrestrial and marine elements.

Strategies

The biosphere reserve concept is ideal for conserving marine systems because it promotes the notion of sustainable development for an entire region, rather than solely within a limited marine protected area. It also offers excellent opportunities to incorporate marine protected areas in fisheries management plans by involving whole coastal communities and their interests in planning processes. In many cases, a biosphere reserve offers the best viable starting point for conserving marine resources (Agardy 1997) because it promotes cooperation rather than exclusion.

In order to adapt the biosphere reserve design to marine and coastal environments, some special considerations are required. As Batisse (1990) outlined, the marine environment has two primary geographic components; the sea-floor and the water column. Although identifying an effective core area for the water column is difficult because of its fluid nature, creating one on the sea-floor to protect benthic communities is more feasible. Batisse (1990) has suggested that the water column above the sea floor core areas might be considered as a buffer zone or transition area in suitable circumstances. Alternatively, the water column above the sea floor site can be conveniently designated as a core area.

Generally, in order for a marine core area to be an effective conservation tool, it has to be much larger than its terrestrial equivalents to better accommodate the open nature of marine systems. 'Dynamic core areas' could also be used in places where complete exclusion of a human activity is not feasible, yet some level of enhanced conservation is desired (Agardy 1997). These dynamic core areas could provide seasonal protection, but still allow for some moderate, non-disruptive harvesting techniques at certain times of the year. Provisions could also be implemented to allow marine core areas to migrate as physical conditions within the ocean change over time (Batisse 1990). For example, as oceanic processes adjust or alter the geomorphologic landscape of the sea floor, a given core area could migrate in accordance with the movements of species requiring specific marine environmental conditions.

Kenchington and Agardy (1990) have proposed a variation on the standard biosphere reserve model. They suggest that since core areas might never entirely conserve *in situ* genetic diversity within the marine environment, because they would have to be impossibly large to do so, marine protected areas within the biosphere reserve should concentrate on the research role of the MAB Programme rather than the conservation role. The authors recommend the establishment of a series of 'reference sites'. These areas would serve as 'scientific reserves' and exclude all human activities that damage the marine environments contained within the ecological area. Baseline scientific data could then be gathered from a relatively undisturbed site, and compared to an intensively harvested one. to help us better understand how our fishing techniques alter marine ecosystems.

Biosphere Reserves in Canada

To date there are six established biosphere reserves in Canada, in addition to over twenty other areas that are currently being considered for designation (Birtch 1994). Although the existing biosphere reserves share the UNESCO/MAB label, they differ widely in character and management.

The two western biosphere reserves — Waterton Biosphere Reserve in Alberta and Riding Mountain Biosphere Reserve in Manitoba — are based on National Parks. The core and buffer areas are contained within the pre-existing protected areas and there is a flexible zone of cooperation in the surrounding rural municipalities (Roots 1989).

Moving east, the Long Point Biosphere Reserve in Ontario is based on a 32-km long sand spit on Lake Erie and includes a mosaic of different management areas, including two national wildlife areas, a provincial park, and a Ramsar site (Birtch 1994; Francis 1991). A second Ontario site is the Niagara Escarpment Biosphere Reserve. Located near Canada's largest city, and including the 105 parks of the Niagara Escarpment parks system, this biosphere reserve maintains a research focus on the pressure of human recreational activities on the natural environment (Birtch 1994; Canada/MAB 1990a).

With an area of only 5 500 hectares, Mont-Saint-Hilaire is Canada's smallest biosphere reserve. It is owned by McGill University and the nearly 500 publications resulting from its existence attest to its importance as a site for scientific research and monitoring activities (Canada/MAB 1997a). The Charlevoix Biosphere Reserve, east of Quebec city, is a multi-core biosphere reserve that has a locally-elected management board and a buffer zone that is home to approximately 30 000 people (Birtch 1994; Francis 1991; Canada/MAB 1990b).

Canadian biosphere reserves focus on a variety of issues and activities, including acid rain monitoring, forest ecology, human-wildlife interaction, farm management practices, private land stewardship, and visitor interpretation (Birtch 1994). Their activities are linked to each other, and to the international biosphere reserve network, by the Working Group on Biosphere Reserves; an organization of the Canadian national committee for MAB (otherwise known as Canada/MAB).

Although there are only six biosphere reserves in Canada thus far, Canada/MAB's National Action Plan has an objective to establish at least one biosphere reserve in each of Canada's fifteen biogeographical areas (Canada/MAB 1987). At present, nominations are being developed for two biosphere reserves in British Columbia - one in the Mount Arrowsmith area on the east coast of Vancouver Island (MABF 1997), and another in the Clayoquot Sound area (WCWC 1997). Plans are also underway in Nunavut to establish the coastal and marine Iqalirtuuq Biosphere Reserve in Isabella Bay. The successful designation of these proposed reserves will go some way towards achieving geographical representation in Canada. There remains, however, a large gap in Atlantic Canada.

Rationale for Selecting a Representative Biosphere Reserve in Atlantic Canada

Despite Atlantic Canada having landscape characteristics, outstanding values, and research communities compatible with the concept of the MAB programme, a biosphere reserve has yet to be established in this region. As we strongly believe that a biosphere reserve is greatly needed in this area, and as we feel this region can support just such a site, we looked for a sub-region that would be representative of Atlantic Canada as a whole, and that would also contain outstanding natural and cultural values, be dependent upon the exploitation of natural resources, have no large urban centers, and already be well supplied with terrestrial and marine protected areas.

The Atlantic region of Canada has several characteristic geographic and oceanographic features: an extensive coastline; forested interiors with plentiful lakes; thin soils often poorly suited to agriculture; and shallow, highly-productive marine shelves, mostly covered with sediments of glacial origin on offshore 'banks' (Davis and Browne 1997). A representative biosphere reserve in Atlantic Canada should contain all of these features.

Economically, ocean- and forest-related industries are significant in this region of Canada, with agriculture and manufacturing being less important than in many other parts of North America. There has been political pressure to diversify the region's economies, tourism being among the favored sectors for economic growth. For these reasons, a biosphere reserve in Atlantic Canada should be located in a region where forestry and fishing are economic mainstays and in which the development of tourism is feasible in the near future.

Since biosphere reserves are primarily concerned with the development of sustainable economies associated with the use of natural resources and conservation of ecological values (UNESCO 1984), the inclusion of an adequate amount of protected space is essential. Since conservation scientists have not agreed on the minimum quantity of protected spaces necessary to achieve sustainability (Noss and Cooperrider 1994), it is sensible to err on the side of caution, and thus a region with a relatively high proportion of space devoted to conservation should be considered more suitable for the establishment of an Atlantic Canada biosphere reserve than a region with a relatively low proportion.

Rationale for Selecting Southwestern Nova Scotia

Southwestern Nova Scotia meets all of the above criteria for the establishment of an Atlantic Canada biosphere reserve. It is representative of the region as a whole, contains outstanding natural and cultural values, is dependent upon the exploitation of natural resources from land and the sea, lacks a large urban center, and contains a relatively high concentration of terrestrial and marine protected areas.

In addition, Francis and Munro (1994) have already proposed that the region surrounding Kejimkujik National Park in southwestern Nova Scotia is a suitable candidate for a terrestrial biosphere reserve. This proposal was based upon the already existing concentration of research effort in the park (see: Drysdale 1995) and the importance of conserving rare coastal plain floral elements in the region. The good working relations between national park staff and several regional forest harvesting operatives (C. Drysdale, *pers. comm.*) is of additional benefit.

Kejimkujik National Park has two components, an interior forested park and a coastal 'adjunct', but there is not a marine element associated with the park. This is not a reason, however, to exclude the marine environment from an Atlantic Canada biosphere reserve proposal. The main reason for the lack of officially designated marine protected areas in this region, particularly at a distance from the shore (the 'offshore', as it is known locally), is that suitable legislation and policy for the establishment of marine protected areas was not in place in Canada until the passage of the Oceans Act in 1997 (DFO 1997). As shown below, however, fisheries regulations have been widely used in southwestern Nova Scotia to create fishery closed areas. There is, therefore, some precedent for considering conservation initiatives in the marine environment.

We, therefore, propose establishing a biosphere reserve in southwestern Nova Scotia that contains both terrestrial and marine elements. As is indicated in Figure 1, a Scotian Coastal Plain Biosphere Reserve could consist of a general wedge-shape, covering much of the terrestrial and marine environments of southwestern Nova Scotia, with two associated adjuncts; one near Sable Island and the other in the Bay of Fundy.

Existing Terrestrial Protected Areas

There is a remarkable concentration of terrestrial protected areas in southwestern Nova Scotia (see Fig. 2). Kejimkujik National Park is the most visited of these sites, but the largest protected area is the Tobeatic Wilderness Area lying adjacent to the national park. The Tobeatic is one of four wilderness areas in this region that have been slated for conservation through Nova Scotia's Systems Plan of Parks and Protected Areas (NSDNR 1994). The other three sites are Tidney River, Lake Rossignol, and Bowers Meadows Wilderness Areas. There are three nature reserves in the area that are officially protected under Nova Scotia's Special Places Protection Act — Sporting Lake, Ponhook Lake, and Tusket River-Wilsons Lake Nature Reserves — and several more are to be designated in the near future. In 1997 the Shelburne River was proclaimed under the Canadian Heritage Rivers programme when cooperative agreements were reached between governmental agencies and the forest harvesting company, Bowater-Mersey (DNR 1996). A list of terrestrial protected areas in the region is presented in Table 1.

Depending upon where a putative outer boundary of the proposed Scotian Coastal Plain Biosphere Reserve is drawn, approximately 25-30% of the region is already legally protected. An additional 30-35% of the land is in provincial Crown ownership, thereby making it easier to establish buffer zones and to reach cooperative agreements with companies that lease large forest harvest blocks from the government, than if the land was entirely privately held. This relatively high proportion of Crown land is especially important for this proposal because much of the rest of Nova Scotia is privately owned. Ideally, the existing protected areas would become core areas, Crown land would constitute buffer zones and corridors, while private land would predominantly form the transitional area of the terrestrial components of the Scotian Coastal Plain Biosphere Reserve.

Existing Protected Areas in the Coastal Zone

While the geographical area protected is not as great as in the fully terrestrial zone, there is a similarly large concentration of protected areas along the coast. In addition to the 'Seaside Adjunct' of Kejimkujik National Park, there are several provincial parks and protected beaches in the region (see Table 1 and Fig. 2). These are protected primarily for their amenity value and include Thomas Raddall, Summerville Beach, and Rissers Beach provincial parks. Several others, however, are protected for conservation purposes; most notably, a series of four migratory bird sanctuaries near Port Joli intended to provide feeding and rest stops for waterfowl migrating along the Atlantic flyway.

Existing Fishery Closures and Marine Conservation Initiatives

Under the Fisheries Act, regions of the ocean within Canada's exclusive economic zone may be closed to activities, such as dredging, that threaten to damage commercial fisheries, or degrade natural habitats (see: Shackell and Lien 1995). While these provisions have generally been used only after impacts on fisheries have been drastic, experimental fishery closures have been used on occasion in the past. Of special interest here is that the two largest long-term closures on the Scotian Shelf lie within the fishery management zones in the offshore regions of southwestern Nova Scotia (see Fig. 1). Generally speaking, the fishery for cod and haddock in the Northwest Atlantic Fisheries Organization (NAFO) sub-area 4X (within the boundaries of the proposed biosphere reserve) is often considered a model for the Nova Scotian fishery because it remained open to commercial fishing in the mid 1990s (albeit with reduced quotas) while other regions were closed to most fisheries.

The fishery closure on Emerald and Western Banks (NAFO sub-area 4W), known as the 'haddock box', has been in effect for over t10 years, with almost all types of fishing gear now excluded. It was put in place in 1987 because surveys showed that the by-catch of juvenile haddock was consistently high, which has been interpreted to indicate that it may be a possible nursery area for this important commercial groundfish species (Nancy Shackell, *pers. comm.*).

The Brown's Bank haddock box is closed to fishing between February 1 and June 15 during the haddock spawning season (K. Zwannenberg, *pers. comm.*). This legal closure was initiated at the request of fishermen in the region. The same general area is also closed to lobster fishing for conservation purposes. There is support among many local fishermen for these closures, there being a general belief that the measures are proving to be an effective conservation tool for groundfish and lobster stocks (B. Giroux, *pers. comm.*).

In addition to marine conservation measures established for commercial species in southwestern Nova Scotia, there are three whale sanctuaries in the general marine region, protected only through notices to mariners. Their locations are indicated in Figure 1. The Roseway Basin and Grand Manan sanctuaries are intended to protect Right whales (Brown *et al.* 1995), while that in the Gully was established to protect the threatened northern bottlenose whales (Faucher and Whitehead 1995).

Features of Outstanding Value

Southwestern Nova Scotia contains numerous outstanding values of national and international significance. These features, in addition to the representative and practical reasons described above, make the region ideal for the establishment of a biosphere reserve.

Southwestern Nova Scotia contains a disjunct population of rare coastal plain flora, separated from the mainland eastern seaboard population by the Bay of Fundy. These plant species embody evolutionary adaptations that allow them to survive in nutrient-poor, highly stressed, freshwater shoreline areas, where they cannot be competitively excluded by faster growing shrub species (Wisheu and Keddy 1994). The floral elements typically thrive in areas of intense ice scour, strong wave activity, and fluctuating water levels (Hill and Keddy 1992). Nova Scotia harbors endemic and globally rare coastal plain species, such as *Euthamia galetorum*, as well as those that are nationally endangered, including the water pennywort (*Hydrocotyle umbellata*) and the thread-leaved sundew (*Drosera filiformis*) (Francis and Munro 1994; Maher *et al.* 1977). Francis and Munro (1994) have proposed that a biosphere reserve in southwestern Nova Scotia would help to conserve and better manage these rare plant assemblages and their unusual ecological niches.

The Scotian Coastal Plain Biosphere Reserve would incorporate several unique terrestrial and marine landscape elements. The Sable Island Gully, for example, is the largest submarine canyon in eastern North America and is a site of strong upwelling and associated rich biodiversity (Shackell *et al.* 1996). Furthermore, the Gully is adjacent to Sable Island; an unusually distal, offshore sand spit (Davis and Browne 1997). The Bay of Fundy, like the Gully, exhibits strong water mixing and is known internationally for its concentrations of right and humpback whales, as well as for generating the world's highest tides. The proposed biosphere reserve would include the largest relatively undisturbed wilderness area in the Maritimes (the combined Tobeatic-Kejimkujik wilderness area), and in so doing, help protect the headwaters of dozens of river systems, some of which support Atlantic Salmon (*Salmo salar*) populations. Southwestern Nova Scotia also contains some of the last remaining patches of old-growth forest in the Maritimes. Places such as Sporting Lake, Big Dam Lake, Silvery Lake, and Big Pine Lake contain several isolated pockets of these ancient forest stands.

In addition to the coastal plain flora, the region supports a relatively high concentration of Canada's endangered, threatened, and vulnerable species (see Table 2). The endangered right whale (*Eubalaena glacialis*), piping plover (*Charadrius melodus*), and Acadian whitefish (*Coregonus huntsmani*) populations are of particular importance to the area. Right whales are concentrated in the Bay of Fundy and the Roseway Basin (Brown *et al.* 1995), while piping plover populations are found near the Kejimkujik Seaside Adjunct and elsewhere in the region. The Acadian whitefish is now reported exclusively within a single river in the proposed Scotian Coastal Plain Biosphere Reserve: the Petite Riviére (Davis and Browne 1997). The northern bottlenose whale (*Hyperoodon ampullatus*) is a threatened species found within the Sable Island Gully (Whitehead *et al.* 1997), while the threatened blandings turtle (*Emydoidea blandingi*) is most commonly located in Kejimkujik National Park (Kejimkujik 1995). Vulnerable species, such as the wood turtle (*Clemmys insculpta*), the ipswich sparrow (*Passerculus sandwichensis princeps*), and the humpback whale (*Megaptera novaeangliae*), are also present within this region. For a complete listing of the rare species found in the area, refer to Table 2.

The waters off Nova Scotia contain northern deepwater coral species. They are typically located at depths below 200 m along the continental slope and are vulnerable to certain fishing techniques; most notably to different types of dragging (Breeze 1997). These species can form extensive 'coral forests' and may provide essential habitat for economically important groundfish species. More research is required, however, to determine their distribution, morphology, and status as a keystone species.

The Shelburne Barrens candidate nature reserve, also located in southwestern Nova Scotia, is of exceptional scientific interest because it contains ecosystems that are naturally recovering from anthropogenic disturbance regimes (Miller 1997*a*). Research at this site may yield valuable information concerning the resilience of nature to certain types of human activities.

The outstanding value of southwestern Nova Scotia is not restricted to natural phenomena. The designation of the town of Lunenburg, in the region, as a UNESCO World Heritage Site in 1997 gives testimony to a rich cultural history. Since World Heritage Sites can often complement biosphere reserves (Vernes 1992), the close proximity of Lunenburg to the proposed Scotian Coastal Plain Biosphere Reserve greatly enhances this proposal.

Potential Cooperating Agencies and Groups

In order to formally designate a biosphere reserve, there must be extensive community involvement, as well as the support of cooperating agencies. Future work is required to identify these groups, but some of those whose support may be needed are listed in Table 3. Parks Canada is part of the Department of Canadian Heritage; migratory bird sanctuaries are the responsibility of Environment Canada; fisheries closures, whale sanctuaries, and most marine protected areas are the responsibility of the Department of Fisheries and Oceans; provincial parks and wilderness areas are currently administered by the Nova Scotia Department of Environment; and provincial Crown lands other than parks are administered by the Nova Scotia Depertment of Natural Resources. The planning departments of Queens, Shelburne, Yarmouth, Digby, and Annapolis Counties would be primary contacts at the municipal level.

The support of some non-governmental organizations, such as the Nature Conservancy of Canada and the Nova Scotia Nature Trust, would be valuable, as would that of commercial enterprises involved with the harvesting of natural resources. The long-term success of such a biosphere reserve would be contingent upon sufficient support from local resource user organizations, such as lobstermen's associations, fishermen's unions, and forestry associations. Since tourism development is relevant to this proposal, the support of local community economic development organizations, tourism associations, and sport and recreation providers might also be sought. The involvement of local Mi'kmaq bands and community organizations should be encouraged throughout.

Nova Scotia has an enviable record with regard to higher education and research. The universities and research institutions in Halifax contain the largest concentration of educational and scientific capacity in the Atlantic region. Ocean studies, life science, physical science, social science, and law, are strongly represented. Thus, the capacity to provide the research and scientific expertise to support a significant biosphere reserve exists only a short distance from the proposed site. Furthermore, in many ways, Kejimkujik National Park is already functioning as a biosphere reserve because of its focus on research and monitoring activities related to the Ecological Monitoring and Assessment Network (EMAN) and associated Smithsonian Institute - Man and the Biosphere (SI-MAB) biodiversity plots (Drysdale 1995).

Because this biosphere reserve proposal integrates a wide range of human endeavor, it will undoubtedly take some time before the idea will be generally understood (Kellert 1986). For this reason, a gradual approach involving extensive community consultation and discussion will be necessary. Efforts should be undertaken immediately to encourage local residents to participate in the development of this biosphere reserve proposal.

Potential Community Benefits

A biosphere reserve can produce a wide range of local community benefits ranging from generating financial gains to promoting a cleaner environment to enhancing cultural identity and cooperative links (Mullins and Neuhauser 1991). Increased tourism and employment opportunities are often created as well (Solecki 1994). The proposed Scotian Coastal Plain Biosphere Reserve would be no exception, and the communities of southwestern Nova Scotia should anticipate the benefits of living within a biosphere reserve.

Biosphere reserve designation will likely attract positive international attention to Atlantic Canada, which would in turn be likely to increase tourism-related revenues. This attention might also go some way to counteract the notoriety brought on by the fisheries management strategies that led to the collapse of the North Atlantic cod stocks and to the controversy generated by the seal hunting industry. Furthermore, the unique nature of a Scotian Coastal Plain Biosphere Reserve in the region would focus regional and national attention on southwestern Nova Scotia, attracting visitors, researchers, and media. A biosphere reserve in southwestern Nova Scotia is also likely to stimulate local creativity and enhance local expertise. Likely spin-offs could include pilot projects in regional sustainable agriculture or transportation, inter-community cooperation, green-housing, research and development into renewable sources of energy, and the restoration of degraded habitat. Most significantly, however, this biosphere reserve would provide a strong focus on management experiments in sustainable harvesting of potentially renewable oceanic and forest-related resources.

The UNESCO biosphere reserve concept is a means to facilitate the experiments necessary to develop a sustainable economy. By bringing together local communities and industries with academic and government research communities, solutions can be reached. These range from developing locally appropriate and economically feasible fisheries management strategies to pioneering and developing sustainable technologies. While these activities could occur, or are occurring, in the absence of biosphere reserve designation, the biosphere reserve label would serve to elevate the international profile of sustainable development innovations, and attract research and project funding to the region. This has the potential to benefit local enterprises directly, particularly those small, resource-based endeavors that often have difficulty obtaining research assistance. In the long run, local communities could benefit from the advantages of a sustainable lifestyle, and the dollars that economic spin-offs and tourism would generate.

Conservation Infrastructure Still Required

With the concentration of terrestrial, coastal, and marine protected areas in southwestern Nova Scotia, most of the conservation infrastructure necessary for an Atlantic Canada biosphere reserve is already in place. A few specific sites are still required, however, to better facilitate scientific research in the proposed biosphere reserve.

Missing, arguably, is an officially designated marine protected area adjacent to the shore. These sites are required to allow for the collection of baseline scientific data. Brothers (1997) and Miller (1997b) have examined the potential of Port Joli Harbour as a candidate site and recognize its importance for research and outdoor education. Also lacking is an officially designated offshore marine protected area. The Sable Island Gully or the Roseway Basin have been identified as suitable candidates (Lane & Associates 1992).

Several significant terrestrial ecological sites in the region, many of which have been candidate protected areas for over 25 years, would have to be legally protected under the Nova Scotia's Special Places Protection Act to accommodate the proposed Scotian Coastal Plain Biosphere Reserve. This would help prevent the ecological integrity of these sites from being compromised in the interim by development.

If the proposed protected areas described above have public support, and if they can be successfully implemented, then the Scotian Coastal Plain Biosphere Reserve proposal will be greatly enhanced.

Conclusions

Canada requires additional terrestrial, coastal, and marine biosphere reserves to complete its national system for UNESCO/MAB. Atlantic Canada is a case in point. Since a biosphere reserve should incorporate representative landscape features typical of the biogeographical province in which it is located, it is logical to establish a biosphere reserve in Atlantic Canada that incorporates both terrestrial and marine elements, given this region's strong ecological, economic, and socio-cultural attachments to the ocean. Limiting a biosphere reserve solely to the terrestrial realm would fall short of representing the natural and cultural features of this region of the biosphere.

Southwestern Nova Scotia appears to be an excellent site for the establishment of a biosphere reserve. This region is representative of Atlantic Canadian landscapes and contains numerous features of outstanding value. It is already well supplied with protected areas in terrestrial, coastal, and marine environments, and is dependent upon the sustainable use of its natural resources both on the land and in the sea. These features, in addition to the presence of a strong research community, make southwestern Nova Scotia an excellent choice for the establishment of Atlantic Canada's first biosphere reserve.

The proposed Scotian Coastal Plain Biosphere Reserve has the potential to benefit local communities directly, link numerous cooperative agencies, and facilitate the scientific research necessary to learn how to live within the ecological limits of the earth. This biosphere reserve would encourage sustainable living on land and in the ocean: a concept that is vital to the long-term well-being of Atlantic Canada.

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Table 1 Existing terrestrial, coastal, and marine protected areas in the proposed Scotian Coastal Plain Biosphere Reserve

	Terrestrial	Coastal	Marine
Federal			
National Park	• Kejimkujik National Park	• Kejimkujik National Park Seaside Adjunct	
National Marine Conservation Area			• Roseway Basin (candidate) • Sable Island and Gully (candidate)
Canadian Heritage River	• Shelburne River		
Migratory Bird Sanctuary		• Haley Lake • Port Hebert • Port Joli • Sable Island • Sable River	
National Wildlife Area		• Sand Pond	
Marine Protected Area			• Port Joli Harbour (proposed) • The Gully (proposed)
Whale Sanctuary			• Grand Manan Basin • Roseway Basin • Sable Island Gully
Fishery Closure			• Browns Bank Haddock Box • Emerald and Western Banks Haddock Box • Browns Bank Lobster Closure
Provincial			
Wilderness Area	• Tobeatic • Tidney River • Lake Rossignol • Bowers Meadows		
Provincial Park	• Indian Fields • Ellenwood Lake	• Thomas Raddall • Summerville Beach • Rissers Beach • Sand Hills Beach • The Islands • Bush Island • Glenwood • Sable River	
Nature Reserve	• Sporting Lake • Ponhook Lake • Tusket River-Wilsons Lake		
Wildlife Management Area	• Tobeatic	• Pearl Island	
Protected Beach		• Sandy Bay Beach • Carter's Beach • Johnston's Beach • St. Catherine's River Beach • Cherry Hill Beach	
Private			
Non-Government Sites	• Gilfillan Lake	• Brier Island • Peter's Island Sanctuary • Tusket Island Group Sanctuary • Bon Portage Island • Kelsey Property Sanctuary • Indiand Island Sanctuary	
Forest Industry		• Bowater-Mersey Port L'Hebert Pocket Wilderness	

Table 2. Rare animal species occurring within the proposed Scotian Coastal Plain Biosphere Reserve

Status	Mammals	Birds	Reptiles & Amphibians	Fish
Endangered	• right whale	• piping plover		• Acadian Whitefish
Threatened	• northern bottlenose whale • harbour porpoise • fin whale		• blanding's turtle	
Vulnerable	• humpback whale • blue whale	• ipswich sparrow	• wood turtle	

Table 3. Potential cooperating groups and agencies in the Scotian Coastal Plain Biosphere Reserve

Government

-Federal

- Canadian Wildlife Service
- Department of Canadian Heritage - Parks Canada
- Department of Fisheries and Oceans
- Environment Canada
- Natural Resources Canada

-Provincial

- Department of Economic Development
- Department of Education and Culture
- Department of Environment - Parks and Recreation
- Department of Fisheries
- Department of Housing and Municipal Affairs
- Department of Natural Resources
- Sport and Recreation Commission
- Tourism Nova Scotia
- Transportation and Public Works

-Municipal

- Towns of Bridgewater, Clark's Harbour, Liverpool, Lockeport, Lunenburg, Shelburne, and Yarmouth
- Annapolis, Digby, Queens, Shelburne, and Yarmouth Counties
- Wardens of the following municipalities: County of Annapolis, District of Argyle, District of Barrington, District of Clare, District of Lunenburg, Region of Queens, District of Shelburne, District of Yarmouth.
- Recreation and Leisure Services - Western Region
- Parks and Natural Services - Western Region

Local Resource Users

-Fishing

- Atlantic Herring Co-op Ltd.
- NS Swordfish Association
- Scotia-Fundy Inshore Fishermen's Association
- Scotia-Fundy Mobile Gear Fishermen's Association
- Southwest Nova Fixed Gear Association
- Southwest Nova Lobster Association
- Southwestern Nova Scotia Aquaculture Association
- Southwest Nova Tuna Association
- Southwest Seiners Association
- SW Fishermen's Rights
- Swordfish Harpoon Association
- Tusket River Gaspereau Dipnetter's Association

-Forestry

- Christmas Tree Council of Nova Scotia
- Nova Scotia Forestry Association
- Nova Scotia Woodlot Owners and Operators Association

-Recreation

- Crossburn Snowmobile Club
- LaHave River Yacht Club
- Lunenburg Yacht Club
- Shelburne Harbour Yacht Club
- South Shore Paddling Club

-Agriculture

- Freedom to Farm
- Nova Scotia Berry Crop Association
- Nova Scotia Mink Breeders Association
- Nova Scotia Organic Growers Association
- Vegetable and Potato Growers Association

First Nations

- Acadia Band
- Acadia First Nation
- Union of Nova Scotia Indians
- Wildcat Reserve

Tourism

- Evangeline Trail Tourism Association
- South Shore Tourism Association
- Yarmouth County Tourist Association

Environmental Organizations

- Atlantic Salmon Federation
- Bluenose ACAP (Atlantic Coastal Action Project)
- Canadian Ocean Habitat Protection Society
- Citizens for Recycling Society (Yarmouth)
- Friends of Crescent Beach
- Friends of Nature Conservation Society
- Lunenburg County Organization for the Environment
- Lunenburg County Wildlife Association
- Lunenburg Enviro Towns Committee
- Lunenburg Wise Wasters
- Nova Scotia Nature Trust
- Nova Scotia Salmon Association
- Nova Scotians for a Clean Environment
- Port Joli Basin Conservation Society
- Queens/Lunenburg South Shore Environmental Protection
- Shelburne County Recyclers Against Pollution
- Society of Nova Scotians for a Clean Environment
- South Shore Naturalists Club
- Tobeatic Wilderness Committee
- Tusket River Environmental Protection Association

Industry

- Bowater-Mersey
- Clearwater
- JD Irving
- National Sea Products
- Mineral Exploration Companies
- Oil and Gas Exploration Companies

Research/Education

- Acadia University
- College of Geographic Sciences
- Dalhousie University (and Dal-Tech)
- Mount Saint Vincent University
- St. Mary's University
- Maritime Museum of the Atlantic
- Nova Scotia Museum of Natural History
- Local public schools
- HeartWood Institute
- Goose Hills Coastal Eco-Centre (proposed)

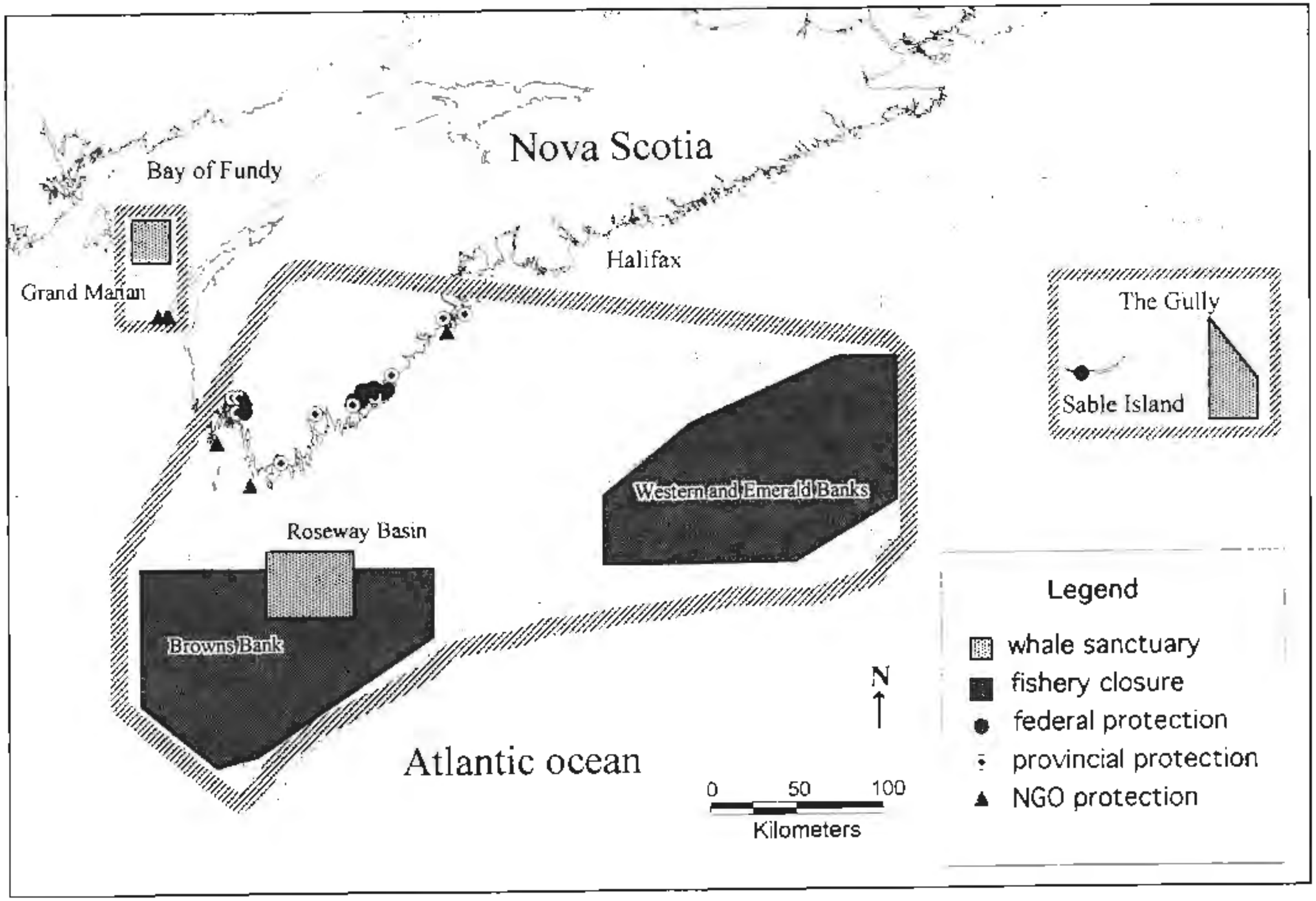

Figure 1. Existing coastal and marine protected areas in southwestern Nova Scotia and the general location of the proposed 'Scotian Coastal Plain Biosphere Reserve'

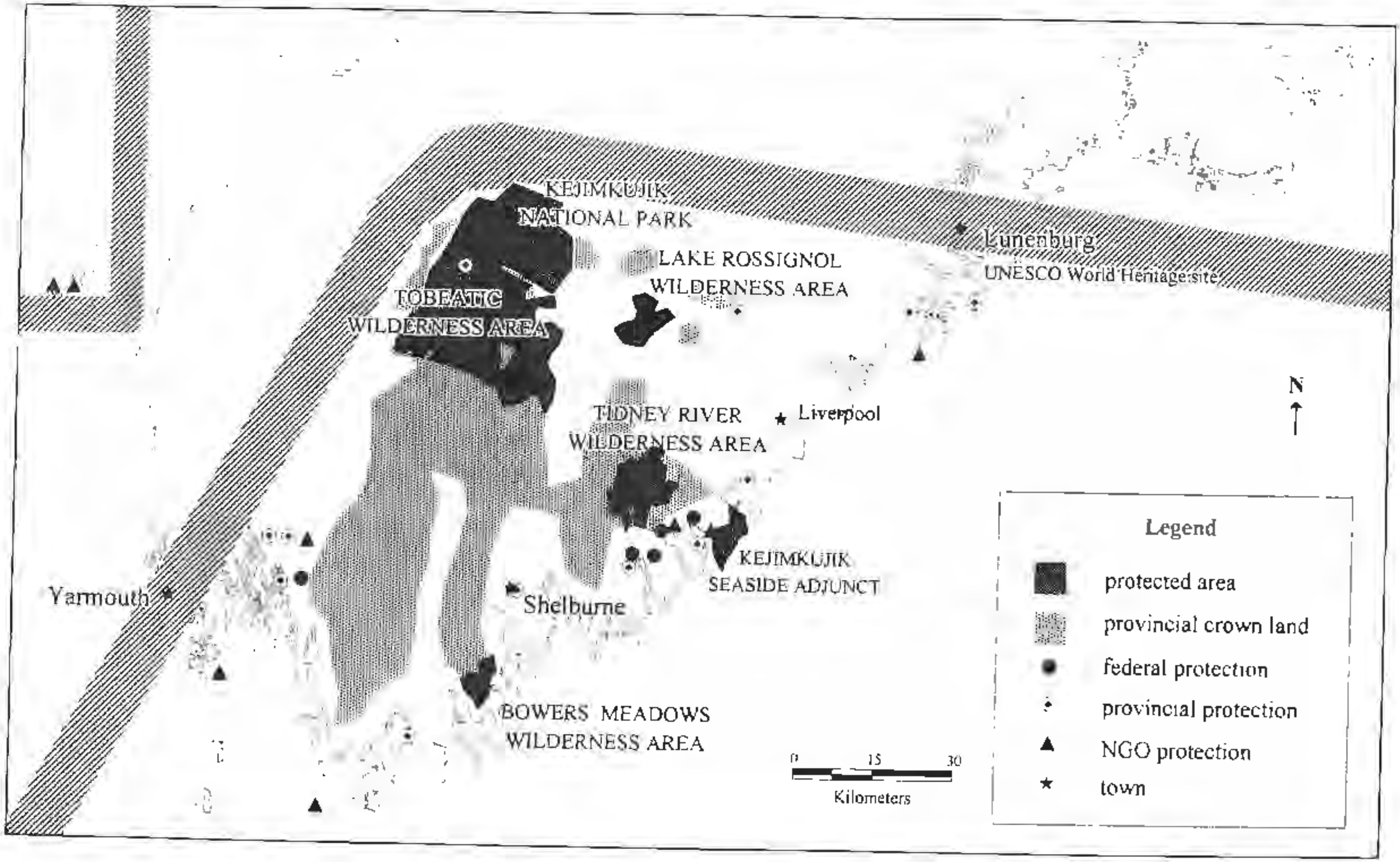

Figure 2. Existing terrestrial and coastal protected areas in southwestern Nova Scotia and the general location of the proposed 'Scotian Coastal Plain Biosphere Reserve'

MARINE PROTECTED AREAS IN CANADA: AN INADEQUATE STRATEGY FOR BLUEFIN TUNA *(THUNNUS THYNNUS THYNNUS (L))*

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Abstract

Atlantic bluefin tuna (Thunnus thynnus thynnus (L)) is a wide-ranging pelagic species that, in the western Atlantic, migrates from the Gulf of Mexico to the northern Atlantic Ocean. Regional bluefin fisheries in Canadian waters have come and gone over the past century. Some of the earlier fisheries lasted, in various forms, for up to 80 years, while some of the more recent ones lasted for as little as 10 years. Unlike many species that have constant migration routes that persist from generation to generation, the Atlantic bluefin tuna appears to have a 'learned migration' pattern that can vary from one generation to the next.

The strategy of fixed site protected areas is inadequate for a commercial species that has a variable 'learned' migration pattern. The entire 'greater marine eco-zone' for this species must be managed under an ecosystem type plan that will provide protection similar to at least IUCN Category V and VI areas for terrestrial species.

Sommaire

Le thon rouge (Thunnus thynnus thynnus (L)) constitue une espèce pélagique dont l'aire de répartition est vaste et qui, dans l'ouest de l'Atlantique, migre du golfe du Mexique jusqu'au nord de l'Océan. Des pêcheries régionales de thon rouge situées en eaux canadiennes ont existé puis ont disparu au cours du siècle passé. Certaines des premières pêcheries ont duré sous des formes diverses jusqu'à 80 ans, alors que certaines des plus récentes n'ont pas duré dix ans. Contrairement à de nombreuses espèces dont les parcours de migration sont constants de génération en génération, le thon rouge de l'Atlantique semble suivre des parcours de « migration appris » qui varient d'une génération à l'autre.

La stratégie des zones de protection marine à des emplacements fixes ne convient pas à une espèce commerciale dont les parcours de migration sont variables. L'ensemble de l'« écozone maritime élargie » de cette espèce doit être géré selon un plan de type d'écosystème qui assure une protection similaire aux secteurs des catégories V et VI de l'UICN pour les espèces terrestres.

Introduction

Tuna species around the world are being overfished due to their high commercial value (Kemf *et al.* 1996) and the difficulty in managing highly migratory straddling stocks (Hoover 1983; Meltzer 1994). This is especially true of the Atlantic bluefin tuna (*Thunnus thynnus thynnus* (L.)) (Safina, 1993). A recent assessment by the International Commission for the Conservation of Atlantic Tunas (ICCAT)[1] indicates a 90% decline in the spawning stock biomass between 1970 and 1990 (Anon. 1990), with relative stability between 1990 and 1995 (Kemf *et al.* 1996). This species was recommended for listing as endangered under Appendix II of the Committee on International Trade in Endangered Species (CITES) by Sweden in 1992, and again by Kenya in 1994 (Radonski *et al.* 1990, Anon. 1994b). With such a decline occuring under traditional international management, alternate methods need to be examined.

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[1] ICCAT was established in 1969. The 21 member nations are responsible for management of Atlantic bluefin and other large pelagics.

Management of Bluefin Tuna

Atlantic bluefin tuna is a highly migratory species requiring international cooperative management. Some consider such management to be impossible if not detrimental to such stocks (Hoover 1983). However, these arguments maybe founded more on the inability (or unwillingness) of individual nations to cooperate, rather than on the concept of international management.

As adults, bluefin tuna can migrate thousands of kilometers and cross several international jurisdictions. Hence, management of this species requires more sensitivity and imagination than is usually applied to commercial marine fish whose more limited movements keep them within a single management jurisdiction. The only international attempt at management of this species, particularly the western stock from which the Canadian landings are taken, has been through ICCAT. The difficulties of international management are mirrored in Canadian domestic management where five provinces and several fishery sectors are actively involved (Ruest 1974), often demanding widely different objectives.

Marine Reserves in Canada

Canada has been planning a marine reserve system for over 20 years "attempting to play catch-up" with other nations (Mondor 1988). In recent years, the Government of Canada has been classifying adjacent seas and coastal areas to identify unique marine eco-regions. Twenty-nine marine regions have been identified from the three oceans and the Great Lakes (Mercier and Mondor 1995). The long-term plan calls for a representative protected area in each of these regions. Much planning has been accomplished, unfortunately little action has followed. Both National Parks and proposed National Marine Conservation Areas (NMCAs) relate to the International Union for the Conservation of Nature (IUCN) Category[2] II protected areas (McComb 1997). The perception of marine protected areas has changed from the 1970s when they were referred to as National Marine Parks (Anon. 1986) incorporating the concept of near total protection. In the 1990s their new label is NMCAs (Anon. 1994a) and the concept of protection now incorporatas sustainable resource use.

There is consideration that marine protected areas need to be different from those of the terrestrial system (Hutchinson 1995; Kenchington 1988). A marine reserve is often expected to be larger than a terrestrial one and to be actively harvested. This philosophical view may be based less on true ecological differences and more on past results of human impacts on the terrestrial ecosystem that have caused extirpation of most of the commercially important large migratory mammals (*e.g.*, bison, caribou, wolf, cougar, *etc.*). Relatively small terrestrial parks can provide a sense of protection for 'islands' of biodiversity for the 'smaller' sized components of the remaining terrestrial ecosystem. A similar size Marine Protected Area (MPA) would be considered inadequate in the sea where it could only protect the non-migratory components but would be inadequate for large migratory fish and marine mammals.

The Oceans Act

In 1996, the Oceans Act was passed to coordinate the efforts of Parks Canada (Anon. 1994a), Environment Canada (Zurbrigg 1996), and the Department of Fisheries and Oceans (DFO) (Anon. 1997) and to develop a unified approach to responsible use of the oceans. Although this Act could improve efficiency and stop duplication, it could also lead to enhanced bureaucracy and more elaborate exercises in systems planning.

[2] The categories used to define the status of protected areas in this note are those adopted by the IUCN in 1994 and described by Phillips and Harrison (1997).

One area of confusion is the broad use of the term MPAs (Anon. 1997). Under this Act, an MPA can include any area from a permanent 'no-take' reserve to a seasonal closure for a commercial fishery. Area closures have been used as a fishery management practice for many years but did not qualify for consideration as an MPA. A potential pitfall that could affect implementation of the Oceans Act is the attempt to use the management of commercial fisheries as a tool for protecting biodiversity. An additional weakness is that no resources have been provided under the Act for enforcement, protection, or maintenance of the new MPAs.

The Challenge

Migratory and straddling stocks have long posed a challenge for managers to develop the consensus needed to formulate a plan that each fishing sector can accept. Small MPAs cannot provide protection to fish stocks when the migration of a stock can change over a period of years. This review will show how NMCAs are unlikely to protect highly migratory marine species such as bluefin tuna while a lower level of protection, if implemented over the working seascape could provide the needed safeguards.

Atlantic Bluefin Tuna

Biology

This species comprises two stocks (east and west Atlantic) with limited mixing (Clay 1991). The eastern stock spawns in the Mediterranean Sea and the western stock spawns in the Gulf of Mexico between mid-April and mid-June. In the west, after larval development, the juveniles follow the currents of the Gulf Stream in what will become their annual north-south migration. Unlike most fish, tuna have the ability to maintain their body temperature up to 10°C above ambient water temperatures. This ability to thermoregulate provides increased physiological efficiency and is probably related to their ability to thrive in more northern (cooler) waters as they increase in size (age). With increasing age (size), individuals can extend their migration further north until after maturity (approximately age 10) when they have a fixed migration from their ancestral spawning grounds in the Gulf of Mexico to various sites along the coast of the northwest Atlantic (Caddy and Butler 1976; Suzuki 1991). Clay and Hurlbut (1990) first postulated that these migrations might be variable, learned (probably trophic), and size dependent. It was on the basis of this hypothesis that the DFO changed the bluefin management strategy for Canada in 1989.

Fisheries

There are two broad types of bluefin tuna fisheries in the west Atlantic. These are the mobile offshore (>100 km from shore) and the nearshore (<100 km) fisheries. These latter fisheries tend to harvest fish in a specific and limited geographic area.

I have selected example nearshore fisheries from Canada's Atlantic bluefin tuna fishery over the past century (Clay and Hurlbut, *unpublished*). However, similar examples could be selected from European waters (North Sea, Irish Sea, Norwegian coast, Bay of Biscay, *etc.*) and from the related southern bluefin tuna (*Thunnus maccoyii*), in the south Pacific (New Zealand and Australian fisheries (Talbot Murray, Ministry of Agriculture and Fisheries (NZ), Wellington, *pers. comm.* 1992)).

In each of the selected fisheries, bluefin were known to have been present in the area before the fishery began. Each fishery developed rapidly, after a need was identified by local fishers. After a period of stable catches the fishery declined almost as rapidly as it began. The fishery initially harvested relatively small fish,

[3] The time identified for each fishery was taken as the period required to take 95% of the total catch for that area.

continued for a period[3] with increasing mean size and over time decreasing numbers. Such fisheries occurred in the southern Gulf of St. Lawrence between 1970 and 1985 (Figure 1), in St. Margaret's Bay near Halifax from 1950 to 1982 (Figure 2), along the northeast coast of Newfoundland, centered in Conception Bay between 1961 and 1972 (Figure 3), and off Wedgeport, Nova Scotia between 1936 and 1955 (Figure 4).

The Gulf of St. Lawrence rod and reel fishery extended for a period of 16 years (Figure 1). During that period the mean size (mass) increased from 325 kg to 450 kg. The St. Margaret's Bay trap fishery lasted 33 years (Figure 2) with a mean size increasing from about 75 kg to 425 kg. The Newfoundland rod and reel fishery lasted only 12 years (Figure 3) and did not show the same increase in mean size (230 kg to 260 kg). The mean size of individuals in this fishery did increase to about 325 kg by the 1980s. The Wedgeport, Nova Scotia rod and reel fishery had several complicating factors, not the least of which was World War II. In addition there was a large nearby harpoon fishery and other fisheries that may confound observations. This fishery lasted about 20 years (Figure 4) with the mean size increasing from 90 kg to 164 kg and eventually to 350 kg in 1965. Following the collapse of these nearshore fisheries, despite continued interest by the local fishers, there was no recovery, no indication of new (younger) fish arriving, and no return of other schools of large fish.

Two hypotheses regarding size-specific migration were developed from information on northern European Atlantic bluefin fishery collapses (Tiews 1975) and similar bluefin fishery collapses along the US eastern seaboard (Caddy and Butler 1976). The first is that the north-south migration is either a continuous stream-like movement of fish up the east coast of North America with larger fish moving further north than smaller ones. The second is that discrete assemblages[4] of bluefin move to selected sites and return to that site with some fidelity.

The west Atlantic purse seine fishery allows for an interesting test of these hypotheses. The purse seine fishery targeted juvenile bluefin[5] from 1960 to about 1980 (Clay and Hurlbut, *unpublished*). This effectively removed any significant recruitment from all year classes from the late 1950s to the late 1970s. Thus these example nearshore fisheries had little, if any, recruitment after 1960.

If the 'steady stream' hypothesis were true, there would be a uniform fishery, showing a uniform decline and/or recovery, and a uniform change in mean size. This is not the case in Canada's bluefin fisheries. As the Newfoundland fishery collapsed, the Gulf of St. Lawrence fishery began. In turn when it collapsed two new fisheries began, one off southern Nova Scotia and one on the Grand Banks.

If the 'discrete assemblage' hypothesis were true there should be clumped distributions of catches, with unrelated declines and/or recoveries, and changes in mean size could vary by assemblage. This is the case for bluefin in the northwest Atlantic. They congregate in discrete areas along Canada's east coast. These assemblages are not totally cohesive and tagging studies indicate mixing does occur between them. Under steady-state conditions, an area such as the southern Gulf of St. Lawrence would be expected to have a relatively stable assemblage with continuous but variable recruitment. The assemblage would tend to appear constant to the fishers. However during the period 1960 to 1980 there was little or no such recruitment and the combined fishing and natural mortality reduced the assemblage to a minimum size where it probably began to break up to join other larger assemblages. This would explain the sudden decline, usually in 1 or 2 years, seen in the local fishery.

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[4] The term assemblage refers to a single school or group of schools that return to specific feeding areas.

[5] This was due to regulations limiting mercury content of fish sold in the North American market to < 0.5 ppm, effectively restricting commercial fishing to individuals < 4-5 years of age.

New assemblages have occurred in the late 1980s, off southern Nova Scotia (the Hell Hole) and off Newfoundland (Virgin Rocks) indicating there are 'new' schools available. None has returned to past historic sites. After the collapse of each of the selected local fisheries, the assemblages have not returned, implying the migration was a 'learned response' probably to a trophic stimuli rather than a genetic inheritance. Such behavior results in a species whose migration would be determined by local abundance of forage fish during years of strong bluefin recruitment, the 'learning phase' for the bluefin assemblage.

Protected Areas and Working Seascapes

Phillips (1996) pointed out that globally 41% of protected areas are managed in accordance with IUCN Category II (protected for science and recreation). However, in Europe where wild-lands are limited, 67% are managed as Category V and VI (protected landscape/seascape incorporating sustainable resource use). Although this may appear as a fallback due to a shortage of available lands, it may be that even in countries such as Canada insufficient wild-lands are protected to maintain the biodiversity. The scale of area required for migratory species such as bluefin tuna may be beyond what society is willing to set aside in highly protected areas. Thus Phillips (1997) has suggested that extensive protected areas of Category V and VI may be superior to more limited areas of Category II.

The marine environment comprises two thirds of the planet's surface, but marine conservation is conspicuous by its absence (Ballantine 1995). 'No-take' reserves conserve local biodiversity and because of the dispersive aspects of various life history stages of marine organisms, a representative network of reserves must be planned. Ballantine (1995) identified several serious philosophical impediments to the creation of marine protected areas: in the marine environment, rights are provided to users of public property but not to the public and there is a tendency to concentrate on the rare and special rather than the frequent and common. This tenet of communal property was discussed 30 years ago by Garret Hardin (1968) in his essay 'The Tragedy of the Commons'.

Past and Present Management Options

To protect against over fishing, society has developed a responsive active fisheries management system through quotas, closures, and gear restrictions. In this system, government and large corporate interests have taken the lead but despite significant scientific input, they have not been successful. During the period of major bluefin stock collapse (1970 to 1990) only two regulations were ever implemented by ICCAT. One reduced mortality on 1-year-old fish (< 6.4 kg), and the second reduced the overall west Atlantic catch to twice what was scientifically recommended. Often decisions to reduce overall catch are politically difficult to make. Seasonal closure of areas of high concentrations of fish, (*e.g.*, the area closed for spawning haddock (*Melanogrammus aeglefinus*) off Brown's Bank, southern Nova Scotia) can now be considered a variation of an MPA. The objective of seasonal closures is to reduce the overall catch rate and thus annual catch without the political necessity of closing the fishery. Hutchings (1995) recommended similar seasonal closure of parts of the Grand Banks of Newfoundland for spawning northern cod (*Gadus morhua*) as a conservation measure that, he suggests, might have averted the collapse of the stock.

Future Management Options (Oceans Act)

Parks Canada has proposed a network of NMCAs that would include commercial fishing and other resource use activities 'consistent with sound conservation practice' (Anon. 1994*a*). DFO has been managing fisheries with much the same objectives. An MPA appears under current thinking, to be commercial fisheries management by a different name.

The main achievement of the Oceans Act is that local communities have a means of requesting the implementation of specific fisheries management actions for specific areas. However, the same community can remove an MPA when they consider the objectives have been achieved. This provides an untried management tool for protecting areas of local biodiversity and possibly some localized commercial stocks. Shackell and Lien (1995) pointed out how little is known about how these or other variations of MPAs might integrate with traditional fishery management techniques.

Future Management Options (Working Seascape)

To protect migratory marine species with large home ranges alternative strategies to MPAs are required (Harvey-Clark 1995). One alternative strategy suggested was the model ocean approach to develop sustainable management techniques to protect biodiversity (Allard *et al.* 1995). However, model oceans, as presently proposed, are experiments to develop the tools necessary to manage the marine resources effectively. For species such as bluefin tuna, more immediate action is required.

Migratory species such as bluefin that may exhibit a variable 'learned' migration require ecosystem management on a larger scale. It must cover more than a network of local fixed 'no-take' reserves. Flexible capacity to protect a moving target must be incorporated into the system via protected working seascapes with core 'no-take' zones. Such areas will need to be large. The east coast of North America from the Gulf of Mexico to the Grand Banks is over 4000 km in length, but management over this area is necessary for the protection of such species. Marine protected areas must be more than a means to separate incompatible activities through zoning. The Great Barrier Reef Marine Park of Australia (GBRMPA) is a functioning example of a large (350,000 km^2) working seascape (Woodley and Ottesen 1992). Kelleher (1996) outlined the degree to which GBRMPA involves the public in decision making and management, a probable reason for its success and acceptance by its constituent communities.

A working seascape will need to reflect the knowledge, experience and values of the local communities who have the most to gain or lose from management decisions. In many instances, the issue is very simple: over-use of limited resources and the only management option is to reduce the resource harvest. A decision to limit harvesting is difficult but must be made by the local users, and supported by the greater society. Finally, individuals must be involved, as governments and corporations do not have the long-term vision required for such resource planning.

Traditional management has tried the active mode of 'fixing' the system when it is considered broken. Ecosystem management follows the premise of preventative maintenance through regular ecosystem monitoring. Although there is much talk of moving from resource management to eco-system management, there is little in the way of substantive evidence that this is happening. The strategic goal must be for sustainable fisheries in healthy ecosystems. This can only happen with management of large scale IUCN category V and VI working seascapes.

Traditional international management has proven ineffective. It is now time for a change.

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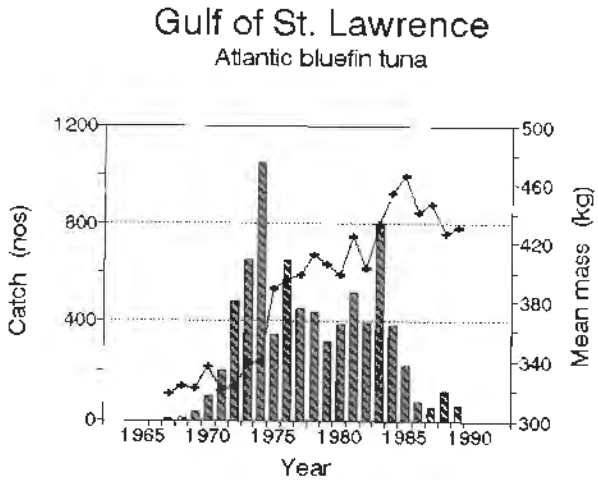

Figure 1. The catch of Atlantic bluefin tuna (*Thunnus thynnus thynnus*) from the fishery in the Gulf of St. Lawrence. Catch represented by bars, mean weight of fish by solid line. The fishery (95% of the catch) lasted from 1970 to 1985.

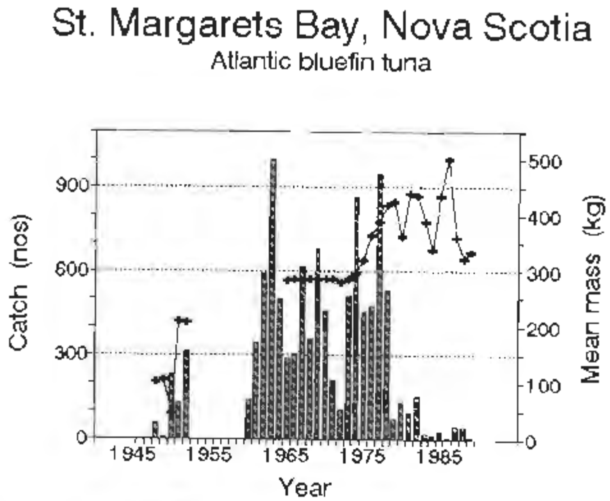

Figure 2. The catch of Atlantic bluefin tuna (*Thunnus thynnus thynnus*) from the fishery in St. Margarets Bay, Nova Scotia. Catch represented by bars, mean weight of fish by solid line. The fishery (95% of the catch) lasted from 1950 to 1982.

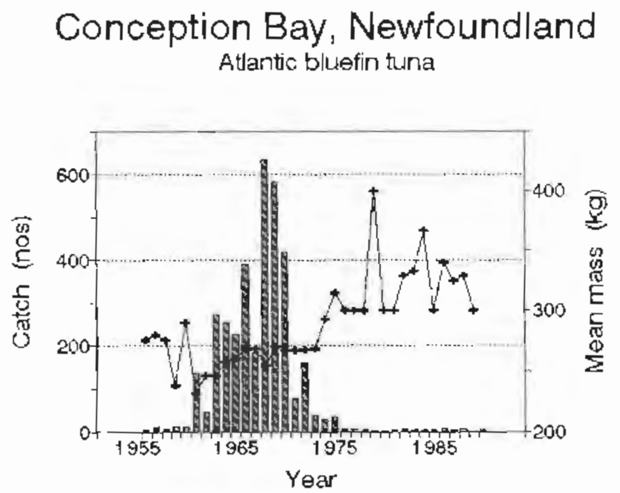

Figure 3. The catch of Atlantic bluefin tuna (*Thunnus thynnus thynnus*) from the fishery in Conception Bay, Newfoundland. Catch represented by bars, mean weight of fish by solid line. The fishery (95% of the catch) lasted from 1961 to 1972.

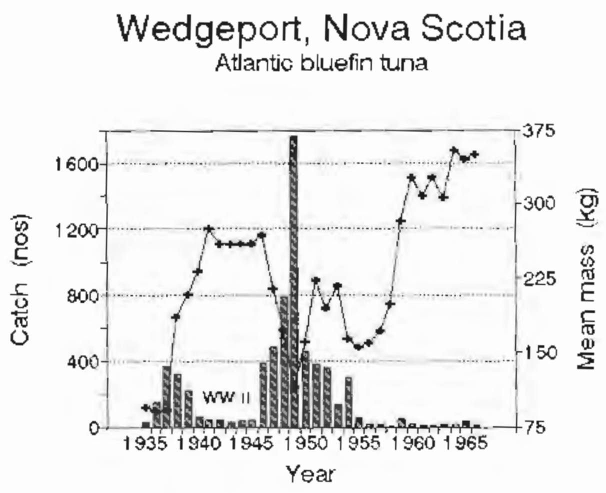

Figure 4. The catch of Atlantic bluefin tuna (*Thunnus thynnus thynnus*) from the fishery near Wedgeport, Nova Scotia. Catch represented by bars, mean weight of fish by solid line. The fishery (95% of the catch) lasted from 1936 to 1955.

MOVING FROM THEORY TO DESIGNATION: A REVIEW OF SOME CANDIDATE MPA SITES IN ATLANTIC CANADA

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Abstract

More than four years after the Canadian Council of Ministers of the Environment, Canadian Parks Ministers' Council, and Wildlife Ministers' Council of Canada signed the Tri-Council Statement of Commitment to "accelerate the protection of areas representative of Canada's marine natural regions," and agreed to adopt frameworks, strategies, and time-frames for this work, little concrete progress has been made. There are no MPAs in Atlantic Canada meeting Endangered Spaces Campaign protection standards. This means there are no MPAs in the Atlantic Region that have long-term legal designation protecting them from human activities that could cause large-scale, long-term habitat disruption, such as oil and gas development, dumping, mining, bottom-trawling, and dragging.

The passage of the Canada Oceans Act on January 31, 1997 provides new legislation for the establishment of marine protected areas (MPAs) and a real opportunity to accelerate the protection of marine natural regions. According to the Act, MPAs can be established for: conservation and protection of fishery and non-fishery resources; endangered or threatened marine species; unique habitats; marine areas of high biodiversity or productivity; and any other marine resource or habitat that is necessary to fulfil the mandate of the Minister of the Department of Fisheries and Ocean (DFO), the lead federal agency for MPAs. This presentation takes a look at some candidate MPA sites in Atlantic Canada and matches them to the goals of the Canada Oceans Act. It also explores some of the scientific and technical issues associated with establishing a network of representative MPAs.

Sommaire

Plus de quatre ans après que le conseil canadien des ministres responsables de l'environnement, le conseil canadien des ministres responsables des parcs et le conseil canadien des ministres responsables de la faune aient signé l'engagement formel d'« accélérer la protection des secteurs représentatifs des régions marines naturelles du Canada » et convenu d'adopter des cadres directeurs, des stratégies et des échéances à cette fin, peu de progrès ont été réalisés. Au Canada atlantique, il n'existe aucune ZPM qui satisfasse aux normes de protection de la campagne pour les espaces en danger. Cela signifie que dans la région de l'Atlantique, aucune ZPM ne possède de désignation officielle à long terme qui la protège contre les activités humaines susceptibles de provoquer une perturbation des habitats à long terme et à grande échelle, comme l'exploitation du pétrole et du gaz, les décharges de déchets, l'exploitation minière, le chalutage par le fond et le dragage.

Le vote de la Loi sur les océans le 31 janvier 1997 signifie l'existence d'une nouvelle loi qui régit la création de zones de protection marine (ZPM) ainsi qu'une possibilité concrète d'accélérer la protection des régions maritimes naturelles. En vertu de la Loi, des ZPM peuvent être créées pour les fins suivantes : conservation et protection des ressources halieutiques et non halieutiques; des espèces maritimes menacées ou en voie de disparition; d'habitats uniques; d'espaces marins riches en biodiversité ou en productivité biologique; et d'autres ressources ou habitats marins nécessaires à la réalisation du mandat du ministère des Pêches et des Océans (MPO), l'organisme fédéral qui assume la responsabilité essentielle des ZPM. Le présent document évalue certains sites du Canada atlantique qui pourraient devenir des ZPM et il les évalue en fonction des objectifs de la Loi sur les océans. Les auteurs ont également analysé certains des enjeux scientifiques et techniques associés à la création d'un réseau de ZPM représentatives.

THE MAGAGUADAVIC RIVER: IS PROTECTION POSSIBLE?

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Abstract

The river-by-river management philosophy leads to an entire watershed becoming the focus of conservation plans, and hence "protected areas". The Magaguadavic River, New Brunswick, Atlantic salmon run has suffered logging, dams, poaching, and industrial effluent (pulp and paper, mining). The most recent anthropogenic activity to impact the wild salmon was the establishment of the Bay of Fundy salmon aquaculture industry. The industry developed rapidly, bringing significant social and economic benefits to coastal communities. However, concerns arose when cultured salmon escaped into the wild. Wild salmon form distinct stocks among (and often within) rivers because of genetic adaptations to local environmental conditions. The genetics of cultured salmon are altered by selective breeding and their genetic variability is reduced. Escaped cultured salmon may introduce exogenous genes when they interbreed with wild salmon, potentially reducing the fitness of wild fish. Escaped salmon now penetrate the Magaguadavic River from both seacages and freshwater facilities. Escapees from seacages make up over 75% of the salmon entering the river, and have spawned and interbred with wild fish. Cooperation is needed among stakeholders to develop appropriate management strategies and mitigation measures to protect and conserve salmon rivers. Currently, there are two diametrically opposed opinions on what to do: open the river to escapees, or close the river to escapees. A final decision on this may be arrived at by "non-decision" as groups argue themselves into paralysis. The protection offered by river-by-river management would then fail, leading to a loss in biodiversity.

Sommaire

Selon la philosophie de gestion des cours d'eau, l'ensemble du bassin hydrographique d'un cours d'eau doit être le centre d'attention des plans de conservation et il doit être considéré comme un « secteur protégé ». La remontée du saumon de l'Atlantique dans la rivière Magaguadavic au Nouveau-Brunswick a souffert de l'exploitation forestière, de la présence de barrages, du braconnage et des effluents industriels (pâtes et papiers, mines). Le développement de l'industrie de l'aquaculture du saumon dans la baie de Fundy constitue l'activité anthropogénique la plus récente qui ait eu une incidence sur le saumon sauvage. Cette industrie s'est développée rapidement, offrant des retombées très positives sur les plans social et économique aux collectivités côtières. Toutefois, l'échappée de saumons de culture a soulevé des appréhensions. Les saumons sauvages constituent des stocks qui diffèrent selon les cours d'eau (et fréquemment au sein d'un même cours d'eau), compte tenu des adaptations génétiques aux conditions environnementales locales. La génétique du saumon de culture est modifiée par l'élevage sélectif et la variabilité génétique de l'espèce est réduite. Les saumons de culture qui se sont échappés sont susceptibles d'introduire des gènes exogènes lorsqu'ils se reproduisent avec des saumons sauvages, facteur susceptible de réduire la viabilité de ces derniers. Les saumons échappés pénètrent à l'heure actuelle la rivière Magaguadavic, à partir des centres d'aquaculture situés en eau douce et des cages marines. Parmi les saumons qui pénètrent le cours d'eau, 75 % sont des poissons échappés des cages marines, qui ont frayé et se sont reproduits avec des saumons sauvages. Il est nécessaire que les parties concernées se concertent de manière à élaborer des stratégies de gestion et des mesures d'atténuation adéquates, et ainsi à protéger et à préserver les rivières à saumon. À l'heure actuelle, il existe deux opinions diamétralement opposées relativement aux mesures à prendre : laisser les saumons qui se sont échappés pénétrer dans les rivières ou les empêcher de le faire. Compte tenu de l'impossibilité des groupes concernés de parvenir à un consensus, il pourrait en découler une paralysie du processus décisionnel. La protection offerte par les gestionnaires des cours d'eau serait alors abolie, avec pour conséquence une perte de biodiversité.

A MARINE PROTECTED AREAS PROGRAM FOR THE GULF OF MAINE

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Abstract

The Gulf of Maine, one of the world's most productive marine ecosystems, is experiencing the negative impacts of human activities on both the land and at sea. Marine protected areas (MPAs) have been identified as an important tool for addressing many of the ecological and socioeconomic problems contributing to the decline of the Gulf of Maine ecosystem. A coherent network or system of MPAs can provide an effective framework for ecosystem management by promoting the sustainable use and conservation of regionally significant habitats in the Gulf of Maine. Through careful planning and trensboundary coordination, an MPA program can offer ecological and administrative benefits not gained through traditional ad hoc or reactive approaches to marine protection.

A survey of marine users and other interested parties was conducted to evaluate the need for and value of an ecosystem-based MPA program in the Gulf of Maine. Based on the results of this survey, a binational workshop on developing an MPA program for the Gulf was held in April 1997. The findings of the survey and outcomes of the workshop represent the first steps in developing an MPA program for the Gulf of Maine that seeks both to meet the needs of human communities and protect the ecological and economic value of the marine resources on which they depend. While a preliminary plan of action has been set forth, future steps are necessary to ensure the long-term success of a network or system of MPAs.

Sommaire

Le golfe du Maine, l'un des écosystèmes marins les plus productifs du monde, subit les répercussions négatives de l'activité humaine, tant sur terre qu'en mer. Les zones de protection marine (ZPM) ont été considérées comme une formule utile du point de vue du traitement de nombre des problèmes écologiques et socio-économiques qui contribuent au déclin de l'écosystème du golfe du Maine. Un réseau ou système cohérent de ZPM pourrait s'avérer un cadre directeur efficace de la gestion des écosystèmes, en faisant valoir l'utilisation durable et la conservation d'habitats importants d'un point de vue régional dans le golfe du Maine. Sous réserve d'une planification et d'une coordination transfrontalière soigneuses, un programme de ZPM peut revêtir des avantages sur les plans écologique et administratif que ne peuvent offrir les stratégies de protection des secteurs maritimes ponctuelles ou non planifiées.

Un sondage auprès des utilisateurs des secteurs maritimes et d'autres parties intéressées a été effectué afin d'évaluer la nécessité et l'utilité d'un programme de ZPM axé sur l'écosystème dans le golfe du Maine. À partir des résultats de ce sondage, un atelier binational consacré à la mise sur pied d'un programme de ZPM pour le Golfe a été organisé en avril 1997. Les résultats du sondage et les conclusions de l'atelier constituent les premières étapes en vue de l'élaboration d'un programme de ZPM pour le golfe du Maine, programme qui vise à satisfaire à la fois les besoins des collectivités humaines et à protéger les valeurs écologiques et économiques des ressources maritimes dont ces collectivités dépendent. Même si un plan d'action préliminaire a été formulé, il conviendra de prendre d'autres mesures pour garantir le succès à long terme d'un réseau ou d'un système de ZPM.

LANDOWNER VIEWS AND RESPONSIBILITIES FOR PROTECTED AREAS

INTEGRATING NATURAL AND CULTURAL FACTORS IN LANDSCAPE STEWARDSHIP: THE TANTRAMAR PILOT PROJECT IN HERITAGE LANDSCAPE ASSESSMENT

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Abstract

Heritage policy and practice is evolving across Canada. In New Brunswick, government agencies are responding to public concerns by redefining the scope of heritage and expanding their approaches to stewardship. Since adoption of the 1994 New Brunswick Heritage Policy, Through Partnership to Stewardship, the Province has recognized landscapes within the scope of heritage, and the Heritage Branch is espousing a holistic view of nature and culture.

The Heritage Branch now aims to facilitate the community-centered conservation of heritage landscapes within municipal and rural land-use planning. To do this, the Branch and partner agencies needed to learn how to understand, protect, and manage the integrity of landscapes, including the intangible and tangible attributes that people value. Thus, in 1995, the Branch and the Tantramar Planning District Commission co-sponsored a pilot project in heritage landscape assessment. The site is a 450-km^2 watershed abutting the Bay of Fundy and containing protected areas, municipalities, and varieties of private property.

Sommaire

La politique et les pratiques dans le domaine du patrimoine changent à l'échelle du Canada. Au Nouveau-Brunswick, les organismes gouvernementaux donnent suite aux préoccupations du public en élargissant la définition du patrimoine et leur conception de la gérance. Depuis l'adoption de la politique sur le patrimoine du Nouveau-Brunswick en 1994, La gestion par le partenariat, la province a reconnu officiellement que les paysages faisaient partie du patrimoine et la Direction du patrimoine épouse cette conception holistique de la nature et de la culture.

La Direction du patrimoine vise désormais à faciliter une conservation des paysages du patrimoine axée sur les collectivités, dans le cadre de la planification de l'utilisation des terres municipales et rurales. Pour ce faire, la Direction et les organismes partenaires doivent apprendre à comprendre, à protéger et à gérer l'intégrité des paysages, ce qui inclut les caractéristiques tangibles et intangibles que valorise la population. Ainsi, en 1995, la Direction et la commission du district d'aménagement de Tantramar ont parrainé de concert un projet pilote consacré à l'évaluation des paysages du patrimoine. Le projet porte sur un bassin hydrographique de 450 kilomètres carrés adjacent à la baie de Fundy et qui inclut des secteurs protégés, des municipelités et une série de propriétés privées.

The pilot project explored processes and techniques that could be applied in planning jurisdictions across the province. Specific objectives shaped project design, including the need for: 1) developing forms of public participation that would build trust and awareness while integrating the knowledge and values of experts and residents; and 2) combining natural and cultural landscape data within a GIS format.

By May 1997, the pilot project produced: a mapped and a written eco-cultural history of the watershed; photos and texts from a Residents' Photo Survey attesting to such landscape values as biodiversity, beauty, way of life, and sacredness; a GIS database supporting assessment of natural and cultural landscape heritage; heritage landscape character areas identifying management units; and a prototypical public participation and education process. The final task is development of a landscape management strategy which the Commission can use in municipal and rural plans.

Le projet pilote a été consacré à l'évaluation de processus et techniques susceptibles d'être appliqués aux districts d'aménagement à l'échelle de la province. La conception du projet était axée sur des objectifs précis, ce qui inclut les exigences suivantes : 1) détermination de formules de participation du public susceptibles de promouvoir la confiance et la sensibilisation, tout en intégrant les connaissances et les valeurs des spécialistes et des résidents; et 2) intégration des caractéristiques naturelles et culturelles du paysage, sous un format comparable au SIG

En date de mai 1997, les résultats suivants avaient été produits dans le cadre du projet pilote : rapport sur l'histoire écoculturelle du bassin, avec illustration cartographique; photographies et textes tirés du relevé photographique des résidents et qui témoignent de valeurs reliées au paysage comme la biodiversité, la beauté, le mode de vie et le caractère sacré; base de données du SIG appuyant l'évaluation du patrimoine des paysages naturels et culturels; secteurs caractéristiques des paysages du patrimoine précisant les unités de gestion; et processus expérimental de participation et d'éducation du public. La tâche finale consiste à élaborer une stratégie de gestion des paysages que la commission soit susceptible d'utiliser dans le cadre de la planification municipale et rurale.

NEW BRUNSWICK'S NATURE TRUST: A SNAPSHOT OF PRIVATE LAND STEWARDSHIP IN THE NOT-FOR-PROFIT SECTOR

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Abstract

The Nature Trust of New Brunswick has, since its founding in 1987, been a province-wide outlet for private land philanthropy, complementing government protection programs and others, such as that of the Nature Conservancy of Canada.

While the New Brunswick government struggles to find the correct number and type of areas to call "protected", the Nature Trust operates quietly behind the scenes to acquire land holdings of ecological significance, indeed some of national importance. Its ability to attract land donations comes as much from perception as reality: people want a non-government entity to which to give their land, sometimes their most prized possession, because they feel it will be safe from harm in the future.

While not vast in area, the Trust's nine nature preserves are a cross-section of New Brunswick's landscapes, from river valley to islands to salt marsh. One could argue that these properties contribute virtually nothing to protecting biodiversity, simply due to their limited size. However their existence is more than symbolic. They are living laboratories for scientific study and public enjoyment. And their management by volunteer stewardship committees is a model of how individuals, acting with the community's interests at heart, can effectively perform the at-times costly and demanding task of protecting environmentally significant land.

Sommaire

Depuis sa création en 1987, la Fondation pour la protection des sites naturels du Nouveau-Brunswick est l'un des organismes philanthropiques appuyés par les propriétaires de terres privées à l'échelle de la province; elle complète les programmes de protection du gouvernement ainsi que d'autres programmes de la Société canadienne pour la conservation de la nature.

Alors que le gouvernement du Nouveau-Brunswick déploie des efforts importants pour déterminer le nombre et le type exacts de secteurs qu'il convient de désigner « secteurs protégés », la Fondation travaille discrètement dans l'ombre, en faisant l'acquisition d'avoirs fonciers qui revêtent une importance écologique, dont certains, de portée nationale. La capacité de l'organisme d'amener des propriétaires à effectuer des dons de terrains est axée à la fois sur les perceptions et sur la réalité : la population réclame un organisme non gouvernemental à qui elle puisse confier ses terrains, qui constituent parfois ses avoirs les plus précieux, étant donné qu'elle estime ainsi assurer la protection de ses terrains pour l'avenir.

Même si leur superficie est modeste, les neuf réserves de la Fondation regroupent l'éventail des paysages du Nouveau-Brunswick, depuis les vallées fluviales jusqu'aux îles et aux marais salins. On pourrait avancer que, pratiquement, ces propriétés ne contribuent qu'à la protection de la biodiversité, tout simplement du fait de leur superficie limitée. Toutefois, leur existence est plus que symbolique. Il s'agit de laboratoires vivants qui peuvent être mis à profit pour des études scientifiques et des activités récréatives de la population. De plus, leur gestion par des comités de gérance bénévoles constitue un modèle qui illustre la façon dont des particuliers qui se soucient des intérêts de la collectivité peuvent relever le défi exigeant et parfois coûteux que constitue la protection des terres importantes d'un point de vue environnemental.

In 1995, when it successfully developed an extensive database inventory of environmentally significant areas throughout the province, the Nature Trust established itself as a credible source of information on what should be protected and why in New Brunswick. Working with private paper companies, additional areas have been identified on Crown land. Now a major push is on to inventory and assess critical areas in New Brunswick's northern Appalachian forest. By instilling an awareness and sense of obligation on the part of government, by drawing attention to these truly wonderful areas, and by capitalizing on landowner willingness to donate or protect land, the Nature Trust of New Brunswick is acting as a catalyst to advance the cause of protected areas in the province.

En 1995, lorsqu'elle a constitué avec succès un répertoire exhaustif des bases de données relatives aux secteurs importants d'un point de vue environnemental à l'échelle de la province, la Fondation s'est imposée comme source crédible d'information sur les secteurs à protéger au Nouveau-Brunswick et sur les motifs de leur choix. En collaboration avec des papetières privées, des secteurs complémentaires situés sur les terres de la Couronne ont été recensés. À l'heure actuelle, des efforts intensifs sont déployés pour recenser et évaluer les secteurs critiques de la Forêt appalachienne du nord du Nouveau-Brunswick. En sensibilisant les pouvoirs publics et en leur inspirant un sentiment d'obligation, en attirant l'attention sur ces secteurs réellement spectaculaires, ainsi qu'en mettant à profit le désir des propriétaires fonciers d'effectuer des dons de terrains ou de protéger ces derniers, la Fondation pour la protection des sites naturels du Nouveau-Brunswick joue un rôle de catalyseur des efforts de défense des secteurs protégés dans la province.

PROTECTED AREAS AND THE INFLUENCE OF THE FOREST CERTIFICATION PROCESS

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Abstract

The recent emphasis on certification of forest products and forest management represents a unique opportunity to integrate protected areas into forest management planning. The existence of protected areas typically is one of the principles or criteria for certifying a well-managed forest, or sustainable forest management (SFM) system. However, the relevant principles are not clear regarding the type, size, and amount of protected area expected in a working forest landscape. This paper addresses this issue by outlining the criteria associated with protected areas in the various SFM initiatives, principally the two main initiatives in North America, the Forest Stewardship Council and the Canadian Standards Association. We will summarize how these principles have been applied on forest lands that have met certification requirements and present recommendations for assessing the degree of protection within a forest certification process.

Sommaire

L'importance récente accordée à l'homologation de la gestion des boisés et des produits de la forêt offre la possibilité unique d'intégrer les secteurs protégés à la planification de l'aménagement forestier. L'existence de secteurs protégés constitue en règle générale l'un des principaux critères qui permettent de déterminer si une forêt est bien gérée ou constitue un système d'aménagement viable de la forêt. Toutefois, les principes relatifs au type, à la superficie et au nombre de secteurs protégés qui doivent régir un paysage forestier faisant l'objet d'une exploitation ne sont pas clairs. Le présent document traite cette question en soulignant les critères reliés aux secteurs protégés dans le cadre des diverses initiatives du système d'aménagement viable de la forêt, principalement les deux principales initiatives en Amérique du Nord, soit le Forest Stewardship Council et l'Association canadienne de normalisation. Nous résumerons sous quelle forme ces principes ont été appliqués aux terrains forestiers qui ont satisfait aux normes d'homologation et nous présenterons des recommandations sur le plan de l'évaluation de durée de la protection dans le cadre d'un processus d'homologation des forêts.

IDENTIFYING ECOLOGICALLY SIGNIFICANT AREAS IN A HIGHLY FRAGMENTED FOREST ECOSYSTEM IN WESTERN NEW BRUNSWICK

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Abstract

For many highly fragmented forest ecosystems, information on the distribution, abundance, species composition, and threats to survival of remnant patches is limited. Existing databases often only contain accessible large-sized sites identified using ad hoc survey procedures, impeding the consideration of connectivity, isolation distance, and replication of site types during the design of a protected areas network. To offset such deficiencies, a GIS-based habitat modelling procedure was used to systematically identify remnants of Appelachian Hardwood Forest (AHF) in western New Brunswick. This forest type, highly fragmented and rich in rare, vascular plant and bryophyte species, is habitat-specific, occurring on well-drained, edaphically-rich upland and alluvial sites. Identified sites were surveyed to assess the accuracy of the forest cover classifications, to assess levels of recent disturbance, and to determine the distribution of rare plant taxa. Of the area classified as suitable for AHF in the central St. John River valley (147,338 ha), less than 2% supported mature forest in patches averaging 9.0 ha in size. 16% of the sites were wrongly identified as mature tolerant hardwood forest, likely due to interpretation error. 84 patches showed evidence of selective harvesting, and 43% had been partially clearcut since the forest cover data was classified in 1981.

Sommaire

Dans le cas de nombre d'ecosystèmes forestiers extrêmement fragmentés, l'information relative à la répartition, à l'abondance, à la composition des espèces et aux facteurs qui menacent la survie des îlots subsistants est limitée. Les bases de données existantes renferment fréquemment des sites accessibles de superficie importante recensés au moyen de procédures d'évaluation ad hoc, ce qui ne permet pas de tenir compte des notions de connexion et de distance entre les divers types de sites ainsi que de leur répétition, dans le cadre de la mise sur pied d'un réseau de secteurs protégés. Pour compenser ces lacunes, une procédure de modélisation des habitats axée sur le SIG a été utilisée afin de recenser de manière systématique les secteurs restants de la forêt de feuillus appalachienne (FFA) dans l'ouest du Nouveau-Brunswick. Ce type de forêt, qui est très fragmenté et riche en plantes vasculaires et en espèces de bryophytes, est particulier sur le plan des habitats et se trouve sur des sites alluviaux et des hautes terres bien drainées et riches sur le plan édaphique. Les sites recensés ont fait l'objet de relevés afin d'évaluer l'exactitude des classifications du couvert forestier et les degrés de perturbation récente, ainsi que de déterminer la distribution des espèces de plantes rares. Parmi les secteurs considérés comme des secteurs adéquats de la FFA dans le centre de la vallée de la rivière Saint-Jean (147 338 ha), moins de 2 % contenaient des peuplements adultes, dans des îlots d'une superficie moyenne de 9,0 ha. Parmi ces sites, 16 % ont été à tort considérés comme des forêts adultes de feuillus tolérants, vraisemblablement en raison d'erreurs d'interprétation. Quatre-vingt-quatre îlots avaient à l'évidence fait l'objet d'une exploitation sélective et 43 % de coupes à blanc partielles, depuis la classification des données sur le couvert forestier en 1981.

Ten sites were completely cut. 47 sites hosted one or more rare species, all of which were new records to the province. The most widely distributed were Asarum canadense, Cypripedium calceolus var. pubescens, Carex plantaginea. and Adiantum pedatum, suggesting that each has effective long-range dispersal mechanisms. All other taxa were restricted to the Meduxnekaeg River watershed, a tributary of the St. John River with headwaters in Maine. The GIS-based habitat data provided a rapid and systematic means for determining the distribution and status of AHF in western New Brunswick. Given the continuing loss or degradation of remnant mature stands and the restricted distribution of many of the rare species, immediate conservation action appears necessary to maintain this threatened forest assemblage in New Brunswick. The results of this survey will serve as the basis for this work.

Dix sites avaient fait l'objet d'une coupe rase. Quarante-sept sites abritaient une ou plusieurs espèces rares, qui n'avaient jamais été recensées auparavant dans la province. Les plus largement distribuées étaient Asarum canadense, Cypripedium calceolus var. pubescens, Carex plantaginea et Adiantum pedatum, ce qui semblerait indiquer que chacune de ces espèces possède des mécanismes efficaces de dispersion sur de longues distances. Toutes les autres espèces étaient limitées au bassin hydrographique de la rivière Meduxnekaeg, un affluent de la rivière Saint-Jean dont le cours supérieur se situe dans le Maine. Les données sur les habitats axés sur le SIG ont permis de déterminer de manière rapide et systématique la répartition et l'état de la FFA dans l'ouest du Nouveau-Brunswick. Étant donné la poursuite de la perte ou de la dégradation des peuplements adultes restants et la distribution limitée de nombreuses espèces rares, des mesures de conservation immédiates semblent nécessaires pour conserver cette diversité d'espèces forestières menacées au Nouveau-Brunswick. Le présent projet sera basé sur les résultats de cette étude.

THE NATURE CONSERVANCY OF CANADA: A PRIVATE SECTOR APPROACH TO CONSERVATION

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Abstract

Establishing a network of protected areas across Canada requires a coordinated approach and active participation from all sectors of society: governments, non-government organizations, corporations, foundations, and individuals. Governments have traditionally taken a lead role in setting aside large tracts of Crown land as parks and ecological reserves; however, smaller tracts of private land have received less attention. Although only about 10% of the Canadian landscape is in private ownership, it is in many of these areas where biodiversity is highest yet the greatest threat exists. Working cooperatively with individual landowners in these ecologically rich areas is integral to the successful establishment of a protected areas network in this country.

The Nature Conservancy of Canada is a national charitable organization dedicated to protecting biodiversity through purchasing and securing natural areas of ecological significance, outstanding beauty, and educational interest. To achieve this mandate, The Conservancy works with willing landowners and undertakes land securement "projects". These projects involve the application of one or more land securement techniques. Most frequently, The Conservancy's projects involve the following:

1. land purchases: where the Conservancy buys a parcel of land, either in its own name or in that of another organization;

2. land donations: where land title is donated to the Conservancy;

3. conservation agreements: where the Conservancy is the holder of an easement or covenant on a property;

4. contributions to acquisitions: where the Conservancy makes a financial contribution to a land purchase being undertaken by another organization.

Sommaire

La création d'un réseau de secteurs protégés à l'échelle du Canada nécessite la coordination et la participation active de tous les secteurs de la société : pouvoirs publics, organismes non gouvernementaux, entreprises privées, fondations et particuliers. Les gouvernements ont toujours joué un rôle de chef de file des efforts de préservation de larges secteurs des terres de la Couronne, pour en faire des parcs et des réserves écologiques; toutefois, les terrains privés de superficie plus modeste ont fait l'objet d'une moindre attention. Même si seulement 10 % des paysages canadiens appartiennent à des intérêts privés, c'est dans nombre de ces secteurs qu'on recense la plus grande diversité biologique; or ces secteurs sont les plus menacés. La collaboration avec les propriétaires de boisés sur une base individuelle dans ces secteurs riches d'un point de vue écologique est essentielle au succès de la création d'un réseau de secteurs protégés au Canada.

La Société canadienne pour la conservation de la nature est un organisme de bienfaisance national qui se consacre à la protection de la biodiversité, en faisant l'acquisition de secteurs naturels importants d'un point de vue écologique, spectaculaires d'un point de vue esthétique et présentant un intérêt éducatif, ainsi qu'en protégeant ces secteurs. Pour réaliser ce mandat, la Société collabore avec les propriétaires de boisés qui le souhaitent et réalise des « projets » d'acquisition de terres. Ces projets supposent l'application d'une ou de plusieurs techniques d'acquisition. Plus fréquemment, les projets de la Société incluent les volets suivants :

1. Achats de terrain : lorsque la Société achète une parcelle en son nom propre ou au nom d'un autre organisme;

2. Dons de terrain : lorsque le titre du terrain est cédé à la Société;

3. Accords de conservation : lorsque la Société détient une servitude ou un droit relativement à une propriété;

4. Contributions aux acquisitions : lorsque la Société contribue financièrement à l'achat d'un terrain par un autre organisme.

Occasionally, other types of projects, such as negotiating the relinquishment of privately held land use rights (i.e., mineral, timber, water), are pursued.

Once an area is secured, arrangements must be put in place for property management and monitoring to ensure the land remains protected. With limited resources available and a desire to focus on securement, the Conservancy usually enters into partnerships with government and non-government agencies, as well as local groups and individuals, to oversee the future management of areas it has helped to protect. These partnerships range from informal agreements with volunteer stewards, to short and long-term leases, to outright transfer of title, and usually involve the signing of a formal agreement to ensure that the ongoing management of the land is in keeping with the mandate of The Conservancy. Factors used to determine the type of arrangement developed for a property include the sensitivity of the ecological features, the degree to which active management is required to maintain those features, the size of the property and whether it is part of a larger area or ongoing acquisition program, and other partners involved in the project.

Through a series of case studies, this presentation will illustrate how The Conservancy works with willing landowners, in partnership with a range of organizations, to secure natural areas and ensure that they remain protected now and into the future.

Il arrive que d'autres types de projets, parmi lesquels la négociation de la renonciation aux droits d'utilisation de terrains appartenant à des terrains privés (c.-à-d. minéraux, bois d'œuvre, eau), soient effectués.

Lorsqu'un terrain est acquis, des accords prévoyant la gestion et le contrôle des propriétés afin de garantir que le terrain demeure protégé doivent être conclus. Compte tenu de ses ressources limitées et de la priorité qu'elle souhaite accorder à l'acquisition, la Société conclut généralement des partenariats avec les organismes gouvernementaux et non gouvernementaux, ainsi qu'avec les groupes locaux et les particuliers, afin de superviser la gestion ultérieure des secteurs qu'elle a contribué à protéger. Ces associations vont d'accords informels avec des conservateurs bénévoles, à des baux de courte et de longue durée ou des cessions de titre, et ils supposent généralement la signature d'un accord officiel afin de garantir que la gestion courante du terrain se fait dans l'esprit du mandat de la Société. Les facteurs utilisés pour déterminer le type d'accords conclus selon la propriété incluent la fragilité sur le plan écologique, le degré de gestion active requis pour conserver les caractéristiques écologiques, la superficie de la propriété et le fait qu'elle s'inscrive ou non dans un programme d'acquisition en cours ou fasse partie d'un secteur plus vaste, ainsi que les autres parties prenantes associées au projet.

Au moyen d'une série d'études de cas, ce document illustre sous quelle forme la Société collabore avec les propriétaires de boisés qui le souhaitent, en partenariat avec une série d'organismes, afin de faire l'acquisition de secteurs naturels et de veiller à ce qu'ils demeurent protégés à l'heure actuelle et dans l'avenir.

NEW BRUNSWICK WOODLOT OWNERS AND PROTECTED AREAS

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Abstract

Increasing numbers of woodlot owners are expressing an interest in helping to conserve biodiversity. The potential exists for their active participation in conservation programs through a variety of mechanisms such as regional efforts to obtain sustainable forest management certification and individual stewardship agreements. Conservation organizations who wish to cooperate in realizing this potential need to be sensitive to some simple ground rules, starting with: always obtain permission first before visiting privately-owned land. The enthusiastic involvement of landowners in efforts to promote conservation of endangered species and endangered habitat is a powerful tool for achieving these goals.

Sommaire

Un nombre croissant de propriétaires de boisés souhaitent contribuer à promouvoir le maintien de la biodiversité. Ils ont la possibilité de participer de manière active à des programmes de conservation, dans le cadre d'une diversité de mécanismes, parmi lesquels les efforts régionaux visant à obtenir l'homologation de la gestion durable des forêts et des accords de gérance individuels. Les organismes de conservation qui souhaitent coopérer à la mise à profit concrète de ce potentiel doivent être sensibilisés à certaines règles de base, dont en premier lieu : obtenir toujours au préalable la permission de visiter les terrains appartenant à des intérêts privés. La participation enthousiaste des propriétaires de boisés aux efforts de promotion de la conservation des espèces et des habitats menacés constitue un outil efficace de réalisation de ces objectifs.

POSTERS

METHODOLOGY OF A GAP ANALYSIS CONDUCTED IN THE BLACK BROOK DISTRICT IN NORTHWESTERN NEW BRUNSWICK, CANADA

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This poster will present the methodology of a gap analysis study conducted at the ecosite level (1 :12 500) within the Black Brook District (approximate size: 150 000 ha). The aim of the study is to provide information required to focus conservation efforts to maintain native biodiversity within the District. Furthermore, this information can be used to develop a comprehensive protected areas design to help complete the efforts to maintain native biodiversity within the District's respective ecodistricts and ecoregion.

The study was conducted at a relatively "fine" scale compared to other gap analysis studies found in the literature. The ecosite scale (1: 12 500) was chosen for two different types of gap analysis because of information availability and its usefulness with respect to forest management decisions. The two types of gap analysis conducted within the District include: 1) **Ecosite** gap analysis to determine the adequacy, inadequacy, or total absence of representivity the current unique areas system provides, and 2) **Special Feature** gap analysis to evaluate the adequacy, inadequacy, or total absence of protection the current unique areas system provides with respect to unique features such as unusual geological formations and the location of known rare plants.

These two types of gap analysis were accompanied by an on-site field research component to ground proof the map information and further develop the ecosite data. The field research included soil and vascular plant surveys conducted along an appropriate environmental gradient to compare the unique areas with respect to its ecosite. Field research related more specifically to the second type of gap analysis included vascular plant surveys within waterway buffer strips to identify their ability to protect rare vascular plants. This information will be used to evaluate the unique areas, and provide information that can be used to design an appropriate protected areas design.

The results of this study will provide basic information to focus conservation efforts to protect native biodiversity of the northwestern region of New Brunswick. The study will not provide all information required to protect all native biodiversity of the region, i.e., unknown areas of rare or endangered species. The study is design to identify ecosites that require immediate protection or special management plans to help protect the native biodiversity of the Black Brook District.

L'affiche présente la méthodologie d'une analyse des lacunes réalisée à l'échelon des écosites (1:12 500) dans le district de Black Brook (superficie approximative : 150 000 ha). L'objectif de l'étude consiste à fournir l'information requise pour cibler les efforts de conservation dans le but de préserver la biodiversité des espèces indigènes dans le district. De plus, cette information peut être utilisée pour concevoir un projet exhaustif d'établissement d'un réseau de secteurs protégés dans le but de contribuer aux efforts de préservation de la biodiversité des espèces indigènes au sein des écodistricts et de l'écorégion du district.

L'étude a été réalisée à une échelle relativement « petite » en comparaison des autres analyses de lacunes recensées dans la documentation. L'échelle de l'écosite (1: 12 500) a été choisie pour deux types distincts d'analyses de lacunes, en raison de la disponibilité de l'information et de son utilité du point de vue des décisions d'aménagement de la forêt. Les deux types d'analyses de lacunes réalisées au sein du district incluaient : 1) **l'analyse des lacunes de l'écosite** afin de déterminer le degré de suffisance ou d'insuffisance, ou l'absence totale de représentativité du système des secteurs uniques en vigueur; et 2) **l'analyse des lacunes sur le plan des caractéristiques spéciales** afin d'évaluer le degré de suffisance ou d'insuffisance, ou l'absence totale de protection offerte par le système des secteurs uniques en vigueur, du point de vue de caractéristiques uniques, comme les formations géologiques inhabituelles et l'emplacement de plantes rares connues.

Ces deux types d'analyses de lacunes ont été accompagnés de recherches sur le terrain afin de valider sur place l'information cartographiée et d'élargir la base de données sur les écosites. Les recherches sur le terrain incluaient un recensement des plantes vasculaires le long d'un gradient adéquat d'un point de vue environnemental, dans le but de comparer les secteurs uniques du point de vue des écosites qui les composent. Les recherches sur le terrain reliées plus précisément au second type d'analyse des lacunes incluaient un recensement des plantes vasculaires au sein des bandes tampons situées le long des cours d'eau afin de préciser leur capacité de protéger les plantes vasculaires rares. Cette information servira à évaluer les secteurs uniques et fournira de l'information susceptible de servir à la conception d'un réseau adéquat de secteurs protégés.

Les résultats de cette étude permettront de réunir l'information de base nécessaire au ciblage des efforts de conservation dans le but de protéger la diversité biologique des espèces indigènes dans la région du Nord-Ouest du Nouveau-Brunswick. L'étude ne permettra pas de réunir toute l'information requise pour protéger l'intégralité de la biodiversité indigène de la région, c'est-à-dire les secteurs inconnus où vivent des espèces rares ou menacées. L'étude vise à recenser les écosites qui nécessitent une protection immédiate ou une gestion spéciale, dans le but de faciliter la protection de la biodiversité indigène dans le district de Black Brook.

DEFINING AND IDENTIFYING EXCEPTIONAL FOREST ECOSYSTEMS : A MEANS OF PROMOTING THE CONSERVATION OF QUÉBEC'S FOREST HERITAGE

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Problems and goals

The study on the biodiversity of Quebec forests recently published by the Department of Natural Resources (MRN) has clearly shown that our knowledge of exceptional forests and the threats facing them is lacking. Consequently, the MRN is focusing on identifying and protecting Quebec's exceptional forests; to this end, it has created the Exceptional Forest Ecosystems Working Group (GTEFE). The mandate of this group is to:

- define what an exceptional forest ecosystem (EFE) is;
- locate Quebec's EFEs;
- examine the means available to preserve these forests.

Methods

Initial efforts to identify EFE sites and acquire information about these forests began in 1994. Researchers, professional foresters, biologists, and forest technicians were consulted to make a preliminary list of potential exceptional forests. Several other potential sites were identified through analysis of ecological studies, theses and similar documents.

The sites proposed are recorded in a data bank that comprises 86 descriptive fields; these are later validated in the field.

Results

To date, 406 EFEs have been proposed. The sites identified are located within the various bioclimatic domains south of latitude 52E North. Their area rarely exceeds 100 ha. The EFEs have been divided into three types. rare forest ecosystems, old-growth forests, and forests sheltering endangered or vulnerable species. Once the definition of EFEs was finalized, initial analysis and mapping (1:1,250,000) of EFEs was carried out.

Using forest and ecological data collected in temporary and permanent sampling plots (forest survey data), the working group intends to develop criteria that will facilitate the identification of EFEs in the field.

Applications

Ongoing work to identify and analyze the distribution of EFEs should lead to the development of tools that will foster better management of exceptional forests under both public and private tenure. Furthermore, a departmental framework for the preservation of EFEs is under development. Thanks to current and future location and mapping work (1:20,000), it will be possible to file EFE data into the MRN's GIS database. Following consultations with specialists, representatives of the forest industry, RCMs and NGOs, changes and additions to programs, regulations, legislation, and policies will be made.

Problématique et buts poursuivis

Le bilan de la biodiversité du milieu forestier produit par le ministère des Ressources naturelles (MRN) du Québec soulevait récemment l'insuffisance de nos connaissances sur les forêts exceptionnelles et sur leur niveau de précarité. Dans cette optique, le MRN prenait l'engagement de mettre l'accent sur l'identification et la protection des forêts exceptionnelles du Québec. Pour réaliser cet engagement, le groupe de travail sur les écosystèmes forestiers exceptionnels (GTEFE) a été créé. Ses mandats consistent à:

- définir ce qu'est un écosystème forestier exceptionnel (EFE);
- de les localiser sur le territoire québécois;
- d'examiner l'ensemble des moyens disponibles pour maintenir ces forêts dans le paysage forestier.

Démarche

Depuis 1994, les premiers efforts ont été consacrés au repérage de sites abritant des EFE et à l'acquisition d'informations sur ces forêts. Pour identifier les propositions de forêt exceptionnelle, des enquêtes auprès de chercheurs, ingénieurs forestiers, biologistes et techniciens forestiers ont été réalisées. D'autre part, plusieurs propositions ont été identifiées à partir de l'analyse des thèses, études écologiques, *etc.*

Les propositions saisies dans une banque de données de 86 champs descripteurs font l'objet d'une validation terrain.

Résultats

À ce jour, 406 propositions d'EFE ont été recueillies. Les forêts répertoriées, présentes dans tous les domaines bioclimatiques au sud du 52E de latitude nord, présentent des superficies qui excèdent peu fréquemment 100 ha. Les EFE sont classifiées en 3 types : écosystèmes forestiers rares, les forêts anciennes ("old growth forest"), les forêts refuges d'espèces menacées ou vulnérables. À la suite des derniers travaux sur les concepts et définitions de EFE, une première analyse et cartographie des EFE (1/1 250 000) a été complétée.

À partir des données et écologiques cueillies dans les placettes-échantillons temporaires et permanentes (données d'inventaire forestier), le groupe de travail veut étaborer des critères d'identification qui faciliteront la reconnaissance des EFE sur le terrain.

Applications

Les travaux en cours sur l'identification et l'analyse de la répartition des EFE débouchent sur des outils de reconnaissance qui faciliteront une meilleure gestion des forêts exceptionnelles qu'elles soient de tenure publique ou privée. D'ailleurs, un cadre ministériel de conservation des EFE est en préparation. Compte tenu des travaux de localisation et cartographie (1/20 000) actuels et futurs, il sera possible d'intégrer les EFE au système d'information à référence spatiale du MRN. Des consultations auprès des spécialistes, des représentants de l'industrie forestière, des MRC et des ONG laissent envisager des changements ou des ajouts en terme de programmes, de règlements, de lois ou de politiques.

AN ECOLOGICAL RANKING SYSTEM FOR THE PEATLANDS OF BOREAL ALBERTA - A STEP TOWARDS PEATLAND RESOURCE MANAGEMENT

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Abstract

Most peatlands in Alberta are located in the boreal forest and cover 16% of the landbase. Provincially, peatlands (bogs and fens) have not received much attention due to their up-to-recent low economic significance and their perceived unattractive environment. Currently the economic profile of peatlands is increasing and, therefore, the threat of anthropogenic disturbance and exploitation.

Peatlands are threatened by:
- oil and gas explorations — impact by seismic lines, pipelines, lease sites, roads
- drainage for land use in forestry, agriculture, and housing developments
- peat harvesting for horticultural use
- peat extractions for electric power generating stations
- sorbent industry (used in oil spills, diapers, menstrual pads)

While economic factors still prevail in natural resource management, it is important to establish protective measures now while the opportunity to conserve ecologically important peatlands exist. Presently, Alberta has no guidelines or policies for peatland management but an ever-expanding natural resource industry.

Classification, inventory, and mapping are essential prerequisites for peatland management, but decisions must be based ecologically and consist of a wide spectrum of parameters.

This project aims at, a) establishing criteria by which peatlands should be managed — focusing on maintaining biodiversity in perpetuity and the natural state of the peatland; b) establishing an algorithm by which to rank peatlands ecologically; and c) developing a system based on the above by which ecologically important peatlands can be identified.

Sommaire

La plupart des tourbières de l'Alberta sont situées dans la forêt boréale et couvrent 16 % du territoire. A l'échelon provincial, les tourbières (marais et tourbières minérotrophes) n'ont pas fait l'objet d'études soigneuses, en raison de la faible importance qui leur a été accordée jusqu'ici sur le plan économique ainsi que de l'opinion selon laquelle cet environnement est inhospitalier. À l'heure actuelle, on accorde un intérêt économique croissant aux tourbières et de ce fait, les risques de perturbation anthropogénique et d'exploitation s'accroissent.

Les tourbières sont menacées par les activités suivantes :
- explorations pétrolière et gazière — impact des profils sismiques, des oléoducs ou gazoducs, de l'emplacement des ponts et des routes;
- drainage associé à l'exploitation du terrain, dans le cadre de la sylviculture, de l'agriculture et des projets immobiliers;
- exploitation de la tourbe pour l'horticulture;
- extraction de la tourbe pour les centrales électriques;
- industrie des sorbents (utilisée lors de déversements d'hydrocarbures ainsi que pour la fabrication de couches et de serviettes hygiéniques).

Même si la gestion des ressources naturelles demeure influencée en priorité par des facteurs économiques, il importe de mettre sur pied des mesures de protection, alors que la préservation des tourbières importantes d'un point de vue écologique est encore possible. À l'heure actuelle, l'Alberta ne possède aucune norme ou politique en matière de gestion des tourbières, alors que l'industrie des ressources naturelles ne cesse de croître.

La classification, l'inventaire et la cartographie constituent des volets préalables essentiels à la gestion des tourbières, mais les décisions doivent être justifiées d'un point de vue écologique et tenir compte d'une vaste gamme de paramètres.

Le projet vise a) à fixer des critères selon lesquels les tourbières doivent être gérées, en mettant l'accent sur le maintien de la biodiversité à perpétuité ainsi que l'état naturel des tourbières; b) fixer un algorithme selon lequel classer les tourbières sur le plan de la valeur écologique; et c) concevoir un système axé sur les éléments qui précèdent, et qui permette le recensement des tourbières importantes d'un point de vue écologique.

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Sous-comités du programme : ordre du jour, orateurs, présentations/ateliers

Roberta Clowater, PNAC; Jessie Davies, UNB; Graham Forbes, UNB; Martha Gorman (coprésidente), Judy Loo, SCF (copresidente); Mike Sullivan, Pêche sportive et chasse, MRNE; Vince Zelazny, Aménagement forestier, MRNE

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