Wetlands Stewardship in Canada

Contributed Papers from the Conference on Canadian Wetlands Stewardship

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WETLAND STEWARDSHIP IN CANADA

CONTRIBUTED PAPERS FROM THE CONFERENCE ON CANADIAN WETLANDS STEWARDSHIP

February 3-5, 2003
Ottawa, Ontario

Compiled and Edited
by Clayton D.A. Rubec

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Introduction

Hosted by the North American Wetlands Conservation Council (Canada), and the Federal Wetlands Forum, the Conference on Canadian Wetlands Stewardship was held in Ottawa, February 3-5, 2003. Designed to set new directions for Canadian wetland policy and management for the next 10 years, the event went well beyond its original objectives – a reflection of the passion and dedication of the diverse range of participants with a common interest in wetlands.

It was exciting to see participants enthusiastically outline not only innovative recommendations pertaining to policies, but identifying the tools needed to support and facilitate the policy framework and implementation needs for stewardship of our nation's wetlands. They also identified roles for their particular organization in the "next steps" for a post-conference process, demonstrating their commitment.

We were all reminded of the need to continually broaden the wetland community through communications and education programs (one of our six themes) so that an understanding of the critical economic, ecological and social value of wetlands is integrated into the decision-making process across all sectors and incorporated into our national accounting system.

With a number of major challenges ahead, I believe we now have the building blocks of a decade of change in how we approach, study, manage and document Canada's wetlands. The recommendations, outlined in the record of the conference discussions (Campbell and Rubec 2003), are just the beginning. The next step is to analyze and synthesize the recommendations, creating a "Conference Report: Implementation Strategy" that will be carried out by the individuals and organizations who participated in the conference and potentially all Canadians.

This publication *Wetland Stewardship in Canada* captures both the contributed and background papers developed for this meeting. These papers were developed to kick start the discussions of the Working Groups that crafted the recommendations in the meeting.

Acknowledgements

The Organizing Committee of the Conference on Canadian Wetlands Stewardship would like to express their sincere thanks to the North American Wetlands Conservation Council (Canada) and the Federal Wetlands Forum for their vision in organizing this conference. It was a great success and significant “first step” on an exciting road towards making our vision for Canada’s wetlands a reality.

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We thank our many sponsors and exhibitors for their generous contributions and help in making this event possible.

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References

Campbell, L. and C.D.A. Rubec. 2003. *Interim Report: Synthesis of What You Said. Recommendations of the Conference on Canadian Wetlands Stewardship. February 3-5, 2003*. Report No. 03-1. North American Wetlands Conservation Council (Canada). Ottawa, Ontario.

CHAPTER 2: THE STATE OF CANADIAN WETLANDS: BUILDING A CONSERVATION STRATEGY

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Introduction: Wetland Resources in Canada

Wetlands have various meanings to people in Canada, not so much because it is a matter of scientific dispute, but more so because of the wide range of wetlands. In general, they literally refer to lands that are wet for prolonged periods of time and this is reflected in the development of particular soil, fauna and vegetation types. Historically, Canada had an abundance of wetlands. Due to the impacts of land use changes and pressures such as urban development, increased population, resource development and extraction, etc., particularly in southern Canada, there are currently fewer wetlands remaining. To conserve and protect the wetlands that remain, regular and careful monitoring and planning practices will be required.

Why should we care about the status of wetlands in Canada? Wetlands are special habitats and ecosystems throughout Canada. For a vast array of wildlife species in particular, as well as for people, they provide critical places that are fundamental in sustaining life and ecological services. Unlike other ecosystems (e.g. forests, grasslands), wetlands occur all over Canada's immense landmass and along its vast fresh and saltwater shorelines. Wetlands are typically the biological reservoirs in grassland, forested and arctic landscapes, and coastal areas, hosting and sustaining many of the country's natural assets such as plants, birds, insects and mammals. Just as important, they sustain the mainstay physical resources, such as water and soils. In an overarching capacity, the combined biophysical properties of wetlands are the life networks and homes for many wildlife species. Without habitat, there can be no wildlife. It is a simple relationship.

Wetlands are shared resources – shared by many species, as well as by jurisdictions throughout Canada and, even, across the Americas and within the circumpolar region. Within the country, wetlands sustain habitats for local, regional and far ranging species that freely cross provincial and territorial boundaries. Internationally, countries such as

Mexico, Argentina, United States and Russia rely on Canadians to care for and manage the country's wetlands, which have importance to other countries largely because of migratory species. Stewardship practices, at the farm gate through to international levels, help to ensure that highly migratory and other species of common concern have the critical places required in their lifecycles. Borders favour the territorial behaviour of people but not the inherent behaviour of wildlife species and ecosystems.

During most of the past century, Canadians did not really value the country's natural biodiversity except in the sense of harvesting products such as furs, timber and fish. At the landscape level, grasslands and wetlands were places that needed to be transformed so that they would become useful. For urban developers, farmers, and road construction people, as examples, wetlands often have been seen as obstacles that needed to be drained, filled-in or built-around. In southern Canada, especially the Prairies, around the lower Great Lakes, and along the St. Lawrence Lowlands, this has been especially marked and many of the more productive and rare wetlands have been altered and destroyed. It is estimated that since European settlement, Canada has lost about 20 million hectares to agricultural developments alone. These losses are in some of the smallest but most productive ecozones – the Prairies Ecozone and the Mixedwood Plains Ecozone (Wiken *et al*. 1996).

Attitudes and interests in wetland conservation have fortunately changed in most cases. Particularly over the past few decades, wetlands are seen as assets both within and outside of urban areas. Greater care and stewardship have been provided to wetlands, but this is generally in areas where widespread damage has already occurred and not so much in Canada's mid and northern latitudes.

Governance of Canada's wetlands is shared among private, public interests, and to a lesser degree, by organizations such as the Nature Conservancy of Canada. The federal government has the responsibility for 29% of Canada's wetlands, specifically those located in federal lands and waters, particularly in the northern territories (Cox 1993). Most of the rest is divided between private landowners and provincial governments.

Where are Canada's Wetlands and How Much is There?

Canada has an estimated 1.6 million square kilometres of wetlands or about 18% of Canada's total land area distributed among 15 terrestrial ecozones (Wiken *et al*. 1996; Moore and Wiken 1998). The amount of wetlands estimated by various authors varies somewhat according to the techniques and methods used. The total amount of reported forested land or grassland in Canada also varies to some degree (Environment Canada 1996).

The distribution of wetlands varies greatly across Canada. By jurisdictions, most of Canada's wetlands are located in Manitoba and Ontario (National Wetlands Working Group 1988; Cox 1993). Almost all ecozones have a significant percentage of wetlands in them (Table 1). No other terrestrial habitat type occurs this widely across Canada's

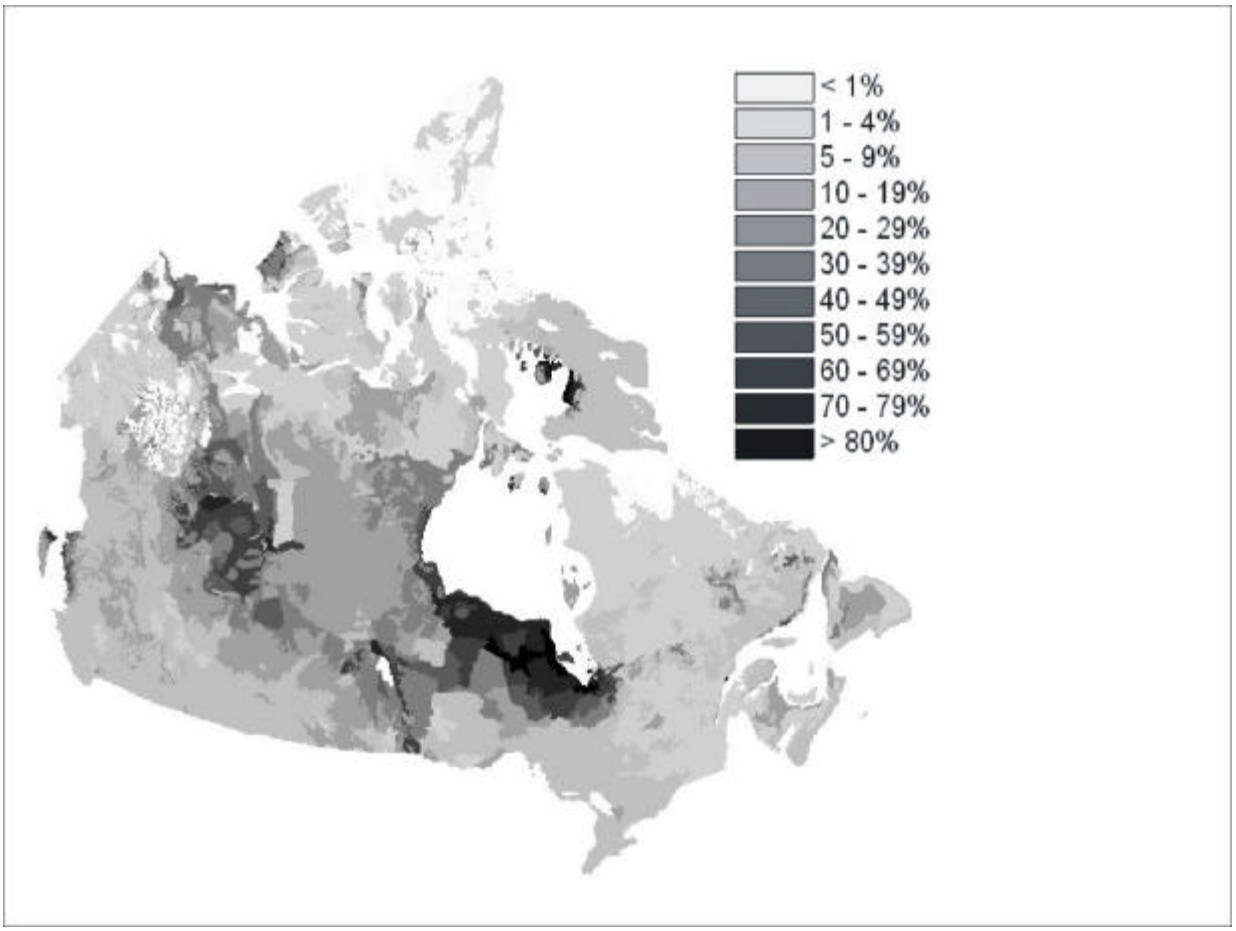

Figure 1: Distribution of Wetlands in Canada

landmass. The largest concentrations of wetlands are in the Boreal Shield, Boreal Plains, Hudson Plains and Taiga Plains Ecozones, amounting to about 69% of the total wetland area in Canada (see Figure 1).

It is estimated that Canada's wetlands comprise 24% of all wetlands of the earth (National Wetlands Working Group 1988). These wetlands exist in a variety of classes and forms (Warner and Rubec 1997) and complement the variation within the 217 mapped ecoregions in Canada. These ecoregions represent regional scale ecosystem units and they are subdivisions of ecozones. Wetlands provide numerous functions and services to humans and species alike. Many of the country's inherent species such as polar bear, moose, deer, beaver, etc. depend on these habitats for their survival. Some use these habitat types year round and others use them seasonally. Millions of migratory birds use Canadian wetlands of the Fraser River Delta, the Northwest Territories, Hudson Bay and Northern Ontario and the Bay of Fundy as wintering or stop over habitats in their annual migrations from the Canadian north to warmer climates in southern latitudes. Many of Canada's 415 species at risk depend on wetlands for their survival. In the context of people, wetlands provide many ecological

services from sources of water through to hunting and recreational areas as described in the book *Wetlands of Canada* (National Wetlands Working Group 1988).

Continental Importance – Critical Connections

Canada's large wetland habitats are important to other countries such as the United States, Mexico and Argentina. Sometimes, they are directly shared as is quite apparent around the border areas near Vancouver (i.e. Boundary Bay), the Great Lakes, St. Lawrence River region and the Gulf of Maine. Sharing may also involve the "stepping stone" areas that migratory species use for summering and wintering areas, and stop-over areas in between. Knowing the status (i.e. conditions, trends, etc.) of wetlands in one country can directly affect what actions should take place in the neighbouring country and the information is critical for management and planning activities, such as species population control and enhancing habitat quantity and quality.

Countries such as the United States have lost much of their wetlands. In the 1600s, over 89 million hectares (220 million acres) of wetlands are thought to have existed in the lower 48 states. Since then, extensive losses have occurred, and over half of its original wetlands have been drained and converted to other uses. This wetland loss was especially acute during the mid-1950s to the mid-1970s, however, since then, the rate of loss has decreased. By the mid-1980s, the lower 48 states contained an estimated 41.8 million hectares (103.3 million acres) of wetlands. Recent estimates of wetland trends on non-federal lands indicate a loss rate between 23 500 to 28 330 hectares (58 000 to 70 000 acres) per year (United States Environmental Protection Agency 2002).

Other seemingly distant places such as Mexico and Russia also influence Canada's wetland habitats and species. In the late 1980s, acid rain generated from industrial and power plants within Canada and the United States affected hundreds of thousands of wetlands in southeastern Canada. The long range transport of organic pollutants from Russia, Japan, Mexico, etc. is a continuous, but not well understood, threat that affects the Arctic wetlands, as is climate change (Wildlife Habitat Canada 2001).

While known for some time, an understanding of these international and continental processes and connections of nature is becoming more critical as a management tool in governing human activities as well as natural resources. As environmental and ecosystem issues and impacts become more international in scope (i.e. global warming, biodiversity loss, air pollution), so too are the scientific and technical concerns about accounting for macro ecosystem processes and relationships.

Table 1: Amount of Wetlands and Population by Ecozone in Canada

General Setting	Ecozone	Ecozone Area (km^2)	Wetland Area (km^2)	Percentage of Wetland in Ecozone	Total Population by Ecozone
Agricultural	Mixedwood Plains	120,137	8,238	6.9	14,840,411
Agricultural	Prairies	457,736	103,391	22.6	3,979,522
Forested	Taiga Plains	575,094	231,119	40.2	23,986
Forested	Taiga Shield	1,305,281	166,487	12.8	36,560
Forested	Taiga Cordillera	251,534	21,142	8.4	368
Forested	Boreal Plains	678,267	309,644	45.7	745,172
Forested	Boreal Shield	1,842,246	333,658	18.1	2,894,961
Forested	Boreal Cordillera	444,766	15,732	3.5	30,324
Forested	Pacific Maritime	191,795	13,325	6.9	2,848,289
Forested	Montane Cordillera	477,845	28,441	6.0	851,656
Forested	Atlantic Maritime	200,224	17,558	8.8	2,549,061
Northern/ Arctic	Arctic Cordillera	230,933	1,686	0.7	1,196
Northern/ Arctic	Northern Arctic	1,404,947	54,218	3.9	18,881
Northern/ Arctic	Southern Arctic	786,972	74,208	9.4	11,729
Northern/ Arctic	Hudson Plains	357,414	295,349	82.6	11,811
Canada	---	9,325,191	1,674,197	17.9	---

Human-Generated Stresses Affecting Wetlands in Canada

Conflicts between wetland conservation and wetland use are mostly concentrated in Canada's southern latitudes such as along the Windsor to Quebec City corridor (the Mixedwood Plains Ecozone) and the prairies (the Grassland Ecozone) – places where population, agricultural and urban pressures are the most intense and where wetland changes have been the most dramatic (Table 1). Compared to Canada's landmass of 9.7 million square kilometres, these more affected southern areas and their wetlands do not comparatively represent a large amount of territory (about 12 to 15%). While

smaller parts of the Canadian landscape, they represent unique and productive ecosystem types that are not found elsewhere in the country. The central Grasslands represent about 5% of the landmass and about 25% of largely fragmented areas remain in their natural state (Gauthier and Wiken 2001; Gauthier *et al.* 2002). The remaining wetlands in the Grasslands or St. Lawrence Lowland areas represent some of the most endangered wetlands and ecosystem types.

Other pressures include drainage, deposition of fill material, diking, and damming, logging, mining, runoff, pollution and garbage dumping, release of toxic chemicals, introduction of non-native species. They are currently less acute in terms of the total area degraded but nevertheless important stressors. Some effects on wetland quantity and quality are not as evident as direct physical destruction or degradation. Global climate change could affect wetlands through increased air temperature, shifts in precipitation, floods and increased carbon dioxide concentration. Climate change would affect not only the wetlands in Canada's southern latitudes but those in the Arctic too (Wildlife Habitat Canada 2001).

The extensive wetlands in areas such as Hudson Bay and Mackenzie Bay could be drastically affected by either lack of, or excess precipitation, ice melting and sea level rise. This would inevitably lead to changes in the wetland dynamics and composition in these areas, and consequently, affect species potentially leading to their endangerment or extinction.

Wetland Changes

Conducting a "status" assessment of assets such as wetlands involves the analysis of past, current and future landscape changes. Documenting the changes are vital to answer questions concerning why the changes are occurring, the significance of the changes in ecological and socio-economic terms, and societal (or management) responses to address the changes. This would include the national wetlands conservation strategy that is suggested in the title of this paper. As a process, the assessment should:

(1) recognize parts of nature as resources and having some mechanism or opportunity for governing those resources. Much of this has been outlined very successfully in existing wetland policy and analysis documents (National Wetlands Working Group 1988; Lynch-Stewart *et al.* 1999);
(2) analyze changes in the conditions of those resources. The changes might refer to the quantities of the resource, the time periods and rates at which the changes have occurred and the places in which these changes have occurred; and
(3) involve evaluating future scenarios about the implications of ongoing trends or expected changes.

These three steps all seem simple. However, they are typically difficult to implement owing to inadequate resource inventories and monitoring programs, as well as the lack of simple standards and techniques for measurements (Wiken and Gauthier 1998).

So far it is known that Canada's wetlands have been drained and converted to what was perceived to be more beneficial land uses. Inevitably, this short-sightedness has led to the loss of millions of hectares of wetlands in the more southern latitudes of the continent (Commission on Environmental Cooperation 2001). Over 80% of the wetlands near major urban centres that are largely in the southern quarter of Canada have been converted to agricultural uses or urban areas. The former is the major cause of 85% of Canada's wetland losses. Since European settlement, wetland conversion to agriculture is estimated at over 20 million hectares (Cox 1993).

In brief, it is estimated that wetland losses are around 65% in the coastal marshes of Atlantic Canada, 70% in southern Ontario, 71% in the Prairies, and 80% of the Fraser River Delta in British Columbia. These areas generally coincide with the denser concentrations of people and human settlements, the more productive areas for agriculture and forestry and the warmer climates in Canada (Statistics Canada 2000). In the north, extensive human impacts have been less evident. There is concern about the cumulative effects from mining, oil and gas developments, climate change and the long distant transport of airborne pollutants on the more fragile arctic and taiga wetland ecosystems (Wildlife Habitat Canada 2001).

Learning from Wetland Changes

At the turn of the 20th century, it must have been difficult for anyone to imagine that species and habitats of any kind would ever become so endangered in an area as vast as Canada. However, farther south on the North American continent, the signs of disappearing wildlife and the degradation of natural areas, even in the mid-1800s, were quite evident in the United States and more so in Mexico. Over the past 100 years in Canada, the perception of the vastness and apparent inexhaustibility of resources such as wetlands, forests and species has fundamentally changed. Canadians and others are increasingly becoming worried about the losses and alterations affecting the nation's inherent landscapes and seascapes. The general lessons that we have learned from wetland changes, and the species, habitats and services that they provide include understanding:

- the importance of critical wetland connections at the continental and macro ecosystem scales;
- the realization that happenings outside of a province or neighbouring state and, at times, a nation, could have critical impacts on regional wetlands;
- the thresholds and breaking points of wetland ecosystems and habitats could be breached under the pressure of human-generated stresses;
- that seemingly minor or negligible by-products of human activities could accumulate in local and distant wetlands, and have significant negative long-term impacts on habitats and species;
- that the wetlands could become so extensively degraded and altered at the continental and macro ecosystem scales;
- that wildlife and habitats would reach unexpected degrees of economic and social importance; and that to sustain wetland-dependent species, it is critical to protect

their wetland habitats and the associated upland/upstream ecosystems that sustain them.

Principles for Action

From these lessons learned about the status, causes and types of wetland changes, it seems clear that the conservation of Canadian wetlands can only be accomplished according to guiding principles based on ecosystem management and stewardship. Considerations of habitat and ecosystem integrity, human health and well-being, and natural resource sustainability are essential. This requires that we think, plan and act in terms of the sustainability of wetlands. In that context, a collaborative, comprehensive, shared vision for wetland conservation and protection is needed.

Such a vision is based on the recognition that:

1. choices and decisions about how wetlands are managed and planned for must be based on timely, regular and relevant information that complements goals set to meet sustainable development and biodiversity objectives;
2. interactions between the biophysical features (i.e. air, water, land and biota) and human activities (i.e. social, cultural and economic systems) are inseparable parts of ecosystems;
3. through their activities and decisions, humans are a major driving force of wetland, habitat, ecological and species changes;
4. habitats critical for the maintenance of all wetland biodiversity and, in particular, wildlife species of common conservation concern must be sustained;
5. healthy wetlands are linked to the economic and social viability of communities (e.g. the direct, human benefits of healthy wetland ecosystems);
6. there are substantial benefits to be realized from maintaining and restoring Canadian wetlands to sequester carbon, maintain water quality and mitigate potential negative climate change effects;
7. the needs of current and future generations must be an integral basis for wetland conservation; and
8. the integrity of wetlands must be sustained and there is an urgent need to reestablish the integrity of wetland habitats and ecosystems throughout Canada and elsewhere in the Americas and Polar Regions.

Based on the guiding principles, governments, non-government organizations, institutions, businesses, industries and individuals of Canada should adopt a vision to recognize the status and conserve the nation’s wetlands. A wetland conservation vision for Canada should aim to sustain the ecological integrity and viability of wetlands in Canada through environmental, social and economic actions designed to meet the needs of current and future generations.

In adopting this vision, governments, non-government organizations, institutions, businesses, industries and individuals should be encouraged to continue pursuing national and international strategies of collaborative policies, programs and actions to:

- contribute to the maintenance of the ecological integrity of Canadian wetland

ecosystems and habitats;
- sustain environmental, economic and cultural values in ways that assure the continued health and integrity of Canadian wetland habitats and ecosystems;
- contribute to the mitigation, reduction and eventual elimination of current and future threats to the shared species, habitats and ecosystems of Canadian wetlands;
- foster a cross-border and integrated perspective to the management, conservation and sustainable use of wetland biodiversity (i.e. genetics, species, habitats/ecosystems);
- strengthen the capacity of a wide array of sectors of Canadian society to conserve the nation's wetland biodiversity; and
- promote wide public involvement in the stewardship, conservation, sustainable use and the equitable sharing of benefits of Canadian wetland biodiversity.

To these ends, a national organization and forum for wetland conservation should be further shaped to advance a comprehensive Canadian Wetland Conservation Strategy. This strategy should be inclusive of a suite of activities covering themes such as inventory, monitoring, assessment, reporting, communication and policy.

Conservation of Important Wetland Habitats

Canadians have a fairly good idea about what wetlands have been lost but factors related to mitigating the rates and occurrences of changes are less well described. For example, what wetlands have been protected through initiatives such as protected area programs? Canadians have recognized the importance of protecting vital wetlands. Through governments, private landowners or local organizations, conservation action plans have resulted in the designation of areas such as Migratory Bird Sanctuaries and Ramsar sites. Over 10% of all of Canada's wetland areas lie within a protected area ranging from federal, provincial or territorial parks, to wildlife sanctuaries and privately managed wildlife areas.

The World Conservation Union–IUCN (Phillips 1998) identifies six protected area management categories (Table 2). Fifty-seven percent of all Canadian wetlands that are protected fall into IUCN categories I, II, and III (Table 3). These tend to be the categories where few human activities take place on the landscape (Moore and Wiken 1988). The remaining 43% fall into IUCN categories IV, V and VI.

Under IUCN categories I-III the Arctic Cordillera, Hudson Plains and Boreal Plains Ecozones have the greatest degree of protection to date, ranging from 17% to 8%. Turning to IUCN categories IV–VI, the Northern Arctic, Southern Arctic and Hudson Plains Ecozones have the greatest degree of protection ranging from almost 16% to 6%. About 5% of the wetlands have been protected under IUCN categories I-III, and about 4% under IUCN categories IV-VI. For all of the wetlands in Canada, roughly 9% are protected.

Table 2: IUCN Protected Areas Categories

IUCN Category	Type of Protected Areas
I a	Strict Nature Reserve/Wilderness Protection
I b	Wilderness Area
II	National Park
III	Natural Monument
IV	Habitat/Species Management Area
V	Protected Landscape/Seascape
VI	Managed Resource Protected Area

Table 3: Types of Wetland Conservation in Canada's Ecozones

Ecozone	Total area of wetlands (km^2)	Area of wetlands (km^2)	Area of wetlands secured IUCN I-III (km^2)	Percent wetlands secured IUCN I-III (%)	Area of wetlands secured IUCN IV-VI (km^2)	Percent wetlands secured IUCN IV-VI (%)
Arctic Cordillera	1,686	290	290	17.2	0	0
Northern Arctic	54,218	9,484	876	1.6	8,608	15.9
Southern Arctic	74,208	12,369	1,189	1.6	11,180	15.1
Taiga Plains	231,119	16,525	11,737	5.1	4,789	2.1
Taiga Shield	166,487	10,022	6,464	3.9	3,558	2.1
Taiga Cordillera	21,142	1,361	813	3.8	548	2.6
Hudson Plains	295,349	42,395	24,431	8.3	17,964	6.1
Boreal Plains	309,644	31,477	25,586	8.3	5,892	1.9
Boreal Shield	333,658	19,276	10,828	3.2	8,449	2.5
Boreal Cordillera	15,732	1,143	1,026	6.5	117	0.7
Pacific Maritime	13,325	960	908	6.8	52	0.4
Montane Cordillera	28,441	1,582	1,566	5.5	16	0.1
Prairies	103,391	5,726	1,153	1.1	4,573	4.4
Atlantic Maritime	17,558	924	398	2.3	526	3.0
Mixedwood Plains	8,238	52	16	0.2	36	0.4
CANADA	1,674,197	153,587	87,281	5.2	66,306	3.9

These figures simply represent how much area is involved. With protected areas, they can range greatly in size, from small to big areas. They may be in remote Arctic lands or near urban centres. The size and location of protected wetlands are examples of factors that influence their chances of maintaining ecosystem and habitat integrity. Without further assessments, the question about how well biodiversity conservation of wetlands has been achieved cannot be readily determined.

Wetland Biodiversity Protection

Biodiversity initiatives are aimed at protecting genetics, species and habitats/ecosystems. How well have we protected wetland habitat/ecosystem diversity? Canadian wetlands have been categorized according to five classes: bog, fen, swamp, marsh and shallow water as well as more detailed forms and types (National Wetlands Working Group 1988; Warner and Rubec 1997). These categories represent first order ideas about wetland habitat and ecosystem diversity. Table 4 (Moore and Wiken 1998) shows the general distribution of these wetland classes based on Advanced Very High Resolution Radiometer analysis and wetland and soil inventories.

Responsibilities for Wetland Protection

The federal role in protecting wetlands rests with three agencies – the Canadian Wildlife Service (CWS) of Environment Canada, the Parks Canada Agency and Fisheries and Oceans Canada. CWS has protected wetlands along Canada's coasts, particularly for migratory waterfowl, through Migratory Bird Sanctuaries and National Wildlife Areas. Many of these sites are recognized internationally for their conservation values, through the Ramsar Convention and the Western Hemisphere Shorebird Reserve Network.

Organizations such as Wildlife Habitat Canada, Ducks Unlimited Canada and the Nature Conservancy of Canada have taken on the responsibility to conserve, restore and in some cases acquire wetlands in Canada. Over the past 17 years, Wildlife Habitat Canada has invested approximately $19.3 million in wetland habitat conservation initiatives. The National Round Table on the Environment and the Economy is developing the Environment and Sustainable Development Indicators Initiative. One proposed national indicator is a measure of the wetland area in Canada (i.e. the presence and absence of wetlands).

Programs that Contribute to Wetland Conservation

What is the status of programs that are designated to protect and conserve wetlands? A number of programs have been implemented at the federal level and many parallels exist with provincial and territorial legislation (Lynch-Stewart *et al*. 1999). These types of programs tend to work best on formally designated areas, but wetland conservation requires many forms of private land and water stewardship and planning processes that look at the total landscape and waterscape. The North American Waterfowl

Table 4: Distribution of Wetland Classes* and Mineral Soils* by Ecozone

Ecozone	% Bog	% Fen	% Swamp	% Marsh	% Mineral Soils
Arctic Cordillera	37.3	0	0	0	62.7
Northern Arctic	43.7	4.6	0	0	51.7
Southern Arctic	68.9	3.7	0	0	27.3
Taiga Plains	76.7	21.9	0.5	0.2	0.8
Taiga Shield	69.9	29.2	0.7	0.1	0
Taiga Cordillera	0	35.9	7.5	4.2	52.4
Hudson Plains	37	51.8	2	2.2	6.9
Boreal Plains	100	0	0	0	0
Boreal Shield	92.2	7.6	0	0.2	0
Boreal Cordillera	82.6	13.9	1.2	2.4	0
Pacific Maritime	81	19	0	0	0
Montane Cordillera	58.1	41.9	0.1	0	0
Prairies	24.1	75	0	0.2	0.6
Atlantic Maritime	29.1	17	6.6	34.7	12.6
Mixedwood Plains	84.9	13.3	0.1	1.7	0

**These wetland classes are generic categories. Thus, a bog in the Arctic versus a bog in the Prairies will be very distinctive from one another, in the sense of ecological properties and biodiversity.*

Management Plan has rehabilitated or restored over 685 000 hectares of wetlands and associated upland habitats in Canada during the 1986-2003 period.

There are many programs that do, or could contribute to, wetland conservation (Lynch-Stewart *et al.* 1999; Beasley and Boardman 2001). Canada has implemented *The Federal Policy on Wetland Conservation* (Government of Canada 1991). Action plans have been developed at various levels to manage wetland and other significant areas. Some examples include: the Great Lakes Action Plan; Prairie Conservation Action Plan; the Fraser River Action Plan; and St. Lawrence Vision 2000. Through the Canadian Wildlife Service, Canada implements its obligations under the Ramsar Convention, an international agreement that provides the framework for cooperation in the protection of important wetland habitats worldwide. The *Canada Oceans Act*, passed in 1996, authorizes the Government of Canada, led by Fisheries and Oceans Canada, to establish a national system of marine protected areas and to make regulations that allow Marine Protected Areas to be designated, zoned and closed to certain activities. The *Migratory Birds Convention Act* (1994), the *Canada Wildlife Act* (1994) and the *Canadian Environmental Assessment Act* (1992) have also contributed to wetland conservation in Canada.

Provinces such as Alberta, Manitoba, Saskatchewan, Ontario, Prince Edward Island, Nova Scotia and New Brunswick have also developed their own wetland policies and legislation. Alberta produced the *Alberta's Wetlands Law and Policy* in 1991, Manitoba developed the *Manitoba Water Policies* in 1990, New Brunswick produced its *Wetlands*

Conservation Policy in 2001, and Prince Edward Island created its *Provincial Policy on Wetland Conservation* in 2002.

Conclusions

Wetlands are important and unique resources in Canada and elsewhere in the world. What does the knowledge of their status in Canada tell us? Like many natural resources in Canada, governments and non-government bodies have done a moderate job on taking stock of wetlands. A number of one time inventories exist but regular and standardized approaches regarding the monitoring of wetlands is very poor. We understand the diversity of wetland types and have advanced standardized classification systems that cover the range of Canadian wetlands. So we know the potential biodiversity, and we have some one window and generic snapshots regarding the distributions, types and quantity of wetlands. However, we lack the ability to track the changes in our wetlands due to poor inventories and monitoring programs. This places the country into a conundrum in the sense of wetland management – "How can we understand and manage what we cannot measure?" Measurements through inventories, classification systems and monitoring are essential tools to support decision-making and assessments. Wetlands are found in all of Canada's ecozones. The variation on amounts of wetlands between ecozones is great as are the impacts of human activities, biodiversity and conservation concerns, jurisdictional authorities and approaches to ecosystem management.

Changes affecting wetlands have been most extreme in the southern areas of Canada (within and near agricultural areas and urban centres). These areas cover about 15% of Canada's landmass, largely within the nation's smallest and most unique ecosystem types, such as the grasslands and the Carolinian forest. These are areas where the Canadian population is the highest, urban centres are the densest, where land conflicts are the greatest, stressors like pollution and fragmentation are the highest, and the loss of natural assets from species to habitats are the most pronounced. Even the wetlands in the more southern forests are experiencing many changes and pressures. Conservation groups like Ducks Unlimited Canada and programs such as the North American Waterfowl Management Plan have been somewhat successful in conserving remnant wetlands and restoring others. The landscape conditions in southern Canada promote management themes based on "restoration" and perhaps "salvaging of the last." With world conservation goals such as sustainable development, biodiversity conservation and ecosystem management, they are all rather incongruous but a reflection of what has to be avoided. The remaining 85% of Canada in the mid and northern latitudes have some of the greatest number of wetlands and this is where management themes based on "anticipate" and "prevent" can best benefit from ongoing habitat status reports.

Has the status of legal instruments and policies changed to support wetland management? In general terms, there has been steady progress in creating mechanisms, policies and avenues to protect wetlands across the country and internationally. The failings are in implementing these tools. The governance and care

of wetlands has suffered from a lack of political will, basic resources and implementation, and forums for cross-border/agency management discussions and actions, scientific and technical knowledge, and perhaps a sense of urgency.

The future status of wetlands has many implications. In the southern parts of Canada, it is not just a case of continued wetland losses but also a reflection about how we care for life-sustaining resources. Wetlands are closely linked with water resource management and the quality of water and the care given to the landscape that water drains from is vital to wildlife and people. Climate change will, under most scenarios, affect the mid and higher latitudes in Canada where most wetlands exist. What does this mean in the sense of national, federal/provincial/territorial and international resource conservation commitments and plans? When will the expected changes be given serious consideration in adaptive management? Given the status of wetland knowledge now (conditions, stressors, responses), what types of wetland goals and objectives exist? We generally lack specific landscape and ecosystem based objectives that will serve as targets and performance measures to plan and meet future wetland conservation needs.

References

Beasley, K. and R. Boardman. 2001. *Politics of the Wild. Canada and Endangered Species.* Oxford University Press. Don Mills, Ontario.

Commission for Environmental Cooperation. 2001. *The North American Mosaic: A State of the Environment Report*. North American Commission for Environmental Cooperation. Montreal, Quebec.

Cox, K.W. 1993. *Wetlands: A Celebration of Life*. *Final Report of the Canadian Wetlands Conservation Task Force.* Sustaining Wetlands Issue Paper, No. 1993-1. North American Wetlands Conservation Council (Canada). Ottawa, Ontario.

Environment Canada. 1996. *The State of Canada's Environment*. Minister of Public Works. Ottawa, Ontario.

Gauthier, D. and E. Wiken. 2001. Monitoring the Conservation of Grassland Habitats, Prairie. *EMA Journal.*

Gauthier, D., L. Patino and K. McGovern. 2002*. Status of Native Prairie Habitat, Prairie Ecozone, Saskatchewan*. Report No. 8.65A.1R-01/02. Wildlife Habitat Canada. Ottawa, Ontario.

Government of Canada. 1991. *The Federal Policy on Wetlands Conservation*. Environment Canada. Ottawa, Ontario.

Lynch-Stewart, P., I. Kessel-Taylor and C.D.A. Rubec. 1999. *Wetlands and Government: Policy and Legislation for Wetland Conservation in Canada*. Sustaining

Wetlands Issues Paper, No. 1999-1. North American Wetlands Conservation Council (Canada). Ottawa, Ontario.

Moore, H. and E. Wiken. 1998. *Wetland Conservation Analysis*. Canadian Council on Ecological Areas Technical Report. Ottawa, Ontario.

National Wetlands Working Group. 1988. *Wetlands of Canada*. Ecological Land Classification Series, No. 24. Canada Committee on Ecological Land Classification. Sustainable Development Branch, Environment Canada and Polyscience Publications Inc. Montreal, Quebec.

Phillips, A. 1998. Management Categories for Protected Areas. *Canadian Council on Ecological Areas ECO Newsletter* 12: 4-9.

Statistics Canada. 2000. *Human Activity and the Environment 2000*. Statistics Canada. Ottawa, Ontario.

United States Environmental Protection Agency. 2002. *America's Wetlands: Our Vital Link Between Land and Water*. Washington, D.C.

Warner, B.G. and C.D.A. Rubec (eds). 1997. *The Canadian Wetland Classification System*. *Second Edition*. National Wetlands Working Group. Wetlands Research Centre. University of Waterloo. Waterloo, Ontario.

Wiken, E. B., D. Gauthier, I. Marshall, K. Lawton and H. Hirvonen. 1996. *A Perspective on Canada's Ecosystems: An Overview of the Terrestrial and Marine Ecozones*. Canadian Council on Ecological Areas Occasional Paper, No. 14. Ottawa, Ontario.

Wiken, E.B. and D. Gauthier. 1998. Reporting on the State of Ecosystems: Experiences with Integrating Monitoring and State of the Environment Reporting Activities in Canada and North America. pp. 233-238 In *Proceedings of the North American Symposium on Towards a Unified Framework for the Inventorying and Monitoring Forest Ecosystem Resources.* Guadalajara, Mexico. C.A. Bravo and C.R. Franco (compilers). Technical Report No. RMRS-P-12. United States Department of Agriculture, Rocky Mountain Research Station. Fort Collins, Colorado.

Wildlife Habitat Canada. 2001. *The Status of Wildlife Habitats in Canada–2001*. Wildlife Habitat Canada. Ottawa, Ontario.

CHAPTER 3: WETLAND INVENTORY AND MONITORING: PARTNERING TO PROVIDE A NATIONAL COVERAGE

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Abstract

Inventory and monitoring are key elements for effective implementation of wetland management programs, policies, legislation and agreements. The extent, date, resolution, classification standard and availability of digital wetland inventory information varies among Canada's 14 political jurisdictions. Canada currently has poor capacity to definitively report on the status and trends of its wetland resources, the success of its conservation programs or compliance with international agreements using existing wetland inventories. Advances in remote sensing and processing technology and data management systems can facilitate synoptic wetland inventories. Joint Ventures under the North American Waterfowl Management Plan have proven the value of regional and national partnerships in delivering wetland programs. The convergence of technology with an effective delivery mechanism establishes the opportunity to implement a National Wetland Inventory and Monitoring Program using a national classification standard.

Key issues

The review by Spiers (1999) suggests realistic estimates of the global extent of natural freshwater wetlands are 530 million hectares (Matthews and Fung 1987) and 570 million hectares (Aselmann and Crutzen 1989). The extent of wetlands in Canada is not known with any level of accuracy, but has been estimated at 127 million hectares (National Wetlands Working Group - NWWG - 1988) and more recently at 148 million hectares (Pole Star Geomatics Inc. 1997).

With at least 22% and potentially 28% or more of the world's freshwater wetlands, the various levels of government within Canada have shared national and global stewardship responsibilities for the wetlands within their jurisdictional boundaries. Within Canada this responsibility is expressed through legislation, policy and national accords such as the Canadian Biodiversity Strategy and Canada's Stewardship Agenda. International commitments have also been made by Canada to protect and restore its wetlands, specifically as a Contracting Party to international Conventions on Wetlands, Climate Change, Biological Diversity and Combating Desertification.

Canada, however, has limited national capacity to track or report on the status of its wetland resources. Achieving sustainable development is predicated upon informed decision making, particularly when integrating economic resource development and ecosystem health. Regional wetland inventories and national data sets that do exist have serious deficiencies in contributing to a national overview. The nation currently has poor capacity to definitively report on the status of all its wetland resources or the success of its conservation programs. There is no nation-wide wetland inventory, no reporting on regional trends in wetland loss or gain of area, functions or character, and no regular national status reporting of wetlands. Previous attempts at a national inventory have been frustrated by jurisdictional and institutional barriers, differing classification and mapping standards to meet operational needs, available technology and associated costs, and a poorly defined national strategic need.

A Decade of Review

The Sustaining Wetlands Forum held in 1990 was a catalyst for society's recognition of the ecological, hydrological, social, and educational attributes, functions and values of wetlands. This recognition is increasingly demonstrated through the application of a diverse suite of legal mechanisms by Canadian governments at all levels to promote wetland conservation and sustain their ecological and socio-economic functions (Lynch-Stewart *et al*. 1999).

Wetland inventory and site and ecosystem level evaluation and monitoring are key elements for effective implementation of resource management programs, policies and sustainable development indicators. Provincial, regional and national wetland inventories and data sets do exist (see summaries in: Hanson and Calkins 1996; Cihlar and Tarnocai 2000). However, the extent, date, resolution, classification standard and availability of digital wetland inventory information vary among Canada's 14 political jurisdictions.

There is broad agreement on the definition of a wetland as "*land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity adapted to a wet environment"* (NWWG 1988). A primary goal of wetland classification systems is to impose boundaries on natural ecosystems into like units that can be defined and characterized for the purposes of inventory, evaluation and management (Cowardin *et al.* 1979; NWWG 1988). The *Canadian Wetland Classification System* (CWCS)

(NWWG 1988), revised in 1997 (Warner and Rubec 1997), is hierarchical, scientifically based on ecological parameters that influence the growth and development of wetlands, designed to accommodate wetlands within the many ecoclimatic zones across Canada's large land area, and intended to meet the varied user interests and objectives. The hierarchical levels group wetlands by overall genetic origin of the ecosystem (class), surface morphology, surface pattern, water type, underlying mineral soil (form), and vegetation physiognomy (type).

Representing nearly 90% of Canada's wetlands, detailed attention to peatlands is critical for any classification system adopted for use in a national inventory. Significantly, the CWCS recognizes two of the five classes of wetlands as peatlands (bogs and fens). Peatlands are not easily recognized at the upper or lower levels of the Cowardin system, which has been adopted for use in the United States (Cowardin *et al*. 1979). Among the wetland classification systems used in Canada to undertake inventories, there is a need to examine the similarities and establish linkages between systems.

The Sustaining Wetlands Forum urged governments to undertake comprehensive wetland inventories to support the decision-making process at all levels (Cox 1993). Recommendations reported by Wedeles *et al*. (1992) – integration of existing data into comprehensive data bases and inventories and developing a well designed monitoring program – were restated in the report by the Canadian Wetlands Conservation Task Force (Cox 1993). Environment Canada was recommended to lead its development in cooperation with appropriate government agencies and non-government organizations.

The Secretariat to the North American Wetlands Conservation Council (NAWCC) (Canada) subsequently organized a National Workshop on Wetland Data Integration (Lynch-Stewart and Rubec 1993) and facilitated a series of studies (Consulting and Audit Canada 1994; Geomatics International 1995a, 1995b) to lay the groundwork for a proposed National Wetland Inventory Project using existing data to meet user needs. The information needs among users of wetland information is similar despite their varied backgrounds and interests. Users supported creation of an integrated data base(s); they wanted detailed management information; they continued to be frustrated by a lack of accuracy, detail and standardization; and they wanted both hard copy and digital access and products. Based on analyses, it was recommended that no additional resources be expended on integrating existing inventories. It was further recommended that once national standards were adopted, then each jurisdiction could launch its own new data set that could allow integration across provincial boundaries. The studies urged standardization of data in terms of vector format, attribute format, attribute structure and data locational georeferencing information.

Wetland inventories, old and new, exist for much of Canada at different scales, mapping conventions and digital systems to meet particular objectives. Although enormous effort went into developing the CWCS, it has not been widely adopted at the regional or provincial level where most high resolution wetland inventory and mapping has occurred. Other systems have been implemented to suit the objectives of specific

inventories (e.g. Stewart and Kantrud 1971; Golet and Larson 1974; Ontario Ministry of Natural Resources 1993; Halsey and Vitt 1996), and not with the perspective of contributing to a national effort (Davidson *et al.* 1999). This has negatively impacted Canada's capacity to definitively report on the status and trends of its wetland resources. Moreover, Davidson *et al*. (1999) conclude this lack of a national inventory with a standard classification system makes it virtually impossible to monitor wetlands at the ecosystem level except in those areas that have developed their own inventories, but then only if the same methodologies are adhered to over time.

A standard national approach to identifying and classifying wetlands would provide a basis for future monitoring. Advances in remote sensing technologies, combined with a wealth of information on wetlands in Canada, would facilitate the development of a national database. However, given the tremendous number of wetlands in northern Canada alone, the feasibility of this sort of inventory may not be possible given the limited available resources unless new mechanisms are developed to synergistically link fiscal, technical and human resources.

Emerging Opportunities

The Commissioner of the Environment and Sustainable Development (2001) has called for designation of a lead agency to facilitate federal wetland actions; and noted there is a significant need to integrate information and to monitor the status of wetlands. The Federal Wetlands Forum, created in February 2001 as a focal point for action-oriented exchange on wetland management issues among federal departments and several national non-governmental organizations, is supportive of a national wetland inventory. Moreover, wetlands are proposed as one of a national set of environment and sustainable development indicators within the National Round Table on the Environment and the Economy's (NRTEE) Environment Sustainable Development Indicators (ESDI) Initiative (Delaney 2002).

The ESDI Initiative, brought forward by the Minister of Finance in the 2000 Spring federal budget, is to develop a set of national environment and sustainable development indicators to complement the macro-economic indicators that currently summarize the state of the national economy. Rather than emphasizing *income*, sustainable indicators place an emphasis on *wealth*, which are those factors upon which we depend for continued development as a society, particularly the services provided by a clean environment. The ESDI Initiative also recommends improvement in the quality and quantity of environmental information. Ensuring the *capital* is sufficient to meet the needs of future generations is the substance of sustainable development. Delaney's report proposes remote-sensing technology be used to develop a National Wetland Inventory and Monitoring Program using an approach that is strategic, collaborative and achievable.

A National Wetland Inventory would be an immense undertaking exceeding the resources any single agency could realistically allocate. The North American Waterfowl Plan (NAWMP) was developed to address an analogous situation that exceeded the

resources of the federal United States, Mexican and Canadian wildlife management agencies, specifically the restoration of waterfowl populations to the levels recorded during the 1970s. To implement the NAWMP, partnerships of government and non-government agencies at all levels organized into Joint Ventures across North America. In Canada there are four habitat-based Joint Ventures delivering wetland conservation programs with an effective governance structure to facilitate cooperation and avoid duplication from the local to national level. These Joint Ventures have proven the value of regional and national partnerships in delivering wetland programs. The NAWMP is coordinated at the national level by the North American Wetlands Conservation Council (NAWCC) (Canada).

In the last several years, numerous groups have begun to seriously explore developing national inventory and monitoring initiatives that could contribute to our understanding and management of wetlands. The Earth Observation for Sustainable Development of Forests (EOSD) Project is a partnership of federal and provincial governments, industry and universities to develop a land cover map of the forested, including wetlands, area of Canada based on Landsat data (Wulder 2002). In February 2002 a workshop organized by GeoConnections (Natural Resources Canada) was held to develop a consensus on Canadian land cover standards and classification schemes; and to establish conditions for the integration of existing and emerging mapping initiatives into a National Land Cover Initiative (NLCI) based on the EOSD Project. Cihlar and Tarnocai (2000) call for further development of a national wetlands data base as part of the Canadian Climate Observing System. These national initiatives are complemented by provincial (e.g. Southern Ontario Land Resource Information System) and regional (e.g. Western Boreal Forest Initiative) mapping programs.

These efforts suggest the opportunity exists to establish the foundation and implement a National Wetland Inventory based on the convergence of these ideas. An approach that relies upon remote-sensing technology holds the promise of greater efficiency, lower costs, and ease of repeatability (and thus developing a trend indicator, not just a one-time status inventory). Acquisition costs of Landsat TM and Radarsat 1 imagery have been reduced, and some barriers have been removed for data sharing. Technological capabilities in remote sensing (such as Landsat TM, Radarsat 1 and 2) have advanced rapidly in recent years (and can be expected to continue to advance), making a synoptic remote-sensing wetland inventory a very realistic proposition. The convergence of technology with an effective delivery mechanism establishes the opportunity to implement a National Wetland Inventory and Monitoring Program using a national classification standard.

A New Approach

There are however numerous challenges to overcome, both technically and operationally to achieve a National Wetland Inventory. A multi-agency project has developed to refine techniques, develop protocols and move to a consensus on standards for a national inventory; and to set the stage for a second phase to develop a high resolution digital wetland thematic map product for all of Canada. The Project

(Phase 1) has a small coordination team with representatives of the Canadian Wildlife Service (Environment Canada), the Canadian Space Agency, Ducks Unlimited Canada, Radarsat International and the North American Wetlands Conservation Council (Canada). This effort is grounded in the following assumptions:

- There is a genuine desire by federal, provincial and territorial governments and national non-government organizations to ensure that (a) wetland inventories should meet minimum national standards, and (b) there are operational needs to have national or compatible regional inventories;
- A national or regional standardized approach to wetland inventory should be coordinated nationally to ensure national consistency, delivered regionally where the field expertise exists, and be operationally directed using a team approach;
- Advances in computer and software technology since 1995 provide increased flexibility for undertaking and processing wetland inventory data at remote locations;
- Based on the analyses conducted in the 1990s, existing wetland data inventories cannot be integrated into national inventory because of the heterogeneity of the many data sets, but will provide valuable ancillary data;
- The inventory must be based on proven techniques;
- Synergies can be achieved among partnering agencies, that is impossible if undertaken separately, for a national inventory to be timely, cost effective and achievable;
- Data sharing and co-funding agreements and protocols can be facilitated among partner agencies and governments;
- The national inventory can be used as a basis for monitoring wetland changes in the future.

Phase 1 builds upon ongoing wetland inventory programs in Nova Scotia and Prince Edward Island, the Lower St. Lawrence River (Quebec), southwestern Manitoba and north-central Alberta. Each target area has its own partnership to deliver the project. It is a remote sensing based inventory using both Landsat TM and multi-temporal Radarsat 1 SAR, pattern recognition and/or decision tree software (e-Cognition and CART, respectively), and ancillary information (e.g. ground-truthing, DEMs, vector data, existing inventory data). The Canadian Centre for Remote Sensing, in partnership with the Centre for Topographic Information, is providing orthorectified Landsat 7 TM to the project through Environment Canada. While the EOSD and National Land Cover Initiative (NCLI) are using Landsat exclusively, Deslandes *et al*. (2002) reported increased discrimination between dry and wet lands by using a combination of Radarsat 1 and Landsat TM images. Phase 1 is examining the application of this approach to other ecological regions of the country, adapting and refining techniques to extract and validate wetland and vegetation information.

Much effort is being devoted to the classification scheme. Although Phase 1 is based on the CWCS (NWWG 1988; Warner and Rubec 1997), some modifications must be made because this is a remote sensing exercise. As such, cutoff or “trigger” points in all classes must be based on interpreting spectral signatures. The classification

scheme needs to be robust enough to allow crosswalks to other classification systems at different scales, both larger and smaller, and other related projects like the NCLI.

Phase 1 has been organized to operate within the existing governance structure provided by the NAWCC (Canada) under the umbrella of the North American Bird Conservation Initiative (NABCI). Because of the importance of solid partnerships and the necessity of a focus on wetlands, Phase 1 is managed through the existing partnerships within the federal, territorial and provincial governments as well as in the conservation community.

Summary

1) Canada currently has no nation-wide wetland inventory, limited capacity to report on regional trends in wetland loss or gain of area, functions or character, and no regular national status reporting of wetlands;

2) There is no designated federal agency to promote and facilitate a national wetland inventory among federal departments or to coordinate efforts with other levels of government and non-government agencies;

3) Existing wetland data inventories cannot be integrated into a national inventory because of the heterogeneity of the many data sets, but will provide valuable ancillary data to a national initiative;

4) The *Canadian Wetland Classification System* has not been widely adopted at the regional or provincial level, and crosswalks with other classification systems have not been formalized;

5) There are numerous land cover inventory initiatives ongoing or planned that could contribute to delivering a synoptic wetland inventory that meets strategic needs, is collaborative in its delivery and achievable;

6) Advances in technology, removal of some barriers to data sharing and a history of collaborative partnerships delivering wetland programs provide an opportunity that never existed previously to deliver a national wetland inventory.

Recommendations

1) With input from the Federal Wetlands Forum, establish a lead department or organization to promote and facilitate national consultations in support of a national wetland inventory, and to coordinate initiatives and inputs of federal partners;

2) Create a Working Group of the various groups and interests discussing establishment of national inventories or monitoring programs for land cover, land use, and sustainable development indicators in order to identify project

compatibilities, efficiencies in data sharing and data processing protocols, and resource and project coordination;

3) A national wetland inventory should be coordinated nationally to ensure national consistency, delivered regionally where the field expertise exists and be operationally directed using a team approach;

4) Establish an interdisciplinary working group to include wetland ecologists, classification specialists and mapping experts to create crosswalks between classification systems that can be uniformly applied;

5) Adopt space-based remote sensing as a primary tool for inventory and monitoring of wetland resources and continue to assess technological opportunities as they become available;

6) Remove impediments to data sharing.

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References

Aselmann, I. and P.J. Crutzen. 1989. Global distribution of natural freshwater wetlands and rice paddies, and their Net Primary Productivity, seasonality and possible methane emissions. *Journal of Atmospheric Chemistry* 8: 307–358.

Cihlar, J. and C. Tarnocai. (eds). 2000*. Wetlands of Canada and Climate Change: Observation Strategy and Baseline Data.* Report of a workshop 24-25 January 2000. Ottawa, Ontario. 67 p. (http://www.ccrs.nrcan.gc.ca/ccrs/rd/sci_pub/biblio_e.html).

Commissioner of the Environment and Sustainable Development – Report to Parliament. 2001. *Chapter 1. A Legacy Worth Protecting: Charting a Sustainable Course in the Great Lakes and St. Lawrence River Basin*. Office of the Auditor General of Canada. Ottawa, Ontario. (www.oag-bvg.gc.ca/domino/reports.nsf/html/ c2001menu_e.html).

Consulting and Audit Canada. 1994. *User Needs Survey for Wetland Information, Phase 3*. Contract Report to the North American Wetlands Conservation Council (Canada). Ottawa, Ontario.

Cowardin L.M., V. Carter, F.G. Golet and E. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. Report No. FWS/OBS-79/31, Fish and Wildlife Service, United States Department of the Interior. Washington, D.C.

Cox, K.W. 1993. *Wetlands: A Celebration of Life. Final Report of the Canadian Wetlands Conservation Task Force*. Sustaining Wetlands Issues Paper, No. 1993-1. North American Wetlands Conservation Council (Canada). Ottawa, Ontario. 67 p.

Davidson, I., R. Vanderkam and M. Padilla. 1999. *Review of Wetland Inventory Information in North America*. Wetlands International – Americas. Ottawa, Ontario. (http://www.wetlands.org/inventory&/GRoWI/report_list.html).

Delaney, V. 2002. *A Wetlands Indicator for Canada. Final Report*. Environment and Sustainable Development Indicators Initiative. National Round Table on the Environment and the Economy. Delaney and Associates Inc. Ottawa, Ontario.

Deslandes, S., M. Grenier, L. Bélanger, G. Lacroix and V. Zingraff. 2002. The Wetland Conservation Atlas of the St. Lawrence Valley Produced from Decision Tree Classification of Radarsat and Landsat Images. In *Proceedings of 2002 International Geoscience and Remote Sensing Symposium*. June 24-28, Toronto, Ontario.

Geomatics International. 1995a. *National Wetland Data Integration – A Feasibility Study*. Contract Report to the North American Wetlands Conservation Council (Canada). Ottawa, Ontario.

Geomatics International. 1995b. *Study of National Topographic Data for Wetland Inventory*. Contract Report to the North American Wetlands Conservation Council (Canada). Ottawa, Ontario.

Golet, F.C. and J.S. Larson. 1974. *Classification of Freshwater Wetlands in the Glaciated Northeast*. U.S. Fish and Wildlife Service Resources Publication No. 116. Washington, D.C. 56 p.

Halsey, L.A. and D.H. Vitt. 1996. Alberta Wetland Inventory Standards. In *Alberta Vegetation Inventory Standards*. Resource Data Division, Alberta Environmental Protection. Edmonton, Alberta.

Hanson, A.R. and L. Calkins. 1996. *Wetlands of the Maritimes: Revised Documentation for the Wetland Inventory*. Technical Report Series, No. 267. Canadian Wildlife Service, Environment Canada. Sackville, New Brunswick.

Lynch-Stewart, P. and C.D.A. Rubec. 1993. *Summary Report of the National Workshop on Wetland Data Integration.* North American Wetlands Conservation Council (Canada) Report No. 93-2. Ottawa, Ontario.

Lynch-Stewart, P., I. Kessel-Taylor and C. Rubec. 1999. *Wetlands and Government. Policy and Legislation for Wetland Conservation in Canada.* Sustaining Wetlands Issues Paper, No. 1999-1. North American Wetlands Conservation Council (Canada). Ottawa, Ontario. 57 p.

Matthews, E. and I. Fung. 1987. Methane emission from natural wetlands: Global distribution, area, and environmental characteristics of sources. *Global Biogeochemical Cycles* 1(1), 61–86.

National Wetlands Working Group (NWWG) 1988. *Wetlands of Canada*. Ecological Land Classification Series, No. 24. Sustainable Development Branch, Environment Canada and Polyscience Publications Inc. Montreal, Quebec. 452 p.

Ontario Ministry of Natural Resources. 1993. *Ontario Wetland Evaluation System*: *Southern Manual*. NEST Technical Manual TM-002. Toronto, Ontario.

Pole Star Geomatics Inc. 1997. *Wetland distribution of Canada*. Map and database. Geological Survey of Canada, Agriculture and Agri-Food Canada and Environment Canada. Ottawa, Ontario.

Spiers, A.G. 1999. *Review of International/Continental Wetland Resources*. Environmental Research Institute of the Supervising Scientist. Jabiru, Northern Territory, Australia. (http://www.wetlands.org/inventory&/GRoWI/report_list.html).

Stewart, R.E. and H.A. Kantrud. 1971. *Classification of Natural Ponds and Lakes in the Glaciated Prairie Region*. Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, United States Department of the Interior. Washington, D.C. 57 p.

Warner, B. G. and C.D.A. Rubec (eds). 1997. *The Canadian Wetland Classification System*, *Second Edition*. National Wetlands Working Group. Wetlands Research Centre, University of Waterloo. Waterloo, Ontario. 68 p.

Wedeles, C.H.R., J.D. Meisner and M.J. Rose. 1992. *Wetland Science Research Needs in Canada*. Canadian Wildlife Service, Environment Canada; North American Wetlands Conservation Council (Canada); and the Wetlands Research Centre, University of Waterloo. Waterloo, Ontario. 30 p.

Wulder, M. 2002. Mapping the Land Cover of the Forested Area of Canada with Landsat Data. *In Proceedings of 2002 International Geoscience and Remote Sensing Symposium.* June 24-28, 2002. Toronto, Ontario.

CHAPTER 4: WETLANDS IN THE WORKING LANDSCAPE … AN INTEGRATED APPROACH

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Abstract

Wetlands make up an integral part of Canada's mosaic of landscapes. They are dotted across the country, and assume different forms, depending on local ecosystems. Most are naturally occurring, whether they be permanent or seasonal, however some are man-made. Types of wetlands include natural marshes and bogs of eastern Canada, peatlands, prairie potholes, mountain and northern wetlands, and in contrast, wetlands constructed to serve a specific purpose. Wetlands are found throughout Canada's working landscape in agricultural, forested, mining and energy-producing regions, in parks and other protected areas, within watersheds where hunting, fishing and tourism occur, and within densely-populated urban areas. Seven examples of wetland stewardship programs and activities in Canada's working landscapes are given.

Key Issues

Three key issues have been identified:

What is the situation now? Wetlands are a product of their environment. They may be complemented by functions of the working landscape. Alternatively, they may be at the mercy of their environment. Their conservation and sustainable use may be greatly influenced by the land use in which they occur. Though there are numerous examples of good conservation practices and beneficial wetland management in all sectors, one must also consider the potential for the detrimental use and/or neglect of wetland resources. Extensive wetland resources have already been lost, largely due to the lack of integrated resource management planning.

What has occurred? Activity in the working landscape has affected the quality of wetlands, and in fact, the mere existence of many wetlands. With respect to agriculture, it is no secret that drained and/or seasonally dry wetlands have been plowed and cultivated to extend crop area. Some operations have allowed livestock full access to wetlands for use as watering holes. As in other resource-based industries, there have also been cases of serious pollutant seepage to groundwater. From a different perspective, overuse of groundwater can affect surface wetlands. There are more

examples where other industries have directly affected wetlands as well. Some forested areas have been intensely harvested without due regard to soil erosion and runoff into wetlands. Some mining operations have severely altered the local landscape resulting in pollution of adjacent wetlands. With respect to parks and fisheries issues, impacts to wetlands have arisen from over-populated usage of adjacent watercourses, and/or biological interventions (beaver dams, invasive plant and animal species). Perhaps the most vulnerable wetlands however, have been those located in close proximity to urban centres. Many have been filled in for residential or industrial development sites. The occasional construction of an artificial wetland may not prove to be an adequate alternative.

Where do we want to go and how do we get there? Canada's wetland resources must be conserved. "Awareness of the benefits" may be the most valuable tool available to ensure that this goal is met. Government departments, non-government organizations, associations, industry, landowners and users, and the general public must all be made aware of the benefits of these wetland resources. Wetlands have great ecological, environmental, economic, cultural and social relevance for society. They host an incredible source of both plant and animal life, including some species at risk. They provide water and critical habitat for many local animal species, and they provide very important staging habitats for migratory waterfowl. Protection and/or restoration of wetland habitat are crucial for the conservation of biodiversity and the preservation of wetland genetic resources. Wetlands can also play an important role in terms of water storage and groundwater recharge. In terms of environmental risk management, they can serve as retention basins for nutrients, sediments and pollutants, and subsequently, serve as natural filters for water flowing or seeping into adjacent watercourses. Wetlands are also natural reservoirs for flood prevention, and may play a role in the stabilization of local climatic conditions. Organic soil wetlands are net carbon reservoirs, and therefore serve as natural sinks for greenhouse gases. There is a growing awareness that most wetlands are indeed valuable economic resources in their natural state. An added benefit is that they also offer recreation, ecotourism, hunting and fishing opportunities.

Considerations

From another perspective, one must understand how vulnerable wetlands can be. In the context of climate change, global warming could have a significant detrimental effect on the rate of evaporation of wetlands. If temperature rises and moisture becomes more scarce, the importance of wetlands could rapidly surface in the public forum. In a more local context, wetland water quality can be negatively influenced by surface run-off from urban development, industry, manufacturing, forestry (soil erosion), mining and agriculture. Harmful elements in the wetlands could then affect groundwater and adjacent watercourses. The amount of water sustaining a wetland could be adversely impacted by upstream damming, whether by beavers or human alteration. Such a change could affect an entire wetland ecosystem.

Wetland stewardship must be encouraged, from the federal/national level through to the "hands on" local level. Existing programs should be documented so that gaps may be identified. Coordinated efforts could then focus on developing wetland preservation strategies where needed.

Case Studies

Seven wetland stewardship programs and actions in working landscapes are given below. Within the context of this paper the following seven case studies are presented to generate discussion. These represent a sample of the resource-based interests of agriculture, forestry, mining and energy, fisheries, parks, transportation and urban development. The contributors and their affiliations for the case studies are listed in each section.

The following case studies look at: (I) Agriculture, (II) Forestry, (III) Fisheries and Mining, (IV) Provincial Stewardship Initiative (Saskatchewan), (V) Parks, (VI) Wetlands in the Urban Context and (VII) Constructed Wetlands.

I. Agriculture … A Federal Perspective

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Wetlands are features of our environment that naturally occur on land which is now farmed. They are important as they can affect surface and groundwater, soil moisture and nutrients in adjacent areas, air quality (as wetlands offer potential for carbon sequestration), and of course, biodiversity (plants and animals). As agriculture is a business, it is important to realize that out of necessity, farm management decisions are made with economics in mind. Generally speaking, farmers are good stewards of the land. Many have developed environmental farm plans, have practised conservation tillage, used integrated pest management and have upgraded their manure storage and handling systems. However, as farm management decisions can affect the quality of the environment, it is important that one recognize how all resources are connected.

Agricultural Policy Framework: Recently, the federal government announced the new Agricultural Policy Framework (APF) for Canada. This federal/provincial/territorial initiative was developed through consultation, to set Canadian agriculture out front as the world leader in sustainable agricultural production. Today's agricultural sector is faced with many pressures of intensified international competition, increasing consumer demands, advances in science and increased complexity in the industry. The government has committed to move the agricultural sector beyond crisis management. With all this comes more environmental challenges. The new APF addresses these concerns and the "Environment" is one of its five elements. Others are food safety and quality, science and innovation, business risk management and renewal.

The focus of the “Environment” element will be on national, coordinated action towards achieving the highest standard of environmentally-responsible production. The APF will focus on the goals of improving the quality of our air, water, soil and biodiversity. To achieve these goals, new programs have been developed. The programs that will specifically address issues, including wetlands on the farm, are Environmental Farm Plans and Greencover. Farmers will need support as they take accelerated on-farm action to address environmental challenges.

Environmental Farm Plans: Environmental Farm Planning will become part of normal farm operations, at a national scale. Environmental scans, potentially at the watershed level, followed by Environmental Farm Plans (EFPs) will allow for areas of risk to be identified and for incentives to be targeted. These EFPs may then be complemented by provincial programs, such as Nutrient Management Plans. There is potential for farms to become “EFP-certified,” based on this comprehensive, whole-farm approach to assess and address all risks, and to develop an action plan within the means of the farm operation. Consideration will also be given to existing stewardship activities.

Greencover Program: The objective of the Greencover Program is to increase the adoption of more sustainable land use and land management practices on environmentally sensitive lands through the provision of technical and financial assistance to producers and landowners, and to integrate shelterbelts for all agricultural lands. The Program will include four components: conversion, critical area, shelterbelt and technical assistance. The objective of the conversion component is to convert “environmentally sensitive” cultivated lands to permanent cover. These include lands that should never have been cultivated. The objective of the “critical areas” component is to protect water quality by enhancing the health and function of riparian areas and/or critical wildlife habitat. These include wetlands in groundwater recharge areas.

Agriculture and Agri-Food Canada’s Analytical Capacity: Agriculture and Agri-Food Canada (AAFC) has in place, the strong analytical capacity to assess the relationships between environmental, social and economic factors that may affect the agricultural industry. AAFC has worked with others to develop a series of agri-environmental indicators, and would now like to include the capacity to address the unique issues associated with wetlands. AAFC is now moving ahead to develop an independent wetland indicator, in collaboration with other experts in the field.

II. Forestry … A Federal Perspective

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Canadian Forest Service Research Program: Forests cover about half of Canada’s landmass and consequently contain much, if not most, of Canada’s freshwater. The Canadian Forest Service (CFS) conducts research on issues driven by forestry practices, forest health, protection and landscape management as part of its mandate

for the sustainable development of our forest resources. Thus, the issues surrounding water quality and quantity are related to a large part of the CFS Research Program.

This Program includes:
1. Harvesting practices and natural disturbances that have a direct and, frequently, an immediate impact on water abundance flow and timing;
2. Forest management activities such as pest management result in the application of substances to protect the forest resource and maintain biological diversity, but the addition of these substances can impact water quality;
3. Application of forest management policies such as afforestation, establishment of energy crops, and climate change mitigation activities involve land use changes, the application of waste products to lands, the need to protect crops, all of which impact water quality and quantity;
4. Classification of forest lands including peatlands and wetlands; and
5. Inventory of carbon in soils and wetlands as part of the modelling of the carbon budget of forests and forest products.

There are several considerations:
1. Current management and conservation policies for forests and wetlands have evolved under consideration of a relatively stable climate.
2. These policies of consumption and management have been in place over relatively short times; that is within one to three rotations in forest ecosystems.
3. Current socio-economic considerations are evolving rapidly as citizen and non-government organization participation in resource utilization decision-making is becoming more common.
4. Environmental conditions are changing as climate becomes less predictable and the probability of extreme events increases.
5. Past management and utilization activities have made some environments more vulnerable to external changes.

III. Fisheries and Mining – A Case Study in the Mountain Wetlands of British Columbia…Using Wetlands to Treat Acid Mine Drainage

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Acid Mine Drainage (AMD) is produced when large quantities of rock containing sulfide minerals are exposed to air and water after mining operations. The reaction creates sulfuric acid often leading to the growth of bacteria, which accelerates oxidation and acidification and leaches trace metals from the exposed rock.

Trace metals such as copper have been found to be toxic to salmonids at extremely low concentrations. In 1995, water quality objectives were reported upon for the Tsolum

River on Vancouver Island, indicating that soluble copper had to be reduced below seven micrograms per litre for restoration of salmonids to the river. The Tsolum River salmon populations were severely impacted following the operation of a copper mine from 1964 to 1967 in the upper watershed. Various means of reducing the acid mine drainage and dissolved copper in the Tsolum system have been attempted since 1988. One method that has been considered, but not yet used in the Tsolum, is the "wetland option" whereby contaminated water from the mine site would be diverted into wetlands on the mountainside.

The report titled, *State of the Tsolum River – A Comprehensive Report on the Work Completed by the Tsolum River Task Force 1997-1999* makes the following comment: "Wetlands have the ability to naturally filter metals from water and neutralize acid mine drainage. Copper is initially removed from the water by the wetland vegetation. The vegetation dies, sinks to the bottom of the wetland and decays. The decomposition process removes oxygen, whereby sulfate is reduced to sulfide, which immobilizes the copper. This natural phenomenon is limited to large wetlands experiencing low flows, relatively mild temperatures and acidity. It is not known if there is sufficient wetland area in the upper Tsolum River watershed to handle the very high peak copper loads which occur in the spring and fall."

As of December 2002 there has still not been wetland treatment of contaminated water in the Tsolum River watershed although there seems to be agreement that the "wetland option" is viable. Current thinking indicates that the wetland treatment might be effective if used with other remediation options such as covering the waste rock with glacial till to reduce water and air exposure. Some concerns have been expressed about the use of healthy wetland systems to absorb mine waste. See the website of the Environmental Mining Council of British Columbia: www.miningwatch.org/emcbc/.

IV. Provincial Stewardship Initiatives … Saskatchewan Sets an Example

Contributor:
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Saskatchewan Watershed Authority

It must be acknowledged that within the provinces and territories, there are numerous examples of groups working together to develop wetland stewardship initiatives. These include conservation authorities, stewardship councils, land trusts, municipal and community interest groups, non-government organizations and others.

On October 1, 2002, the Saskatchewan Watershed Authority was formed. Its mandate is aimed at source water protection through aquifer and watershed planning and stewardship activities and programs. It brought together SaskWater, all of Saskatchewan Wetlands Conservation Corporation and some Saskatchewan Environment staff.

While the Authority has no regulatory function, its main programs are delivered through two divisions: (a) the Operations Division, comprised of groundwater management, basin operations, infrastructure management and regional operations, is responsible for the allocation of ground and surface water and maintenance and analysis of water sources and infrastructure; and (b) the Stewardship Division consisting of watershed and aquifer planning, geomatics, projects and partnerships, and watershed monitoring and assessment, is responsible for watershed management and planning through the establishment of partnerships and projects to ensure the protection and restoration of the province's water sources.

V. Parks … A Federal Perspective

Contributor:
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Parks Canada Agency

Parks Canada's purpose is to fulfill national and international responsibilities in mandated areas of heritage recognition and conservation; and to commemorate, protect and present places which are significant examples of Canada's cultural and natural heritage in ways that encourage public understanding, appreciation and enjoyment of this heritage, while ensuring long-term ecological and commemorative integrity.

Parks Canada's heritage activities entail direct responsibility for the management of federal lands and their associated resources. This is the case for national parks, aspects of marine conservation areas and a number of national historic sites, including historic canals. National parks and national historic sites receive more than 26 million person-visits per year.

There are 39 national parks and national park reserves in Canada. Each protects an outstanding example of the nation's natural beauty and ecological diversity, and most include wetlands. They are part of an international system of protected areas in Canada, North America and the global community. Wood Buffalo National Park in Alberta and the Northwest Territories includes two Ramsar sites, the last remaining natural nesting area for the endangered whooping crane and the Peace-Athabasca Delta, one of the largest freshwater deltas in the world. The Ramsar Convention designates wetlands of international importance. Two other Ramsar sites are the Old Crow Flats in Vuntut National Park, Yukon and the marshes of Point Pelee National Park, one of the largest wetlands remaining in southern Ontario.

Parks Canada also manages 145 national historic sites and canals. The two largest historical canal systems, the Rideau Canal and the Trent-Severn Waterway have extensive wetland complexes. Nine national parks and national historic sites include or are parts of UNESCO World Heritage Sites.

Management of ecosystems for national park purposes differs markedly from that of other lands, where effort may be directed toward modifying or controlling nature, producing crops or extracting natural resources. Within national parks, efforts are directed at maintaining ecosystems in as natural a state as possible. This goal has far-reaching implications in that many concepts and practices that are relevant or essential to successful resource management on other lands are inappropriate in national parks.

Sustaining the integrity of park ecosystems is a major challenge because parks seldom contain complete or unaltered ecosystems. This, combined with increasing and cumulative stress from sources such as adjacent land use, downstream effects of air and water pollution, invasion by exotic species, visitor use and climate change can result in irreversible degradation of park ecosystems, the loss of biodiversity and impoverishment of gene pools.

Ecosystem management provides a conceptual and strategic basis for the protection of park ecosystems. It involves taking a more holistic view of the natural environment and ensuring that land use decisions take into consideration the complex interactions and dynamic nature of park ecosystems and their finite capacity to withstand and recover from stress induced by human activities. The shared nature of ecosystems also implies that park management will have effects on surrounding lands and their management.

Management is guided by the establishment of clear, practical and measurable objectives that are consistent with the park management plan and by the rigorous application of science in the collection and interpretation of research and monitoring data. Thus, the concept of partnerships is particularly important since universities, conservation organizations and the private sector have much to contribute towards research and ecological monitoring initiatives within national parks. The national parks are currently engaged in a number of research, monitoring and active management initiatives in support of restoration and conservation of wetland and aquatic ecosystems and associated species, including species at risk. Work has begun on the development of a National Monitoring Program. The results of research and monitoring of park ecosystems are incorporated in the biennial State of Heritage Areas Report to Parliament and the State of the Parks Report produced every five years by each national park as input to the review of the Park Management Plan.

Parks Canada works closely with other land management agencies to develop a better understanding of the relationship between existing land use practices and their effects on the natural environment. National parks are becoming increasingly important in national and international efforts to maintain biodiversity and genetic resources. Consequently, Parks Canada negotiates specific agreements with provincial and territorial planning and conservation agencies and also supports involvement in the UNESCO Man and the Biosphere Program as a means of integrating regional planning around parks.

VI. Wetlands in the Urban Context … A Federal Perspective

Contributor:
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The following is a case study on the conservation and restoration of the Oshawa Second Marsh, on the north shore of Lake Ontario. This project is an excellent example of a diverse wetland project that involves all levels of government, numerous community interests, a major corporate partner, a "Friends of" organization and industry partners. The watershed is changing from agriculture to residential and industrial so land use issues figure prominently in the landscape. The marsh is bounded on the west by the Oshawa Harbour, an active industrial shipping centre, on the north by Highway 401 and to the east, the national headquarters of General Motors of Canada Ltd. As a coastal marsh it is subjected to the myriad of stressors (carp, water levels, etc.) associated with the Great Lakes. It is clearly a working landscape.

A GLWCAP Project with Many Partners: The southern Ontario area of the Great Lakes basin is a working landscape that supports many valuable coastal and inland wetlands that are under intense agricultural, urban and industrial development pressure. The Great Lakes Wetlands Conservation Action Plan (GLWCAP) is a partnership between Environment Canada, the Ontario Ministry of Natural Resources, Ducks Unlimited Canada, the Nature Conservancy of Canada and the Federation of Ontario Naturalists to conserve wetlands of the Great Lakes basin. All partners take responsibility to collectively deliver individual projects, milestones and strategies that best complement their strengths and interests. One GLWCAP project is at Oshawa Second Marsh.

Located in the City of Oshawa, Ontario on the north shore of Lake Ontario, the 123-hectare Oshawa Second Marsh was once a healthy, well-vegetated barrier beach wetland, with a robust and diverse wildlife community. The streams that feed the marsh drain a large, developed watershed. The Canadian Headquarters of General Motors of Canada and its associated McLaughlin Bay Wildlife Reserve is located on one side, with the Oshawa Harbour on the other.

The story of the degradation and subsequent rehabilitation of Oshawa Second Marsh is long and ongoing. By the 1970s, a combination of sedimentation from upstream agriculture and urbanization, dredgeate dumping, carp arrival and direct sewage discharges had seriously degraded the wetland. The final damaging events began in 1974, when the Oshawa Harbour Commission blocked the western outlet to the lake in order to raise water levels in the marsh, and allow heavy equipment to drill boreholes in preparation for harbour expansion. The following spring, large clumps of vegetation floated out to Lake Ontario through a new eastern outlet during record high water levels. This vegetation loss continued and, by the 1980s, vegetation was reduced to a narrow fringe of cattail.

Both the Harmony and Farewell Creeks drain into Oshawa Second Marsh. These watersheds continue to be under pressure from widespread land use changes as they are among the most rapidly developing areas in southern Ontario. Over the years, large-scale residential and infrastructure developments, intensive agriculture in the upper reaches of the watershed, and industrial activities have drastically altered the natural hydrology of the landscape.

It has been, and continues to be an enormous challenge to address the stressors affecting the wetland. Beginning in the mid-1990s, Oshawa Second Marsh was a rehabilitation demonstration site of the GLWCAP. The Second Marsh rehabilitation story is largely one of the government, non-government, community and corporate partnerships that have been formed.

Rehabilitation was initially led by Environment Canada from 1994 to 1996, working together with the City of Oshawa, Friends of Second Marsh and General Motors of Canada (a neighbouring landowner). In addition, a Watershed Stewardship Program was initiated in this period to contact upstream landowners and encourage and facilitate the adoption of best management practices for agricultural lands throughout the watershed. The goal of these partners in the first phase of rehabilitation was to restore, as much as possible, the wetland community of plants and animals that had existed prior to 1970.

Efforts included:
1. reopening of the western channel through the barrier beach;
2. creation of four deflector islands used to restore historic water flow patterns, built where such islands had previously existed; attempts to exclude carp through various means including a link fence, log barriers and protective cells made of discarded Christmas trees; creation of 11 habitat islands made of various materials. Some were filled with soil and rocks; others floated on logs in fixed locations. Nesting Common Terns unexpectedly occupied one island, resulting in the re-design of an island specifically for terns; and
3. construction of trails, bridges, viewing towers and boardwalks to encourage community appreciation of the marsh.

Each effort had variable successes and challenges. Valuable lessons were learned about coastal wetland rehabilitation that could be applied elsewhere around the Great Lakes. However, it seemed that a more intensive approach would be required to fully restore the original functions and values of Second Marsh.

Ducks Unlimited Canada (DUC) is leading the next phase of marsh rehabilitation. In 2001, DUC began a project to divert the sediment-laden Harmony Creek around Second Marsh to the lake to alleviate further sedimentation of the wetland and decrease turbidity. Construction of an earthen dyke on the eastern bank of the channel in the winter of 2001/2002 used natural channel design for the lower portion of the creek below the historic inflow to the wetland. A fishway was also constructed through the dyke between the diverted Harmony Creek and the marsh, allowing marsh access

for most fish, but excluding large carp that destroy submerged vegetation and cause increased turbidity. In addition, marsh water levels will be managed to promote vegetation regeneration using a pump located at the barrier beach.

The rehabilitation efforts appear to be working already. In the summer of 2002, turbidity levels dropped significantly in Second Marsh. The resulting improvement in water clarity has increased diversity and growth of submerged plants. Aquatic vegetation diversity, not seen in Oshawa Second Marsh in years, was observed and will be further encouraged by a drawdown of the marsh in 2003.

While short-term efforts appear to be working, the long-term solution calls for even better watershed management through a local landowner stewardship program and subsequently perhaps re-opening the marsh to the lake and creek once the vegetation has recovered.

VII. Constructed Wetlands

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Constructed wetlands are built with a specific purpose in mind. Just as the beaver builds a dam to deepen the water in a wetland, so do humans alter the landscape to restore, enhance or create wetlands. Wetlands are usually constructed in conjunction with a natural wetland site. They are either created with more than one goal in mind, or in fact, they end up serving more than one purpose. For example, wetlands may be constructed agricultural areas to aid in the fall/winter decomposition of crop stubble. In such a case, water could be held for spring/summer release when needed. This type of wetland could also provide fall and spring staging habitat for migratory waterfowl. Conservation organizations often aid in the restoration and/or enhancement of wetland habitats (e.g. Ducks Unlimited Canada).

In urban areas, the practice of constructing wetlands is becoming more prevalent, coupled with the realization (and regulation) of preventing direct urban runoff into adjacent watercourses. Many residential and industrial developments now incorporate these urban wetlands, as settling or filtering ponds, urban wildlife habitat and recreational trail sites. Some use these areas to contribute to their open space percentage requirement for development.

Wetlands may also be constructed to serve as wastewater settlement and filtering ponds. They may be used as final treatment extensions of urban wastewater facilities, or they may be constructed on farms or corporate processing sites to treat and filter animal or industrial waste. Again, they not only serve as effective filtering sites, but also provide habitat for local and migratory species.

Strategic Perspective – Looking Ahead

We must realize and build on the interdisciplinary nature of wetlands. This should be based on the following principles:

1. Work together – with government, associations, non-government organizations, industry and the general public, to identify and develop wetland stewardship programs that incorporate mandated activities.
2. Document existing research, policies and programs.
3. Identify wetland issues – strengths, weaknesses, opportunities and threats or gaps.
4. Build on the strengths, and encourage and take advantage of opportunities.
5. Accept that there are weaknesses, and try to develop these areas of work.
6. Identify threats and work to minimize or eliminate potential problems.
7. Identify gaps, then disseminate information, develop programs and allocate resources.
8. Provide information and offer advice based on good science.
9. Work in cooperation with landowners, while respecting their wishes and rights.
10. Be good stewards and acknowledge the efforts of others.

Recommendations

The authors propose the following three recommendations for national action to support an integrated approach to wetland management in Canada's working landscapes:

1. Work collaboratively with government departments and others interested in wetlands, towards the development of both short- and long-term wetland stewardship initiatives and policies, created within a sustainable development perspective.
2. Focus on means of addressing most current and pressing wetland issues, and in a timely fashion, disseminate knowledge, resources and assistance to landowners and stewards.
3. Identify and document the many wetland stewardship initiatives being implemented by landowners and interest groups at the local level, and acknowledge their contributions.

CHAPTER 5: WETLAND EDUCATION

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Abstract

This paper sets out a vision for what wetland education should look like in Canada. Wetland education should take place within parameters of good Environmental Education (EE) leading to ecological literacy. Effective EE is developing the knowledge, experiences and skills needed to evaluate environmental issues, and make informed decisions, value choices and actions. In this vision, an integrated network of business, governments, philanthropic institutions and non-government organizations cooperate to develop and deliver wetland education programs having high impact on target audiences. These programs, both existing and new, are well funded, have the necessary human resources, are of high quality and are delivered in the school system and in communities so that they reach key sectors of society, both youth and adults. The outcome of these programs is that individuals understand and celebrate Canada's wetland heritage, appreciate the tremendous values wetlands provide for their personal well-being, realize the vulnerability of wetlands and are inspired to take action to protect and restore wetlands in their communities. This vision is achievable in the next 10 years and the authors describe a working model that incorporates many of these concepts which is now operating in microcosm at the Tantramar Regional High School in Sackville, New Brunswick in partnership with Ducks Unlimited Canada and others. While the approach taken at Tantramar is unique, many of the elements of this award-winning wetland education program can be replicated and expanded upon in other centres of excellence across Canada. A set of recommendations are presented to achieve this vision.

Introduction

Our focus is on environmental education of youth in relation to wetlands, but we include education of others because change is best achieved through a family and community approach.

Much wetland loss has resulted from actions by individuals, both consciously and through secondary outcomes. These actions occur daily on small properties as the result of personal decisions by people about how they will use their land to make a living, or for recreational or other uses. Some decisions may include draining wetland complexes, but they may also include smaller acts in rural, urban and recreational settings that can have damaging effects (i.e. clearing waterfront vegetation to enhance a view, farming buffer zones with large machinery, carelessly maintaining vehicles near waterways, applying fertilizers and pesticides around wetlands, disposing toxic waste in drain systems, or discarding chemical containers, garbage and landfill in low lying areas). Such behaviours may not be motivated by economic considerations so much as by a lack of ecological literacy (EL) (i.e. inappropriate understanding of environmental consequences and alternative choices).

Corporations, resort holdings, municipalities, developers and communal farms operating on larger land blocks make similar decisions with greater environmental consequences. These groups too are made up of individual decision makers. Such decisions and actions affecting the environment occur within the context of policies, laws and regulations enacted to protect society. This process takes place through an electorate and the people they select to represent them. The majority of these people are unlikely to be fully ecologically literate.

People are both the problem and the solution relative to wetland conservation; human actions result in negative, neutral or positive consequences for wetlands. The outcome depends on the level of EL of those involved. Based on a review of progress since the last wetland policy conference the authors suggest recommendations to enhance the ecological literacy of Canadians. These recommendations result from the authors' vision for wetland education, and a model that is now operating in microcosm at the Tantramar Wetlands Centre in New Brunswick.

What is Environmental Education and Ecological Literacy?

Wetland education should take place within parameters of good Environmental Education. Environmental Education (EE) is not just nature study or learning how to enjoy outdoor recreation. Effective EE is developing the knowledge, experiences and skills needed to evaluate environmental issues, and make informed decisions, value choices and actions. Roth (1992) defined environmental literacy as the capacity to perceive and interpret the relative health of environmental systems and take appropriate actions to maintain, restore or improve the health of those systems.

Environmental Education is delivered by practitioners representing non-government organizations (NGOs), the formal school system, government agencies, corporations and others. Most provinces have one or more EE associations and the Canadian Network for Environmental Education and Communication (EECOM) is a national body having funding support from Environment Canada. Its mission is to engage Canadians in learning about their environment. The *Canadian Journal of Environmental Education* publishes refereed research while *Green Teacher* is published in Canada to enhance environmental education at all grade levels. There is no formal structure specifically for wetland education but wetland education comes within the mandate of all these entities.

In the United States, the EE system is further advanced at both state and national levels. The North American Association for Environmental Education (NAAEE) is relatively well supported and is associated with the *Journal of Environmental Education*, which publishes peer-reviewed research. NAAEE has established guidelines to enhance EE standards (e.g. *Environmental Education Materials: Guidelines for Excellence; Guidelines for the Initial Preparation of Environmental Educators; Guidelines for Excellence in Nonformal Environmental Education Program Development*). These resources apply equally well for Canadian Environmental Education.

The United States government passed and reauthorized the *National Environmental Education Act* with an Office of Environmental Education established within the Environmental Protection Agency (EPA) to provide national leadership to increase environmental literacy. EPA and NAAEE support the Education and Training Partnership in Environmental Education (EETAP) at the University of Wisconsin. EETAP's role is to build EE teacher capacity. Some EETAP courses are accessible to Canadians on-line.

The George C. Marshall Institute in the United States, a non-profit think tank on public policy and research, created the Independent Commission on Environmental Education and Literacy (ICEE) to review existing EE materials (including textbooks) and make recommendations for improvements. Their conclusion was that there were many good resources, but also many weaknesses. Recommendations from the ICEE included the need to deliver biased-balanced EE that was factually accurate, science-based and without emotionalism and advocacy. No such formal review has taken place of Canadian resources although some programs have established standards of excellence similar to those of NAAEE (e.g. the Green Street Program funded by the J.W. McConnell Family Foundation and administered by Learning for A Sustainable Future (see www.green-street.ca).

Experiential Learning Toward Ecological Literacy

Louis Aggassiz in the 1800s practised his dictum of "read nature not books"; i.e. experience nature first hand. Krupa (2002) outlined how he does this in stages with his students. Children form attitudes at an early age toward the environment. Bixler *et al*. (2002) found teens who played in nature in early childhood had more positive attitudes

towards the environment. This underlines not only the need to have programs that expose children to wild places, but for rural and urban planners to ensure such features exist in local communities to support EE programs.

Sobel (1996) described the learning stages through which children progress. He suggested that early environmental education programs should centre on developing empathy for the natural world, slightly older children on exploration, and for those in early adolescence and beyond, on social action. Beginning with problem solving (the ultimate goal for ecological literacy) too early can turn children off of the environment and make them fearful.

The statements “Think globally, act locally…” and “Environmental education proceeds from awareness, to knowledge, to action….” are examined in Hammond (1997) using the Action Learning Triangle. Hammond’s framework includes equal emphasis on learning about action, learning through action and learning from action, facilitated through case studies, ethical standards, taking risks and mentorship. This framework has been put into practice successfully in Lee County School District, Florida. Elements of Hammond’s framework include: be for something not against something; become knowledgeable about your subject area; understand opposing viewpoints and look for common ground; treat all people with respect; avoid stereotyping; avoid laying blame; recycle your thought process; be patient and persistent; and think big but act in achievable steps toward goals. These and other characteristics have been established as excellence criteria for effective environmental education.

For action to be a logical outcome, students must develop a bond or an emotional attachment so that they will have a predisposition and motivation for action. Such bonding is strongest when developed in preschool and elementary years. Vaske and Kobrin (2001) found that children who made repeated visits to a local natural place developed a strong emotional attachment to it. Successful EE often begins close to home, encouraging learners to understand and forge connections with their immediate surroundings. Wetlands are numerous and can be found close to most places of learning, making them interesting and excellent sites for environmental education.

In older youth, emphasis needs to be on action projects requiring the application of skills, knowledge and understanding to go beyond simple information acquisition and recitation. The premise is that if students are trained in action skills relative to the environment they care about, they will learn how to apply these skills in their daily lives and retain them as they grow older. Ballantyne *et al*. (2001) found that children involved in interesting, hands-on EE programs brought their learning home and shared their experiences with their families; leading to a broader community impact.

Tom Puk of Lakehead University proposes significant time be spent by students in experiential learning in outdoor natural settings like marshes, rivers and ponds. Funding for outdoor ecological centres is a key component of this as is enhanced teacher training, compulsory ecological education for all university/college students and research funding to identify best practices. Finally he is a proponent of an integrated

lifelong approach to developing ecological literacy through all sectors and levels of society, and that a connection be made between a concern for the environment and individual health and well-being.

Why don't more elementary level students take part in outdoor field trips to wetlands and other ecosystems? Elementary teachers are generalists and usually are responsible for all courses. Many of them have had little science training and therefore less likely to have the background and confidence to lead an investigative field trip. These teachers require the expert services of NGOs and interpretive facilities to help them deliver such programs. Another alternative is team teaching and course specialization. With reduced budgets for education, funds for field trips and bussing are reduced. Schools in poorer neighbourhoods are even less likely to participate in field trips because families are unable to make up the extra fees.

Why don't more middle and high school programs systematically engage students in personal and community action? Hammond concludes this is to avoid student failure and potential confrontation, teacher criticism, and even, liability. The education system must be changed to remove these concerns and Hammond suggests creating new curriculum with combinations of science, ethics, economics and politics that encourage environmental action. In the upper grades, science teachers often have specialized training and greater capability to deliver field trips. However, reduced budgets for bussing and equipment are issues, and the logistics of finding a suitable field trip site may discourage many from participating. Liability issues may also be a problem – in Calgary, school field trips outside the city have been largely eliminated for this reason. In order for classes to take a field trip, supply teachers must be paid and special arrangements made with other teachers to make up class time for absent students.

Prior to the recent World Summit on the Environment, the Youth Summit Team of the United Nations Society of Canada conducted a survey of 1300 people under 30 years of age to identify their priority concerns for sustainability. The top ranking issue was human health and the environment with freshwater/groundwater and habitat/biodiversity among those ranking fifth. A disturbing finding from this survey was the identification of barriers hindering young people from taking meaningful action toward solutions. Respondents said they did not know how to get involved and they felt powerless to act because of their self-professed lack of knowledge and inability to cause change. The education system needs to be modified so that these barriers for young people are removed.

Canadian K-12 Curriculum on Wetland Environmental Education

The 1997 Pan-Canadian Protocol for Collaboration on School Curriculum – A Common Framework of Science Learning Outcomes lays out a vision for scientific literacy in Canada; i.e. development of skills, attitudes, knowledge, problem solving, decision making, life-long learning and a sense of wonder about the world. The authors suggest that for some areas of study in the life sciences, that students get outside to observe a local habitat.

Manitoba, Ontario and the Atlantic Provinces have adopted the Pan-Canadian Framework to varying degrees, while British Columbia and Quebec are reviewing their science curricula. However, in Ontario several recent changes have negatively affected EE. Ottawa and Toronto School Boards have been forced to close many of their residential education centres due to budget constraint. Ontario once mandated that students take two outdoor education field trips leading up to a one-week stay at a residential facility in grade 6. This program is lost. Ontario once had a series of dedicated courses in environmental science at the secondary level as well. These have been dropped and aspects integrated into other science courses (called infusion). This is expected to lead to less focus on environmental sciences, reduced EE training for teacher's college students, and subsequently, less demand for EE professional development. Analysis reported by Puk (2002) has demonstrated that these changes have led to a significant reduction in the time dedicated to environmental studies in grades 9-12. He finds this extremely troubling in light of the recent water disaster at Walkerton, Ontario. He concludes that the "infusion model" is a failure as practised in Ontario.

Although wetland ecosystems are local, accessible and full of raw materials for educational investigation and issues study, few provinces require teachers to use wetlands as a specific topic of study. A new web-based tool, called the Canadian Environmental Education Curriculum Assessment Program (CEECAP), was used to determine K-12 curriculum links with wetland related topics. Unfortunately "wetland" is not included as a key search word so "water" and "ecosystem" were used as surrogates. The format used by provinces to list their curriculum documents on the Internet vary widely and some do not lend themselves to efficient searches to determine the level to which wetlands are suggested as a specific area of study.

Alberta alone at the grade 5 level has mandated that teachers cover a series of learning outcomes under the title Wetland Ecosystems. As well, in grade 8, Alberta science teachers cover a unit called Freshwater and Salt Water Systems, which includes review of key concepts on water quality, adaptations, erosion and human impacts. Manitoba also has a similar grade 8 unit on Water Systems, but it has very little to say about the role wetlands play in water quality, flood protection and groundwater recharge. There is a grade 4 unit on Habitats and Communities in Manitoba, Ontario and the Atlantic Provinces (an optional unit exists in grade 5 on a similar topic in Saskatchewan), and in Manitoba teachers are referred to the web-based resources provided by Ducks Unlimited Canada on wetlands (www.ducks.ca/edu/resource.html). Likewise, Alberta has officially approved these DUC resources for use and has developed its own supporting resources on wetlands for teachers. Project Wet workshops are available as professional development for teachers in some provinces (e.g. Manitoba, British Columbia, Saskatchewan and New Brunswick), but the delivery mechanism for these is variable.

In grade 7, Alberta, Manitoba, Ontario and the Atlantic Provinces all have units on Interactions within Ecosystems and here there are logical links teachers can make to the study of wetlands. In Saskatchewan, core linkage to topics on ecosystems takes

place in grade 6 where a suggestion is made to study pond life in curriculum guidelines. In grade 9 in the unit on Diversity of Ecological Regions, the study of wetland formation and function are specifically suggested as an instructional method in Saskatchewan.

At the high school level all provinces offer a variety of courses on ecology, environment, diversity and evolution but these courses generally are options. None require a specific study of wetland systems or related conservation issues. However, in Saskatchewan under grade 10 Biology 20, the curriculum suggests that students learn about the North American Waterfowl Management Plan and linkages are made between wetlands and the hydrologic cycle.

Despite the desirability of having greater curriculum consistency across provinces this has only been partially achieved since the publication of the Pan-Canadian Framework and wetlands are not a high priority for study in most grades and provinces. Thus, there is variable demand for resources and programs focusing on wetlands.

Frameworks, Partnerships and Nonformal Environmental Education

The Canadian Government recently presented *A Framework for Environmental Learning and Sustainability in Canada*. The framework sets out a vision, values and an action plan. The report provides a restatement of maintaining high standards of EE, promoting broad collaboration, developing methods of communication and youth mentoring, promoting action oriented programs to develop skills, and finally assessing outcomes and employing adaptive management principles. Suggested actions include the establishment of a council to lend support and visibility to environmental education initiatives, funding programs and developing a web-based clearinghouse for information and resources. Also among the recommendations is establishing a recognition program to acknowledge leading practitioners (one is in place through EECOM).

In some jurisdictions corporations, schools and nonformal education facilities are developing new partnerships. NGOs can provide teaching resources, safe sites and facilities for field trips, expertise in conducting fieldwork and equipment. Funding for such programs is provided by individual, corporate, government and foundation partners with an interest in environmental education. Examples include the Oak Hammock Marsh Interpretive Centre (2002 winner of British Airway's "Tourism for Tomorrow" Best Environmental Experience Award), and Chevron's Open Minds Program. The Oak Hammock Centre, in partnership with the Manitoba government, delivers tourism, public and school programs specifically on wetlands, provides professional development programs for teachers and mobile outreach education across Manitoba. Under the Open Minds formula, corporate funding allows teachers to design and deliver part of their course work at an offsite facility with the help of experts. Students are actively involved in hands-on experiences and they are able to spend time observing and reflecting. However, no known Open Minds Program presently exists for wetland education.

The recently launched Green Street Program developed by the J.W. McConnell Family Foundation has a wetland field study component (www.greenstreet.ca) and ePALS, in partnership with Ducks Unlimited Canada and other government and foundation partners, has created a program called *Healthy Wetlands, Healthy You* (www.epals.ca/projects/ducks_unlimited) for grade 4-12 classes. In both programs, information sharing, curriculum links, mentoring and hands-on activities are key features.

Many other resources and programs exist. Information and ideas about wetlands are made available to classes and the public through Wetkit (www.wetkit.net). Such events as Wildlife Week and Earth Day have been successful catalysts for public involvement. However, World Wetlands Day falls in February and has drawn little attention. The International Year of Fresh Water over the next two years is one model that has promise to capture the attention of Canadians around a variety of wetland themes under the banner Wonder of Water (WOW). A network of interpretive facilities across Canada provide wetland education programs but these are generally not coordinated. Youth groups like Scouts, Guides, 4-H, Junior Forest Wardens and others have programs in environmental action but enrollment is declining. Scouts Canada's Jumpstart Program for Cubs on the environment has a number of activities focusing on wetlands. These programs need to be expanded, broadened and linked with greater emphasis on wetland conservation.

There are numerous guidebooks, resources and programs focusing on wetlands and water in Canada and the United States (e.g. Wetland Keepers, Project Wet, Bog Ho, Digital Field Trip to the Wetlands, Wonder of Wetlands, Ducks Unlimited Canada's Wetland Ecosystem series, Read Aloud Wetlands, Digital Frog, Envirothon, Ecoscope, Living By Water, Adopt-A-Class, Marshmallow, Make Way for Wildlife, Adopt-A-Pond, Aquakit, Wade Into Wetlands, The Yellow Fish Road, Water Watchdog, Greenwing and many more). A number of these have action-oriented components with mentoring, while others are investigative. Some of these materials are available only in hard copy, some are free through websites and others can only be acquired after going through training and accreditation. Only some of these show curriculum linkages to facilitate use by teachers. Several agency and government websites provide valuable background information on wetlands as well as links to other sites with resources (e.g. United States Fish and Wildlife Service, United States Department of Agriculture, WetKit, United States Environmental Protection Agency, Environment Canada and Ducks Unlimited Canada).

A number of programs are repositories for data on indicators of ecosystem health (e.g. Ecological Monitoring and Assessment Network (EMAN), RiverWatch and Globe). These and others (e.g. projects on purple loosestrife, Important Bird Areas Program and various watershed monitoring programs) offer groups an opportunity to take action by collecting useful monitoring information.

The Tantramar Wetlands Centre – Integrated Wetland Education in Microcosm

Tantramar Regional High School in Sackville, New Brunswick has developed an innovative approach to teaching and learning about wetlands. In partnership with Ducks Unlimited Canada and the local school district, a 15-hectare freshwater wetland was created in 1998 right on the school's campus. Established as an outdoor classroom, the impoundment was designed so students *could get up close and personal* with all of the excitement that wetlands offer. In the years since and with the help of additional private and public sector partners, the school has developed a wetlands education centre, adding indoor laboratory space to support the outdoor activities, acquiring essential equipment and developing a wide range of programs.

The decision to build and operate the Wetlands Centre came from the school's desire for a program that would be largely experiential, teach a range of authentic (work-related) skills and have the potential to enrich the learning environment for students of all abilities and grade levels. The Wetlands Centre model accomplishes all three objectives while at the same time turning students on to science, nature and the value of our natural world. Tantramar pupils learn about wetlands through their direct involvement in the day to day operation of their wetlands education centre. Initially, 12 students (dubbed the "dirty dozen" by their principal) were given the opportunity to work with Ducks Unlimited Canada biologists and engineers in the design and construction of the impoundment. In the years that followed more and more students have become involved in managing the habitat through participation in a wide range of activities that include banding ducks, battling purple loosestrife, monitoring water quality and even trapping muskrats. Today, students are not only looking after these responsibilities, but also participating in wetland research projects, and generating valuable information by working alongside wildlife biologists and field technicians from the project's partners.

The largest number of students by far assist in the delivery of the Centre's wetland programs for visiting schools. Each year, over 3000 students from New Brunswick, Nova Scotia and Prince Edward Island visit Sackville to take part in the school's award-winning experiential programs that feature the same rubber-boots approach to teaching about wetlands that the Tantramar students themselves enjoy. Many of these are sponsored through DUC's Adopt-A-Class and Green Street Programs. It is a terrific opportunity for the *Wetheads* (as they call themselves) to "strut their stuff" and pass on what they have learned to other enthusiastic groups of students, parents and teachers.

Preparing the Tantramar students to perform these tasks is a key component of the program. It is accomplished both in and outside of the regular curriculum by Tantramar teachers and professional staff from the project partners who volunteer to provide mentorship and training. Pupils do not earn academic credit for their involvement in the Centre nor is its operation connected to any specific course or courses. The Wetlands Centre is available to all students as a school-wide enrichment initiative. Because participation often results in the pupils being absent from regularly scheduled classes, teacher permission is the key requirement for eligibility. The school's administration expects teachers to encourage their students to take advantage of this program and to

assist them in meeting the extra demands resulting from time away from class. In spite of the additional workload, each year more students are participating in wetland activities, citing interest, enjoyment, job training and, of course, time out of class as the main motivators.

The Wetlands Centre has also undertaken a lead role in providing in-service training to support teachers in their efforts to teach more effectively about wetlands. In cooperation with Ducks Unlimited Canada, Educating for Sustainability and the New Brunswick Wildlife Federation the Centre conducts workshops for up to 100 teachers each year. Geared to helping the teachers meet specific environmental outcomes as defined by the Atlantic Provinces Education Foundation (APEF) curriculum documents, these sessions demonstrate how effective wetland case studies can be in achieving these goals and how much fun the learning becomes.

Curriculum integration is also a key component of the Tantramar program. Initially, the school implemented a thematic approach to curriculum delivery at the grade 9 level. Specific outcomes across a range of subjects were linked to wetland topics and activities taking place in the Wetlands Centre. This approach was an excellent fit with a major reorganization of the high school program that the Province was mandating at the time that required schools to move towards a team approach in grades 9 and 10. As the role of the Wetlands Centre expanded and more and more students became directly involved in its operation, the prescribed cross-curricular program for grade 9 pupils evolved into a very practical school-wide integration that sees subject areas responding to the needs of a thriving school enterprise. Technology students manage the Centre's website; maintenance has become the responsibility of the industrial arts classes; chemistry students routinely monitor water quality; culinary classes look after all of the catering requirements; theatre arts students deliver skits that add energy to the education programs for visitors, and there is even a wetlands choir that loves to sing about *Wetheads*, muskrats and cattails.

Program Results

This model has shown itself to be very successful in educating students about wetlands. The high school students demonstrate their knowledge and passion for wetlands each time they deliver a program to a visiting school. Visiting teachers and parents, consistently rate the educational value of this program as outstanding and point to the talents of the *Wetheads* and the experiential nature of the program as the keys in making the learning fun, effective and meaningful. Tantramar's Wetlands Centre has received provincial and national awards for its innovation and continues to attract more and more visitors each year.

Demonstrating the importance of wetland conservation is an important component in all of the Centre's education programs. Through games, skits, presentations and field activities the consequences of wetland destruction are made real. However, the best indicator that this model is helping to promote the long-term protection of our wetlands is the feedback from the students who after spending a day at the Centre are saying

things like "*wetlands are cool,"* or *"wetlands are awesome"* or *"that was amazing."* In many cases, these are first impressions that will last a lifetime.

Tantramar's Wetlands Centre is meeting the needs of classroom teachers and has been successful in delivering knowledge, developing skills and teaching about decision making.

Replicating this Model

Creating a wetlands centre should not be viewed as something out of the realm of possibility for most schools. In Tantramar's experience, obtaining the funding and in-kind support to build and maintain the facility has not been the biggest challenge. Partnerships are commonplace in public education today providing the extra dollars needed to enhance school programs, and the elements of environmental stewardship, education and youth that this approach combines are likely to be very well received in both the private and public sectors in any part of this country. Also, any expertise required beyond what the school itself can provide is present in most communities and a project like this often creates the spark that brings it into the schoolhouse. The keys to getting started and maintaining the momentum are strong leadership from the school principal and a solid commitment on the part of the school district.

While Tantramar's Wetlands Centre approach will not be desirable or possible to replicate in every school setting, incorporating the key elements of its success in any wetland education program is something that can and should be done.

- *Experiential Learning* should take place outdoors and often. However, there are lots of quality 'hands-on' activities that can be adapted to the lab and classroom setting.
- Empower students to take on *Authentic Tasks* and do something with what they are learning. With minimum equipment, schools can establish or plug into national/international monitoring programs that involve students in collecting, recording and analyzing data on a wide variety of wetland parameters.
- Teachers cannot do it all. Bring in the experts to teach special skills, provide insight into controversial issues, supply essential equipment and model future careers. *Mentoring* of students and having the students do *Peer Teaching* of other kids are powerful ways to learn. When the Wetheads get a group of elementary students out in their wetland, what happens is magic.
- Wetlands are *Inclusive*. There is something for everyone in wetlands. Enrichment should be available to students of all ability groups, interests and ages.

Recommendations for Wetland Education in Canada

1. Work to have Canada and the provinces enact Environmental Education legislation which will establish government leadership to lead, nurture and fund environmental education; follow-up to formalize the *Framework For Environmental Learning and Sustainability in Canada.*

2. Develop a Coalition of Wetland Educators to operate within the existing Environmental Education structure to raise the profile and level of wetland education.
3. Human behaviour is grounded in values, changes in societal behaviour will only occur as societal values change. Develop a public marketing/education strategy to target rural and urban audiences (e.g. landowners, business, youth, planners, teachers, politicians) about wetlands, based on their functions of providing clean water, flood protection, carbon sequestration, biodiversity and places to learn and enjoy, in order to capture attention about their importance, vulnerability and ways to get involved in conserving them.
4. Develop an annual focus for wetland action in which the media, schools and the public can take part (see Winging Northward: A Shorebird's Journey as one model, or Adopt-A-Wetland Week, etc.). Encourage wetland/watershed/groundwater festivals with a focus on education and celebration. Organize these through watershed associations.
5. Encourage family and youth-oriented activities around wetlands including heritage fishing and hunting days.
6. Develop and equip a network of high profile and well publicized wetland sites as foci for public and school education and tourism. Ramsar, International Biological Program (IBP), wetland Biosphere Reserves and sites like the Oak Hammock Marsh Interpretive Centre and the Tantramar Wetlands Centre should be key components of this network. Establish urban wetland sites.
7. Encourage new "centres of excellence" by replicating the Tantramar Wetlands Centre to foster partnerships, integration, cross-curricular programming, and experiential and inclusive programs. Incorporate what has been learned from the Lee County Project.
8. Link nonformal centres teaching wetland education to coordinate and improve programs and provide support services to teachers.
9. Work to have wetlands become a highly visible component of the school curriculum at all levels; from this will come demand for teacher training, professional development and other support services.
10. Have programs like CEECAP enhanced to allow curriculum searches by "wetland." Specify where wetland study could be used to meet learning outcome requirements in each province's existing curriculum.
11. Develop new wetland programs and resource materials that enhance ecological literacy of participants and are based on excellence standards. Have an independent body review and rate existing materials and programs (including textbooks) so teachers can decide on their value and improvements can be made.
12. Develop programs like *Open Minds* focused on wetland education.
13. Involve citizens, corporations and foundations in providing resources to help fund outdoor wetland education.
14. Develop a variety of meaningful action-oriented wetland projects that students and the public can get involved in with support from NGOs and others (e.g. Envirothon, science fairs). Have recognition associated with these to reward and celebrate excellence. Incorporate mentoring and peer teaching.

15. Engage teachers in professional development research projects on wetlands, watersheds, etc. to enhance learning and information transfer to their students.
16. Develop a data repository for wetlands on EMAN that community and school groups can use. Encourage mentoring and interaction through programs like ePALS.
17. Geographic Information Systems (GIS) should be used to develop location maps of public, safe wetland sites that could be used as a resource for teachers to help plan wetland field trips near their schools.
18. Develop partnerships between wetland educators and youth groups (Scouts, 4-H, etc.).
19. The Wetkit system and newsletter should be marketed more widely and potentially be developed into a more interactive site with a youth-oriented section that can provide greater visibility for wetlands and service to those interested in learning more about them.

References

Ballantyne R., J. Fein and J. Parker. 2001. Program effectiveness in facilitating international influence in environmental education: lessons from the field. *Journal of Environmental Education* 32(4): 8-15.

Bixler, R.D., M.F. Floyd and W.E. Hammitt. 2002. Environmental socialization: quantitative tests of childhood play hypothesis. *Environment and Behaviour* (34)(6): 795-818.

Hammond, W.F. 1997. Educating for action: a framework for thinking about the place of action in environmental education. *Green Teacher* Winter 1996-97: 6-14.

Krupa, J.J. 2002. Multiple stages of weekend field trips to expose students to Nature: emphasis on discovery and awareness. *The American Biology Teacher 64-3: 194-200.*

Puk, T. 2002. *Ecological Literacy as the First Imperative. Principles For Achieving Ecological Literacy in the Next Ten Years: First Steps*. Report 807-342-8710. Department of Lifelong Learning. Lakehead University. Thunder Bay, Ontario. 10 p.

Roth, C.E. 1992*. Environmental Literacy: Its Roots, Evolution and Directions in the 1990s*. ERIC/SMEAC. Columbus, Ohio.

Sobel, D. 1996. *Beyond Ecophobia, Reclaiming the Heart of Nature Education.* The Orion Society and the Myrin Institute. Great Barrington, Maine. 45 p.

Vaske, J.J. and K.C. Kobrin. 2001. Place attachment and environmentally responsible behaviour. *Journal of Environmental Education* 32(4): 116-121.

CHAPTER 6: INNOVATIONS IN TREATMENT WETLAND TECHNOLOGY IN CANADA

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Abstract

The water quality improvement function of wetlands has been known for many years. How best to harness and apply this treatment technology has led to debates amongst engineers, scientists and regulators. Much of the friction is centered on insufficient data from wetlands used for treatment in our Canadian climate. Treatment efficiency is variable and development of a database is required to better understand how well wetlands function in Canadian cold climate regions. This would naturally lead to development of standardized design criteria that are specific to our Canadian climate that would provide a standard that regulators could measure from. In addition to water quality improvement, wetlands, whether natural or constructed, provide habitat for a wide diversity of wildlife. The long-term effects of some contaminants are not all well known and caution is required when using wetlands for the dual purpose of water quality improvement and habitat creation. Here, again, the database could provide guidance for wetland practitioners.

On a watershed basis where nutrient-laden stormwater is discharged to receiving waters from farming operations and other non-point sources of poor water quality, pockets of relatively small wetlands that are strategically placed in the landscape have demonstrated proficiency for dramatically reducing the contaminant loads to the ultimate receiver. In some cases, natural wetlands have been incorporated into stormwater or wastewater quality improvement schemes with little regard for the function of or long-term impact on the wetland due to the change in nutrient load and hydroperiod. National guidelines are required to protect sensitive natural wetland areas from this type of misuse. Wetlands will continue to be incorporated into water quality improvement projects in the future. It is important to anticipate the future needs and challenges and address them now so that the groundwork is established for intelligent decision making.

Wetland Issues

In the last decade, Canadians in the public and private sector have been at the forefront in developing new technologies to restore, create and utilize wetlands for a variety of public policy objectives. These objectives include restoration of wetlands and peatlands used for horticultural products, forestry operations and agriculture as well as development of new means to enhance and modify habitats for wildlife including fish

and waterfowl. In particular, however, it has become widely recognized that wetlands are a vital component in maintaining and improving water quality. This paper focuses on the water quality components of recent innovations in treatment wetland technology and the future directions Canadians can take in their application.

For the last several decades, the benefits of wetlands for improving stormwater and wastewater quality, which affect people, communities and natural ecosystems have become increasingly apparent. Loss of wetlands due to agricultural practices, urban sprawl and road construction has resulted in degraded downstream surface water and groundwater quality. High sediment loads have covered spawning beds and habitat of fish, crustaceans and other aquatic organisms. The removal of trees and other vegetation from the banks of watercourses has reduced the shading potential, resulting in increased water temperatures as well as reduced stability of stream banks. Efforts have been made to curb the claiming of wetlands for crop production or construction projects, but these efforts have met with resistance and wetlands continue to be lost. Wetland restoration initiatives have met with some success and continue to be an avenue that will restore at least a portion of the lost wetland function.

The design and construction of a treatment wetland is another approach to restoring the lost wetland function in large urban communities and in remote, sparsely populated locations. Considerable research has been conducted to determine the functions that occur within a wetland that allow it to improve the water quality. Wetlands can now be engineered to provide sufficient treatment capability to provide an outflow water quality that can meet water quality objectives so as not to degrade downstream receivers. However, while this approach can restore large wetland areas, the acceptance of this approach has met with some resistance. Much of the challenge in the past has come from a limited understanding of treatment wetlands by the public, engineers and regulators. Understanding among these groups is growing and the technology is gaining acceptance; in fact, embracing this technology is becoming the norm. Reasons for incorporating wetlands into treatment systems include typically lower capital costs, much lower operations and maintenance costs, public and wildlife benefits, and longer life expectancy than conventional concrete and steel solutions.

Key Issues

Key issues associated with wetlands for water quality improvement include:

1. A limited Canadian/cold climate database of long-term monitoring data for wetland design and sizing for optimum treatment efficiency.
2. Understanding of a watershed approach of best management practices that includes preserving existing and creating new wetlands to control nutrient release from farming communities.
3. A need for national guidelines for controlling the use of natural wetlands for water treatment purposes.
4. A Treatment Wetland Design Manual is required to reflect the Canadian experience. It must reflect the expected cold climate performance for water quality improvement as well as address issues such as the control of mosquitoes and other vectors that

might breed within wetlands since the occurrence of the West Nile virus has become a public health concern.
5. Providing regulators with the information they need to approve constructed treatment wetlands (i.e. for the creation of a wetland within a land area that had not formerly been a wetland or may have been a wetland but not in recent history).
6. There has been considerable discussion of the impacts of treatment wetlands on wildlife, particularly when the flow originates from an area or process that may contain constituents that would be considered a detriment to the health of resident and migratory wildlife.

Each of these issues will be discussed under the following headings: (a) Progress, (b) Barriers and Challenges, and (c) Opportunities and Strategies. Following the development of each of the key issues, a vision for the next 10 years and a set of draft recommendations for consideration by the conference attendees is presented.

Database Development

Progress

Wetlands have been utilized in Canada for the treatment of stormwater and wastewater for more than 40 years. There are currently more than 100 treatment wetlands in Canada that are improving the quality of stormwater, municipal wastewater, industrial wastewater and groundwater. Some of the earliest accounts of the benefits of wetlands came from Cootes Paradise (Hamilton, Ontario) and Haines Junction (Yukon). With each passing year, more wetlands are being designed and constructed, thereby improving the understanding and acceptance of these treatment systems.

Barriers and Challenges

While the benefits are being realized, there are still wetland systems that are being designed based on outdated criteria. With the improved understanding of wetland functions that has occurred internationally, current design criteria have been developed. However, many regulators and clients are skeptical of design guidelines that have been developed based on warm climate data or on data from countries outside of Canada. In order for Canadian design guidelines to be prepared, a comprehensive database of water quality monitoring of the Canadian wetland sites is critical to determine long-term trends and impacts related to weather, contaminant and hydraulic loading as well as wildlife use.

Opportunities and Strategies

For many of the treatment wetlands that are currently in use, the water quality and flow data are being collected on a routine basis. At many sites, this information is being stored electronically, increasing the ease of downloading and transferring to a database. Preparation of a database that would lead to the development of design guidance should be a high priority.

Watershed Approach to Implementing Nutrient Management Controls

Progress

In Ontario, the Conservation Authorities embarked on a program in the mid-1990s to demonstrate the effectiveness of wetlands for improving the quality of agricultural discharges, such as milkhouse washwater, manure storage tank overflow and feedlot runoff, at about a dozen sites across southern Ontario. The Nova Scotia Department of Agriculture and Marketing also became interested in treatment wetlands at about the same time and has constructed and monitored several wetland systems. Other Maritime Provinces followed Nova Scotia's initiative and many wetland systems have been constructed and operated for more than half a decade. Manitoba and Alberta also have treatment wetland systems that are treating feedlot runoff and have been collecting data for three to five years.

Barriers and Challenges

Within the farming community, the origin of much of the nutrient load to receiving waters (surface and subsurface) is related to sources including runoff from fields and feedlots, milkhouse washwater discharge and manure holding tank overflows. While at some limited locations there is some form of flow interception that will hold and/or control the discharge to some extent to reduce the impact on the receiving water, many of these contaminant-laden flows continue unabated. To this point, there was little incentive for farm operators to control these contaminant flows and this was a major barrier to implementing water quality improvement measures. However, following the tragic events in Walkerton, Ontario controls will begin to be imposed by the regulators.

Opportunities and Strategies

An approach for improving the water quality of specific watercourses would be to identify watercourses that are subject to major degradation due to farm-related discharges and runoff, define the watershed that contributes flow to the receiver, and then implement best practical technologies that include the natural treatment technologies (wetlands and poplar tree systems). Natural treatment systems have been demonstrated in Alberta, Manitoba, Ontario and the Maritimes to reduce contaminant loads from individual farming operations. If applied to an entire watershed, the impact of nutrient load reduction could be significant. Opportunity exists to finance this approach through nutrient trading schemes, carbon credits and government greening funds.

Guidelines for the Approval of Natural Wetlands for Water Quality Improvement

Progress

In 2000, CH2M HILL finalized a document that set out guidelines for Alberta Environment on the evaluation and approval of natural wetlands for wastewater and stormwater polishing and to provide protection for natural wetlands. This document has

allowed Alberta Environment to reply to proponents who wish to use natural wetlands for treatment purposes with a consistent response on the accepted approach for incorporating natural wetlands.

Barriers and Challenges

There has been considerable controversy on some fronts on the use of natural wetlands for treatment or polishing of stormwater and wastewater flows because the introduction of nutrients to a natural wetland will inevitably change both the hydroperiod and the floral and faunal diversity and species makeup. With the added nutrient and hydraulic load, the vegetation density increases and the more aggressive emergent vegetation such as cattail (*Typha* spp.), bulrush (*Scirpus* spp.) and tall reed grass (*Phragmites* spp.) may dominate. Also, there is a concern for metals accumulation within the wetland soils and plants and the risk this might pose to wildlife.

Opportunities and Strategies

The protection of natural wetland functions should be of highest priority. However, opportunities for incorporating natural wetlands into a treatment system should not be ruled out without detailed understanding of the wastewater loadings and the condition and function of the wetland. As was completed for Alberta Environment, a comprehensive *Wetland Evaluation and Treatment Design Guidance Manual* could be used to provide national standardized controls to this approach.

Guidelines for the Design of Cold Climate Constructed Treatment Wetlands for Water Quality Improvement

Progress

Guidelines for the design of treatment wetlands have been produced over the past 20 years by many proponents including Canadian provincial ministries, the United States Environmental Protection Agency, the Tennessee Valley Authority, Water Environment Federation and authors such as Kadlec and Knight (1996). These documents, for the most part, consider design elements for constructing wetlands in areas that had not been wetlands previously or for restoring lost wetlands. In each case, conventional pretreatment is required when considering application of the treatment wetland technology. For stormwater, a sedimentation forebay must be incorporated to meet municipal or provincial standards. For polishing wastewater, the wastewater must first pass through a conventional wastewater treatment plant prior to discharging to the wetland.

Barriers and Challenges

While many of the pre-1990s documents currently in use still have relevant design guidance, they may not reflect advances in understanding that have occurred over the past five years since their focus was on conventional parameters including the five-day

biochemical oxygen demand (BOD_5) and the total suspended solids (TSS). Also, many are focused on or have incorporated into their design a mix of warm climate and cold climate data making them less relevant to the Canadian climate. This latter concern is especially critical for designing for cold weather treatment efficiency.

In a treatment wetland, there are wildlife species that are considered a nuisance to the physical integrity of the wetland, cause adverse effects on water quality, or breed in the wetland and become vectors of human pathogens/disease. Wetland design must account for these factors. Muskrats can burrow into dykes and berms and breech them causing the wetland to be drained. Carp and muskrats will stir up the bottom sediment and increase the turbidity of the water making it difficult to meet discharge criteria. While treatment wetlands tend to breed more predators that consume mosquito larvae than natural wetlands, the mosquito population may require further controls that may include the construction of swallow and purple martin nesting boxes, bat roosting boxes, dragonfly larvae release, or, if natural means fail, chemical controls may be necessary.

Opportunities and Strategies

The preparation of a Cold Climate Design Manual based on the Canadian experience would provide a more relevant design document for applications in Canada.

Regulatory Approval of Treatment Wetlands

Progress

Wetlands designed and built for improving pre-treated wastewater and stormwater quality are becoming an accepted technology by the regulators in many provinces. Consultants are adding wetlands to their “toolbox” of conventional technologies. While the regulators are approaching wetlands with caution, as they should with any relatively new technology, they are finding that systems that have been properly engineered are demonstrating significant benefits. This has led to an acceptance of wetlands for reducing the loading of many contaminants.

Barriers and Challenges

In some provinces, the policy on treatment wetlands, if one exists, reflects outdated understanding of the wetland treatment mechanisms and misinterpretation of data that may have been collected during early pilot and full-scale testing. This has led to skepticism by some regulators of the potential for consistent water quality improvement.

Opportunities and Strategies

Review of existing policies and guidelines related to constructed wetlands from each province where they exist would be helpful as a base for preparing a national policy on treatment wetlands.

Treatment Wetlands and Their Impacts on Wildlife

Progress

Operators, designers and patrons of many of the treatment wetlands that have been constructed in Canada and internationally have reported extensive wildlife use of the wetland. Some have become well known as the best birding locations within many hundreds of kilometres due to the large and diverse population of birds that are attracted to these sites to feed on the many organisms that are produced because of the increased nutrient load.

Barriers and Challenges

While treatment wetlands have been demonstrated to provide considerable water quality improvement, there has been a concern expressed about the potential for wetlands to harbour large enough inventories of contaminants that wildlife ingesting aquatic organisms from the wetland will become adversely affected. Although there are reports that support this premise, there are also reports that suggest the contrary.

Opportunities and Strategies

Wetlands can be engineered to minimize potential negative wildlife impacts. Wastewater characterization, added pretreatment and proper design guidance can help to dramatically reduce the likelihood of adverse wildlife effects. A comprehensive literature search to document efforts to quantify the effects of treatment wetlands on wildlife and providing research opportunities at existing wetlands could provide guidance for wetland designers and end users for avoiding potentially hazardous situations for wildlife. Preparation and use of an ecological risk assessment approach for evaluation of suitability of the site (i.e. contaminants in soil), water (i.e. presence of bioaccumulative chemicals such as selenium and mercury) for constructed treatment wetlands will be a valuable tool/approach for reducing the potential of adverse wildlife effects due to contaminant accumulation.

Vision for the Next Ten Years

An increasing number of treatment wetlands are being constructed in Canada. Over the next ten years, the vision for this technological approach can be summarized in the following:

1. Preparation of a current Design Guidance Manual for the design and construction of treatment wetlands to suit the Canadian climate.

2. Implementation and monitoring of best management practices including the use of wetlands on selected watersheds to demonstrate the positive effects on the receiving water quality.
3. Preparation of a national document for the evaluation of natural wetlands that are being considered for water quality improvement.
4. Acceptance and recognition by engineers, regulators, and the public of treatment wetlands for improving the water quality of stormwater and wastewater.
5. Wildlife monitoring of selected treatment wetlands that are suspected of having a potential negative impact on the wildlife community.

Recommendations

1. Prepare a database of the treatment wetlands in Canada that will be accessible to all stakeholders.
2. Develop a Manual for the Design and Construction of Treatment Wetlands to suit Canadian climate conditions based primarily on Canadian experience and data.
3. Prepare a document that presents the procedures required to address water quality issues on a watershed basis.
4. Prepare National Guidelines on the use of natural wetlands for providing water quality improvement.
5. Prepare documentation that will educate regulators, engineers and the public on the value of treatment wetlands.
6. Prepare a standard wildlife monitoring procedure that can be used across Canada as a template.

References

Kadlec, R.H. and R.L. Knight. 1996. *Treatment Wetlands.* CRC Press/Lewis Publishers. Boca Raton, Florida.

Lemly, A.D. and H.M. Ohlendorf. 2002. Regulatory Implications of Using Constructed Wetlands to Treat Selenium-Laden Wastewater. In *Ecotoxicology and Environmental Safety*, Issue No. 52. Pp. 46-56. Elsevier Science (U.S.A.). New York, New York.

Mainguy, S.K., J. Pries and K. Chinniah. 2000. *Guidelines for the Approval and Design of Natural and Constructed Treatment Wetlands for Water Quality Improvement*. Alberta Environment Publication No. T/518. Edmonton, Alberta. On-line edition: see www.gov.ab.ca/env/.

Ohlendorf, H.M. 1996. Ecological Risk Assessment for Constructed Wetlands. In *Proceedings, Constructed Wetlands in Cold Climates (Design, Operation, Performance) Symposium*. Niagara-on-the-Lake, Ontario.

Ontario Ministry of Environment Approvals Branch. 1998. *Constructed Wetlands: MOE Approvals Branch Interim Approach to Review and Approval of Constructed Wetlands*

Wastewater Treatment Technologies Under Ontario Water Resources Act (OWRA). Ontario Ministry of the Environment. Toronto, Ontario.

Pries, J. 1994. *Wastewater and Stormwater Applications of Wetlands in Canada*. Sustaining Wetlands Issues Paper, No.1994-1. North American Wetlands Conservation Council (Canada). Ottawa, Ontario.

Pries, J. 2002. Treatment Wetlands: Operations and Compliance Challenges. In *Proceedings, 31st WEAO Technical Symposium and OPSEA Exhibition and Conference*. April 21-23, 2002. Hamilton, Ontario.

Pries, J. and P. McGarry. 2000. Feedlot Stormwater Runoff Treatment Using Constructed Wetlands. In *Treatment Wetlands for Water Quality Improvement – Proceedings, Quebec 2000 Conference.* Quebec City, Quebec.

Pries, J. and J. Philips. 2000. Addressing Challenges from Agencies and Public for Acceptance of Treatment Wetlands. In *Proceedings, 29th Annual WEAO Technical Symposium and OPCEA Exhibition and Conference*. April 16-18, 2000. Hamilton, Ontario.

Wren, C.D., C.A. Bishop and D.L. Stewart. 1996. Potential Risk of Chemicals in Constructed Wetlands to Fish and Wildlife. In *Proceedings from the Constructed Wetlands in Cold Climates (Design, Operation, Performance) Symposium.* Niagara-on-the-Lake, Ontario.

CHAPTER 7: WETLANDS, CLEAN WATER AND HEALTHY WATERSHEDS

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Abstract

Wetlands and associated riparian areas are vital components of freshwater resource sustainability in North America. The hydrological functions of wetlands include storage and eventual release of surface water, recharge of local and regional groundwater supplies, reduction in peak floodwater flows, de-synchronization of flood peaks and erosion prevention. Wetlands also influence many aspects of water quality, including nutrients, suspended solids, pathogenic microbes and anthropogenic pollutants such as pesticides. Although significant advances have been made in our understanding of wetland hydrology in recent years there is a lack of sound environmental information. This lack of information hinders decision-making at all levels of government and affords little protection for wetlands and riparian areas that provide water quantity and quality benefits.

The federal governments must play a leadership role in wetland protection and restoration. Wetlands and riparian areas must be viewed as an essential component of any watershed management strategy and a critical link to drinking water source protection through the process of Integrated Watershed Management (IWM) planning. The federal government should establish IWM protocols and planning processes that include wetlands and riparian areas. Provincial and territorial governments should develop and implement water management strategies that incorporate wetlands and riparian areas as effective tools for source water protection. Federal, provincial and territorial government policy must now move forward using the best available information. Successful implementation of policies and programs to ensure long-term water supply and quality will require insightful leadership from all levels of government, non-government organizations and private citizens groups.

Introduction: Wetlands and Clean Water

Fresh water is a vital resource for human society. We depend upon water for drinking, hydropower, irrigation, cooling and cleaning; for products such as food, plants and minerals; and for services such as waste purification, transportation and recreation (Naiman *et al*. 1995). Currently, freshwater resources are being depleted and degraded both in Canada and throughout the world; as a result, experts agree that a better understanding of the environmental and economic benefits of freshwater ecosystems is paramount to prevent further losses and degradation.

Recent events in Canada such as the Walkerton and North Battleford drinking water crises and the numerous boil water advisories that have been issued across Canada indicate that our freshwater resources should not be taken for granted. Canadians no longer feel that they have an abundant, never ending supply of clean water. In the past, human society has operated as if they have unlimited capacity to alter water resources and the landscape without degrading the ability of those systems to supply clean water. Previously the assumption existed that there is sufficient understanding and available technology to replace or compensate for lost ecological functions.

Today, there is an acknowledgement of the importance of the environment for sustaining clean water. Canadians are putting pressure on the federal, provincial and territorial governments to ensure safe drinking water supplies and calling for a more holistic approach to the issue than simply building larger water treatment facilities. Source water protection through watershed management is now recognized as the most practical approach to sustainable water management and Integrated Watershed Management (IWM), not more treatment plants, is critical to the future of our water supplies. IWM planning is a comprehensive multi-resource management planning process, involving stakeholders who cooperatively work toward identifying the watershed's resource issues and concerns, as well as develop and implement a watershed plan with solutions that are environmentally, socially and economically sustainable. For example, three upstate watersheds provide New York City's drinking water. In order to maintain and protect the high-quality water supply, New York City planners have developed a watershed protection plan as an environmental and economically responsible alternative to the much higher cost of a new water filtration plant (Ehlers *et al*. 2000).

Wetlands and associated riparian areas are vital components of freshwater resource sustainability in North America. Riparian areas are the interface between terrestrial and aquatic ecosystems. Wetlands and riparian areas must be viewed as an essential component of any watershed management strategy and a critical link to drinking water source protection. If we desire to understand the role of wetlands and riparian areas in maintaining both the quantity and quality of water supplies, we must approach management and research from a holistic viewpoint, incorporating all components of the watershed. Successful wetland conservation in North America requires that society, as a whole, perceives broader and more significant values of freshwater wetlands (Murkin 1998).

Wetlands are a continuum within the watershed and interdependent with other watershed units (Bedford and Preston 1988; Mitsch and Gosselink 2000a); thus, alterations to the watershed affect wetland functions and vice versa. Current scientific understanding acknowledges that landscape factors (i.e. topography, geology and landscape configuration) and climate influence wetland functions and diversity (Hill and Devito 1997; Bedford 1999). The landscape mediates delivery of water, minerals, nutrients, sediments and biota to wetlands (Brinson 1993; Bedford 1999); it is these factors that determine wetland functions.

Proper watershed functioning maintains high quality water supplies. Watersheds collect water as rainfall, snowmelt and runoff; store it for varying lengths of time; and then discharge it as surface runoff or groundwater flow (Black 1997). Wetlands and riparian areas are vital components of watersheds; as such, it is important to understand each of these individual components within the larger context of watershed function.

This paper focuses on the function and value of the wetlands and associated riparian areas for securing the long-term supply and quantity of drinking water resources. In addition, this paper provides an overview of challenges, opportunities and strategies that exist with respect to wetland and riparian area protection and restoration in Canada.

Hydrological Functions of Wetlands

The hydrological functions of wetlands include storage and eventual release of surface water, recharge of local and regional groundwater supplies, reduction in peak floodwater flows, de-synchronization of flood peaks and erosion prevention (Carter 1986; LaBaugh 1986; Winter and Woo 1990; LaBaugh *et al*. 1998; Winter 1999; Mitsch and Gosselink 2000a; Price and Waddington 2000). These functions are dependent on local topography, climate, geology and watershed characteristics (see Figure 1).

Wetlands are dynamic, continuously receiving and releasing water through interchange with the atmosphere, surface flow and groundwater (Winter and Woo 1990). Although significant advances have been made in our understanding of wetland hydrology in recent years (Winter and Woo 1990; Hill and Devito 1997; Winter 1999; Price and Waddington 2000) we have a limited understanding of hydrology for many of the wetland types that exist in Canada. This ultimately affects our understanding of many wetland functions (Doss 1995; Hill and Devito 1997; Hill 2000).

Water Storage and Flood Reduction

Flood reduction is an important wetland function, both environmentally and economically. The ability of wetlands to store incoming water is highly variable. Position in the landscape, location of the water table, soil permeability, slope and antecedent moisture conditions influence the ability of any given wetland to attenuate floodwaters (Carter 1986; Winter and Woo 1990; Devito *et al*. 1996; Cey *et al*. 1998).

Positive flood control benefits of maintaining wetlands in the landscape are well known. For example, the United States Army Corps of Engineers recommended the acquisition and protection of wetland areas along the Charles River in Massachusetts as the least expensive method of flood control (Carter *et al*. 1978). The large 1993 and 1995 floods in the Mississippi River Valley were linked to wetland drainage (Miller and Nudds 1996). They also demonstrated that wetland drainage in the United States is correlated with greater river flow rates than in Canada, where landscape alteration is much less severe. Hey and Philippi (1995) suggested that the restoration of approximately 5.3 million

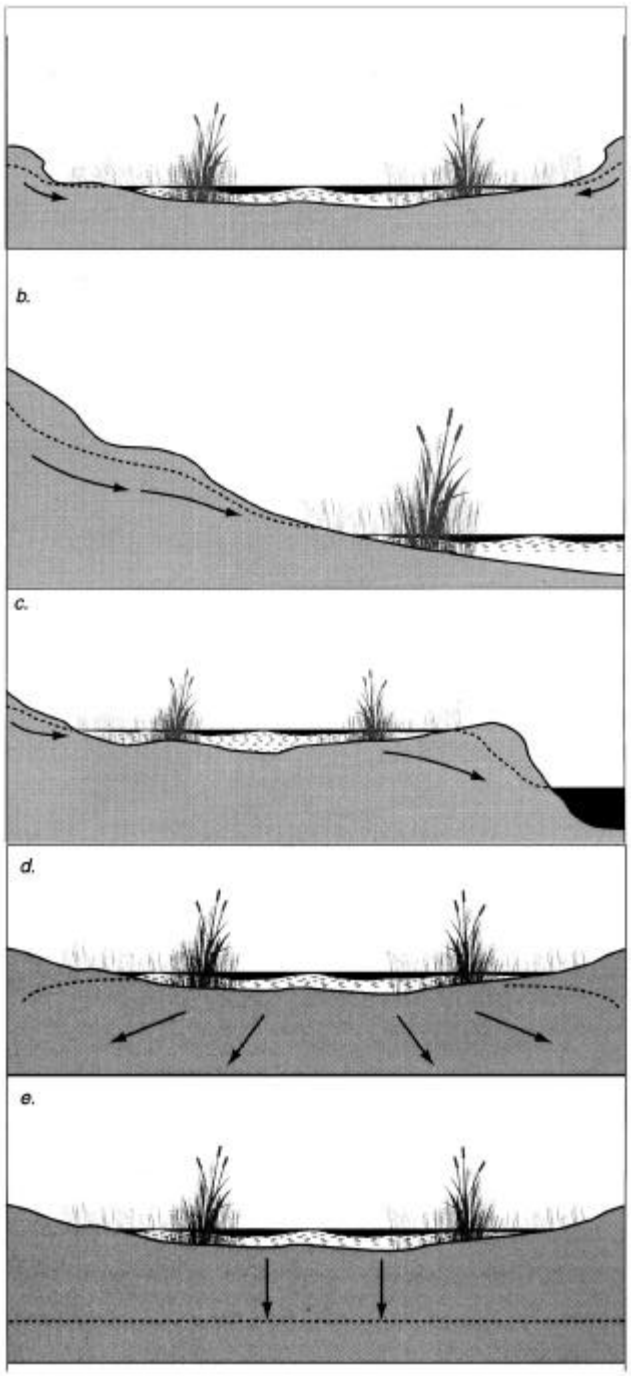

Figure 1. Possible discharge-recharge interchanges between wetlands and groundwater systems including: (a) marsh as a depression receiving groundwater flow; (b) groundwater spring or seep wetland or groundwater slope wetland at base of a steep slope; (c) floodplain wetland fed by groundwater; (d) marsh as a recharge wetland adding water to groundwater; and (e) perched wetland or surface water depression wetland (Mitsch and Gosselink 2000).

hectares of wetlands in the Upper Mississippi and Missouri Basins would provide enough floodwater storage (approximately 1m deep) to accommodate the excess river flow associated with the disastrous flood in midwestern United States in 1993. They concluded that an estimated 7% of the watershed would be sufficient to deal with even extreme event floods on a large scale.

Groundwater Recharge

Interactions between wetlands and local or regional groundwater supplies are complex and site-specific (Hill 1990; Winter and Woo 1990; Winter 1999; Devito *et al*. 2000a; Price and Waddington 2000) and are affected by the position of the wetland with respect to groundwater flow systems, geologic characteristics of the substrate and climatic setting (Winter 1999).

Recharge of groundwater is an extremely important function of some wetlands and occurs when water percolates slowly from wetlands to underground aquifers. Groundwater recharge occurs from many areas in the landscape, including wetlands (from seasonal to permanent) and uplands (Winter 1988; van der Kamp and Hayashi 1998). Hydraulic conductivity of the materials overlying aquifers determines the rate of aquifer recharge.

Prairie potholes in the semi-arid portion of the northern prairies are known to be important for groundwater recharge (van der Kamp and Hayashi 1998). Local groundwater flow systems extend over large horizontal distances (hundreds to thousands of metres) around prairie wetlands. This is due to the high hydraulic conductivity of prairie soils within a few metres of the surface that results in seepage from the wetland. They concluded that these small wetlands are important for recharge of local groundwater supplies, but the effect on regional aquifers is less certain.

Water Quality Functions

Wetlands influence many aspects of water quality, including nutrients, suspended solids, pathogenic microbes and anthropogenic pollutants such as pesticides. Because of their high biological productivity, wetlands can transform many pollutants into harmless byproducts via natural processes (Kadlec and Knight 1996).

Nutrient Assimilation

Many factors affect the ability of wetlands to assimilate nutrients including their position in the watershed, watershed hydrology, groundwater flow path, and sediment type, location and permeability (Hill 1996; Devito *et al*. 2000; Hill 2000). Similar wetlands can have quite different biogeochemical behaviour based on their position and connection to the watershed (Hill and Devito 1997; Bedford 1999). Several wetland characteristics contribute to their roles as nutrient sinks. In general, they accumulate organic matter, retain nutrients in buried sediments, promote sedimentation of organic matter; and by

their shallow water depth maximize water-soil contact and therefore microbial processing of nutrients (Mitsch *et al*.1989; Kadlec *et al*. 2000; Murkin *et al*. 2000).

There is evidence that wetlands are effective nitrate sinks in agricultural landscapes (Crumpton and Goldsborough 1998; Mitsch and Gosselink 2000b). Crumpton and Goldsborough (1998) reviewed several studies of prairie potholes receiving sustained nitrate loads, and found that upwards of 80% of nitrate loading could be lost through denitrification within the wetlands.

The primary means of net long-term storage of phosphorus is through wetland soil/sediment accretion (Kadlec and Knight 1996). Plants transform inorganic phosphorus to organic forms that are stored in organic peat, mineralized by microbial activity or exported from the wetland.

Wang and Mitsch (1998) studied phosphorus retention in a tributary watershed of the Laurention Great Lakes and estimated that about 15% of the watershed area should be in wetlands to provide phosphorus retention benefits. This would result in a reduction of two-thirds of the existing phosphorus load to Saginaw Bay from the watershed.

Sediments

Water bodies located in agricultural landscapes are prone to receiving high sediment loads due to alteration of wetland catchment areas and cultivation of grasslands that once protected soils from erosion (Gleason and Euliss 1998). Hydrology is a primary determinant of the sediment-retention capacity of a wetland (Brown 1988; Johnston 1991). Hydrology controls the source, amount and spatial and temporal distribution of sediment inputs to wetlands and other receiving water bodies (Johnston 1991). In a review of studies on the sedimentation of wetlands, Gleason and Euliss (1998) indicated that wetlands in agricultural landscapes have shorter topographic lives than wetlands in grassland landscapes. When wetlands fill with sediments they lose their capacity to perform most natural wetland functions. The trade-off between the importance of sediment removal as a water quality benefit and maintaining the topographic life of wetland basins needs to be integrated into management strategies of wetlands and watersheds (Gleason and Euliss 1998).

Pathogens

Many of the processes that reduce pathogen populations in natural systems are equally or more effective in wetland treatment systems (Kadlec and Knight 1996, p. 535). Structurally and functionally, most wetlands are dominated by naturally-occurring populations of microbes and plant life (Kadlec and Knight 1996, p. 154). Microbial populations in wetlands include the diverse flora of bacteria, fungi and algae that are important for nutrient cycling and biological processing. In addition, zooplankton grazers may be an important pathogen removal mechanism in wetlands during certain seasons. Macrophytes are essential because they provide surface contact area for microbes that

mediate most of the nutrient and pollutant transformations that occur in wetlands (Hamilton *et al*. 1993).

The ability of constructed wetlands to reduce populations of pathogenic microorganisms in wastewater effluent has been demonstrated globally (e.g., Kadlec and Knight 1996; Schreijer *et al*. 1997; Stott *et al*. 1997; Hill and Sobsey 1998; Decamp and Warren 2000; Neralla and Weaver 2000). Treatment wetland removal efficiencies are nearly always greater than 90% for coliforms and greater than 80% for fecal streptococcus (Kadlec and Knight 1996).

Contaminants

The ability of wetlands to degrade and remove contaminants such as pesticides, metals, landfill leachate and urban stormwater runoff has been examined in natural wetlands (e.g. Fernandes *et al*. 1996; Goldsborough and Crumpton 1998), and to a much greater extent in constructed wetlands (e.g. Hammer 1989; Kadlec and Knight 1996). In general, common pesticides of surface and groundwater disappear rapidly from wetlands, primarily due to adsorption to organic matter in sediments and decomposing litter and other degradative processes such as photolysis, abiotic hydrolysis and biodegradation, as well as by volatilization into air, adsorption and outflow from the wetland (Goldsborough and Crumpton 1998).

Challenges

(1) Information Gaps – Environmental and Economic

In general, there is a lack of understanding by the public and governments regarding the value and importance of protecting wetlands and riparian areas. The lack of sound environmental information hinders decision-making at all levels of government and affords little protection for wetlands and riparian areas that provide water quantity and quality benefits. Environmental and economic data on the function and value of wetlands and riparian areas will increase the understanding and appreciation for the protection and restoration of wetlands and riparian areas and is critical for the development of effective and sustainable water resource management strategies.

The ecological goods and services provided by wetlands and riparian areas can be divided into two categories; (1) the provision of direct market goods and services such as drinking water, transportation, electricity generation, pollution disposal, and irrigation; and (2) the provision of non-market goods or services which include things like biodiversity, support for terrestrial and estuarine ecosystems, habitat for plant and animal life and the satisfaction people derive from knowing that a lake, river or wetland ecosystem exists (Wilson and Carpenter 1999). Unfortunately, empirical data on market and non-market values for wetlands are lacking and those that do exist are often uneven in quality (Costanza *et al*. 1997; Postel and Carpenter 1997).

Economic information is critical to the development of policy that protects and restores wetlands and riparian areas for the environmental goods and services they provide. An economic model must be developed that can be applied to watersheds across Canada. The model must be sensitive to the diversity of watersheds that exist and the land use activities that occur within each watershed. Adequate inventories of wetlands, riparian areas and other natural features (e.g. forest, grassland, etc.) must be available to provide reliable information for making accurate predictions regarding the economic benefits of protection and restoration measures.

To provide the necessary scientific information (both environmental and economic), policy makers and government managers must invest immediately in research and scientists must be aware of the information needs of policy makers and managers as a first step. It is critical that all available scientific information be assembled and that information gaps are identified that pertain to the information needs of policy makers and managers.

Specific areas of research demanding attention at a watershed scale are as follows:

Hydrological Functions: There is a need to improve our understanding of the role and ability of wetlands and riparian areas to reduce and store surface water runoff. As well, an improved understanding of the groundwater recharge function of wetlands and riparian areas is required.

Water Quality Functions: There is a need to improve our understanding of the role and long-term sustainability of wetlands and riparian areas to retain nitrogen and phosphorus, attenuate microbial pathogens and dissipate pesticides in agricultural landscapes. As well, there is a need to develop models for predicting water quality effects of different wetland and riparian protection and restoration scenarios.

Economic Value of Goods and Services: There is a need to improve our understanding and develop effective modeling of the economic benefits of wetlands and riparian areas for these hydrological and water quality functions.

Although there is a lack of information, we cannot wait until all the environmental and economic benefits of wetlands are completely understood. We must strive to improve our scientific understanding of the functions and values of wetlands while at the same time, take action to ensure the protection and restoration of wetlands and riparian areas.

(2) Integrated Watershed Management and Wetlands

Watershed management groups are established or are forming across Canada in response to water quality and supply issues. Unfortunately, there is a lack of consistency and understanding of effective IWM and the fundamental principles that underlay the process. Wetlands and riparian areas are critical to water resource management and must be viewed as integral components of IWM. Effectively, IWM must be enabled through legislation, empowered through regulatory authority and supported with policies and resources that will ensure implementation and compliance.

The federal government should establish IWM protocols and planning processes that include wetlands and riparian areas. The IWM process should be effectively communicated to government and non-government organizations as a nationally accepted approach to watershed management.

(3) Protection Mechanisms for Wetlands

The federal government must play a leadership role in wetland protection and restoration. Currently, no federal department has the specific responsibility to ensure wetland protection and restoration in Canada. Wetlands are important to the five federal natural resource agencies (Environment Canada, Natural Resources Canada, Agriculture and Agri-Food Canada, Health Canada and Fisheries and Oceans Canada) and therefore they need to coordinate activities with respect to protection and restoration.

The federal government should provide staff and funding to help develop research programs that are needed to fill existing information gaps. The federal government should also develop programs that provide for sustainable water resource management and provide funding and the appropriate partnering mechanisms needed to ensure effective program implementation.

Generally, provincial and territorial governments are responsible for water management within their boundaries. Provincial and territorial governments should develop and implement water management strategies that incorporate wetlands and riparian areas as effective tools for source water protection. These governments should promote the development of watershed management groups and the use of the IWM process, and provide watershed groups with the authority and resources necessary to effectively manage water resources.

All governments should assume a leadership role as facilitators and partners in securement, stewardship, education and awareness of wetlands and riparian areas within their jurisdiction and promote their values for source water protection in an IWM process. Governments, in cooperation with non-government organizations and watershed groups, should promote and assist in the development of wetland and riparian area education programs, facilitate the exchange of information and expertise regarding wetland and riparian area issues, and encourage all government departments to ensure that policies and programs are consistent with, and supportive of, wetland and riparian area conservation objectives.

(4) Effective Communication

Knowledge is required to provide leadership and direction for government and non-government groups across Canada with respect to wetland and riparian area protection and restoration. The federal government should develop a national communication strategy to ensure the effective transfer of information from researchers to federal, provincial, and territorial government, non-government organizations, and watershed

management groups involved in the implementation of IWM. It is also critical that the federal government provide the general public with sound scientific information regarding the environmental and economic benefits of wetlands and riparian areas to gain acceptance and support for programs that ensure water resource sustainability.

The federal government should develop a national communication strategy to ensure that research information is effectively transferred to government and non-government policy makers and managers. As well, the general public must have the appropriate environmental and economic information to gain support for programs related to wetland and riparian area protection and restoration.

Recommendations

1. The federal government must determine the appropriate agency responsible for wetlands in Canada and provide the resources necessary for effective protection and restoration.
2. The federal government should lead a Watershed Science Forum to review existing research on the environmental and economic benefits of wetlands and riparian areas. The forum should provide the scientific foundation for the design and implementation of the research to fill the environmental information gaps and provide direction for the associated economic modeling that is needed.
3. In consultation with NGOs, the federal government should establish IWM protocols and planning processes that includes wetlands and riparian areas as a fundamental component of effective watershed management. The IWM process should be effectively communicated to government and non-government organizations as a nationally accepted watershed management process.
4. Federal, provincial and territorial governments should promote watershed management and watershed management groups as an effective process and mechanism for ensuring water resource sustainability.
5. The federal government should develop a national communication strategy to ensure that research information is effectively transferred to government and non-government policy makers and managers, as well as the general public.
6. The federal, provincial and territorial governments should review all existing legislation, regulation and policy to ensure the protection of wetlands and riparian areas. New legislation, regulation and policy should be developed to provide protection and restoration measures where required.

Conclusions

Immediate action is required to ensure the quality and quantity of Canada’s drinking water. Sustainable water resource management requires focusing on the development of water management strategies that promote IWM and wetlands and riparian areas as fundamental components of the planning process. Led by the federal, provincial and territorial governments, watershed management programs and policy must move forward now using the best available information. Successful implementation of policies and programs to ensure long-term water supply and quality will require insightful

leadership from all levels of government, non-government organizations and private citizens groups.

References

Bedford, B.L. 1999. Cumulative effects on wetland landscapes: Links to wetland restoration in the United States and southern Canada. *Wetlands* 19:775-788.

Bedford, B.L. and E.M. Preston. 1988. Developing the scientific basis for assessing cumulative effects of wetland loss and degradation on landscape functions: Status, perspectives, and prospects. *Environmental Management* 12:751-771.

Black, P.E. 1997. Watershed functions. *Journal of the American Water Resources Association* 33:1-11.

Brinson, M.M. 1993. Changes in the functioning of wetlands along environmental gradients. *Wetlands* 13:65-74.

Brown, R.G. 1988. Effects of wetland channelization on runoff and loading. *Wetland*s 8:123-133.

Carter, V. 1986. An overview of the hydrologic concerns related to wetlands in the United States. *Canadian Journal of Botany* 64:364-374.

Carter, V., M.S. Bedinger, R.P. Novitzki and W.O. Wilen. 1978. Water resources and wetlands. In *Wetland Functions and Values: The State of Our Understanding*. (P.E. Greeson, J.R. Clark, and J.E. Clark, eds). pp. 344-376. American Water Resources Association. Minneapolis, Minnesota.

Cey, E.E., D.L. R.udolph, G.W. Parkin and R. Aravena. 1998. Quantifying groundwater discharge to a small perennial stream in southern Ontario, Canada. *Journal of Hydrology* 210:21-37.

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. vanden Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387:253-260.

Crumpton, W.G. and L.G. Goldsborough. 1998. Nitrogen transformation and fate in Prairie wetlands. *Great Plains Research* 8:57-72.

Decamp, O. and A. Warren. 2000. Investigation of Escherichia coli removal in various designs of subsurface flow wetlands used for wastewater treatment. *Ecological Engineering* 14:293-299.

Devito, K.J., A.R. Hill and N. Roulet. 1996. Groundwater-surface interactions in headwater forested wetlands of the Canadian Shield. *Journal of Hydrology* 181:127-147.

Devito, K.J., D. Fitzgerald, A.R. Hill and R. Aravena. 2000. Nitrate dynamics in relation to lithology and hydrologic flow path in a river riparian zone. *Journal of Environmental Quality* 29:1075-1084.

Doss, P.K. 1995. Physical-hydrogeologic processes in wetlands. *Natural Areas Journal* 15:216-226.

Ehlers, L.J., M.J. Pfeffer and C.R. O'Melia. 2000. Making watershed management work. *Environmental Science and Technology* 34:464A-471A.

Fernandes, L., M.A. Warith and F. La Forge. 1996. Modelling of contaminant transport within a marshland environment. *Waste Management* 16:649-661.

Gleason, R.A. and N.H. Euliss Jr. 1998. Sedimentation of prairie wetlands. *Great Plains Research* 8:97-112.

Goldsborough, L.G. and W.G. Crumpton. 1998. Distribution and environmental fate of pesticides in prairie wetlands. *Great Plains Research* 8:73-95.

Hamilton, H., P.G. Nix and A. Sobolewski. 1993. An overview of constructed wetlands as alternatives to conventional waste treatment systems. *Water Pollution Research Journal Canada* 28:529-548.

Hammer, D.A. 1989. *Constructed Wetlands for Wastewater Treatment*. Lewis Publishers. Chelsea, Michigan.

Hey, D.L. and N.S. Philippi. 1995. Flood reduction through wetland restoration: The upper Mississippi River basin as a case study. *Restoration Ecology* 3:4-17.

Hill, A.R. 1990. Groundwater flow paths in relation to nitrogen chemistry in the near-stream zone. *Hydrobiologia* 206:39-52.

Hill, A.R. 1996. Nitrate removal in stream riparian zones. *Journal of Environmental Quality* 25:743-755.

Hill, A.R. 2000. Stream chemistry and riparian zones. In *Streams and Groundwaters* (J. Jones and P. Mulholland, eds). pp. 83-110. Academic Press. San Diego, California.

Hill, A.R. and K.J. Devito. 1997. Hydrologic-chemical interactions in headwater forest wetlands. In *Northern Forested Wetlands: Ecology and Management* (C.C. Trettin, F. Jurgensen, D.F. Grigal, M.R. Gale and J. Jeglum, eds). pp. 217-233. CRC/Lewis Publisher. Boca Raton, Florida.

Hill, V.R. and M.D. Sobsey. 1998. Microbial indicator reductions in alternative treatment systems for swine wastewater. *Water Science and Technology* 38:119-122.

Johnston, C.A. 1991. Sediment and nutrient retention by freshwater wetlands: Effects on surface water quality. *Critical Reviews in Environmental Control* 21:491-565.

Kadlec, J.A., A.G. van der Valk, and H.R. Murkin. 2000. The MERP nutrient budgets. In *Prairie Wetland Ecology: The Contribution of the Marsh Ecology Research Project.* (H.R. Murkin, A.G. van der Valk and W.R. Clark, eds) pp. 37-54. Iowa State University Press. Ames, Iowa.

Kadlec, R.H. and R.L. Knight. 1996. *Treatment Wetlands*. Lewis Publishers. New York, New York.

LaBaugh, J. W. 1986. Wetland ecosystem studies from a hydrologic perspective. *Water Resources Bulletin* 22:1-10.

LaBaugh, J.W., T.C. Winter and D.O. Rosenberry. 1998. Hydrologic functions of prairie wetlands. *Great Plains Research* 8:17-37.

Miller, M.W. and T.D. Nudds. 1996. Prairie landscape change and flooding in the Mississippi River Valley. *Conservation Biology* 10:847-853.

Mitsch, W.J. and J.G. Gosselink, 2000a. The value of wetlands: Importance of scale and landscape setting. *Ecological Economics* 35:25-33.

Mitsch, W.J. and J.G. Gosselink, 2000b. *Wetlands*. 3rd Edition, John Wiley and Sons, Inc., New York, New York.

Mitsch, W.J., B.C. Reeder and D.M. Klarer. 1989. The role of wetlands in the control of nutrients with a case study of western Lake Erie. In *Ecological Engineering: An Introduction to Ecotechnology*. (W.J. Mitsch and S.E. Jørgensen, eds). pp. 129-158. John Wiley and Sons. New York, New York.

Murkin, H.R. 1998. Freshwater functions and values of Prairie Wetlands. *Great Plains Research* 8:3-15.

Murkin, H.R., A.G. van der Valk, and J.A. Kadlec. 2000. Nutrient budgets and the wet-dry cycle of Prairie wetlands. In *Prairie Wetland Ecology: The contribution of the Marsh Ecology Research Project*. (H.R. Murkin, A.G. van der Valk and W.R. Clark, eds). pp. 99-121. Iowa State University Press. Ames, Iowa.

Naiman, R.J., J. J. Magnuson, D.M. McKnight and J. A. Stanford (eds). 1995. *The Freshwater Imperative: A Research Agenda*. Island Press. Washington, D.C.

Neralla, S. and R.W. Weaver. 2000. Phytoremediation of domestic wastewater for reducing populations of Escherichia coli and MS-2 Coliphage. *Environmental Technology* 21:691-698.

Postel, S.L. and S.R. Carpenter. 1997. Freshwater ecosystem services. In *Nature's Services*. (G. Daily, ed.). pp. 195-214. Island Press. Washington, D.C.

Price, J.S. and J.M. Waddington. 2000. Advances in Canadian wetland hydrology and biogeochemistry. *Hydrological Processes* 14:1579-1589.

Schreijer, M., R. Kampf, S. Toet and J. Verhoeven. 1997. The use of constructed wetlands to upgrade treated sewage effluents before discharge to natural surface water in Texel Island, The Netherlands – pilot study. *Water Science and Technology* 35:231-237.

Stott, R., T. Jenkins, M. Shabana and E. May. 1997. A survey of the microbial quality of wastewaters in Ismailia, Egypt and the implications for wastewater reuse. *Water Science and Technology* 35: 211-217.

van der Kamp, G. and M. Hayashi. 1998. The groundwater recharge function of small wetlands in the semi-arid northern prairies. *Great Plains Research* 8:39-56.

Wang, N. and W.J. Mitsch. 1998. Estimating phosphorus retention of existing and restored wetlands in a tributary watershed of the Laurentian Great Lakes in Michigan, United States of America. *Wetlands Ecological Management* 6:69-82.

Wilson, M.A. and S.R. Carpenter. 1999. Economic valuation of freshwater ecosystem services in the United States: 1971-1997. *Ecological Applications* 9:772-783.

Winter, T.C. 1988. A conceptual framework for assessing cumulative impacts on the hydrology of non-tidal wetlands. *Environmental Management* 12:605-620.

Winter, T.C. 1999. Relation of streams, lakes, and wetlands to groundwater flow systems. *Hydrogeology Journal* 7:28-45.

Winter, T.C. and M.K. Woo. 1990. Hydrology of lakes and wetlands. In *Surface Water Hydrology* (M.G. Wolman and H.C. Riggs, eds). pp. 159-187. Geological Society of America. Boulder, Colorado.

CHAPTER 8: CANADA'S WETLAND INDUSTRY

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Abstract

Canada has a large, well-established and diverse industry dependent upon the wetland resources of the country. The industry can be subdivided into four primary sectors: (a) Products and Manufacturing; (b) Supplies and Distribution; (c) Services; and (d) Knowledge. Specific representative examples within each of these sectors show that the economic impacts of gross output, value added, employment and tax generation of businesses dependent upon wetlands are significant. The existence and economic importance of Canada's wetland industry has been overlooked largely because the wetland industry itself lacks identity: many of the businesses are small, family-run operations, many of the activities are scattered in rural and economically disadvantaged parts of the country, and there is a lack of will to change or develop new techniques for utilizing wetland resources. Canada has been, and should continue to be, a world leader in the wetland industry. There is a need to promote the wetland industry nationally and globally, quantify the economic value of Canada's industry, bring the wetland industry together in a National Trade Fair and Information Forum, establish an industry association to represent businesses, develop common codes of practice, and establish wise resource use protocols. This paper makes additional recommendations for organizing, expanding and supporting new business opportunities for Canada's wetland entrepreneurs in the future.

Background

Wetlands are as characteristic of Canada as are the beaver, maple syrup and hockey. About 15% of the country or about 148 x 10^6 hectares of wetland cover the landscape. This estimate could probably double if we included wetlands situated along the freshwater and marine coastlines and those lost through conversion to other land uses in the past. As such, wetlands are unavoidable in Canada. Most Canadians encounter and come in contact, either directly or indirectly, with wetlands on a daily basis. As such there is interdependence between our wetlands and Canadian society. This interdependence has led to the need and opportunity for business and economic development. This is Canada's "wetland industry," which is probably one of our best-kept national secrets.

Traditionally, wetlands were perceived to be obstacles – any drained wetland was superior to an undrained one. With the arrival of the first European immigrants, many people were employed and companies prospered in response to the development of

the nation. There was a need to clear land for habitation and agriculture, dig tile drains and ditches, design special roads and infrastructure across wetland terrain, mine peat for fuel, and sell swamp for cedar for fences, ash for furniture and pine for British naval ships. In more recent decades with conservation efforts to protect wetlands, an enlightened populace and agencies were needed to develop new policy and regulatory guidelines and undertake wetland resource evaluations and impact assessments. Information and knowledge about wetlands had to be collected because it was realized that wetlands were important for wildlife habitat, water quality, coastal zone protection, watershed protection, biomass storage, climate regulation, pollutant absorption, subsistence production and cultural and spiritual uses.

Current practices on the use and management of wetlands wisely has, yet again, created the need to invent new nature-sensitive technologies and practices for the benefit of both human society and the wetland resource. This evolution in the way Canadians have come to view wetlands has created business opportunities; some that have come and gone and others await new entrepreneurial spirit. Canadians today have the opportunity, and perhaps obligation, to be world leaders in a wetland industry because of our wetland wealth and our long history of dealing with wetlands.

Are we aware of what businesses make up the wetland industry in Canada? Are these businesses that have a common resource interest themselves aware of whom they are? Is there any benefit of these businesses coming together to share experiences to ensure best management practices and care for the wetland resource that they depend on so strongly? What is the advantage in dealing with the wetland resource in a more business-like fashion? Do we have a true appreciation of the value and impact of these businesses on local, regional and national economies? How does this largely unknown industry contribute to the economic well-being of Canadians and Canada?

What is the Canadian Wetland Industry?

In general terms, our *wetland industry* can be defined as “those specialized and distinct business activities that derive quantitative and qualitative economic and social benefits and services generated from directly linked and spin-off activities stimulated by and from wetlands.” A *Canadian brand* exists because of a Canadian style of activities, products, innovations, technologies, knowledge and experience associated with our vast and unique wetland resources. There are relatively few national measures of the economic value of Canadian wetlands. Rubec *et al*. (1988) estimated that Canadians derive over CA$10 billion in economic benefits from direct resource and non-consumptive uses of wetlands each year. However, most attempts to estimate the value of wetlands, both within and outside Canada, have focused on the economic significance and non-quantitative value of wetlands on the landscape as opposed to non-wetland use for the same landscape (Rubec *et al.* 1988; Environment Canada 2001).

The view taken in this paper is much broader than conventional viewpoints. Any and all activity surrounding wetlands is a business as defined above. The facts are that many

Canadians depend upon wetlands for their livelihoods. Many Canadian enterprises, both for profit and not for profit have had and will continue to have long-established business interests surrounding wetlands. The vast majority of these enterprises is small to medium in size and is situated in rural and economically disadvantaged parts of the country. Alone, any one of these enterprises might not be considered significant, but together and because of where they are located, they are extremely important and significant in total.

Key Issues

For ease of characterizing the nature of the Canadian wetland industry, we can recognize four primary sectors around which specialized businesses have developed: (a) Products and Manufacturing; (b) Supplies and Distribution; (c) Services; and (d) Knowledge. Table 1 provides examples of enterprises in each sector that exemplify this wetland industry. Each of these sectors has measurable economic impacts (as also highlighted in Table 1), although comprehensive data have never been collected for the wetland industry as a whole. However, we can examine data for small components within the various sectors.

Included in the Products and Manufacturing Sector are the enterprises focused on collecting and selling the raw materials from wetlands and those enterprises that are transforming wetland materials into some value-added product. This sector is largely comprised of wholesale enterprises. The Canadian peat moss industry is one of Canada's longest running wetland industries (Warner and Buteau 2000). It is a wetland industry that has taken a leadership role in responsible resource use and economic development. Canada is the world's largest producer of horticultural peat moss, a position it has held since World War II. In 1999, CA$170 million was generated from peat moss, 75% from activities in Quebec and New Brunswick (Daigle *et al.* 2001).

Canadian peat is used not only as raw material for a garden soil conditioner, but can be processed into a number of products such as peat pots, boards and pellets for nurseries, specialized soil mixes, industrial absorbent material, charcoal and filtration material, and insulation. Another wetland industry that has emerged in Canada in recent years is the harvesting of cranberries for many products. The total exports of Canadian cranberries, all of which were grown on managed bogs, generated between CA$29 to CA$60 million in 1998 and 1999 (Vandenberg and Parent 1999). British Columbia alone is the world's third largest producer growing about 95% of the cranberries in Canada (British Columbia Ministry of Agriculture 2002). These two examples illustrate the measure of gross output of these two small sectors within the Products and Manufacturing Sector of the wetland industry, without considering the value-added, employment and taxation impacts.

Table 1. Sectors in the Wetland Industry and the Economic Impacts

WETLAND INDUSTRY SECTOR	EXAMPLES	ECONOMIC IMPACTS
Products and Manufacturing	cranberries, wild rice, market vegetables, nursery stock, sod, peat moss, lumber, wetland machinery (i.e. peat harvesters, "cookie cutters"), insect protection products, wetland trail material, boats	Gross output Value added Employment Tax generation
Supplies and Distribution	nurseries, greenhouse operators, specialized wetland product companies, trucking companies, export distributors	Gross output Value added Employment Tax generation
Services (a) Private and Not for Profit Companies (b) Public Companies	(a) environmental consulting, engineering and construction, leading of fishing, hiking, camping trips, organizing of wetland events, professional, advocacy, charity groups (b) resource evaluation and inventory monitoring, policy and regulation, management control, legislative enforcement (i.e. conservation officers)	Gross output Value added Employment Tax generation
Knowledge	Research and development activities, training and teaching, knowledge spin-off businesses, knowledge transfer spin-offs	Research and development investments Institutes, universities, and colleges as operating units Trained skilled specialists Knowledge transfer spin-offs

Black spruce is the dominant tree species on bogs and swamps in the Boreal Ecozone of Canada. It is also the preferred species used in the pulp and paper industry yet there has been little attempt to manage the wetlands on which black spruce grows for pulp wood production. This is perplexing when there are extensive stands of swamp and bog black spruce close to existing pulp mills, much closer than the far greater distances preferred for the harvesting of black spruce on upland sites.

There is a multitude of low to high-end value-added products that exist or await invention such as cranberry liqueurs, cattail flour, wastewater treatment units, wild rice

popcorn, crafts and artwork, books, pharmaceutical and related products, contaminant-free durable construction material for wetland trail boardwalks, and mosquito and black fly protection products. Another group of enterprises in this sector are those involved in the design and manufacturing of special wetland instruments and equipment used in the wise-management of wetlands, such as the field equipment used in mining peat in the peat moss industry, the “cookie cutters” for maintaining open water in marshes, and special wetland tour boats, rail cars and all-terrain vehicles for transporting people in and out of wetlands in support of activities in the Services Sector. Also, there are enterprises that manufacture packaging materials for delivering wetland products to market such as the plastic bags for packaging peat moss bales or the packaging and the packaging used for the various wetland food products. The potential for growth in both the domestic and export markets in this sector is huge. There is great opportunity to develop and market the “Canadian brand” in this sector.

Businesses representing the Supplies and Distribution Sector are largely retail that supply, market and distribute various products and goods produced by the manufacturing sector. These enterprises may not necessarily specialize in wetland products but include them in their activities. All transportation activities associated with the movement of wetland materials and products are another big component in this sector.

The Services Sector can be subdivided into two subsectors, private and not-for-profit enterprises and public enterprises. In the case of the former subsector, Ducks Unlimited Canada can be cited as an example in the Services Sector. It is probably the largest business specializing in wetland management in this country as well as the United States, Mexico, Australia and elsewhere. Its 2001 annual budget was CA$78 million (Ducks Unlimited 2001). Another large component in the private subsector is represented by the multitude of Canadian environmental and engineering consulting companies. Nearly every such company in Canada is involved in wetland work in some fashion, although few promote that aspect of their company profile as strongly as they should. The hundreds of these enterprises that exist across the country exemplify the importance, need and diversity of wetland issues for which professional services are required, both domestically and abroad. Unfortunately, there has not yet been any attempt to tally the economic worth or scope of this activity or to use existing mechanisms that might promote it. Industry Canada, for example, has a national database of corporate consulting expertise in environmental fields but almost none of the firms listed highlight their wetland consulting expertise.

Closely connected to the consulting enterprises are contracting and construction businesses involved in building wetlands alone and in building roads, pipelines, fishways, reservoirs and other structures in and around wetlands. These companies require specialized wetland experience and skill because wetland terrain is distinctly different than skills and equipment utilized on upland terrain.

Recreational and tourist activities are another large component in this subsector that is fast growing and probably, as yet, under-utilized. For example, a single but important

wetland comprising most of Point Pelee National Park in Ontario, is estimated to generate CA$386,000 annually (Environment Canada 2001). There are at least another 100 or 150 wetlands in parks and wildlife sanctuaries elsewhere in Canada that are equally attractive to hundreds or thousands of visitor birdwatchers, hikers, campers and weekend naturalists annually. Examples of such sites dominated by wetland systems are the National Wildlife Areas at Cap Tourmente in Quebec, Cape Jourimain in New Brunswick and Last Mountain Lake in Saskatchewan. Other heavily visited sites are provincial wildlife management areas such as the George C. Reifel Refuge in British Columbia and Oak Hammock Marsh in Manitoba. A considerable number of wetland recreational activities occur in our typical Canadian wilderness near remote and often Aboriginal communities. This brings revenue, and often the only revenue, to these isolated communities. Significant local cultural opportunities from waterfowl festivals to natural history beauty contents have arisen in relation to such local wetland resources and recreational interests in many of our small towns across the land. Some activities revolve around celebrating World Wetlands Day and World Bog Day. Again, nobody has yet assessed the economic contributions, in both direct gross output and associated multiplier effects of this activity in the country.

A fast growing component included in this subsector includes professional, advocacy, awareness-raising and charity groups that do not operate with profits. They range in size from small, locally based citizen groups to large international groups with a great interest in wetlands such as the Nature Conservancy, the World Wildlife Fund, the Society of Wetland Scientists and the International Peat Society.

A public sector, comprising local to federal governments, characterizes the second major subsector in the Services Sector of the wetland industry. Despite government budget cuts in recent years, downsizing of operations, and privatization of some traditional governmental activities, there remains a vital and important role for wetland agencies that are supported by public funds. Because the wetland resources themselves and the activities and interests surrounding wetlands are unlike other natural resources, wetlands have fallen between the cracks with no government agency with a wetland mandate. It may be appropriate to create a government agency with a mandate whose role would focus on the regulation, management and protection of existing and future wetland resources. Only 10% of Canadian wetlands are in protected areas. Much remains to be done to ensure removing important and representative wetlands from the threat of unwise and non-sustainable uses to ensure protection of species at risk and ecologically sensitive habitats. Not only is it important to protect wetland ecosystems *per se*, but also consideration must be given to wetlands for their role in the protection of large water supplies unthreatened by contamination. Wetlands, as large water reserves, are becoming more critical than ever as water supplies shrink, climate becomes drier and new water contamination sources are discovered.

Currently, public access to, and therefore public appreciation of, wetlands is poor. A very small and unrepresentative proportion of Canada’s wetlands are within a 50 km drive for over 60% of Canadians. It is important that we work toward ensuring that our children learn about and gain first hand awareness of this distinctive and valuable part

of their homeland. Growing up not knowing where their cranberry juice comes from is like growing up not knowing where milk comes from. As we encourage and create opportunity for our children and many others to learn about wetlands, we need government bodies that will regulate and control all such activities in a reasonable and organized way. Canada was the first country to have a *Federal Policy on Wetlands Conservation*, much to the surprise and envy of many countries much smaller in size and with much less wetland than Canada. This policy applies only to federal lands but a large proportion of Canada's wetlands are not on land under federal control.

Wetlands have a large role to play in our national carbon inventory and as such represent major carbon reserves in the country. The net carbon stored in our peatlands and in other organic-rich wetland soils greatly exceeds the carbon stored in the nation's forests and agricultural soils, but goes unrecognized for its role in balancing greenhouses gas emissions and carbon sinks in Canada. How, and if, this carbon is to be priced in terms of economic worth for sale and trade on the world market or for credit in meeting international obligations to off-setting carbon emissions has yet to be determined. While government departments and groups such as Ducks Unlimited have taken a lead in this area, there will continue to be the need for greater evaluation of the importance of wetlands in the climate change initiative now that Canada has ratified the Kyoto Protocol. Governments in particular must be heavily involved in managing wetland resources, in terms of needed research, evaluation and a direct management responsibility for vast wetland areas found on Crown lands, wildlife reserves and parks.

Contrary to current government trends, there is and will continue to be a need for regulation, policy development and legal enforcement. Existing policies and regulations evolve and new ones will be needed. Government bodies are the only agencies that can do this. There will continue to be those who monitor the extent, health and inventory of existing resources. Law enforcement and conservation officers will continue to be required to manage resources.

The role of Canada's public and private organizations in the last sector, the Knowledge Sector, cannot be underestimated. Universities, colleges, governments and private organizations (i.e. Crown corporations and Networks of Excellence) are involved in various aspects of research and development on wetlands. Public and high school curricula in some provinces incorporate local and traditional wetland knowledge in educational modules. There is also training of wetland specialists and entrepreneurs who will be equipped to contribute the latest and newest to the industry. There is economic worth in these activities first as operating units and in the new knowledge that will be transferred to newly trained personnel and in the spin-off enterprises that will result from this activity.

Challenges

Lack of identity of wetland resource: We have been slow to recognize that wetlands contribute significantly to the Canadian economy. As such, we must characterize and quantify the economic impacts and social benefits of each of the sectors or sub-sectors

involved in the wetland industry. Part of the difficulty has been that the wetland industry is diverse and the business enterprises are perhaps unconventional. The wetland resource can and should be viewed in the same way as other natural resources such as forests, fisheries and mining. It is likely to be revealed that wetlands contribute as much or more to the economic well-being of Canadians as other resource sectors. Wetlands have been a component of the landscape that has been difficult to differentiate from other landscape units. There is now consensus in the scientific community that wetlands are distinctive and unique landscape units and that perhaps only Russia has more wetlands than Canada. The wetland resource needs to be managed differently than other resources and in ways that are specific to wetlands.

Lack of recognition of the wetland industry: Canada has a long and well-established history of business involved with wetlands. The industry is different in some ways than other industries. It is also diverse and difficult to clearly define, which may have contributed to its low profile or apparent lack of identity. Clearly, there is a large industry linked to this common wetland resource. The wetland resource is something that can be regarded as uniquely Canadian.

Lack of tools for resource economic evaluation: After more than 20 years of work, there are tools, such as the *Canadian Wetland Classification System* (Warner and Rubec 1997), which are important first steps in characterizing the wetland resource of the nation. Canada was one of the first countries in the World to have a national wetland classification system. Also, in spite of its large size, we have a good first approximation on the nature and extent of Canadian wetland resources though improvements are still required. There is however an urgent need to develop tools to allow assessment on the value and economic impact of the wetland resource of Canada. Regional tools for some aspects of wetland significance exist but nothing nationally. Methods and models for quantifying some aspects of the economic contribution of wetland resources also exist, and even some specialized tools exist for some small sectors of the wetland industry (i.e. Dufournaud *et al*. 1999). However, much that has been done is localized geographically and unrepresentative for the wetland industry as a whole. Economists and wetland specialists must work closely together to better assess the true economic worth of the Canadian wetland industry.

The available techniques need to be explored and tested or modified to suit the various sectors in Canada's wetland industry. There may also be the need for new techniques to be developed. Confidentiality reasons may prevent some information from being available to adequately assess and quantify economic impacts. Estimating economic impacts in some sectors may prove difficult. However, we should attempt at least good first approximations. This would be more than what currently exists.

Industry is comprised of small enterprises: Many of the businesses are small enterprises – many being family-run operations. There may be reluctance or a feeling of being "too small to count." Individual operations, indeed, may be too small to influence or regulate their own industry in areas such as pricing, total supplies, production quotas, product quality, industry codes of ethics or other business aspects that will ensure their

position in the economy. Regardless, there is much to be gained by working together and pooling resources as a group of independent operations or businesses, not unlike other associations, councils and administrative units representing business enterprises.

Industry is intermittent: Much of the wetland industry is seasonal with many operations or activity occurring in the spring-summer-fall. This is not a characteristic unique to the wetland industry, being true of most natural resource industries.

Industry is diffuse: Many of the businesses involved in the wetland industry are widely scattered, being located in rural and remote regions of the country. This is both a weakness and strength in that they are situated in economically disadvantaged parts of the country. The wetland industry may be the sole economic activity in these regions.

Non-entrepreneurial mindset: There must be a willingness to change old ideas on how some sectors of the natural resource sector, in general, and a readiness to accept the new and different requirements offered by wetland resources to take full advantage of the economic opportunities. For example, even though business as usual in non-wetland may be "easier" than wetland, there must be an open-mindedness to accept the new challenges and economic opportunities of the wetland resource.

Barriers

The Canadian wetland industry's enterprises have been slow or reluctant to recognize themselves and the value of their existence. To some, the very concept of a wetland industry may seem strange or unnecessary. Efforts, therefore, should be made to raise the profile of the wetland industry and its contribution to the Canadian economy. As such, there is considerable merit in the industry coming together to identify a common purpose and the diverse and cross-linked interests in the wetland resource.

Opportunities

There are many opportunities that can be promoted by common action:

- The Canadian wetland resource is huge.
- No other country has the diversity and extent of wetland resources as does Canada.
- Canada has been a world leader in recognizing the importance and value of wetland resources and has the unique opportunity to (and obligation) to continue to be a leader.
- Canada has a long history of entrepreneurship and innovation with respect to its wetland resource that have led to prosperous businesses and contributions to local and national economies.
- Canada's wetland industry is a well kept secret that must be promoted and have its profile raised both nationally and globally.
- The wetland industry has much potential to expand existing activities and move into many new, as yet, under-exploited sectors.

- Canadian businesses can work with each other and can assist and teach other nations about Canadian approaches, policies and technological innovations internationally.
- The Supplies and Distribution and Services sectors in the wetland industry represent major areas for growth.
- A large part of what the wetland industry does involves “green” ecologically friendly technologies that are the technologies of the future.

Recommendations

(a) A national workshop should be organized with representatives of the various wetland industry sectors and other stakeholders involved in the wetland industry as a means of recognizing, promoting, supporting and producing a product representing the wetland industry in Canada.
(b) Representatives of the wetland industry should establish an association to represent their interests, give profile to and develop sound business and management practices (including sectoral Codes of Conduct) for the on-going wise use of wetland resources.
(c) A “Wetland Industry Association” should develop partnerships with other businesses, governments, and public enterprises, both within Canada and abroad.
(d) An annual National Wetlands Trade Fair and Information Forum should be organized.
(e) An economic study which characterizes and quantifies the contribution of the whole wetland industry in Canada, sector by sector, including gross economic output, spin-offs and multiplier effects should be undertaken (as suggested in Table 1).
(f) Economic development assistance programs should be established to support existing activities and encourage new growth of the wetland industry, especially because the wetland industry is a major economic driver in economically disadvantaged regions of the nation.
(g) Provide information, know-how and financial support to small to medium size entrepreneurs interested in establishing wetland businesses through existing government programs (i.e. Industrial Research Assistance Program of the National Research Council) or through private organizations (i.e. Canadian Innovation Centre or through financial institutions).
(h) *Products and Manufacturing Sector*
    - work toward adopting an industry policy on the wise use, management and protection of wetland resources
    - adopt an industry product certification program
    - develop an industry long-range resource plan for the wise use, management and protection for wetland resources and more detailed marketing plans for specific subsectors
    - assess the potential feasibility of adopting a resource utilization levy for reinvestment into the management and protection of future wetland resources
(i) *Supplies and Distribution Sector*
    - probably similar to recommendations given for the Products and Manufacturing Sector

(j) *Services Sector*

- compile a directory of businesses in the services sector
- support the training and accreditation of wetland professionals
- have wetland resources recognized and governments take on responsibilities for wetland resources as they have for other natural resources in Canada (i.e. forests, fisheries and mineral resources). Wetland resources are the only natural resource sector not recognized by federal or provincial governments in Canada.

(k) *Knowledge Sector*

- support the compilation and publication of a volume on state-of-the-art information on Canada's wetland resources
- support and provide funding for the resurrection of Canada's National Wetlands Working Group
- continue with exploration, assessment and inventory of the whole wetland resource in Canada
- identify, prioritize and fund opportunities for research and development business partnerships between research enterprises and specific sectors of the wetland industry (i.e. research and development tax credits)

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References

British Columbia Ministry of Agriculture. 2002. *Cranberries.* Plant Products Branch, Ministry of Agriculture, Food and Fisheries, British Columbia. Victoria, British Columbia. (www.agf.bc.ca/aboutind/products/plant/cranberry.htm).

Daigle, J.-Y., H. Gautreau-Daigle and D. Keys. 2001. *Canadian Peat Harvesting and the Environment. Second Edition*. North American Wetlands Conservation Council (Canada), Sustaining Wetlands Issues Paper, No. 2001-1. Ottawa, Ontario.

Ducks Unlimited Canada. 2001. *Annual Report 2001*. Ducks Unlimited Canada. Stonewall, Manitoba.

Dufournaud, C.M., J.T. Quinn, A. Olinsky and B.G. Warner. 1999. Calibration of cost functions for individual firms as an alternative to estimation: An application to New Brunswick peat-mining firms. *Environment and Planning* A31:551-558.

Environment Canada. 2001. *Putting an Economic Value on Wetlands – Concepts, Methods and Considerations*. Great Lakes Fact Sheet. Environment Canada. Downsview, Ontario.

Rubec, C.D.A., P. Lynch-Stewart, I. Kessel-Taylor and G.M. Wickware. 1988. Wetland Utilization in Canada. Chapter 10 In *Wetlands of Canada*. Environment Canada and Polyscience Publications. Ottawa, Ontario.

Vandenberg, J. and G. Parent. 1999. *Profile of the Canadian Cranberry Industry*. Fact Sheet. Market Industry and Services Branch, Agriculture and Agri-Food Canada. Ottawa, Ontario.

Warner, B.G. and P. Buteau. 2000. The early peat industry in Canada, 1864-1945. *Geoscience Canada* 27:57-66.

Warner, B.G. and C.D.A. Rubec (eds). 1997. *The Canadian Wetland Classification System*. *Second Edition*. National Wetlands Working Group. Wetlands Research Centre, University of Waterloo. Waterloo, Ontario.

CHAPTER 9: INNOVATIVE OPPORTUNITIES FOR HABITAT STEWARDSHIP IN CANADA: THE CEA-DFO MOU AS A MODEL FOR COOPERATION

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Abstract

With the advent of *Canada's Stewardship Agenda*, national initiatives by industry are taking on greater profile. The Canadian Electricity Association (CEA) has been particularly active in advancing industry-government cooperation on stewardship. This paper reports on a specific project – a Memorandum of Understanding between CEA and Department of Fisheries and Oceans – that could become an important model for cooperation in efforts to safeguard the wetland environments in and around industry operations across Canada.

Introduction

The Canadian Electricity Association (CEA) is the industry association for over 95% of electricity generation across Canada. As such, its operations can have an impact on the natural environment routinely, and are subject to the legislative framework of, amongst other pieces of legislation, the *Fisheries Act*.

In an ongoing effort to achieve a range of policy objectives, CEA has been working on a number of specific cooperative initiatives with the Government of Canada. One of the most advanced of these is a Memorandum of Understanding (MOU) with the Department of Fisheries and Oceans (DFO) with respect to the *Fisheries Act*. This paper will focus on that CEA-DFO MOU as a model for cooperation between government and industry.

Sectoral Agreements in Context

CEA member companies initiated the Environmental Commitment and Responsibility (ECR) Program in 1997 as a public commitment to continue providing economical and reliable electricity while reducing their impact on the environment. Essentially, CEA members are seeking better ways of producing, transmitting and delivering electricity while managing environmental matters responsibly. This undertaking has led industry to look for further opportunities to work together with Canadian stakeholders in view of furthering the stewardship of Canada's natural environment. CEA's good relations with the federal resource ministries (Natural Resources, Environment and Fisheries and Oceans) provided the electrical industry with an opening to explore closer government collaboration.

Generally, government has three principal policy tools to deal with environmental issues. These are:

- Regulatory (legislation, regulation, policy initiatives)
- Economic (taxation, incentives, targeted programs)
- Voluntary (MOUs, voluntary disclosure initiatives, environmental management systems)

A combination of these tools provides greater flexibility while at the same time ensuring that there is a consensus with all the actors involved (possibly including different levels of government and representatives of companies). They may or may not be backstopped by regulatory requirements, but there are some material consequences for not complying. As well, they can operate at a number of levels (e.g. global issue framework, sectoral agreements, company-specific negotiations). Precedents exist in other jurisdictions (e.g. United States, Europe).

Because environmental issues cannot be solved simply through regulatory obligations imposed unilaterally by the government(s), industry needs to get engaged. The electricity sector has been exploring the opportunity for such engagement on fish and fish habitat issues for the last several years. In short, CEA sought a cooperative mechanism that would allow industry and government to reach a mutual understanding of the issues and use realistic solutions to real problems. Given the vast reach of the *Fisheries Act*, whereby any “harmful alteration, disruption or destruction of fish habitat” will trigger enforcement provisions, CEA sought to negotiate such a cooperative mechanism that could address specific provisions of that Act.

Member company installations can have an impact on fish habitat, by for example, their effects on spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly. CEA members are committed to the protection of fish habitat and the sustained production of fish that support Canada’s commercial, aboriginal and recreational fisheries. In tandem with DFO’s policy for no net loss, CEA members have consistently respected habitat and supported programs to increase the number of fish.

With this in mind, the CEA signed a bilateral Memorandum of Understanding (MOU) with the Department of Fisheries and Oceans (DFO) in July 2002 on the implementation of the *Fisheries Act*. Deputy Minister Peter Harrison represented DFO and President Hans Konow represented the CEA. Press Releases were distributed shortly afterwards.

The CEA-DFO agreement has opened the doors for mutual understanding of each other’s concerns and provided the opportunity for more creativity and less confrontational approach to managing the issue of fish habitat. For instance, this MOU is providing the opportunity for:

- Regular consultation between the sector and DFO

- Development of a national *Fisheries Act* compliance framework
- Joint support for stewardship initiatives across the country
- Coordinated development of programs and materials for education and training
- Collaborative work on research and monitoring

Understanding the MOU Approach

A Memorandum of Understanding brings both parties to agree on common goals and objectives. In a succinct manner, the agreement synthesizes the position of each party on a given subject matter and proposes to lead further discussion in a certain direction.

CEA and the Department of Fisheries and Oceans are both dedicated to conserving and protecting Canada's fish and fish habitat resources. In a cooperative fashion, CEA wishes to further this objective while balancing the interests of industry to deliver reliable, affordable electricity to Canadians. The preamble to the MOU commits both sides to cooperate effectively in developing and implementing a Habitat Management Program in a manner consistent with the requirements of the *Fisheries Act*. To facilitate a working relationship, the MOU dictates a framework of deliverables that both industry and government will advance through their selected representatives. Reviewing these component elements of the Memorandum can improve understanding of the far-reaching implications of a government-industry collaborative approach.

Ongoing Senior-level Consultation

Regular consultation at the highest level between the parties is a principal feature of the MOU. An entire range of issues can be canvassed through face-to-face meetings of regional and national officials. This facilitates the exchange of information, resolution of conflicts, and above all, develops and implements initiatives contained in the MOU document. The commitment binds the parties to the following consultations:

- conduct an annual senior level meeting between industry executives and DFO officials to monitor progress;
- convene twice annual operations level meetings to define priorities, review progress, discuss specific concerns, advance stewardship, education and training and research initiatives, and share ideas on fish habitat management; and
- encourage and facilitate meetings between electricity industry and DFO regional representatives in regions across Canada.

Reaching consensus is never easy, but the fact of staging consultations is a marked departure from "action-reaction" type strategies that have been a mainstay of government-industry relations over the past decades. Industry-wide habitat management initiatives and issues are best presented at policy-making levels. Ultimately, decision-makers have to weigh in on the work done to date or propose initiatives. The MOU delivers a structured, if informal manner, of approaching long-term policy questions and the impediments faced by both sides in carrying out their mandates.

Specifically, CEA and DFO have already hosted a number of these meetings, beginning prior to the MOU being signed, in November 2001 and May 2002. Subsequent to the MOU signing, regional representatives met in November 2002 to forge consensus on seminal documents that will guide the process under the agreement. At the senior level, the two signatories to the MOU met in October 2002 to consider progress to date and reflect on the overall direction. Although not realized this year, CEA executives and the Minister of Fisheries are scheduled to meet yearly under the MOU.

National Compliance Framework under the *Fisheries Act*

Perhaps the most notable feature of the MOU is the introduction of the idea of a national *compliance framework*. From the industry's perspective this is the most valuable component of the MOU as it furthers clarity, certainty and efficiency in the interpretation of the *Fisheries Act* across the DFO regions. Both sides agree that developing a framework that sets out commonly held objectives and principles would provide a foundation for mutually acceptable compliance decisions. When fully elaborated, this proposed framework will describe legally based and scientifically sound fish and fish habitat conservation and protection requirements, which are to be applied consistently across Canada, with appropriate recognition of local and regional differences. Cooperation in developing such a national compliance framework gets to the heart of the MOU approach. Merging wide-ranging, philosophical objectives with the nuts and bolts of everyday compliance decisions requires great patience and ability to stay focused at the negotiating table.

The MOU approach envisioned by CEA and DFO brings together policy, legal and science experts to advance the position of the respective parties. Without leaving aside the issue of legislative authority to delegate and the discretionary aspect of day-to-day decision-making, both signatories approach the issues frankly and try to arrive at a mutually acceptable compromise. There will be give and take, no doubt, but the fundamental, overriding objective is conservation and protection of fish and fish habitat. Under the MOU, the parties can explore how industry best provides habitat management and not trigger aggressive enforcement techniques by DFO officers. The emphasis is kept on what has worked, what Canadians expect in regard to protection of the natural environment, and how best practices can keep industry in compliance for the future. It may be helpful to have regard to the initial steps taken over the first six months of the CEA-DFO MOU to understand the MOU approach.

Initial discussion of a national compliance framework began at a two-day joint CEA-DFO workshop in November 2001. Since this meeting, the CEA member representatives prepared a table of contents, a statement on the scope of the framework, and a section on objectives and principles. These documents state, in brief but incisive language, the goals of the compliance framework. In addition, a Core Group composed of a small number of representatives from CEA and from DFO oversees the implementation of the MOU and negotiation on the terms of the compliance framework. As such, the Generation Council of CEA and DFO representatives on the Core Group have approved final versions of the table of contents and scope.

Since the signing of the MOU, Core members have initiated further negotiation on the principles and objectives underlying the national compliance framework. At an August 2002 face-to-face meeting, Core group members arrived at an agreed-upon slate of basic principles for comment by industry and DFO internally. Subsequent versions were prepared leading to a November 2002 workshop where a full complement of industry representatives and regional DFO officials discussed specific principles and their ramifications on compliance decision-making across the regions. A final version with full legal input is presently under consideration and should be completed by March 31, 2003.

Working collaboratively with DFO, CEA Core members have also produced a *Matrix of Works and Undertakings for Hydroelectric Installations*. This matrix categorizes a minimal set of operations carried out in the course of construction, maintenance and decommissioning of a hydroelectric generating installation. The matrix may serve as a starting point for a more ambitious "interpretive bulletin" approach to reaching consensus between industry practice and government enforcement. A series of interpretation bulletins (similar to those under the *Income Tax Act*) would incorporate key sections of the *Fisheries Act* and bring very specific proposals to DFO for a consistent, reasonable interpretation of the Act as it is applied to the electricity industry. The MOU approach has a considerable advantage in this respect: the parties have undertaken consensus building and produced a long-term framework that achieves results.

Stewardship Initiatives

Central to the MOU is the development and exchange of information on Stewardship programs currently underway at member utilities. In tandem with the *Canada's Stewardship Agenda* (CSA) (Federal-Provincial-Territorial Stewardship Working Group 2002), CEA and DFO agree to work together to encourage and coordinate fish habitat stewardship initiatives across the nation. These stewardship initiatives will be consistent with the objectives of the relevant regulatory and policy documents, the priorities of the Habitat Management Program, and the priorities of the CEA and its members companies. When mutually agreed upon, they will be developed and implemented at the local level by CEA member companies and regional representatives of DFO. Through media such as the Stewardship Canada Web Portal (www.stewardshipcanada.ca) and its *Compendium of Stewardship Programs and Activities in Canada* (Rubec *et al*. 2002), the CEA and DFO plan to involve other government agencies, specifically Environment Canada, and other resource-based industry associations.

Pursuant to the MOU, CEA plans to complete an inventory of electricity industry stewardship activities by March 31, 2003. Information continues to be gathered from member utilities and DFO is likewise engaged in preparing its own inventory, due for completion at the end of its fiscal year. The member companies have established parameters for the document and the CEA will gather and organize information for the industry inventory during the early winter months. The inventory provides a

documentation of initiatives by industry that serve to benefit the natural resource base of fish and fish habitat. Through the publication of these joint initiatives, the MOU further serves to raise industry profile in the management of fishery resources across the country.

CEA has along with DFO, Environment Canada, and the Forest Products Association of Canada, undertaken a project to assess how industry in Canada might be involved in Canada's Stewardship Agenda.

Education and Training

The MOU provides that CEA and DFO agree to coordinate development of programs and materials used for public education and staff training with respect to electricity generation and fish and fish habitat conservation and protection. To this end, the CEA agrees to encourage the inclusion of DFO habitat management training materials in staff training programs of its member utilities. DFO, for its part, agrees to include CEA materials on electricity generation practices in its staff training programs. Both parties agree that their public education programs and materials about electricity will identify known effects of electrical generation on fish and fish habitat, while also highlighting the many innovative approaches being taken across the country to protect fish and fish habitat. The CEA and DFO also agree to develop joint public education materials and programs about fish and fish habitat conservation and protection and electricity generation.

Specifically, CEA has prepared two education documents on hydroelectric generation and fish habitat (a fact sheet and slide presentation). The slide presentation has been used twice now with DFO and is in the process of revision. These will be the first of what could be many practical tools or education and training of the industry and DFO about the other's business. The collaborative emphasis of the MOU will ensure that DFO field officers and CEA member utilities operations employees consult a consistent set of materials. The furtherance of mutually agreed-upon practices ultimately increases habitat conservation and protection.

Research and Monitoring

Research is also identified as a priority under the MOU, as the parties recognize the importance of research and monitoring in providing scientific knowledge necessary for the effective conservation and protection of fish and fish habitat. Therefore, in order to better understand the impacts of electricity generation facilities on fish and fish habitat, assess the effectiveness of measures taken to protect and conserve fish and fish habitat, and improve the performance of electricity generation facilities with respect to the protection, conservation, and enhancement of fish and fish habitat, they agree to exchange information and develop research and monitoring priorities together. CEA and DFO also agree that, whenever warranted by budget consideration and mutual advantage they will initiate joint research and monitoring efforts. CEA and DFO further

agree to publicize such joint initiatives, and in such publicity to recognize the respective role of each party.

In accordance with a mutually agreed-upon workplan, CEA and DFO are compiling a database of research projects with an eye to identifying gaps for further research requirements. Research initiatives are ongoing across the country and a database will be a valuable tool to avoid duplication and document results to date. Briefly stated, this section of the MOU approach provides a cross industry-government pooling of resources for the benefit of wider stewardship and conservation goals.

Annual Reporting

Under the agreement, CEA and DFO agree to prepare and present an Annual Report to the Minister of Fisheries and Oceans and the CEA Executive Committee describing progress in implementing the MOU and the contribution of initiatives launched under the agreement to the sustainable management of fish and fish habitat resources and electricity generation in Canada. The results will be identified in the Department's Annual Report to Parliament on Habitat Management.

Key Criteria for Negotiations and Ensuring Good Faith

The parties to the MOU are bound by their commitment to good faith over the course of their negotiations. As noted above, initial discussions between industry and government resulted in the development of a Core Group composed of members of both sides to proceed with the bargaining. This Core Group has the authority to proceed with tabling viewpoints, arguments and generally represent the interests of the industry and the government. After a consensus is reached, each side returns to their stakeholders (members) to consult further action. Compliance and enforcement under the *Fisheries Act* provide ample discussion opportunities for both sides.

Bargaining in good faith is an essential premise under an MOU. Positions of the parties are stated frankly thus allowing both sides to seek an understanding of where the difficulties lay. Good communication and clearly enunciated objectives are vital if government and industry are to agree on coordinated means for habitat protection of the natural environment.

Lessons for Industry and Government Relations

In the recent Speech from the Throne, the Government of Canada premised the development of "smart" regulation as a means to develop Canadian competitiveness globally. Canadian business benefits when the regulatory process is streamlined and allows for the most efficient use of natural resources in the interests of Canadian consumers. The CEA-DFO Memorandum of Understanding is an excellent example of the "smart" regulation that the government seeks to promote. In many ways, industry-government collaboration provides the best context to further competitiveness and ensure environmentally sound policies at the same time. Under the MOU, Canada's

electrical energy industry is prepared to make recommendations that will track environmental performance and result in certainty and consistency under the *Fisheries Act*.

This case study of voluntary stewardship focusing on the MOU approach recognizes that both industry and government can move in the other's direction in the interest of improved resource management. In particular, three recommendations flow directly from the considerations outlined above.

First, overcoming narrow views of how industry functions with respect to the natural environment is fundamental if government actors are to engage in frank dialogue with the business sector. In this respect, CEA has made great strides in publicizing its efforts to minimize environmental impacts on the environment. This, in turn, has provided a compelling argument to policy makers that industry is serious about the issue.

Secondly, promoting Canada's competitiveness demands a realistic assessment of what is possible rather than restating principles that are non-negotiable. Both sides have to respect the other's original position, but progress demands that industry and government forge consensus. This will include expenditure targets as well as societal concerns about fragile ecosystems or diminished species.

Finally, the investment made in voluntary sectoral agreements via agreed-upon management practices and shared research produces benefits for both regardless of how little progress is made in arriving at more certain and consistent regulatory processes.

References

Federal-Provincial-Territorial Stewardship Working Group. 2002. *Canada's Stewardship Agenda. Naturally Connecting Canadians*. Environment Canada. Ottawa, Ontario.

Rubec, C., G. Thompson and R. Laing (eds). 2003. *Canada's Stewardship Agenda*. *Compendium of Stewardship Programs and Activities in Canada*. Environment Canada. Ottawa, Ontario.

CHAPTER 10: THE CANADIAN PEAT INDUSTRY

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Abstract

The Canadian peat industry, through the Canadian Sphagnum Peat Moss Association (CSPMA), has developed policies and initiatives to deal with environmental and other issues. This document provides an overview, some Canadian peatland facts, and a list of some of the issues and the ways they have been handled. It concludes with a list of recommendations. More information can be found on the web site of the CSPMA, www.peatmoss.com. Much of the following information is taken from the report entitled *Canadian Peat Harvesting and the Environment (*Daigle *et al*. 2001*).*

Overview

For generations, growers and gardeners everywhere have used peat or peat moss for a variety of applications. Since the 1940s the Canadian peat harvesting industry has emerged as a significant rural employer and user of peatland resources. Peat, mainly derived from *Sphagnum* moss, is marketed as a soil supplement to enhance gardening and, as well, as a soil-less base for greenhouse production. It is one of nature's truly green products offering a large number of horticultural uses. Peat, in various sizes of compressed packages and bales, is readily available at hardware stores and garden centres throughout North America.

In 2001, 1.2 million metric tonnes or about 10 million cubic metres of peat were harvested in Canada. This volume of peat harvested each year is small in comparison to the estimated 70 million tonnes or more of peat that accumulates naturally each year in Canada. On a volume basis, there are an estimated three trillion cubic metres of peat deposits in Canada. Peat is accumulating nearly 60 times faster than the amount harvested. In the same year, this production was valued at approximately $170 million f.o.b. production site. At present, less than 17 000 hectares of Canada’s 113 million hectares (one hectare in 6000) of peatlands are being used for peat or peat moss harvesting.

Canadian *Sphagnum* peat moss, regarded as among the best quality peat in the world, is sold to markets in the United States and Japan as well as across Canada. However, Canada has only a small share of the annual world peat production accounting for approximately 8% of global peat moss produced.

The need to protect natural resources and to ensure wise, sustainable use of the environment is greater today than at any point in our history. Like other natural resource sectors, the harvesting of peat moss around the World has attracted the interest of concerned environmental groups, governments and the public.

The majority of Canadian peat companies involved in this industry, through their association with the CSPMA, have articulated a policy for the preservation of environmentally sensitive peatlands, and for restoration or reclamation of harvested sites. The industry, in association with government and non-government interests, environmental groups and universities, has funded a long-term research project that is looking for the best ways to restore harvested bogs back to functioning peatlands. This ongoing research indicates that new and many existing peatland development sites can be revegetated successfully by *Sphagnum* moss. *Sphagnum* moss is, with proper site management during and after use, the key peat-forming plant in Canadian peatlands. The CSPMA *Preservation and Reclamation Policy* urges peat producers to manage peatland after-use, including restoration of harvested bogs to a functioning peatland when harvesting is finished. Older sites can also be reclaimed to valuable agricultural, forestry or wildlife habitat uses.

According to Jean-Yves Daigle, author of the issues paper, *Canadian Peat Harvesting and the Environment* (Daigle *et al.* 2001), “It is evident that Canadian peat moss harvesting is not contributing to a decline in peatland functions or values on a national or regional scale in Canada. Site management issues are being successfully addressed by the industry and government regulations. There is room for further growth of the industry in a co-operative, consultative manner with regulators and environmental interests to ensure a balance between the needs of the environment and sustainable development.”

Canadian Peatland Facts and Harvesting Activities

- Peatlands, covering approximately 113 million hectares of Canada's land and freshwater area (over 11% of the surface area of the nation), comprise 76% of the 148 million hectares of the wetlands across Canada.
- The volume of peat on Canadian wetlands is an estimated three trillion cubic metres, a major portion of the global peat resource.
- Most peatlands occur in the boreal zone of Canada and are generally unaffected by agricultural, urban, ports/harbours and industrial impacts.
- Only specific ranges of peatland forms have peat and/or peat moss that is suitable for use in horticultural and other current applications.
- Peatlands support a complex mixture of ecological functions such as habitats for wildlife and other biological resources as well as social and cultural benefits.
- Horticultural peat and peat moss are valuable, environmentally friendly products used by millions of residents of North America for gardening, greenhouse and a variety of other applications. Peat moss has also entered the global marketplace in a range of uses, such as balneology, biofiltration technologies and hydrocarbon sorbants.

- Over 70 million tonnes of peat are estimated to accumulate in the natural environment each year in Canada, while current applications utilize approximately 1.2 million tonnes annually.
- Less than two hundredths of one percent (17 000 hectares) of Canada's peatland area is currently being used for horticultural peat harvesting and related applications. At present, no peat in Canada is used for fuel purposes.
- Total revenues for horticultural peat in 1999 were approximately CA$ 170 million and the industry provided employment for thousands of residents in rural areas of the nation.
- An integrated national inventory of peatland distribution and sites of regional or national significance does not exist in Canada. However, detailed peatland databases in portions of Canada are now in place, notably parts of the Prairie Provinces, central and southern Ontario, southern Quebec, the Island of Newfoundland and all three Maritime Provinces.
- Several provinces have wetland conservation and management policies in place: Alberta, Saskatchewan, Manitoba and Ontario, while New Brunswick, Nova Scotia and Prince Edward Island are at various stages of developing such policies. Other provinces, such as British Columbia, Quebec and Newfoundland are addressing wetland conservation through natural resources and wildlife programs.

General Issues

Loss of Wetland Area: Peat Harvesting in Perspective

Conservation of wetlands for their wildlife habitat and other ecological values is an important issue. Overall, development has accounted for a loss of 15% of Canadian wetlands. More importantly, wetland loss has become acute in some regions of Canada and has become a public concern. A diverse range of development factors have resulted in this loss of wetlands. The majority of wetland loss in Canada since the nation was settled has been as a result of agriculture, urbanization, and industrial developments including port and harbour projects. Agricultural development, particularly in the Prairie regions of Canada, is the single greatest cause of wetland loss in Canada. In perspective, peat harvesting has affected only a relatively small percentage (0.02%) of wetlands relative to other uses (Rubec 1996).

Effects on Large Wildlife

Loss of wildlife habitat, particularly waterfowl nesting areas, is another general wetland issue of concern. The swamp, marsh and shallow open water wetland classes are favoured habitat for most waterfowl and a wide range of other wildlife species due to the diverse range of vegetation and the common occurrence of open water. In contrast, bogs tend to have a minimum of open water, low diversity of vegetation and limited cover for waterfowl or other bird nesting purposes. The number of waterfowl and wildlife species and the total wildlife populations in bogs are generally lower in comparison to other wetland classes or to mineral soil ecosystems.

However, a few species of small mammals, such as muskrat and beaver, and game species such as caribou, moose and deer, utilize peatland habitat. Other species use peatlands on a seasonal basis (IEC Beak Consultants 1983). Rare or endangered bird and mammal species that are known to utilize peatlands include Whooping Crane, Trumpeter Swan, Piping Plover and the wood bison.

Gautreau-Daigle (1990) evaluated natural peatlands (domed bogs) and peat harvesting areas in close proximity to each other in New Brunswick. Overall, wildlife use of the bogs was found to be low, probably due to the low vegetation productivity of the bog habitat.

Effects on Small Wildlife

Peatlands are also recognized as rich refugia for a wide range of other biological resources including invertebrate species. For example, the Biological Survey of Canada of the National Museums has organized a National Peatland Entomology Project. This project is leading to a better understanding of the distribution and composition of the biodiversity of peatlands beyond our more obvious plants and animals or birds. Some of the species now being found in Canadian peatlands are new to science. The Wagner Bog in Alberta is one site where focused biological research is ongoing.

Effects on Vegetation

Vegetation conservation, especially the protection of rare or endangered species, is also an issue relating to peatland utilization. The composition of the vegetation community is largely a function of wetland class, in combination with factors such as climate and topography. The vegetation community, which occurs on a typical peatland bog, includes several species that are not common in mineral soil ecosystems. For example, pitcher plants (*Sarracenia* spp.), bladderworts (*Utricularia* spp.) and sundews (*Drosera* spp.), which can all capture insects to provide nutrients, are considered unusual and unique in some areas (Warner 1992). These and other unique plants occupy an ecological niche that few other species are suited to and can be found on many bog ecosystems. Many of these species are widely distributed throughout Canada's boreal wetland regions.

Effects on Greenhouse Gases

Carbon gases released due to peatland development is another environmental issue of concern. The accumulation of peat in a peatland is a function of the anaerobic environment, i.e. lack of oxygen due to a high water table. Draining of the peatland lowers the water table and accelerates the decomposition process. As a result, carbon, which is stored in the peat, is released to the atmosphere as carbon dioxide. Release of carbon gases to the atmosphere, which is primarily due to the combustion of fossil fuels (including coal, wood, peat and petroleum products), has been related to global warming (the "greenhouse" effect). In addition to combustion of fossil fuels, other sources of carbon also contribute to this process. These include the loss of peatland

vegetation as a net carbon accumulator through photosynthesis as well as the role of peatland waters in the carbon cycle.

Site-specific Issues

Site-specific issues relating to peatland development include a range of water management considerations, which result from the development of a drainage system on the peatland. Water quality factors including suspended solids and various chemical parameters are an important concern. The impact on the water flow regime must also be considered including the runoff rate, attenuation of peak flows, groundwater recharge, and several related parameters. Air quality, due to wind erosion of production areas and stockpiles, is also a site-specific concern for horticultural peat developments. Reclamation and restoration of peatlands at the conclusion of harvesting is another issue that is receiving increased attention.

Business Related Issues

1. Establishing a balance between development and conservation.
2. Encouraging provinces to adopt uniform policies on peatland restoration and reclamation.
3. Maintaining good cooperation between environmental groups, government agencies and the peat industry.

What the Industry has Done to Date

1. *Preservation and Reclamation Policy* – in 1991 established the first national industry wetland policy.
2. *Peatland Restoration Guide* – in 1997 wrote the first manual for peat producers based on restoration research initiated in 1992.
3. *Industry Code of Practice* – in 2001 adopted a national Code of Practice for the peat industry.
4. *Wise Use of Mires and Peatlands: Background and Principles including a Framework for Decision-making* – since 1997 the industry has had representatives on an international working group that completed this groundbreaking book on peatlands.
5. Industrial Chair of Canada for Peatland Management – in 2002 members of the CSPMA agreed to fund a five-year industrial chair for continued research on restoration and reclamation of peatlands.

Recommendations

1. Establish uniform policies among the provinces for peatland restoration and reclamation.
2. Adopt the book, *Wise Use of Mires and Peatlands*, as a guide to peatland management in Canada.

References

Daigle, J.-Y., H. Gautreau-Daigle and D. Keys. 2001. *Canadian Peat Harvesting and the Environment.* Second Edition. Sustaining Wetlands Issues Paper, No. 2001-1. North American Wetlands Conservation Council (Canada). Ottawa, Ontario.

Gautreau-Daigle, H. 1990. *Evaluation of Ecological Constraints on Peat Mining in New Brunswick. I. Waterfowl Population Survey. II. Moose Population Survey*. Open File Report, No. 90-6. New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division. Fredericton, New Brunswick. 71 p.

IEC Beak Consultants. 1983. *Fish and Wildlife Use of Peatlands in Canada*. Report No. NRCC 21238. National Research Council of Canada. Ottawa, Ontario.

Rubec, C.D.A. 1996. The Status of Peatland Resources in Canada. In *Global Peat Resources.* E. Lappalainen (ed.). International Peat Society. Saarijärvi, Finland. pp. 243-251.

Warner, B.G. 1992. Peat: Nature's Compost. *Earth* 1 (2):44-59.

CHAPTER 11: TOWARDS OPERATIONAL WETLAND MONITORING

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Abstract

In 2001, a Canadian team led by Atlantis Scientific Inc. was awarded a competitive contract by the European Space Agency (ESA) to develop Treaty Enforcement Services using Earth Observation (TESEO) related to wetland monitoring with particular support for the international Ramsar Convention on Wetlands. This project achieved major advances in the application of Earth Observation (EO) technology for wetlands through a three-phase effort:

1. An analysis of the requirements of individual wetland managers in the context of the Ramsar Convention, including exploratory studies to explore the potential of the latest EO sensors and technology.
2. The development of an exhaustive set of products and services that could be provided using EO technology, and the refinement of this set into five prototype products for further development.
3. Implementation of five prototype information products for three Ramsar test sites: Doñana in Spain, Mer Bleue in Canada, and Djoudj in Senegal.

Major accomplishments of this effort include:

- A thorough, well-documented understanding of the information requirements of wetland managers and the Ramsar Convention bureau, the current state of the art for EO technology, and an identification of those areas where EO technology can support wetland needs.
- A suite of demonstrated and validated EO-derived products that provides useful information responding to the needs of wetland managers.
- Technical advances to improve the reliability and decrease the cost to produce these products.

The information products resulting from the project are:

- Dynamic monitoring of water cover (open water and inundated vegetation);
- Current land use;
- Current land cover;
- Land cover change, from which changes in land use can be inferred; and
- A case study that provides a model for communication with wetland managers.

These products have been produced in the form of shape files for a GIS (Geographic Information Systems) environment. They can be combined and used to derive numerous secondary and tertiary products that were identified as part of the product definition.

Atlantis Scientific Inc. proposes that the technology and the political will are now ready for operational monitoring of wetlands. The authors see this with the willingness of the European Space Agency to commit funds for further product development and partnership building between national and non-government environmental organizations and providers of monitoring information products. The authors also see a willingness by national and international user and research organizations to work together to make operational monitoring a reality. Canada has an opportunity to show the world how to use modern technology to set up wetland monitoring programs over vast areas, both for baseline inventory and for repeated monitoring and surveillance. This leadership can translate into opportunities for Canadians worldwide.

The team makes recommendations that will result in the definition of a program of (a) Wide-area wetland inventory, (b) Detailed inventory of selected or randomized wetlands, and (c) Ongoing monitoring and surveillance of selected or randomized wetlands.

Introduction

Treaty Enforcement Services Using Earth Observation (TESEO), a project of the European Space Agency (ESA), was defined in response to the growing concern of the international community with the environmental problems that affect our planet. This concern on the part of the international community has resulted in a number of international treaties designed to respond to these problems. In this context, ESA has recognized that Earth Observation (EO) technology may represent a fundamental source of information for the different national and international bodies involved in the implementation of such treaties. This has resulted in the TESEO initiative.

The ESA awarded contracts in 2001 to industrial teams to study ways in which Earth Observation (EO) technologies could support the information requirements of four international treaties or agreements: Ramsar Convention on Wetlands, United Nations Convention to Combat Desertification, Kyoto Protocol to the United Nations Convention on Climate Change and MARPOL 73/78, and the International Convention for the Prevention of Maritime Pollution from Ships.

The TESEO contract for wetland monitoring was awarded to Atlantis Scientific Inc. and its international team that included DB Geoservices Inc. (Canada), TerreVista Earth Imaging (Canada) and SITEM S.L. (Spain). A key aspect and requirement of the activity was end-user involvement. The authors recruited end-users who were willing and able to work within the TESEO Ramsar Convention activity to help specify and evaluate the products to be developed. Our end-users included:

- National Capital Commission of Canada, the managers of Mer Bleue, a Ramsar site in Ottawa, Canada;
- Estación Biológica de Doñana, the managers of Parque Nacional de Doñana, a Ramsar site in southern Spain;
- World Resources Institute (WRI), an international body with a direct potential interest in the work; and
- Centre du Suivi Écologique, the managers of Djoudj, a Ramsar site in Senegal.

The Ramsar Convention

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 136 Contracting Parties to the Convention, with over 1235 wetland sites, totaling 106.6 million hectares, designated in the Ramsar List of Wetlands of International Importance.

The team studied the text of the Ramsar Convention and related documents, and found that member countries are expected to undertake inventory of the designated wetland sites; they are also expected to perform monitoring and assessment to detect changes that could signal deterioration of the ecological character of the sites. Experience told the authors that EO technologies could play a role in fulfilling these expectations.

Understanding User Needs for Geospatial Information

The authors conducted extensive analysis of end user requirements, by studying the Ramsar Convention documentation, reviewing the literature on wetland monitoring, talking to end users and conducting an international web-based user survey. In answer to the question about what types of information are needed, respondents of the web survey identified the following main categories of information:

1. Identification and physical description of wetlands;
2. Change in vegetation, land use, environmental pressures, dominant vegetation, invasive species, and water quality and quantity, preferably on a two to five-year update frequency; and
3. Water quality information.

Selection of Prototype Products

A list of 48 innovative products and services based on EO technology was created that responded to the user needs analysis and the survey results. End user collaborators were then asked to comment on the priorities of each product or service from his/her

perspective. All 48 of the proposed products and services were evaluated according to the following criteria:

- Technical feasibility for EO-based products;
- Priority identified by the questionnaire of our end users;
- Practical advantages;
- Contribution to the needs of the Ramsar Convention;
- Contribution to users (our assessment based on knowledge of the technology); and
- Novelty.

It was agreed that operational information products must be: Reliable, Robust, Affordable and Repeatable.

The result of this evaluation was the selection of the following products which were prototyped at three test sites of Mer Bleue, Doñana and Djoudj:

1. Open water and flooded vegetation;
2. Vegetation cover and vegetation cover change;
3. Land use map
4. A case study describing these information products for a particular Ramsar site (Mer Bleue), and showing the value of the products in clear terms intended for an audience of biologists.

Open Water and Flooded Vegetation Products

The marshland at the edge of the Mer Bleue bog has a mixture of open water and flooded vegetation. Synthetic Aperture Radar (SAR) is an excellent sensor for detecting open water, which appears nearly black on radar imagery. It is an excellent sensor for detecting flooded vegetation, which appears very bright on Radarsat-1 imagery, because of the “corner reflector” effect. The authors used these characteristics to map areas of open water and flooded vegetation. Four dates of flooded vegetation, areas where there was flooded vegetation on only one of the four dates, areas that had flooded vegetation on two, three or four dates, areas with open water, and those areas with open water on more dates were identified.

This product can be used to map seasonal changes in water extent on a yearly basis. Through discussions with wetland managers, it was learned that a monitoring effort such as this must be carried out on an on-going basis. Managers recognize that the first few years will be needed to establish a range of normal conditions from which deviations and trends can be detected. Since water is the lifeblood of a wetland, this product is very significant.

Vegetation Cover and Changes in Vegetation Cover

The Vegetation Cover product is called Land Cover and changes in Vegetation Cover are demonstrated by the Land Cover Change product. The use of EO data for Land Cover is well developed, although insufficiently automated. In view of the tremendous amount of work that has already been invested in Land Cover mapping, it was decided

to use existing methodologies, rather than try to make a significant advance in this area. The approach adopted to Land Cover mapping was to use traditional multispectral image classification techniques (spectral clustering) in conjunction with Landsat-7 ETM+ data. Land Cover maps were created for the wetland itself and another map of Land Cover outside the wetland using a different set of classes.

Based on the feedback that was received from end-users, it is clear that this technique gives useful information for wetland managers. As more data is collected for each site, cost savings will result by having data banks of ground control points and training areas, and knowledge of the wetland will increase.

For Land Cover Change, it was decided to use an approach that has been known by specialists for a long time, but which, in the authors' opinion, has been under-utilized. This approach uses changes in the red spectral region (that is very sensitive to changes in vegetation) to produce a two-date colour display that forms the basis for land cover change interpretation.

Significant Land Cover Changes at Mer Bleue between 1987 and 2002 were measured. Many of these changes can be explained by new urban developments, conversion of forestland to agriculture, abandonment of farmland, and conversion of an industrial site to a golf course. The changes within Mer Bleue itself are intriguing and warrant further investigation. In fact, they may indicate important changes in ecological functioning that have been unnoticed before now.

This simple approach to Land Cover Change does not require as much specialized knowledge as the task of Land Cover classification. This approach can be used to show historical changes, as done in this project. More importantly, it can be used as a screening tool to alert wetland stakeholders and managers to areas where change is taking place, identify the general nature of the changes, and help determine when updated Land Cover or Land Use maps must be produced.

Land Use

The Land Use product shows the wetland manager threats to the wetland from influences in the remainder of the catchment area, such as industry, residential developments or transportation. Land Use typically requires EO products with greater spatial detail than does Land Cover. To create this detailed image, data were merged from the HRG sensor of the SPOT-5 satellite (2.5 metre panchromatic) with multispectral Landsat ETM+ data (30 m resolution). The panchromatic image provided details and texture, while the multispectral data showed vegetation information with much greater apparent detail than the original Landsat image. This "pan-sharpened multispectral" image was visually interpreted to create a Land Use map.

In order to validate all of these products, Mer Bleue and vicinity was overflown and hundreds of photographs were taken from a light aircraft, and later from the ground. Ninety minutes of video camera footage was also recorded from the aircraft.

Case Study

The authors also produced a case study describing these information products for the Mer Bleue Ramsar site and showed the value of the products in clear terms intended for an audience of biologists. This case study is a stand-alone document that provides a model for communication with wetland managers. It could be a model of communications between wetland managers, or with the Ramsar Convention Bureau.

Suite of Information Products

This suite of information products was evaluated by the end-user partners and found to be very useful and promising as future operational monitoring tools, albeit with some recommended improvements. These products have been produced in the form of shape files for a GIS (Geographic Information Systems) environment. They can be combined and used to derive numerous secondary and tertiary products that were identified as part of product definition.

The Way Forward

Atlantis Scientific Inc. proposes that the technology and the political will are now ready for operational monitoring of wetlands. This is seen with the willingness of the European Space Agency to commit funds for further product development and partnership building between national and non-government environmental organizations and providers of monitoring information products. A willingness is also seen by national and international user and research organizations to work together to make operational monitoring a reality. Canada has an opportunity to show the world how to use modern technology to set up wetland monitoring programs over vast areas, both for baseline inventory and for repeated monitoring and surveillance. As well as providing the obvious benefit to the global environment, this leadership can translate into worldwide opportunities for Canadians.

Recommendations

Based on this work during the TESEO Project, the Atlantis team makes the following recommendations:

1. For greater credibility, the ability to produce information products must be demonstrated for more wetlands in a wider diversity of geographical areas across Canada.
2. The continuity of data sources is not assured. The Canadian Space Agency (CSA) should strongly consider making a long-term commitment to ensure the continuity for one or more of the required data types. The data types required for wetland monitoring, based on this analysis, are Synthetic Aperture Radar (C and L band), fine resolution (1 to 5 metre) panchromatic data and moderate resolution (about 25 metres) multispectral data.
3. Guidelines for choosing wetlands to monitor are proposed. These are wetlands where the management:

a) recognizes the need for information products for baseline inventory, surveillance and monitoring;
b) has a budget for collecting data and information (this does not mean budget for the full cost of the information products, but can contribute a share of the cost as a symbol of commitment);
c) is open to new technology and new ways of getting information;
d) is committed to providing feedback through an assessment of the prototype information products; and wants to be seen as a leader.

4. CSA should support the development of a service industry to deliver wetland products derived from EO and other data.
5. A program should be defined for Wide-area wetland inventory, Detailed inventory of selected or randomized wetlands, and On-going monitoring and surveillance of selected or randomized wetlands. This program should have appropriate levels of funding approved.

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CHAPTER 12: WETLAND PROTECTION – THE TRANSITION FROM A TRADITIONAL REGULATORY APPROACH TO PERFORMANCE BASED MANAGEMENT

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Abstract

Increasingly, organizations, whether public or private, are becoming more results and accountability oriented. Governments are looking for more cost effective ways to manage public resources and an emerging solution is a shift from a command and control approach of governing to performance or results-based management. Adopting the concept of performance or results-based management should be a consideration in developing new directions for wetland stewardship and management.

Introduction

The purpose of this paper is to give a brief overview of the concept of Performance-Based Management (PBM), describe the driving needs of government and business for adopting PBM and examine some key implementation issues and strategies for managing the issues associated with PBM. As part of the conclusion, the paper identifies some products and actions that are deemed to be important in fostering performance-based wetland stewardship and management.

What is Performance-Based Management?

Definition

The term “performance-based management” appears in various contexts throughout the literature. It is generally seen as one of the key tools in shifting from traditional *command and control* approaches of environmental governance to a *next generation* of environmental policy.

Next generation environmental management is seen to be “a more performance-based, information-rich, technology-spurring, flexible, accountable regulatory system, where government sets goals and allows participants to determine how best to meet them…If the ‘first generation’ of environmental strategies was concerned with compliance, the ‘next generation’ promises to focus on performance” (Kettl 2002). Table 1 summarizes the main differences between first and next generation approaches to environmental management.

The United States Environmental Protection Agency, through partnership agreements with various States, is adopting performance-based policies that emphasize "sector-based regulatory approaches that replace facility-specific state permits with industry-wide environmental performance standards and annual certifications of compliance." (e.g. Massachusetts Environmental Results Program and New Jersey Gold Track Program for Environmental Performance).

Table 1. "First" and "Next" Generation Environmental Compliance Strategies

First Generation:

- activities that may harm the environment are defined; activities that prevent or mitigate the harm are prescribed, and sanctions are identified to punish or deter non-compliance with the prescriptions.
- focus is on end-of-pipe pollution, mostly at stationary, large point sources at the firm level.
- implementation is assigned to single agency.
- regulatory success is measured by the number of compliance actions taken or not taken.
- companies comply with performance standards because they have a legal duty to do so.

Next Generation:

- government sets clear goals, standards and targets and lets participants determine how best to meet them.
- integrated focus is on both point and non-point pollution sources, area-based planning and collective action solutions.
- inter-jurisdictional cooperation is common with partnerships between government, business and communities.
- companies comply with performance standards because they see the benefit in doing so (e.g. economic benefits, regulatory relief); focus is on continuous improvement; a mix of incentive-based measures and regulatory enforcement measures.
- regulatory success is measured by environmental outcomes and the cost-effectiveness of regulatory effort.

Recent work done in Ontario on environmental management best practices suggests that the emerging direction in leading jurisdictions is towards an "integrated approach to environmental compliance assurance" and that this, among other things, is much more performance-based rather than rules-based, with greater emphasis on government's role to set outcomes and then work with the regulated community and the public to determine how best to meet them (Executive Resources Group 2001). In other words,

there is flexibility in the *means* by which performers achieve performance results, but not the *ends* they are expected to achieve.

Given these precedents, a suggested working definition of PBM is…

> *An environmental management approach where roles and accountabilities are defined to reduce the amount of government intervention and give the regulated sector more flexibility and responsibility on how to achieve objectives, and where the focus is on performance, not process.*

The primary roles and accountabilities within a performance-based environmental management regime are shown in Table 2. The term "results-based" environmental management has also been used to communicate the ideas described in Table 2 of shifted accountabilities and responsibilities. It is suggested, however, that the terms "performance-based" and "results-based" management are not synonymous. PBM is a somewhat wider concept that includes the establishment of incentives as an important element for motivating voluntary compliance with standards. In this paper, the term "results-based" is used only in the context of performance standards.

Table 2. Accountabilities and Responsibilities in a PBM Regime

Accountability

Government is accountable *to* the public for designing and implementing environmental management regimes that achieve environmental goals.

The Regulated Community is accountable *to* government (and shareholders) for meeting government's performance standards and regulatory requirements.

Responsibility

Government is responsible for:

- defining environmental goals
- setting measurable performance standards that are consistent with goals
- establishing incentives for good performance and disincentives for poor performance
- auditing compliance with established performance standards and taking enforcement action as appropriate
- communicating with the public on compliance and overall system effectiveness
- reviewing and adapting environmental management system components, based on compliance and effectiveness results

The Regulated Community is responsible for:

- helping government to formulate environmental goals and appropriate performance standards
- determining appropriate methods (industry-wide and at the firm level) for achieving government's performance standards

- monitoring and reporting performance (to government and possibly also the public) relative to government's performance standards
- adjusting methods for achieving performance standards, based on performance results
- communicating to the public and shareholders

The Public is responsible for:

- helping government to formulate environmental goals and potentially also performance standards
- making government and the regulated community aware of compliance issues
- responding to information reports about compliance and overall system effectiveness

Critical Elements

To effectively implement PBM for any sector, four critical elements must be in place:
a) Environmental Goals
b) Performance Standards
c) Monitoring Systems
d) Enforcement Regime

(a) Environmental Goals – What are the ultimate environmental conditions that we want to achieve?

Environmental performance measures that government establishes must relate directly to underlying environmental goals, such as water quality protection, biodiversity conservation, or prevention of health impacts. Agreed-upon goals provide the entire context for PBM and can be established through strategic land use planning initiatives.

(b) Performance Standards – What measurable outcomes will government hold parties to account for achieving, in order to attain overall goals?

Performance standards are measurable and enforceable "proxies" for broader goals. They may be expressed either as a "result" or a "rule," both of which are measurable and thus enforceable.

Results-based performance standards: These typically define a maximum permissible disposal or impact threshold. For example, the concentration of a particular chemical in wastewater discharge or a receiving environment; minimum in-stream flow levels; forest age class distribution within a defined zone. Requiring users of the environment to stay within the established threshold is presumed will achieve the environmental goal.

Rules-based performance standards: These define processes, techniques or technologies that are required because they are known (or thought) to be effective means of achieving environmental goals. Examples include the prohibition or restriction of certain activities or facilities in specified locations; a requirement to follow a specified operating practice; a requirement to develop an impact management/mitigation plan.

Within a performance-based environmental management system the focus is on trying to define results-based performance standards where feasible. The challenges of developing and implementing efficient and effective results-based standards are mentioned later on.

(c) Monitoring Systems—How do we know if ultimate environmental conditions (goals) and intermediary outcomes (performance standards) are being achieved?

Monitoring in a PBM system is needed at two levels – *compliance monitoring* at the individual operator level, and *effectiveness monitoring* at the larger ecosystem level.

Compliance Monitoring: Monitoring individual operators provides information for determining if performance standards are being achieved and is needed as a basis for compliance and enforcement action. Although this same requirement applies in conventional environmental management systems, PBM differs somewhat from conventional management in that environmental regulators should be equally interested in poor *and* good performance. Under-performers will be subject to some form of sanction and operators who meet or exceed performance standards will receive some form of benefit—the idea being to motivate voluntary good performance.

PBM also differs somewhat from conventional management in the sense that a PBM regime focuses on measuring compliance with results-based performance standards. Under more conventional management, monitoring is more likely to focus on whether or not prescriptive rules or processes have been followed. It will often be cheaper to measure compliance with a simple rule than with an environmental result.

Governments normally maintain some level of audit function to check the veracity of industry-supplied monitoring results. It is expected that this approach would continue to be followed under a PBM approach. It could also be supplemented by the following management approaches to monitoring:

(1) require monitoring to be conducted by independent third parties,
(2) accept monitoring results that are generated by independent auditors operating under voluntary certification systems, or
(3) require monitoring to be conducted by professionals who are subject to qualification and conduct standards that are set and enforced by the governing professional body.

All of these are approaches for continuing to require the regulated sector to pay for monitoring while addressing potential concerns about industry “regulating itself.”

Effectiveness monitoring attempts to determine, for larger ecosystems, if performance standards are an adequate means of achieving environmental goals. The measurement focus is on indicators of environmental condition (e.g., at the watershed level or for a sub-region). If environmental condition deteriorates over time, regulators will know to adjust performance standards – be they rules-based or results-based performance standards – so that they are more consistent with underlying environmental goals.

The reason that effectiveness monitoring is an important component of PBM is that there is a need for some mechanism to "replace" the type of evaluation that normally occurs under a permitting system – where local conditions and assimilative capacity is assessed as a basis for defining project-relevant performance standards and permit conditions. If, under a PBM system, generic performance standards are defined and individual permitting is discontinued for classes of operators, the ability to assess incremental and cumulative impacts and risks through case by case analyses at the "front-end" is foregone. Ambient monitoring at the "back-end" is needed to determine if ecosystem thresholds are being exceeded. It is the only way, under a PBM system, of knowing if established performance standards are effective.

(d) *Enforcement Regime – What happens if performance standards are not achieved, if they are met, or if they are exceeded?*

Policies and systems for implementing compliance are relatively well defined in most Canadian jurisdictions. Regulations set out sanctions for non-compliance and government staff are in place with clear enforcement responsibilities. Review and appeal provisions are generally in place as a check and balance on the discretionary authority of compliance enforcement decision-makers. Currently, however, there are few, if any, policies that define what happens if performance standards are consistently achieved or exceeded by individual operators. Encouraging voluntary compliance through financial or other incentives is an element of PBM.

Fundamental Needs of Government and Business and the Shift to PBM

There are several main drivers behind this policy shift. Foremost is the belief that it is not an appropriate role for government to be involved in defining the methods of environmental protection, and that a realignment of basic roles can produce public cost-savings. It is thought that, if government focuses on the "front" and "back" ends of environmental management (i.e. objective setting and compliance monitoring and enforcement), and leaves accountability for handling "the middle" (i.e. the "how to") to the regulated sector, then environmental protection can be achieved with fewer resources.

Government also believes that a performance-based approach will be more cost-effective for the regulated sector. Replacement of permitting requirements with performance standards defined in regulations that apply sector-wide is expected to yield cost-savings, innovation and enhanced industry competitiveness. As well, government wishes to create a more certain business climate by clearly defining its environmental expectations.

Government and business each have some fundamental needs respecting environmental regulation:

Business Needs

Certainty and predictability – sectors need to know what is expected of them respecting environmental protection, the same as they need, for example, to know government's labour standards and tax rates. Without basic knowledge of the regulatory environment within which they must operate, business planning and investment decisions can be difficult.

Cost-effective regulation – sectors need to know that they are not facing a more costly regulatory burden than their competitors. To compete successfully, they need regulatory cost reduction, meaning that they need fewer and faster approvals processes, and greater freedom to select the cheapest methods for achieving the performance expectations that government establishes.

Government Needs

Environmental Protection – government must put into place environmental management regimes (laws, programs, policies) that are capable of achieving environmental protection goals – goals that Canadians, as well as national and international interests, expect will be achieved.

Cost Reduction – environmental goals must be achieved with fewer resources than have been allocated for this purpose in the past.

Adaptability – government requires the opportunity to adjust its regulatory regime, based on new knowledge about impacts and effects, and to reflect shifting social preferences. While providing regulatory certainty is important, an overly rigid interpretation of this would prevent government from asserting the public interest over time.

Performance-based management (PBM) is a possible way to address, at least in part, *both* business and government needs by:

1. *Replacing some permitting requirements with performance standards defined in sector-wide regulations*. This should reduce costs to both government and industry and, if this approach is applied to the right sectors or sub-sets of sectors (i.e., low risk activities and products) then it should still be possible to achieve environmental goals. Clarification of performance standards will also enhance certainty and predictability for private sector investors.

2. *Defining results-based performance standards, where possible*. These types of performance standards allow industry to select the most cost-effective methods of compliance with the standards. They make environmental performance expectations absolutely clear for sectors, given that they are objective and measurable. Government is saved the costs of reviewing individual development proposals and helping businesses determine appropriate methods of compliance.

3. *Increasing the use of qualified, independent professionals to confirm compliance with performance requirements*. This should reduce the need for direct business-government interaction with some associated cost savings for business, but primarily for government. It should also provide credibility respecting regulatory compliance.

4. *Creating incentives for voluntary 'good' performance*. Government saves enforcement costs when operators are motivated through incentives to meet or exceed performance standards, and naturally, good performance will achieve environmental protection goals. Also, good performers will benefit from less government interference.

Key Implementation Issues

Implementing PBM approaches, notably adopting results-based performance standards as a central element of PBM, is not necessarily an easy thing to do. Consequently, a PBM approach to environmental management has degrees of applicability; universal application is likely not feasible. The biggest issues in taking the PBM path are:

(a) *Increased risk of environmental degradation* – This is because PBM is "after the fact" regulation. There is no front-end opportunity to review and disallow a proposed activity that is clearly sub-standard, or to address site-specific concerns by establishing impact mitigation conditions that an operator must abide by as a contractual obligation. Operators may proceed without receiving an authorization and if they fail to achieve established performance standards, it will be too late to do anything about it – the damage will have been done.

(b) *Inappropriate performance standards* – Generic, "lowest common denominator" performance standards that apply equally to everybody and everywhere may result in excessive cost for some operators, or excessive environmental risk for some ecosystems. In large and diverse regions of Canada, it is virtually impossible to develop locally-relevant performance standards to overcome the weakness of generic national or region-wide standards. The opportunity to customize site-appropriate performance standards for individual operations is one of the biggest advantages of permitting processes.

(c) *Inherent difficulties in defining results-based performance standards* – Results-based performance standards must be: (1) scientifically supported, (2) as locally-relevant as possible, (3) accepted by the public and stakeholders, (4) enforceable by being capable of being measured, and (5) affordable and feasible to implement. These can be very difficult criteria to meet in all circumstances.

(d) *Reduced public trust in environmental regulators when problems occur* – The existing environmental management system is generally effective in preventing or minimizing large incidents of environmental impact. If, as a result of PBM reforms, some significant or visible environmental problems occur, this could shake the public's confidence in the government's ability to deliver an effective environmental management regime. Furthermore, PBM approaches are essentially aimed at

regulating point source pollution. The origin of pollution or impacts must be identifiable and measurable in order to effectively implement performance standards. It is now well accepted that the biggest environmental challenge facing environmental regulators are insidious cumulative and non-point source impacts, but PBM is not specifically directed towards this challenge.

Strategies for Managing the Issues

The following are suggested general strategies for managing the above key issues that are associated with adopting a PBM regime.

(a) *Risk-based Management:* Environmental managers should re-frame the regulatory goal. Whereas the emphasis has recently been on implementing *performance-based environmental management*, it should be on implementing *risk-based environmental management*, where the "right regulatory tool is applied to the right job." Performance standards, be they results-based or rules-based performance standards, are one important regulatory tool that can be applied, but they are not the only one. The way to determine which regulatory tools should apply to various activities and products is to classify the environmental and human health risks that are inherent in different activities and products. Different levels of risk will require different regulatory tools for managing those risks. Low risk activities have the greatest potential for deregulation and associated cost-savings, while still achieving environmental protection goals.

(b) *Performance Standards:* Results-based performance standards, as a central element of a PBM approach, are frequently difficult to establish. The practical limitations on developing results-based standards, especially for some activities and resources such as pesticide application and wildlife resources should be recognized and alternatives to this approach pursued. Rules-based standards will sometimes be a more practical and cost-effective way for achieving environmental goals. Deregulation can still occur through de-permitting and the placement of rules-based standards in regulations that apply sector-wide. Good spatial planning processes can help by defining locally-relevant performance standards in the form of specific and measurable objectives for managing land and resources. Even though planning can never be expected to provide performance standards for all resources in all locations, it should continue to be undertaken for priority locations as an important foundation for implementing PBM approaches.

(c) *Effectiveness Monitoring:* Checking individual operators for compliance with performance standards is of similar importance in both conventional and PBM regimes. Information is needed as a basis for sanctioning poor performers and rewarding good performers. The type of monitoring, however, that becomes more essential under a PBM system is *effectiveness monitoring* at the larger watershed or ecosystem level. If case-by-case permitting reviews are eliminated under a PBM system in favour of sector-wide regulatory performance standards, the opportunity is lost to local assessments of carrying/assimilative capacity and cumulative effects, and to manage these issues through permitting/licensing processes. To

compensate for this lost “front-end” opportunity to do local risk assessment, “back end” monitoring information on broader ecosystem condition is needed to determine if the performance standards that individual operators are subject to are adequate for protecting ecosystem health (i.e. “Are government’s environmental goals being achieved by the performance standards that have been established?”). An integrated environmental monitoring strategy would have to be implemented concurrently with the implementation of PBM approaches.

(d) *Incentives for Motivating Voluntary “Good” Performance:* The compliance and enforcement component of conventional environmental management focuses largely on penalizing under-performance. While strong and effective penalties are still needed under a PBM regime, mechanisms are also needed to motivate voluntary good performance in relation to established standards. Compliance enforcement is expensive to implement, for both operators and government. These costs could be reduced if incentives were in place for encouraging voluntary compliance. Incentives could take a number of forms, such as: relief from regulatory requirements (e.g. less frequent reporting of monitoring information); recognition (e.g. annual publication of a “good performers” list); or financial benefits (e.g. fees reduction). Policies in this area should be strengthened as an element of PBM implementation.

(e) *Informed Implementation:* Present environmental regulation in most regions of Canada is relatively conservative. For example, regulatory tools that are suited to managing the most high-risk activities are applied widely to low-risk activities (e.g. case by case permitting reviews). Underlying government’s policy direction to adopt PBM approaches is a deregulation theme. Performance-based environmental management is seen as a way to reduce costs to both government and business. However, to reduce costs from where we are today will result in some amount of increased risk – agencies will simply have to manage less conservatively than they have in the past. This risk can potentially be managed, not only by focusing on the deregulation of lower risk activities, but also by implementing PBM in an informed way, on the basis, for example, of structured pilot projects for specific sectors to enable trial and error learning, and through collaborative processes. “Looking before leaping” and gaining stakeholder and public buy-in could be vitally important for engendering an awareness and confidence that PBM is more than just a cost-cutting measure.

Managing Risk

The following is a brief description of the basic tools that environmental and natural resource regulators have at their disposal for managing environmental and associated human health risks. Table 3 summarizes the risk management tools and how they might be applied in relation to risk levels.

Table 3. Environmental Risk and Risk Management Tools

Regulatory Tools for Managing Environmental Risk	**"Lower" Risk Activities or Products**	**"Higher" Risk Activities or Products**
1. Activity/Product Ban – prohibition of specified activity or product	No	Yes, if risks considered too great
2. Notification Requirement – operators required to register their activity with government	Yes	More than this required
3. Permitting/Licensing Requirement – aimed at defining site-specific impact mitigation measures	No / Possibly	Yes
4. Plan Development and Approval – operators required to develop operating, management or engineering plan for mitigating impacts; government reviews and approves plans	No	Possibly
5. Professional Qualification Requirement – facilities design, mitigation plans, monitoring programs, etc. must be signed off by registered professional	No	Yes
6. Best Management Practices/Guidelines – operators are recommended to follow accepted impact mitigation strategies (not legally enforceable)	Yes	More than this required
7. Rules-based Performance Standards – requirement to follow specified regulatory rules (e.g. procedures, practices, technologies)	Possibly	Yes, some likely
8. Results-based Performance Standards – requirement to achieve specified, measurable environmental outcomes	No, risk too low to justify monitoring costs	Yes, some likely
9. Formal, Integrated EIA – impact identification and mitigation review,	No	Yes, likely

Regulatory Tools for Managing Environmental Risk	"Lower" Risk Activities or Products	"Higher" Risk Activities or Products
conducted under enabling legislation		
10. Compliance Monitoring and Reporting – requirement to monitor and report performance (i.e. extent to which performance standards have been achieved)	No / Possibly (e.g., government order to stop/modify activity)	Yes
11. Incentives and Sanctions – rewards for achieving compliance; penalties for non-compliance	Possibly	Yes, with strong legal sanctions
12. Compliance Support/Assistance – government works with sectors (e.g. education, joint scientific research, etc.) aimed at defining, meeting, exceeding standards	Possibly	Yes, work closely with sectors
13. Economic Instruments – harnessing market forces to achieve environmental goals (e.g. emissions trading, pollution charges, liability shifting, subsidies)	Possibly	Yes, as part of comprehensive policy response

The above describes the array of regulatory tools that are available to environmental regulators, and suggests that the tools that are selected for various activities and products should match the risks that are inherent in those activities and products. While this may be conceptually attractive as an underpinning policy for environmental management, it may be challenging to implement. Putting this policy into effect in an explicit and structured manner would require:

(1) defining suitable criteria for assessing risk;
(2) applying the criteria to all of the various activities and products to classify them into risk categories; and
(3) deciding which regulatory tools to apply, relative to the assigned risk classes.

With respect to the first above requirement, some rudimentary criteria for evaluating risk are described in Table 4. It can be seen from Table 4 that applying these criteria to any activity, sector or product would require a substantial knowledge base. Consider, for example, the subject of regulating waste discharge. Activity categories that are generally regulated by permitting processes include: municipal effluent, aluminium smelting, pulp and newsprint, saw-milling, commercial waste disposal operations, mining, etc. To decide which of these activities could be regulated with tools other than permitting processes in shifting towards a PBM approach would require regulators to identify the sub-sets of these activities that are low risk. The risks that are inherent in

each of these activities, as judged by applying the criteria in Table 4, will depend on their size, location and the nature of industrial processes that are applied. Defining a category of “low risk” activities within each activity grouping would likely require the definition of thresholds. Defining thresholds to differentiate the regulatory processes that would apply is not necessarily an easy thing to do – sound justification is needed to treat classes of businesses differently.

Table 4. Criteria for Determining Environmental Risk

“Lower” Risk Activities / Products	**“Higher” Risk Activities / Products**
• No known or likely human health impacts	• Known or likely human health impacts, or high uncertainty about the possibility of impacts
• Reversible ecosystem impacts	• Irreversible ecosystem impacts
• Short lag time between cause and effect	• Long lag time between cause and effect
• Low public liability in event of “failure”	• High public liability in event of “failure”
• Low social response in event of “failure”	• High social response in event of “failure”

The same challenge would exist, for example, for water allocation regulation. To be able to apply less regulatory intervention to “low risk” water users (e.g. to replace a permit requirement with regulatory standards), regulators would need to be able to designate provincial water bodies into categories – for example, those that experience water shortages, and those where water is plentiful. This could be a sizable task. Moreover, once categorization has been made and different regulatory requirements apply to different categories, there is an ongoing need to monitor and review the appropriateness of the thresholds that define the categories, and to put into place two sets of administrative procedures.

Environmental regulation approaches that are applied to various activities and products should be driven by the environmental and human health risks that are inherent in those activities and products. Although implementing performance-based environmental management, with its emphasis on adopting rules-based performance standards, is a potentially valuable and important regulatory tool, there are a dozen or more regulatory tools that can also be applied. The trick is applying the right tools to the right job, and this can be determined by classifying industrial activities and products into risk categories.

Systematic reviews of activities in efforts to classify risk levels and assign regulatory tools that are commensurate with managing those risk levels could potentially lead to more efficient environmental regulation, and still achieve environmental and human health protection. The greatest efficiency and de-regulation gains will be for activities and products that are classed as low risk to human health and the environment. Less

expensive and less invasive regulatory tools can be more readily adopted for these activities and products because these tools sufficiently protect the public interest. However, where activities or products pose high or even moderate risks, then government must continue to apply regulatory options that are effective in managing such risk, which are invariably more invasive and thus costly. It is possible that few if any changes to existing regulatory approaches will be appropriate for higher risk activities and products.

Agencies should be challenged as a first priority to identify their client sectors' activities that are judged to be "low risk," as a basis for considering whether or not regulatory tools can be applied that are more appropriate for managing this risk level.

Summary

Performance-based management as an environmental approach where industry is given increased operating flexibility while taking on added responsibility for achieving broad sustainable goals. Achievement of these goals is measured against performance standards that are generally set by government. To effectively implement PBM, government should establish:

1. the desired future condition of environmental resources (i.e. define environmental goals);

2. measurable performance standards that reflect the degree of risk to human/environmental health and are consistent with environmental goals that business will be accountable for achieving;

3. monitoring systems that are capable of determining the extent of compliance with performance standards and the degree to which performance standards are effective in achieving environmental goals; and
4. enforcement regimes that detail both the penalties of non-compliance with performance standards, and the rewards for meeting or exceeding performance standards.

In moving from a conventional management system, implementing PBM and achieving government's objectives for more cost-effective environmental regulation would involve placing a stronger emphasis on the above four elements than they currently receive. Notably, they would be:

- followed by appropriate risk assessment, increased effort to replace rules-based performance standards with results-based performance standards that would apply broadly to sectors or classes of activities, with a concomitant reduction in permitting individual activities or facilities;

- increased emphasis on the use of qualified and independent professionals to measure and confirm compliance with performance standards;

- increased commitment to environmental effectiveness monitoring as a basis for informing decision-makers on how successful performance standards are in achieving environmental objectives; and

- greater attention on developing incentives for encouraging voluntary compliance with performance standards.

Recommendations

The following recommendations are proposed for defining new directions for wetland conservation.

1. Review the applicability of Performance-Based Management as a possible future direction for wetland conservation and management.

2. Develop national Best Management Practices (BMPs) to conserve specific wetland functions and values that can be adapted for different regions or sectors. The BMP's for maintaining wetland functions/value could consist of an objective stating expected outcomes (results), science-based standards essential for wetland protection (legally binding practices) and guidelines that state recommended practices for achieving results. The BMPs could also be developed for wetland creation/restoration.

3. Develop wetland ecosystem indicators as part of an environmental effectiveness monitoring program for informing sectoral groups and decision-makers on how successful performance standards are in achieving wetland conservation objectives. The indicators could form the basis of a regional or national indicator on wetland health.

4. Review and develop incentives for wetland protection on private lands (e.g. tax exemption on wetlands that meet proper function and condition criteria).

References

Executive Resources Group. January 2001. *Managing the Environment: A Review of Best Practices*. Executive Summary. Available at www.ene.gov.on/ca/envision/ ergreport/index.htm. Government of Ontario. Toronto, Ontario.

Government of British Columbia. 2000. *Performance-based Environmental Management in British Columbia*. Contract report by Daryl Brown Associated Inc. and Victoria Consultation Network Ltd. Victoria, British Columbia.

Kettl, D.F. (ed.). 2002. *Environmental Governance: A Report on the Next Generation of Environmental Policy*. The Brookings Institution. Washington, D.C.

CHAPTER 13: THE EFFECTS OF LAND USE POLICIES ON THE LANDSCAPE IN SASKATCHEWAN AND THE RAMIFICATIONS ON STEWARDSHIP AND WATERFOWL CONSERVATION

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Abstract

The author reviews the impact of government policy of the settlement history of Saskatchewan. From the early 1970s to the early 1990s a 1.4 million hectare (3.5 million acre) increase in cultivation of farmland in Saskatchewan resulted in some of the original rationale for the North American Waterfowl Management Plan (NAWMP). The author reviews changes to Canadian agricultural programs and policies that impact land use. Duck population trends and problems are briefly reviewed.

Recent trends found in the Statistics Canada *Census of Agriculture* indicate that during the last two census periods a reduction in total Saskatchewan farmland of 2.2% has occurred. Statistics Canada also indicates that alfalfa and alfalfa mixtures has become the fourth largest crop in Saskatchewan. The Saskatchewan Department of Agriculture statistics indicates that the amount of tame hay has increased dramatically in Saskatchewan. When the amount of cultivated land in Saskatchewan is adjusted for the amount of land in tame hay the difference in the amount of land cultivated between the early 1970s and 2001 is only a half million acres. This is only a 1% difference and the change is occurring at a rate that cannot be accounted for by NAWMP activities. The removal of agricultural grain production subsidies has changed the economic picture so much that the stewards of the land are moving land use to forage-based agriculture. This trend is environmentally positive and appears to be accelerating.

Census statistics also reveal that the way the agricultural landscape is utilized has dramatically changed. The amount of summer fallow in Saskatchewan has fallen from a level of 6.9 million hectares (17 million acres) in the 1970s to almost half at 3.4 million hectares (8.4 million acres) in 2000. This reduction is inextricably linked to the adoption of continuous cropping practices. The impacts of land use changes are discussed. While the impacts may be beneficial to benign for most waterfowl, continuous cropping in particular may have had a deleterious effect on northern pintail. The author reviews Prairie Habitat Joint Venture (PHJV) habitat evaluation work that indicates that the trends in land conversion within the NAWMP target areas are occurring faster than the non-target areas. This work also notes that Canadian Agricultural Census data indicate that very few differences occur at the landscape level between NAWMP target and non-

target landscapes. While major problems remain for the northern pintail, for most prairie nesting waterfowl habitat may well have become a “just add water” problem.

A Brief Historical Perspective On Western Canadian Agricultural Policy

In the late 1800s the Dominion Government in Ottawa was concerned about American annexation of Rupert’s Land. The disputed territories of western Canada were a “no man’s land” which, to assert sovereignty, had to be converted to deeded land. A pattern of privately owned land was established in western Canada with the passage of a series of legislation tied to the construction of the railway and creation of the government’s ability to grant homesteads. Land tenure became the principal tool of nation building. The original “homestead” was a free quarter section of land (64 hectares or 160 acres) given to any settler provided that he or she live on it and cultivate a certain portion of it. The railway was completed in 1885 but the massive influx of settlers did not materialize in spite of hard times and starvation in Europe and massive emigration to the United States.

The government’s response was *The Crows Nest Pass Act*, which was passed on September 6, 1897. Twelve years after the completion of the rail line the federal government realized that being more than a 1000 miles from an export position placed grain farming on the Canadian prairies at a severe disadvantage. Subsidizing the export of grain was the essential element required to make grain production on the Canadian prairies viable. Subsidized freight of grain initiated the land rush. For the next 100 years western Canadian grain farmers paid only a portion of the freight bill on exported grain. The whole infrastructure of prairie Canada was built on the back of the grain industry. Prairie grain farmers and the industry they created still affectionately refer to the subsidy and the *Western Grain Transportation Act* (WGTA) that replaced it as the “Crow.”

Now there was no question about who owned Western Canada. The key for securing the west and future prosperity was more people on the land. The key to keeping them on the land was cultivation. Provisions in federal and later provincial legislation ensured that if land was allowed to “go wild” the homestead rights were revoked or land taxes increased. These ensured that the new settlers would not allow their land to revert to pasture. Grain production continued to receive increasing government support through a myriad of programs until the early 1990s while the livestock sector was essentially unsubsidized. This resulted in much higher economic rents being paid to land in grain production than in livestock production. The impact of this inequity on the landscape was inescapable and is reflected in the land use of the Canadian Prairies today.

The Current Policy Framework

The situation today is much different. Perceptions by the environmental conservation community and governments have met on common ground. There is recognition that subsidies undermine the profitability of agriculture and have dramatic environmental costs.

Western Canadian agriculture is now essentially a deregulated industry. The WGTA that subsidized the rail transport of export grains was removed in the early 1990s. The Gross Revenue Insurance Program (GRIP) that guaranteed an average price for grains was discontinued. The Net Income Stabilization Account (NISA) that is basically a retirement fund is now whole farm based not just based on production of export grains. The Beef Tripartite Program (beef price stabilization) was discontinued, although in actuality it never made any substantial payouts. The acreage-based quota system which distributed marketing opportunities based on the amount of cultivated land that a farmer owned has been scrapped in favour of a system that divides access to market-based on the farmer's ability to supply grain on contract, the amount of land he or she cultivates is immaterial. The Western Canadian Wheat Board remains but cannot be considered a subsidy, and support for it is mixed and its future is uncertain.

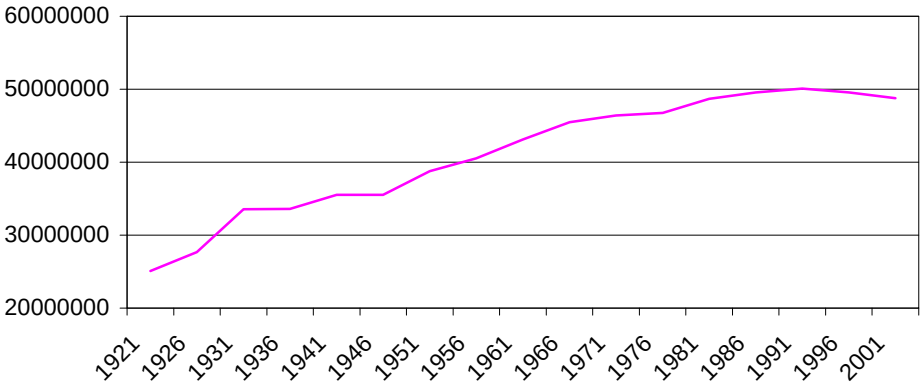
Annual ad hoc acreage-based subsidy programs (such as drought payments) have not been seen in many years. This strengthened the need and demand for Crop Insurance, which is the only subsidy that remains. To the Crop Insurance Program's credit, it has recently introduced forage and pasture insurance programs that have removed any bias in favour of grain production. Crop Insurance programs will be forced to undergo major changes as (or if) the regulations under the General Agreement on Trade Tariffs (GATT) come into effect. Crop Insurance programs around the world will use a much shorter yield-averaging period. This type of change will only cut the peaks and valleys off the yield cycle and over the long term will likely reduce the value of crop insurance to farmers.

Both the federal and provincial governments are aware that pro-grain production policies have resulted in the cultivation of much land that is physically marginal for grain production. Two years ago the Government of Saskatchewan announced a five-year Conversion Cover Program with a five-million dollar annual budget. It offers a $15 per acre one time payment to assist with seeding marginal cropland back to permanent cover with no restriction on land use. This program has been oversubscribed both years. Recently, the federal government announced the Green Cover Program to help convert marginal cropland back to grass. This program's final details are yet to be announced but it will not likely include a land idling option.

Policy Impacts on Land Use – A Century of Cultivation

The end result of more than a century of Canada's cultivation-based settlement policy was, as would be expected, one of the most rapidly altered landscapes on the planet. In Saskatchewan's case, by the late 1980s, 26 million hectares (65 million acres) of land have been brought into agriculture, 20 million hectares (50 million acres) or roughly 75% of it cultivated. Beginning in 1921, approximately 20 years after farming began in Saskatchewan, Statistics Canada collected excellent data through the census every five years. The total land in cultivation in Saskatchewan based on these statistics is reported in Figure 1.

Figure1. Cultivated Acres Over Time in Saskatchewan



Source: Statistics Canada 1996 and 2001

Generally speaking, over the last century there was a steady increase in the amount of cultivated land in Saskatchewan. The increase in cultivation in the late 1970s and 1980s had real negative impact. Bearing in mind that almost all of Saskatchewan's Class 1, 2 and 3 farmland was cultivated by the early 1950s almost all of the land cultivated in the 1970s and 1980s was marginal for grain production. Many in the waterfowl community believed that this was the loss of habitat that caused the downturn in waterfowl numbers.

The upward trend in cultivation was not universal. There was a decline in the 1930s that was a result of the drought and depression. A current decline beginning in the early 1990s is a result of the removal of grain production subsidies principally the ending of the *Western Grain Transportation Act*.

The United States Fish and Wildlife Service and the Canadian Wildlife Service began collecting breeding waterfowl population statistics in the early 1950s. Waterfowl numbers were considered high in the 1950s and the 1970s. The 1990s were relatively wet years in Saskatchewan. Continental waterfowl populations reached all time highs in 1999 (United States Fish and Wildlife Service 2002). By the late 1980s after a period of prolonged drought, waterfowl numbers crashed and alarm bells began to ring within the waterfowl conservation community. The paper by Johnson and Shaffer (1987) entitled "Are Mallards Declining in North America?" is considered by many to be one of the focal points that initiated the NAWMP. Mallard populations were lower from 1971 to 1985 than the spring pond count should have indicated. The hypothesis was that mallards were no longer fully utilizing their habitat range. Data presented by Johnson and Shaffer and confirmed by Statistics Canada show that the habitat conditions in Saskatchewan had changed. From the early 1970s to the late 1980s almost 1.4 million hectares (3.5 million acres) of native prairie in Saskatchewan was converted to wheat

fields. After much scientific, economic and political work and negotiations the NAWMP was born. Early in the delivery of the NAWMP the Prairie Habitat Joint Venture (PHJV) took an active role in agricultural policy reform. Appendix A contains a brief review of these activities.

The Effect of Subsidy Removal on Permanent Cover

The decline in cultivation in the 1990s was a result of the policy framework for agriculture being deregulated. The Statistics Canada Agricultural Census (Statistics Canada 1996, 2001) both demonstrate reductions in the amount of land in farms of 1.1% for a total reduction of 2.2% in just 10 years. Some 0.57 million hectares (1.43 million acres) just does not disappear especially in a province with a static population. Where did this land go? The short answer is that no one really knows for sure except to say that it is not part of active farming operations anymore. Not only has the amount of land being farmed changed, but major changes have taken place in how the cultivated land is farmed.

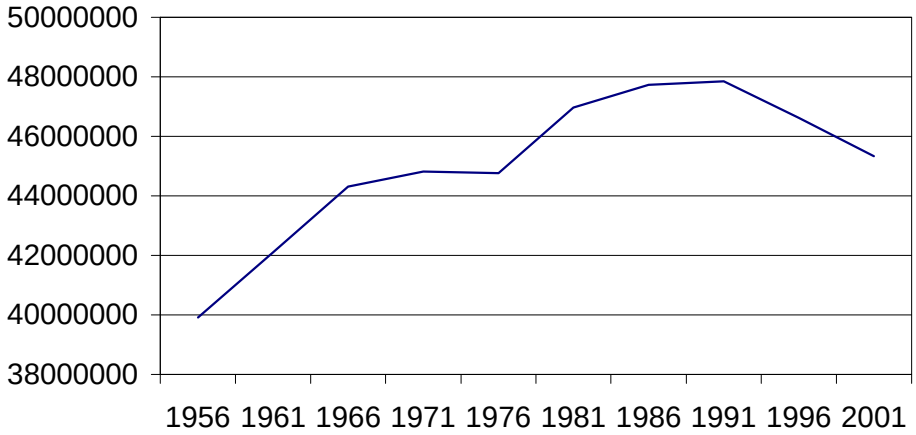
Cultivated land according to Statistics Canada's definition was any land in annual crop, hay or newly seed pasture (less than five years old). From a waterfowl production perspective lands in hay or pasture are dramatically different from land in a wheat fallow rotation. Statistics Canada only recently began to keep statistics on tame hay production. The Saskatchewan Department of Agriculture has been keeping statistics on the amount of land in tame hay production since 1921 (Saskatchewan Agriculture and Food 2000). From this data the amount of tame hay produced in any federal census year can be used to adjust the acreage of cultivated land in Saskatchewan. This data from 1956 on is reported in Figure 2.

The amount of cultivated land when adjusted for tame hay production has dramatically declined from all time highs in the late 1980s and early 1990s to a level in 2001 that was only a half million acres higher than cultivated acreages of the 1960s and 1970s. So significant is the increase in tame hay production in Saskatchewan that it went from being a minor crop on the crop acreage report to the fourth largest crop in Saskatchewan in the 2001 Agricultural Census.

The continuing trend is driven by poor grain profitability while American and European grain production and export subsidies continue. Officials with the Saskatchewan Department of Agriculture's Conversion Cover Program indicate that in 2002 their program seeded 119,890 hectares (296,244 acres) (Giroux 2002) even with a 20 hectares (50 acres) per farmer limit. Their clients advised them that they seed an additional 41,186 hectares (101,769 acres) for which they were not eligible for payment. This totals 161,076 hectares (398,013 acres) of cover seeded in 2002 that is not shown in Figure 2. Farmers who did not apply for the $15 per acre one time subsidy are also not included in this data.

All landowners consider themselves to be good stewards; it does not matter if they are ranchers or grain farmers. In European culture, the notion of stewardship begins in a

Figure 2. Acres in Cultivation Adjusted for Hay Production in Saskatchewan

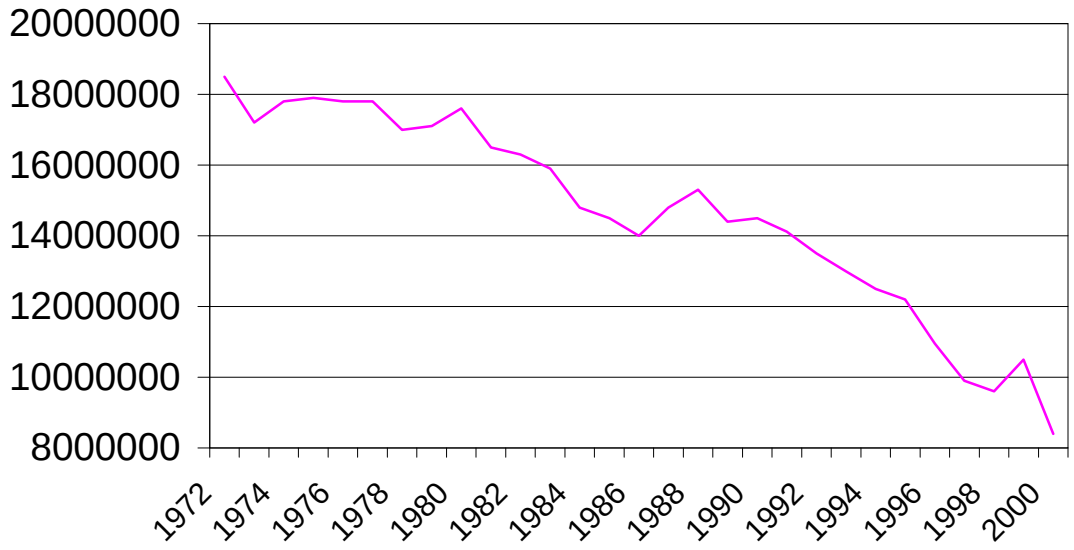


biblical context in which the steward maintains the productivity of his master's money. Today, the conservation movement has expanded stewardship to mean the proper care of the natural system. We must be careful to acknowledge that a great many farmers consider good stewardship to mean nice clean healthy crops from fence line to fence line. It is this old biblical notion of stewardship that in many ways works against the conservation of native habitats. When you couple this notion of stewardship with governmental pro-grain production policy farmers reacted to bring land into "production." From the beginning of European settlement to the late 1980s Saskatchewan's landscape had changed dramatically to the detriment of waterfowl and wildlife habitat in general. However, beginning before the NAWMP the landscape of Saskatchewan has significantly changed again. Being good stewards, landowners are again rapidly adjusting how they farm the land. It is now fairly safe to say that the amount of land in Saskatchewan with permanent cover is roughly the same now as it was in the 1960s and 1970s. While the land that has been reseeded does not have the same ecosystem integrity as the native prairie is does provide functionality at a much higher level than the cropland it replaced. That is great news for those concerned about waterfowl conservation but it is not the whole picture.

Changes on the Landscape Resulting from Technological Change

The reduction in land farmed and increases in the amount of permanent cover are important from a conservation perspective. However, the major driving force on the landscape of Saskatchewan and the rest of the Northern Great Plains for that matter is the development of effective zero till or minimum tillage systems that have been spawned by the manufacturers of modern air seeders. Seeding is now fast and efficient

Figure 3: Summerfallow Acreage, Saskatchewan



with minimal disturbance of the soil and maintenance of crop carry over or "trash." One farmer is now able to seed vast acreages very quickly. There are highly significant savings in manpower, diesel fuel and capital costs. As a result the technology has been adopted quickly. The first casualty of this technology was the practice of summer fallow. Summer fallow was one of the agronomic practices that originally enabled the prairies to be farmed and was long considered the "right" way to manage. In fact, with high carryovers of wheat in the early 1970s the federal government actually paid farmers to summer fallow in 1971 with the Lower Inventories For Tomorrow Program (LIFT) and its practice peaked in Saskatchewan at a high of approximately 9.7 million hectares (24 million acres) (Saskatchewan Agriculture and Food 2000). As would be expected, the following year there was a significant decline.

Figure 3 shows the demise of summer fallow in Saskatchewan since the LIFT Program. In Saskatchewan, the acreage of summer fallow was relatively stable in the 1970s at slightly more than 6.9 million hectares (17 million acres), since then it has gone steadily downward to a low of 3.4 million hectares (8.4 million acres) in 2001. Unlike changes to permanent cover that has impacted several million acres, continuous cropping has impacted tens of millions of acres of cropland as the other half or two thirds of the summer fallow-cereal rotation was converted to minimum tillage along with the disappearing summer fallow.

The Temporal Significance of Summer Fallow for Prairie Nesting Ducks

The reduction in summer fallow is good news from a soil and air quality perspective but it is not necessarily good for ducks. To understand its impact on waterfowl you have to understand the temporal aspects of summer fallow on the timing of breeding and

nesting of various species of ducks. Everyone thinks of a summer-fallowed field as barren, black and completely devoid of vegetation and trash. That field, however, does not reach that condition until late spring or early summer. It may have been worked once after harvest in the fall depending on moisture conditions but not usually. It was left untouched until the previous year's summer fallowed fields were seeded in May and early June. In some years with poor weather it may have been first cultivated as late as after the completion of spraying for weed control in mid to late June. In most years, until early or perhaps late June it remained attractive habitat for birds that utilize low cover like the northern pintail. Being early nesters who will utilize short cover the pintails took advantage of the roughly half the cropland still unworked stubble to nest and were likely successful in getting their broods off the fields prior to the first June tillage. The summer fallow from the previous year that was seeded in May was a completely barren field of dirt that would have had low attractiveness even to pintails. Coincidentally the downturn in the pintail population follows the curve in reduction of summer fallow (in actuality, the adoption of continuous cropping) beginning in the early 1980s. A hypothesis similar to this was originally postulated in a paper presented at the Wildlife Society 9th Annual Conference (Guyn *et al*. 2002).

When the practice of summer fallow is juxtaposed with continuous cropping that is associated with zero or minimum till a big difference is apparent. When summer fallow is practised (in a half and half rotation), half the land is cropped and half is tilled. With minimum tillage all the land is cropped but it is never reduced to bare soil. It is almost never worked in the fall and lots of trash builds up. All of this type of landscape is attractive to pintails. The problem is it is all disturbed in May with seeding operations, right when the pintails are nesting. Pintails being relatively poor re-nesters are clobbered by continuous cropping practices. The opposite situation exists for late nesting or re-nesting ducks. Once the seeding is completed in May or early June the only impact on the field are very wide sprayers that are unlikely to do serious damage to nests. The cover conditions of the crop in June are certainly more attractive to most waterfowl than stubble. Many species of prairie nesting waterfowl like the gadwall, blue-winged teal and northern shoveler whose populations have been relatively stable through past moisture cycles expanded spectacularly in the 1990s.

The author does not mean to suggest that continuous cropping alone is the reason for the rebound of many species of waterfowl in the 1990s as other land use changes such as the American Conservation Reserve Program (CRP) have also resulted in tremendous land use changes. However, only continuous cropping has the ability to account for the demise of the northern pintail. With the adoption of continuous cropping over the last 30 years over half the cropland base (approximately 12 million hectares – 30 million acres in Saskatchewan alone) that pintails could use reasonably successfully may have been converted into an ecological sink. Seeding as much of the marginal cropland as possible back to pasture is the best mechanism to remove this threat. However, even if all the marginal cropland in the northern Great Plains was converted to pasture almost half of the agricultural landscape will likely remain as a potential environmental trap for northern pintails. Pintail nest selection and habitat attractiveness

research (especially the role of spring sheet water on cropland) should be the highest research priority if pintail populations are to be restored to historic levels.

Impact of the NAWMP on the Western Canadian Landscape

How much of the landscape change in upland habitat is attributable to the NAWMP? To answer that very question the PHJV Habitat Monitoring Program was set up by Environment Canada. This program's first report was issued in 2002 (Watmough *et al*. 2002). The team, led by Mike Watmough, has monitored land use changes on the ground to look at the wetland and upland landscape changes in NAWMP target and non-target areas. By following ground transects in NAWMP target areas they observed that the trend to forage-based agriculture is large and more prevalent in NAWMP target areas than on the general agricultural landscape. This group conducted 152 transects each containing 24 quarter sections, for a total area assessed of 236,215 hectares (583,680 acres).

Watmough *et al*. (2002) also utilized the Statistics Canada Agricultural Census to look at the impact of change on the whole prairie landscape. They did this by requesting Statistics Canada to break up the census information into NAWMP target and non-target areas. The findings of that analysis are expanded upon and condensed below in Table 1.

Table 1: Agricultural Census Data: Upland Habitat Changes 1986 to 1996

Cover Type	NAWMP Target Area			Remaining Non-Target Landscape		
	1986	1996	Change	1986	1996	Change
Summer Fallow	14.53%	10.53%	- 4.0%	15.99%	12.33%	- 3.66%
Annual Crop	45.68%	46.93%	+ 1.25%	44.78%	45.69%	+ .91%
Total Cultivated	60.21%	57.46%	- 2.75%	60.77%	58.02%	- 2.75%
Native Pasture	26.13%	25.21%	- .92%	23.88%	23.36%	- .52%
Tame Pasture	4.3%	6.33%	+ 2.03%	4.57%	6.14%	+ 1.57%
Tame Hay	3.79%	5.15%	+ 1.36%	5.11%	6.79%	+ 1.68%
% Cover Change			+ 2.47%			+ 2.73%
All Other Land	5.58%	5.84%	+ .26%	5.67%	5.68%	+ .01%

Note: Total "Cultivated Land" is the sum of "Summer Fallow" and "Annual Crop"; % "Cover Change" is the sum of changes in "Native Pasture," "Tame Pasture" and "Tame Hay."

The rate of change over the 10-year period that Table 1 reports shows that very small differences in the rates of change exist between the two landscapes. The differences that do exist are most likely a result of the fact that the NAWMP target areas are glacial moraine landscapes that contain high wetland densities and are generally less suitable for the production of grain. The major changes occurred in both landscapes at roughly the same rates. The NAWMP target areas had less summer fallow but more annual

crop with no difference in the rate of change in total cultivated acres. The NAWMP target areas lost more native prairie, had more tame pasture seeded but less tame hay seeded than the non-target landscape for an overall slower rate of change in permanent cover than the non-target landscape. At the end of 10 years the difference in the rate of change in permanent cover on the two landscapes can be made up almost exactly by the target areas .26% increase in the “All Other Land” category of the target areas.

These percentages are for western Canada, and they closely parallel the numbers from Saskatchewan Agriculture and Food (SAF) used in my calculations adjusting the amount of cultivated land for hay production. SAF tame hay statistics show an increase between 1986 (0.75 million hectares – 1.86 million acres) and 1996 (1.19 million hectares – 2.95 million acres) of 0.44 million hectares (1.09 million acres) that is 1.68% of the roughly 26.3 million hectares (65 million acres) in farms in Saskatchewan.

The reduction in the amount of land farmed, increases to the amount of permanent cover especially in recent years and the adoption of continuous cropping on tens of millions of acres has dramatically impacted the Saskatchewan agricultural landscape. The important message to take away from this is that the stewards of the land are changing the landscape so fast that the impact of the NAWMP is almost completely masked by the scale of the change. As profitability declines the abandonment of farmland has become a serious concern to rural economies with almost twenty times more land dropping out of agriculture than conservation agencies have the ability to buy. The landscape has changed dramatically to the benefit of most waterfowl not only in Canada through subsidy removal but also in the United States through the American Farm Bill. Waterfowl have responded and in the late 1990s demonstrated that the habitat is there for record waterfowl production. Our attention must be diverted to species that are still at risk or are impacted negatively by these landscape changes.

Recommendations

1. Migratory bird plans should be re-written to take into account the changes on the landscape in the United States and Canada and habitat trends on the northern Great Plains in general.

2. Migratory bird plans should use long-term population trends rather than short-term trends as the indicators of population trends. The definition of what constitutes a stable population needs to be delineated so that real comparisons can be made.

3. Migratory bird plans should remove the bias toward importance of a species in the harvest and replace it with a species’ lack of responsiveness to increased moisture, management and landscape changes.

4. With good moisture conditions waterfowl populations have shown the ability to reach all time highs well above target levels. United States and Canadian federal money

should be targeted at the broader NABCI landscape initiatives. The use of the United States non-federal match may have to be revised to enable this to happen.

5. Landscape problems associated with reductions in the amount of summer fallow and increases in continuous cropping and the impacts of these on northern pintail need special attention.

6. The impact of drainage of cropland on breeding, nest selection and overall nest success of waterfowl needs to be investigated.

Appendix A: Review of Prairie Habitat Joint Venture Initiatives Regarding Agricultural Policy Reform

Background

At the beginning of the North American Waterfowl Management Plan (NAWMP) it was realized that reforms to agricultural policy and programs would be essential. The original *Prairie Habitat Joint Venture (PHJV) Implementation Strategy* (Prairie Habitat Joint Venture 1990) stated that to meet objectives 25% of the ducks produced would have to result from policy reform. As expenditure levels were lower than planned the importance of policy reform increased. The PHJV, through the work of the former Saskatchewan Wetland Conservation Corporation (SWCC), has taken an active role in the effort to reform Canadian agricultural policy. Funding for this work was obtained from Wildlife Habitat Canada (WHC) when SWCC's former Agricultural Services Manager applied for and received funding for the WHC Prairie Agricultural Landscape Project. This project provided the funding necessary for the coordination of the PHJV's Agricultural Policy reform efforts.

The PHJV set up a Land Use Committee (LUC) with representation from all of the interested partners. This committee met via conference call and in person on an as needed basis. It developed its strategy in consultation with the PHJV Advisory Board.

Activities

At one of its first meetings the LUC initiated the socio-economic reviews of NAWMP activities in each of the three Prairie Provinces. This type of review was to be conducted every five years. In its first cooperative action, the LUC commissioned "*A Socio-economic Evaluation of the NAWMP: A Synopsis of the Provincial Components*" by Burden and Taylor (1994). This Synopsis pulled together the common threads in all three previously conducted provincial studies. These studies documented that the activities of the NAWMP were well accepted by the general public and landowners and were paying fair market price for conversion of agricultural land to waterfowl habitat. At about the same time, a study looked at the savings to the taxpayer that resulted from the NAWMP taking marginal land out of production. This study entitled "*Land Analysis*

of the PHJV Initiatives on Prairie Agricultural Subsidy Requirements" by Gray (1993) indicated much the same findings as similar studies on the Conservation Reserve Program (CRP) in the United States. It indicated that the programming delivered by the PHJV was saving the Canadian taxpayer as much money as it was costing to deliver. As Canadian taxpayers were paying 25% of the cost of NAWMP delivery the overall saving ratio exceeded 4 to 1. It must be remembered that at the time the subsidies in Canadian agricultural policy approached $65 per acre per year.

On behalf of the PHJV, SWCC staff prepared a series of discussion papers that reviewed agricultural subsidies that were in place in Canada, their impact on land use decision-making, and options for the reform of these individual policies and a general philosophical approach to the formulation of new farm support mechanisms. The stance of the SWCC and the PHJV was always to continue to support the farmer in the light of continued foreign subsidization. However, a commodity-decoupled stance was advocated to capture as much environmental benefit as possible. To bolster this position a study was commissioned by the PHJV to look at the cost of decoupling farm support from commodities and acreage based payments to applying the subsidies to the complete land base including habitat lands. This report entitled "*Decoupled Payments for Habitat Conservation: A Preliminary Assessment of Cost*" by Gray, Conacher and Burden (1994) indicated that the cost of subsidizing habitat land in terms of a dilution of the existing payments was only 5%. The decoupling formula developed in this study was utilized in a high profile academic submission for the payout of the *Western Grain Transportation Act* (WGTA).

One of the major threats to the delivery and acceptability of the NAWMP was and remains the problem of waterfowl damage to farmers' fields in the fall. This was found to be one of the common problem areas in the Synopsis of the Socio-economic evaluations. To address this a study entitled "*Compensation vs. Prevention of Waterfowl Damage to Farmers in Saskatchewan: Issues and Options"* by Duncan and Gray (1993) was done. This study made a series of recommendations regarding the need for further research and on improving program delivery and harmonization potential for compensation and prevention programs. Ongoing research stimulated by this study looked at the most effective mechanisms to reduce overall costs and improve the effectiveness of the compensation and prevention programs. Subsequently a study entitled "*The Financial Implications of Quality Adjustments for Waterfowl Damage Compensation*" by Gray, Sulewski and Riemer (1995) looked at the cost savings that would accrue from paying waterfowl damage compensation based on the actual grade of the crop consumed rather that the "high price option" which was a predetermined quality level. This study indicated that significantly higher percentage payments could be made to the farmer at no additional cost to the program if the real grade of grain consumed by waterfowl was used to determine the value of the crop rather than an arbitrary grade 2.

SWCC, on behalf of the PHJV, prepared discussion papers and briefing notes for submission to all Federal agricultural policy reviews including the five-year Canada Grains Commission review which looked at the acreage-based quota system and

replaced it with contract marketing, the environmental assessment of Crop Insurance, the reviews of Gross Revenue Insurance Program (GRIP) and Net Income Stabilization Account (NISA) and the Saskatchewan and Alberta farm safety net review committees.

The PHJV, through the SWCC, took a leadership role in interpreting the impact of Free Trade and the General Agreement on Tariffs and Trade (GATT) on the environment and land use by preparing PHJV discussion papers on the issue and presenting refereed papers on the subject at national conferences.

In the mid 1990s with the removal of the *Western Grain Transportation Act*, the manager of the Agricultural Services Division of SWCC decided to stop applying for WHC funding for agricultural policy reform work and no formal PHVJ Land Use position existed for many years. The PHJV Land Use Committee has been relatively inactive over the past few years but has recently received a boost with the establishment of a new coordinator's position and a budget for studies and investigations.

How Did We Do?

The goals were to decouple farm support to include habitat lands and to remove the distortion of land use that results from government support for the export grains sector. We believe that overall the mission has been accomplished. We were unsuccessful at maintaining farm support at the existing levels. However, the quota system has been abandoned, and NISA was decoupled from commodities and acreage based calculations. The WGTA pay out was based on a "productivity of the soil" basis but not decoupled from commodities. Not everything we desired to be changed has been changed but tremendous gains in deregulating agricultural policy have been made. Overall land use distorting farm support has fallen to almost zero.

Our role in this change has to be kept in perspective, the fiscal situation was bleak and for the first time ever, there are international trade rules impacting agricultural trade. While our role has been small when the agricultural policy community wanted an environmental perspective on policy changes we were always among the first contacted. We were the only environmental agency in western Canada to take an active role in studying the impacts of and lobbying for agricultural policy change.

References

Burden, D. and J. Taylor. 1994. *A Socio-economic Evaluation of the NAWMP: A Synopsis of the Provincial Components.* Contract Report to Land Use Committee, Prairie Habitat Joint Venture. Edmonton, Alberta.

Duncan, R. and R.S. Gray. 1993 *Compensation vs. Prevention of Waterfowl Damage to Farmers in Saskatchewan: Issues and Options.* Report prepared for Saskatchewan Wetlands Conservation Corporation. Department of Agricultural Economics, University of Saskatchewan. Saskatoon, Saskatchewan. 25 p.

Giroux, L. 2002. Manager, Saskatchewan Conservation Cover Program. Regina, Saskatchewan. Personal communication.

Gray, R.S. 1993. *Land Analysis of the Prairie Habitat Joint Venture Initiatives on Prairie Agricultural Subsidy Requirements*. Report prepared for the Prairie Habitat Joint Venture, Department of Agricultural Economics, University of Saskatchewan. Saskatoon, Saskatchewan.

Gray, R.S., G. Conacher and D. Burden. 1994. *Decoupled Payments for Habitat Conservation: A Preliminary Assessment of Cost*. Report prepared for the Prairie Habitat Joint Venture Land Use Committee. Department of Agricultural Economics, University of Saskatchewan. Saskatoon, Saskatchewan.

Gray, R., T. Sulewski and G. Riemer. 1995. *The Financial Implications of Quality Adjustments for Waterfowl Damage Compensation*. Report prepared for the Prairie Habitat Joint Venture Land Use Committee. Department of Agricultural Economics, University of Saskatchewan. Saskatoon, Saskatchewan.

Guyn, K.A., J.H. DeVries, K.M Podruzny and L.M. Armstrong. 2002. The deception of pintails on the Canadian prairies. *Proceedings of The Wildlife Society 9th Annual Conference.* Bismarck, North Dakota.

Johnson, D.H. and T.L. Shaffer. 1987. Are mallards declining in North America? *Wildlife Society Bulletin* 15: 340-345.

Prairie Habitat Joint Venture. 1990. *PHJV Implementation Strategy.* Edmonton, Alberta.

Riemer, G., J. Taylor and D. Burden. 1995. A case study of sustainable land use, the delivery of the NAWMP in Prairie Canada: socio-economic Impacts. *Proceedings of Conference on Planning for a Sustainable Future: The Case of the North American Great Plains.* Lincoln, Nebraska. May 1995.

Saskatchewan Agriculture and Food. 2000. *Agricultural Statistics 2000*. Regina, Saskatchewan.

Statistics Canada. 1996. www.statcan.ca/start.html.

Statistics Canada. 2002. www.statcan.ca/start.html.

Sulewski, T. 1995. *The Economic Rationale of Alternative Waterfowl Damage Compensation and Prevention Program Designs*. Masters Thesis, College of Graduate Studies, Department of Agricultural Economics, University of Saskatchewan. Saskatoon, Saskatchewan.

U.S. Fish and Wildlife Service. 2002. *Waterfowl Population Status*. Department of the Interior. Washington, D.C.

Watmough, M.D., D.W. Ingstrup, D.C. Duncan and H.J. Schinke. 2002. *Prairie Habitat Joint Venture Habitat Monitoring Program Phase 1: Recent Habitat Trends in NAWMP Targeted Landscapes.* Edmonton, Alberta.