CANADIAN PEAT HARVESTING AND THE ENVIRONMENT

SECOND EDITION

wetlands

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CANADIAN PEAT HARVESTING AND THE ENVIRONMENT

SECOND EDITION

by
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Hélène Gautreau-Daigle

First Edition by
David Keys

Issues Paper, No. 2001 - 1

North American Wetlands Conservation Council Committee

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Executive Summary

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, but also from reed and other sedge deposits across the country, is marketed among many uses as a soil supplement to enhance gardening and as a soil base for greenhouse production. It is one of nature's truly green products offering a large potential of horticulture uses and at the same time can be disposed of without causing any damage to the environment. Peat, in various sizes of compressed packages and bales, has become a readily available product at our local hardware and garden centres. What would spring gardening be like without a few bales of peat moss to dig into your flowerbeds or to plant with some new shrubs or roses? However, consumers of peat moss want to know whether this important soil additive is being harvested and applied in ways that protect the overall resource and the environment.

In 1999, 1.2 million metric tonnes or about 10 million cubic metres of peat were produced 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 1999, this production was valued at approximately $170 million f.o.b. production site. Canadian *Sphagnum* peat, 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 very small share of the world market accounting for approximately eight percent of global peat moss used.

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.

In early 1991, the Canadian Sphagnum Peat Moss Association (CSPMA), the New Brunswick Department of Natural Resources and Energy, and the Secretariat to the North American Wetlands Conservation Council (Canada), representing the combined interests of industry, government and researchers, initiated the production of the First Edition of this report. This Second Edition updates the status of peat harvesting and environmental issues concerning the use of peat and peat moss in Canada.

At present, less than 17,000 hectares of Canada's 113 million hectares of peatlands are being used for peat or peat moss harvesting. The majority of companies involved in this industry, through their association with the CSPMA, have articulated a policy for the preservation of environmentally sensitive peatlands use and for site restoration or reclamation of harvested sites. The industry, in association with government and non-government interests, environmental groups and universities, has developed a national peatland research strategy to promote awareness of peatland restoration technology and science. 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 (see policy in Appendix). Older sites can also be reclaimed to valuable agricultural, forestry or wildlife habitat uses.

It is very 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 regulators. 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.

Preface to Second Edition

In the decade since the First Edition, environmental issues have been at the forefront of peatland management as well as a priority on the Canadian peat industry's agenda. Over this period, the volume of harvested peat increased by 45 percent while the harvested peatland surface areas only increased by 25 percent which is still less than 0.02 percent of the total peatland area in Canada. Furthermore, some 500 hectares of worked surfaces are being restored.

This Second Edition has been revised and extended to include the collaborative effort between the North American Wetlands Conservation Council Committee, the federal and provincial government agencies and the peat industry (Canadian Sphagnum Peat Moss Association). A new section on peatland restoration was created to illustrate the dynamism in this field. The Canadian horticulture peat industry has adopted *Peatland Restoration Guidelines* that it has shared with the international industrial community.

The common vision is wise use of this valuable natural resource in Canada and around the world while contributing in a significant way to our economy.

Jean-Yves Daigle
Hélène Gautreau-Daigle

Preface to First Edition

"Canadians need and will continue to need peat and peatlands. We cannot and should not halt use altogether, though wise management and intensive use on selected sites must be encouraged."

So said my colleague Barry Warner of the University of Waterloo in correspondence about this proposed paper when it was being developed. Of course Barry is right. Unfortunately, Canadians are surprisingly unaware of our peatlands and the opportunities Canada is blessed with in having so many peatlands present in this nation. Hence, this paper is about peatlands in Canada. It addresses what they are, how our peatland resources are being used (in particular for horticultural peat uses and for other peat moss applications), and what the environmental issues are that must be addressed by Canadians. The paper also examines what is being done to ensure the sustainable, wise use of our peatlands.

David Keys

CANADIAN PEATLAND FACTS AND HARVESTING ACTIVITIES

- Peatlands, covering approximately 113 million hectares of Canada's land and freshwater area (over 11 percent of the surface area of the nation), comprise 76 percent 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 which 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 one million tonnes annually.
- Less than 0.02 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 CDN$ 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.

1.0 Introduction

There has been increased recognition of the value of wetland ecosystems in recent years. Wetland loss due to agriculture, urbanization, industrial development, water management projects and a variety of related activities has made wetland conservation an issue in many jurisdictions. Modification or loss of wetland ecosystems has been extensive in much of southern Canada. For example, over 70 percent of the wetlands in the southern portions of the central Prairies, southern Ontario and the Fraser Lowland in British Columbia have been converted to other land uses. However, wetland disturbance has been minimal in lightly populated areas of Canada such as the boreal zone.

Canada's peat-dominated ecosystems are a major component of the nation's total wetland resource base. In this paper, the term "peatland" is used to refer to the peat-dominated areas within the total wetland resource of Canada. Peatland resources are utilized for many purposes including agriculture, forestry, peat harvesting and wildlife habitat. Partially decomposed peat suitable for horticultural applications and peat moss are harvested in several regions of Canada. However, most of the wetlands in southern Canada that the general population recognize are not suitable for this purpose. Thick accumulations of suitable quality peat, normally found only in certain categories of peatlands such as bogs and fens, are a basic requirement for peat harvesting interests.

The objective of this paper is to examine the relationship between peatlands and the horticultural peat industry. The study provides an evaluation of environmental and sustainable wise use issues in a Canadian context, and provides an international perspective where possible. Case studies are used to examine several specific situations where peatland development proposals have undergone environmental assessments. The present status of peatland conservation in Canada is reviewed and topics relating to sustainable development with respect to the horticultural peat industry are examined in greater detail. An appendix outlining the *Preservation and Reclamation Policy* of the Canadian Sphagnum Peat Moss Association is included.

Photo: Jean-Yves Daigle

Studying vegetation near a bog pool.

2.0 Canadian Wetlands

According to *The Canadian Wetland Classification System, Second Edition* (Warner and Rubec 1997), the term "wetland" has a broad definition and is used to describe areas that are waterlogged all or most of the time. A "peatland" is a wetland on which extensive organic material has accumulated. The European terms "mire" and "moor" have related meanings. Accumulation of peat can occur when climatic and other physical conditions result in a rate of production (growth) of plant materials such as mosses, reeds or sedges that exceeds the rate of decomposition. About 76 percent of the wetlands in Canada are classed as peatlands (see Table 1). The volume of peat present in these peatlands has been estimated by the National Research Council to be over three trillion cubic metres (Tarnocai 1984).

Photo: Clayton Rubec

Fen complex, Kejimkujik National Park, Nova Scotia.

Wetlands are dynamic ecosystems that continue to evolve and change over time. These are wetlands developed in Canada following the most recent retreat of glacial ice and are typically between 5,000 and 10,000 years old. The rate at which wetlands evolve is controlled by a complex interaction of climatic, biological, hydrological and related factors.

2.1 Wetland Development and Classification

Wetlands are subdivided into five "classes": bog, fen, swamp, marsh and shallow open water. Definitions of these terms and methods for wetland differentiation have been developed for Canada by the National Wetlands Working Group (1986, 1988), Warner and Rubec (1997). Each of the five classes can be further subdivided into various "forms" based on landscape, hydrological and other physical factors and "types" related to vegetation characteristics.

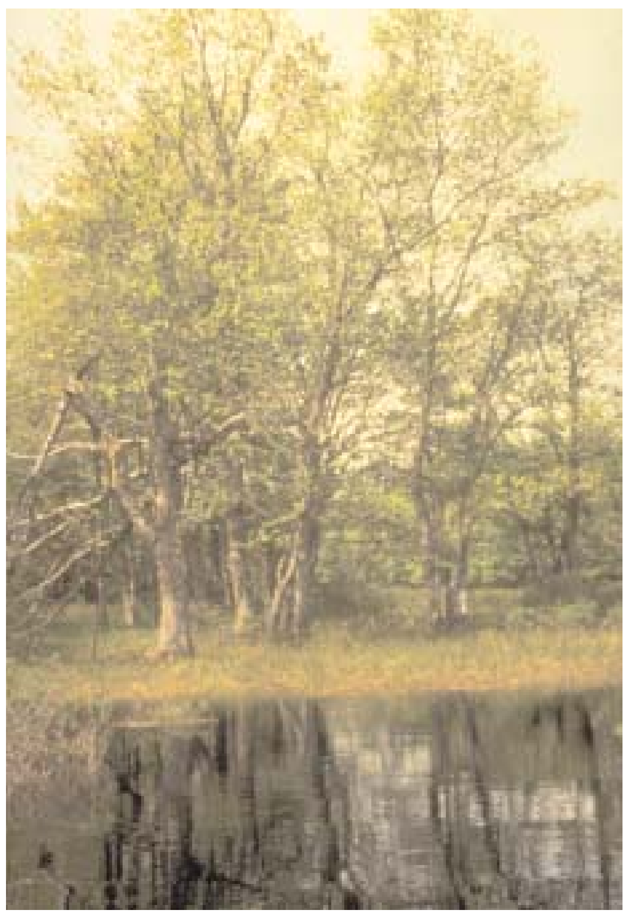


Photo: Clayton Rubec

Forested swamp, Kejimkujik National Park, near Bridgewater, Nova Scotia.

In the initial stages of wetland development, where vegetation obtains its nutrients from soil and groundwater, a wetland is termed "minerotrophic".

Common vegetation types in the swamp, marsh and shallow water classes include a variety of reeds, sedges, shrubs and other species. Because there is a nutrient-rich environment, a diverse range of plant species is typical.

Accumulation of organic matter, in the form of peat, can occur under favourable conditions. The rate of accumulation can be as much as one to two mm/year (10 to 20 cm per century) but generally may average from 0.6 to 0.7 mm/year in many Canadian peatlands. A minimum accumulation of 40 cm of peat is used to define the term peatland. As the peat layer accumulates, access to nutrients in the underlying soil is reduced and the vegetation must obtain its requirements from groundwater seepage. The type of vegetation and the diversity of species tend to reflect this change in nutrient regime. Plants such as mosses (*Sphagnum* spp.) and sedges (*Carex* spp.) become common and the overall diversity of species becomes lower. These conditions are frequently associated with the "fen" class of wetlands.

The accumulation of peat in bogs can result in the surface of the wetland being raised above the surrounding waters and mineral soil. The surface vegetation is then virtually unaffected by base cation-rich waters and it obtains nutrients primarily from precipitation. The wetland is termed "ombrotrophic" and includes species such as *Sphagnum* mosses and shrubs. The diversity of species tends to be low, presumably due to the acidic, low base cation environment. Such conditions are typical of the "bog" class of wetlands.

Many peatland forms commonly expand in a lateral direction as well as having vertical accumulation. This process of "paludification" results in more land gradually becoming part of the peatland ecosystem. Natural activities such as beaver ponds can contribute to this process. Generalized cross-sections of a bog and fen are shown in Figure 1. In the case of the fen, base cation-rich groundwater percolates through the system and influences the nature of the vegetation. In the bog illustration, a living surface layer (usually 10 to 20 cm thick) is underlain by an accumulation of weakly decomposed *Sphagnum* peat which formed in a bog environment, i.e. under ombrotrophic conditions. Underlying this is a layer of moderately decomposed *Sphagnum* peat that accumulated in a fen environment influenced by seepage of minerotrophic waters. The basal layer consists of highly decomposed sedge peats that accumulated in a fen and/or marsh environment. An open water phase may have been present in the centre of the basin during the early stages of peatland development. Reconstruction of the development history of a peatland can be achieved by an evaluation of peat cores to determine the stratigraphy of the accumulated peat.

A detailed discussion of wetland classification is presented in *Wetlands of Canada* (National Wetlands Working Group 1988). A brief summary of the major wetland classes is presented below.

Bog

An ombrotrophic peatland with the water table at or near the surface. Bogs may be treed or treeless. Vegetation species tend to show a limited diversity due to the acid, nutrient-poor environment with *Sphagnum* mosses and ericaceous shrubs common.

Fen

A minerotrophic peatland with the water table usually at or just above the surface. Vegetation may include sedges, grasses, reeds, brown mosses, certain *Sphagnum* species, ericaceous shrubs and trees.

Swamp

A mineral wetland or peatland with standing or gently flowing waters occurring in pools or channels. The water table usually is at or near the surface. The vegetation is characterized by a dense cover of deciduous or coniferous trees or shrubs, herbs and some mosses.

Photo: Clayton Rubec

Bay marshes and estuary, Queen Charlotte Islands.

Marsh

A mineral wetland that is periodically inundated by standing or slowly moving waters. Surface water levels may fluctuate seasonally and vary from fresh to highly saline. Vegetation includes emergent sedges, grasses, rushes and reeds, which may have interspersed areas of open water and aquatic plants.

Shallow Open Water

A mineral wetland that is intermittently or permanently flooded and has open expanses of standing or flowing water. Shorelines, mud flats, shallow lakes, ponds, pools, oxbows, channels and similar features are included in this class. Vegetation, when present, consists of submerged and floating aquatic plant forms.

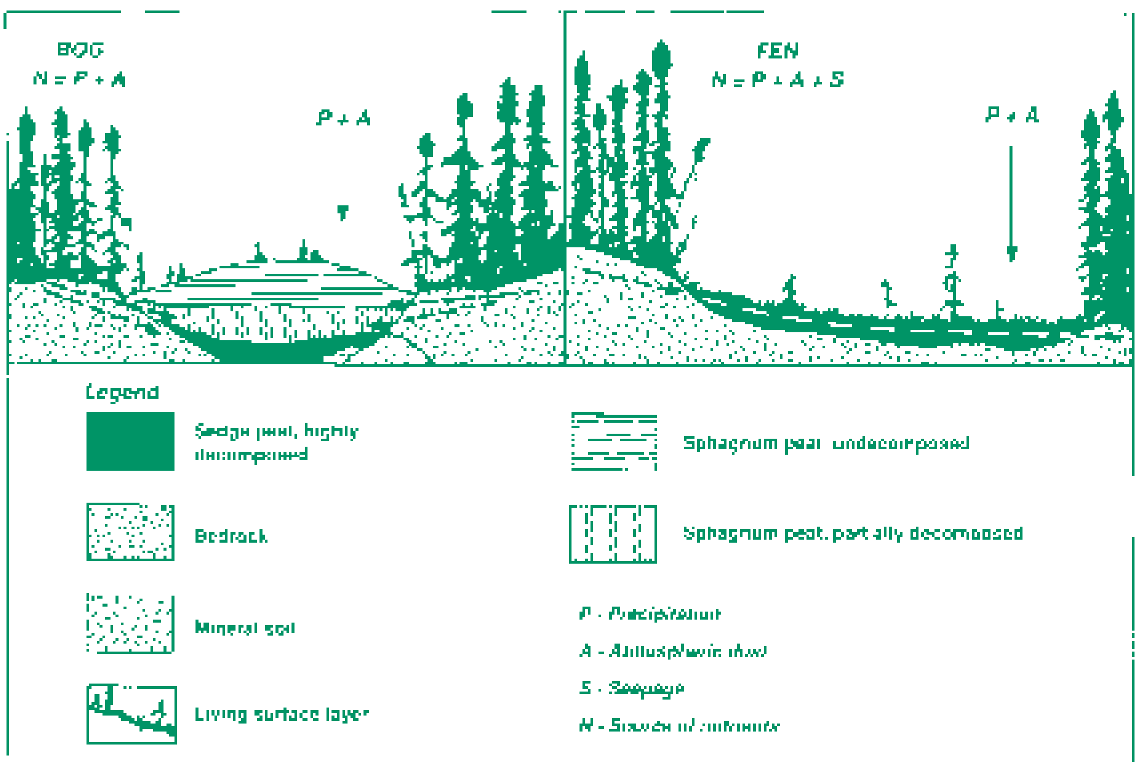


***Figure 1: Generalized illustrations of bog and fen showing differences in morphological development and sources of nutrient input**.*

Source adapted from: Wells and Hirvonen (1988)

2.2 Distribution of Canadian Wetlands

The distribution of wetlands is controlled by many factors including surface hydrology and the interaction of climatic and topographic factors. Table 1 lists Canada's wetland occurrence on a provincial basis and provides an overview of comparable peatland distribution. Major wetland or peatland inventory programs have been completed in several regions of Canada including the Pacific estuaries, the southern Prairies, southern Ontario, southern and eastern Quebec, and the Atlantic Provinces excluding Labrador. Current summary information on the location of Canadian wetland inventories can be found on the Internet (www. wetkit.net).

Climatic and topographic factors also influence the type of wetland that occurs in a particular region. Twenty wetland regions, and a series of wetland subregions based upon climatic factors, are recognized in Canada (National Wetlands Working Group 1986). A detailed discussion of wetland distribution and of the characteristics of the wetlands in each wetland region is provided in *Canada's Wetlands* (National Wetlands Working Group 1986, Geomatics Canada website: www.geomaticscanada.com). Figure 2 illustrates the location of the four boreal wetland regions (including High, Mid, Low and Atlantic Boreal). These wetland regions have cold winters but warm summers with amounts of precipitation moderate in the centre of the continent to high in the maritime coastal areas. Over 70 percent of Canada's wetlands are estimated to occur within this zone where the dominant vegetation consists of coniferous forest or various proportions of coniferous and broad-leaved forest (La Roi *et al.* 1967). The majority of these are bog and fen ecosystems, and most of the peat harvesting operations are within these boundaries.

Photo: Ontario Ministry of Natural Resources

River edge, fen, bog complex near Timmins, Ontario.

Table 1
OCCURRENCE OF WETLANDS AND PEATLANDS IN CANADA

PROVINCE OR TERRITORY	PEATLAND AREA		TOTAL WETLAND AREA	
	ha × 10^6	% of area of province or territory	ha × 10^6	% of area of province or territory
Alberta	18.0	27.2	23.3	35.2
British Columbia	4.9	5.1	5.3	5.6
Manitoba	19.2	29.5	23.3	35.9
New Brunswick	0.2	4.4	0.3	5.6
Newfoundland-Labrador	5.4	13.4	6.8	16.8
Northwest Territories and Nunavut	16.9	4.9	27.8	8.1
Nova Scotia	0.4	6.3	0.6	10.5
Ontario	31.3	29.3	33.5	31.3
Prince Edward Island	<0.01	<1	0.07	<1
Quebec	11.2	7.2	15.8	7.9
Saskatchewan	4.9	7.5	9.7	14.8
Yukon Territory	1.1	2.3	1.5	3.4
Canada	113.4	11.4	147.9	14.4

Source: Rubec 2000, Tarnocai et al. 2000.

3.0 The Canadian Peat Industry

In 1999, there were approximately 85 operations in Canada that produced horticultural peat. About 99 percent of the total national production comes from the combined operations of 15 corporate groups who currently form the Canadian Sphagnum Peat Moss Association (CSPMA). The locations of principal production sites are shown in Figure 2. Some operations have been in production for over half a century. Peat production has occurred in each of the provinces at one time or another. At present, the majority of the operations are located in southern and southeastern Quebec and eastern and northeastern New Brunswick. Peat production also occurs in western Canada, in central Alberta, southern Saskatchewan, and eastern Manitoba as well as in Nova Scotia, Prince Edward Island, Ontario and Newfoundland. Table 2 provides a summary compiled by Natural Resources Canada of recent peat shipments by province.

Figure 2 shows that peat production occurs primarily in the boreal wetland regions. Most of the operations are situated in the Atlantic Boreal and the Low Boreal Wetland Regions. The bog class of wetland, which is characteristic of these wetland regions, is also the focus of horticultural peat developments in Canada. This reflects the demands of the marketplace for high quality peat products. Canadian *Sphagnum* peat in 1999 represented about 99.9 percent of the volume and about 99.3 percent of the dollar value of peat products exported into the United States (Jasinski 1999). Figure 3 shows that annual shipments of Canadian peat for 1994 to 1999 have ranged from 914,000 to 1,216,000 tonnes.

Table 2
CANADIAN PEAT SHIPMENTS BY PROVINCE, 1994–1999

	1994		1995		1996		1997		1998		1999	
Province	Quantity (× 000 T)	Value (× 000 $)	Quantity (× 000 T)	Value (× 000 $)	Quantity (× 000 T)	Value (× 000 $)	Quantity (× 000 T)	Value (× 000 $)	Quantity (× 000 T)	Value (× 000 $)	Quantity (× 000 T)	Value (× 000 $)
Newfoundland	4	779	×	×	2	462	1	164	2	423	2	417
Prince Edward Island	–	–	21	2 266	21	2 327	22	2 404	33	5 601	43	3 541
Nova Scotia	×	×	×	×	×	×	×	×	×	×	×	×
New Brunswick	328	40 378	370	46 597	379	49 857	430	55 199	402	50 382	444	57 558
Quebec	283	43 793	274	48 012	259	40 130	286	37 644	324	41 016	372	49 864
Ontario	×	×	×	×	×	×	×	×	×	×	×	×
Manitoba	×	×	×	×	×	×	×	×	×	×	×	×
Saskatchewan	×	×	×	×	×	×	×	×	×	×	×	×
Alberta	×	×	110	23 840	125	23 770	149	26 636	216	41 449	178	26 511
British Columbia	×	×	–	–	–	–	–	–	–	–	–	–
Total	914	133 345	886	139 154	901	141 019	1 054	146 404	1 125	166 542	1 216	168 767

– nil
× values not released due to confidentiality
Values are sales, f.o.b. works, less the cost of containers
Source: Bergeron, 1996 (for 1994-1995); Paquette and Gauthier 1999 (for 1996-1998), 2000 (for 1999)

Figure 2. Communities in Canada that are the Focus of Peat Harvesting Operations and Employment

The number of operations are indicated between parentheses when there are more than one.

ALBERTA:
1 Athabasca
2 Newbrook
3 Seba Beach
4 Vilna
5 Wandering River

SASKATCHEWAN:
6 Carrot River

MANITOBA:
7 Caribou
8 Elma
9 Giroux
10 Julius

ONTARIO:
11 Alfred
12 Fort Frances

QUEBEC:
Communities grouped according to Regional County Municipalities (RCM)
13 Lac St-Jean Est and Saguenay
- St-Ludger-de-Milot
- L'Ascension
- La Baie

14 Portneuf
- Grondines

15 Charlevoix
- La Baleine (2)

16 La Haute Côte-Nord
- Escoumins
- St-Paul-du-Nord

17 Manicouagan
- Pointe-Lebel

18 Sept-Rivières
- Port-Cartier
- Sept-Îles (2)

19 Coaticook / Drummond
- Coaticook
- St-Bonaventure

20 Desjardins / Bellechasse
- St-Charles
- St-Henri

21 Kamouraska
- St-Alexandre (4)
- Rivière Ouelle
- St-André

22 Rivière-du-Loup
- L'Isle-Verte (2)
- Rivière-du-Loup (4)
- St-Arsène (2)
- St-Modeste (3)

23 Les Basques / Rimouski–Neigette
- Ste-Anne-de-la-Pointe-au-Père
- St-Eugène-de-l'Adrière (2)
- St-Fabien (5)
- St-Simon

24 Matane
- St-Ulric-de-Matane (2)

NEW BRUNSWICK:
25 Acadian Peninsula
- Burnt Church
- Grande-Anse
- Inkerman (3)
- Lamèque Island (7)
- Maisonnette
- Pokesudie
- Rivière-du-Portage
- Tabusintac
- Tracadie

26 Escuminac Peninsula / Miramichi
- Baie-Ste-Anne
- Baie du Vin
- Black Brook
- Escuminac
- Eel River Bridge
- Pointe-Sapin
- Rogersville
- St-Margarets

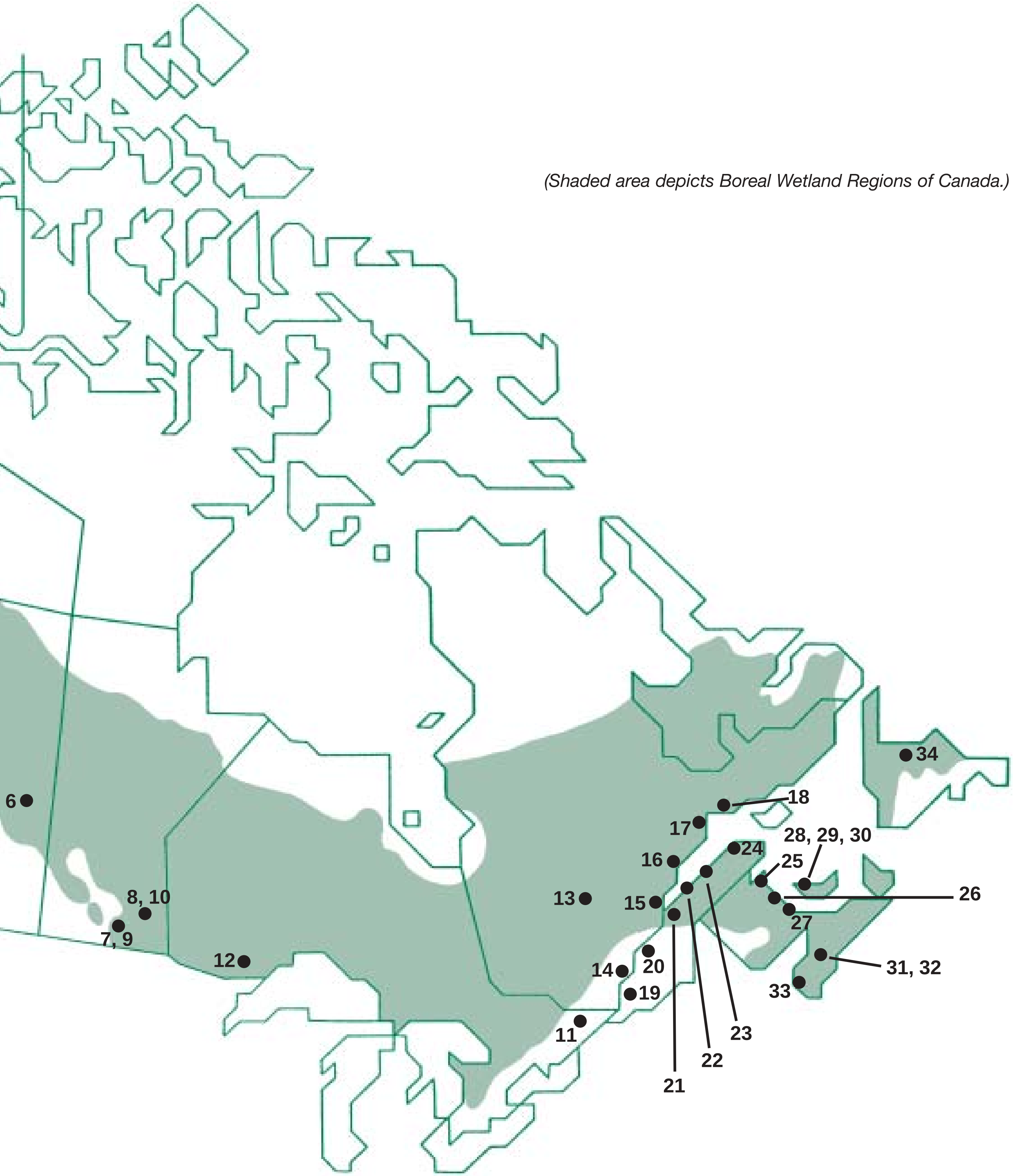
27 Southeast New Brunswick
- Birch Ridge
- Rexton
- Shediac

PRINCE EDWARD ISLAND:
28 Ellerslie (2)
29 Foxley River
30 Miscouche

NOVA SCOTIA:
31 Berwick
32 Kennetcook
33 Saulnierville

NEWFOUNDLAND:
34 Bishops Falls

Source: Updated from Ecoregions Working Group 1989.


(Shaded area depicts Boreal Wetland Regions of Canada.)
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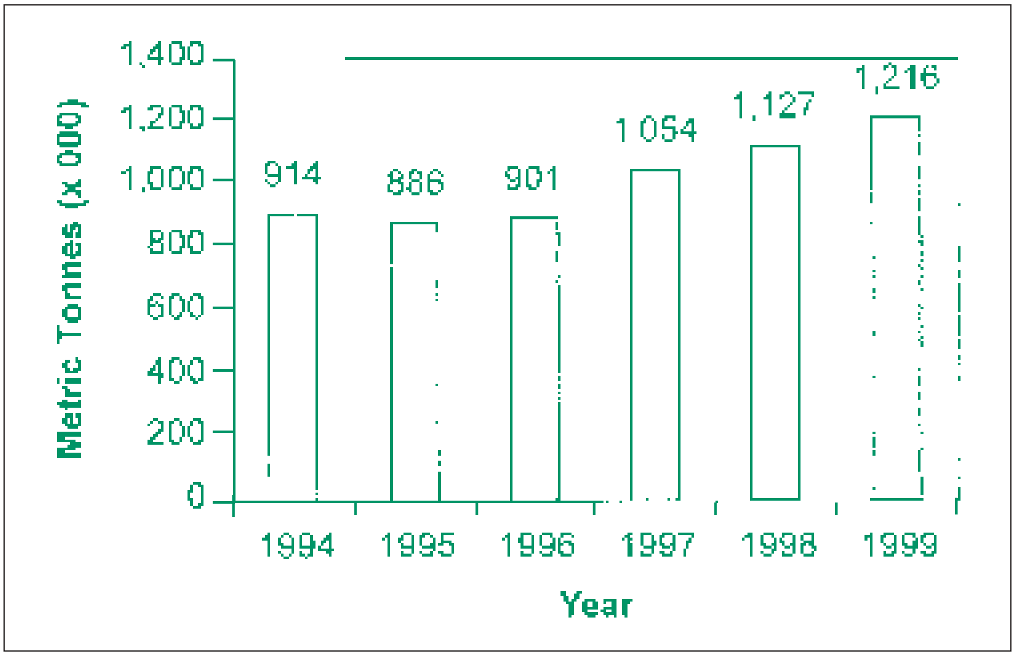


Figure 3: Canadian Peat Shipments, 1994-1999

Sources: Bergeron (1996) (for 1995); Paquette and Gauthier (1999) (for 1996-1998); and Paquette and Gauthier (2000) (for 1999)

A weakly decomposed peat composed mainly of *Sphagnum* mosses is the preferred product for a horticultural peat operation. This peat type is found in regions where the appropriate combinations of climatic and topographic factors have resulted in the development of bogs and fens. Thick layers of weakly decomposed *Sphagnum* peat can accumulate when the right combinations of factors exist. However, even when peat quality is acceptable, several other criteria must be met for a peat deposit to be suitable for production. There are many basic considerations in the selection of a peatland for production of horticultural peat:

- peat quality must meet market requirements.

- the thickness of the high quality peat layer must be sufficient to warrant development. An average depth of two metres is generally considered to be a minimum.

- the areal extent of the peatland should be large enough to warrant development. An area of 50 hectares is usually required, although smaller sites are occasionally developed.

- the peatland must have a good potential for development of enhanced drainage.

- proximity to a transportation infrastructure (highways, truck availability), a low density of tree cover, availability of a labour force, access to electrical power, and similar factors are preferable.

- climatic factors must be suitable for drying of the peat layer during the harvesting period, such as there being appropriate periods of consecutive days without rainfall.

Once a peatland has been selected for development, surveying is carried out and a drainage plan is prepared. The high water holding capacity of the peat layer necessitates the use of closely spaced ditches. A 30 m ditch spacing is common. The surface vegetation is removed following the completion of the ditching. The deposit is then ready for peat production.

Production requires the use of the sun and wind to dry the surface peat layer. An uppermost layer is usually harrowed, breaking capillary flow and enhancing the drying process. Technically this process is called "milling" the peat. After one to three days, the dry peat layer is then collected using large vacuum harvesters or other equipment. The peat is transported to a processing facility for screening and packaging. The main peat production season in Canada is the late May to mid-September period. Production can be severely inhibited by abnormally wet spring or summer weather resulting in significant variation in annual production (as can be seen in Table 2).

Most of the peat that is produced is sold in compressed bales for use in the horticultural and nursery industries and for domestic (household) consumption. Some peat is used for the production of soil mixes by adding nutrients and other materials. Peat is also used for compressed peat pots, in biofiltration technologies and as hydrocarbon sorbants.

Photo: Jean-Marie Boudreau

Peat pots produced by Jiffy Company.

In 1999, peat shipments in Canada were valued at almost $170 million (Paquette and Gauthier 2000). The industry employs the majority of its workers on a seasonal basis and provides the equivalent of 1,400 to 1,600 person-years of direct employment annually. Due to the seasonal nature of employment, the actual number of employees could be tripled. It is also estimated that several thousand additional jobs in Canada and the United States are related to the shipping, trucking and handling of these peat products. In many regions, such as rural Alberta, Quebec or New Brunswick, the peat industry is an important employer.

Photo: Premier Tech

Vacuum harvesting.

On an international basis, an International Peat Society (IPS) survey done in 1999 indicated that Canada ranked second in the global production of horticultural peat, after Germany (Table 3). In 1997, total production of peat for horticultural, fuel and other purposes was about 93.7 million cubic metres, of which 65 percent was designated for fuel uses. Ten percent of total global peat production occurs in North America. Canada currently accounts for about 75 percent of this production with about 7.3 million cubic metres of peat harvested (Hood and Sopo 1999). Canada produces approximately 22 percent of the world's horticultural peat, making it first or

Table 3
PEAT PRODUCTION BY COUNTRY IN 1997

COUNTRY	ENERGY USE (× 000 cubic metres)	HORTICULTURE USE (× 000 cubic metres)
Belarus	7 848	272
Canada	0	7 250
Estonia	1 367	3 497
Finland	30 120	1 626
Germany	0	9 000
Ireland	8 400	1 616
Norway	0	140
Poland	0	680
Russia	8 680	2 540
Sweden	3 381	1 203
Ukraine	1 225	85
United Kingdom	40	2 500
United States	0	2 201
Total	61 061	32 610

Source: Hood and Sopo (1999)

second among nations, depending upon Germany's production in a given year. Of the 13 nations in this survey five including Canada did not use peat as an energy source in 1997.

Canadian production has undergone a steady growth over the past decade. The United States continues to represent 85 to 90 percent of the export market for peat produced in Canada, while Japan consumes up to about 10 percent of Canadian exports with the remainder being sold to a variety of other markets. About 10 percent of the total Canadian production of horticultural peat is sold on the domestic market. Peat produced in Canada is gradually capturing an increased market share in the United States. In 1987, imports from Canada represented 35 percent of consumption. This had risen to 44 percent by 1990 and to 54 percent by 1998 (Cantrell 1990, United States Department of the Interior 1991, Jasinski 1999). Peat produced in the United States is generally classed as reed-sedge or *Hypnum* peat whereas the imports from Canada typically are a weakly decomposed *Sphagnum* peat, which has a higher market value per tonne.

4.0 The Value of Wetlands in Our Environment

Wetlands are defined 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 which are adapted to a wet environment. Wetlands include bogs, fens, marshes, swamps and shallow water" (Warner and Rubec 1997).

Wetlands have played a crucial role in human history. Major stages in the evolution of life itself probably took place in nutrient rich coastal waters. Some of the first coastal Indian communities in North America depended on wetlands for food and materials for building, shelter and clothing.

The dependence is now less direct. However, two thirds of the fish we eat depends on wetlands at some stage in their life cycle. Wetlands perform a wide range of functions that are essential for supporting plant and animal life and maintaining the quality of the environment. In addition they offer numerous opportunities for recreational, cultural and aesthetic as well as commercial activities. People are increasingly aware of the serious consequences of wetland transformation and the potential losses not only for wildlife, but also for the well-being of human communities.

Wetlands exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry, dominant plants, and soil or sediment characteristics. The dynamics of water supply and loss are fundamental to the development, maintenance and functioning of wetlands. Hydrology in turn influences the physical and chemical characteristics of the wetland which have major implications for both flora and fauna as well as for ecosystem dynamics (Maltby 1991).

Photo: Clayton Rubec

Estuarine marsh, Queen Charlotte Islands.

5.0 Environmental Impacts of Peat Harvesting

Development of peatlands for horticultural peat production involves several environmental issues of a general nature as well as more site-specific concerns. General issues include conservation of wetland functions and provision of wildlife habitat. These also involve a site-specific component, but this is better evaluated in a regional context. Other factors such as protection of rare or unusual species and release of stored carbon in relation to global warming should also be evaluated as a site-specific concern within a regional or global framework.

Site-specific issues relating to individual peatland developments include a variety of management considerations. Water quality aspects such as suspended solid discharge and changes in water chemistry, as well as water quantity factors such as runoff rates and flow attenuation also must be considered. Air quality considerations (i.e. dust control), and reclamation/restoration issues also are of a more site-specific nature.

5.1 General Issues

Loss of Wetland Areas: 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 percent of Canadian wetlands (Figure 4). More importantly, wetland loss has become acute in some regions of Canada and is a public concern. A diverse range of development factors has resulted in this loss of wetlands. Figure 4 portrays data showing that agriculture, urbanization, and industrial developments including port and harbour projects, have been the cause of the majority of the wetland loss in Canada since the nation was settled. 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 percent) of wetlands relative to other uses (Rubec 1996).

Unlike most other developments, peat harvesting does not usually result in an irretrievable loss of wetlands. Peat harvesting activities maintain most functions of a wetland while in use, and, can be restored after use is complete as described in the Peat Bog Restoration, Reclamation and Conservation section.

Wetland loss due to urban, industrial and agricultural development has been greatest in the marsh, swamp and shallow water classes with only a relatively low percentage of bogs and fens affected by these factors. This is because the bog and fen wetland classes are less common in areas of Canada

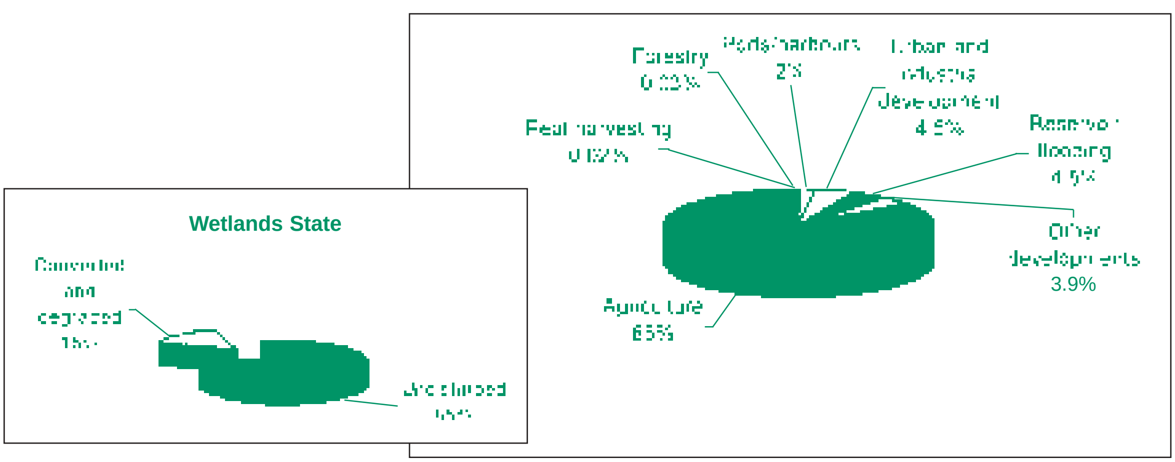


Figure 4: Land Use Impacts on Canadian Wetlands since Settlement
Source: Rubec 1996

where settlement and development have occurred. Horticultural peat developments, however, tend to mainly affect the bog wetland class and have minimal relationships with other wetland classes such as marshes and swamps. As previously discussed, horticultural peat developments are primarily found on bogs within the boreal wetland regions. Due to the geographic location of these regions, many of the conservation issues of greatest concern, i.e. agricultural drainage or infilling, urbanization, and industrial development, have relatively little relationship to the horticultural peat industry. The peat industry, due to its concentration in certain geographic areas of the nation such as the Prairie Provinces, northeastern New Brunswick and southeastern Quebec, is focusing its attention on the effects of peat harvesting in these areas.

The environmental impacts of peatland development are increasingly being documented. Osborne (1982) discusses potential impacts and presents a set of assessment guidelines developed by Environment Canada for peatland developments. A study by Clarke-Whistler *et al*. (1984) provides a summary of the technical literature on the topic. This study was based on the premise that an understanding of the structure and functions of the peatland ecosystem was needed to evaluate the significance of potential environmental impacts. The report provides considerable detail on the physical and biochemical properties of peat. The study concluded that potential aquatic impacts arising from peatland development relate to alteration of the hydrological regime and impairment of water quality, with subsequent direct or indirect effects on aquatic biota. The study proposed a modelling method for the prediction of impacts.

Wetlands and peatlands can be utilized for a variety of purposes, but these typically require the alteration of their natural state. Some utilization involves the removal of the peat layer whereas other uses do not actually remove the peat. Agricultural use of peatlands is one type of non-harvesting use. Developments such as the Holland Marsh and Bradford Marsh in southern Ontario, and similar areas in British Columbia, southern Quebec, Newfoundland, New Brunswick and other regions, are used for vegetable and small fruit production, pastureland and related purposes. Rubec *et al*. (1988) and Rubec and Thibault (1998) have estimated the value of market gardening crops derived from peatlands exceeds $100 million annually in Canada. Canada's wetlands are further estimated to provide in excess of $12 billion in economic benefits to Canadians each year.

Photo: Clayton Rubec

Vegetable production on peatland near Brandon, Manitoba.

Peatland forestry is another non-harvesting use. About 25,000 hectares of Canadian peatlands are now partially drained to facilitate forest operations. However, most of the harvesting of timber from Canada's large expanse of forested peatlands is carried out in winter during frozen ground conditions, minimizing site impacts and facilitating use of appropriate machinery. Peatland drainage is used to enhance tree growth in several European countries, but this is not widely practised in Canada at present. Peatland forestry developments in Alberta, northern Ontario, eastern Quebec and Newfoundland are being used to evaluate peatland drainage as a forest management tool in Canadian conditions.

Another non-harvesting use of wetlands and peatlands is the use of water control structures and other methods to enhance wetlands as waterfowl and wildlife habitat. This is extensively practised in several regions of the country. Ducks Unlimited Canada (2000), for instance, on their internet site notes that they currently manage over 5,000 wetland sites in co-operation with landowners and other government and non-government partners to enhance waterfowl and wetland values. Wetland enhancement and development are widely accepted as key elements in national and international programs to conserve and/or re-establish migratory waterfowl populations. One of the world's most successful examples of sustainable development in action is the North American Waterfowl Management Plan. By the end of 2000, over 750,000 hectares of wetland and upland habitats were secured or enhanced under this international plan and an additional two million hectares had their use modified to support the objectives of the Plan. (Environment Canada 2001).

On a global scale, development of peatland for the purpose of peat harvesting can be divided into two main categories: (i) fuel peat use, and (ii) horticultural peat and other peat moss applications (see Table 3). The use of peat as a fuel source is extensive in several European countries including Finland, Ireland and the Community of Independent States (CIS-former Soviet Union). There was considerable interest in fuel peat development in Canada during the mid-1970s, the early 1980s and the early 1990s, but actual production for this purpose has been minimal. To date, economic factors and the availability of other energy sources has not resulted in peat becoming an attractive energy product in Canada. Production of peat for horticultural and other non-fuel purposes, however, has been undertaken in several regions of Canada.

Effects on Large Wildlife

Loss of wildlife habitat, particularly waterfowl nesting areas, is a wetland issue of national and international concern. The swamp, marsh and shallow 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 min-

Photo: Ducks Unlimited Canada

Wetland enhancement project near Minnedosa, Manitoba.

imum 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.

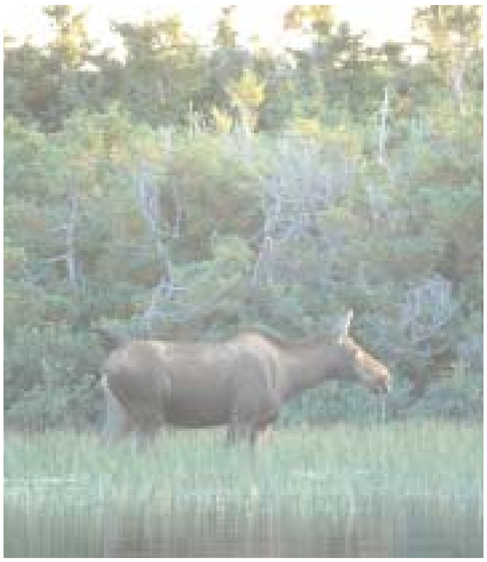


Photo: Kouchibouguac National Park

Moose (Alces alces) standing in a bog in New Brunswick.

Many 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 *(Grus americana),* Trumpeter Swan *(Cygnus buccinator),* Piping Plover *(Charadrius melodus)* and the wood bison *(Bison bison athabascae).* Over 120 species that are wetland dependent are listed as species at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Gautreau-Daigle (1990) evaluated natural peatlands (domed bogs) and peat harvesting areas in close proximity to each other in New Brunswick. Some use of bog ponds by waterfowl was observed but usage seemed to be primarily for staging and migration with only limited brood-rearing. Usage appeared to be directly proportional to the availability of open water. Little difference was noted between the natural and developed areas. Overall, wildlife use of the bogs was found to be low, probably due to the low vegetation productivity of the bog habitat. A related investigation of moose populations (Gautreau-Daigle 1990) indicated some usage occurred but a difference in population or activities was not observed between developed and undeveloped bogs. Black Duck (*Anas rubripes*), a target species for population recovery of the North American Waterfowl Management Plan, often use peat harvesting ponds as habitat in Eastern Canada.

In order to evaluate the potential of bog ecosystems to recover following peat harvesting, bird species diversity, abundance, and assemblages and vegetation were studied over naturally revegetated and undisturbed bog sites in several areas of the province of Quebec (Desrochers *et al.* 1998). Abandoned sites, especially post-vacuum-harvested areas, were less vegetated even after 20 years. Bird species richness and abundance were similar in natural and naturally revegetated block-cut sites and both were higher than in post-vacuum-harvested sites. Ten of the 28 species studied in detail responded to site perturbation, the Palm Warbler *(Drendroica palmarum)* being most closely associated with natural sites. The study suggests that bog habitat restoration should be accompanied by a preservation "safety net" area to counteract the lasting effect of vacuum peat harvesting on bird species assemblages.

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, 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.

Brodeur (1996) investigated the relative abundance of selected groups of arthropods: ants, spiders and ground beetles in Quebec, and found that spiders and ground beetles were more abundant in developed bogs, while diversity in species and numbers of ants were larger in natural bogs. The arthropods chosen for the study have been found to be good indicator species for the characterization of different bog types.

Photo: Bruno Drolet

Green frog (Rana clamitans) in pool on Burnt Church Bog in New Brunswick.

Mazerolle (1999) investigated amphibian populations in bog natural and edge habitats of active harvesting sites in southeastern New Brunswick. Results indicate that species diversity and amphibian abundance are greater in natural sites. Peat harvesting activities were found to influence amphibian communities. However, local vegetation and landscape features such as ponds were also important. Green frogs *(Rana clamitans)* were particularly sensitive to nearby harvesting activities. This ongoing research is expected to evaluate the overall impact on amphibian populations.

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). The ability of unusual flora, such as the pitcher plant, to obtain nutrients from sources other than groundwater enables them to survive in the ombrotrophic and acid conditions that are found on bogs. They occupy an ecological niche that few other species are suited to and can be found on many bog ecosystems. Many of these species, however, are widely distributed throughout Canada's boreal wetland regions. The pitcher plant for example, while the provincial flower for the Province of Newfoundland and Labrador, is found across the entire boreal zone of Canada.

Photo: Clayton Rubec

Pitcher plant (Sarracenia spp.), in Newfoundland.

Rare orchids (*Orchidaceae*) capture the eye in their occurrences in peatlands across the nation. Outside Edmonton, Alberta in the Wagner Bog Natural Area, 16 species of provincially or nationally rare orchids have been identified (Thormin 1982). Much work needs to be done to document the richness and variety of rare and endangered flora in our nation's peatlands. Presently, vegetation surveys, which also document the presence or absence of rare plants, are carried out during the course of environmental assessments, which are a prerequisite to bog development approval.

The vegetation types found on bogs tend to have fairly typical association of individual species which are well adapted to the conditions present on bogs. Some species, such as black spruce (*Picea mariana*), can tolerate a wide range of conditions and also can be found in non-wetland environments. Other species can tolerate a relatively narrow range of conditions and are not typically found outside a bog environment. While the use of a particular peatland can result in the loss of local habitat for certain species that occupy a narrow ecological range, the relative impact that results can also be considered within a regional context rather than just a site-specific basis. Modifications made to the only remaining bog in a particular region must be viewed differently than the use of a bog in a region where the majority of the wetlands are of the bog class and representative and/or unique bog ecosystems have been earmarked or are secured for conservation objectives.

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 (Figure 5). 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.

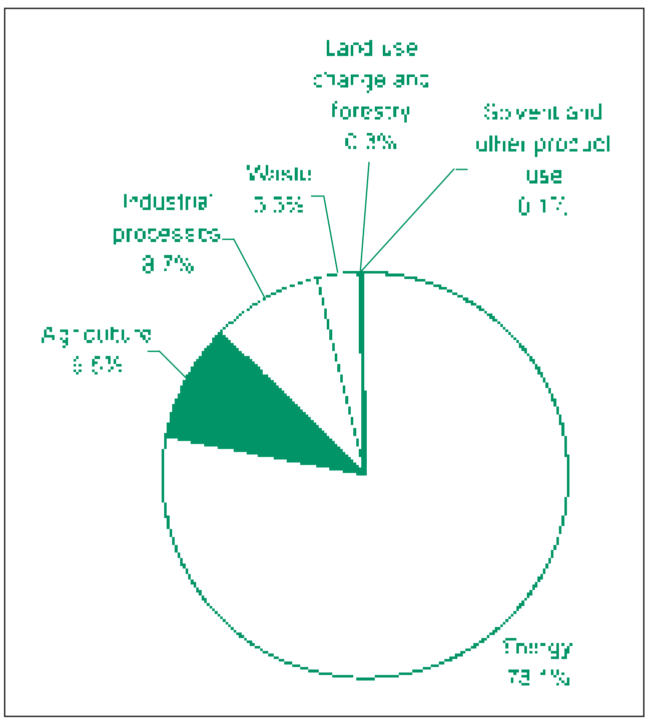


Figure 5: Greenhouse Gases Emissions by Sector in Canada
Source: Neitzert et al. 1999

Gorham (1991) assessed the impact of peatland development on the carbon cycle. The study indicates that, on a global basis, combustion of peat as a fuel releases about three times the quantity of carbon as is released from drained peatlands. Drained peatlands for fuel peat production represent a large percentage of the total area of developed peatlands on a global basis. The study also noted that the release of methane from undrained peatlands has a greater impact than the combined total impact from areas used for peat combustion and other drainage. The current level of development of peatlands in Canada, for horticultural peat production or other applications, does not appear to impact significantly on the National greenhouse gases emissions.

Canada's Greenhouse Gas Inventory (Neitzert *et al.* 1999) estimates at 0.05MT CO_2 eq the amount of greenhouse gases (GHG) contributed by the organic soils in Canada. This would represent less than 0.001% of the total Canadian GHG emission (682 Mt CO_2 eq) in 1997. Because peatland extraction is active on less than 0.02% of organic soils, the GHG contribution related to this industrial activity would be less than 0.0000002% (or 2×10^{-7} %).

However, the picture is much more complex and greenhouse gas emissions remain a very active issue. During the past decade, carbon cycling has received increased attention from the scientific community. Studies are focused on quantifying fluxes in natural and drained peatlands to gain a better understanding of the global impacts on the environment as predicted climate changes occur. Studies by Waddington and Roulet (1996) indicate there is a significant variation in carbon fluxes within each peatland as well as between peatlands. Results of studies by Roulet *et al.* (1993) and Waddington *et al.* (1998) provide an insight on how fluxes might change with variation in water table positions and peat temperature. For example, if future climatic conditions lead to warmer, wetter peatlands, methane emission should increase and carbon dioxide fixation should decrease.

At a joint meeting of the International Peat Society (IPS) and International Mire Conservation Group (IMCG) in November, 1999, the climate change issue, including carbon sinks and sources in peatlands, was recognized as a rapidly emerging theme of significant importance to all organizations involved in peatlands. Taking an active part in this meeting, the CSPMA and the Canadian research community are keeping well informed on developments in this area in order to be proactive with the Canadian peat industry. Under existing terms of the Kyoto Protocol on Climate Change, Canada must reduce its greenhouse gas emissions by 20 percent by the year 2012. To meet this objective, industry will be required to play a significant role in reducing its emissions and the peat industry will not be exempt from this exercise.

The total volume of horticultural peat produced in Canada in 1999 was approximately 1.2 million tonnes and was comprised of about 50 percent water and 50 percent dry peat (i.e. the quantity of bone dry peat was about 608,000 tonnes). In comparison, the mean annual rate of accumulation of dry peat and organic matter in boreal peatlands over the past 1,500 years, after compaction and losses by decomposition are figured in, was about 0.1 kg per square metre per year (Zoltai 1991) or about 1 tonne per hectare. While accumulation rates are lower in many northern peatlands, the total annual accumulation on the 113 million hectares of peatland in Canada still is substantially greater than the annual quantity of peat and peat moss harvested. If an average estimated peat accumulation figure of only 0.5 tonne per hectare per year can be assumed to be reasonable, the total peat volume accumulation in the natural environment in Canada would exceed 70 million tonnes each year. Peat is accumulating nearly 60 times faster than the amount harvested and will continue to be an important carbon sink. Furthermore, peatlands used for forestry applications enhance green growth, thus promoting carbon storage in standing forests, an experience well documented in countries such as Finland. The majority of tree stock in North America matured in greenhouses use "peat plugs" as a rooting soil base. Thus, millions of trees planted each year are dependent on this unique peat product.

5.2 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.


Photo: Jean-Yves Daigle

Settling pond designed by Peat Research and Development Centre.

Effects on Water Quality

The potential effect on downstream aquatic ecosystems of drainage water from developed peatlands is a significant environmental issue that has received considerable research interest. Several studies (Carpenter and Farmer 1981; Monenco Maritimes 1986; Shotyk 1986; Washburn and Gillis 1982; Klove 1997, 1998, 2000) have compiled data on this topic. Much of the work was oriented toward fuel peat developments but is generally applicable to horticultural operations. Both the physical and chemical quality of the water must be considered.

Physical parameters such as suspended solids are a concern for a horticultural peat development. Preparation and operation of a bog results in the removal of surface vegetation.The exposed peat particles can be transported into the drainage system and leave the peatland site. In most provinces, the installation of sedimentation ponds is now mandatory where drainage waters flow into a receiving body of water as means of controlling this situation. Design of the ponds must incorporate sufficient residence time to permit settling of solids during periods of peak rainfall (Gemtec 1993).

Chemical parameters, such as pH and a range of elements, are also a consideration in the operation of a peatland. These factors receive less emphasis because natural drainage waters from bogs tend to already have a low pH. Dilution of drainage waters by receiving bodies minimizes the impact of these factors but short-term anomalous concentrations could occur during the initial development of drainage systems when large quantities of water are being released. Responsible, environmentally sensitive management of such sites in the development phase is required.

The amount of water discharged from a developed peatland relative to the amount discharged from a natural peatland has been a subject of sustained interest. The establishment of an extensive network of drainage ditches enhances the opportunity for precipitation to be transported off a peatland. This would be expected to result in a quicker rate of runoff in mineral soils but does not appear to be the case with peatlands. The reduced water level in the peatland, which results from the introduction of a drainage system, allows greater storage of water following a precipitation event. As a result, runoff peaks tend to be of a lower magnitude from developed peatlands rather than from natural, undisturbed peatlands. The water stored in the peat layer tends to discharge over a period of several days. Studies of peatland hydrology have been conducted in New Brunswick (Gemtec 1991, 1993, 1994) and Newfoundland (Northland Associates 1989).

6.0 Peat Bog Restoration, Reclamation and Conservation

According to industry sources, peat and/or peat moss harvesting has ceased on only about 2,300 hectares of peatland in Canada as yet (CSPMA 1999). However, the concepts of reclamation and restoration have become peatland management priorities in this nation. Reclamation is focused on the after-use of harvested peatland sites. Restoration implies reestablishment of the site as a peatland functioning ecosystem with characteristics as close as possible to a range of conditions found in surrounding natural peatlands.

Reclamation requirements for peatland developments in Canada have not been clearly defined. With few peatlands at the end of the production life, Canadian industry has little direct experience in this field. In countries such as Finland, Ireland and Germany, peatland reclamation has received significantly greater attention. This reflects their long history of peatland use and the more frequent occurrence of peat deposits where the reserves have been exhausted. Reviews of the literature on reclamation are provided by Daigle *et al*. (1988) and Nilsson *et al*. (1990).

In 1993, an International Peat Society symposium on the theme of "Restoration of Temperate Wetlands" was held in the United Kingdom to consider and review current knowledge on the science of wetland restoration (Wheeler *et al.* 1995). In 1998, a second International Peat Society symposium held in Duluth, Minnesota provided a venue for critically examining peatland restoration and reclamation from a technical standpoint (Malterer *et al.* 1998).

Photo: Jean-Yves Daigle

Scientists and peat producers visiting Thorne Moor in England.

There are several options for peatland reclamation. They include the transformation of the site into a new, (but ecologically changed), functioning wetland providing values such as waterfowl habitat; development of an agricultural cropland; or a forestry plantation on-site.

Afforestation of depleted peatlands (also termed cut-over peatlands) is practised in many European countries with several techniques used. Most involve the use of the drainage systems left at the conclusion of peat harvesting. In some cases, a 30 to 50 cm (or deeper) layer of peat is left on the peatland for afforestation purposes. In other cases, deep ploughing is carried out to blend the basal peat with the underlying mineral soil. Fertilizer and lime may also be applied to enhance tree growth or increase the pH. Similar techniques can be used to develop biomass production sites where rapidly growing species such as willow (*Salix* spp.), alder (*Alnus* spp.), or cattail (*Typha* spp.) can be harvested as a fuel source.

Agricultural use of peatlands can also be a viable option for depleted peatlands. Agricultural development on the organic soils characteristic of peatlands is common in several parts of Canada, e.g. southern Ontario, southern Quebec and the Fraser Delta of southwestern British Columbia. Site preparation techniques, equipment and fertilization requirements, for example, have been refined through experience (Parent *et al.* 1991, Lévesque *et al.* 1988, Parent 2000). A variety of crops is produced including carrots, cabbage and onions. The technology used at these sites is likely to be readily transferable for horticultural peatland reclamation. The existing drainage system from peat harvesting would facilitate agricultural use. As with most agricultural endeavours, climate and growing season are major factors in the overall viability of crop production.

Photo: Gerry Hood

Cranberries growing on reclaimed peat bog near Lac St. Jean, Quebec.

Establishment of waterfowl habitat is also a peatland reclamation option in certain circumstances (Clarke-Whistler and Rowsell 1982). When the configuration of the base of the peatland is suitable, the drainage system can be blocked to create ponds or lakes. Revegetation of depleted peatlands with naturally occurring wetland vegetation is a viable peatland restoration option and has become the favoured approach since the early 1990s. A study by Nilsson *et al*. (1990) presents several case histories from eastern Canada and the United States for harvested peatlands that were abandoned and allowed to naturally revegetate. The rate of revegetation was found to be as short as a few years on minerotrophic sites. For large expanses of ombrotrophic bogs, vegetation cover required in the range of 15 to 20 years to become fully re-established. Studies by Jonsson-Ninniss *et al.* (1991) and Lavoie *et al.* (1996) provide more data on the subject from bogs in Ontario and Quebec.

Several factors influence the nature and rate of revegetation. The hydrologic regime at the site, nutrient status (ombrotrophic versus minerotrophic conditions), and proximity to other vegetation for recolonization all have significant influence. The hydrologic regime is largely a function of the status of the peatland's drainage system. If the drainage system is functional, there is a reduced water level relative to natural conditions. The type of vegetation, as well as the rate of revegetation, reflects this situation. Species that prefer "wet" conditions are infrequent whereas species more tolerant of "dry" conditions tend to recolonize. The method of peat harvesting is also an important factor. Most abandoned sites have until now been block-cut, leaving high ridges interspersed with low moist areas. The vacuum method of peat harvesting, in wide use since the early 1980s, leaves large expanses of disturbed terrain that present a much greater challenge to restoration. The drainage networks on peat harvesting sites are designed to control the water level in the peatland. This network can also be used to influence the hydrologic regime during restoration of the peatland. For example, the drainage system can be blocked every 50 metres to create open water reservoirs that will help keep the peat substrate moist during the dry periods of summer (Larose *et al.* 1997).

The nutrient status of a peatland is also a controlling factor on the rate of revegetation and on the type of species that recolonize a site. If a site is ombrotrophic (rain-fed, nutrient-poor), plant species tolerant of these conditions are the main recolonizing species. Overall species diversity tends to be low, as is the case in a natural ombrotrophic peatland. On minerotrophic sites, herbaceous species tend to represent the initial phase of succession, followed by shrub and tree-dominated communities. Species diversity is higher and the vegetation tends to be more robust than that found under ombrotrophic conditions. Mineral seepage also controls the rate of revegetation. Fen sites typically revegetate in three to seven years. Ombrotrophic sites can take between one and two decades to revegetate in unmanaged locations. However, liming to reduce soil acidity accelerates revegetation. Nitrogen, phosphorous and potassium (NPK) amendments on ombrotrophic sites can result in revegetation of naturally occurring species in less than five years (Nilsson *et al*. 1990).

The availability of species for recolonization is also a factor in the revegetation process. For some species, wind borne seeds enhance the recolonization process. Other species propagate by less mobile methods (Campbell *et al.* 2000). Transplants of rhizomes (root structures) and plant fragments could be considered as a method of recolonization of some species. Transplants of clumps of shrubs and herbs also are a potential method of recolonization. In Germany, the retention of strips of natural vegetation in the design of new peatland developments has been suggested as a means to enhance the availability of plants for propagation.

6.1 Restoration Field Work

In February 1992, the CSPMA, the Peat Research and Development Centre (PRDC) in New Brunswick and government agencies hosted a national workshop on peatland reclamation methods and guidelines. Recommendations for fostering research and appropriate technologies in support of the implementation of peatland reclamation and restoration were developed.

This national workshop led to a three-year research project on peatland restoration, launched under the direction of Dr. Line Rochefort of the Université Laval, which later became the Peatland Ecology Research Group (PERG 2000). This project looks at restoration from a Canadian standpoint, because information from research in Europe, while useful in a general sense, was not regarded as being particularly pertinent to bogs in the North American context. It was recognized that the basic knowledge and techniques required for restoration need to be developed in accordance with conditions in Canada in partnership with the peat industry. According to the objectives of the project, research has been conducted and is ongoing in several of the following areas (Rochefort *et al.* 1996) at eight peat producers' operations.

1. *Comparison of the hydrology and biogeochemical cycles of natural and cut-over bog substrates.*

Low recolonization success on base post-vacuum-harvested sites near Lac St.-Jean, Quebec indicate that physical and chemical conditions have been modified. Soil microbiological, physical and chemical parameters as well as hydrological conditions were studied at natural and cut-over sites. A rewetting model has shown that pools contribute to stabilize the rise of the water table as well as favour water storage that in turn favours revegetation of the site.

Photo: Ichiro Tagawa

Dr. Line Rochefort viewing the re-growth of Sphagnum moss on Bois-des-Bel peatland in Quebec.

Peat harvesting activities were found to significantly reduce the microbial flora; however, results from field restoration trials suggest rapid re-establishment of microorganisms would likely occur following restoration.

2. *Determination of factors that have an incidence on the establishment of Sphagnum mosses and the relative importance of these factors.*

Natural and naturally revegetated sites were studied to describe the biological and physico-chemical conditions essential to peat-accumulating *Sphagnum* species. Detailed vegetation surveys were carried out at Cacouna-Station, Quebec where post-block-cut and post-vacuum-harvested sites have successfully revegetated. Furthermore, paleoecological studies were carried out at well regenerated sites. Results confirm changes in the field conditions following restoration of cut-over sites. The successive vegetational changes indicate conditions are approaching those of natural sites, favouring the development of a vegetation cover comparable to that of a natural site. *Sphagnum* species have rapidly recolonized post-block-cut trenches and in many cases have accumulated a several centimetre layer of peat forming vegetation.

3. *Evaluation of bird and arthropod populations on both natural and developed bogs and identification of indicator species (bio-indicators) to evaluate evolution of regenerated sites.*

The identification of bio-indicator species present on natural peatlands and at regenerated sites may be used to evaluate the success of the restoration. Bird population surveys were conducted at more than 200 peatland sites and adjacent open areas in different parts of the province of Quebec. Results have confirmed there is no difference in species richness and total bird populations at natural and well-regenerated post-block-cut sites. A few species were not present at post-vacuum-harvested sites. Peat harvesting activities were found to have little negative effect on bird usage of neighbouring natural sites, except possibly on reproduction. Spiders and ground beetles were found to be more abundant on peat harvested sites, because of the relatively drier conditions, while abundance and species richness of ants were greater on natural sites. Changes in arthropod populations are a good indicator of site restoration progress.

Photo: François Quinty

Equipment used to spread Sphagnum spores to accelerate restoration of a harvested peatland.

4. *Development of Sphagnum and vascular plant reintroduction techniques. Sphagnum mosses constitute the most important element of bog vegetation and are essential to the return of functional peat accumulating systems. These techniques include evaluating the regeneration potential of Sphagnum, water management, fertilization, topography modification, as well as the use of mulches and wind breaks.*

Sphagnum fragments spread on post-vacuum-harvested sites have a high re-establishment


Photo: François Quinty

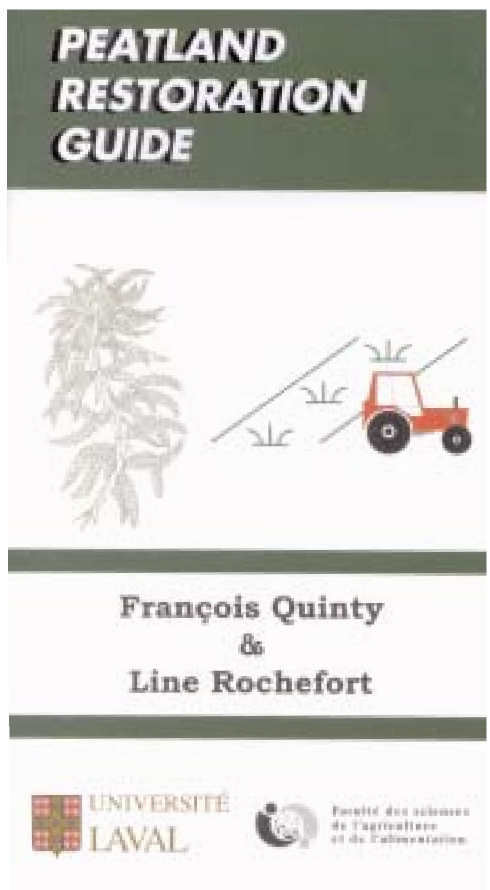
Straw blower used to spread as mulch over Sphagnum spores; one of the steps in restoring a harvested peatland.

The *Peatland Restoration Guide* (Quinty and Rochefort 1997), published by the CSPMA, evolved from this research effort. It promotes the restoration of cut-over peatland to an environment similar to that which existed before harvesting. The document, in practical pocket-size format, spells out the advantages of planning ahead, such that restoration can be integrated with bog development. It explains in user-friendly terms the steps involved in reintroducing *Sphagnum* mosses on abandoned sections of peatland.

success rate. However, the collection of source material from natural sites, as well as their storage conditions, have to be carefully synchronized with field spreading activities. Results have indicated little difference in *Sphagnum* regeneration success rates when field work is carried out in the fall versus in the spring. The latter has the advantage of offering better floatability for heavy equipment, since partly frozen field conditions are present. Collection of the top layer of vegetation fragments is also facilitated and the material can be stored for several months without losing its ability to regenerate.

Raising the water table to the bog surface level seems to induce the most favourable hydrological conditions for the re-establishment of most *Sphagnum* species. Diaspores are very much affected by the conditions at the air-soil level. A straw mulch was found to keep high moisture conditions, decrease air temperature at the air-soil interface and reduce light intensity, which all contribute to higher recolonization success. Although donor sites are negatively affected at collection time, studies have shown that these sites regenerate within two to five years, causing no loss of natural sites and are ready to be used again as a donor site.

5. Preparation of a practical restoration guide.



Peatland Restoration Guide.

The following is a summary of the recommendations found in the *Guide* and improvements made since:

- As a pre-development strategy, a section of peatland should be preserved in a natural state in order to ensure a supply of plants for future restoration work.
- The conservation of a peat layer at least 50 cm thick facilitates the regeneration process.
- One of the most important steps in the actual restoration process is to restore water levels as close to the surface as possible by blocking drainage ditches every 50 metres. This is often done as the last step.
- Crowned fields should be reshaped to form a depression in the centre or be flattened in combination of creating bunds or shallow basins.
- Advice is offered on the choice and appropriate size of plant collection sites as well as on the actual collection and spreading of the plants.
- Mulch should be applied to create conditions favourable to the survival and growth of the applied plant fragments.
- A light phosphorous amendment improves the stability of the peat substrate through the stimulation of vascular plant growth.
- Follow-up of restoration work should be done on a yearly basis, preferably by the same observer, by monitoring plant cover on established observation stations.
- Regional variations, for example the frequent occurrence of strong winds or the absence of access to a plant source, require adaptation of the above restoration techniques.
- Research to improve the efficiency of existing methods and to measure the success of restoration efforts must continue.

6.2 Bois-des-Bel Restoration Project

Based on the positive results gained from their research efforts, in 1999 PERG initiated a large-scale restoration project on a section of the Bois-des-Bel peatland, near Rivière-du-Loup (Quebec). Research in site restoration has been successful on small plots at numerous cut-over bog areas in Canada. However, the hypothesis and techniques need to be tested at an industrial scale. The 11.5-hectare site, which supported peat harvesting activities until 1980, is within a relatively large natural peatland which will allow comparison with the variety of conditions found in the natural peatland. Access to the site has been guaranteed for 15 years. Field work was planned and implemented during workshops held with the active participation of Canadian peat producers.

Photo: Gerry Hood

Monitoring equipment used to measure carbon flux on the Bois-des-Bel peatland in Quebec. (Equipment of Dr. Mike Waddington and PhD student Rich Petrone of McMaster University.)

Principal objectives for this large-scale restoration project include validation of restoration techniques, evaluation of hydrological processes, reconstitution of pools, determination of biological productivity and establishment of the nutritional elements cycle, identification of the point and conditions at which the site once again becomes a carbon sink, and finally, monitoring of re-establishment of site biodiversity.

In the fall of 1999, site preparation including blocking of ditches, removal of shrubs, levelling of fields, creation of bunds across slope of drainage and creation of pools was carried out. *Sphagnum* diaspores, collected from nearby sites, were spread on the entire prepared area followed by an application of straw mulch and phosphorous fertilizers. A step-by-step video of the process and instructions produced by PERG, can be purchased from the Canadian Sphagnum Peat Moss Association (www.peatmoss.com) or PERG.

6.3 Other Research

Other research initiatives include prototype restoration plans for two peat vacuum-harvested sites in New Brunswick, one in an early phase of development, the other partly at the post-vacuum-harvested state (Famous *et al*. 1995); and reintroduction of black spruce on shallow peat soils to act as windbreak.

6.4 Application by the Canadian Peat Industry

By the spring of 2000, all members of the CSPMA had committed to the principle of restoration and nine of the 15 members of the CSPMA had initiated restoration projects based on the procedures outlined in the *Peatland Restoration Guide*. Many of the companies' employees have attended hands-on restoration workshops conducted by PERG at the Bois-des-Bel peatland in November 1999 and November 2000.

6.5 Status of Peatland Conservation in Canada

The vast peatland resource in Canada is not extensively used. Only about 17,000 hectares (0.02 percent) of the over 113 million hectares (Table 1) of peatland in Canada are used for horticultural peat or peat moss applications. Almost no peatland area in Canada has to date been utilized for operational peat fuel applications. An additional 25,000 hectares have been drained for forestry production and a further several million hectares is used for forest harvesting (mainly in winter for pulpwood). In comparison, it has been estimated that, since the era when Canada was first settled, almost 20 million hectares of wetlands have been converted to other land uses through agricultural development, urbanization and a variety of other factors (see Figure 4) (Rubec 1996).

An inventory of protected peatlands and wetlands in Canada is certainly required. To date, there has not been a comprehensive or systematic national compilation of peatlands that are currently "protected" under some form of federal, provincial or municipal legislation or through private sector land stewardship initiatives. Nationally, it is estimated that about 10 percent of Canada's wetlands are protected from development and much of this area consists of peatlands (Rubec 1996). Tarnocai *et al.* (1995, 2000) have developed an integrated database on peatland distribution. Regional or provincial summaries or wetland and peatland conservation plans are ongoing.

However, in some areas, a reasonable balance between development and protection does exist. In eastern New Brunswick, for example, many raised bogs are used for horticultural peat production. About 3,000 hectares of similar peatlands are within Kouchibouguac National Park. This "known" level of protected peatlands of the same type can be compared to the approximately 4,000 hectares currently developed for peat production in New Brunswick. About 11,000 hectares of peatland in total are owned or leased by the peat harvesting companies in New Brunswick. An additional wetland area in excess of 5,000 hectares has been secured in New Brunswick for enhancement as waterfowl habitat by Ducks Unlimited Canada. The Province has also conducted studies to identify representative peatlands from each of the seven peatland zones in New Brunswick. These sites are proposed for protection as ecological reserves.

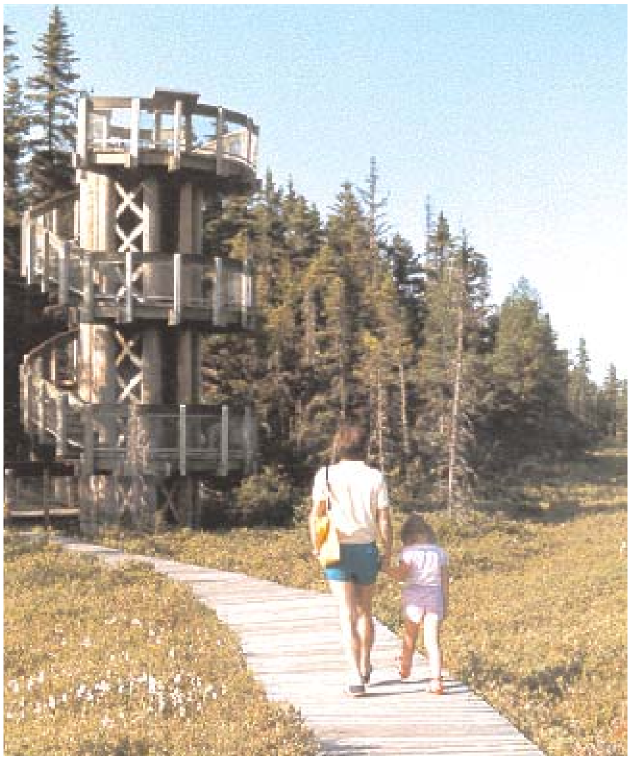


Photo: Hélène Gautreau-Daigle

Boardwalk and observation tower on Kelly's Bog, Kouchibouguac National Park, New Brunswick.

In 1991, the Government of Canada adopted *The Federal Policy on Wetland Conservation* (Government of Canada 1991). The objective of this Policy, the first of its kind by any nation in the world, is "to promote the conservation of Canada's wetlands to sustain their ecological and socio-economic functions, now and in the future." The Policy outlines a series of "guiding principles." These include recognition that on-going development and research is fundamental to the achievement of wetland conservation.

One of the seven strategies for implementing this federal policy is the development of a national network of "secured wetlands of significance to Canadians" that represents the full range of wetland functions and forms. The attainment of this goal will require the cooperation of provincial and municipal governments, conservation groups and industry. As peatlands will be a vital component of such a network, the peat industry in Canada is a significant stakeholder in this concept. Implementation of this strategy will involve the adoption of systematic national and regional criteria for identification and management of significant wetlands and peatlands. The federal policy also identifies the key roles industry and governments must take to promote both research and sustainable wise use of wetland resources in Canada.

In the 1990s, several Canadian peatland systems have been recognized as Wetlands of International Importance under the Ramsar Convention. Three new Ramsar sites designated between 1993 and 1998 are peatlands. These are the Mer Bleue (Ontario), the Tabusintac Estuary and Lagoon (New Brunswick), which includes deep peat deposits and Minesing Swamp (Ontario) (Rubec and Thibault 1998).

The peat industry in Canada is encouraging the development of peatlands in accordance with environmentally sound practices. Gerry Hood, President of the CSPMA, has noted that "Canadian peat producers have a new role to play, not only as producers, but as people responsible to the environment." This view has not changed since first stated in 1991. The CSPMA has updated its peatland preservation and reclamation policy, which encourages its member companies to approach bog development with a restoration perspective and to cooperate with government and conservation bodies towards preservation of appropriate bogs (CSPMA 1999).

7.0 Case Studies

Environmental regulations have undergone substantial change in the past decades. Environmental impact assessments are now commonplace for peatland developments in many provinces. For example, the provinces of New Brunswick and Nova Scotia require that all undertakings that involve more than two hectares of wetland must be registered for review to determine whether a full environmental assessment is required. Several cases in Canada have arisen where developments for horticultural peat production have undergone review. Canadians have also had the fortune to learn from European experience. Examples from Canadian provinces and Europe are discussed below.

7.1 Miscouche Bog, Prince Edward Island

In 1990-1991, a proposal to develop the Miscouche Bog on western Prince Edward Island was reviewed under that province's environmental assessment legislation. This site, the single largest bog in the province, is owned by the Acadian Land Purchase Trust. In 1990, the Trust proposed economic development of the peat on this site. A provincial Environment Assessment Panel was established and public review was undertaken. The proposal entailed provision of 20 permanent and seasonal jobs and a $1.4 million development with an expected 20-year production period of 100,000 standard peat bales per year. The site was identified by the International Biological Program in the 1970s as a site of international biological significance and is known for significant occurrence of numerous unusual plants considered rare in Prince Edward Island. Hence, the Island Nature Trust, a non-government conservation foundation, proposed full protection of the area.

In February 1991, the Minister of Environment for the province had received the Panel's recommendations and ruled that the development proceed with the following conditions:

(i) allow time for the scientific community to transplant endangered plants from the Miscouche site to other secured areas.

(ii) the province compensate the scientific community by acquisition of three other important but smaller bogs on the Island: Brae Harbour Bog, St. Peter's Bog and Wood Island Bog; these sites be turned over to the Island Nature Trust for long-term protection and management.

(iii) the proponent provide for and be committed to site restoration/reclamation after peat harvesting to either a natural state or one useable for an appropriate agricultural purpose.

Subsequently, in July 1991, the Island Nature Trust undertook a plant rescue mission at this bog. Some 50 students during a three-day period moved over 2,000 rare or unusual plants amid considerable media coverage. The province has since proceeded with acquisition of the three designated bogs for protection and the peat development project is underway.

7.2 Barrington Bog, Nova Scotia

In Nova Scotia, a proposal to develop 32 hectares of a 100-hectare peatland at Barrington was reviewed under the provincial Environmental Impact Registration Process. Peat harvesting for fuel purposes was the intended utilization. A study found that the thread leafed sundew (*Drosera filiformis*) grows on the peatland (and three other sites in the area) and that the proposed development would endanger this plant species (The Chronicle-Herald 1991). As a result, the Plant Subcommittee of the Committee on the Status of Endangered Wildlife in Canada has added the plant to its endangered species list. The Nova Scotia occurrences are the most northerly reported occurrences of the plant. The plant is also reported to occur in several New England States and has been identified as requiring "protection" in some states. However, the species is designated "common" in some other United States Gulf Coast states. The Nova Scotia Department of Environment determined a full environmental impact study would be necessary and recommended that the proponent evaluate an alternate location. The proponent subsequently decided to abandon the project.

7.3 Bull Pasture Bog, New Brunswick

In New Brunswick, a proposal for a horticultural peat development on Bull Pasture Bog near Fredericton was reviewed under provincial environmental impact legislation and it was determined that an environmental impact assessment was required. Terms of reference were prepared by the New Brunswick Department of Environment and made available for public review. Following much negative public pressure, the proponent decided not to pursue the project.

7.4 Rural Development Plan for Lamèque and Miscou Islands, New Brunswick

Located at the northeastern extremity of New Brunswick, close to one-third of the territory of Lamèque and Miscou Islands is occupied by peat bogs and salt marshes, which are dispersed throughout the territory. The population wished to regulate present and future development through a rural plan to minimize the impact on the environment, promote harmonious development and preserve the rural character of the community.

Following public hearings at which briefs were presented in 1997, the Government of New Brunswick adopted the Rural Plan Regulation for the unincorporated areas of Lamèque and Miscou Islands – *The Community Planning Act*. This Act designates as environmental protection areas all salt marshes and preserves as many wetlands as possible. All peat harvesting operations on Lamèque Island can continue their activities in compliance with provincial regulations (*Quarriable Substances Act* and *Clean Environment Act*). Under the new Act, peat-harvesting activities must have minimal negative environmental effects by limiting particulate emissions and by maintaining a 30 metre buffer zone from high water line and salt marshes. Rehabilitation of sites must be encouraged and all new applications for development must be submitted to public hearings. Furthermore, the peat producers of the area committed to support a recommendation to prevent the harvesting of peat from the bogs on Miscou Island.

The Miscou Island peatland covers approximately 26 percent of the island and is the stopover site for numerous migratory birds. To enable the public to view the beauty of the bog and to watch the thousands of birds on their semi-annual trek, the

Photo: Gerry Hood

Miscou Island conservation site.

Miscou Island Conservation Board has built elevated platforms and a walkway that curves through a section of the site, passing by pools and through areas of herbaceous plants and bog flowers. The CSPMA is helping maintain the site through financial support.

7.5 Guidelines for Peat Mining in New Brunswick

The expansion of peat harvesting activities in the province has led to a greater level of awareness of the effects of this activity on the environment. In 1998, *Guidelines for Peat Mining Operations in New Brunswick* (Thibault 1998) was developed to help plan the commercial development of peatlands to minimize adverse effects on the environment. The principal areas of concern are: the impact of drainage water on receiving water bodies; the impact of habitat change on flora and fauna; the nuisance effect of wind-blown peat particles on surrounding communities; and the issue of post-harvesting restoration or reclamation. The document also serves as a tool for government agencies that review, evaluate or approve development proposals.

7.6 Wetland Policy in Alberta

The draft *Recommended Wetland Policy for Alberta* was created in 1994 by merging the former Wetland Management in the Settled Area of Alberta with a draft policy for managing Alberta's peatlands and non settled wetlands. The objectives with respect to peatlands include the formal designation of individual peatlands for preservation, the allowance of activities on peatlands and development of peat resources, and the mitigation of development on the environment. (Lynch-Stewart *et al*. 1999).

7.7 Europe

In Britain, there has been an ongoing public debate over the continuing use of peatlands. Conservation groups and peat producers have engaged in a controversial media campaign to present their respective points of view. A national boycott of peat products has been promoted by a coalition of British environmental groups as one method for attracting public interest in this debate.

In Ireland, the situation is less controversial but conservation requirements are receiving increased attention. The need to achieve a balance between development and conservation has been recognized by industry (Welsby 1990). Much of Ireland's peat production for both fuel and horticultural purposes is administered by the National Peat Board (Bord Na Mona) and there is a statutory obligation to manage the peatlands in the best interest of the country. Non-government environmental organizations (such as the Irish Peatland Conservation Council), Bord Na Mona, and the Irish Wildlife Service are working in a positive and co-operative manner to implement a national peatland conservation program with defined targets and firm funding proposals.

In countries such as Germany and the Netherlands, there are few peatlands that have not been altered. In Scandinavia certain peatland types are becoming scarce but mechanisms for protection are in place. Finland, Sweden and Norway all have peatland ecological reserve or park programs established to ensure completion of protected peatland networks.

8.0 Summary

Conversion of Canada's vast wetland and peatland resources due to urbanization, industrial development and agricultural practices has been substantial, exceeding 20 million hectares since the early 1800s. The horticultural peat industry in this context has impacted only a minor area – about 17,000 hectares (less than 0.02 percent) of all the peatland in Canada. Peatlands developed for horticultural purposes are primarily situated in the boreal wetland regions and consist mainly of the bog wetland class. Boreal peatlands will likely be affected by forestry, hydroelectric development and other programs to a much more significant extent than by any amount of horticultural peatland development in the future (Rubec 1996). Because bogs are the main source of the *Sphagnum* peat preferred by the peat industry, peat harvesting has had relatively little impact on the swamp, marsh and shallow water wetland classes as these are less common wetland classes in the boreal wetland regions.

In the last decade there has been a significant shift in appreciation of the value of Canada's wetland resources. Wetland conservation has become an issue of public policy, which has resulted in the initiation of new wetland programs. Several environmental issues related to peatland development have been identified. They include the need for conservation of flora, fauna and other ecological values or functions. The potential for release of carbon gases due to Canadian peat harvesting is considered to be insignificant in relation to other uses of carbon sources such as the combustion of fossil fuel (i.e. coal, oil and natural gas), and is unlikely to influence global warming at the present or projected levels of peatland development in Canada. On a site-specific basis, the influence and mitigation of the effects of drainage of peatlands for peat production on water quality and flow regime are being addressed in Canada through existing regulatory procedures and research.
Site development guidelines to minimize environmental effects have been developed and implemented by the peat industry. Reclamation and restoration of peatlands after utilization is being addressed by the industry in consultation with government and environmental groups. The CSPMA, through its newly revised *Peatland Preservation and Reclamation Policy* (CSPMA 1999) urges its members to restore harvested bogs to functional peatlands once harvesting is ceased. Research on restoration ecology and techniques spearheaded by the CSPMA has resulted in the publication of the *Peatland Restoration Guide* (Quinty and Rochefort 1997) which is a substantial aid to producers in their restoration efforts. Research results show that post-harvested peatland can be restored in periods as short as three to six years. However, the time frame involved in the return to a functional peat accumulating system is a function of many factors and will only be known as the results of successful restoration efforts become available.

Canada has extensive areas of peatlands in a natural state and has the opportunity to select representative peatlands for conservation securement. This opportunity has been lost in most European countries where peat production has been practised for long periods. Although major peatland systems have been protected in Canada including three sites listed under the Ramsar Convention between 1993 and 1998, development pressures are high in some regions and for certain wetland types. Co-operative efforts on a long-term basis between various levels of government, conservation groups and the peat industry will be required to attain a national network of secured wetlands. Such a network must represent the full range of wetland functions and types including the many forms of peatlands across the country.

Current initiatives by the horticultural peat industry in Canada indicate recognition by peat production companies of their responsibilities and roles. The willingness of the industry to be an active partner in wetland conservation and restoration with governments and private sector groups provides a positive atmosphere for the attainment of sustainable wise use of Canada's peatland resources.

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CSPMA Preservation and Reclamation Policy

1. Statement

The members of the Canadian Sphagnum Peat Moss Association will assist and co-operate, wherever possible, with all recognized conservation bodies that are prepared to give constructive help towards complying with this policy. Opportunities will be taken to enhance the public's awareness and enjoyment of our wetland and peatland areas.

2. Aims and Objectives

The CSPMA encourages its members to:

2.1 Reduce the impact of their operations on the environment and strive for maximum land restoration to the continuing benefit of the community.

2.2 Undertake studies, prior to opening new bogs, to ascertain the flora and fauna of virgin peatlands.

2.3 Identify areas of greatest environmental interest and, where possible, leave these undisturbed to act as a refugia when harvesting ceases.

2.4 Cooperate with recognized conservation bodies in the management of refugia or other areas not required for peat production.

2.5 Work with provincial governments to designate appropriate peat bogs as reserve or parkland for the purposes of study and recreation.

3. Peat Production

The CSPMA encourages its members to:

3.1 Implement a practice of bog management in a way that will keep production acreage to a minimum. Operators should avoid preparing peat bogs for harvesting too far in advance of needs, and initiate reclamation procedures as soon as practical after harvesting stops.

3.2 Leave a buffer zone of original vegetation when bogs are cleared for harvesting.

3.3 When opening new acreage for harvesting, use the top spit material from the bog to spread on other bogs that are ready for restoration.

3.4 Leave a layer of peat beneath the harvest level when work ceases, relevant to the peat-type and area, in order to facilitate plant re-growth.

3.5 Plan bog drainage systems being mindful that the most preferred reclamation procedures require damming of ditches to restore the water table.

4. After-use

The CSPMA urges its members to put in place appropriate after-use, such as:

4.1 Apply best-efforts to return a cut-over bog to a functioning peatland using recommended restoration techniques. (See *Peatland Restoration Guide*).

4.2 Where it is impractical or impossible to fulfill point 4.1, develop a plan that would include farming the land, planting trees for reforestation or returning it to a functioning wetland and/or wildlife habitat.

Revised and approved in November, 1999.