Threats and protection for peatlands in Eastern Canada

Monique POULIN
Line ROCHEFORT

Groupe de recherche en écologie des tourbières et Centre d'études nordiques

Stéphanie PELLERIN

Institut de recherche en biologie végétale, Jardin botanique de Montréal

Jacques THIBAULT

Ministère des Ressources naturelles du Nouveau-Brunswick

ABSTRACT

Peatlands (or mires) are acidic freshwater wetlands that cover 4 million km² (*i.e.*, 3-4 %) of the planet's surface, according to recent estimates. Although pristine peatlands are becoming rare in many European countries, most of the peatlands in Canada remain untouched. A recent estimate of the total area of peatlands in Canada is approximately 170 million ha. Precise statistics on peatland destruction and disturbance are difficult to obtain for the entire country, due to its large size. Here, we present detailed information on two provinces of eastern Canada : Québec and New-Brunswick. Approximately 120 000 ha of peatland in Québec have been flooded as a result of construction of hydroelectric dams, the main factor for peat-land lost in that province. It represents 1 % of the total peat-land area. For New-Brunswick, peat extraction is the main threat for peat-lands, with 6 800 ha of peat-land mined for horticultural peat which represents 5 % of the total peat-land resources of that province. Nevertheless, peat-lands in certain regions are strongly affected by human activities and conservation actions must be undertaken to assure equal representation of peatlands across the country. Manitoba, Nova Scotia, Prince Edward Island and New-Brunswick are the four provinces that have achieved the highest conservation rates with 25, 15, 12,5 and 11 % of their

Approximately 3 to 4 % of the earth's surface is covered by peatlands or mires. Global estimations are highly variable, partly due to differences in the definition of a peatland from one country to another (Lappalainen, 1996). In Ireland, for example, an ecosystem must contain a 45-cm thick layer of peat moss before being considered a peatland while in Germany the minimum thickness is approximately 30 cm (Shier, 1996 ; Steffens, 1996). In Canada, the defined thickness varies between 30 cm (Buteau, 1988 ; Gorham 1990) and 40 cm (Tarnocai, 1980). The total global surface area of peatlands is also unknown due to incomplete inventories in several countries. In addition, similar vegetation grows on sites with well-developed peat as on sites lacking an accumulation of peat moss which makes remote assessment difficult.

Recent estimations of the surface area of peatlands in Canada stand at 170 million ha (Gorham, 1990), *i.e.*, the majority of wetlands in the country. Over 90 % of the original peatlands in Canada remain more or less untouched while peatlands account for 17 % of the total size of the country. Estimates of the surface area of peatlands for the province of Québec are inexact and vary between 7 and 9 % of the land area, with the most recent assessment set at 11 826 300 ha (Buteau, *op. cit.* ; Keys, 1992). For New-Brunswick, the estimates are much more precise and the total peatland area has been estimated at 140 000 ha (Thibault, 2002).

In this paper, we first give a general overview of the main threats affecting peatlands in Canada and describe the key policies and laws available for promoting peatland protection. We focus on New-Brunswick and Québec (fig. 1), two provinces that account for about 65% of the peatlands in Eastern Canada and for which we have the most accurate data. We then present the history of peatland conservation in these two provinces as two case studies and review protected areas in detail. Finally, we summarize the research conducted on peatland conservation in Eastern Canada by the Peatland Ecology Research Group (PERG) at Université Laval.

MAIN DISTURBANCE FACTORS FOR PEATLANDS IN EASTERN CANADA

Loss of natural peatlands in Eastern Canada has been caused by several industries, such as construction of hydroelectric dams, reclamation for agriculture, drainage for forestry and peat extraction (for horticultural or therapeutic uses). Construction of hydroelectric dams is the main cause of peatland loss in the country and approximately 900 000 ha of peatlands have been flooded, mostly in Québec, Manitoba and Alberta (Rubec, 1991). Flooding caused by dams is also the main disturbance in the province of Québec, where 120 000 ha of peatland have been affected by flooding (table 1). In contrast, hydroelectric projects are small and infrequent in New-Brunswick and do not represent a major threat for peatlands in that province affecting only 150 ha of peatland.

Peatlands are also used for cultivation of fresh fruits and vegetables. Agriculture is the principal cause of wetland destruction in Canada, a loss of 85 % in terms of surface area or 17 million ha (Rubec, *ibid.*). However, it is notably marshes and swamps that are used for this purpose (Keys, *op. cit.*). For the province of Québec, estimates show that 11 000 ha of peatlands have been used for agriculture (table 1). However, data on extent of agriculture on organic soils are very difficult to obtain and likely underestimate the real amount of peatland loss. The Montérégie region, South of Montréal, is the most productive area of the province. Almost half the farms in Montérégie (130 of 277 farms) grow crops on organic soil (unpublished data from the Ministry of Food, Fisheries and Agriculture, Québec, 2003). This corresponds to 6 863 ha of peatlands, which represents 0,2 % of the total agricultural lands in the province. The Montérégie region counts for one third of the agriculture production in Québec, so we can estimate the loss of peatlands for agriculture to be around 20 000 ha. This estimate is nevertheless very far from being precise and has never been validated.

Cranberry production, which can take place beside or directly on a peatland, is a growing industry in Eastern Canada and there are actually 41 cranberry farms in the province of Québec. Thirty five of those producers are members of an association that records general statistics on cranberry production. A total of 1 155 ha have been estimated to be used for cranberry production for these 35 farms. Most of them occur on mineral soil (979 ha) but some cultivations take place directly on organic soil (176 ha ; table 1). Although the latter do not represent large areas of reclaimed peatland, there could be substantial impact of cranberry productions that are set up beside peatlands. This is because cranberry farming implies drainage of the surrounding land to collect water for harvesting fruit or controlling pests. In New-Brunswick, only 100 ha of peatland are under cultivation for either crops or cranberries (table 1).

Forestry within peatlands is not so widespread in Canada as in northern Europe (Poulin and Pellerin, 2001). Only 25 000 ha of Canadian peatlands had been partially drained to facilitate forestry operations in the early 1990s (Haavisto and Jeglum, 1989). Recent statistics are not available, however peatlands are coming under increasing pressure for logging, as indicated in Prévost *et al.* (2001). An estimated 69 723 ha of peatlands have been drained for forestry in the last 20 years (1983-

2003) in the province of Québec alone (Third Decennial Inventory of the Ministry of Natural Resources, Wildlife and Park services, Québec ; Parent, 2000 ; table 1). This includes forested peatlands that are drained just before or after wood cutting (frequent), open peatlands that are drained for improving forest productivity (rare) and other sites that are drained for logging which contain a thin layer of peat (< 40 cm ; infrequent). No forestry has been conducted on peat soil in New-Brunswick.

In spite of the fact that 7,3 million m^3 of peat are sold each year, the peat moss industry only affects 17 200 ha of the 170 million ha of peatland in Canada, *i.e.*, approximately 0,01 % of the total land area (Hood and Sopo, 1999). Québec and New-Brunswick are the two main provinces extracting peat for horticultural purposes and a total of 6 000 and 6 800 ha of peatlands have been mined for this purpose in these two provinces, respectively. Peat is not used for heating or for the generation of electricity in Canada. Interest in peat as a form of energy has declined since the 1970s due to the availability of less costly sources of energy (Keys, *op. cit.*). Peat extraction for therapeutic uses has also been a very minor activity in the country. The one Canadian company involved in providing peat for thermal mud therapy currently sells approximately 800 tons of moist peat annually and harvests peat from a very localized area (< 1 ha ; http://www.goldenmoor.com).

POLICIES AND LAWS FOR PEATLAND PROTECTION IN CANADA

Canada was the first country to develop a policy for conserving wetlands even though the laws pertaining to the operation and management of most wetlands are under provincial jurisdiction. The Government of Canada adopted the Federal Policy on Wetland Conservation in 1991 (Government of Canada, 1991), based on the wise-use principle of the Ramsar Convention (Rubec, *op. cit.*). The main objective of the policy is to sustain the ecological (water recharge, habitats, etc.) and socio-economic (hunting, trapping, agriculture, etc.) functions of wetlands, now and in the future (Government of Canada, *op. cit.*). The policy ultimately aims at no net loss of wetland functions on all federal lands, *i.e.*, 29 % of all Canada's wetlands. Peatlands are also considered by the policy since they represent 88% of all wetlands in Canada (Tarnocai, 1984). The rehabilitation of wetlands in areas where continuing loss or degradation have reached critical levels is also part of the global objective of the policy. Moreover, the policy comprises seven strategies including development of public awareness and enhancement of cooperation between the federal government and the provinces and territories and non-government agencies.

Several legal tools can also be used to support protection of wetlands in Canada, such as : the Migratory Birds Convention Act (prohibits the deposition of harmful substances in areas frequented by migratory birds), the Fisheries Act (prohibits alteration, disruption or destruction of fish habitat and prohibits the deposition of harmful substances in fish habitat) and the Species at Risk Act (prohibits damage or destruction of the habitat of an endangered or threatened species). Furthermore, the Government of Canada has acceded to the Ramsar Convention (commits Canada to ensuring wise use of wetlands), the North American Waterfowl Management Plan (aims to conserve two million ha of wetland habitat in Canada) the United Nations Convention on Biological Diversity (commits Canada to conserving biodiversity and recognizes wetland conservation as integral to this goal) and the United Nations Conference on Environment and Development-Agenda 21 (identifies wetland conservation as a priority).

At the provincial level, Alberta, New-Brunswick, Ontario, and Saskatchewan have set their own policies for wetland conservation (Rubec, 1994).

New-Brunswick

New-Brunswick has been very proactive for regulations on peatland exploitation. Approximately 65 % of peatland occurs on public lands in New-Brunswick (Keys and Henderson, 1987), where the right to extract peat is regulated by the *Quarriable Substances Act*, which is administered by the Department of Natural Resources. The act was recently amended to include new elements of resource management in the *Provincial Policy on Peat Mining* (Government of New-Brunswick, 2001a). This policy includes the necessity of filing site reclamation plans and providing appropriate reclamation security deposits. All development projects affecting more than 2 ha of public or private wetland are also subject to the Environment Impact Regulation under the *Clean Environment Act* which is administered by the Department of the Environment and local government. An Approval to Operate (*Clean Environment Act*) and a *Watercourse and Wetland Alteration Permit* (*Clean Water Act*) are required before any peat extraction activity can take place.

Québec

In the province of Québec, no policy has been adopted for preserving wetlands to date. Industrial exploitation of peat moss deposits on public land or on sites where mining rights have been revoked is regulated by the *Mining Act* (R.S.Q., 1987, chapter M-13.1). The *Environment Quality Act* (R.S.Q., 1972, chapter Q-2) restricts access to and controls projects on natural peatland. This law

peatlands under protection, respectively. The situation is different in other provinces such as Québec, where 3,6 % of the total peatland area occurs in protected areas. Provincial legislation and protection plans need to be further developed in the future to attain international standards.

KEY-WORDS
Peat-lands, mires, conservation, Canada, peatland loss, disturbance factors, flooding, drainage, acts and policies, protected area, Québec, New-Brunswick.

RÉSUMÉ
Les tourbières sont des milieux humides qui couvriraient entre 3 et 4% de la surface terrestre, soit approximativement 4 millions de km^2. Au Canada, une des plus récentes estimations évalue la superficie des tourbières à environ 170 millions d'hectare et, contrairement aux tourbières européennes, la très grande majorité demeure exempte de toutes perturbations anthropiques. Compte tenu de la très vaste étendue du territoire canadien, il est très difficile d'obtenir des données précises concernant la destruction et l'exploitation des tourbières pour l'ensemble du pays. Nous présentons donc des informations détaillées sur ce sujet seulement pour le Québec et le Nouveau-Brunswick. Au Québec, la perte de superficie des tourbières est principalement attribuable à la construction de barrages pour la production d'hydroélectricité. Ainsi, 120 000 ha de tourbières ont-elles été inondées, ce qui représente environ 1% de l'ensemble des tourbières de la province. Au Nouveau-Brunswick, la récolte de tourbe pour la production de

terreau horticole est la principale source de perturbation. Cela représente 6 800 ha de tourbières qui ont été ou sont encore en exploitation, soit l'équivalent de 5% de la ressource en tourbe de la province. Malgré le faible pourcentage que représentent les tourbières perturbées au Canada, il existe de très forts déséquilibres régionaux; les tourbières ont en effet presque disparues de certaines régions densément peuplées. Des actions immédiates sont donc nécessaires pour assurer le maintien des tourbières dans l'ensemble des régions du pays. Les provinces ayant les plus grandes proportions de tourbières protégées sont le Manitoba (25%), la Nouvelle-Écosse (15%), l'Île du Prince-Edouard (12,5%) et le Nouveau-Brunswick (11%). Dans les autres provinces, la proportion de tourbières protégées est moindre. Par exemple, au Québec 3,6% des tourbières bénéficient d'un statut de protection. Il est donc urgent que le Canada, et chacune des provinces, mettent sur pied des plans de conservation et une législation claire afin de protéger les tourbières et ainsi atteindre les standards mondiaux.

MOTS-CLÉS
Tourbières, conservation, Canada, pertes de tourbières, facteurs de dégradation, inondation, lois et politiques, zone de conservation, Québec, Nouveau-Brunswick.

applies to both public and private land. Article 22 of this act states that anyone erecting or altering any structure, carrying out any works or projects or undertaking to operate any industry on a peatland must first obtain a certificate of authorization from the provincial Minister of the Environment. Nevertheless, several activities such as wildlife management are exempt from this regulation. It is the regional offices that issue these certificates, however these offices are often poorly equipped to evaluate the status of the peatlands involved. Informed decisions are therefore impossible, unless the site is known to harbour endangered or threatened species. In addition, article 22 is complex which discourages its application. According to article 23 of the same law, industrial activity that is likely to harm or destroy the soil surface of a peatland requires submission of a land reclamation plan following use. At present, only projects involving quarries, gravel pits and landfill sites are required to submit such a plan. Also, the term "reclamation" of peatlands does not necessarily imply a return to a peat-accumulating ecosystem. In conclusion, other than the necessary certificate of authorization, there is no legal means to control peatland use in Québec.

Self-implemented management guidelines

Some Canadian industries have formally adopted their own policies regarding exploitation and conservation of wetlands. The Canadian *Sphagnum* Peat Moss Association (CSPMA) developed its Preservation and Reclamation Policy in 1991 (Lynch-Stewart *et al.*, 1993). This policy recommends several intervention strategies at each stage of peatland exploitation and advocates preservation of a remnant of the original vegetation. The CSPMA specifically encourages its members to :

- utilize exploitation methods that will minimize the affected surface area,
- leave some plots of natural peat as a buffer zone and to stimulate recolonization,
- utilize waste surface vegetation to revegetate recently abandoned sites and
- apply restoration techniques following exploitation.

PEATLAND CONSERVATION : THE CASE STUDY OF THE PROVINCE OF NEW-BRUNSWICK

Approximately 85 % of New-Brunswick's 140 000 ha of peatlands is still in a natural state (Thibault, 2002). Of these 119 000 ha of undisturbed peatlands, 15 504 ha are found in designated conservation areas (Table 2). Protected peatlands are well distributed throughout the province. It is worth noting that the highest level of conservation is found in the two principal peat mining areas : the Acadian Peninsula (n°6 on Fig. 2) and the Baie-Sainte-Anne region (n°1 and 7 on Fig. 2).

Two important policy initiatives have resulted in legislative changes that promote peatland conservation in New-Brunswick.

Protected Areas Strategy

In November 1992, the province of New-Brunswick joined with the other provinces and territories and the federal government in signing a statement of commitment to complete Canada's network of protected areas.

The Protected Areas Strategy of New-Brunswick was born from a growing realization that undisturbed natural areas continue to diminish in number and size as land development and resource use continue to expand. The concern was that the relatively small number of permanently protected areas that existed in New-Brunswick did not adequately represent the biodiversity that existed within the province. Also, it was determined that the few, large, relatively undisturbed areas were at risk of being overwhelmed by future development if action was not taken to protect natural areas.

Beginning with a preliminary inventory of existing natural areas in 1996, the work then focused on identifying and assessing potential sites within the seven eco-regions of the province. Each site was evaluated for its potential to support ecological processes and to serve as a control site for the eco-region using enduring features. In addition, each site was assessed for its potential to protect unique, rare or outstanding natural features. Through the inventory and evaluation process, numerous candidate areas were identified for protection. After internal review and analysis, the protected areas plan was released in September 1998 for public review (Lapierre, 1999).

In May 2001, the New-Brunswick government officially announced establishment of 10 protected areas where activities such as forestry, mining and aggregate extraction would be banned. Recreational use of areas would sometimes be permitted however, while scientific investigation was encouraged and supported. Nearly 150 000 ha of land were included in this strategy, of which 9 000 ha were peatlands (table 2 ; fig. 2). The *Protected Natural Areas Act* was adopted in 2003 to establish and manage protected areas in New-Brunswick. The new act replaces the former *Ecological Reserves Act*. Two classes of protected natural areas have been created. Class I is fairly restrictive and applies to lands that are sensitive to human disturbance and where total protection and conservation of the natural environment is critical. Class II allows for some recreational activities. These two classes correspond to category II of IUCN (see table 2). In addition to protected areas, 3 056 ha and 176 ha of peatland are protected in one national park (Kouchibouguac) and one

international park (Roosevelt Campobello), respectively (table 2). As well, a land use plan contributes to the conservation of 3 269 ha of peatland on Miscou Island, an important pristine habitat. It follows that the total area of peatland under conservation status is 15 404 ha, 11% of the total peatland area in New-Brunswick.

Wetlands Conservation Policy

Four per cent of New-Brunswick's land base consists of wetlands, *i.e.*, coastal salt marsh (3 %), Saint John River floodplain wetlands (7 %), freshwater inland wetlands (42 %) and peatlands (48 %). While the first two categories together represent little of the total provincial land base, they are mostly considered to be of international, national or provincial significance (Government of New-Brunswick, 2001b).

In December 2001, the New-Brunswick government initiated public consultations on a proposed Wetlands Conservation Policy. Adopted in 2002, the new policy aims at managing human activity on or near wetlands to ensure that critical ecosystem functions are not compromised thereby strengthening the government's commitment to conserve wetlands and promote wetland stewardship, awareness and education. The policy applies equally to all provincially significant wetlands regardless of size and to all other wetlands that are greater than or equal to 1 ha regardless of ownership. To implement the policy, the Clean Water Act, the Clean Environment Act and the Watercourse and Wetland Alteration Regulation were amended in spring 2003. The amendments provide a clear legislative framework to regulate land use and activity in wetlands that are at least 1 ha in size, as well as within an upland buffer zone of 30 m from these wetlands. In addition, significant wetlands can be specifically designated as protected areas.

PEATLAND CONSERVATION : A CASE STUDY OF THE PROVINCE OF QUÉBEC

For the province of Québec, there has been no global procedure for protecting peatlands and ensuring conservation of a network that is representative of the diversity found in the whole province. Although most peatlands are still in a pristine condition in Québec, only 16 445 ha were under protection until the year 2000. Considering the total peatland area of the province is estimated at 11 826 300 ha (Buteau, *op. cit.*), this corresponded to a conservation rate of only 0,1 %. Since the year 2000, several thousand hectares of peatlands have been protected in new conservation areas. At present, 36 895 ha of peatlands are under protection in ecological reserves and national and provincial parks. An additional 383 001 ha are nowadays protected in biodiversity reserves which were established after 2002. This leads to a total area of 419 896 ha of peatlands under protection, which corresponds to 3,6% of the total peatland area of the province. In addition to these recent efforts, the Minister of the Environment has charged a committee of experts to set conservation priorities for wetlands along the Lower St. Lawrence River Valley, where human populations are concentrated. This committee will select which wetlands should not be submitted to exploitation or destruction activities, based on their uniqueness, localization, and representative-ness of the regional wetlands. Although this committee has no legal authority on wetland development, it could influence other ministries that control resource management.

Peatland protection in Québec mainly relies on three laws : the *Natural Heritage Conservation Act*, the *Canada National Parks Act* and the *Parks Act*. A few other acts can be used to protect peatland in the province, for example, the *Act Respecting Threatened or Vulnerable Species* can be

	New Brunswick	Québec
Total peatland area	140,000	11,826,300
Total peatland losses	7,250	174,000
Hydro-electric production	*150*	*120,000*
Agriculture	*100* (including cranberry production)	*11,000* (including 176 ha of cranberry production)
Drainage for forestry	*0*	*69,723*
Peat extraction	*6,800*	*6,000*
Others (pipelines, roads, inustrial and urban sprawl)	*200*	*2,000*
Protected peatlands	15,404	419,896

Table 1 : Statistics on peatland losses and peatland conservation for the provinces of New-Brunswick and Quebec, eastern Canada (numbers are in hectares)

Identification	Status	IUCN categories[1]	Year created	Peatland area (ha)
(1) Black River	Protected area	II	2001	1,056
(2) Canaan Bog	Protected area	II	2001	1,694
(3) Grand Lake Meadow	Protected area	II	2001	4,708
(4) Spednic Lake	Protected area	II	2001	586
(5) Canoose Flowage	Protected area	II	2001	859
(6) Miscou Island	Land use plan	V	1997	3,269
(7) Kouchibouguac	National park	II	1969	3,056
(8) Roosevelt Campobello	International Park[2]	II	1964	176
Total				**15,404**

[1] IUCN Categories : II = National Park: Protected area managed mainly for ecosystem conservation and recreation; V = Protected Landscape/Seascape: Protected Area managed mainly for landscape/seascape conservation and recreation

[2] The park of Roosevelt Campobello is managed by both Canada and USA

Table 2 : Peatland with official conservation status in the province of New-Brunswick, eastern Canada. Numbers in parenthesis refer to fig. 2

Table 3 : Peatlands with official conservation status in the province of Quebec, eastern Canada. Numbers in parenthesis refer to fig. 3

Identification	Status	IUCN categories[1]	Year created	Peatland area (ha)
(1) Pin-Rigide (du)	Ecological Reserve	I	1977	17
(2) Tantaré (de)	Ecological Reserve	I	1978	2
(3) Pointe-Heath (de la)	Ecological Reserve	I	1978	1,859
(4) Lac-Malakisis	Ecological Reserve	I	1978	65
(5) Thomas-Sterry-Stunt (internationale)	Ecological Reserve	I	1988	53
(6) Thomas-Fortin	Ecological Reserve	I	1990	2
(7) Louis-Babel	Ecological Reserve	I	1991	1,177
(8) Irène Fournier	Ecological Reserve	I	1991	15
(9) Bog-à-Lanières (du)	Ecological Reserve	I	1992	430
(10) Lac-à-la-Tortue (de)	Ecological Reserve	I	1992	566
(11) William-Baldwin	Ecological Reserve	I	1992	293
(12) Dunes-de-la-moraine-d'Harricana (des)	Ecological Reserve	I	1994	291
(13) Grands-Ormes (des)	Ecological Reserve	I	1994	5
(14) Tourbières-de-Lanoraie (des) [2]	Ecological Reserve	I	1994	415
(15) Matamec (de la)	Ecological Reserve	I	1994	1,488
(16) Grand-Lac-Salé (du)	Ecological Reserve	I	1996	809
(17) Léon-Provancher	Ecological Reserve	I	1999	165
(18) Rivière-aux-Brochets (de la)	Ecological Reserve	I	1999	125
(19) Chicobi	Ecological Reserve	I	2002	450
Total (Ecological Reserves)				**8,227**
(20) Mauricie (de la)	National Park	II	1970	2,466
(21) Forillon (de)	National Park	II	1970	109
(22) Archipel-de-Mingan (de l')	National Park	II	1985	1,320
Total (National Parks)				**3,895**
(23) Frontenac (de)	Provincial Park	II	1987	111
(24) Grands-Jardins (des)	Provincial Park	II	1981	> 130
(25) Pointe-Taillon (de la)	Provincial Park	II	1985	3,780
(26) Anticosti (d')	Provincial Park	II	2001	20,000
(27) Mont-Tremblant (du)	Provincial Park	II	1981	> 750
(28) Mont-Saint-Bruno (du)	Provincial Park	II	1985	2
Total (Provincial Parks)				**24,773**
(1) Baie de Boatswain	Planed biodiversity reserve	II or III	2003	4,815
(2) Basses collines du lac Guernesé	Planed biodiversity reserve	II or III	2003	18,432
(3) Buttes du lac aux Sauterelles	Planed biodiversity reserve	II or III	2003	8,060
(4) Collines de Muskuchii	Planed biodiversity reserve	II or III	2003	31,880
(5) Côte d'Harrington Harbour	Planed biodiversity reserve	II or III	2003	23,355
(6) Forêt Piché-Lemoine	Planed biodiversity reserve	II or III	2004	858
(7) Haute Harricana	Planed aquatic reserve[3]	II or III	2004	3,716
(8) Île René-Levasseur	Planed biodiversity reserve	II or III	2003	451
(9) Lac Bright Sand	Planed biodiversity reserve	II or III	2003	3,804
(10) Lac des Quinze	Planed biodiversity reserve	II or III	2004	538
(11) Lac Gensart	Planed biodiversity reserve	II or III	2003	6,938
(12) Lac Opasatica	Planed biodiversity reserve	II or III	2004	829
(13) Lac Pasteur	Planed biodiversity reserve	II or III	2003	9,316
(14) Lac Sabourin	Planed biodiversity reserve	II or III	2003	14,414
(15) Lac Taibi	Planed biodiversity reserve	II or III	2004	3,868
(16) Lacs Vaudray et Joannès	Planed biodiversity reserve	II or III	2003	1,905
(17) Marais du lac Parent	Planed biodiversity reserve	II or III	2004	1,600
(18) Massif des lacs Belmont et Magpie	Planed biodiversity reserve	II or III	2003	6,657
(19) Monts Groulx	Planed biodiversity reserve	II or III	2003	5,163
(20) Péninsule de Ministikawatin	Planed biodiversity reserve	II or III	2003	55,282
(21) Plaine de la Missisicabi	Planed biodiversity reserve	II or III	2003	48,249
(22) Réservoir Decelles	Planed biodiversity reserve	II or III	2004	960
(23) Rivière Ashuapmushuan	Planed aquatic reserve	II or III	2003	538
(24) Rivière Harricana Nord	Planed aquatic reserve	II or III	2003	10,741
(25) Rivière Moisie	Planed biodiversity reserve	II or III	2003	38,350
(26) Vallée de la rivière Natashquan	Planed biodiversity reserve	II or III	2003	21,421
(27) Waskaganish	Planed biodiversity reserve	II or III	2004	60,861
Total (Biodiversity Reserves)				**383,001**
Total protected peatlands				**419,896**

[1] IUCN Categories. I) Strict Nature Reserve : Protected area managed mainly for science and wilderness protection ;
II) National Park : Protected area managed mainly for ecosystem conservation and recreation ;
III) Natural Monument : Protected Area managed for conservation of specific natural features.

[2] In the ecological reserve of Tourbières-de-Lanoraie, guided tours are organized for public education.

[3] Planed aquatic reserves have the same status as planed biodiversity reserves.

implemented to protect particular peatlands or peatland remnants supporting endangered species. As a result, the Minister of the Environment has recently established a conservation zone within a peatland of southern Québec to protect a population of *Gaylussacia dumosa* ([Andr.] Torr. and Gray) var. *bigeloviana* (Fern.), a rare ericaceous species. The 10-ha protected area was based on an agreement between the Minister of the Environment and a peat mining company. A list of vascular plants designated or likely to be designated as threatened or vulnerable and that are likely to be found in peatlands of New-Brunswick and Québec is shown in table 4 (a,b) and table 5 (a, b).

Ecological Reserves

At present, there are 69 ecological reserves in Québec which cover a total of 94 729 ha. The designation of ecological reserve protects the entire natural ecosystem and prohibits human activities, except for scientific and educational purposes. Even these activities are restricted and require a permit. In the province, a total of 8 227 ha of peatlands are protected within 19 ecological reserves. However, only 7 reserves were specifically created to conserve natural peatlands (table 3 ; fig. 3).

The first ecological reserve set to preserve peatlands, Pointe-Heath, was created in 1978 and comprised 1 859 ha of bogs and fens. Only two other ecological reserves conserve more than 1 000 ha of peatlands and they were established after 1990 (table 3). For the remaining ecological reserves, the area of protected peatlands is mainly less than 500 ha for each site, with an average size of 340 ha and the smallest size is 2 ha (table 3). A particularity of ecological reserves is that they are often created for their special attributes or the uniqueness of their ecosystems. This is also reflected in the type of peatlands protected within ecological reserves. Indeed, fens, string peatlands (both ombrotrophic and minerotrophic) and riparian and forested peatlands are more represented in ecological reserves than are open bogs, but it is this latter type of peatland that is mostly found in southern Québec where the main threats of disturbance occur.

National and Provincial Parks

Like ecological reserves, national and provincial parks are mainly established to protect exceptional ecosystems that are undisturbed by anthropogenic activities. Resource extraction for commercial purposes and hunting are prohibited in parks, however education plays an important role in these protected areas that also encourage recreation activities.

Three of the four national parks in Québec encompass peatlands (table 3 ; fig. 3). National parks are usually much larger than ecological reserves and so the peatlands protected within national parks are of considerable surface area. The Mauricie National Park is the largest park with 53 600 ha of protected lands, of which 4,6 % or 2 466 ha are peatlands (Pelletier, 1998). The Archipel-de-Mingan Park covers 11 203 ha on 40 islands and over 2 000 islets and reefs in the northeastern part of the St. Lawrence River. This park protects some 1 320 ha of peatlands, 14 % of the park area (Del Degan, Massé and Associés inc., 1998a,b). The three national parks together protect a total of 3 895 ha of peatlands.

For provincial parks, 6 of 22 parks are known to contain peatlands within their borders (table 3 ; fig. 3). Nevertheless, it is difficult to obtain precise data on peatland conservation within provincial parks since park managers do not always use an ecosystem approach. In addition, there is no central data base that can easily be consulted for peatlands at the Minister of Natural Resources, Wildlife and Parks, the government body responsible for establishment and planning of provincial park networks.

The provincial park that clearly protects the largest area of peatlands is the Anticosti Park on Anticosti Island. This park was created in 2001 and extends over 57 180 ha, including approximately 20 000 ha of peatlands. The Pointe-Taillon Park is the second most important site for peatland conservation in the province and it protects 3 780 ha of peatlands. Other provincial parks protect less than 750 ha each. The total area of peatlands in provincial parks is approximately 24 773 ha (table 3).

Biodiversity Reserves

In the year 2000, the government of Québec has initiated a project for establishing a new strategy for conservation areas. Among others, the project has conducted to the creation of 27 biodiversity reserves. Biodiversity reserves contribute to the objective of safeguarding the character, diversity and integrity of Québec's natural heritage through measures to protect its biological diversity and the life-sustaining elements of natural settings. The first biodiversity reserves that were planed are mainly located in northern regions and thus encompass large areas of peatlands (table 3 ; fig. 4). Although they do not have yet the official conservation status and are considered as planed reserves, we must include them in our global estimation of protected peatlands. Indeed, the status of planed reserves assures the preservation of the affected territory as soon as the territory is registered in the allocation plan of public lands for the province of Québec. This avoids protection delays usually associated with the creation of other type of conservation areas. In fact, any

industrial exploitation is prohibited on the territory from the moment when the biodiversity reserve is planed. In the province of Québec, planed biodiversity reserves contribute significantly to the protection of peatlands and are recognized by the Word Conservation Union (IUCN). A total of 383 001 ha of peatlands are included in biodiversity reserves of the province, which is ten times the area that is actually protected in the ecological reserves and national and provincial parks. This leads to the protection of 3,6% of the total peatland area of the province. Still, by their northern geographic distribution, biodiversity reserves do not contribute to the preservation of natural peatlands in regions where anthropogenic disturbances are concentrated, that is southern-most regions of the province.

THE ROLE OF RESEARCH IN PEATLAND CONSERVATION

The procedures adopted by the New-Brunswick government for protecting peatlands are remarkable when compared to the ad hoc procedures that are often favoured in the rest of Canada. As in many other countries, protected areas are set aside on the basis of site uniqueness, aesthetic characteristics and potential for recreation (Pressey, 1994). Until recently, a scientific approach was not applied in establishment of peatland conservation networks in Canada. In a country where more than 115 million ha of peatlands are still in a pristine state, long-term conservation planning is often omitted from peatland management procedures. Yet, the uneven geographical distribution of peatlands in Canada and a concentration of the main threats to particular regions should encourage governmental agencies and private organizations to undertake cohesive actions for conserving peatlands.

The most extensive peatland areas are found in the boreal zone, above the 50° parallel. In some northern regions, over 50 % of the land surface may be characterized by peatlands whereas in southern Canada, peatlands mostly form patchy archipelagos (National Wetlands Working Group, 1988 ; Poulin *et al.*, 2002). Beside dam construction for the production of hydroelectricity, which mainly takes place in the north above the 50° parallel, other pressures on peatlands, in the form of urban sprawl, agriculture, forestry and peat extraction, occur in the south. This is also where peatlands are least abundant. In some regions, such as the Bas-Saint-Laurent region of southeastern Québec, up to 62 % of the total peatland area has been destroyed or disturbed by logging, farming or peat mining activities between 1929 and 2000 (fig. 5 ; Pellerin, 2003).

It is thus of crucial importance to take into account the geographical distribution of peatlands when setting up conservation areas, particularly the north - south dichotomy in Canada. Bird species assemblages found in ombrotrophic peatlands on the far northern coast of the St. Lawrence River, Québec, are dominated by shorebirds and waterfowls whereas those of peatlands south of the St. Lawrence River are dominated by passerines such as warblers and sparrows (Calmé, 1998 ; Calmé and Desrochers, 1999). In addition, peatlands contain less pools and contrast more with the surrounding landscape as one proceeds south (Couillard and Grondin, 1986). This is partly because boreal forests dominate northern landscapes whereas mixed forests dominate southern landscapes. Southern landscapes are also more disturbed by human activities than are northern landscapes which makes southern peatlands natural refuges for flora and fauna. It follows that the Palm Warbler (*Dendroica palmarum*) has recently been discovered to be strictly associated with peatlands in the south of Québec whereas it occurs in the boreal forest surrounding peatlands in the north (Calmé, *ibid.*).

When selecting individual peatlands to be protected, many factors should be considered. The overall size of the peatland has been shown to be a good indicator of habitat, plant and bird diversity (Calmé and Desrochers, *ibid.* ; Lachance *et al.*, in press) and some passerine species are particularly sensitive to peatland area, such as the Palm Warbler and the Swamp Sparrow (*Melospiza georgiana*). Not only do large peatlands show higher bird species richness, mainly due to increased habitat heterogeneity, but large peatlands are also more likely to harbour rare species (Calmé et Desrochers, *ibid.*). In addition, surrounding habitat influences diversity found within individual peatlands. The probability of occurrence of the Palm Warbler within a particular peatland, for example, increases with the total area of peatlands found in a 10-km *radius* from that peatland (Calmé and Desrochers, 2000). We should thus consider peatlands as a network and avoid selecting isolated peatlands for conservation unless they are large and very unique. It has recently been established that amphibians utilize peatlands after reproducing in adjacent habitats (Mazerolle, 2005). Peatlands should thus be protected as summering sites for amphibians and again, regional landscape structure should be considered to facilitate amphibian dispersion.

In areas where peatlands are not exploited or disturbed, it is possible to select the most interesting sites and protect them entirely. Yet in regions where very few natural peatlands remain, as in the Bas-Saint-Laurent region of southeastern Québec (fig. 5), we must consider alternative strategies such as conservation of residual fragments within mined peatlands. These fragments could be important refuges for flora and fauna during the period of exploitation which would then serve as donor sites when restoring abandoned peat extracted surfaces.

When considering the open part (mire expanse) of a bog, Poulin *et al.* (1999) have shown that the vegetation does not differ between the center and the edge of the bog, other than for the species strictly associated with pools, which are mainly found at the center of bogs. However, plant species assemblages of residual fragments from peat extracted sites differ from those found at the edge of natural bogs. The peat surface of residual fragments is dryer and *Sphagnum* mosses are less abundant than at the edge of natural bogs.

Not only does the flora of residual fragments differ from that of undisturbed peatlands, but it seems that the flora in natural remnants is changing more rapidly than in pristine ecosystems. In the Bas-Saint-Laurent region of southeastern, many residual fragments found within exploited peatlands have been subject to forest expansion for the past 50 years (Pellerin and Lavoie, 2000 ; Pellerin and Lavoie, 2003). This has resulted in changes in both plant and bird species diversity (Lachance *et al., ibid.*). The abundance of bog plant species has declined as forest cover increased whereas the abundance of fen plant species has not changed. For birds, two bog specialists, the Common Yellowthroat (*Geothlypis trichas*) and Lincoln's Sparrow (*Melospiza lincolnii*), have shown significant decreases in occurrence that were related to increases in forest cover. Peat extraction activities were not the precursor of these declines. Rather, the afforestation of residual fragments in this region is mainly associated with episodes of fire during dry summers and with agricultural drainage (Pellerin and Lavoie, *ibid.*).

Exploitation of peatlands for horticultural purposes thus seems to have little impact on the structure of vegetation in residual fragments of open or forested peatlands, however species composition of the vegetation is affected (Poulin *et al.*, 1999 ; Desaulniers, 2000). In addition, species assemblages of birds (Delage *et al.*, 2000), small mammals (Mazerolle *et al.*, 2001) and amphibians (Mazerolle, 1999) in residual fragments of peatlands are not representative of natural peatlands. Amphibians found in residual fragments are also negatively affected by the adjacent peat extracted surfaces (Mazerolle, 2004). As a consequence, the practice of leaving residual fragments of peatlands, such as arranged today in terms of position and surface area, does not represent a viable option for conservation. Only when residual fragments are large and occur in a region where few natural peatlands remain could this practice be considered (Lachance, 2005). Nevertheless, management plans for sites slated for exploitation should include preservation of natural zones, notably as a source of diaspores for restoration.

Conclusion

Wetlands form an essential component in Canadian conservation plans, however these plans are often inadequate in terms of protection of peatlands. Current selection criteria for potential sites are effectively based on vegetative production of the ecosystem which results in marshes and swamps being favoured over peatlands because bogs are relatively unproductive. In addition, conservation plans are strictly tied to habitats used by animals of concern, particularly wildlife. Since peatlands are not considered to be positively selected by wildlife (except for certain species such as Black Ducks - *Anas rubripes* ; Bélanger *et al.*, 1998), peatlands are perceived as sites of minimal importance in Canadian conservation programs.

The Ramsar Convention on Wetlands was until recently an example of a federal conservation program that was inappropriate for peatlands. Canada joined the convention in 1981 and proceeded to conserve wetlands having an international importance in terms of fauna and flora (Matthews, 1993). Designated sites were thus examples of remarkable wetlands within a region and harboured highly productive communities with representative habitat for wildlife (Matthews, 1993). Up until 1996, less than 6 % of the total area of Ramsar sites included peatlands, internationally (Lindsay, 1996). Following the Brisbane conference (Convention Ramsar, 1996), recommendations were made to improve the proportion of peatlands within Ramsar sites. This resulted in the Guidelines for Global Action on Peatlands (2002 ; http://www.ramsar.org/key_res_viii_17_e.htm). Today, 37 % of the total area of Ramsar sites are peatlands which demonstrates the capacity of governments to put

Table 4a : List of vascular plants designated at risk in New-Brunswick and likely to be found in peatlands (unpublished data from Department of Natural Resources, New-Brunswick, 2003)

Species	Family	Habitat
Listera australis	Orchidaceae	Peatlans, black spruce margins

Table 4b : List of vascular plants that may be a risk in New-Brunswick and that could be found in peatlands (unpublished data from Department of Natural Resources, New-Brunswick, 2003)

Species	Family	Habitat
Bartonia virginica	Gentianaceae	Peatlans, heathy black spruce
Carex rariflora	Cyperaceae	Peatlans, heathy black spruce
Drosera anglica	Droseraceae	Peatlans, heathy black spruce
Eriophorum gracile	Cyperaceae	Peatlans, heathy black spruce
Glyceria obtusa	Poaceae	Peatlans, heathy black spruce
Huperzia selago	Lycopodiaceae	Peatlans, heathy black spruce
Vaccinium boreale	Ericaceae	Peatlans, heathy black spruce
Woodwardia virginica	Blechnaceae	Peatlans, heathy black spruce

into place special measures for peatland conservation.

Canadian governments, and more specifically provincial governments on which the conservation of peatlands mainly depends, are becoming increasingly aware of the importance of planning for regional representativeness of preserved sites. The province of New-Brunswick is a leader in eastern Canada for its approach to peatland conservation and other provinces would benefit from applying similar procedures. New-Brunswick has 11 % of its total peatland area under protection whereas 3,6 % is protected in Québec. However, the total peatland area under conservation is 27 times larger in Québec than in New-Brunswick. It follows that we should be careful in presenting general statistics and always consider the geographic distribution of protected peatlands along with their regional context. Other provinces show varying proportions of peatland conservation and preliminary estimates for British Columbia, Prince Edward Island, Nova Scotia and Manitoba range from 3,3, 12,5, 15 to 25 %, respectively.

Recent advances in peatland mapping from satellite imagery (Poulin *et al.*, 2002) should assist the work of conservationists to attain international standards. Since Canada, along with the ex-Soviet Union, contains most of the global peat resources, our responsibility for peatland protection is great. Important factors to consider when choosing conservation sites are now recognized and tools for selecting a reserve's location have been developed (Poulin, unpublished data), so the challenges to peatland conservation in Canada may remain political and socio-economical ones.

Table 5a : List of vascular plants designated as threatened in Quebec and likely to be found in peatlands (Labrecque and Lavoie, 2002)

Species	Family	Habitat
Gaylussacia dumosa var. *bigelovania*	Ericaceae	Bog
Polemonium vanbruntiae	Polemoniaceae	Fen
Thelypteris simulata	Thelypteridaceae	Treed fen

Table 5b : List of vascular plants likely to be designated as threatened or vulnerable in Quebec and likely to be found in peatlands (Labrecque and Lavoie, 2002)

Species	Family	Habitat	Species	Family	Habitat
Amerorchis rotundifolia	Orchidaceae	Fen	*Listera australis*	Orchidaceae	Bog, Treed bog
Arethusa bulbosa	Orchidaceae	Bog	*Peicularis sudetica* spp. *interioides*	Scrophulariaceae	Fen
Bartonia virginica	Gentianaceae	Bog, Treed fen	*Pinus rigida*	Pinaceae	Bog
Calypso bulbosa var. *americana*	Orchidaceae	Treed fen	*Platanthera blephariglottis* var. *blephariglottis*	Orchidaceae	Bog
Carex atlantica spp. *capillacea*	Cyperaceae	Bog	*Proserpinaca palustris*	Haloragaceae	Fen
Carex cumulata	Cyperaceae	Bog	*Ranunculus flabellaris*	Ranunculaceae	Treed fen
Carex hostiana	Cyperaceae	Fen	*Rhynchospora capillacea*	Cyperaceae	Fen
Carex lapponica	Cyperaceae	Bog	*Rhynchospora capitellata*	Cyperaceae	Bog
Carex prairea	Cyperaceae	Fen	*Salix maccalliana*	Salicaceae	Treed fen
Castilleja raupii	Scrophulariaceae	Fen	*Toxicodendron vernix*	Anarcardiaceae	Treed fen
Cypripedium arietinum	Orchidaceae	Treed fen	*Utricularia geminiscapa*	Lentibulariacea	Bog
Cypripedium reginae	Orchidaceae	Fen, Treed fen	*Utricularia gibba*	Lentibulariacea	Fen
Drosera linearis	Droseraceae	Fen	*Valeriana uliginosa*	Valerianaceae	Treed fen
Dryopteris clintoniana	Dryopteridaceae	Treed fen	*Woodwardia virginica*	Blechnaceae	Bog, Fen, Treed

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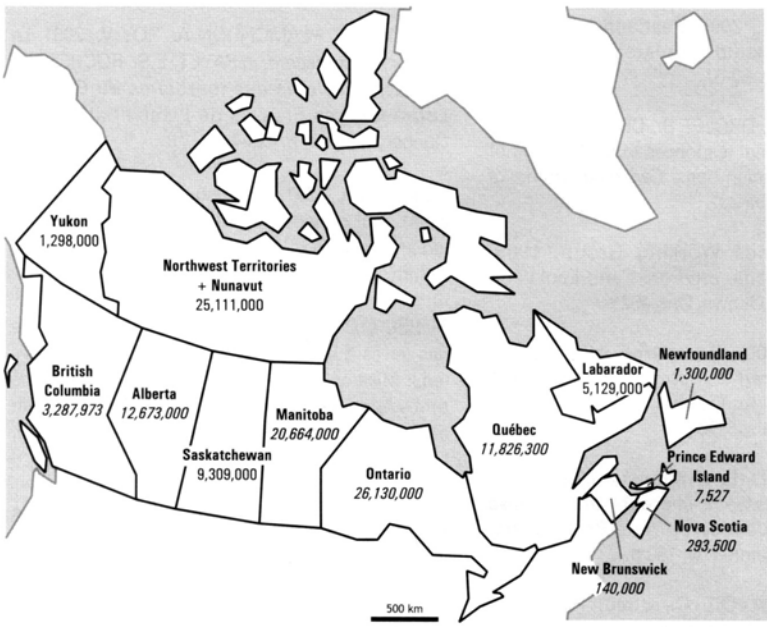
Figure 1 : Map of Canada with province names. Numbers indicate the total area of peatlands for each province (in hectares). Italic statistics refer to estimates revised from Tarnocai (1984), for which data were obtained from the sources listed below. These data were compiled in 2004-2005 by the PERG* (Peatland Ecology Research Group), but the dates when inventories or calculations were made may vary considerably from one province to another *http://www.gret-perg.ulaval.ca/en_presentation.html



Provinces	Source
Newfoundland	Department of Natural Resources and Agriculture Canada (Agrifoods)
Labarador	Tarnocai 1984
Prince Edward Island	PEI Dept of Environment & Energy, Fish & Wildlife Division
Nova Scotia	Department of Natural Resources, Wetlands and Coastal Habitats Program
New Brunswick	New Brunswick Department of Natural Resources
Québec	Buteau 1988
Ontario	Ontario Ministry of Natural Resources, Conservation and Planning Section
Manitoba	Manitoba Geological Survey
Saskatchewan	Tarnocai 1984
Alberta	Turetski, M., K. Wieder, L. Halsey & D. Vitt. 2002. Current disturbance and the diminishing peatland carbon sink. Geophysical Research Letters 29(11), doi10.1029/2001GLO14000.
British Columbia	Ministry of Sustainable Resource Management, Land Information Services Division
Yukon	Tarnocai 1984
Northwest Territories + Nunavut	Tarnocai 1984

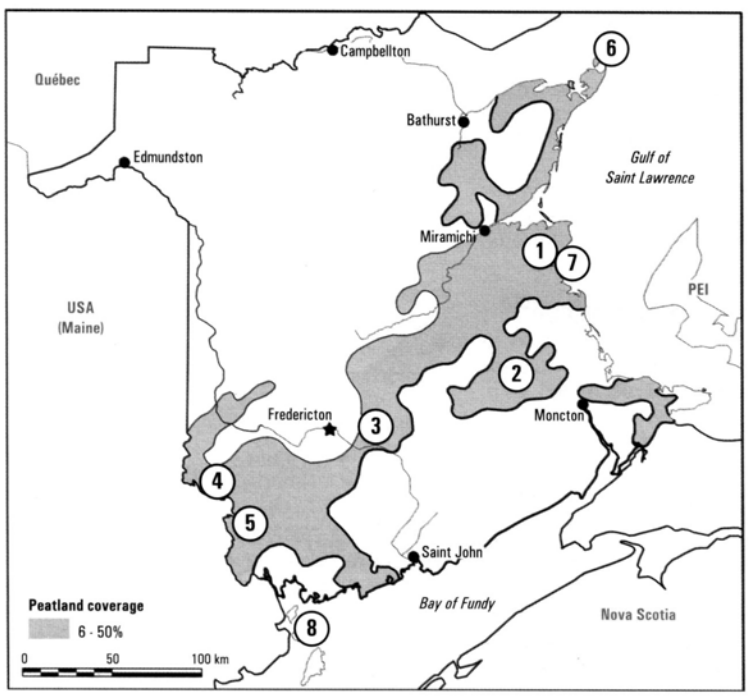


Figure 2 : Map showing regions of New Brunswick where peatlands are common. The numbers in circles show the location of conservation areas that include a significant number of peatlands (Thibault, 2002 ; see Table 2)

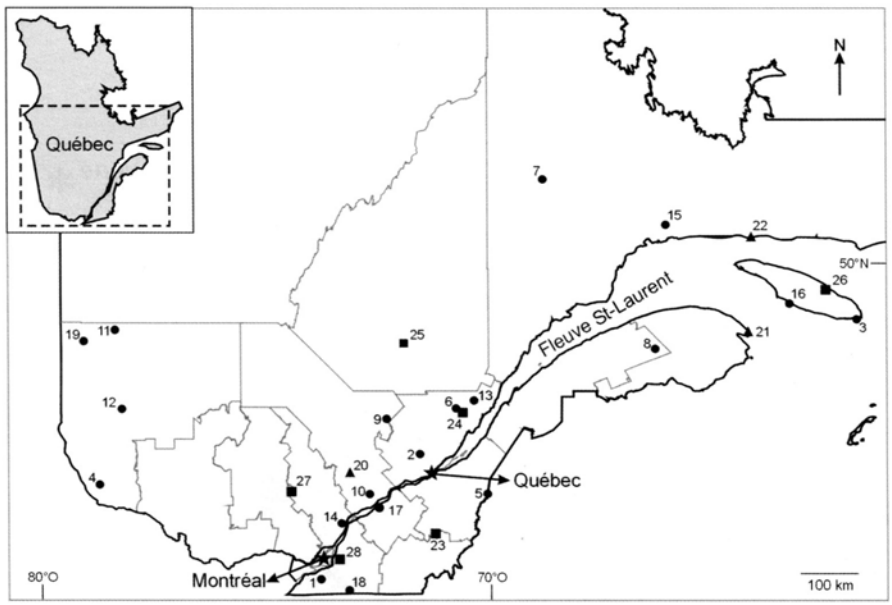


Figure 3 : Location of protected peatlands in the province of Québec. =) Ecological reserves: 1. Pin rigide, 2. Tantaré, 3. Pointe-Heath, 4. Lac-Malakisis, 5. Thomas-Sterry-Stunt, 6. Thomas-Fortin, 7. Louis-Babel, 8. Irène-Fournier, 9. Bog-à-Lanières, 10. Lac-à-la-Tortue, 11. William-Baldwin, 12. Dunes-de-la-moraine-d'Harricana, 13. Grands-Ormes, 14. Tourbières-de-Lanoraie, 15. Matamec, 16. Grand-Lac-Salé, 17. Léon-Provancher, 18. Rivière-aux-Brochets, 19. Chicobi; _) National Parks (Canadian Parks; IUCN category II): 20. Mauricie, 21. Forillon, 22. Archipel-de-Mingan; <) Provincial Parks (IUCN category II): 23. Frontenac, 24. Grands-Jardins, 25. Pointe-Taillon, 26. Rivière-Vauréal, 27. Mont-Tremblant, 28. Mont-Saint-Bruno. (see Table 3)

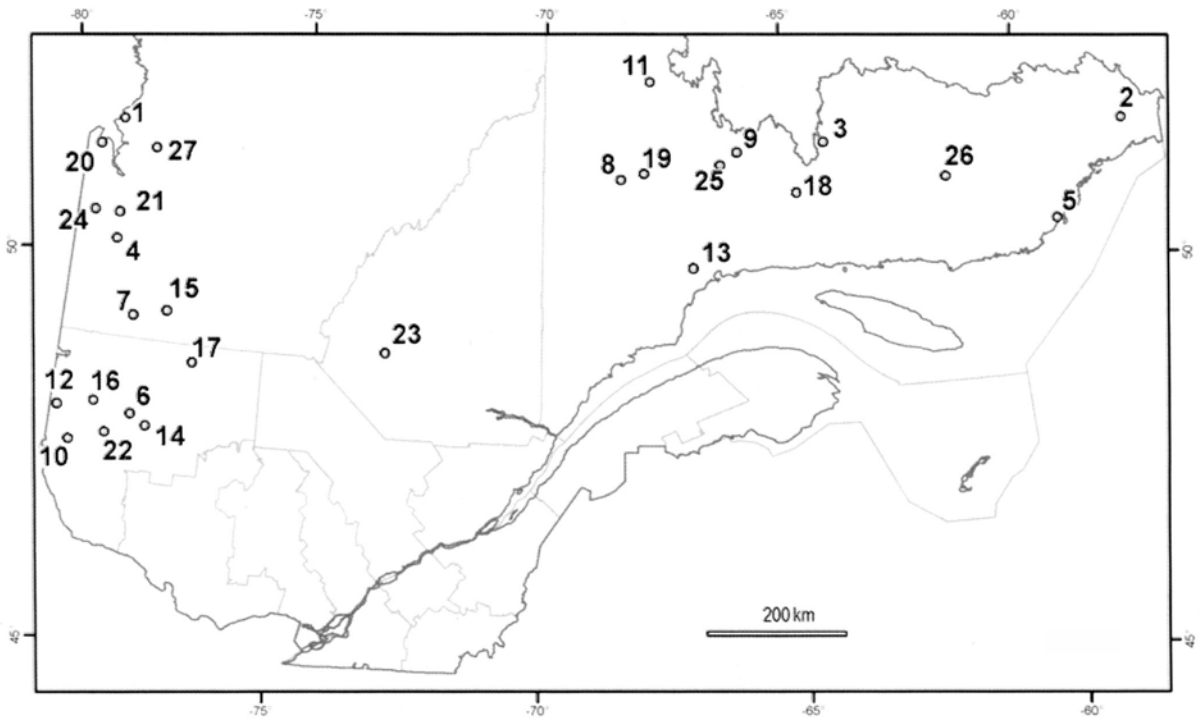


Figure 4 : Location of biodiversity reserves in the province of Québec (Ministry of Sustainable Development, Environment and Parks, Québec). See Table 3 for the list of biodiversity reserves

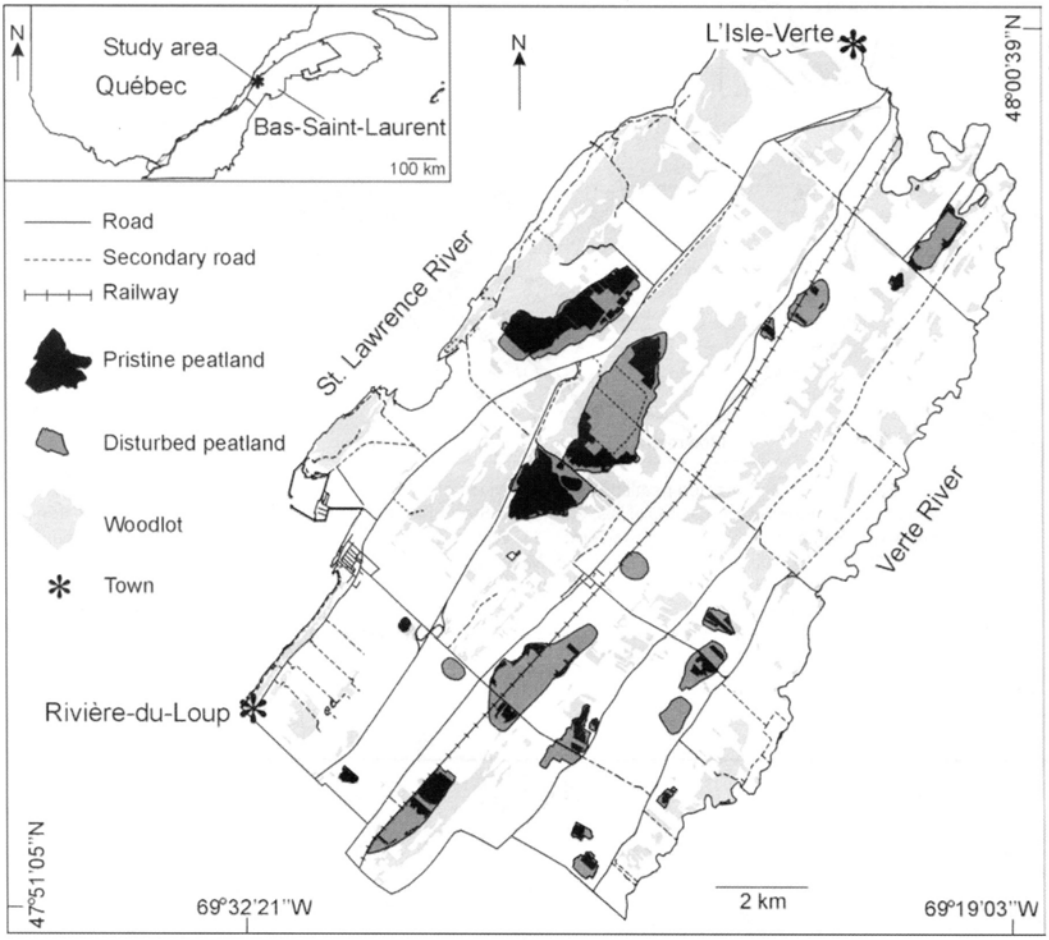


Figure 5 : Map showing the loss and disturbance of peatlands in the Bas-Saint-Laurent region, south-eastern Québec

Adresse des auteurs :

Monique Poulin,
Line Rochefort
Groupe de recherche en écologie des tourbières et Centre d'études nordiques, Pavillon Paul-Comtois, Université Laval, Québec, Québec, Canada G1K 7P4

E.mail :
monique.poulin@plg.ulaval.ca
line.rochefort@plg.ulaval.ca

Stéphanie Pellerin
Institut de recherche en biologie végétale, Jardin botanique de Montréal, 4101 rue Sherbrooke est, Montréal, Québec, Canada H1X 2B2

E.mail :
stephanie_pellerin@ville.montreal.qc.ca

Jacques Thibault
Ministère des Ressources naturelles du Nouveau-Brunswick, C.P. 50, Bathurst, N.-B., Canada
E2A 3Z1

E.mail :
jacques.thibault@gnb.ca

Address for correspondence:
Monique Poulin
Groupe de recherche en écologie des tourbières
Pavillon Paul-Comtois
Université Laval
Québec, Québec
Canada G1K 7P4
Phone: 1-418-656-2131 ext. 13035 (or 3595)
Fax: 1-418-656-7856

E.mail: monique.poulin@plg.ulaval.ca