An overview of the wetlands of Canada

by S.C. Zoltai

1. Abstract

Wetlands occupy the waterlogged portion of the land, including peatlands and mineral soil surfaces that are saturated with water. Such wetlands are widespread across Canada, with particular kinds developing in various climatic regions in response to temperature and precipitation patterns. Characteristic wetlands, from arctic to temperate, and from semi-arid to temperate rain forest conditions, are described.

2. Résumé

Les terres humides occupent la fraction gorgée d'eau du pays, y compris les tourbières et les surfaces de sols minéraux saturées d'eau. Répandues au Canada, elles se subdivisent en types particuliers selon les régions climatiques, en réaction aux conditions météorologiques et pluviométriques générales. Nous décrivons les terres humides caractéristiques, des milieux arctiques à tempérés et des zones semi-arides aux forêts ombrophiles tempérées.

3. Introduction

Wetlands are widespread across Canada, occurring under all conditions of climate and in a variety of landscapes. An accurate survey of Canadian wetlands has not been made, but Zoltai (1979) has estimated their area in the range of 150–170 $\times$ 10^6 ha. Their distribution is uneven, but the greatest concentration is within the boreal zone, situated between the prairie and arctic regions (Wetland Working Group 1981).

In this paper, "wetlands" are areas where wet soils are prevalent, having a water-table near or above the mineral soil for most of the growing season, and supporting a hydrophylic vegetation (Zoltai 1979). Wetlands include peatlands formed by the accumulation of the remains of hydrophylic vegetation. They also include areas that are influenced by excess water, but where, for climatic, edaphic, or biotic reasons, peat is not produced or preserved. Shallow open water, generally less than 2 m deep, is also included. Running water and deeper water bodies are not considered as lands and are excluded.

Wetlands develop where a persistent moisture surplus exists. Such conditions may be created where rainfall exceeds moisture losses through drainage and evapotranspiration. Wetland can also be created in topographic basins where moisture collects and on soils where internal drainage is slow.

The *kind* of wetland that develops is also related to climate. The wetlands of the prairies are distinct from those of the boreal forest. Similarly, the Subarctic and Arctic have unique wetland forms. Although the mechanism of wetland development is poorly understood, climate is involved both directly, and indirectly through its influence on vegetation.

This paper reviews the characteristic wetlands in the various bioclimatic regions of Canada, placing special emphasis on the wetlands of the boreal region.

4. Discussion

For all of Canada, Zoltai *et al.* (1973) named five classes of wetlands on the basis of physiographic features. "Bogs" are peat-covered areas where the vegetation shows the effects of a high water-table and a lack of mineral nutrients. "Fens" are also waterlogged peatlands, but the mineral nutrient status of the surface is considerably higher than in bogs, resulting in a more luxuriant growth of grassy and shrubby vegetation. "Swamps" are wetlands densely wooded by trees or shrubs growing in waterlogged, well-decomposed, nutrient-rich peat or mineral soil. "Marshes" are grassy, wet, mineral soil areas that have a shallow water-table and may be subject to periodic inundation. "Shallow open waters" are nonfluvial bodies of water, free of emergent vegetation, less than 2 m deep, and associated with other types of wetlands.

The above wetland classes occur in different proportions within the climatic zones of Canada; there are many variations of each, forming a vast number of wetland types. What follows is an outline of only those wetlands that are characteristic of the six major bioclimatic zones of Canada.

1. The ARCTIC wetland zone (Fig. 1) is characterized by permafrost that underlies all land surfaces at shallow depths. The precipitation and temperatures are low (Table 1). Wetlands occur only in depressions and in areas watered by late-melting snowbeds. The characteristic wetland is influenced by the development of ice wedges in the ground. As the ice wedges expand, the displaced soil or peat forms dams around small shallow pools (Fig. 2). Such pools are excellent habitats for waterfowl, especially geese. As peat slowly accumulates in the pools, the water disappears from the polygon centres. In the Low Arctic the tops of ice wedges may thaw, developing deep trenches, leaving the centres high and dry. Under such conditions the low-centre polygons become high-centre polygons.

Figure 1
Provisional map of the wetland regions of Canada (Zoltai 1979)

Lush vegetation develops on some slopes that are watered by slowly melting snowbanks, in stark contrast with the drab desert that surrounds them (Fig. 3). Such seepage fens are the favoured summer grazing grounds of muskoxen, which feed on the abundant vegetation composed mainly of *Carex* and *Luzula* spp.

2. In the SUBARCTIC wetland zone most, but not all, wetlands are affected by permafrost. The most common wetland form is the peat plateau, a perennially frozen peatland that is elevated above the regional water table by permafrost. The peat plateaus are surface-dry and the vegetation resembles that of the uplands.

Fossil plants in the peat indicate that the peat plateaus began as mineral-rich fens. Such fens, free of permafrost, are still abundant in the region. Peat plateaus develop as *Sphagnum* becomes established on the fens. Since the *Sphagnum* moss has excellent insulating qualities, eventually permafrost is established under the moss cushions. Volume expansion of ice further elevates the permafrost lens above the fen. Eventually permafrost penetrates into the underlying mineral soil and the small peat plateaus merge to form the large peat plateaus evident in the region (Fig. 4). However, disturbance of the insulating surface peat layer can cause the plateau to thaw and collapse back to the original fen stage.

3. In the PRAIRIE wetland zone the high summer temperatures and low rainfall prohibit the growth of peat-forming vegetation. The typical wetlands consist of depressions that become filled with water in the spring, surrounded by marsh vegetation (Fig. 5). Although many depressions become dry during summer, the ground is sufficiently wet to support a marsh on the bottom of the slough. In the aspen parkland region, a border of shrub-by swamp may develop around the sloughs. The combination of shallow open water with surrounding marshes forms an excellent habitat for a wide variety of waterfowl.

4. The TEMPERATE wetland zone is characterized mainly by hardwood and coniferous swamps, although other types of wetlands are also present. The swamps are waterlogged areas of well-decomposed peat that support such hardwoods as maple and yellow birch (*Acer saccharinum, Betula alleghaniensis*) in the east, and al-

Figure 2
Low-centre polygons in the arctic region. The white patch in the foreground is a group of moulting Snow Geese (*Anser hyperborea*)

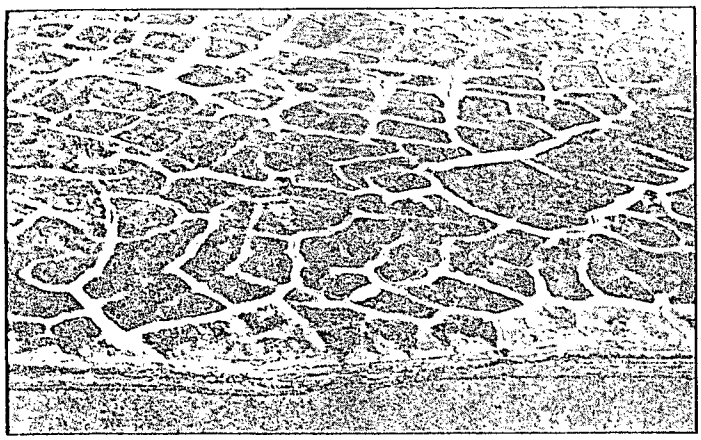


Figure 3
A well-vegetated seepage fen in the polar desert

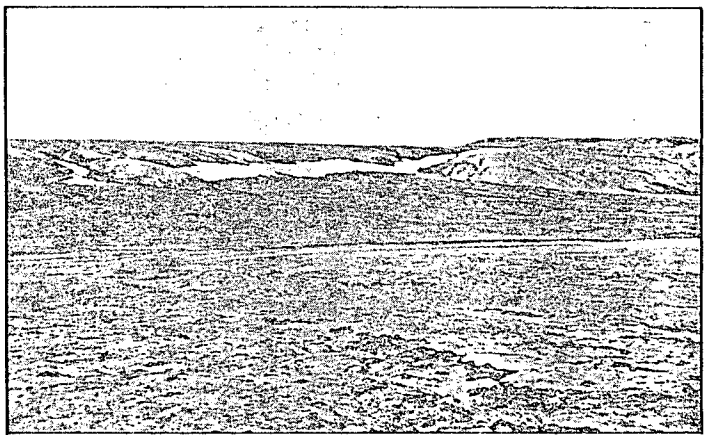


Figure 4
Small, incipient peat plateaus in the subarctic region

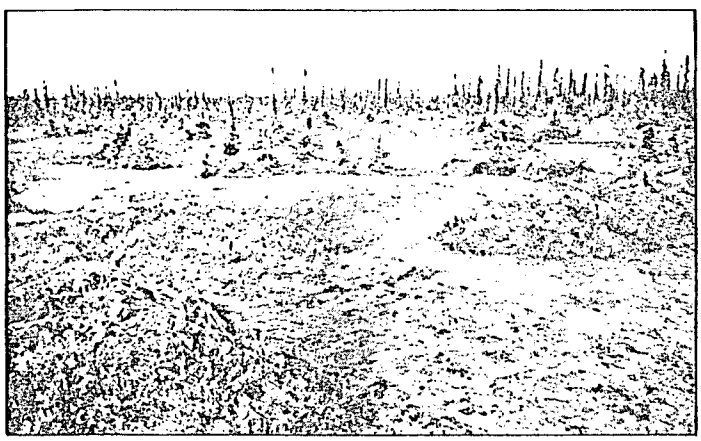


Figure 5
A prairie marsh in the spring — note the muskrat lodges in the mid-distance

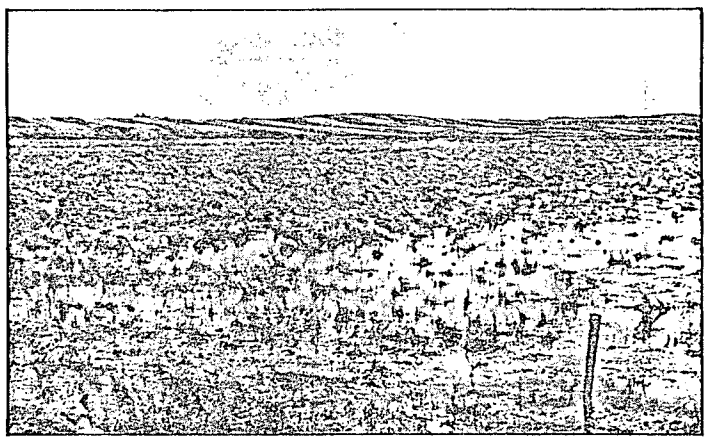


Figure 6
A swamp dominated by hardwoods in the temperate region

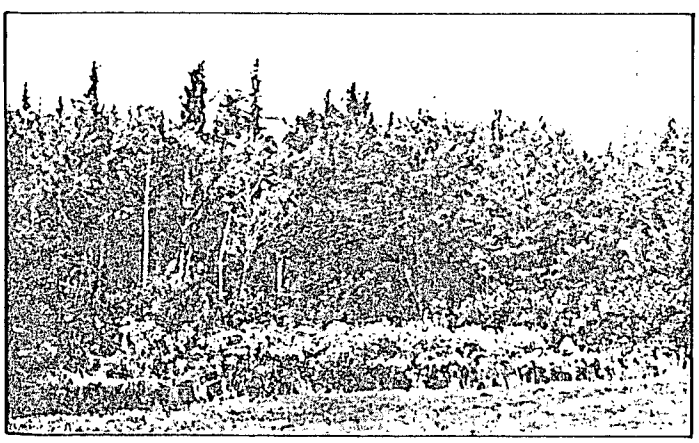
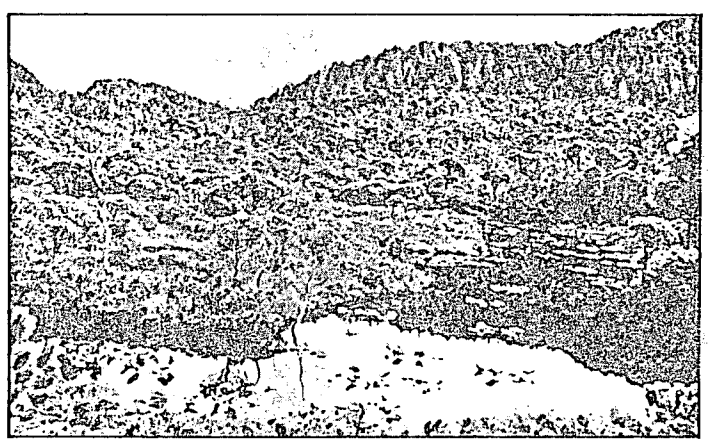


Figure 7
A slope bog with stunted *Pinus contorta* in the oceanic region



der (*Alnus rubra*) in the west, species of the temperate forest (Fig. 6). The wetland develops from a marsh, through fen and bog stages to a swamp. Existing wetlands are all in different stages of this sequence. Marshes occur on some lake margins, providing prime waterfowl habitat. Some large fens and bogs remain relatively undisturbed, although some have been drained to provide productive market gardening lands.

5. The OCEANIC wetland zones occur in coastal areas where the mean annual precipitation is high and winter temperatures are mild (Table 1). The characteristic wetlands are slope bogs or blanket bogs: bogs that developed on gently to steeply sloping terrain. The heavy rainfall permits the growth of peat-forming *Sphagnum* mosses even on steep slopes; the moss retains large amounts of moisture, prompting the development of

Figure 8
A patterned fen with strings in the high boreal region

Figure 9
A small palsa in the high boreal region

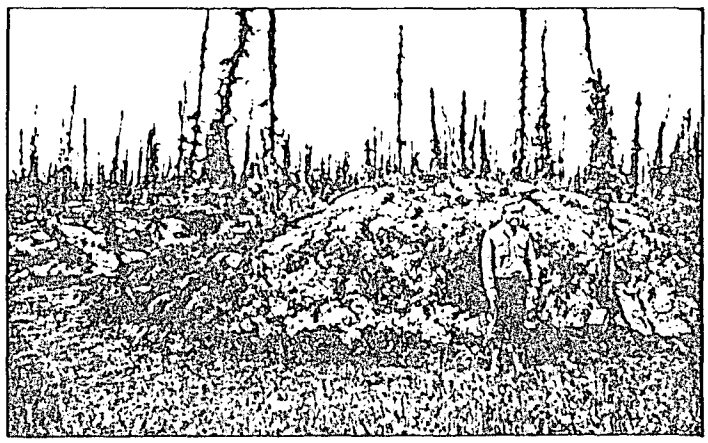


Figure 10
A wooded fen with *Larix laricina* in the mid-boreal region

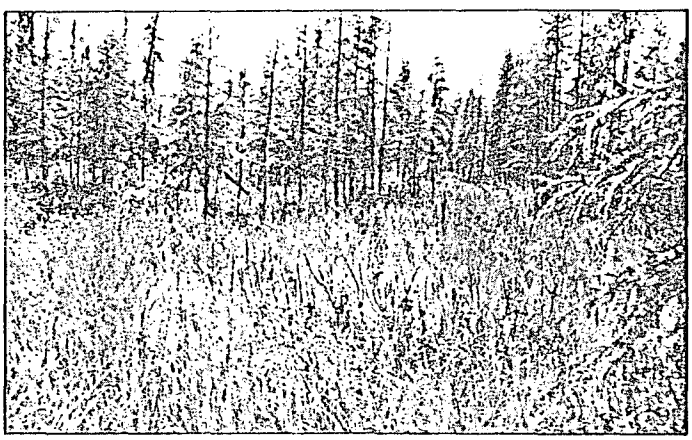


Figure 11
A domed bog with concentric pools in the Atlantic boreal region

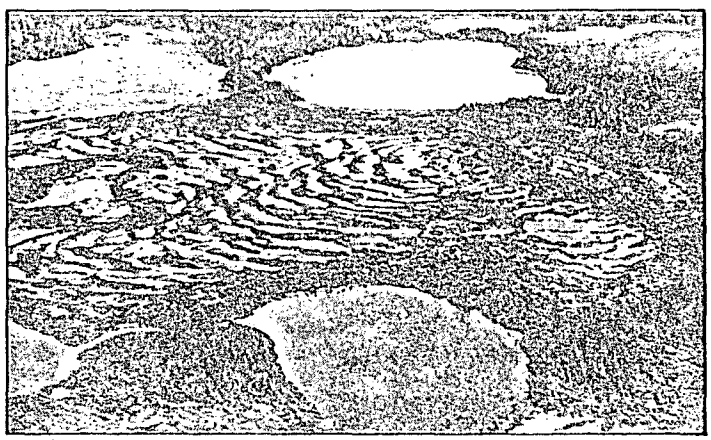


Table 1
Average temperature and precipitation ranges in the wetland zones of Canada (Anon. 1962)

Wetland zone	Mean daily January temp., °C	Mean daily July temp., °C	Mean annual precip., mm
Arctic	−28 – −40	3 – 13	80 – 250
Subarctic	−23 – −30	10 – 17	250 – 500
High boreal	−18 – −23	14 – 18	300 – 800
Mid boreal			
Continental	−15 – −23	16 – 18	400 – 650
Humid	−18 – −23	13 – 18	650 – 1000
Low boreal	−7 – −18	18 – 21	600 – 1050
Atlantic boreal	0 – −18	16 – 18	900 – 1300
Temperate	2 – −7	18 – 22	800 – 1500
Oceanic	4 – −1	13 – 16	2300 – 2550
Prairie	−12 – −18	17 – 20	300 – 500

more hydrophylic vegetation. Often the peat forms small ridges, enclosing small, shallow pools on slopes and ridges. Peat sections show that peat deposited in pools alternates with *Sphagnum* peat of the slope bogs. This indicates that, although the location of the pools has changed over time, the process has been in effect for thousands of years. The slope bogs on the west coast are unique in Canada in terms of their vegetation: stunted pine (*Pinus contorta*) is the dominant tree (Fig. 7) instead of the familiar black spruce (*Picea mariana*).

6. The BOREAL wetland zone stretches across the North American continent within a zone of moderate precipitation, cold winters, and warm summers (Table 1). The characteristic wetlands are various forms of bogs and fens. The zone has been subdivided into regions (Fig. 1) on the basis of wetland development that reflects a north–south temperature gradient, and an east–west moisture gradient.

6a. The *high boreal* region occupies the most northerly portion of the zone where the winters are longer and colder than farther south. The characteristic wetlands are patterned fens and wooded peat plateaus, although many other types of wetlands, such as deltaic marshes occur in suitable areas.

The patterned fens consist of a series of low peat ridges cutting across the drainage in fens (Fig. 8). The areas between the ridges, the flarks, are wet, often with

shallow pools where wading birds can be found. Peat sections reveal that the ridges are usually quite stable, as they have been maintained for thousands of years. Although the vegetation may change on the ridges from shrubby fen to wooded bog conditions, they show drier conditions than the flarks for most of the section. Their mode of formation is still unclear, but it appears to be related to a complex interaction between the water regime and the vegetation.

Wooded peat plateaus and palsas are the only permafrost-affected wetlands in this region. Their formation is similar to that of the more northerly peat plateaus and depends on the insulating qualities of the invading *Sphagnum* moss. Palsas occupy smaller areas than the peat plateaus, but they are considerably higher, often reaching 3–4 m. Palsas usually occur as islands in very wet fens (Fig. 9). Water can penetrate into the palsa from all sides, elevating the palsa as it freezes. Both peat plateaus and palsas are vulnerable to disturbances. If the dense forest growth is removed by cutting or fire, extensive thawing of the frozen core may destroy them. Such areas are marked by collapse scars: nearly circular fens around the collapsing peat plateaus.

6b. The *mid-boreal* wetland region is characterized by cold winters and warm summers (Table 1). In the central part of the continent the mean annual precipitation is considerably lower than in the more humid east (Table 1). The wetlands reflect this difference: in the continental areas treed bogs and fens develop in depressions; in the more humid east treed bogs can develop even on gentle slopes.

Broad expanses of treed fens characterize the continental mid-boreal region; sometimes these display patterns formed by low peat ridges. The trees are dominantly tamarack (*Larix laricina*), with a well-developed willow (*Salix* spp.) and birch (*Betula pumila*) shrub layer, and sedge in the ground layer (Fig. 10). The chief peat-forming mosses are the brown mosses *Drepanocladus* spp. and, in mineral-rich fens, *Scorpidium scorpioides*. The peat sequence shows that some fens originated when shallow ponds were filled in; others progressed from marshes, through various treeless, shrubby, and treed phases.

Bog islands of various sizes are common in fens. The vegetation reflects a lower nutrient status than in the surrounding fen, as shown by the dominant black spruce vegetation, with ericaceous shrubs and a *Sphagnum* moss layer. Peat sections show that many bog islands originated from a slightly elevated part of the lowland: while the wetter areas developed into fens, the drier parts became bogs. In many cases the bog island is expanding slowly over the surrounding fen.

In the humid eastern part of the mid-boreal region domed bogs are found that display a distinct, but low convex shape. The vegetation is characteristic of a habitat poor in nutrients and consists of black spruce, ericaceous shrubs, and *Sphagnum* moss. The peat sections reveal that many of these bogs originated on gently sloping, well-forested land. Bog vegetation spread over the slopes from local depressions or valleys, aided by the high rainfall. Once established, the *Sphagnum* was able to hold vast quantities of water and perpetuate the bog conditions.

6c. The *low boreal* wetland region has cold winters, warm summers, and relatively high precipitation (Table 1). The characteristic wetland is the bowl bog, which is often surrounded by coniferous swamps. Other wetland forms, such as treed and open fens (with or without bog islands) and marshes, are also common. The bowl bogs are situated in depressions, with trees gradually decreasing in height toward the centre. The trees are predominantly black spruce with an ericaceous shrub and *Sphagnum* moss understory. The coniferous swamps that often occur on the bog margins are densely wooded with black spruce or white cedar (*Thuja occidentalis*).

6d. The *Atlantic boreal* wetland region is characterized by cold winters, cool summers, and abundant precipitation (Table 1). The characteristic wetlands are domed bogs, although small fens and swamps are found in appropriate locations. The domed bogs are strongly convex, with the centres 2–5 m higher than the edge. They are mostly treeless, with ericaceous shrubs and *Sphagnum* mosses, but scattered black spruce trees may be found on inland locations. Crescent shaped shallow pools may form a concentric or eccentric pattern on the higher domed bogs (Fig. 11). Peat sections indicate that, although some bogs originated when ponds filled in, most bogs began as fens or swamps in moist depressions. Bogs developed where *Sphagnum* peat accumulated and caused a rise in the water-table.

5. Conclusion

A wide variety of wetlands exist across Canada, each one the result of a particular interaction between climate, surrounding terrain, and hydrology. Some wetlands, such as the prairie marshes, are productive wildlife habitat. Others, such as the boreal bogs, are virtual deserts. Increased pressures on wetlands, whether for biological production or for peat mining, dictate that we must understand the dynamics of wetland ecosystems if we are to avoid costly, and often irreversible, mistakes.

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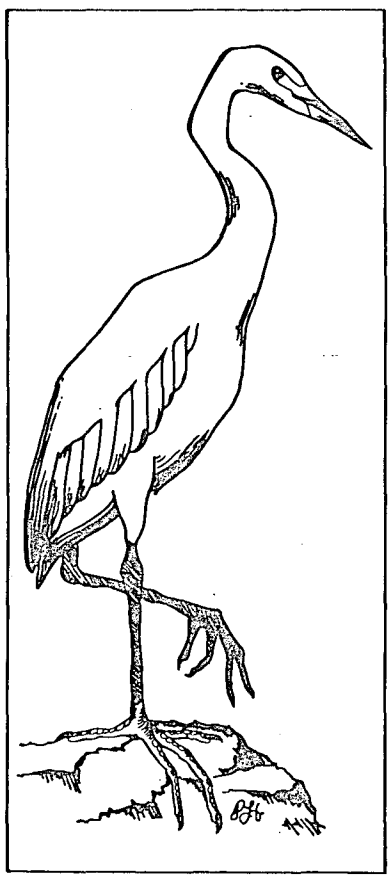

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