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Developing a Wetland Classification for Canada

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A subcommittee of the National Committee on Forest Land[1] was established in 1970 with the mandate to prepare a classification of wetlands for Canada. The proposed classification was to be compatible with the Bio-Physical Land Classification System prepared by the National Committee (11). It was decided that the wetland classification should be based on criteria important to many disciplines. Furthermore, it should be hierarchical in structure, descending from the generalized to the specific level, and be readily applicable to air photo interpretation.

In the early stages of preparation, a number of difficulties confronting a wetland classification were apparent. The greatest difficulty was formulation of a common basis of classification for the many prospective users. Whereas certain wetland attributes must be included for one user's requirements, to another, these same attributes may be of marginal interest. Another problem was posed by the climatic variation across Canada. Wetlands in the semi-arid interior, for example, differ greatly from wetlands in the subartic or in the perhumid maritime regions. Compounding this problem is the variation in amounts and kinds of information available concerning wetlands in these different climatic regions. Wetland terminology also is a problem. Many widely used wetland terms have acquired a number of definitions or meanings, dependent on the emphasis placed upon the term within each classification.

The combination of these problems dictated against the development of a rigid classification at present. Instead, the subcommittee has developed a more tentative approach which is flexible and subject to modification. This approach is presented in a hierarchical framework. The higher levels have

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[1] *This committee was a Federal-Provincial group, established in 1966 by the Department of Forestry and Rural Development to advise the Deputy Minister on matters pertaining to the classification and use of forest land. The committee was dissolved in 1972.*

been assigned multispectral (ecosystemic) definitive and descriptive criteria, the lower levels having more specific criteria. This particular approach should enable many disciplines to use the higher levels of the system as presented while permitting them to deviate into their own subsystem at lower levels, where their needs are more specialized. Guidelines will have to be developed to minimize misuse of the system and to indicate how this system may be applied consistently.

Options Open

Wetlands are areas where wet soils are prevalent (18) having a water table near or above mineral soil, as indicated by gleying in the mineral soil horizon (13). The wetland vegetation, itself influenced by climate, moisture regime, nutrient status, water quality, seed availability, frequency of disturbances, etc. (8, 24) initiates the deposition of peat. The peat buildup, in turn, changes the physical characteristics of the wetland, which is reflected in vegetation development. Therefore, wetlands are dynamic natural systems of interdependent components.

Wetland classifications have been developed in many parts of Europe, the Soviet Union, and in North America, but a comprehensive review is beyond the scope of this paper. Existing classifications usually group wetlands according to external features of the wetlands (vegetation, morphology, etc.) or according to internal features (hydrology, peat chemistry, peat types, etc.)

The classification systems based on external features may be subdivided into those stressing either the biotic or the abiotic elements. The biotic classifications stress features of plant physiognomy, dominance (*e.g.* 9, 14, 25), or floristics (*e.g.* 15).

The abiotic surface characteristics are emphasized in a landform approach to classification where the surface form of sites (8, 22) or of wetlands and their enclosing basins (1, 21) are used to differentiate various types. Patterns of landform and current vegetation apparent on aerial photographs (airforms) are the basis for classifying "muskeg" or peatlands from the air (16).

The internal properties of wetlands are examined to determine soil type and nutrient status. The chief distinguishing parameters examined are the degree of decomposition of the organic residues, the occurrence of other characteristics such as rock or mineral soil substrata, and the floristic origin of the organic residues (13). The nutrient status, as expressed by differences in water chemistry of wetlands, is used as a basis for classification in Europe (2, 6, 7) and in North America (8, 12, 19, 20, 21). Allied to this approach is the classification of Von Post and Granlund (23), based on the origin of water influencing peatland dynamics. Furthermore, Kulczynski (10) classified "peatlands" on the ecological criterion of water movement in conjunction with changes in vegetation through successional sequences.

Close examination of the various wetland classification systems reveals that such systems are somewhat artificial. Without exception, each system incorporates more environmental attributes than those stressed. Those site parameters which are stressed seem to form a framework into which complex wetland systems are conveniently fitted. This form of site categorizing has resulted in extensive overlap among existing wetland classifications.

Table 1. Provisional key to wetland classes.

	Class
1. Well-defined wetland basins in which at least 75% of the area is occupied by central expanses of permanent open water less than 2 m in depth	*Shallow Open Water*
1. Wetlands where permanent open water is restricted to scattered small pools occupying less than 75% of the area, or where standing water is present only seasonally or not at all	*Other Wetlands* – 2.
2. Predominantly ombrotrophic wetlands, developed on acid peat forming a level, raised, or sloping surface with elevated hummocks and wet hollows, usually overlain by a continuous carpet of spongy moss dominated by *Sphagnum*, and supporting a layer of Ericaceous shrubs, with or without trees	*Bog*
2. Predominantly minerotrophic wetlands on less acid peat or mineral soil, without a continuous moss substrate and with a water table persisting seasonally at or very near the surface.	*Fen, Marsh and Swamp* – 3.
3. Open wetlands with level or depressional surfaces except for low hummocks or ridges, and dominated by sedges and grasses. Pools of open water or drainage tracks may be present	*Fen and Marsh* – 4.
3. Wooded, non-bog wetlands usually with a flat or hummocky surface and supporting about 25% cover of trees or tall shrubs more than 1.5 m in height. Associated with stream courses, lake edges, subsurface drainage, glacial depressions, and bog margins	*Swamp*
4. An open, relatively uniform and consolidated surface occasionally with subparallel ridges or elevated islands, linear drainage features, and a dispersion of small pools. Surface vegetation consists of sedges and grasses and a sparse layer of shrubs and trees	*Fen*
4. An unconsolidated open, flat to depressional surface with clumps of emergent sedges, grasses, and reeds interpersed in standing water with occasional small pools and channels, or patches of bare soil exposed during seasonal water drawdowns. Often associated with open water in streams, flowage lakes, glacial depressions, or on marine terraces	*Marsh*

Outline of a Proposed Wetland Classification

At present, the subcommittee has not finalized a wetland classification: however, the following is a favoured approach which complies with the terms of reference and objectives of the subcommittee, but has not yet been tested or scrutinized by possible users. There are four proposed levels of classification:

Level 1.

This level is the most generalized and is based on site features which either constitute or contribute to the physiognomy of the wetlands. The units exhibit considerable integrity regarding surface morphology, soil type, nutrient and moisture regimes, drainage regime, and vegetative cover. The main wetland

Table 2. Provisional and incomplete key to bogs[a]

	TYPE
1. Surface not raised above surrounding terrain	
2. Surface concave	*Bowl Bog*
2. Surface relatively level	
3. With abrupt marginal peat walls in permafrost terrain	*Collapse Bog*
3. Without marginal peat walls	
4. With small sink pools	*Sinkhole Bog*
4. Without sink pools	
5. Adjacent to water bodies	
6. Floating	*Floating Bog* (includes Floating Island Bogs)
6. Not floating	*Shore Bog*
5. Not adjacent to water	*Flat Bog*
1. Surface raised or appreciably sloping	
7. Surface level to irregular, but not conspicuously domed or sloping	
8. With frozen core	
9. With network of polygonal fissures	*Polygonal Peat Plateau*
9. Without fissures	
10. Without thaw pockets	*Peat Plateau*
10. With oval or irregular thaw pockets	*Thermokarst Peat Plateau*
8. Without frozen core	*Bog Plateau*
7. Surface domed or sloping	
11. Abruptly domed, usually in a fen matrix	
12. Frozen core	*Palsa Bog*
12. Without frozen core	*Peat Mound Bog*
11. Gently domed, sloping or with a "stepped" surface	
13. Topographically extensive	*Blanket Bog* (includes Slope Bogs)
13. Topographically confined, usually with central pools and/or marginal wet troughs (flarks) and a marginal fen (lagg)	*Raised Bog*

[a] J. S. Rowe, May 1972, personal communication.

classes are: bogs, fens, marshes, swamps, and shallow open waters (Table 1). The following are definitions of these terms, based on the work of several authors (1, 4, 5, 8, 12, 21).

Bogs. Bogs are peat-covered areas or peat-filled depressions with a high water table and a surface carpet of mosses, chiefly *Sphagnum*. The water table is at or near the surface in the spring, and slightly below during the remainder of the year. The mosses often form raised hummocks, separated by low, wet interstices. The bog surface is often raised, or if flat or level with the surrounding wetlands, it is virtually isolated from mineral soil waters. Hence the surface bog waters and peat are strongly acid and upper peat layers are extremely deficient in mineral nutrients. Peat is usually formed *in situ* under closed drainage and oxygen saturation is very low. Although bogs are usually covered with *Sphagnum*, sedges may grow on them. They may be treed or treeless, and they are frequently characterized by a layer of Ericaceous shrubs.

Table 3. Provisional and incomplete key to fens[a].

	TYPE
1. Surface not raised above surrounding terrain except in low hummocks and ridges	
2. Surface pattern of ridges and depressions	
3. Subparallel pattern of ridges and furrows	
4. Broad pattern along lowland drainages	*String Fen* (includes Ribbed Fen)
4. Narrow ladderlike pattern along bog flanks	*Seepage Fen* (includes Water Track Fen)
3. Reticulate pattern of ridges	*Net Fen*
2. Without pronounced surface pattern	
5. Featureless, without surface water	
6. Adjacent to water bodies	
7. Floating	*Floating Fen*
7. Not floating	*Shore Fen*
6. Not adjacent to water	
8. Fitted to narrow drainages	*Draw Fen*
8. Without obvious drainage control	*Horizontal Fen*
5. With surface water or filled depressions	
9. With round or irregular ponds	*Pond Fen*
9. Depressed thaw hollows	*Collapse Fen*
1. Surface raised or appreciably sloping	
10. Mounds with frozen core in pattern fens	*Palsa Fen*
10. Without frozen core	
11. Surface irregular due to upwelling water	*Spring Fen*
11. Surface regular but sloping	*Slope Fen*

[a] J.S. Rowe, May 1972, personal communication.

Fens. Fens are peatlands characterized by surface layers of poorly to moderately decomposed peat, often with well-decomposed peat near the base. They are covered by a dominant component of sedges, although grasses and reeds may be associated in local pools. *Sphagnum* is usually subordinate or absent, with the more exacting mosses being common. Often there is much low to medium height shrub cover and sometimes a sparse layer of trees. The waters and peats are less acid than in bogs of the same area, and sometimes show somewhat alkaline reactions. Fens usually develop in restricted drainage situations where oxygen saturation is relatively low and mineral supply is restricted. Usually very slow internal drainage occurs through seepage down very low gradient slopes, although sheet surface flow may occur during spring melt or periods of heavy precipitation.

Table 4. Provisional and incomplete key to swamps.

	Type
1. Adjacent to permanent water body	
2. Adjacent to moving water	*Alluvial swamps*
2. Adjacent to non-moving water	*Lakeside swamps*
1. Not adjacent to permanent water body	
3. In topographically defined basins	
4. On perimeter of peatlands	*Peat margin swamps*
4. Not on perimeter of peatlands	*Catchment swamps*
3. Not in topographically defined basins	*Seepage swamps*

Table 5. Provisional and incomplete key to marshes.

	Class
1. Adjacent to or influenced by marine tidal water	
2. In river estuaries or adjoining bays where tidal flats, numerous channels and pools are inundated by fresh, brackish or salt-water	*Estuarine Marsh*
2. On marine terraces remote from estuaries, or in embayments or lagoons behind barrier beaches, where there is periodic inundation by tidal brackish and saltwater	*Coastal Marsh*
1. Adjacent to inland water body	
3. Adjacent to permanent water body	
4. Adjacent to moving water	
5. Occupying water courses or flood plains	*Fluvial Marsh*
4. Adjacent to standing water	
5. Occupying lake shores or bays of flowage lakes	*Lentic Marsh*
3. Not adjacent to permanent water body	
4. Occupying topographically defined basins	*Catchment Marsh*
4. Not in topographically defined basins, usually at low elevations or at the base of slopes	*Seepage Marsh*

Swamps. Swamps are wooded wetlands where standing to gently flowing waters occur seasonally or persist for long periods on the surface. Frequently there is an abundance of pools and channels indicating subsurface water flow. The substrate is usually continually waterlogged. Waters are circumneutral to moderately acid in reaction, and show little deficiency in oxygen or in mineral nutrients. The substrate consists of mixtures of transported mineral and organic sediments, or peat deposited *in situ*. The vegetation cover may consist of coniferous or deciduous trees, tall shrubs, herbs, and mosses. In some regions, *Sphagnum* may be abundant.

Marshes. Marshes are grassy wet areas, periodically inundated up to a depth of 2 m or less with standing or slowly moving water. Surface water levels may fluctuate seasonally, with declining levels exposing drawdown zones of matted vegetation or mud flats. Marshes are subject to a

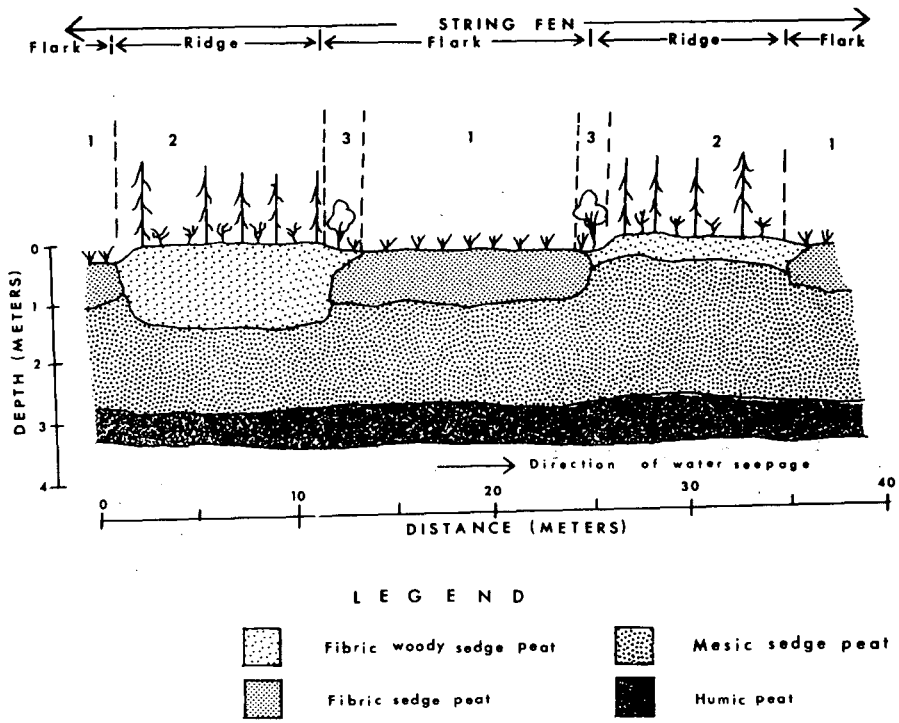

FIGURE 1. String fen, Manitoba. **Location:** 54°21'N & 100°34' W. **Vegetation:** 1. *Carex-Drepanocladus*; 2. *Larix-Chamaedaphne*; 3. *Salix-Carex*. **Remarks:** String fens are typical of patterned fens in the Subarctic Wetland Region. They occupy very slightly sloping depressions, with ridges at right angles to the direction of drainage. They often occur in conjunction with somewhat raised bog plateaus, peat plateaus, or palsas.

gravitational water table, but water remains within the rooting zone of plants during at least part of the growing season. The substratum usually consists of mineral or organic soils with a high mineral content, but there is little peat accumulation. Waters are usually circumneutral to alkaline, and there is a relatively high oxygen saturation. Marshes characteristically show zonal or mosaic surface patterns of vegetation, comprised of unconsolidated grass and sedge sods, frequently interspersed with channels or pools of open water. Marshes may be bordered by peripheral bands of trees and shrubs, but the predominant vegetation consists of a variety of emergent nonwoody plants such as rushes, reeds, reedgrasses, and sedges. Where open water areas occur, a variety of submerged and floating aquatic plants flourish.

Shallow Open Waters. Shallow open waters, which are locally known as ponds or sloughs, are relatively small, nonfluvial bodies of standing water occupying a transitional stage between lakes and marshes. In contrast to marshes, these waters impart a characteristic open aspect, with proportionately large expanses of permanent surface water that lack emergent cover, except for relatively narrow zones adjoining shorelines. Open water usually occupies most of a defined basin area, or is held within large depressions within extensive peat mats. The basin usually exhibits a saucer-shaped profile with gently sloping or recessional shorelines. The discrimination of shallow open waters from deeper lakes is based upon the relative extent of the littoral zone,

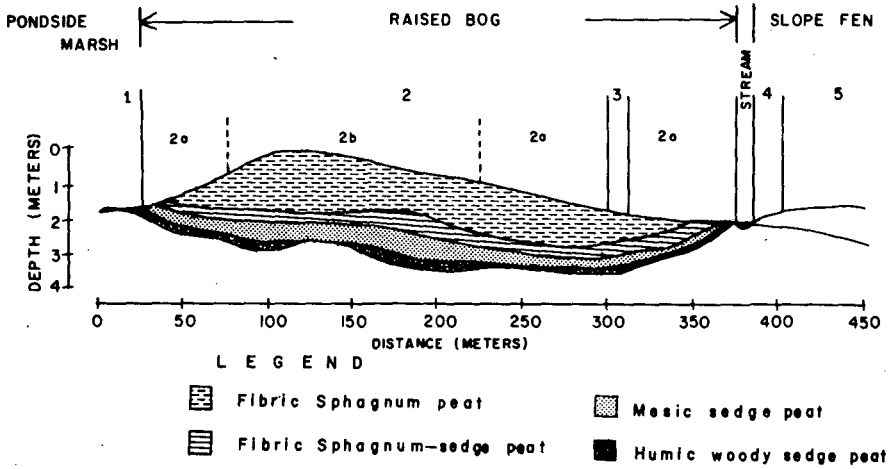

FIGURE 2. Eccentric raised bog, Newfoundland. **Location :** 49°08'N & 56°07' W. **Vegetation :** 1, *Myrico – Caricetum rostratae*; 2. *Kalmio – Sphagnetum fusci* (a) *Typicum*, (b) *Scirpetosum*; 3. *Eriophoro – Sphagnetum papillosi*. **Remarks :** Eccentric raised bogs are typical of raised bogs in the more sheltered locations of the Maritime Boreal Wetland Region. Often they occur in juxtaposition with slope fen.

usually indicated by maximum growth of rooted aquatic macrophytes. This zone, which is arbitrarily defined as the range in depth from 0 to 2 m, usually extends to the middle of the basin or occupies at least 75% of the basin area, with remaining portions occasionally attaining greater depths. Shorelines may be firm, soft, or floating, and they consist of materials varying from rock or silt to organic deposits.

Forms of wetlands which are transitional between the classes described also occur. In general, the wetlands develop from marshes to fens to bogs and in certain areas bogs may develop into swamps. Many other wetland successions have been recorded; for example, in certain regions, swamps develop into bogs. Such transitional stages may be difficult to classify; it has been proposed[2] that such stages, if identifiable, be named by composite names as bogfens, fenmarshes, etc.

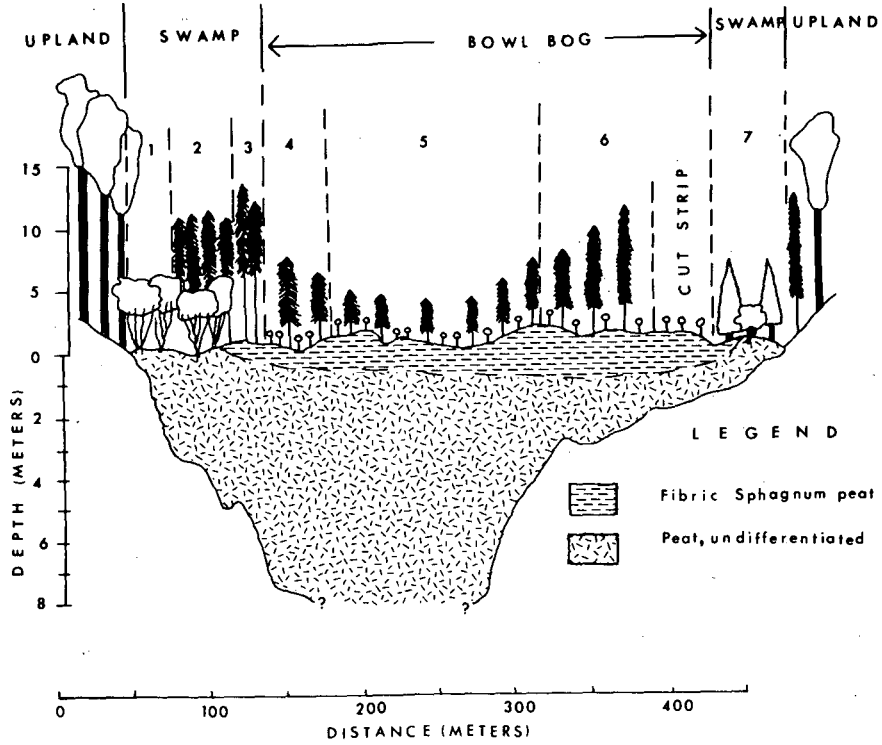

FIGURE 3. Bowl bog, Ontario. **Location :** 48°05' N & 80°11' W. **Vegetation :** 1. *Alnus*; 2. *Picea mariana – Alnus*; 3. *Picea mariana – Sphagnum*; 4. *Picea – Sphagnum – Ericaceae*; 5. *Picea mariana – Chamaedaphne*; 6. *Picea – Sphagnum – Pleurozium*; 7. *Thuja – Alnus*. **Remarks :** The bowl bog occupies the central part of a broad depression, which has a drainage outlet. The bowl is surrounded by taller black spruce growing in a swamp.

Level 2.

This level is based primarily on surface morphology of the wetlands, including the distribution of surface water, and in some cases, on the morphology of the confining basin. Such features as raised or level surfaces, patterns of ridges, depressions, or pools are noted, as shown by the key developed by Rowe[2] (Tables 2 and 3). In contrast to bogs and fens, the marshes and swamps are not readily characterized by surface morphology. The association of marshes and swamps to hydrotopographic features (rivers, lakes, slopes, etc.) can be used to differentiate them (Tables 4 and 5). Shallow open waters may be classified according to the adjoining wetland or land types, *e.g.* mineral pools, bog pools, marsh pools, etc.

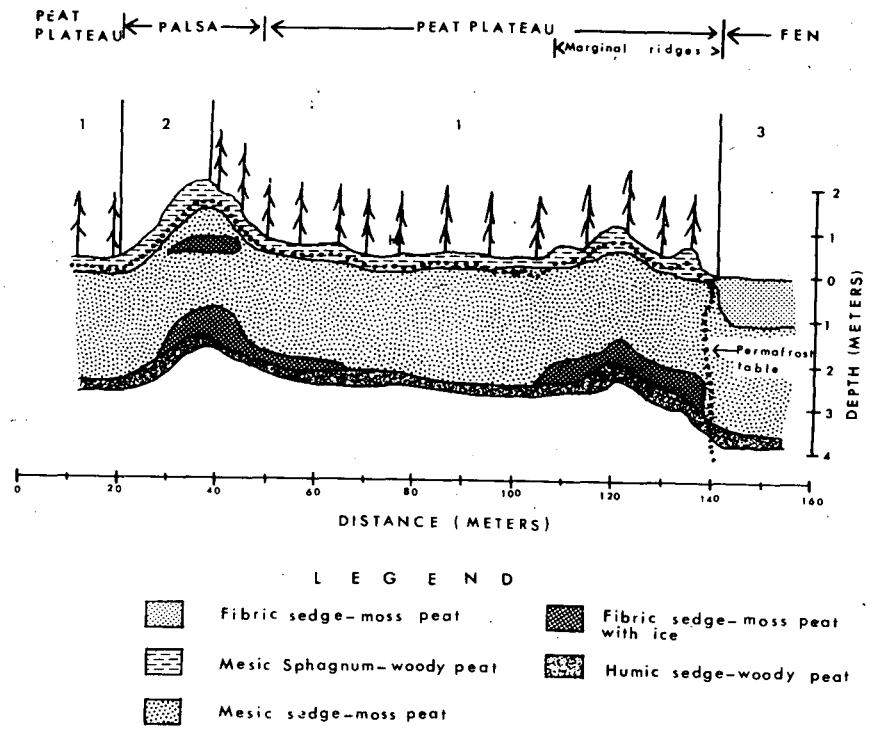

FIGURE 4. Peat plateau and palsa, N.W.T. **Location :** 66°36'N & 133°26' W. **Vegetation :** 1. *Picea mariana – Cladina*; 2. *Ledum – Cladina*; 3. *Carex – Drepanocladus*. **Remarks :** The peat plateau – palsa complex with marginal ridges (near the fen) is characteristic of the perennially frozen peatlands on the Subarctic Wetland Region. They occur in association with fens, often with fen pools.

[2] *J. S. Rowe, May, 1972, personal communication.*

Level 3.

At level 3, the wetland types identified in Level 2 are defined on the basis of their vegetation characteristics. At this level, regional environmental influences, such as regional climate, edaphic conditions, or trophic levels become more important in classification and, subsequently, wetland subdivisions may be defined for each wetland region. For example, a catchment swamp in the St. Lawrence Lowlands may support a heavy growth of hardwood forest, but further north, coniferous forests become the dominant vegetation type, whereas, in subarctic regions, tall shrubs will be growing on such swamps.

Level 4.

In the most detailed level of classification, the specialized needs of disciplines are recognized. For example, if a particular interest lies in botany, the wetlands can be further subdivided into floristic units; wetland units can be evaluated on basis of engineering qualities, etc.

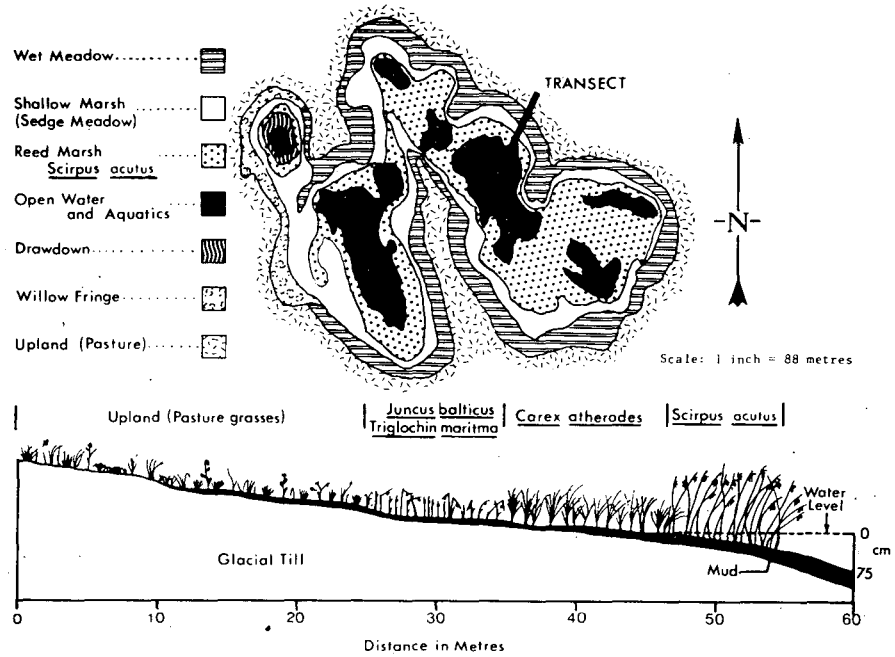

FIGURE 5. Catchment marsh, Manitoba. **Location :** 50°10' N & 100°19' W. **Remarks :** The marsh collects water from undulating clay loam till uplands. Surface waters are semi-permanent, covering 20% of the basin. This catchment marsh is typical of those occurring in the Prairie Wetland Region.

With the present information available concerning wetlands in Canada, the units in each level of classification can only be defined in descriptive terms. To prevent an uncontrolled proliferation of wetland types being incorporated into the literature, it might be desirable that each type in Level 2 be described from a "type" location. Each description would include as much information on the external and internal structure, composition, and physical and chemical characteristics as possible. It is recommended by the subcommittee that a national body scrutinize these submissions and decide whether they are significantly distinct to be included in wetland subtypes. Some attempts at describing certain morphological wetland types have been made by Adams and Zoltai (1) and by Tarnocai (22). Examples of such wetland types, representative of different regions in Canada, are shown in Fig. 1–5.

Wetland Regions

Wetlands, characterized by a complex and dynamic interaction of the biotic and abiotic environment, reflect regional differences in climate. Such regions were recognized in Finland (17) and in Europe (3) on the basis of occurrence of dominant peatland forms, and indications are that similar regions could be defined in Sweden, the Soviet Union, and Canada (17). In Canada, some distinct and sharp boundaries separating different peatland regions have been identified (26), but for the most part our knowledge is

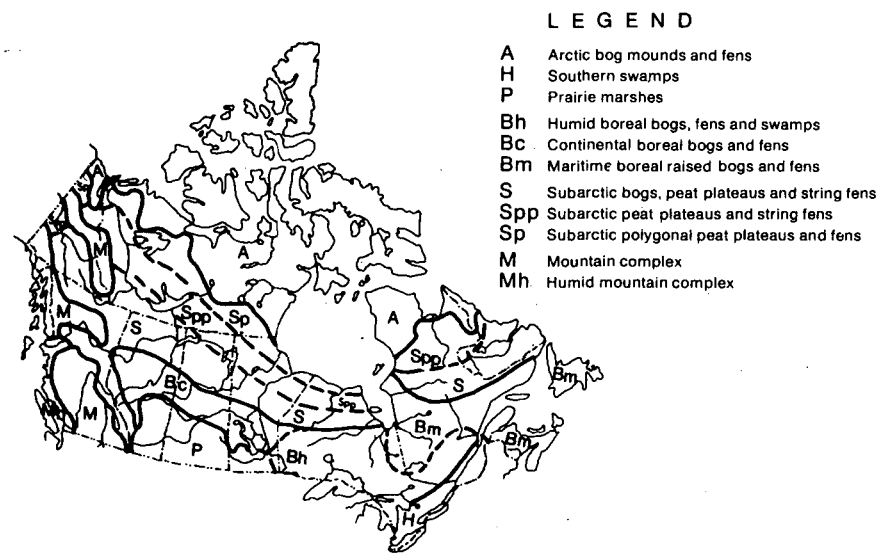

FIGURE 6. Wetland regions in Canada.

insufficient to locate diffuse boundaries. Nevertheless, a broad regional division of Canada is attempted here (Fig. 6) as a first approximation, based on regional tendencies to develop distinctive wetlands in different climatic-edaphic-biotic regions.

Southern Swamps – characterized by heavy growth of hardwood and cedar: bog outliers in cool depressions. Locally prominent marshes.

Prairie Marshes – characterized by fresh and saline marshes, often associated with permanent or intermittent ponds.

Humid Boreal Bogs, Fens, and Swamps – characterized by bogs (often raised) and fens. Swamps with coniferous tree cover occur on former bogs.

Continental Boreal Bogs and Fens – characterized by bogs (often somewhat elevated) and fens. Local marshes and swamps.

Maritime Boreal Raised Bogs and Fens – characterized by domed bogs, blanket bogs, and fens (some patterned). Local marshes and swamps.

Subarctic Bogs, Peat Plateaus, and String Fens – characterized by bogs (often somewhat elevated), wooded peat plateaus elevated by permafrost, and string fens.

Subarctic Peat Plateaus and Fens – characterized by peat plateaus and palsa bogs elevated by permafrost, with fens in thermokarst depressions; patterned fens. Local shrubby swamps.

Subarctic Polygonal Peat Plateaus – characterized by peat plateaus elevated by permafrost displaying a polygonal pattern caused by ice wedges; patternless fens underlain by permafrost.

Arctic Bog Mounds and Fens – characterized by thin peat development in local mounds and in tussocky fens. Polygonal pattern is common. In the high arctic, only local fens occur.

Mountain Complex – variable conditions in temperature and humidity cause peatland forms to transcend several regions.

Humid Mountain Complex – variable conditions in temperature; generally bog and fen development in depressions, blanket bogs in north.

Coastal Marshes – characterized by fresh, brackish and salt marshes in tidal flats.

Conclusions

A hierarchical classification system is provided with four levels of detail determined by the following criteria: Level 1 – physiognomy of the wetland;

Level 2 – surface morphology; Level 3 – vegetation; and Level 4 – needs of particular disciplines. This structure should facilitate a more meaningful communication among wetland users. Nevertheless, the various users must still subject this approach to thorough field tests.

The development of 'Wetland Regions' introduces a further flexibility into the proposed classification system. It enables more precise definition of wetland types within climatically determined regions.

Acknowledgments

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1958. Conference held at Michigan State University.
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1973. Conference held at Laval University, Quebec.
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