ECOLOGICAL ASSESSMENT OF FLOOD CONTROL IN THE MUSQUODOBOIT WATERSHED

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ECOLOGICAL ASSESSMENT OF FLOOD CONTROL IN THE MUSQUODOBOIT WATERSHED

by

Dr. Hinrich Harries

Department of Biology
Mount Allison University
Sackville, New Brunswick

PROGRESS REPORT FOR THE FISCAL YEAR

1967/68

INTRODUCTION

This survey assesses the effects of a flood control program in the Musquodoboit River watershed in Nova Scotia on wetlands in this watershed. It will provide a basis for the consideration of wetland wildlife values in this program and in similar projects elsewhere. The present report summarizes information obtained during the first year of the survey. Generalizations and conclusions given in this report are in some instances in need of support by further evidence. For this reason, information in this report is not to be quoted in publications except by permission of the author. No literature references are given; the following sources were, however, of special importance in relation to the subject of this report.

(1) MacDougall, J.I., D.B. Cann, and J.D. Hilchey. 1963. Soil Survey of Halifax County, Nova Scotia. Report No. 13, Nova Scotia Soil Survey, Truro, N.S. 53 pp.

(2) Williams, N. 1967. Soil and water conservation under the Agricultural and Rural Development Act. Meeting of Fisheries and Wildlife Biologists, Quebec City, Feb. 12 to 15.

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FLOOD CONTROL IN THE MUSQUODOBOIT WATERSHED

The Musquodoboit is a river in Halifax County, Nova Scotia, draining into the Atlantic Ocean east of Halifax. Its watershed covers about 270 square miles. Agricultural use of the Musquodoboit flood plain is impeded by frequent flooding. ARDA conducted a preliminary study on the flooding problem and recommended a combination of headwater control and channel improvement. Headwater control was to be achieved through the building of small storage reservoirs on fifteen tributary streams of the main river, while channel improvement would be accomplished through dredging of constricted sections of the river and through removal of rocks. In response to these recommendations, work on flood control was started in 1967, and two of the proposed fifteen retarding dams were built this year (Jennings Lake and Cox Lake) while four more dams (Frazer Lake, Little River Lake, Shaw Brook and Sherlock Brook) are scheduled for construction in 1968.

WORK DONE TO DATE

Field work included one trip from September 12 to 14, with a total of 25 field hours, accompanied by Mr. Paul Dean and Mr. Jon Van Zoost of the Canadian Wildlife Service, Sackville. Main objective was a survey of the Jennings Lake and Cox Lake areas, both of which are going to be flooded in 1968, in order to have a basis for the assessment of the flooding effects. For each of the two reservoir areas the different surface conditions were grouped into "landscape units" and a map was prepared showing the distribution of these units. Water samples were taken and pH, alkalinity, and chlorinity determined in the laboratory. A brief visit was made to an area along Sherlock Brook where a retarding dam will be built in 1968. A total of 15 hours was spent with the writing of the report.

LANDSCAPE PATTERN

The Musquodoboit watershed can be subdivided into three landscape zones: (a) crystalline uplands, (b) Musquodoboit Valley slopes, (c) Musquodoboit floodplain. These three zones differ with regard to bedrock, surface deposits and topography, soils, vegetation, and land use potential.

Crystalline Uplands. Bedrock are Precambrian quartzites and slates and Devonian granites. Pleistocene ice-caps have scoured the surfaces, with resulting destruction of Pre-pleistocene drainage systems and formation of an irregular topography with low relief, composed of alternating knobs or ridges and basins. The ice-caps have left only a thin veneer of glacial till. This till is stony and bouldery, predominantly of sandy loam texture, and in composition largely in conformity with the underlaying bedrock. Texture of the till shows some difference related to the bedrock source, becoming less coarse and thus with higher water-holding capacity from granite to quartzite to slate till.

Prevalent vegetation are red spruce-fir moss forests or early successional stages following fire with heath shrubs, white birches, and red maple. Soils have a raw humus associated with either a podzol or stagnogley. Soil pH is about 3.5 to 4.0 near the surface and rises to about 5.0 in the subsoil.

The soils of the crystalline uplands are generally too infertile, stony, shallow, and droughty for agriculture. The uplands have therefore been left almost entirely in forest.

Musquodoboit Valley Slopes. This zone includes long and smooth slopes between crystalline uplands and Musquodoboit floodplain. Bedrock is predominantly soft and reddish-brown sedimentary rocks of the Mississippian Windsor formation, including sandstones, mudstones, shales, limestones, and gypsum rocks.

The till layer over the bedrock is deep, of relatively low stone content, and of predominantly sandy clay loam texture.

Soil and forest vegetation are similar to those of the crystalline uplands. Soil pH is, however, somewhat higher, ranging from about 4 near the surface to 5 to 5.6 in the parent material.

At the foot of the till-covered slopes there is a discontinuous belt of interbedded gravel, sand, and finer sediments of glacio-fluviatile character. In some of the lateral valleys branching off the Musquodoboit there are areas of varved glacio-lacustrine silty clay loam deposits. A representative soil profile (MacDougall et al., 1963; p. 22) is distinguished by high pH values ranging from 6.2 at the surface to 7.2 in the subsoil.

A considerable portion of the Musquodoboit valley slopes are cleared. Agricultural use of the land is, however, limited by low fertility, poor drainage, and susceptibility to erosion.

Musquodoboit Floodplain. The Musquodoboit Floodplain is covered by about one to five feet of stone-free silt loam, overlaying a layer of gravel. Topography is level. Most of the floodplain is well-drained. Poorly drained backswamp areas occur away from the main river channel and in contact with the adjacent uplands. The floodplain deposits are distinguished by relatively high base and fertility levels. The pH in a representative soil profile (MacDougall et al., 1963; p. 31) ranges from 5.3 at the surface to 5.6 in the subsoil. The ecology of the floodplain is controlled by the factor of flooding. Flooding limits the biotic component of floodplain ecosystems to those organisms which are tolerant of it. The deposition of unweathered sediment particles is responsible for the maintainance of the floodplain soils in an immature and fertile state.

A cessation of this influence would result in progressive leaching and podzolization of these soils which would consequently lose their relatively base-rich and fertile character and become similar to those of the uplands. Because of the favourable chemical and physical properties of its soils, the floodplain has been almost entirely cleared. Agricultural use is limited, however, by flooding and by a short frost-free season as a result of cold-air drainage into the valley.

WETLANDS OF THE CRYSTALLINE UPLANDS

Wetlands in the crystalline uplands are represented by the Jennings Lake area and the Cox Lake area. The two areas were surveyed in 1967 prior to flooding by storage reservoirs in 1968. Bedrock in the watersheds of the two areas is quartzite and slate. Both wetland areas occupy bedrock depressions, scoured out by Pleistocene ice sheets. Both areas receive from the east a sizeable stream; the East Frazer Brook drains into the Jennings Lake area and the South Musquodoboit into the Cox Lake area.

The eastern part of both wetland areas is occupied by level lowlands with muck or peat soils with water table at or close to the soil surface. Conditions in the lowlands are controlled mainly by the degree of flooding and sedimentation from the streams. Close to the point where the stream leaves the uplands and where there is a sudden decrease in gradient and consequently maximum flooding and sedimentation, conditions are those of a floodplain or delta. Landscape units found here are alder carr and swamp meadow. In greater distance from this junction point and with less flooding influence, these two landscape units are replaced on Jennings Lake by mixed carr, grading into heath bog or, under drier conditions, into swamp forest. On Cox Lake there is, with weakening flooding influence, a gradient from swamp meadow to Rhynchospora fen.

On Cox Lake, streams flowing through these lowlands are widened into runs with almost stagnant water and dys-oligotrophic character. Depth is about 2 to 4 ft. They border onto the the adjacent peatlands with a steep margin, about 2 ft. in height. Jennings Lake and Cox Lake are likewise dys-oligotrophic. They border to the east with a similar steep margin onto carr or fen, while elsewhere they are in direct contact with forest-covered uplands, with quartzite bedrock covered by a very bouldery and stony till. In spite of the relative steepness of the adjacent lower slopes, the two lakes appear to be relatively shallow, probably reaching not much below 6 ft. depth.

The following landscape units were observed in the two wetland areas: running waters, dys-oligotrophic waters, Rhynchospora fen, bog heath, swamp meadow, alder carr, mixed carr, swamp forest.

Running Waters. Along the South Musquodoboit River, two portions of wide and stagnant run are separated by a rather narrow section with considerable current. This section contained an aquatic vegetation formed by a grass (cfr. Glyceria spec.), water-horsetail (Equisetum fluviatile) and the rush Scirpus subterminalis.

Dys-Oligotrophic Waters. All bodies of standing water are classified as belonging to the dys-oligotrophic waters. The water is base-poor, with pH values between 6 and 7 and alkalinity values in the very soft range (< 11 ppm $CaCO_3$). It is stained yellowish brown with Secchi disk readings between 3 and 6 ft. The vegetation is distinguished by the almost complete lack of submerged species of Potamogeton, Myriophyllum, and other genera, characteristic of eutrophic to mesotrophic waters and by the prominence of emergent aquatics, including the rush Juncus militaris, pickerelweed (Pontederia cordata), and the burr-reed Sparganium americanum, and of the submerged aquatics white-buttons (Eriocaulon septangulare) and the rush Scirpus subterminalis.

In Jennings Lake the shallow periphery of the lake is occupied by a dense aquatic vegetation composed of a considerable number of species. The deeper central part of the lake, on the other hand, is devoid of vascular plants. Most prominent in the former is a continuous belt of Juncus militaris, occurring at a depth of about 1.5 to 3.5 ft. In the more shallow parts of this belt and shoreward of it are dense stands of Pontederia cordata. Between the emergents and both outward and shoreward of them are pads of Nymphaea odorata and some floating-leaf pondweed (Potamogeton natans). In shallow water, in between and shoreward of the emergent plants, Eriocaulon septangulare and Scirpus subterminalis are dominants. Other species, occurring occasionally in this shoreward belt of aquatic vegetation are arrowhead (Sagittaria latifolia), floating-leaf burr-reed (Sparganium fluctuans), pond lilies (Nuphar variegatum and N. microphyllum), floating-heart (Nymphoides cordata), quillwort (Isoetes muricata) and water-lobelia (Lobelia dortmanna), both occurring in association with Eriocaulon septangulare in shallow water on mineral bottom material, several bladderworts (Utricularia vulgaris, U. geminiscapa, U. purpurea), milfoil (Myriophyllum farwellii) and pondweeds (Potamogeton confervoides, P. pusillus, and cfr. P. epihydrus).

In Cox Lake there is a similar shoreward belt of aquatic vegetation; it is, however, more poorly developed, both in extent and in the number of species. On Cox Lake this belt is also $\pm$ discontinuous, being restricted largely to wind-sheltered, east-facing shores. Dominant close to the shore line is Pontederia cordata with lesser amounts of Juncus militaris. Outward of the emergent vegetation Nymphaea odorata is dominant. The floating-leaf pondweed Potamogeton oakesianus occurs locally. Apparently lacking entirely are submerged species of Potamogeton and Myriophyllum.

A quite different vegetation is found in the runs dissecting the fen areas east of Cox Lake. Dominant along the water edge is three-way sedge (Dulichium arundinaceum). In contact with it is a belt of emergent aquatics, formed shoreward by burr-reed (Sparganium americanum) and outward by pickerel weed (Pontederia cordata). Apart from this belt, the runs are largely devoid of vegetation, in spite of only 2.5 to 4 ft. depth and light penetration to the bottom, except for occasional plants of pond lily (Nuphar variegatum), sea lily (Nymphaea odorata), the rush Scirpus subterminalis, and the pondweed Potamogeton epihydrus. Found only once each were the two floating-leaf burr-reeds Sparganium angustifolium and Sparganium fluctuans. In narrow and shallow ditches in the fen occur the bladderworts Utricularia intermedia and U. vulgaris, the floating-leaf pondweed Potamogeton oakesianus, and the sea lily Nymphaea odorata.

Marsh. The marsh landscape unit is entirely lacking in the Jennings Lake area and represented in the Cox Lake area only by a small patch of cattail (Typha latifolia) on the south shore of the lake.

Rhynchospera Fen. This landscape unit covers a considerable proportion of the Cox Lake area. The soil is a compact and shallow peat which is water-logged up to or close to the surface. Dominants are rushes and sedges, including Rhynchospora alba, Carex michauxiana, Carex lasiocarpa, and Dulichium arundinaceum. In relatively dry areas either of the former two is dominant while in wetter areas dominance shifts to either of the two latter. Dulichium arundinaceum is especially prominent along the edge of runs. Other species are the rush Juncus pelocarpus, the cotton-grasses Eriophorum tenellum and E. virginicum, yellow-eyed grass (Xyris montana), the orchid Habenaria clavellata, hardhack (Spiraea tomentosa), sweet gale (Myrica gale), leatherleaf (Chamaedaphne calyculata), cranberry (Vaccinium macrocarpon), bog-rosemary (Andromeda glaucophylla - in wet areas close to the

water edge), St. John's-worts (Hypericum canadense, H. ellipticum, H. virginicum), violets (Viola lanceolata, V. primulifolia, V. cfr. pallens), sundew (Drosera intermedia), mermaid-weed (Proserpinacea pectinata), willow-herb (cfr. Epilobium palustre), screw-stem (Bartonia paniculata), boneset (Eupatorium perfoliatum), bog aster (Aster nemoralis), goldenrod (Solidago graminifolia), and the clubmoss Lycopodium inundatum. Bryophytes are represented mainly by sphagnum-mosses. These occur, however, generally only in scattered patches and become only locally dominant.

Areas transitional towards the swamp meadow are distinguished by the rushes Juncus canadensis and Scirpus cyperinus and the grasses Agrostis scabra, Calamagrostis canadensis, and Glyceria obtusa, blue flag (Iris versicolor), loosestrife (Lysimachia terrestris), the aster Aster umbellatus, the goldenrod Solidago rugosa, the royal fern Osmunda regalis, and the sensitive fern Onoclea sensibilis.

Bog Heath. The bog heath landscape unit occupies the center of a lowland area extending southwestward from Jennings Lake, and grades towards the upland edge into mixed carr. Dominants in the bog heath are rhodora (Rhododendron canadense) and leatherleaf (Chamaedaphne calyculata). Other species include black spruce (Picea mariana), larch (Larix laricina), witherod (Viburnum cassinoides), mountain holly (Nemopanthus mucronata), laurels (Kalmia angustifolia and K. polifolin), Labrador tea (Ledum groenlandicum), bog-rosemary (Andromeda glaucophylla), crowberry (Empetrum nigrum), sweet gale (Myrica gale) chokeberry (Pyrus floribunda), cotton grasses (Eriopherum spissum and E. virginicum), goldenrod (Solidago uliginosa), pitcher plant (Sarracenia purpurea), sphagnum mosses, and lichens (Cladonia mitis, C. rangiferina).

Swamp Meadow. This landscape unit is found under floodplain or delta conditions in both Jennings Lake and Cox Lake areas. It is dissected by narrow and deep (2 ft. +) water channels with steep edges, containing either stagnant or

running water. These channels are generally free of aquatic vegetation, possibly due to shading by the banks and tall vegetation. The surface of the swamp meadow itself may have in the wetter areas a more or less tussocky character. Main dominant, and over considerable areas only vascular plant, is the blue-joint grass (Calamagrostis canadensis). Other dominants, especially in the wettest areas are the rattlesnake grass (Glyceria canadensis) and tall sedges (Carex lurida and other spp.). Herbs include sensitive fern (Onoclea sensibilis) and water-horehound (Lycopus uniflorus). Various tall compositae occur under relatively dry conditions, including goldenrods (Solidago canadensis, S. rugosa, and S. uliginosa) and asters (Aster umbellatus and cfr. A. folicens).

Alder Carr. Alder carr (dominant Alnus rugosa) occurs in both wetland areas on delta sites upstream from the swamp meadow. Along the edge between the two landscape units there are found in the Cox Lake area scattered shrubs of willow (Salix rigida).

Mixed Carr. The mixed carr is found in the Jennings Lake area under conditions of no or little flooding influence. Dominants are medium-sized shrubs, including sweet gale (Myrica gale), meadow-sweet (Spiraea latifolia), chokeberry (Pyrus floribunda), rose (Rosa nitida), winterberry (Ilex verticillata) and leatherleaf (Chamaedaphne calyculata). Other species are the royal fern (Osmunda regalis), aster (Aster cf. radula), and goldenrod (Solidago uliginosa).

Swamp Forest. Landward, the mixed carr on the southeast shore of Jennings Lake grades into a swamp forest with larch (Larix laricina) and red maple (Acer rubrum). The trees had been logged during the previous year in preparation for the flooding, and it was therefore not possible to describe this landscape unit properly.

WETLANDS OF THE MUSQUODOBOIT VALLEY SLOPES

Wetlands of the Musquodoboit Valley Slopes are represented by the Sherlock Brook impoundment site. As noted during a brief visit, landscape units in this wetland area differ greatly from those in the crystalline uplands, probably mainly due to a very different base status. A water sample had an alkalinity of 139 ppm as compared to values of 6-11 ppm in the Jennings Lake and Cox Lake areas. Related to this high base status is the occurrence of such calciphilous plants as golden-hardhack (Potentilla fruticosa), showy lady's slipper (Cypripedilum reginae), and the algae Chara spec., and the prevalence of "brown mosses" (fam. Amblystegiaceae) rather than sphagnum mosses in the fen vegetation. This interesting area will be surveyed in more detail in 1968, prior to flooding scheduled for 1969.

WETLANDS OF THE MUSQUODOBOIT FLOOD PLAIN

The wetlands of the Musquodoboit Flood plain have yet to be investigated.

ANIMAL LIFE

Crystalline Uplands. It appears that in the wetland ecosystems the animal component is relatively poorly represented. Mollusks are apparently lacking. During the two field days waterfowl were observed only twice, a diving duck (cf. ring-necked) on Jennings Lake and a flock of circ. 10 black ducks on the run of the South Musquodoboit River northeast of Cox Lake. The muskrat is apparently absent from the two areas.

Musquodoboit Valley Slopes. No observations.

Musquodoboit Flood Plain. No observations.

FLOOD CONTROL AND WILDLIFE VALUES

The flood control measures in the Musquodoboit Watershed will have a two-fold effect on wildlife values. On one hand, there will be a local effect in the impounded upland areas where there will be an increase in area, depth, and seasonal water level fluctuations of the affected water bodies and a corresponding loss through flooding of other landscape units. On the other hand, there will be an over-all effect on the Musquodoboit flood plain due to reduction in the frequency and extent of flooding.

Jennings Lake has a level of 281 ft. and occupies about 44 acres. The planned impoundment will have a maximum summer water level of 285 ft. At this level, the lowlands adjacent to the lake, formerly occupied by swamp forest, alder carr, mixed carr, heath bog, and swamp meadow, will be flooded by the impoundment. This impoundment will cover about 100 acres and will extend on all sides up to the upland slope. Over about 1/2 of its area, the impoundment will be only 1 to 4 ft. deep at the summer maximum, and some of its bottom will become exposed when the water level goes down. Over a large part of its area the impoundment will be

shallow enough to support rooting plants and to be potentially attractive to game ducks. Fluctuations in water levels and base- and nutrient-poverty will, however, be limiting factors.

Cox Lake has a water level of 389.5 ft. and occupies about 40 acres. Minimum and maximum water levels of the planned impoundment will be, respectively, 395 ft. and 398 ft. At the minimum level the lowlands adjacent to the lake, formerly occupied by alder carr, swamp meadow, and Rhynchospora fen, will be flooded. The impoundment will then cover about 200 acres and will extend almost everywhere up to the upland slope. Its depth will range largely from 1.5 to 5.5 ft. at the summer low and from 4.5 to 8.5 ft. at the summer high, except for the area of the present Cox Lake which will be deeper. Much of the impoundment will be too deep as to be potentially attractive to game ducks and possibly even as to support rooting plants. As in the Jennings Lake impoundment, fluctuations in water levels and base- and mineral-poverty will be limiting factors.

Winter maxima anticipated for the two impoundments will be, respectively, at 290 ft. and 405 ft., or 5 ft. and 7 ft. above the summer high. The area which will thus be exposed in summer but may be flooded in winter is small because of relatively steep slopes and is largely covered by forest. It will be interesting to see how this vegetation will be modified by winter flooding.

In the impoundment areas there will be striking changes as result of the raised and strongly fluctuating water levels. The over-all character of these changes will be one of simplification; relatively complex patterns, composed of several landscape units and of many species, will be replaced by more simple and uniform conditions, with a decrease in the number of both landscape units and species. This loss may be considered as not too serious for the Jennings Lake and Cox Lake areas, because the conditions in these two areas, while interesting, are found widely on the Atlantic Slope of Nova Scotia. The Sherlock Brook

area, on the other hand, because of base-rich parent material in its watershed, is distinguished by rare and localized occurrences of species, landscape units, and landscape pattern, and its destruction by flooding has to be regretted.

Flooding of the Jennings Lake and Cox Lake areas would be most beneficial to animals, and especially game ducks, if it would result in a relatively constant summer water level not more than two feet above the present surface of the lowlands adjacent to the two lakes. This condition is approached in the Jennings Lake impoundment, while the water levels planned for the Cox Lake impoundment appear too high.

It appears doubtful whether even with optimal water levels the two reservoir areas would become productive habitats because of unfavourable nutrient levels. Nutrient levels might be improved by liming and possibly fertilizing. Conditions for such manipulation appear, however, rather unfavourable because of the strong flow of water through both impoundments. It is thus proposed that at the present no special consideration should be given to wildlife values in either of the two impoundments, but that changes brought about as a result of water impoundment be observed, and their importance with regard to habitat management for wildlife be assessed.

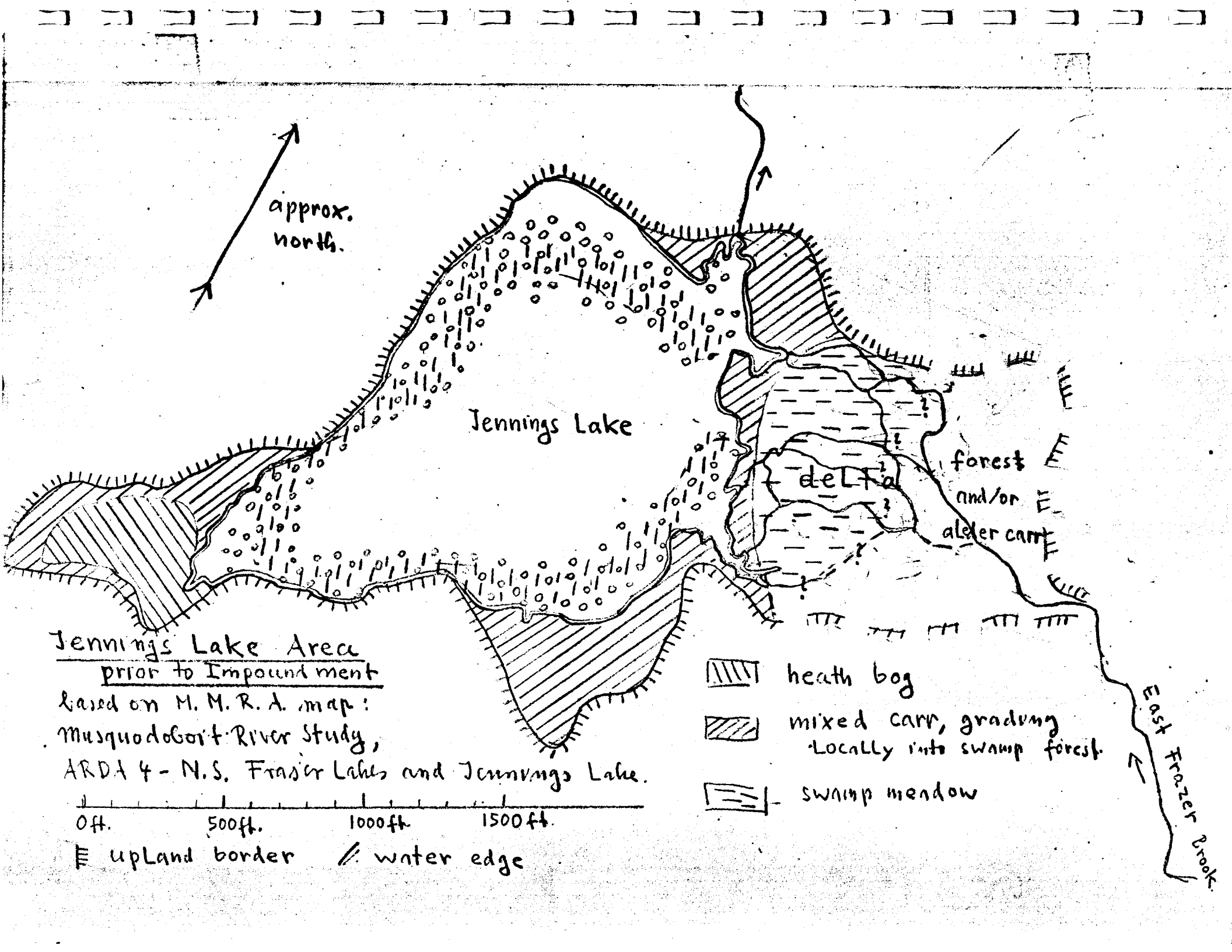
WORK PLANNED FOR 1968/69

The work planned for 1968/69 does include the following items:

(1) Assess changes resulting from impoundment in the Jennings Lake and Cox Lake areas.

(2) Survey the Frazer Lake, Little River Lake, Shaw Brook, and Sherlock Brook impoundment areas in order to obtain a basis for assessment of changes as result of flooding, beginning in winter 1968/69.

(3) Start with a survey of wetlands on the Musquodoboit flood plain in order to obtain a basis for assessment of changes, brought about by reduction in the frequency and extent of flooding as result of flood control.


approx. north.
Jennings Lake
delta
forest and/or alder carr
heath bog
mixed carr, grading locally into swamp forest
swamp meadow
East Fraser Brook
Jennings Lake Area
prior to Impoundment
based on M. M. R. A. map:
Musquodoboit River Study,
ARDA 4 - N.S. Fraser Lakes and Jennings Lake.
0ft.
500ft.
1000ft.
1500ft.
upland border
water edge

South Musquodoboit River

Lewis Black Brook

approx. north

Cox Lake

delta

South Musquodoboit River

Cox Lake Area prior to Impoundment

based on M.M.R.A. map: Musquodoboit River Study, ARDA 4 - N.S. Mill Lake Area.

0 ft. 500 ft. 1000 ft. 1500 f

- upland border
- water edge
- forest
- alder carr
- swamp meadow
- Rhynchospora carr
- sw. mead. - Rh. carr intergrade
- emergent and floating-leaf aquatics