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CRANDON PROJECT

WETLANDS ASSESSMENT REPORT

Prepared for

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TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION 1.0-1

2.0 REGIONAL INFORMATION 2.1-1

2.1 REGIONAL GEOLOGY 2.1-1

2.1.1 Surficial and Bedrock Geology 2.1-1
2.1.2 Ground-water Hydrology 2.1-1
2.1.3 Surface Water Hydrology 2.1-3

2.2 WETLAND SOILS 2.2-1

2.3 VEGETATION 2.3-1

2.4 ANIMALS 2.4-1

2.4.1 Herpetofauna 2.4-1
2.4.2 Avifauna 2.4-2
2.4.3 Mammals 2.4-2

3.0 DESCRIPTION OF THE WETLAND STUDY AREA 3.1-1

3.1 PHYSICAL SETTING 3.1-1

3.2 VEGETATION 3.2-1

3.3 WILDLIFE 3.3-1

3.3.1 Herpetofauna 3.3-1
3.3.2 Avifauna 3.3-2
3.3.3 Mammals 3.3-2

3.4 PROPOSED PROJECT ACTIVITIES WITHIN THE STUDY AREA . 3.4-1

3.5 WETLANDS OF SPECIAL INTEREST 3.5-1

4.0 METHODS 4.1-1

4.1 WETLANDS DEFINITION AND IDENTIFICATION 4.1-1

4.2 WETLANDS CLASSIFICATION 4.2-1

4.3 WETLAND MAPPING 4.3-1

PAGE

4.4 QUANTITATIVE FIELD INVENTORY 4.4-1

4.4.1 Vegetation 4.4-1
4.4.2 Herpetofauna 4.4-5
4.4.3 Avifauna 4.4-6
4.4.4 Mammals 4.4-7

4.5 EVALUATION ELEMENTS AND IMPLEMENTATION OF WETLAND INVENTORY 4.5-1

4.5.1 Evaluation Elements 4.5-1
4.5.2 Implementation of Wetland Inventory 4.5-5

4.6 DEVELOPMENT AND ADAPTATION OF MODELS 4.6-1

4.7 AQUATIC STUDY AREAS, SANCTUARIES AND REFUGES WITHIN STUDY AREA 4.7-1

4.8 REGIONAL WETLAND ANALYSIS 4.8-1

5.0 WETLANDS EVALUATION PROCEDURE 5.0-1

6.0 RESULTS AND DISCUSSION 6.0-1

6.1 QUALITATIVE AND QUANTITATIVE FIELD STUDIES 6.1-1

6.1.1 Qualitative Description of Wetlands of Special Interest 6.1-1
6.1.2 Quantitative Field Inventory 6.1-31

6.1.2.1 Vegetation 6.1-31
6.1.2.2 Herpetofauna 6.1-41
6.1.2.3 Avifauna 6.1-43
6.1.2.4 Mammals 6.1-52

6.1.3 Threatened and Endangered Species 6.1-57

6.1.3.1 Vegetation 6.1-58
6.1.3.2 Herpetofauna 6.1-58
6.1.3.3 Avifauna 6.1-61
6.1.3.4 Mammals 6.1-61

6.2 MODEL RESULTS FOR WETLANDS 6.2-1

6.2.1 Unnormalized Data 6.2-1
6.2.2 Normalized Data 6.2-8

6.3 ANALYSIS OF MODEL RESULTS FOR WETLANDS OF SPECIAL INTEREST 6.3-1

6.3.1 Biological Function Model 6.3-1

PAGE

6.3.2 Watershed Function Models 6.3-12
6.3.3 Socio-Cultural Models 6.3-23
6.3.4 Summary of Model Results 6.3-32

6.4 COMBINED WETLAND RANKING 6.4-1

6.4.1 Unnormalized Values 6.4-1
6.4.2 Normalized Values 6.4-8

6.5 REGIONAL CONTEXT EVALUATION 6.5-1

6.6 AQUATIC STUDY AREAS, SANCTUARIES, AND REFUGES WITHIN THE STUDY AREA 6.6-1

7.0 QUALITY ASSURANCE 7.0-1

8.0 LITERATURE CITED 8.0-1

APPENDICES

A. Surficial Geologic History A-1

B. General Ecology of Wetland Types B-1

C. Description of Wetland Inventory Elements C-1

D. Wetland Inventory Report Example D-1

E. Description of Wetland Functional Models E-1

F. Model Use Examples F-1

G. Wetland and Watershed Area Data G-1

H. Regional Scarcity Measurements H-1

I. Wetland Inventory Reports I-1

J. Vegetation and Wildlife Data J-1

K. Threatened and Endangered Species K-1

L. Wetland Ranking Normalization Procedure L-1

LIST OF FIGURES

		PAGE
2.1-1	Regional area for the proposed Crandon Project, wetlands assessment	2.1-2
2.1-2	Hydrologic section showing distribution of hydraulic head for a one-lake system with an extensive aquifer of relatively low hydraulic conductivity in the middle of the ground-water system and illustrating the local aquifer and the main aquifer. Modified from Winter (1976)	2.1-4
3.1-1	Study area for the proposed Crandon project wetlands assessment	3.1-2
3.4-1	Proposed Crandon Project activities within the wetlands study area	3.4-2
3.5-1	Spatial relationships between wetlands of special interest and proposed project activities within the study area	3.5-2
3.5-2	Map showing wetlands of special interest in relation to proposed project activities	(oversize)[a]
4.3-1	Composite map showing watersheds and wetlands within the study area	(oversize)
4.3-1A	Section 1 of the composite map showing watersheds and wetlands associated with the northwest portion of the proposed access road corridor	(oversize)
4.3-1B	Section 2 of the composite map showing watersheds and wetlands associated with the main portion of the proposed access road corridor	(oversize)
4.3-1C	Section 3 of the composite map showing watersheds and wetlands associated with the main portion of the proposed railroad spurline corridor	(oversize)
4.3-1D	Section 4 of the composite map showing watersheds and wetlands associated with the northwest portion of Area 40	(oversize)
4.3-1E	Section 5 of the composite map showing watersheds and wetlands associated with Area 40, mine/mill site, southern portion of the proposed access road and railroad spurline and the northern edge of Area 41	(oversize)

[a]all oversize figures are in the Map Volume.

		PAGE
4.3-1F	Section 6 of the composite map showing watersheds and wetlands associated with the northwest portion of Area 41	(oversize)
4.3-1G	Section 7 of the composite map showing watersheds and wetlands associated with the southwest portion of Area 40	(oversize)
4.3-1H	Section 8 of the composite map showing watersheds and wetlands associated with the southeast portion of Area 40 and the south central portion of the study area	(oversize)
4.3-1I	Section 9 of the composite map showing watersheds and wetlands associated with the southern portion of Area 41	(oversize)
4.4-1	Map showing wetlands in which quantitative biological studies were conducted. (Detailed figure presented in map volume.)	4.4-2
4.8-1	Map of study region showing areas of aerial photograph interpretation and hydrogeologic regions. (Detailed figure is presented in map volume) . . .	4.8-2
6.1-1A	Wetlands of special interest associated with Candidate Tailings Disposal Area 41	6.1-3
6.1-1B	Wetlands of special interest associated with Candidate Tailings Disposal Area 41	6.1-4
6.1-1C	Wetlands of special interest associated with Candidate Tailings Disposal Area 41	6.1-5
6.1-2	Wetlands of special interest associated with Candidate Tailings Disposal Area 40	6.1-15
6.1-3	Wetlands of special interest associated with the proposed Access Road Corridor	6.1-22
6.1-4	Wetlands of special interest associated with the proposed Railroad Spurline Corridor; F13 and F114 are not shown on this figure	6.1-25
6.1-5	Wetlands of special interest associated with the Mine/Mill Site	6.1-29

LIST OF TABLES

		PAGE
3.5-1	Wetlands of special interest	3.5-3
3.5-2	Wetlands in which quantitative studies were conducted	3.5-5
4.2-1	Comparison between the National and Wisconsin Wetland Classification Systems and commonly used terminology	4.2-3
4.4-1	Vegetation inventory sheet for proposed Crandon Project wetlands assessment	4.4-4
4.4-2	Summary of trapping effort in the wetland habitat types of the study area on June 17-20, 1981	4.4-9
6.1-1	Summary of major elements used to describe and evaluate wetlands of special interest	6.1-2
6.1-2	Summary of phytosociological characteristics of three marsh communities (Transects 6, 7 and 15; 15 plots sampled) in the study area	6.1-33
6.1-3	Summary of phytosociological characteristics of three shrub swamp communities (Transects 3, 11 and 13; 13 plots sampled) in the study area	6.1-34
6.1-4	Summary of phytosociological characteristics of three deciduous swamp communities (Transects 1, 5 and 12; 15 plots sampled) in the study area	6.1-36
6.1-5	Summary of phytosociological characteristics of three bog communities (Transects 4, 10 and 14; 14 plots sampled) in the study area	6.1-38
6.1-6	Summary of phytosociological characteristics of four coniferous swamp communities (Transects 2, 16, 17 and 18; 19 plots sampled) in the study area . .	6.1-40
6.1-7	Summary of herpetofaunal utilization of wetlands in the study area, April-June 1981	6.1-42
6.1-8	Summary of species diversity, richness, equitability, and total bird density for each of the wetlands surveyed, May-June 1981	6.1-44
6.1-9	Densities of birds in number per acre (.404 ha) observed along transects in five wetland communities in May 1981. Densities from listening posts are not included	6.1-45

PAGE

6.1-10	Densities of birds in number per acre (.404 ha) observed along transects in five wetland communities in June 1981. Densities from listening posts are not included	6.1-46
6.1-11	Similarity index values (upper right-hand corner of table) and number of species shared in common (lower left-hand corner) for the avifaunal communities in the wetlands surveyed in May. Boxed values are for comparing wetlands of the same classification type	6.1-48
6.1-12	Similarity index values (upper right-hand corner of table) and number of species shared in common (lower left-hand corner) for the avifaunal communities in the wetlands surveyed in June. Boxed values are for comparing wetlands of the classification type	6.1-49
6.1-13	Summary of small and medium-sized mammal captures (number caught per 100 trap nights) by wetland habitat type, June 1981. Actual number caught is shown in parentheses	6.1-53
6.1-14	The relative abundance in percent of small and medium-sized mammal species trapped in each of the wetland types, June 1981. Density in number per hectare (2.47 acres) is shown in parentheses . . .	6.1-54
6.1-15	Results of systematic searches for spotted salamander egg masses, April-May 1981	6.1-59
6.2-1	Unnormalized results of 10 functional models for 127 wetlands in the study area	6.2-2
6.2-2	Normalized results of 10 functional models for 127 wetlands in the study area	6.2-6
6.3-1	Summary of key model elements used to rate and rank wetlands of special interest	6.3-2
6.3-2	Biological function values for wetlands of special interest	6.3-3
6.3-3	Hydrologic support function values for wetlands of special interest	6.3-14
6.3-4	Ground water function values for wetlands of special interest	6.3-15
6.3-5	Storm and flood water storage function values for wetlands of special interest	6.3-16
6.3-6	Shoreline protection function values for wetlands of special interest	6.3-17

PAGE

6.3-7	Water quality maintenance function values for wetlands of special interest	6.3-18
6.3-8	Cultural/Economic function values for wetlands of special interest	6.3-24
6.3-9	Recreational function values for wetlands of special interest	6.3-25
6.3-10	Aesthetic function values for wetlands of special interest	6.3-26
6.3-11	Education function values for wetlands of special interest	6.3-27
6.3-12	Wetlands of special interest with total scores above the actual or model mean	6.3-33
6.4-1	Unnormalized results of 10 functional models for the top 10 wetlands in the study area	6.4-2
6.4-2	Normalized results of 10 functional models for the top 10 wetlands in the study area	6.4-9
6.5-1	Regional scarcity expressed as the percentage of wetlands in the study area versus those in the region	6.5-2
6.6-1	Important natural resource lands in the region of the study area	6.6-2

PREFACE

An assessment of the wetlands within and adjacent to the site area of the proposed zinc-copper mine near Crandon, Forest County, Wisconsin, was conducted by Exxon Minerals Company (Exxon) in accordance with Wisconsin Administrative Code NR 132. The primary purpose of this assessment was to map and evaluate the functional values of wetlands within the areas proposed for project activities. Wetland functional values were compared utilizing a procedure which combined qualitative descriptions of wetlands of "special interest" (those most closely associated with proposed project activities) with a numerical modeling approach. The results of this assessment are intended to provide data that can be utilized for projecting potential environmental consequences to those wetlands related to the proposed construction and operational activities.

Maps of the study area in two different scales are presented in a separate volume of this report because of their large size, quantity and their importance to the wetlands assessment. Each wetland is designated on the maps by a letter for the watershed in which it occurs and a number for the sequence in which it was mapped. The smaller scale map (1 inch = 800 feet) is included in the map volume to provide an overview of the study area wetlands. Nine separate maps at a scale of 1 inch = 400 feet are included to provide detailed information on wetland subtypes and surface water interconnections within each watershed.

The information contained in this report is for the sole purpose of evaluating the functional values (i.e., biological, watershed, and socio-cultural) of wetlands in relation to siting specific project activities. It is not intended to be an assessment of projected environmental consequences to wetlands. Once proposed project activities have been finalized, Exxon will utilize the information contained herein to evaluate potential environmental consequences of these activities on the affected wetlands in the Crandon Project Environmental Impact Report.

Principal investigators of the wetland assessment were Normandeau Associates, Inc. (NAI) and Interdisciplinary Environmental Planning, Inc. (IEP) located in Bedford, New Hampshire and Wayland, Massachusetts, respectively.

This submittal consists of four separate documents which include the following: Wetlands Assessment Report, Wetlands Assessment Appendices, Wetlands Assessment Maps and Wetlands Assessment Inventory Reports.

1.0 INTRODUCTION

Recent awareness of the role of wetlands in performing valuable functions important to public and private interests has resulted in the passage of regulations such as Wisconsin Administrative Code NR 132 which describes and defines such functions for wetlands. This regulation requires that mining applicants conduct assessments of wetland functions, define those essential elements that give rise to these functions, and relate the wetland functions to siting project activities. No defined wetland assessment methodology is presented in NR 132 or any other Wisconsin statute. Therefore, in response to NR 132, Exxon Minerals Company (Exxon) has undertaken an assessment of the wetlands within and adjacent to the site area of the proposed zinc-copper mine near Crandon, Forest County, Wisconsin.

In general, Wisconsin wetland regulations are based upon the following three assumptions:

1. Wetlands can be identified, mapped, and classified;
2. Wetlands have various elements, biological, hydrological, geological, socio-cultural, and others that can be identified and inventoried, which separately, or in combination, represent identifiable and, in most cases, quantifiable wetland functions; and
3. Beneficial functions can be rated so that land use and administrative judgments concerning the protection of specific wetlands can be made.

The primary objective of this assessment was to map the study area wetlands, evaluate and compare their functional values, and relate these data to project siting activities. Each wetland of the study area was identified and mapped. Semi-quantitative numerical evaluation models for wetland functions were developed based upon information in the Wisconsin Administrative Code NR 132 and scientific literature. From these models, a list of resource elements was developed. Field studies were conducted to identify, map, and inventory 127 wetlands that were larger than .10 ha (0.25 acre). Data from the inventory list were entered into each numerical model and a score was generated for each wetland function, then these individual model scores were totaled for each wetland.

The wetland functions modeled were as follows:

1. Biological,
2. Hydrological support,
3. Ground water,
4. Storm and flood water storage,
5. Shoreline protection,
6. Water quality maintenance,
7. Cultural/economic,
8. Recreational,
9. Aesthetic, and
10. Educational.

Numerical model results were related to proposed project activities through a detailed analysis of data for 46 wetlands which were of special interest because of their relationship to these activities. The model results were evaluated in a regional context by determining the regional scarcity of each wetland type. To provide supporting data for the assessment of wetland functions, the plant and animal (wildlife) communities were quantitatively sampled in each representative wetland type.

The data and results of this assessment are intended to aid Exxon, the Wisconsin Department of Natural Resources (DNR), and the public in applying Wisconsin Administrative Code NR 132, to mining activities.

tion will be used to evaluate wetlands for siting project facilities to ensure that overall environmental effects are minimized on study area and regional wetlands.

2.0 REGIONAL INFORMATION

The region was defined as the watershed of the Wolf River above Langlade (Figure 2.1-1). This watershed contained portions of Oneida, Forest, and Langlade counties and is approximately 121,967 ha (301,900 acres) in size. The wetland study area (Figure 2.1-1) occurred near the center of the region.

2.1 REGIONAL GEOLOGY

2.1.1 Surficial and Bedrock Geology

The region contained bedrock consisting of volcanic pyroclastic and sedimentary rocks of Precambrian age (Schmidt et al., 1978). These rocks were covered with up to 91 m (296 feet) of a complex stratigraphy of Late Wisconsin surficial geologic deposits. These deposits consisted of interbedded glacial till and stratified outwash sand and gravel created by the Green Bay and Langlade glacier lobes. Simpkins et al. (1981) presented a discussion of the surficial geologic history of the study area and a detailed surficial geologic map. Dames and Moore (1981a) and Golder Associates (1980) compiled detailed sub-surface boring data concerning the surficial geology. A more detailed discussion of the surficial geologic history is presented in Appendix A.

2.1.2 Ground Water Hydrology

The ground water of the region surrounding the study area has been investigated by Dames and Moore (1981b) and Golder Associates (1980).

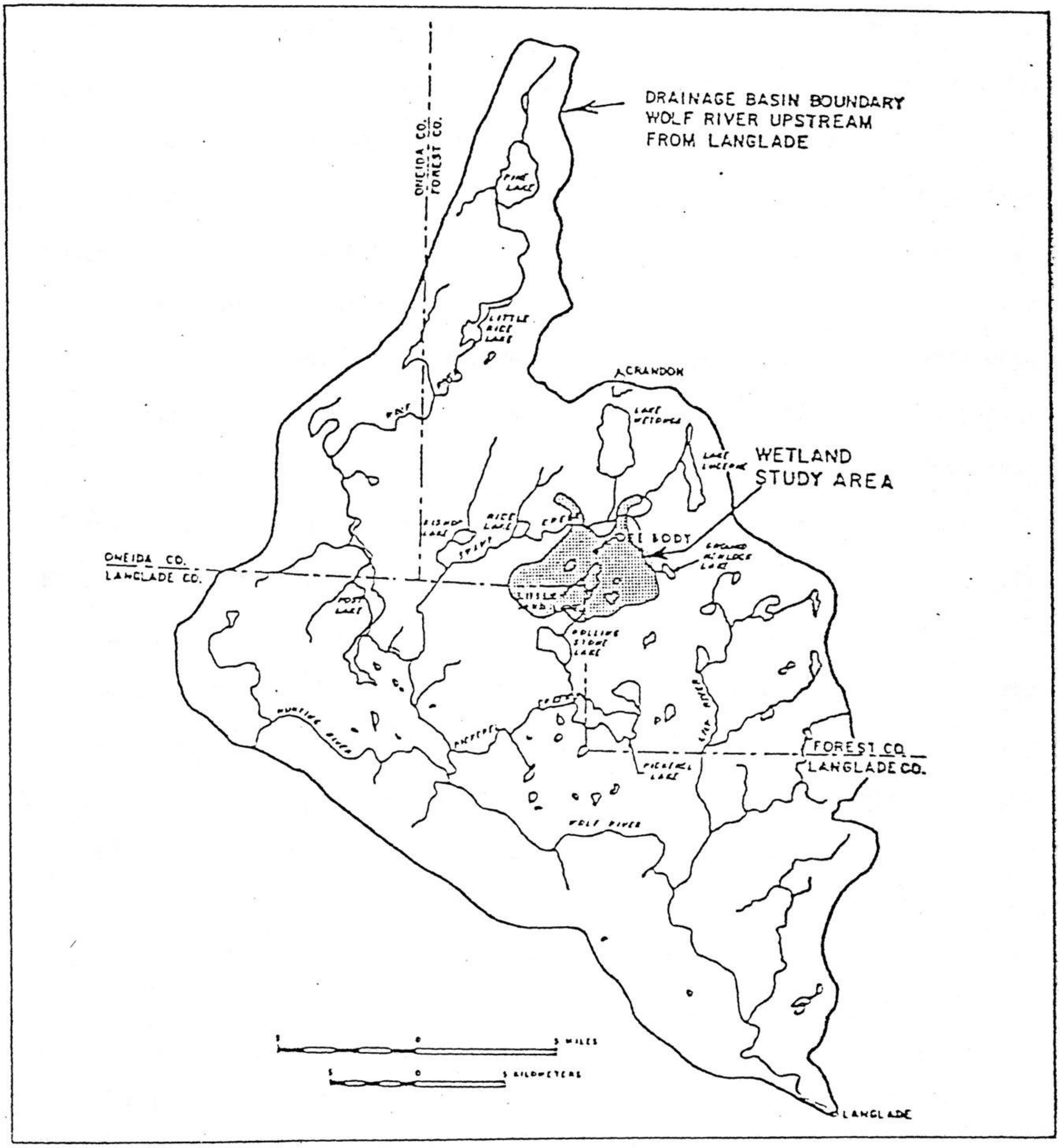

Figure 2.1-1. Regional area for the proposed Crandon Project, wetlands assessment.

Ground water occurs within the bedrock and the glacial deposits which are hydrologically connected. Water in the bedrock occurs primarily in weathered zones and fractures, the secondary porosity of the rock. Ground water in the glacial deposits occurs in pores between grains as primary porosity. A continuous water table aquifer exists under the region. The water table is highest under the region's hills and slopes downward to surrounding discharge areas such as streams, rivers, ponds and lakes. The Wolf River is the ultimate discharge area for the region. The glacial stratigraphy in which the water table occurs can be simplified from bedrock to the surface: glacial till, stratified outwash sand and gravel, glacial till, and ice-contact stratified sand and gravel, wherever it has been laid down (Dames and Moore, 1981a). The stratified outwash sand and gravel aquifer (main aquifer) may also connect with stratified outwash deposits found at the land surface (Figure 2.1-2). Many of the region's wetlands, lakes and ponds may be perched water table hydrogeologic situations, particularly those that occur at higher regional elevations, and are associated with impermeable glacial till.

2.1.3 Surface Water Hydrology

Dames and Moore (1981c) investigated the hydrology of the region using existing data and on-site measurements of stream flow. The annual average precipitation was 78.7 cm (31 inches), with the majority returned to the atmosphere through evapotranspiration, leaving only 30 to 40 percent available to recharge the groundwater system or flow off as surface water. Surface water runoff peaks were low because of infiltration and subsurface

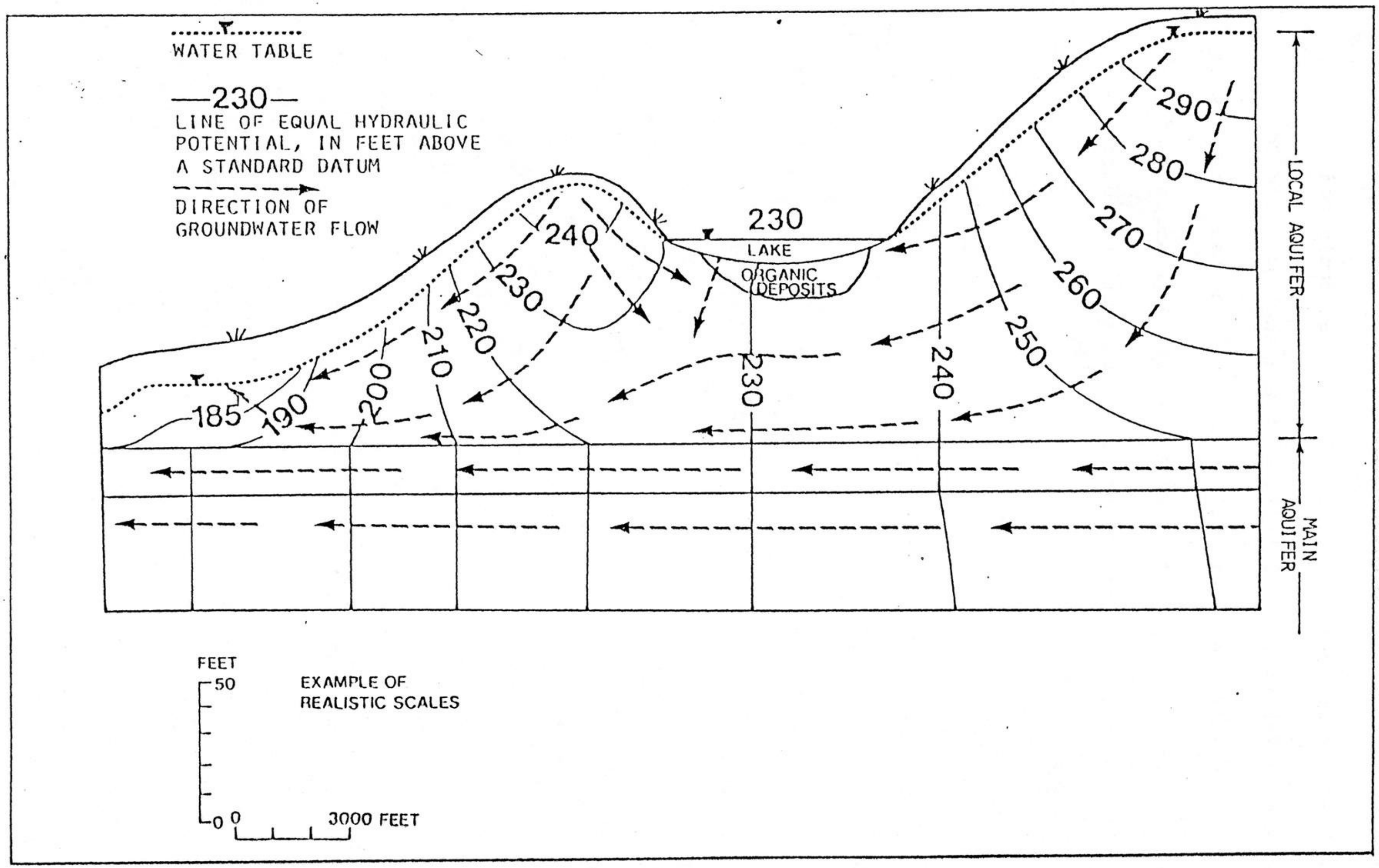

Figure 2.1-2. Hydrologic section showing distribution of hydraulic head for a one-lake system with an extensive aquifer of relatively low hydraulic conductivity in the middle of the ground-water system and illustrating the local aquifer and the main aquifer. Modified from Winter (1976).

water flow, dense vegetation and the large number of wetlands. Base surface water flow of perennial streams was believed to be ground water dominated. Water level fluctuations of lakes were small because of the shallow shoreline gradients that allow water to spread and the fact that many lakes have an outlet or overflow. The net results indicate a region where large amounts of water are removed by evapotranspiration and ground water recharge, and direct surface water runoff is reduced.

2.2 WETLAND SOILS

Because the topographic features in which the region's wetlands are found were formed 14,000 years ago (Black, 1976), the occurrence of ground water and surface water near or at the land surface in these depressions has allowed the development of wetland vegetative communities and corresponding soils. Organic debris deposited in anaerobic conditions has fostered the development of organic soils. As climates have changed, various wetland vegetative communities have developed. Vegetative change has also occurred from plant community succession. The type of organic deposits reflect the wetlands' hydrology and its past and present vegetative communities. The thickness of organics is determined by the original depth of the depression and the elevation of the wetlands' outlet. Where no outlet occurs, the elevation of the surface of the organic soils is controlled by the elevation of the water table. Both fibric (peat) and sapric (muck) soils occur in the region's wetlands (U.S. Soil Conservation Service, Soil Survey Staff, 1975).

2.3 VEGETATION

The study area was located in the northern conifer-hardwood forest (Curtis, 1959) which consisted of three distinct communities: northern mesic forest, northern xeric forest and northern lowland forest. In the northern mesic forest, the dominant species are sugar maple (Acer saccharum), yellow birch (Betula lutea) and hemlock (Tsuga canadensis). The northern xeric forest is composed of two segments, the dry segment having jack pine (Pinus banksiana), red pine (Pinus resinosa) and white pine (Pinus strobus) as dominants, and the dry mesic segment dominated by white pine, red maple (Acer rubrum) and red oak (Quercus borealis). The northern lowland forest is also composed of two segments, the wet segment and the wet mesic segment. The wet segment includes the tamarack (Larix laricina) - black spruce (Picea mariana) bog forests and the white cedar (Thuja occidentalis) - balsam fir (Abies balsamea) coniferous swamps. The wet mesic segment of the northern lowland forest is dominated by the black ash (Fraxinus nigra) - yellow birch - hemlock hardwood swamps (Curtis, 1959).

The wetland vegetative communities of Wisconsin, as described by Curtis (1959), include bog, shrub swamp, deciduous swamp, coniferous swamp, marsh and aquatic bed. The bog community consists of a shrub layer dominated by heath species and an herbaceous layer dominated by the sedge family. Deciduous vegetation is most characteristic of shrub swamps and frequently the predominant species is alder (Alnus rugosa). Deciduous swamp wetlands are synonymous with Curtis' (1959) wet mesic northern lowland forest. The species composition of deciduous swamps and other wetlands depends on the flow of water and nutrients through these wetlands, and the sediment load (Bay, 1967).

Coniferous swamps are synonymous with Curtis' (1959) wet northern lowland forest in which white cedar and balsam fir are dominant. In swamps where yellow birch and white cedar dominate, the community is classified as a wet mesic northern forest (Curtis, 1959). The dominant species in marshes are sedges (Carex spp.) and blue-joint grass (Calamagrostis canadensis), which conform to the southern sedge meadow or the wet prairie community described by Curtis (1959). Aquatic beds are dominated by water lilies (Nymphaea sp.) and bur-reed (Sparganium sp.). This type of wetland is classified as an emergent and submersed aquatic community by Curtis (1959). The ecology of each of these wetland types is discussed in Appendix B.

2.4 ANIMALS

The faunal species of Wisconsin are largely a consequence of the transition zone vegetation. The animal (wildlife) communities in the mixed forests typically contain species characteristic of both the boreal forests to the north, and deciduous forests to the south.

2.4.1 Herpetofauna

The ranges of 34 amphibian and reptile species extend into northeastern and southeastern Wisconsin (Conant, 1975). Of these, 23 occur in Forest County (Dames and Moore, 1981d). Species typical of the northern coniferous forests such as the mink frog (*Rana septentrionalis*) and blue spotted salamander (*Ambystoma laterale*) are found together with more southern species (at the northern limits of their range) such as the water snake (*Natrix sipedon*), bullfrog (*Rana catesbeiana*) and pickerel frog (*Rana palustris*). Wetlands containing a mixture of both northern and southern plant species typically have herpetofauna adapted to both, such as the green frog (*Rana clamitans*), spring peeper (*Hyla crucifer*), American toad (*Bufo americanus*) and garter snake (*Thamnophis sirtalis*). Generally all amphibians require wet areas during the breeding season and many reptiles use them for both feeding and cover. Accordingly, the majority of these species can be found in Wisconsin wetland communities at various times of the year.

2.4.2 Avifauna

Approximately 245 species of birds occur in northeastern Wisconsin (Barger et al., 1975), and 165 species have been observed in Forest County (Dames and Moore, 1981d). Vandershaegen (1981) documented 244 species of birds in Forest, Oneida, and Vilas counties. Species typical of the northern coniferous forests such as raven (Corvus corax), ruby-crowned kinglet (Regulus calendula) and evening grosbeak (Hesperiphona vespertina) are found together with those characteristic of the deciduous forests to the south, including great crested flycatcher (Myiarchus crinitus), black and white warbler (Mniotilta varia) and red-eyed vireo (Vireo olivaceus). The majority of these species migrate south during the winter when little food is available. It is estimated that one-third of all species of North American birds rely upon wetlands for some resource (Kroodsma, 1978). As with most other types of habitats, the variety of breeding bird species occurring in a particular wetland community is believed related to its vegetational, spatial or structural complexity (MacArthur and MacArthur, 1961; MacArthur et al., 1962). Habitats with permanent water appear to have a greater variety of species than do similar habitats without water (MacArthur, 1964). Surrounding habitats are also particularly important in contributing to the spatial complexity of certain wetland types, especially the smaller ones (Golet and Larson, 1974).

2.4.3 Mammals

Jackson (1961) reported 57 species of mammals in northeastern Wisconsin, and 36 species have been reported in Forest County (Dames and

Moore, 1981d). Unlike birds, most mammals have broad habitat requirements and, hence, have home ranges which include a variety of both upland and wetland habitats. White-tailed deer (_Odocoileus virginianus_) and black bear (_Ursus americanus_), both "big game" species which inhabit Wisconsin, are frequently found in wetlands (Burt, 1957). Dense coniferous swamps serve as winter yarding areas for white-tailed deer and are an essential component of their range throughout the northern Great Lakes states. Many DNR-designated deeryards are located in Forest County. Forest County is also one of the top five counties in the state for the number of black bear harvested by hunters (Dames and Moore, 1981d). Many of the commercially valuable "furbearer" species are also dependent upon wetlands; they include the mink (_Mustela vison_), muskrat (_Ondatra zibethicus_), beaver (_Castor canadensis_) and bobcat (_Felis rufus_). Creed and Ashbrenner (1976) reported that bobcat harvests in Wisconsin are highly correlated with the amount of forested wetlands in each county. Several species of small mammals are characteristic of certain wetland types, including the water shrew (_Sorex palustris_), snowshoe hare (_Lepus americanus_), southern red-backed vole (_Clethrionomys gapperi_), southern bog lemming (_Synaptomys cooperi_), meadow jumping mouse (_Zapus hudsonius_) and woodland jumping mouse (_Napaeozapus insignis_).

3.0 DESCRIPTION OF THE WETLAND STUDY AREA

3.1 PHYSICAL SETTING

The study area, as defined for this report, was located in northeastern Wisconsin in southern Forest County and northwestern Langlade County, near the center of the region (Figure 2.1-1). The study area was 10.9 km (6.8 miles) south of the Town of Crandon and 4.5 km (2.8 miles) east of the Mole Lake Indian Community (Figure 3.1-1) and was approximately 24.4 km^2 (9.4 $miles^2$) or 2437.4 ha (6018.2 acres) in size. Hemlock Creek flowed along the eastern side of the study area and Swamp Creek flowed along the northern side. The study area had a topographic elevation above the floodplains of the two creeks. There were five lakes and 224 wetlands within the study area.

The surficial geology of the study area has been investigated by Simpkins et al. (1981), Dames and Moore (1981a) and Golder Associates (1980). Over 100 borings and numerous test pits have been used to investigate the glacial deposits of the study area. The glacial stratigraphy consisted of (from bedrock to land surface): glacial till, stratified outwash sand and gravel, glacial till, and ice-contact glaciofluvial sand and gravel. This stratigraphy was simplified and many variations and complexities occur because of the complex geologic history of the glacial deposits (Appendix A). The glacial deposits located at the surface were the predominant deposits controlling the occurrence and hydrology of the wetlands in the study area. Three types of deposits controlled the occurrence of wetlands: thick glacial till, collapsed ablation till, and stratified glaciofluvial sand and gravel. Glacial till was the dominant deposit

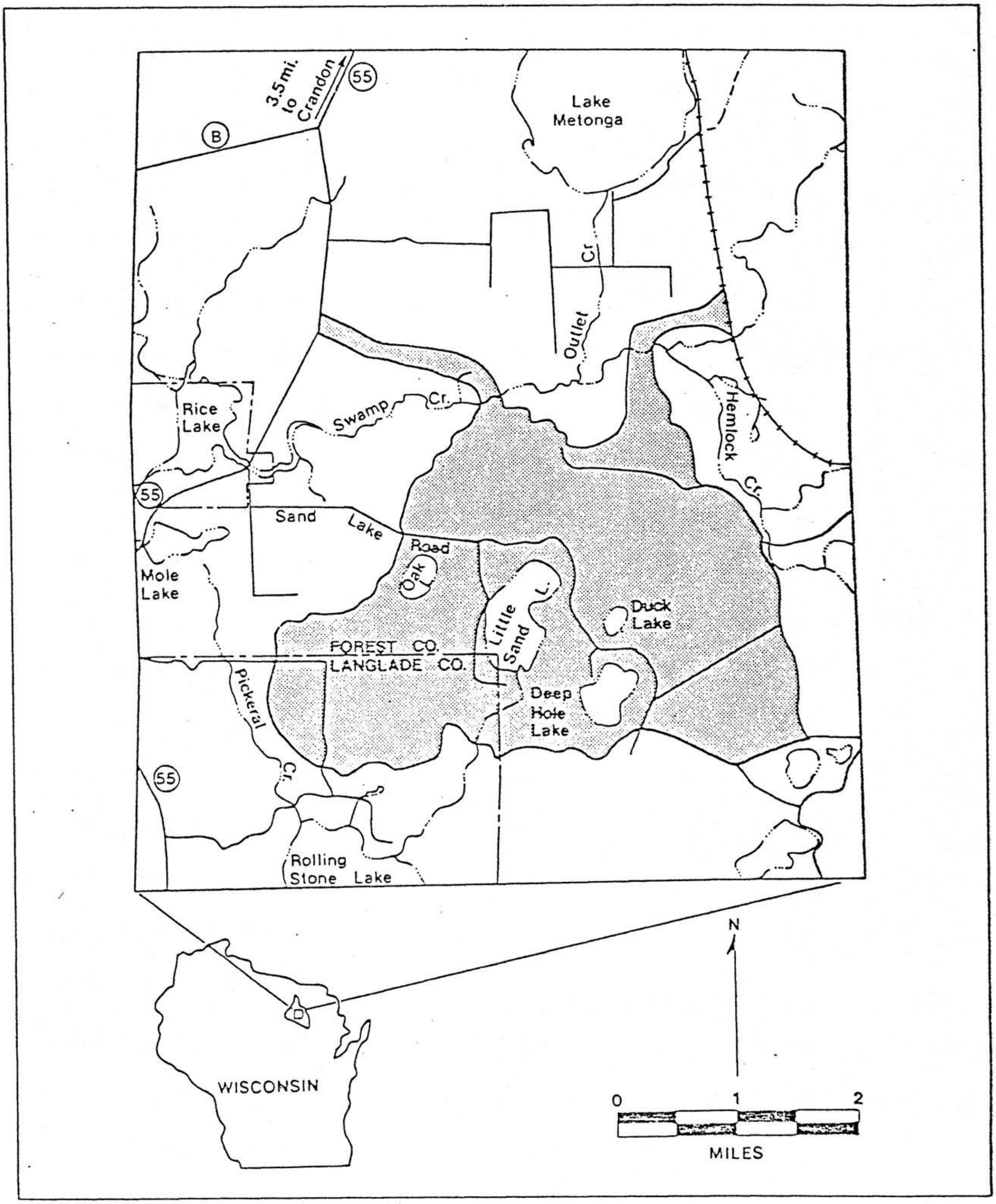

Figure 3.1-1. Study area for the proposed Crandon Project wetlands assessment.

found at the land surface. Wetlands were found in kettle holes, melt-water channels, basins created by glacier erosion of thick till, and valleys created by erosion from flowing water. In many basins and valleys of the study area where water has been near or at the land surface for as long as 14,000 years, wetland vegetative communities were evident. Decay of vegetative debris in anaerobic conditions has created organic soils which, in some cases, completely or partly fill past pond and lake environments.

Ground water hydrology was predominantly controlled by the dense glacial till. The majority of the wetlands were believed to be perched (local) water table situations (Golder Associates, 1980). At depth, below the study area, there occurred an outwash sand and gravel aquifer (main aquifer) of regional extent (Golder Associates, 1980; Dames and Moore, 1981a). Those study area wetlands associated with Swamp Creek were believed to be directly connected to the main aquifer (Golder Associates, 1980).

Surface water hydrology was controlled by an average annual rainfall of 78.7 cm (31 inches) which was distributed throughout the year (Dames and Moore, 1981c). It was also controlled by the surface soils, topography, and upland and wetland vegetation. The net result for the majority of the study area wetlands, excluding Swamp Creek wetlands, was a slow rate of surface water runoff creating a low stream density per unit area. This was also a result of, in part, the location of the study area at or near the top of the watershed for a number of small creeks. The surface area of the watersheds contributing to the wetlands was small, in relationship to wetlands further downstream along the same creeks. Thus, the water budgets of the study area's wetlands were relatively low. In addition, the wetlands received little ground-water discharge (Swamp Creek wetlands excluded) because of the dense till and their location over a ground water high (recharge area) (Golder Associates, 1980).

Wetlands were a common landscape feature of the study area, as a result of its glacial geologic origin. The occurrence and abundance of wetland types in the study area were similar to those of the region.

3.2 VEGETATION

Vegetative wetland types in the study area included bogs, shrub swamps, deciduous swamps, coniferous swamps, marshes, and aquatic beds. Coniferous swamps were the most common wetland type in the study area (Dames and Moore, 1981d). This type was primarily composed of white cedar, tamarack and black spruce. On drier sites these communities were generally an association of black ash, red maple, white cedar and balsam fir. Where the first two species predominated, the wetland was a deciduous swamp. Bogs occurred fairly frequently throughout the study area (Dames and Moore, 1981d). Bog vegetation included species such as black spruce, tamarack, steeplebush (Spiraea tomentosa), cottongrass (Eriophorum spissum), sedges (Carex spp.), pitcher plant (Sarracenia purpurea) and members of the heath family such as leatherleaf (Chamaedaphne calyculata), blueberry (Vaccinium angustifolium) and Labrador tea (Ledum groenlandicum) (Dames and Moore, 1981d).

Shrub swamps occurred primarily along stream banks and in other lowland situations in the study area. The most prevalent species was speckled alder; others that occasionally occurred were red-osier dogwood (Cornus stolonifera), chokeberry (Aronia melanocarpa), shrub birch (Betula glandulosa), winterberry (Ilex verticillata), mountain holly (Nemopanthus mucronata) and willow (Salix sp.) (Dames and Moore, 1981d). Other small, non-woody wetland types, including marshes and aquatic beds, also occurred throughout the study area (Dames and Moore, 1981d). These descriptions of study area wetland communities by Dames and Moore (1981d) were compatible with Curtis' descriptions of these communities for Wisconsin (Curtis, 1959; Section 2.3). However, the scientific nomenclature for this study follows Fernald (1958).

3.3 WILDLIFE

Because of the wide variety of habitat types available, the study area had a diverse assemblage of herpetofaunal, avifaunal and mammalian species. Characteristics of each in the study area are discussed below on the basis of existing information.

3.3.1 Herpetofauna

Dames and Moore (1981d) reported 23 species of reptiles and amphibians for Forest County, and observed 14 in the study area (Dames and Moore, 1981d). Blue spotted salamanders and spotted salamanders (*Ambystoma maculatum*) were frequently observed during spring, but migrated to the uplands during the summer where they were seldom observed. American toads, spring peepers, and wood frogs (*Rana sylvatica*) were abundant around water bodies during the spring. During the summer, American toads and wood frogs were frequently found in upland situations as well as near water bodies. The eastern gray treefrog (*Hyla versicolor*), southern gray treefrog (*Hyla chrysoscelis*), western chorus frog (*Pseudacris triseriata*), green frog, mink frog, and leopard frog (*Rana pipiens*) were much less frequently observed or heard. Three species of reptiles were observed in the study area. Painted turtles (*Chrysemys picta*) were common in water bodies. Several garter snakes and a single fox snake (*Elaphe vulpina*) were also observed (Dames and Moore, 1981d).

3.3.2 Avifauna

Dames and Moore (1981d) reported 165 species of birds for Forest County and observed 147 species in the study area. Although the species observed included raptors, gamebirds, waterfowl, marsh birds and shorebirds, the largest group of birds and the most numerous were the songbirds. Overall, the most abundant songbirds in the study area were the red-eyed vireo, blue jay (Cyanocitta cristata), ovenbird (Seiurus aurocapillus), rose-breasted grosbeak (Pheucticus ludovicianus), great crested flycatcher and white-throated sparrow (Zonotrichia albicollis) (Dames and Moore, 1981d). The highest songbird density and diversity occurred in those habitats having the highest plant species and structural diversity. Waterfowl were most abundant in the study area during the migratory seasons. The study area was not considered a major waterfowl breeding area; however, some species, such as the mallard and wood duck, were common summer residents that breed in the area (Vanderschaegen, 1981). Most waterfowl species require marshes with open water nearby for successful reproduction, and the majority of the wetlands in the study area were wooded swamps and shrub swamps (Dames and Moore, 1981d). Ruffed grouse (Bonasa umbellus) drumming surveys were conducted in the study area to determine population densities. These results, when compared to density estimates for other areas in northern Wisconsin, suggested that wildlife habitats in the study area were of low value to grouse (Dames and Moore, 1981d).

3.3.3 Mammals

Dames and Moore (1981d) reported 36 species of mammals for Forest County and observed 29 species in the study area. The two "big game" species that occur in Wisconsin, white-tailed deer and black bear, have been observed in the study area. There are two deeryards in the study area, the Swamp Creek Deeryard and the Rolling Stone Lake Deeryard. Deeryards are generally lowland areas of coniferous swamp which provide food and shelter during severe winters. The density of deer in the study area was estimated to be 7 deer per 259 ha (1 square mile) which was half of the DNR management goal (15 per 259 ha [1 square mile]) for management units in the vicinity of the study area (Dames and Moore, 1981d). In general the study area was not considered high quality habitat for deer because of the large acreage of pole-sized (130-281 mm [5-11 inches]) trees of northern hardwood species and lesser acreage of aspen stands. Thirteen species of small mammals were captured in the study area (Dames and Moore, 1981d). The five most abundant species, in decreasing order, were the deer mouse (Peromyscus maniculatus), southern red-backed vole, masked shrew (Sorex cinereus), short tailed shrew (Blarina brevicauda) and eastern chipmunk (Tamias striatus). Density and diversity of small mammal species were highest in those plant communities having the highest vegetative diversity.

3.4 PROPOSED PROJECT ACTIVITIES WITHIN THE STUDY AREA

Exxon proposes to develop an underground zinc-copper mine within the wetlands study area (Figure 3.4-1). A mill (concentrator) is proposed at the mine site which will produce copper, lead, and zinc concentrates as products. Waste rock by-products (tailings) from the milling operations will be deposited at a waste disposal area. Areas 40 and 41 are two potential locations for the development of tailings ponds. Tailings ponds will not completely occupy all of the land outlined in each of the two areas presented in Figure 3.4-1. Detailed engineering studies are underway to design tailings ponds layouts that will be compatible with the terrain in these areas and minimize the overall environmental effect of the waste disposal facility. The proposed access road and railroad spurline corridors are also presented in Figure 3.4-1. A more complete description of the Crandon Project is presented in a report entitled, "Preliminary Project Description" (Exxon, 1980). Potential environmental consequences of project activities on wetlands are not included in this document but will be presented in the Crandon Project Environmental Impact Report.

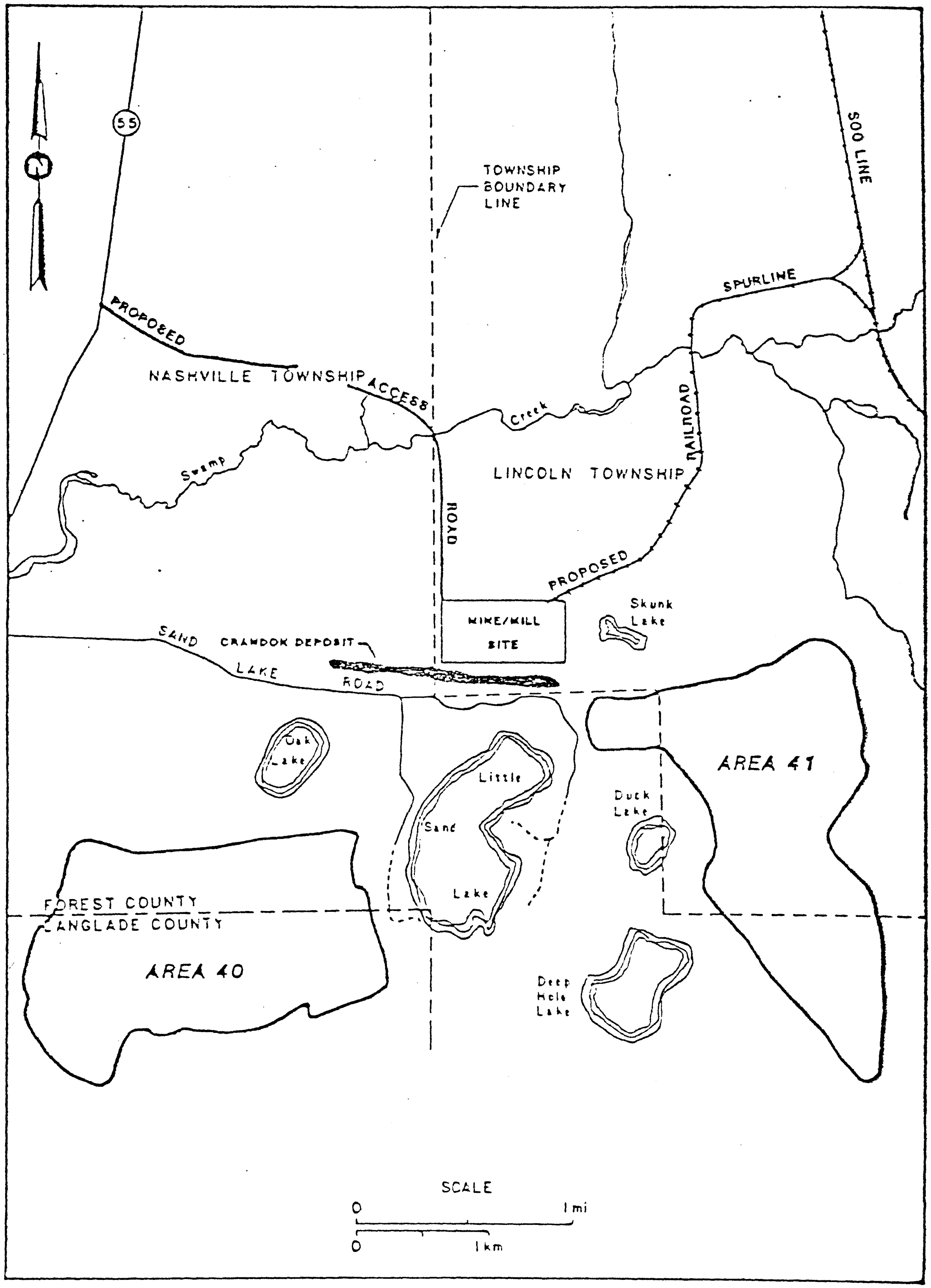

Figure 3.4-1. Proposed Crandon Project activities within the wetlands study area.

3.5 WETLANDS OF SPECIAL INTEREST

Of 127 wetlands investigated in the study area, 46 were of special interest because of their relationship to the proposed project activities mentioned in Section 3.4. The spatial relationship between these wetlands and each of the project activity areas are conceptualized in Figure 3.5-1. Included are wetlands located within the project activity boundaries and those outside, which are sufficiently close to be potentially affected.

There were three coniferous swamps, nine deciduous swamps and a bog within area 40. Candidate tailings disposal area 41 contained four coniferous swamps, 11 deciduous swamps, one marsh, one aquatic bed, two bogs and two shrub swamps. There were two coniferous swamps and a shrub swamp within the proposed access road corridor. The proposed railroad corridor contained three coniferous swamps, a marsh, two bogs and one shrub swamp. The two wetlands which occurred adjacent to the proposed mine/mill site were both coniferous swamps. This information is summarized in Table 3.5-1. A detailed figure showing the actual wetlands is included in Figure 3.5-2.

Quantitative studies of plant and wildlife communities were conducted in representative wetland types to provide supporting data for observations made during the wetland inventory field work. An effort was made to conduct quantitative studies in wetlands that could be directly affected by proposed project activities within areas 40 and 41. The wetlands in which quantitative studies were conducted are shown in Table 3.5-2. The studies were performed using standard transect methods for vegetation, birds, and small mammals.

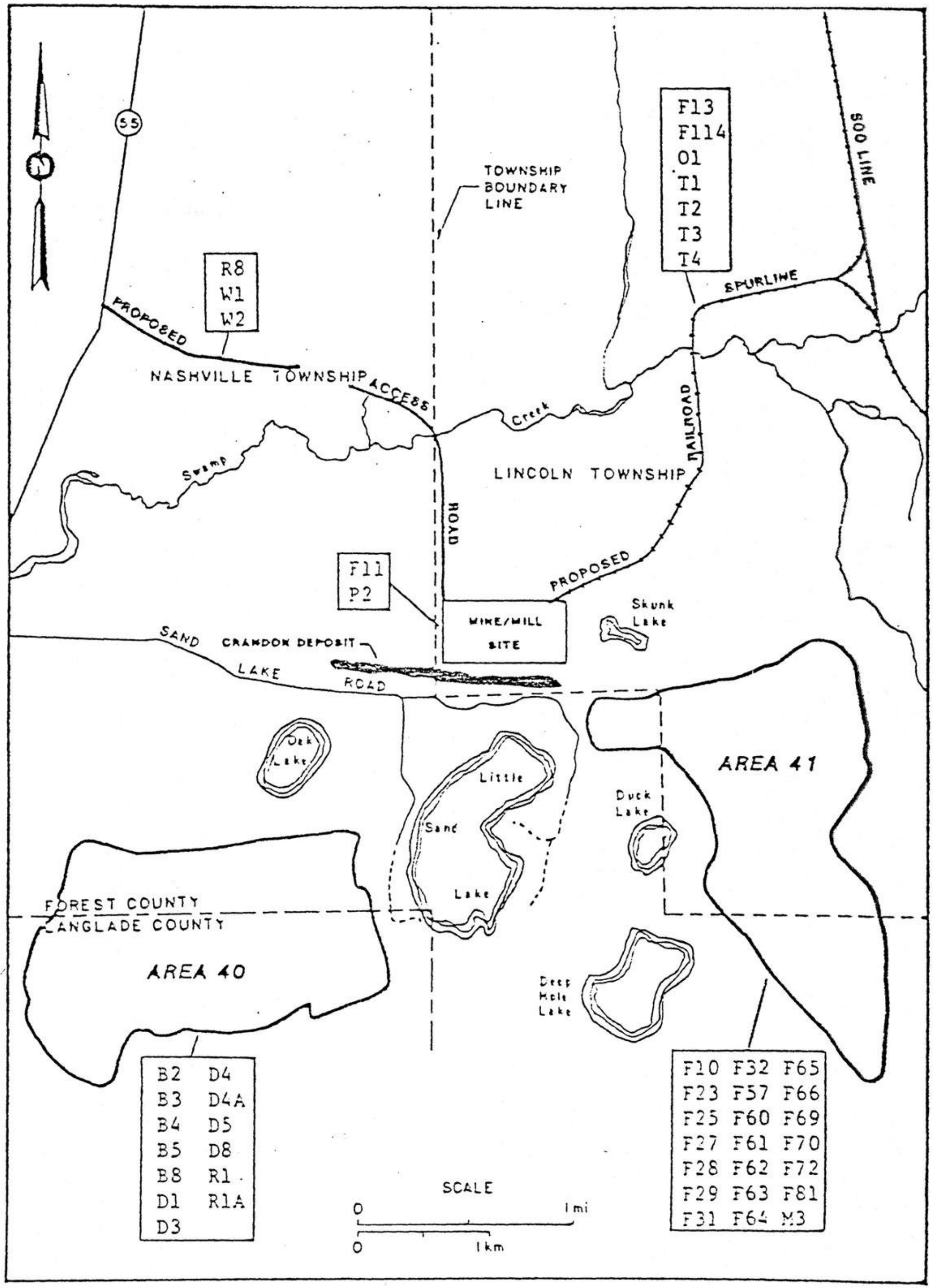

Figure 3.5-1. Spatial relationships between wetlands of special interest and proposed project activities within the study area.

Table 3.5-1. Wetlands of special interest; first column = wetland number, second column = wetland type.

AREA[a] 40		AREA[a] 41		ACCESS[b] ROAD		RAILROAD[c] SPURLINE		MINE/MILL[d] SITE	
D1	CS[e]	F10	CS	W1	CS	T1	B[f]	P2	CS
D3	DS[g]	F23	SM[h]	W2	CS	T2	B	F11	CS
D5	B	F25	DS	R8	SS[i]	T3	SS		
B2	CS	F27	DS			T4	CS		
B4	CS	F28	B			O1	CS		
B5	CS	F29	SS			F13	CS		
D8	DS	F31	CS			F114	SM		
R1	DS	F32	DS						
R1A	DS	F57	DS						
B8	DS	F60	DS						
D4A	DS	F61	DS						
D4	CS	F62	DS						
B3	DS	F63	CS						
		F64	B						
		F65	SS						
		F66	CS						
		F69	DS						
		F70	DS						
		F72	DS						
		F81	AB[j]						
		M3	DS						

[a]Candidate tailings disposal areas.

[b]Proposed access road from Route 55 to mine/mill site.

[c]Proposed railroad spurline.

[d]Proposed mine/mill complex site area.

[e]CS = Coniferous Swamp

[f]B = Bog

[g]DS = Deciduous Swamp

[h]SM = Shallow Marsh

[i]SS = Shrub Swamp

[j]AB = Aquatic Bed

(See map volume Figure 3.5-2.)

Figure 3.5-2. Map showing wetlands of special interest in relation to proposed project activities.

Table 3.5-2. Wetlands in which quantitative studies were conducted.

Transect No.	Wetland No.	Wetland Type	Quantitative Studies: Vegetation	Spotted Salamanders	Birds	Small Mammals
1	F57*	DS[a]	✓		✓	✓
2	F60*	DS	✓		✓	✓
3	F39	SS[b]	✓		✓	✓
4	F16	B[c]	✓	✓	✓	✓
5	F15	DS			✓	✓
6	F15	SM[d]	✓	✓	✓	
7	F11*	CS[e]	✓	✓	✓	✓
8	F12	AB[f]		✓	✓	
9	F12	SM			✓	
10	F28*	B	✓		✓	✓
11	M1	SS	✓		✓	✓
12	M3*	DS	✓			
13	F66*	CS	✓			
14	F64*	B	✓			
15	F37	SM	✓			
16	D4*	DS	✓			
17	F66*	CS	✓			
18	F63*	CS	✓			

*Wetlands of special interest

[a]DS = Deciduous Swamp

[b]SS = Shrub Swamp

[c]B = Bog

[d]SM = Shallow Marsh

[e]CS = Coniferous Swamp

[f]AB = Aquatic Bed

4.0 METHODS

A review was conducted of the available information which included literature searches and contacts with personnel of the appropriate federal, state and private organizations. Of all the literature reviewed, the reports that were most used included geologic and hydrologic reports prepared by Dames and Moore (1981a, b, c), Golder Associates (1980) and the Wisconsin Geological Survey; other major sources of information included the terrestrial baseline report prepared by Dames and Moore (1981d), Curtis' "The Vegetation of Wisconsin" (1959), and the Golet/Larson habitat model for wetland wildlife (Golet and Larson, 1974). The general topics covered in this review included geologic, meteorologic, and hydrologic characteristics of the study area and region (Wolf River Watershed above Langlade), socio-cultural considerations, and characteristics of the terrestrial communities. This information was used to modify the authors' existing functional models in order to rate the functional value of wetlands in the study area, and to design a sampling program to characterize the wetland plant and wildlife communities of northern Wisconsin.

4.1 WETLANDS DEFINITION AND IDENTIFICATION

Wetlands are defined in NR 1.95 as "those areas characterized by surface water or saturated soils during at least a part of the growing season such that moist soil vegetation or shallow water plants can thrive." The presence of plants which require or tolerate water at or near ground surface for a major part of the growing season forms the basis of this wetland definition. The criterion employed during this study was 50 percent or greater of wetland species present in the plant community. This percentage provides accurate boundary resolution in most wetlands, which facilitates wetland definition and mapping (Pappas and Yonika, 1979; Magee, 1981).

4.2 WETLANDS CLASSIFICATION

Wetlands in the study area were classified using the U.S. Fish and Wildlife Service (USFWS) national classification of wetlands and deepwater habitats (Cowardin et al., 1979). The national classification is hierarchical, with Systems forming the highest level; five are defined: Marine, Estuarine, Riverine, Lacustrine, and Palustrine. Of these, only the Palustrine System is applicable to the study area; this System encompasses all non-tidal wetlands traditionally designated by such names as marsh, swamp, and bog.

In the Palustrine hierarchy, the Class is the next level after System, and is based on dominant life form of the vegetation or composition of the substrate. In the present study, only vegetation life form applies. Five Classes based on vegetation life form are defined including Aquatic Bed, Moss-Lichen Wetland, Emergent Wetland, Scrub-Shrub Wetland and Forested Wetland. Classes are distinguished on the basis of the life form of the plants that constitute the uppermost layer of vegetation and that have an aerial coverage of 30 percent or greater. In the study area, all of these Classes apply with the exception of Moss-Lichen Wetland. Classes are further divided into Subclasses; for example, Forested Wetland is divided into such Subclasses as Broad-leaved Deciduous, Needle-leaved Deciduous and Needle-leaved Evergreen. Subclasses are also distinguished on the basis of the predominant life form. Further, distinctions can be made within Subclasses by applying Dominance Types, a modifier based on the dominant species; for example, a Needle-leaved Evergreen Forest Wetland dominated by black spruce would be designated as a *Picea mariana* Dominance Type. It is also possible to apply additional modifiers based on water regime, water chemistry, soils and human influences. To classify the wetlands in the study area, distinctions were made only at the class and subclass level; for purposes of the present study it was not considered necessary to apply the additional modifiers in the hierarchy.

The Wisconsin Classification (Wisconsin Department of Natural Resources, 1980) is a modification of the national classification and is based on a similar, although somewhat simplified hierarchy of components. There are seven Classes defined in this classification: Aquatic Bed, Moss, Emergent/Wet Meadow, Scrub/Shrub, Forested, Open Water and Flat/Unvegetated Wet Soil. All except Moss, Open Water and Flat apply to the study area. Subclasses are essentially defined in the national classification, and both Classes and Subclasses are distinguished on the basis of predominant life form as in the USFWS classification. The hydrologic and human influence modifiers are also similar but have been altered somewhat to adapt these components for Wisconsin wetlands. There are no water chemistry or soils modifiers in the Wisconsin classification, and the special wetland characteristics in the latter have no corollary in the national classification.

The national classification was used to classify the study area wetlands because it was available in published form, whereas the Wisconsin Classification was still undergoing modifications and was not in official form in April 1981 when the wetlands on the Crandon site were being mapped and classified. The applicable Classes, Subclasses and Modifiers and the correspondence between the national classification, Wisconsin classification and the common names used throughout this report are shown in Table 4.2-1. Wetland types in the study area were designated by the abbreviations for

Table 4.2-1. Comparison between the National and Wisconsin Wetland Classification Systems and commonly used terminology.

NATIONAL CLASSIFICATION	ABBREVIATION	WISCONSIN CLASSIFICATION	ABBREVIATION	COMMON NAME
Aquatic Bed –	AB	Aquatic Bed –		Deep Marsh
Rooted Vascular		Submergent	A 1	
Floating Vascular		Floating	A 2	
Emergent Wetland – Persistent	EW-b*	Emergent/wet meadow – Persistent	E 1	Shallow Marsh
Scrub/Shrub Wetland – Broadleaved deciduous	S/Sh-b	Scrub/Shrub – Broadleaved deciduous	S 3	Shrub Swamp
Scrub/Shrub Wetland – Broadleaved evergreen	S/Sh-a *	Scrub/Shrub – Broadleaved evergreen	S 6	Bog
Forested Wetland – Broadleaved deciduous	FW-b	Forested – Broadleaved deciduous	T 3	Deciduous Swamp
Forested Wetland –	FW-a	Forested –		Conifer Swamp
Needleleaved deciduous		Needleleaved deciduous	T 2	
Needleleaved evergreen		Needleleaved evergreen	T 5	

*Lower case a and b are not part of the national classification; they were assigned for convenience in designating subclasses during the coding of wetlands delineated in the study area.

the national classification on the wetlands maps. A brief description of the wetland classes that occurred in the study area is presented below.

Aquatic Bed - This class included wetlands with an average water depth of .92 to 1.8 m (3 to 6 feet) during the growing season. The dominant plant species included submersed species such as wild celery (*Vallisneria americana*) and milfoil (*Myriophyllum* spp.), and plants which float in the water or at the surface such as coontail (*Ceratophyllum demersum*), water shield (*Brasenia schreberi*), pondweed (*Potamogeton* spp.), water lily (*Nymphaea odorata*) and duckweed (*Lemna* spp.).

Shallow Marsh - This class applied to wetlands having an average water depth of 15 cm (6 inches) or less during the growing season. The dominant plant species included erect persistent emergents such as cattail (*Typha latifolia*), bullrush (*Scirpus* spp.) and manna grass (*Glyceria canadensis*), and/or nonpersistent emergents such as arrow arum (*Peltandra virginica*), pickerelweed (*Pontederia cordata*) and arrowhead (*Sagittaria latifolia*). In shallow open water areas, bladderwort (*Utricularia* spp.) and waterweed (*Elodea canadensis*) were often abundant.

Shrub Swamp - Shrub swamps were wetlands in which the soil surface is seasonally or permanently flooded with up to .30 m (1 foot) of water. Dominant plant species were broad-leaved deciduous shrubs, such as alder, red-osier dogwood, willow, highbush blueberry (*Vaccinium corymbosum*) and sweet gale (*Myrica gale*).

Deciduous Wooded Swamp - This class applied to wetlands in which the surface was seasonally flooded by up to .30 m (1 foot) of water; such wetlands commonly occurred along rivers or in upland sites with poorly drained soils. The dominant plant species were broad-leaved deciduous trees, although shrubs and herbaceous plants were usually present. The overstory species typically found included green ash (*Fraxinus pennsylvanica* var. *subintegerrima*), elm (*Ulmus americana*), and red maple. Commonly occurring understory species were winterberry and highbush blueberry.

Bog - Bogs were wetlands generally characterized by floating mats of vegetation which grew outward from shore over the water surface; a moat of water too deep for the growth of emergent plants often occurred between the edge of the mat and the surrounding upland. The bog mat was typically composed of sphagnum moss (*Sphagnum* sp.) and the anastomosing roots of the plants which grew on the mat surface. The dominant plant species were broad-leaved evergreen shrubs; species characteristically found included leatherleaf, Labrador tea, bog laurel (*Kalmia polifolia*) and large cranberry (*Vaccinium macrocarpon*), and stunted or young needle-leaved trees such as black spruce and tamarack.

Coniferous Swamp - This class included wetlands having a seasonal water depth of up to .30 m (1 foot). The dominant plant species were needle-leaved deciduous and needle-leaved evergreen trees, although, as in deciduous swamps, several layers of vegetation were usually present, including trees, shrubs and herbs. Tree species typically found included: black spruce, balsam fir, northern white cedar and tamarack. Shrub species commonly found included Labrador tea and leatherleaf.

4.3 WETLAND MAPPING

A comprehensive wetlands map is important in evaluating wetlands; therefore, a wetlands map was prepared at a scale of 1 inch = 400 feet. This map included: (1) the wetland/upland vegetative boundary; (2) vegetative subtypes; (3) topography; and (4) location of surface water interconnections. Figure 4.3-1 is the wetland map and is a half scale (1 inch = 800 feet) composite of nine separate maps which are presented in Figures 4.3-1a through 4.3-1i (see map volume). The base for the wetlands map was an orthophoto topographic map prepared by Aero-Metric Engineering, Inc., Sheboygan, Wisconsin, using aerial photography dated April 28, 1976, having a scale of 1 inch = 400 feet and a 5 foot contour interval.

Existing aerial photography was obtained and viewed stereoscopically to delineate the wetland/upland boundary and to subtype vegetative communities. Aerial photos that were used included color infrared leaf-on, true color leaf-off, and panchromatic (black and white) leaf-off. Scales ranged from 1 inch = 1600 feet to 1 inch = 400 feet and photo dates ranged from 1976 to 1981. Panchromatic leaf-off photography at a scale of 1 inch = 1600 feet dated April 28, 1976 was most useful. The photography was viewed stereoscopically and wetland/upland vegetative boundaries were delineated. The boundaries were rechecked by another photo interpreter to ensure accuracy. Each delineated wetland area was checked using other photography. Vegetative subtypes were delineated using both the panchromatic 1976 photography and true color 1 inch = 400 feet scale photography dated April 20, 1981. Wetlands were typed regardless of size, and those less than .10 ha (0.25 acre) were easily recognizable.

(See map volume for composite Figure 4.3-1.
Figures 4.3-1a through 4.3-1i are also
presented in the map volume.)

Figure 4.3-1. Composite map showing watersheds and wetlands within the study area.

To insure accuracy during the present study, the personnel conducting the phototyping also visited each wetland during the field inventory program. Before the field checks were conducted, the delineated wetland boundaries were transferred to the 1 inch = 400 feet scale orthophoto topographic base map. This was accomplished by using a Bausch & Lomb zoom transfer scope.

The delineated 1 inch = 1600 feet scale aerial photos and the 1 inch = 400 feet orthophoto topographic map were used in the field to verify each wetland boundary. The actual wetland/upland boundary was viewed in the field and checked by use of terrain features, vegetation features and man-made features against the boundary shown on the 1 inch = 400 feet scale map. When differences were discovered, the aerial photography was stereoscopically reviewed in the field and corrections immediately made on both the aerial photos and the map. The field-truthed map and aerial photos were then used to transfer final wetland boundaries to the orthophoto topographic map mylars which served as the basis for the final wetlands map (Figure 4.3-1).

The wetland boundary definition used was that area where 50 percent or greater of the vegetative community consisted of wetland plant species as listed in Curtis (1959), Fassett (1966), and Magee (1981). Wetlands delineated were identical to those defined in the Wisconsin Wetlands Inventory User Manual (Wisconsin Department of Natural Resources, 1980), with one exception: stream channels, both ephemeral and perennial were mapped as wetlands and inventoried. This was done because the hydrologic interconnection of wetlands is an important factor in many wetland functions.

In addition, nearly all stream channels contain aquatic vegetation and most have adjacent streamside vegetative communities such as shrub swamps or wooded swamps.

Major and minor watersheds were delineated on the wetland map (Figure 4.3-1). Major watersheds are shown with a thick line and are those watersheds that begin at the wetland study area boundary. There are 24 major watersheds lettered A through X. Minor watersheds are found within the major watersheds and are shown with a thin line. Minor watersheds define the watershed of each wetland to its discharge point. Portions of the land surface of the study area are not part of either a major or minor wetland watershed because of their topography. Watersheds were delineated using the five foot orthophoto topographic 1 inch = 400 feet scale map. Field checks were performed to accurately locate watershed boundaries.

Within each major watershed, the wetlands of riparian systems were divided into distinct dominant hydrologic types as defined in Appendix C. Boundaries between these types were indicated on the map as the wetland divider. This division of interconnected riparian wetlands was made in the field by observation.

Each inventoried wetland was identified by a combined letter and number (e.g., B3). Wetlands smaller than approximately .10 ha (0.25 acres) were not numbered, inventoried or assessed. Red flags with the wetland identification letter and number were placed in the field at the wetland boundary for each wetland inventoried. The location of these flags are shown by a dot on the wetland map.

4.4 QUANTITATIVE FIELD INVENTORY

The plant and wildlife communities of each of the five identified wetland types were sampled quantitatively. The primary objective of the quantitative field inventory was to provide supporting data for the qualitative observations made during the wetland inventory by means of more detailed descriptions of the biological elements in each type. Sampling locations were selected in wetlands representative of each type in the study area. The selections of wetlands for quantitative sampling were made following a field visit to each wetland during the wetland inventory field work and were based on qualitative observations of the composition and structure of the plant communities. These observations permitted the selection of the most representative wetlands which best conformed to the type definitions described in Section 4.2.

4.4.1 Vegetation

Wetland plant communities were sampled during mid-May 1981 using a stratified random sampling approach (Mueller-Dombois and Ellenburg, 1974). Sample transects (Figure 4.4-1) were located in three representative areas of each wetland type (except coniferous swamp), to obtain an estimate of variability within the types. The types investigated included:

1. Sedge/blue-joint grass shallow marsh,
2. Alder shrub swamp,
3. Leatherleaf bog,
4. Green ash/aspen deciduous swamp, and
5. Black spruce/tamarack coniferous swamp.

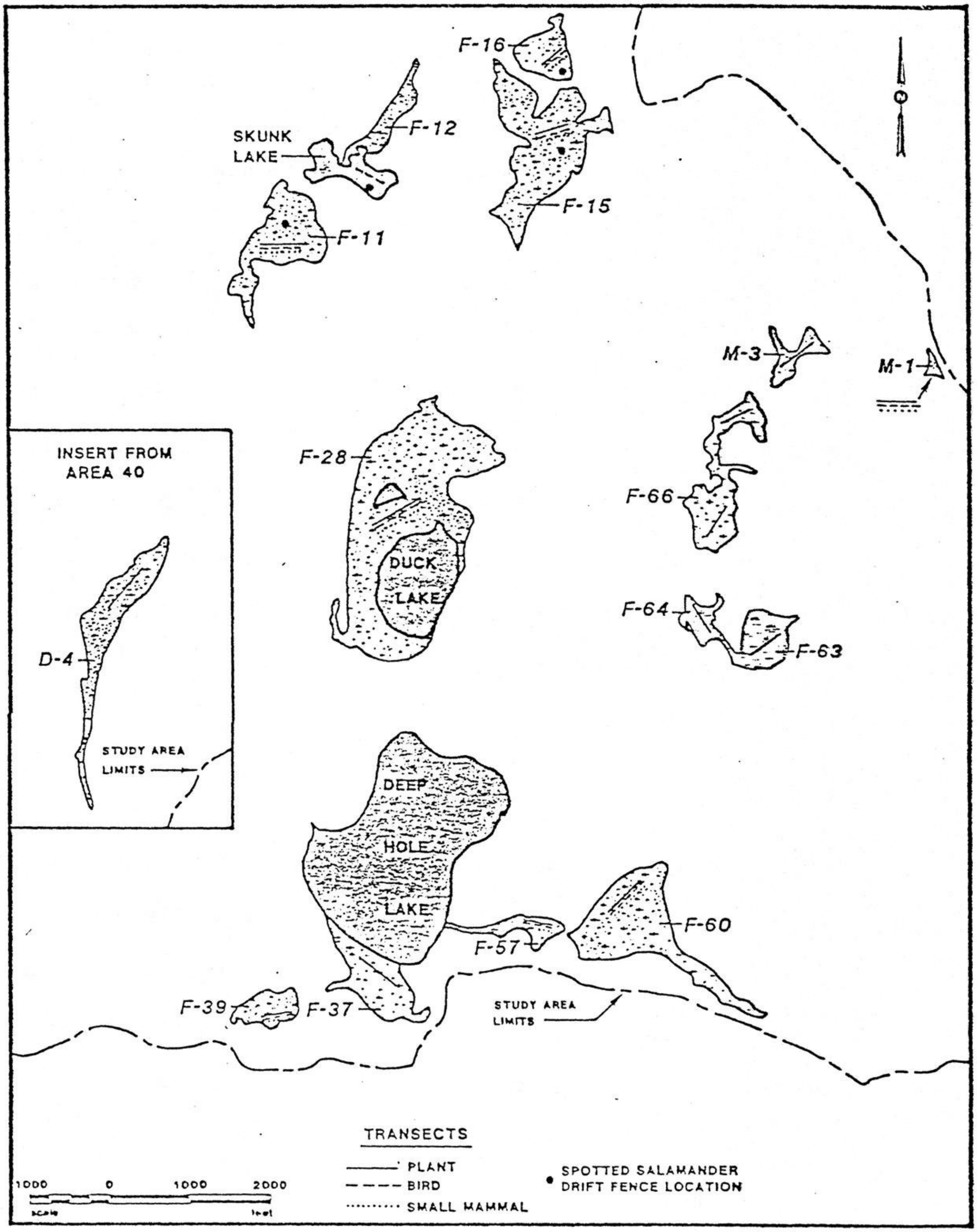

Figure 4.4-1. Map showing wetlands in which quantitative biological studies were conducted. (Detailed figure presented in map volume.)

Sampling was conducted in four black spruce/tamarack coniferous swamps because this type was the most abundant in the study area. Dames and Moore (1981d) also did transect sampling in a white cedar coniferous swamp in the study area. Transect sampling was not conducted in the aquatic bed type because of water depth. Data points were established at 30.4 m (100 foot) intervals along each transect; the number of points sampled was determined by the number of new species found at each subsequent plot, such that further sampling was discontinued beyond the plateau on a species/area curve.

At each point the vegetation was divided into three vertical strata to permit a more detailed analysis of the structure within each stratum. Overstory trees were sampled using the point-centered quarter method (Cottam and Curtis, 1956). A relative importance index was computed for each species (Mueller-Dombois and Ellenburg, 1974) and the relative crown position (e.g., whether codominant, supressed) was recorded for each tree. The intermediate layer, composed of shrubs and saplings, was sampled within 3 x 3 m (9.8 x 9.8 feet) plots at each point used for tree sampling. In addition to importance indices, a cover/abundance scale rating, which measures sociability, was assigned to each species (Becking, 1957). Herbaceous plants were sampled on plots 0.5 x 2 m (1.6 x 6.5 feet) nested within the shrub quadrat and importance indices and cover/abundance were determined for each species.

All data were recorded on an inventory sheet (Table 4.4-1). A separate listing of plants was compiled during the wetlands inventory program. Each wetland was also thoroughly surveyed for threatened and endangered plant species by searching the interior of each wetland type as well as the boundaries and along stream and lake margins. The time actually

Table 4.4-1. Vegetation inventory sheet for proposed Crandon Project wetlands assessment.

Reference Point or Plot	Qtr.	Tree Species	1. %C	2. DBH	3. SL	4. D	5. CP	6. In	Shrub Species	%C	#	7. S	Herb Species	%C	#	S	8. % L	9. % St	10. % B	11. % S	12. % LL

1. Percent aerial coverage
2. Diameter at breast height
3. Number of 16' saw logs
4. Distance from ref. point
5. Crown position
6. Number of "In" trees (prism)
7. Sociability
   a. solitary, growing singly
   b. growing in small groups of a few individuals
   c. large group of many individuals; small scattered patches
   d. patches or a broken mat
   e. extensive mat almost completely covering entire plot
8. Percent logs
9. Percent stumps
10. Percent boulders
11. Percent exposed soil
12. Percent leaf litter

spent in this search varied from one-half hour in wetlands smaller than .40 ha (1 acre) to an hour in wetlands up to 1.8 ha (4.5 acres) in size and up to 2 hours in the largest and most diverse wetlands in the study area. Scientific nomenclature for plants identified in this study followed Fernald (1958).

4.4.2 Herpetofauna

The general survey of the study area for amphibians and reptiles consisted of noting all individuals seen or heard during all phases of the field work from April through June 1981. Except for the spotted salamander studies (see below), most of the records were collected while conducting plant, bird and mammal surveys. The amount of time actually spent in the general survey was approximately 30 ten-hour field days. Anuran (frog and toad) calls which could not be quickly identified by the observer were recorded in the field on a "Realistic Minisette - 9" tape recorder for later comparison with reference tapes.

Spotted salamanders were intensively sampled during the reproductive season in April and early May (Figure 4.4-1). "Drift fences" made of plastic sheeting 30 cm (11.8 inches) wide by 12.2-15.2 m (40-50 feet) long were erected parallel to open water breeding areas to intercept adults migrating to or from the pools (Pierce, 1981, personal communication). Pitfall traps made of 900 ml (32 ounces) plastic cups were buried along both sides of each fence to capture the salamanders as they moved along them. Each trap was checked at least once every 24 hours and the species and number of individuals caught were recorded on standard field data sheets. All individuals that were caught were released on the opposite side of the fence from where they were trapped.

Systematic searches for egg masses laid by spotted salamanders also were conducted concurrently with the trapping described above. Egg masses of this species have a characteristic shape and size which was relatively easy to separate from other species occurring in this region (Bishop, 1947). The edges of open water areas adjacent to preferred habitat were searched while walking with chestwaders and counting all egg masses observed. This information was summarized as the total number of egg masses per 30.5 m (100 feet) of shore length. Scientific nomenclature for reptiles and amphibians follows Conant (1975).

4.4.3 Avifauna

Two representative areas of each wetland type (except aquatic bed) were selected for bird censuses (Figure 4.4-1). Line transects and one listening station were established in all areas except one marsh and the aquatic bed. Only a listening station was used in the latter areas because of their extreme wetness. Transect lengths were dictated by the size of the wetland and ranged from 115 to 400 m (377 to 1312 feet). All bird species seen or heard were recorded along with their number and perpendicular distance to the transect (Anderson et al., 1979). At the listening stations, the distance to each bird from the center point was recorded. All surveys were conducted between 5:00 a.m. and 6:15 p.m. Central Daylight Time (CDT) on 11 - 15 May 1981 and again on 16 - 19 June 1981. The starting times were randomized daily by changing the order in which the transects were surveyed so that all transects and listening stations were surveyed at least once in the early morning within 3 hours of sunrise. The May surveys were conducted by two observers working independently, while the June surveys were conducted by only one observer. All common and scientific names follow Peterson (1980).

Bird species densities were calculated by the "Leopold Method" (Robinette et al., 1974) using only the perpendicular distances measured from the transects. Species diversity (H') and equitability (E) were calculated using the indices described by Shannon and Weaver (1949) and Sheldon (1969), respectively. The avifauna communities of the various wetland types were compared using the "similarity index" described by Krebs (1972).

For analyses of the above parameters, all 4 days of data from the May surveys were used, but only the 3 days with the earliest times were used in June. Bird activity was relatively high throughout the daylight hours in the May survey because territories were being established. In contrast, activity during June decreased somewhat as the day progressed.

4.4.4 Mammals

Two representative areas of each of the wetland habitat types (except marsh and aquatic bed) were selected for trapping of small and medium-sized mammals (Figure 4.4-1). The marsh and aquatic bed types were not censused because of their extreme wetness. In each of the selected areas, trap stations were located at 15 m (49.2 feet) intervals along the same transects used for the bird surveys for a total length of 105 m (344.4 feet). The one exception to these locations was that the trap line in wetland F16 extended over the bog mat instead of around it. In one of the two areas of each type, an "assessment line" 90 m (295.2 feet) in length was also established at a 45 degree angle to the transect to determine the effective trapping width of the transects (O'Farrell et al., 1977). One Sherman live-trap, measuring 7.6 x 8.9 x 22.9 cm (3.0 x 3.5 x 9.0 inches) was placed at each station for a total of eight traps along the transects and six along the assessment lines. Larger Tomahawk live-traps, 15.2 x 15.2 x 61.0 cm (6.0 x 6.0 x 24 inches) were also placed at 45 m (147.6 feet) intervals along the transect lines for a total of two per area. The smaller traps were baited with dry rolled oats and the larger ones with eared sweet corn. Traps were set for four consecutive days from June 17 - 20, 1981. The extent of the trapping effort in each wetland is summarized in Table 4.4-2. All animals caught were toe-clipped and the species, sex, weight, and reproductive condition were recorded before release. All observations of mammals seen incidental to other phases of the work were also recorded. Common and scientific names followed Jones et al. (1979).

Captures in each area were summarized by species and expressed in numbers caught per 100 trap nights. This is the normal convention for such studies with one trap-night defined as one trap set for 24 hours (Krebs et al., 1971). In addition, the relative abundance of each species was calculated as the proportion (expressed as a percent) of all individuals of all species trapped in each habitat type. Where there were sufficient numbers of recaptures, population size was estimated using the Schnabel Method (Schnabel, 1938). When there were insufficient recaptures along the assessment lines for an accurate determination of the effective area of trapping, the transect width was assumed to extend one-half of the inter-trap distance or 7.5 m (24.6 feet) on either side (Stickel, 1954). Population size was divided by area to provide an estimate of density in numbers per hectare (2.47 acres).

Table 4.4-2. Summary of trapping effort in the wetland habitat types of the study area on June 17-20, 1981.

WETLAND		NO. TRAPS		DAYS				NO. TRAP NIGHTS	
TYPE	NO.	SMALL	LARGE	1	2	3	4	SMALL TRAPS	LARGE TRAPS
Deciduous Swamp									
Young	(F57)	8 + 6	2	x	x	x	x	56	8
Mature	(15)	8	2	x	x	x	x	32	8
Subtotal		22	4					88	16
Conifer Swamp									
Mixed	(F60)	8 + 6	2	x	x	x	x	56	8
Homogeneous	(F11)	8	2	-	x	x	x	24	6
Subtotal		22	4					80	14
Shrub Swamp									
Creek Side	(F39)	8 + 6	2	x	x	x	x	56	8
Creek Side	(M1)	8	2	x	x	x	x	32	8
Subtotal		22	4					88	16
Bog									
Mat	(F16)	8 + 5	2	x	x	x	x	52	8
Wooded	(28)	8	2	x	x	x	x	32	8
Subtotal		21	4					84	16
TOTAL		87	16					340	62

4.5 EVALUATION ELEMENTS AND IMPLEMENTATION OF WETLAND INVENTORY

A comparative analysis of the functions of study area wetlands was conducted during the spring and summer of 1981. This analysis involved a three step process:

1. identification of those physical and biological factors which govern each of the functional values;
2. identification of those data elements needed to measure each of the physical and biological factors and development of rating models; and
3. identification of an inventory format that would allow collection of the required data from readily identifiable sources and with maximum efficiency.

4.5.1 Evaluation Elements

In reviewing the existing information and evaluating and modifying the authors' existing models, the first two steps in the above process were completed. During the process of identifying an inventory format, an inventory report form was developed on which to record conditions relating to an individual wetland's capacity to perform one or more of the wetland functions, as defined in the Wisconsin Administrative Code NR 132. The report form (pages 4.5-2 to 4.5-4) was designed to: (1) summarize all the resource elements required as input to the wetland function models, (2) provide a check list to promote consistency in the inventory process from one wetland to another, and (3) become a permanent description of the wetland and a record of the inventory procedures.

The inventory form contained a listing of those resource elements required by the 10 functional models. Under each major element heading were subheadings containing various choices. The inventory team was required to

WETLAND INVENTORY REPORT

PROJECT NUMBER ____________________
WETLAND NUMBER ____________________
FLIGHT, PHOTO NUMBER(S) ____________
____
MAP NUMBER(S) ______________________
____
ACREAGE ____________________________

ACREAGE	PERCENT	
		WET MEADOW
		SHALLOW MARSH
		DEEP MARSH
		SHRUB SWAMP
		WOODED SWAMP
		BOG
		OTHER ____________
		TOTAL

vegetation inventory

	occ	com	dom

number ____________

date ____________

field investigator(s)

____

____

water quality

____

____

____

____

____

Wetland Subclasses

Stream or Brookside Wetland

Open Fresh Water
- ☐ Vegetated Subclass
- ☐ Non Vegetated Subclass

Deep Fresh Marsh
- ☐ Dead Woody
- ☐ Shrub
- ☐ Sub-Shrub
- ☐ Robust
- ☐ Narrow-Leaved
- ☐ Broad-Leaved

Shallow Fresh Marsh
- ☐ Robust
- ☐ Narrow-Leaved
- ☐ Broad-Leaved
- ☐ Floating-Leaved

Flood Plain/Flats
- ☐ Emergent
- ☐ Shrubs and Trees

Wet Meadow
- ☐ Ungrazed
- ☐ Grazed

Shrub Swamp
- ☐ Sapling
- ☐ Bushy
- ☐ Compact
- ☐ Aquatic

Wooded Swamp
- ☐ Deciduous
- ☐ Evergreen

Bog
- ☐ Shrub
- ☐ Wooded

Ecological Elements

Dominant Wetland Class
- ☐ Stream or Brookside Wetland
- ☐ Open Fresh Water
- ☐ Deep Fresh Marsh
- ☐ Shallow Fresh Marsh
- ☐ Yearly Flooded Flood Plain
- ☐ Wet Meadow
- ☐ Shrub Swamp
- ☐ Wooded Swamp
- ☐ Bog
- ☐ Other ____________

Wetland Class Richness
- ☐ >5
- ☐ 4
- ☐ 3
- ☐ 2
- ☐ 1

Subclass Richness (Lateral Diversity)
- ☐ >10
- ☐ 6-9
- ☐ 4-5
- ☐ 2-3
- ☐ 1

Vegetative Interspersion
- ☐ High
- ☐ Moderate
- ☐ Low

Surrounding Habitat
- ☐ >90% of 2 or more of Listed Types
- ☐ 50-90% of 1 or more; 90% of 1
- ☐ <50% of 1 or more of Listed Types

Cover Type
- ☐ 26-75% Scattered
- ☐ 26-75% Peripheral
- ☐ 75% or <25 Scattered
- ☐ 100% Cover; >75% or <25% Peripheral

Percent Open Water
- ☐ 0-30%
- ☐ 34-66%
- ☐ 67-95%
- ☐ 96-100%

Vegetative Species Richness
- ☐ Low
- ☐ Medium
- ☐ High

Proportion of Wildlife Food Plants
- ☐ Low
- ☐ Moderate
- ☐ High

Vegetative Density
- ☐ High
- ☐ Moderate
- ☐ Low

Wetland Juxtaposition
- ☐ Highly Favorable
- ☐ Moderately Favorable
- ☐ Unfavorable

Special Elements
- ☐ Aquatic Study Area
- ☐ Sanctuary or Refuge
- ☐ Wildlife Management Area
- ☐ Fisheries Management Area
- ☐ Educational Study Area
- ☐ Historical Area
- ☐ Other ____________

Topographical Elements

Topographic Configuration
- ☐ Closed Basin
- ☐ Semi-closed Basin
- ☐ Valley
- ☐ Hillside

	unus	rare	end
unusual, rare, or endangered vegetation			

	unus	rare	end
unusual, rare, or endangered fauna			

Wetland Gradient
- ☐ Slight 0-3%
- ☐ Steep >3%

Surrounding Slopes
- ☐ Slight 0-3%
- ☐ Steep >3%

Topographic Position in Watershed
- ☐ Upper
- ☐ Intermediate
- ☐ Lower

Geological Elements

Surficial Material
- ☐ Till
- ☐ Stratified Sand and Gravel
- ☐ Stratified Fine Sand and Silt
- ☐ Alluvium

Bedrock
- ☐ Igneous and Metamorphic
- ☐ Sedimentary

Organic Material
- ☐ Absent
- ☐ High Permeability
- ☐ Low Permeability

Hydrological Elements

Hydrologic Position
- ☐ Perched Wetland
- ☐ Water Table Wetland
- ☐ Water Table/Artesian Wetland
- ☐ Artesian Wetland

Transmissivity of Aquifer
- ☐ Low <10,000 gal/day/ft
- ☐ Moderate 10,000 - 40,000 gal/day/ft
- ☐ High >40,000 gal/day/ft

Dominant Hydrologic Type
- ☐ Condition 1
- ☐ Condition 2
- ☐ Condition 3
- ☐ Condition 4
- ☐ Condition 5
- ☐ Condition 6

Hydrologic Connection
- ☐ Not Part of Riparian System
- ☐ Part of Riparian System

Water Level Fluctuation
- ☐ High
- ☐ Low
- ☐ Vernal Pool

Groundwater Outflow
- ☐ Absent
- ☐ Present

Inlet
- ☐ Absent
- ☐ Present, from wetland ____
- ☐ Perennial
- ☐ Ephemeral

Inlet
- ☐ Absent
- ☐ Present, from wetland ____
- ☐ Perennial
- ☐ Ephemeral

Inlet
- ☐ Absent
- ☐ Present, from wetland ____
- ☐ Perennial
- ☐ Ephemeral

Social-economical Elements

Size
- ☐ Large >4.6 acres
- ☐ Medium 1.1-4.5
- ☐ Small <1 acres

Surficial Geologic Material of watershed
- ☐ Till
- ☐ Stratified sand and gravel
- ☐ Stratified fine sand and silt
- ☐ Alluvium

Percent Wetland Bordering Open Water
- ☐ < 33%
- ☐ 34-66%
- ☐ 67-100%
- ☐ Does not border

Legal Access
- ☐ Yes
- ☐ No

Fetch
- ☐ Over 2000 ft.
- ☐ Under 2000 ft.

Depth of Lake
- ☐ Deep >6 ft.
- ☐ Shallow <6 ft.

Hydrologic Connection
- ☐ Connected to a Small Stream
- ☐ Connected to a River
- ☐ Connected to a Lake
- ☐ Connected to a Combination

Access to Public
- ☐ Within 100 ft of Road
- ☐ Access by Passable Waterway
- ☐ Isolated

Surrounding Population Density
- ☐ <1 person/acre (<320/mi²)
- ☐ 0.5 - 1.9 p/a (430-1220/mi²)
- ☐ >2 p/a (>1220/mi²)

Local Scarcity
- ☐ <200 ft to nearest similar type
- ☐ 201 to 1000 ft to nearest similar type
- ☐ >1000 ft to nearest similar type

Known Crop Value or Potential
- ☐ None
- ☐ Supports 1 family for part of year
- ☐ Completely supports 1 family
- ☐ Supports viable commercial interest

Inlet
- ☐ Absent
- ☐ Present, from wetland ____
- ☐ Perennial
- ☐ Ephemeral

Inlet
- ☐ Absent
- ☐ Present, from wetland ____
- ☐ Perennial
- ☐ Ephemeral

Outlet
- ☐ Absent
- ☐ Present, to wetland ____
- ☐ Perennial
- ☐ Ephemeral

Outlet
- ☐ Absent
- ☐ Present, to wetland ____
- ☐ Perennial
- ☐ Ephemeral

make a choice as to which condition under the subheading best described the wetland. Upon completion of the inventory, those elements checked were entered into the appropriate functional models for the evaluation of each function.

4.5.2 Implementation of Wetland Inventory

Each of the wetland inventory elements is described in detail in Appendix C. These descriptions and procedures for measurement of each element and for identifying the most applicable condition are presented in the order in which they appear in the inventory report.

To collect the field data required for the 10 functional models, a three-man team consisting of a geologist/hydrogeologist and a botanist/wildlife biologist conducted a site visit to each wetland. A hydrogeologist investigated selected wetlands. Each element in the inventory report was evaluated in the field using actual measurements, wherever possible, to determine the most appropriate condition designations. Where it was not possible to obtain measurements, subjective decisions were made based on best professional judgment. A detailed discussion of the field implementation of the wetland inventory is included in the wetland inventory report example provided in Appendix D.

4.6 DEVELOPMENT AND ADAPTATION OF MODELS

A comprehensive literature review was completed and each of the investigators' original functional models was modified, as necessary, for conditions in the study area. Ten functional models were used to assess wetlands in the study area:

1. Biological;
2. Hydrologic support;
3. Ground water;
4. Storm and floodwater storage;
5. Shoreline protection;
6. Water quality maintenance;
7. Cultural/Economic;
8. Recreational;
9. Aesthetic; and,
10. Educational.

The model for biological function value was based primarily on the assessment systems developed by Fried (1973) and Golet and Larson (1974). Of all the systems that have been developed over the last three decades, only these two assessment systems included elements to assess wetland value for many different wildlife species that could be readily measured in the field and/or on aerial photos. These systems were based on a standard of maximum wildlife production and variety which, it was determined, would be more responsive to NR 132.06(4) of the Wisconsin Administrative Code than a standard based only on waterfowl production. Moreover, the Fried and Golet/Larson models were developed in the northeast where wetlands are more similar to those in northern Wisconsin than the Prairie

Pothole wetlands where the majority of the earlier wetland assessment systems were developed.

Preceding all other elements in the biological function model are the pre-emptive elements "Unique Fisheries" and "Presence of Endangered or Threatened Species." If either of these elements applies to a given wetland, that wetland is identified for closer scrutiny regardless of its scores in any of the models. Other pre-emptive categories are discussed in Section 4.8.

To modify the authors' original biological function model the element "Vegetative Density" was added for use both as an index of primary production and an indicator of potential numbers and relative abundance of wildlife species. "Percent of Wetland Bordering Open Water" was added because of the predominance of lakes, streams and rivers as landscape elements in northern Wisconsin, and because wetlands associated with open water bodies are more valuable for wildlife than those which are isolated (Golet and Larson, 1974). "Surface Water Connection" was the third element added because it has been shown that detrital transport is dependent upon connection to a riparian system (Reppert, et al., 1979). Regulation NR 132 of the Wisconsin Administrative Code has listed net primary productivity among the important elements in the biological function of a wetland, and detrital production and transport is a major factor in the primary production of wetlands and receiving waters. The elements, "Dominant Wetland Class," "Hydrologic Connection," "Water Level Fluctuation," and "Surface Water Connection," in addition to their roles in determining wetland function for terrestrial and wetland animals, served as indicators of wetland function for finfish. There were also minor adjustments in the numerical values assigned to certain elements and the conditions under which they occur in northern Wisconsin. For example, the elements "Number of Wetland Subclasses" and "Wetland Size" were modified to reflect actual conditions in the study area.

The watershed functional model (including models 2-6) developed previously by the authors was based, in part, on the works of Baker (1960), Larson (1973), Ladd et al. (1975), Coleman and Kline (1977), Hollands and Mulica (1978) and Reppert et al. (1979). The elements in the original model were for wetlands in glaciated hydrogeologic regions, similar to northern Wisconsin, and only minor modifications were necessary to adapt the authors' model to the study area. The detailed hydrogeologic classification of wetlands in Hollands and Mulica (1978) is applicable to New England where the morphological sequence method of surficial geologic mapping is used by the U.S. Geological Survey. This classification was replaced with surficial geologic material types of Motts and O'Brien (1980) consisting of till, stratified sand and gravel, stratified fine sand and silt, and alluvium. Bedrock types of Motts and O'Brien (1980) consisting of igneous and metamorphic or sedimentary rock types were added. Also added from Motts and O'Brien (1980) were hydrologic positions composed of perched, water table, water table/artesian, and artesian wetlands, and transmissivity of aquifers consisting of low (<10,000 gal/day/ft), moderate (10,000 - 40,000 gal/day/ft), and high (>40,000 gal/day/ft) values.

The socio-cultural functions of wetlands have not received the same level of emphasis in wetlands assessment as the biological or hydrological functions, and the information available is largely in the form of guidelines and criteria that might be considered in assessing these functions.

These guidelines and criteria consisted of four distinct parts that each required a separate model: (1) economics, (2) recreation, (3) aesthetics and (4) education (Greeson et al., 1979). Since there were no existing models for the socio-cultural functions, new models were developed for each of the four categories listed above.

The economic function of wetlands was based on the value of all usable products such as timber, edible plants and wildlife. The commercial value of products obtained from wetlands over large geographic areas have been summarized by Johnson (1979) for timber, Peters et al. (1979) for fish and shellfish, Chabreck (1979) for wildlife, and Dideriksen et al. (1979) for agricultural crops. Foster (1979) discussed the entire process of assigning dollar or capitalized values to wetlands. The point is made that wetland values will vary both geographically and over time.

Based on the information and the guidelines presented in the above references, the elements which were considered important in assessing economic function included: (1) Dominant Wetland Class, (2) Public Access, and (3) Size. "Dominant Wetland Class" had a direct bearing on whether commercial products are present, such as timber, wild rice, furbearers or game fish that have the potential to contribute to the economic base of the region. "Public Access" to wetlands having a potential cash crop was also a factor in a wetland's economic value, and this value increases with ease of access. Finally, "Size" of a wetland containing a potential cash crop was related to total yield of the harvest and was as important in determining economic function as presence of the crop.

The recreational function of wetlands was based on a wide variety of consumptive and non-consumptive uses. Bedford et al. (1974) made frequent reference to the recreational value wetlands provide the public, including hunting, trapping, fishing, water sports and hiking, and they used seven criteria to assess the value of wetlands in Dane County, Wisconsin. Total dollars spent on wetland-based recreational pursuits was also a frequent measure of the recreational value of a wetland (Reimold and Hardisky, 1979). The greater the recreational value, the greater the amount of money that the public will be willing to spend on their use of those wetlands.

Using the guidelines and criteria in the above sources, the elements which were selected to assess the recreational function included: (1) Dominant Wetland Class, (2) Percent Open Water, (3) Surface Water Connection, (4) Public Access, (5) Size, (6) Legal Access, and (7) Output from Biological Function Model. One of the most important elements was "Size", since larger wetlands support a greater variety and density of wildlife and afford more opportunities for recreational activities associated with wetlands such as nature study and hunting. "Percent Open Water" and "Surface Water Connection" were also important because both directly affected the potential for water based recreational activities such as boating and fishing. "Dominant Wetland Class" and "Output from Biological Function Model" were important because they indicated whether a wetland might support wildlife of recreational interest such as deer, waterfowl or songbirds. "Public Access" and "Legal Access" were less important than those elements which actually determine recreational potential because access status can change.

The aesthetic value of a wetland was perhaps the most difficult factor to define and quantify. Reimold and Hardisky (1979) described the sensory stimuli coming from a wetland that contribute to its aesthetic perception. Niering (1979) has reviewed how wetlands have inspired artists, writers and composers throughout history.

Using information contained in the foregoing references, five elements were selected for evaluating aesthetic function: (1) Dominant Wetland Class, (2) Number of Wetland Subclasses, (3) Percent Open Water, (4) Public Access, and (5) Local Scarcity. "Dominant Wetland Class" was one of the two most important elements because certain wetland classes, such as bog and aquatic bed, had higher visual appeal than others. The second most important element was "Percent Open Water" because aesthetic appeal improves as open water increases, with an optimum thought to occur between 67 and 95 percent. "Local Scarcity" played a role in the aesthetic function from the higher visual relief afforded by a rare wetland type in the landscape. "Number of Wetland Subclasses" affected wetland aesthetics because it determined the variety of plant forms and amount of interspersion, and therefore visual richness. Finally, "Public Access" to a view of a wetland was considered important because appreciation of its aesthetic attributes is dependent upon access.

Educational uses of wetlands ranged from simple natural history field trips to sophisticated research studies. Studies by Davis (1965; 1976) and Wright (1972) demonstrated the increasing importance of palynological studies in wetlands. Palynology attempts to document the post-glacial vegetation changes that have occurred in a particular wetland by examining fossil pollen grains, and is especially useful in bogs where the low pH and anaerobic conditions have insured the presence of plant microfossils. Niering (1979) noted that wetlands preservation insures their availability for future studies by nearby schools. He also cited the archaeological value of European bogs in revealing the early history of civilized man.

Based on the above review, two elements were identified as important in assessing the educational function of a wetland: "Number of Wetland Subclasses" and "Public Access". The former element was important because the opportunity to observe natural history phenomena increases as the number of wetland subclasses increases. "Public Access" was also important because wetlands accessible to the public permit larger numbers to study wetland processes than do isolated wetlands.

Since some elements in the biological, watershed, and socio-cultural functional models were of greater importance than others in evaluating a given function, the elements were weighted. The conditions of each element were then numbered and the contribution of each element to the model was determined by multiplying the element's weighted value by the condition. The following is an example of a portion of the ground-water functional model:

Element	Element Weight	Condition Weight	Conditions
Hydrologic Position	5	2	Perched wetland
		4	Water table wetland
		2	Water table/artesian wetland
		1	Artesian wetland
Transmissivity of Aquifer	4	1	Low <10,000 gal/day/ft
		2	Moderate 10-40,000 gal/day/ft
		3	High >40,000 gal/day/ft

Hydrologic position was considered to be of great importance in the ground-water functional model and was given an element weight of 5.

Transmissivity of aquifer was considered nearly as important as hydrologic position and was assigned an element weight of 4. Under hydrologic position, four conditions developed by Motts and O'Brien (1980) occur. Each was assigned a condition weight ranging from 1 to 4.

When an individual wetland was inventoried, the conditions under the hydrologic position most representative of the wetland's hydrogeology were checked. When the ground-water functional model was applied, the hydrologic position element weight (5) was multipled by the condition weight (2) to yield a value of 10. This was done for each element and the sum of all inventoried elements was totalled to yield a numerical value for the wetland's ground-water function.

The 10 functional models are more fully described in Appendix E. The role of each of the model elements, their relative importance in the models and their relationship to Wisconsin Administrative Code, NR 132, are also addressed. Examples of completed biological and hydrological models are presented in Appendix F.

4.7 AQUATIC STUDY AREAS, SANCTUARIES AND REFUGES WITHIN STUDY AREA

A literature search was made to determine which areas within the study area were of special legal or public interest, so that they could be more thoroughly evaluated. Chapter NR 302 of the Wisconsin Administrative Code was reviewed to determine if any wild rivers were located adjacent to or within the study area. The locations of nearby Wisconsin Scientific Areas were determined by reviewing Germain et al. (1977) and a more recent DNR list of areas up to and through area No. 170, Chapter NR 302. The report of a workshop entitled "Heritage Areas of Forest County" was reviewed for similar information on natural areas, and wildlife, forest and mineral resources in the study area. The State map entitled "Public Lands Open to Hunting" provided by the DNR was reviewed for public lands in the study area that are open to hunting.

4.8 REGIONAL WETLAND ANALYSIS

To evaluate the study area wetlands in a regional context, they were compared to the wetlands in the region (defined as the Wolf River drainage basin above Langlade) by determining the frequency of occurrence of the study area wetland types within the region. To accomplish this, a sample of the wetlands in the region was classified as to vegetative type, measured, and the area of each wetland type was estimated for the entire region. The frequency of occurrence of each wetland type was expressed as a percentage of the study area and region. This percentage was determined by first measuring the area of each wetland type in the study area, as shown on the 1 inch = 400 foot scale orthophoto wetland map (Figures 4.3-1A through 4.3-1I). The results of these measurements are presented in Appendix G, "Wetland and Watershed Area Data".

The existing wetland mapping for a portion of the region, at a scale of 1 inch = 2000 feet, was obtained from the DNR (Figure 4.8-1). This mapping had been produced by aerial photograph interpretation and covered only a portion of the center of the region, including the study area.

For the portion of the region not yet mapped by the DNR, the area of each wetland type was estimated. To accomplish this, aerial photography of the type used by the DNR to delineate wetlands was obtained from the DNR for the entire region. Next the region was broken into hydrogeologic regions consisting of till, pitted outwash, and moraine (Figure 4.8-1) based upon data from the Wisconsin Geological Survey. For each hydrogeologic region, townships and range coordinates were randomly selected and the aerial photographs which best covered the coordinate location and surrounding

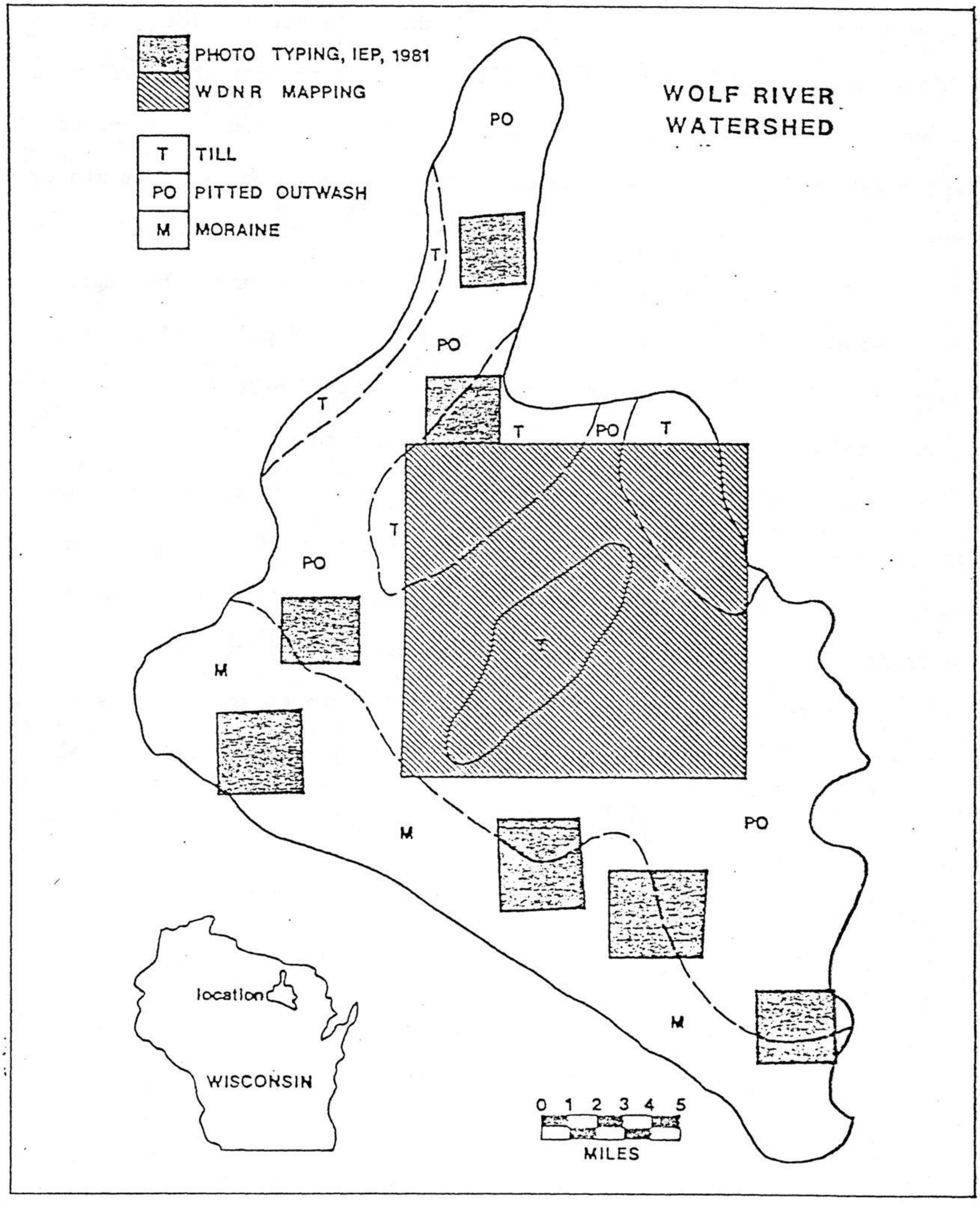

Figure 4.8-1. Map of study region showing areas of aerial photograph interpretation and hydrogeologic regions (detailed map is in map volume).

area were photo interpreted. Figure 4.8-1 shows the areal coverage of each aerial photograph typed. Many of these aerial photographs overlapped two hydrogeologic areas. The wetlands within each selected aerial photograph were classified (phototyped) and the area of each wetland was measured. These data are presented in Appendix H, Regional Scarcity Measurements.

The DNR mapping covered approximately 30 percent of the region and we mapped 11 percent; thus, 41 percent of the regions' total area was phototyped. The area of wetlands in the remaining 59 percent of the region was extrapolated from the 41 percent actually mapped.

The total area of each wetland type in the study area was compared to the total area of each type in the region by dividing the areas of the wetland types in the study area by the total areas of those types in the region. For example, the area of shrub swamp found in the study area (34 ha [84 acres]) was divided by the estimated area of shrub swamps in the region (4073 ha [10,083 acres]) to determine the percentage of regional shrub swamps occurring in the study area.

5.0 WETLANDS EVALUATION PROCEDURE

Several different methods and procedures have been employed to evaluate the functions of wetlands (Golet, 1979; Reppert and Sigleo, 1979; Schamberger et al., 1979). The wetlands evaluation methods reported in the literature were examined to determine the system or systems that would provide information to fulfill the requirements of NR 132. Based on this review, an evaluation system utilizing a qualitative description of wetlands and a semi-quantitative numerical model was used in this investigation.

In the descriptive evaluation, biological and hydrological characteristics of 46 wetlands of special interest were characterized from field notes written for each wetland. These descriptions provided the basis for assessment of wetland functions using best professional judgment. The assessment criteria used were those which, in the professional experience of the investigators, were readily estimated and reliable indicators of the wetland functions. Criteria such as amount of edge habitat and water cover ratio were included for the biological function, and water storage and ground water recharge potential for hydrological functions. The conditions that give rise to the functional characteristics were described and the functions assessed for the wetlands of special interest.

Wetland functions were also assessed based on a standardized field inventory procedure with specific input requirements for 10 functional models. Most of the model inputs required actual measurements on maps and aerial photographs in the laboratory or in the field and only a few required ratings based solely upon professional judgment. The model elements were selected on the basis of an extensive literature review and field experience, and were modified to conform with the geographic locale of the regional study area. Results of the model assessment of wetland functions produced numerical scores for each of the 10 functional criteria for all the wetlands surveyed. A narrative discussion of these functional values as they pertain to specific wetland ecosystem characteristics was provided to supplement the numerical scores.

Absolute numerical values of a given wetland derived from model evaluations are exceedingly important when the scale of reference is broadened to include comparisons with other wetlands (Golet, 1979). However, Reppert and Sigleo (1979) caution that little assurance can be placed in evaluation methods permitting computation of absolute values for wetlands. They contend that absolute values are not comparable over broad geographic areas with different topographic and hydrologic systems. The usefulness of quantifying natural resource elements for decision making processes has long been recognized and has been commonly used (McHarg, 1969). In our study the unnormalized scores for each of the 10 wetland models were summed for convenience, but as noted in Section 6.2, the total value is of limited use per se and the value of each wetland must be determined by weighting each functional element.

In addition to the actual values derived from the 10 functional models, the models were normalized within the range of 0 to 100. The biological model and combined hydrological models were each assigned 40 percent of the total and the sociocultural models 20 percent. The sociocultural functions were assigned a lower percentage because their values are manifestations of the basic biological and physical functions (Reppert and

Sigleo, 1979). The individual functional models were normalized for comparative purposes.

Although many methods have been developed to evaluate wetlands (Richardson, 1981), the general trend has been toward a numerical modeling approach using predominantly measurable biological and physical features of wetlands as evaluation criteria (Golet, 1979). During our assessment, wetlands were described and a numerical rating model was employed. The numerical model approach complimented the purely subjective descriptive evaluation procedure, and added the following advantages: (1) higher repeatability of assigned values between observers and by the same observer over time, (2) less subjectivity in determining the overall value of a wetland and the use of standard procedures to collect data and compute scores, (3) an objective means of evaluating, documenting, and comparing the functional values of a large number of wetlands, and (4) the results can be tabulated in numerical terms in concise format and the values can be readily compared by individuals with little experience in wetland ecology. In applying the modeling method, all wetlands are evaluated using criteria based upon accepted principles.

6.0 RESULTS AND DISCUSSION

The study results and discussion are organized into four major topical areas: (1) qualitative and quantitative field studies, (2) model results, (3) regional context evaluation, and (4) aquatic study areas, sanctuaries and refuges within the study area.

The qualitative and quantitative field studies (Section 6.1) consist of two parts; the first is a qualitative description of the wetlands of special interest in the study area, and the second is a presentation of the results of quantitative investigations for vegetation, herpetofauna, avifauna and mammals. The model approach, in contrast to the qualitative descriptions, is based on numerical value assignments to model elements and conditions and is therefore semiquantitative in nature. Model results consist of three parts; in Section 6.2 model data for 127 study area wetlands are presented in composite tables for each model; Section 6.3 contains an analysis of the data from the biological, watershed and socio-cultural models for the wetlands of special interest; and Section 6.4 presents a discussion of model results for the 10 highest ranked wetlands.

In the comparison of wetland assessment procedures, the qualitative and quantitative wetland assessment approaches are discussed and evaluated. The regional context evaluation relates study area wetlands to other wetlands in the region as a basis for evaluating the wetland scores. Finally, the topic aquatic study areas, sanctuaries and refuges, addresses the status of the study area with respect to these designations and ownership categories.

6.1 QUALITATIVE AND QUANTITATIVE FIELD STUDIES

6.1.1 Qualitative Description of Wetlands of Special Interest

The wetland inventory reports from which the qualitative descriptions were derived for the 46 wetlands of special interest are presented in Appendix I along with the other inventory reports. The wetlands of special interest included two shallow marshes, four shrub swamps, 20 deciduous swamps, five bogs, 14 coniferous swamps and one aquatic bed. Results of the quantitative field investigations are described in Section 6.1.2, and a discussion of the model results for the wetlands of special interest are presented in Section 6.3. To facilitate the following discussion, wetlands were grouped according to surface hydrologic connections. These wetlands are shown in Figure 4.3-1. A summary of the major qualitative elements used to describe and evaluate the wetlands of special interest is presented in Table 6.1-1.

Wetlands of Special Interest - Area 41

Wetlands of special interest in and near Area 41 are shown in Figures 6.1-1A, 6.1-1B and 6.1-1C. Some of the wetlands near Area 41 are not shown on these figures; however, they are presented in Figure 4.3-1 of the map volume.

Wetland F10 - Wetland F10 was one of two wetlands (including F11) in a short connected system that bordered Little Sand Lake. This wetland was a coniferous swamp that formed a dense cover composed mainly of

Table 6.1-1. Summary of major elements used to describe and evaluate wetlands of special interest.

		MAJOR ELEMENTS								
WETLAND NO.	DOMINANT WETLAND TYPE	AMOUNT OF EDGE	WATER/ COVER RATIO	SURROUNDING HABITAT VARIABILITY	% BORDERING OPEN WATER	RECHARGE POTENTIAL	WATER STORAGE	DISCHARGE TO DOWNSTREAM AQUATIC SYSTEMS	LIVING FILTER CAPACITY	SIZE
B2	CS[a]	High	Low	Med	Low	High	High	Med	High	Large
B3	CS	Med	High	Med	Med	Low	Low	High	Low	Med
B4	DS[b]	High	Low	Med	Low	Low	High	High	High	Large
B5	CS	Med	Low	Med	Low	High	Low	Low	High	Small
B8	DS	Low	High	Med	Low	High	Low	Low	High	Small
D1	DS	High	Low	Med	Low	High	High	High	High	Large
D3	DS	Low	Low	Med	Low	Low	Med	Med	Med	Med
D4	DS	Med	Low	Med	Low	Low	High	High	High	Large
D4A	DS	Low	Low	Med	Low	Low	Low	Low	Med	Med
D5	B[c]	Low	Low	Med	Low	High	Med	Low	Med	Small
D6	DS	Low	High	Med	Low	Low	Med	Low	Med	Small
F10	CS	High	Low	Med	Med	Med	High	High	High	Large
F11	CS	Low	Low	Med	Low	Med	High	Med	High	Large
F13	CS	Low	Low	Med	Low	Med	Med	Low	High	Med
F23	SM[d]	Med	Low	High	Med	Med	Med	High	Med	Large
F25	DS	Med	Low	Med	Low	Low	Med	Med	Med	Med
F27	DS	Med	Low	Med	Low	Low	Med	Med	Med	Med
F28	B	High	Med	Med	High	Med	High	High	High	Large
F29	SS[e]	High	Low	Med	Low	Low	Med	Med	Med	Large
F31	DS	Med	Low	Med	Low	Low	Med	Med	Med	Large
F32	DS	Low	Low	Med	Low	Low	Med	Low	Low	Small
F57	DS	Med	Med	Med	High	Med	Med	High	Med	Large
F60	CS	High	Low	Med	Low	Low	High	Med	High	Large
F61	DS	Low	Low	Med	Low	Low	Low	Med	Low	Med
F62	DS	Med	Low	Med	Low	Low	High	Med	High	Large
F63	CS	Med	Low	Med	Low	Low	High	Med	High	Large
F64	B	Low	Low	Med	Low	Low	High	Med	High	Large
F65	SS	Med	High	Med	Low	Low	High	Med	High	Large
F66	CS	High	Low	Med	Low	Low	High	Med	High	Large
F69	DS	Low	Low	Med	Low	Low	Med	Low	Med	Med
F70	DS	High	Low	Med	Low	Low	Low	Low	Med	Med
F72	DS	Low	Low	Med	Low	Low	Low	Low	Med	Large
F81	AB[f]	Low	High	Med	Low	Low	Low	Low	Low	Small
F114	SM	Med	Med	Med	Low	Med	Low	Low	Low	Small
M3	DS	Med	Low	Med	Low	Low	Med	Med	Med	Med
O1	CS	Med	Low	Med	Low	Med	High	High	High	Large
P2	CS	Low	Low	Med	Low	Low	High	High	High	Large
R1	DS	Med	Low	Med	Low	Med	Low	Med	Low	Large
R1A	DS	Med	Low	Med	Low	Med	Med	Med	Med	Large
R8	SS	Med	Low	Med	Low	Low	Low	Low	Med	Med
T1	B	Low	Low	High	Low	High	Med	Low	Med	Med
T2	B	High	Low	High	Low	High	Med	Low	Med	Med
T3	SS	Med	Low	High	Low	High	Low	Low	High	Small
T4	CS	High	Low	High	Med	High	High	High	High	Large
W1	CS	Med	Low	Med	Med	High	High	High	High	Large
W2	CS	Med	Low	Med	Med	High	High	High	High	Large

[a] Coniferous Swamp

[b] Deciduous Swamp

[c] Bog

[d] Shallow Marsh

[e] Shrub Swamp

[f] Aquatic Bed

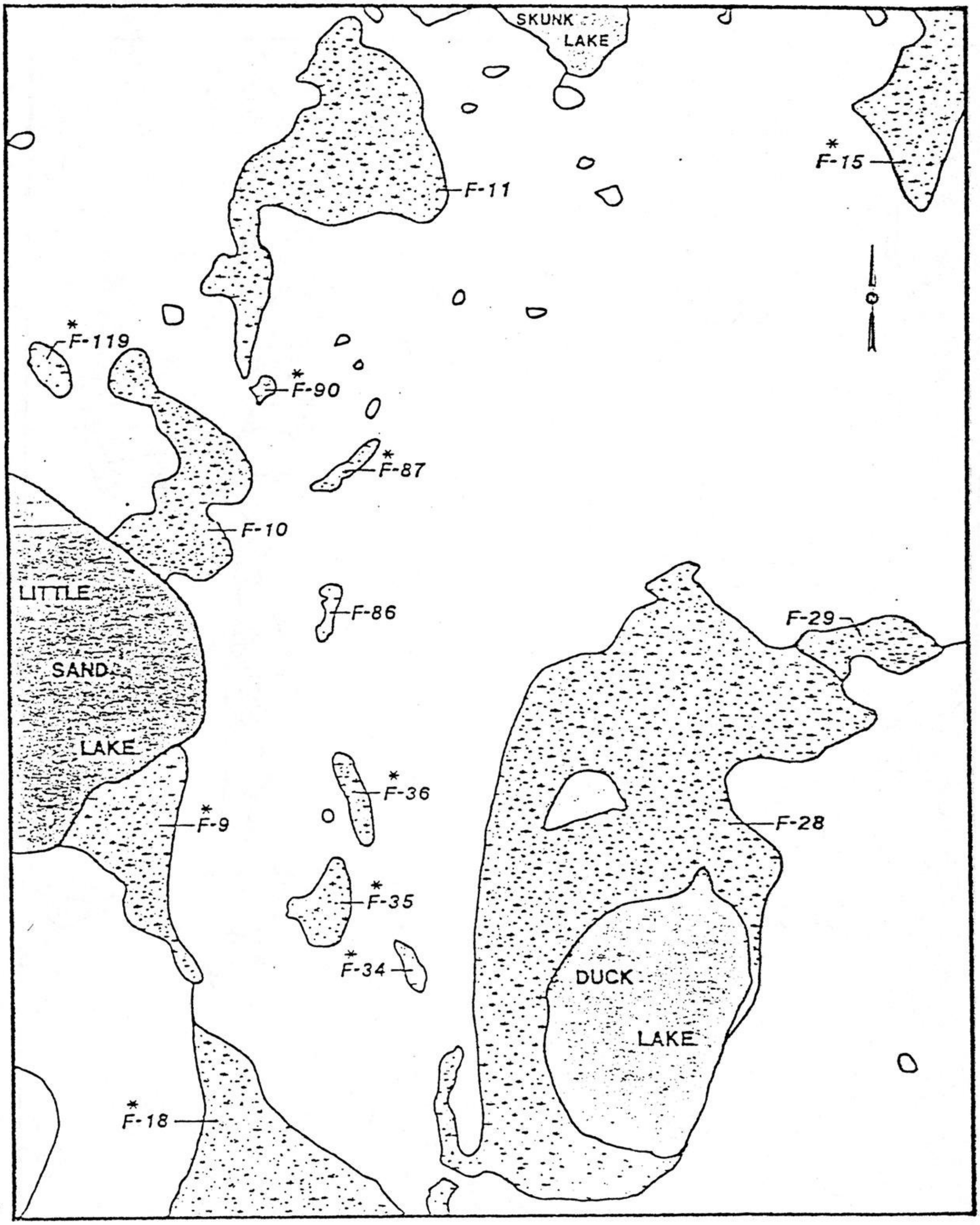

Figure 6.1-1A. Wetlands of special interest associated with Candidate Tailings Disposal Area 41 (*wetlands not of special interest).

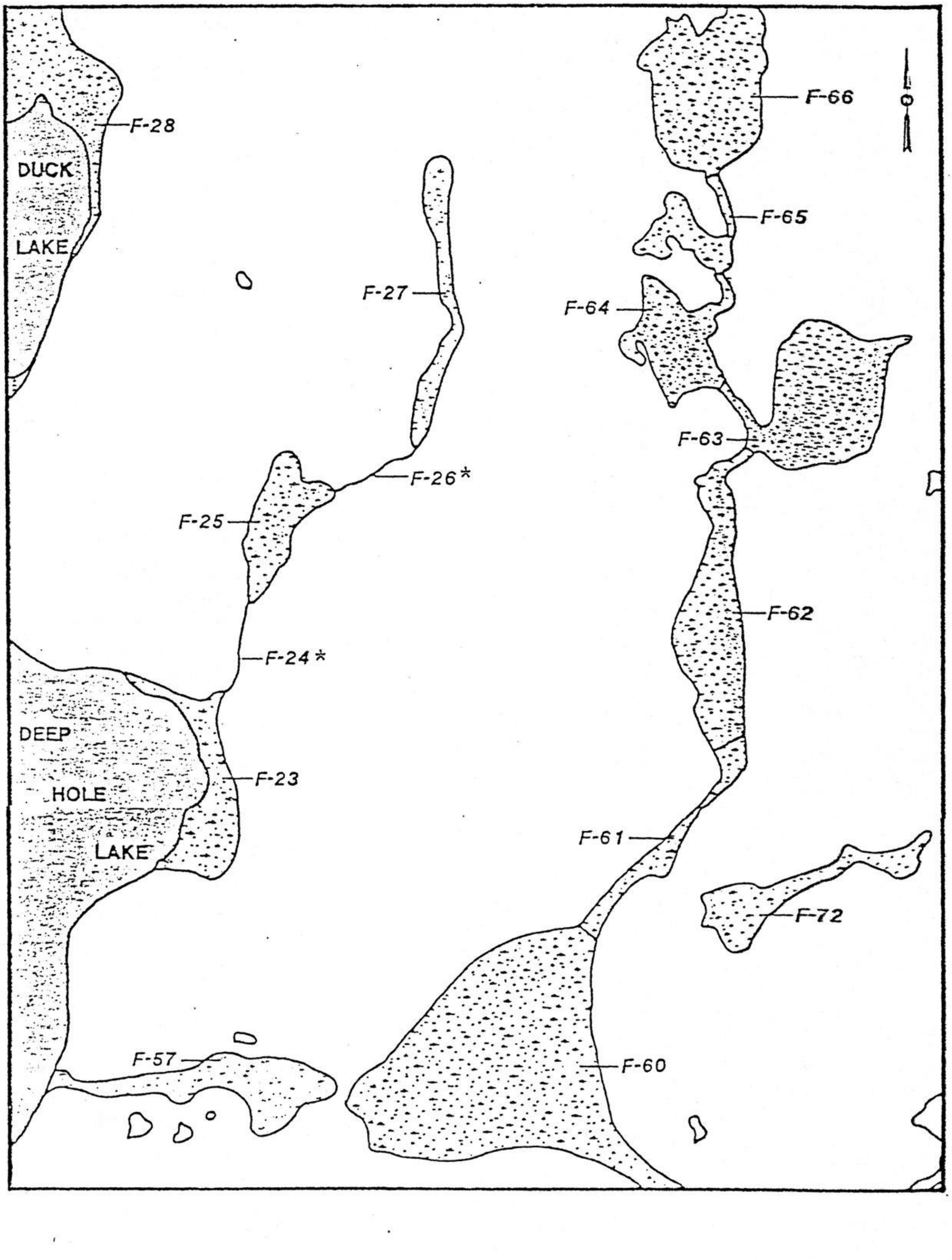

Figure 6.1-1B. Wetlands of special interest associated with Candidate Tailings Disposal Area 41 (*wetlands not of special interest).

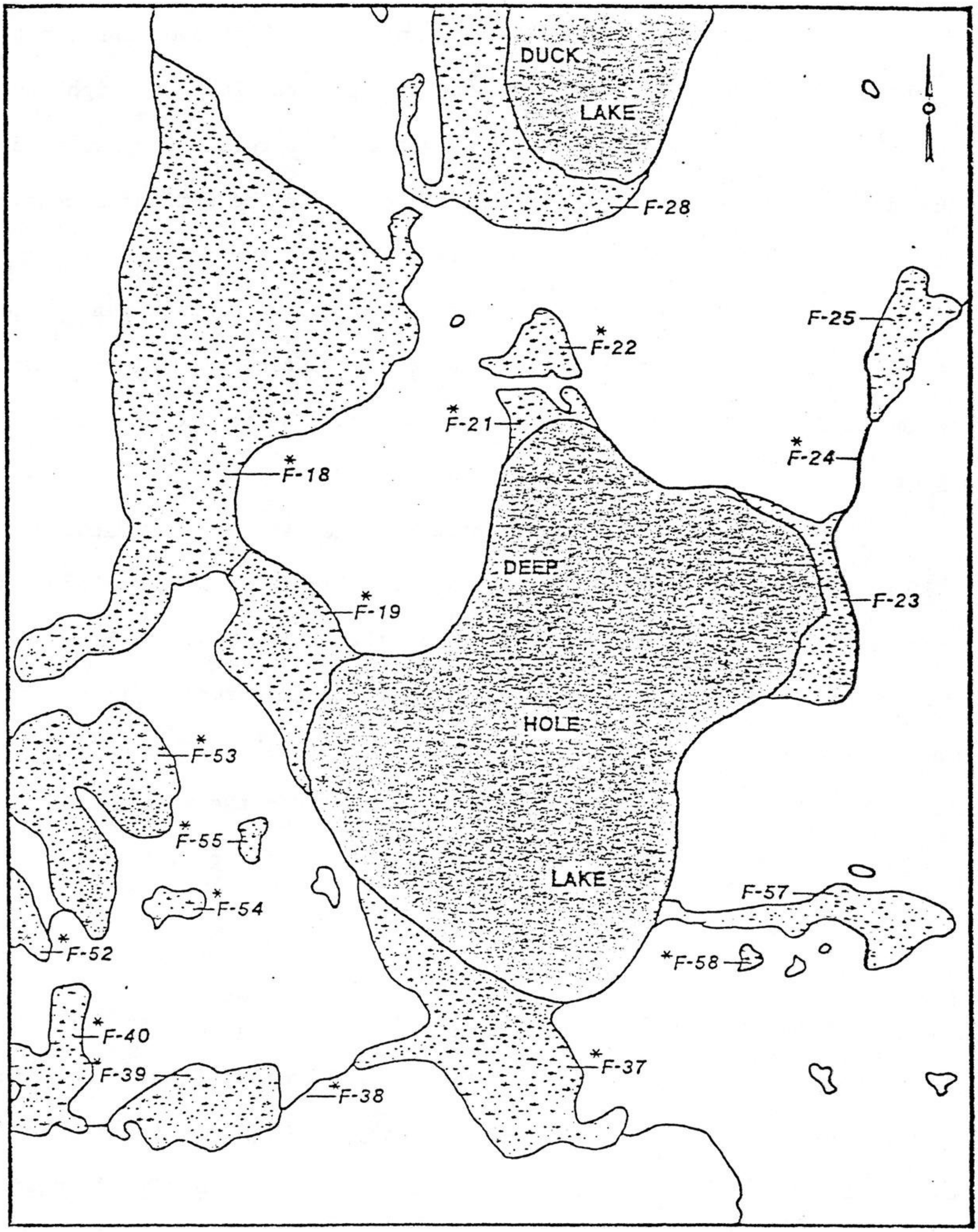

Figure 6.1-1C. Wetlands of special interest associated with Candidate Tailings Disposal Area 41 (*wetlands not of special interest).

tamarack and black spruce in the tree layer and leatherleaf and Labrador tea in the shrub layer. Amount of edge and structural diversity were high and, although there was road access nearby, the wetland was relatively isolated, surrounded by mixed upland forest. These factors, and the wetland's connection to Little Sand Lake provided favorable winter and summer habitat for wildlife. The potential for timber production and other crops appeared to be absent in wetland F10 but opportunities for the socio-cultural considerations, including recreation, cultural, economic, aesthetic and education, were good.

Hydrologically, F10 was part of a riparian system, F11 flowing into F10 which borders Little Sand Lake. Water also flows into wetland F10 from Little Sand Lake when the water level in the lake rises enough to cause flooding of wetland F10. There were no defined stream channels through the wetland and no definable discharge channels into the lake. The wetland functions to allow a high degree of interaction between the water, soils and vegetative community. This results in an excellent water quality maintenance function as well as a good hydrologic support value.

Wetlands F27, F25, and F23 - Wetlands F27, F25 and F23 were a system connected by two streamside wetlands (F26 and F24) that flowed into Deep Hole Lake. Wetland F27 consisted of nearly equal proportions of low density deciduous swamp and shrub swamp, and was composed mainly of American elm and green ash, with wild leek (*Allium tricoccum*) and dutchmans breeches (*Dicentra cucullaria*) representing the ground cover. Wetland F25 was a high density wooded swamp containing black spruce and a deciduous portion composed mainly of American elm, balsam poplar (*Populus balsamifera*) and green ash with a sparse ground cover. Wetland F23 consisted of two components: a high density shrub swamp and a shallow marsh, the latter type being dominant. The most common species in this wetland were leatherleaf, cattail, blue-joint grass, wool-grass (Scirpus cyperinus) and manna grass. The amount of edge throughout this system was high, but structural variability was moderate. Wetlands F27 and F25 were surrounded by mixed upland forest, and both were within 30.4 m (100 feet) of access roads. Based on the condition of the major determining factors, the potential for wildlife habitat appeared to be less in these wetlands than in wetland F23, which was not accessible by road and which bordered Deep Hole Lake. The potential for harvestable crops was absent in all three wetlands but the potential was favorable for the other socio-cultural opportunities, particularly in wetland F25.

Wetlands F27 and F25 were perched on glacial till. They occurred in semi-closed basins and were Condition 5 hydrologic types. They receive, store, and slowly discharge water downstream to wetland F23 via two streamside wetlands, F26 and F24. They were part of a riparian system contributing to Deep Hole Lake. They afford opportunities for storm water control, water quality maintenance, and hydrologic support to Deep Hole Lake. Wetland F23, the last wetland in the series, discharged directly into Deep Hole Lake and provided an important hydrologic link and buffer for the lake.

Wetlands F31, F29 and F28 - Wetlands F31, F29 and F28 were in the upper part of a chain of wetlands that ultimately flowed into Duck Lake. This wetland system was diverse, with several types represented. Wetland F31 was a medium dense deciduous swamp dominated by a tree layer of red maple and American elm, with speckled alder in the shrub layer and blue-joint grass, dutchmans breeches and wild leek constituting the ground cover. This wetland was connected to wetland F29 by a streamside wetland (F30). Wetland F29 was a dense shrub swamp of willow, American elm, and poplar (Populus tremuloides), with scattered alder, tamarack and black spruce. Wetland F28, which surrounded Duck Lake, was the largest in the chain (26.2 ha [65 acres]) and was predominantly bog composed mainly of dense tamarack, Labrador tea, leatherleaf, bog laurel and sphagnum. Wetland F28 was connected to Little Sand Lake by wetland F18, another bog, and wetland F9, a bog. The condition of those factors important in creating wildlife habitat such as edge, life form variability and plant species diversity was highly favorable throughout this system. This coupled with lack of road access and the mixed woodland surroundings provided high potential for wildlife habitat. Potential for harvestable crops was absent, but potential for recreation and other sociocultural opportunities was high throughout the system.

Wetlands F31 and F28 were semi-closed basins whereas F29 was located in a valley. F31 and F29 occurred on glacial till and F28 on ice-contact deposits of sand and gravel. All three wetlands were Condition 5 hydrologic types, having a definable outlet but no flow channel within the wetland, affording good interaction between the wetland soils and vegetation within the water. Wetlands F31 and F29 contained relatively thin, low permeability soils whereas wetland F28 contained thick, high permeability soils with more water in storage per unit volume of wetland soil. In contrast to wetlands F31 and F29, wetland F28 was the dominant component in the hydrology of this system because of its size.

Wetland F32 - Wetland F32 was a small unconnected, dense wooded swamp composed mainly of red maple, green ash and American elm. This wetland was isolated and surrounded by upland hardwood forest. Minimal edge, low life form variability and small size (.20 ha [0.5 acre]) contributed to low potential for wildlife habitat and socio-cultural considerations. This wetland had neither an inlet nor outlet and was not part of a riparian system. It was a perched water table wetland occurring on glacial till. These hydrologic elements contributed to its low watershed value.

Wetlands F63, F62, F61, F60 and F57 - Wetlands F63, F62, F61, F60 and F57 were a chain of wetlands that flowed into Deep Hole Lake. This system consisted of a mixture of deciduous and coniferous swamps with small areas of shrub swamp in F57 and F60 and bog in F63. The deciduous swamps consisted of low to high density red maple, balsam poplar, green ash, American elm and yellow birch in the tree layer with gooseberry (*Ribes glandulosum*), hazelnut (*Corylus cornuta*), and speckled alder in the shrub layer. The coniferous swamps were dominated by dense black spruce, tamarack, hemlock and white cedar in the overstory and a shrub layer of leatherleaf, large cranberry and Labrador tea. This system was surrounded by mixed upland forest and was accessible by several roads. Structural diversity, amount of edge, and interspersion of the vegetation provided good potential for both wildlife habitat and socio-cultural considerations. Crop potential was absent.

All of these wetlands had a continuous surface water hydrologic connection. The surface water connection between wetlands was mostly without a definable stream channel, and was either shallow interflow within the organic soils or through culverts. The exceptions were wetlands F61 and F57 which contained definable surface water flow channels for most of their lengths. Surface water in this system must pass through the dense vegetative communities and the organic soils before reaching Deep Hole Lake. A series of small beaver ponds were present in wetland F57. Culverts and road fill at the outlets of F60 and F62 also controlled waterflow. Wetlands F63, F62, F61, and F60 occurred on glacial till and wetland F57 on stratified sand and gravel.

Wetlands F66, F65 and F64 - Wetlands F66, F65 and F64 constituted a system that was poorly connected. Wetland F66 was primarily a moderately dense coniferous swamp with a small area of sapling shrub swamp. Predominant tree species in the coniferous swamp were black spruce, hemlock and balsam fir, and winterberry, willow and speckled alder were most common in the shrub layer. Wetland F65 was mainly a dense shrub swamp with a small proportion of associated coniferous swamp. The predominant shrub swamp species were green ash, meadowsweet (*Spiraea latifolia*), and willow. Wetland F64, a bog, was dominated by dense leatherleaf and black spruce with sedges and manna grass comprising the herbaceous layer. This system was surrounded by mixed upland forest and was without road access. Overall, life form variability and edge were favorable which was indicative of high wildlife habitat potential. Potential for harvestable crops was absent, but potential for the other socio-cultural opportunities was moderately high.

Wetlands F66, F65 and F64 were located in semi-closed basins in glacial till. All were Condition 5 wetlands with ephemeral outlets. Flow between wetlands was predominantly soil interflow, within the wetland soils. Surface water flow seldom occurred in these wetlands.

Wetland F69 - Wetland F69 was a dense deciduous swamp composed primarily of a tree layer of American elm and poplar, with a shrub layer of speckled alder, winterberry and hazelnut. This wetland was surrounded by an upland hardwood forest and was within 30.4 m (100 feet) of a road. Minimal edge, moderate structural diversity and small size (.40 ha [1 acre]) contributed to low potential for wildlife habitat and moderate potential for socio-cultural considerations. The potential for harvestable crops was absent.

Wetland F69 was poorly connected to F60 by an emphemeral outlet. A small rise in the land surface separated F60 from F69. Wetland F69, a perched water table wetland, occurred in a small kettle formed in glacial till. Wetlands F69 and F70 occurred in the same watershed but no recognizable stream channel connected the two wetlands. This wetland had low hydrologic value.

Wetland F70 - Wetland F70 was predominantly a marsh, with areas of deciduous swamp and sapling shrub swamp. The marsh was composed of dense cattail, and the shrub swamp portion consisted mainly of dense mountain holly and red maple saplings; the deciduous swamp area consisted of American elm, white ash (*Fraxinus americana*) and on drier ground, basswood (*Tilia americana*). This wetland was isolated and was surrounded by mixed upland forest. The life form variability and amount of edge, coupled with the lack of road access and the mixed forest surroundings indicated moderately high potential for wildlife habitat and for the socio-cultural opportunities. Potential for harvestable crops was absent.

The wetland had no definable inlets and occurred at the top of the watershed, nearly at the divide. The outlet flowed towards wetland F69 but disappeared as a vegetative wetland and a defined stream channel. This wetland was perched on glacial till and occurred in a watershed consisting of till. It had low hydrologic value.

<u>Wetland F72</u> - Wetland F72 was a deciduous swamp with a dense stand of American elm, red maple, poplar, and white ash in the tree layer. The ground cover was dominated by wild leek and dutchmans breeches. Mixed upland forest surrounded this wetland and road access was lacking. A low density shrub layer, minimal edge and poor structural diversity provided little habitat for wildlife. The abundance of wild leek represents a potential harvestable crop, but the potential for other socio-cultural considerations was low.

This wetland was perched on till near the top of the watershed. It occurred in a valley where surface water collects and is stored. No definable stream channels flowed into or out of the wetland and it was not part of a riparian system. This wetland generally had low hydrologic value.

<u>Wetland F81</u> - Wetland F81 was small (.12 ha [0.3 acre]) and consisted of more than 75 percent shallow open water. The shoreline was vegetated by low density growths of American elm, yellow birch, paper birch (<u>Betula papyrifera</u>) and jewelweed (<u>Impatiens capensis</u>). This wetland was

surrounded by mixed upland forest and was near a road. The condition of those factors which are important in creating wildlife habitat, particularly vegetation life form variability and edge, was unfavorable and indicated low wildlife habitat potential. Potential for the socio-cultural opportunities was also low, and crop potential was absent.

Wetland F81 was a small kettle wetland perched on till and partly blocked by road fill. It had no inlet nor outlet, was not part of a riparian system, and had little hydrologic value.

Wetland M3 - Wetland M3 was one of three wetlands (including M2 and M1) in a connected system that flowed into Hemlock Creek. Wetland M3 was a wooded swamp consisting of high density deciduous and coniferous components. The deciduous portions were composed mainly of green ash with fewer numbers of red maple, yellow birch and American elm; the coniferous component consisted primarily of hemlock with lesser numbers of black spruce. This wetland system was surrounded by mixed upland forest and lacked road access. Vegetative structural diversity, edge and life form variability indicated moderate potential for wildlife habitat and for socio-cultural considerations. Potential for harvestable crops was absent.

Wetland M3 was perched on till. It had a low nearly flat area which collected surface water and stored it in organic wetland soils. Water passed slowly through this wetland and was discharged intermittently downstream to wetland M2, a small streamside wetland. The wetland occurred at the top of the watershed and had a low water budget. Overall this wetland had moderate hydrologic value, supporting the hydrology of wetlands M2 and M1, and ultimately contributing to Hemlock Creek.

Wetlands of Special Interest - Area 40

Wetlands of special interest in and near Area 40 are presented in Figure 6.1-2.

Wetlands D4, D3, D2 and D1 - Wetlands D4, D3, and D2 were a series of wetlands that flowed into wetland D1. Wetland D4 was a dense wooded swamp containing both deciduous and coniferous components. The tree layer was dominated by white cedar, black spruce, red maple and American elm and the shrub layer by speckled alder and Labrador tea. Wetland D3 was a moderately dense deciduous swamp with green ash and poplar in the tree layer and gooseberry and mountain holly in the shrub layer. Wetland D2, a narrow streamside wetland, connected wetlands D4 and D1. It contained a narrow vegetated zone of low density basswood, American elm and red maple with willow and white trillium (*Trillium grandiflorum*) present in the shrub and herb layers, respectively. Wetland D1 consisted primarily of mixed deciduous and coniferous swamp with a small area of shrub swamp. American elm, balsam fir, white cedar and red maple were predominant in the tree layer and speckled alder was the most common component in the shrub swamp. This system of wetlands was surrounded by mixed upland forest and was isolated except for road access to wetland D1. In wetlands D1 and D4, life form variability, edge and structural diversity provided favorable wildlife habitat and opportunities for many socio-cultural uses. Wetlands D2 and D3 were ranked lower mainly because of poor vegetative structure and, in the case of D2, being a streamside wetland.

Wetlands D1 and D2 occurred primarily on stratified sand and gravel and wetlands D3 and D4 on glacial till. They formed a series of

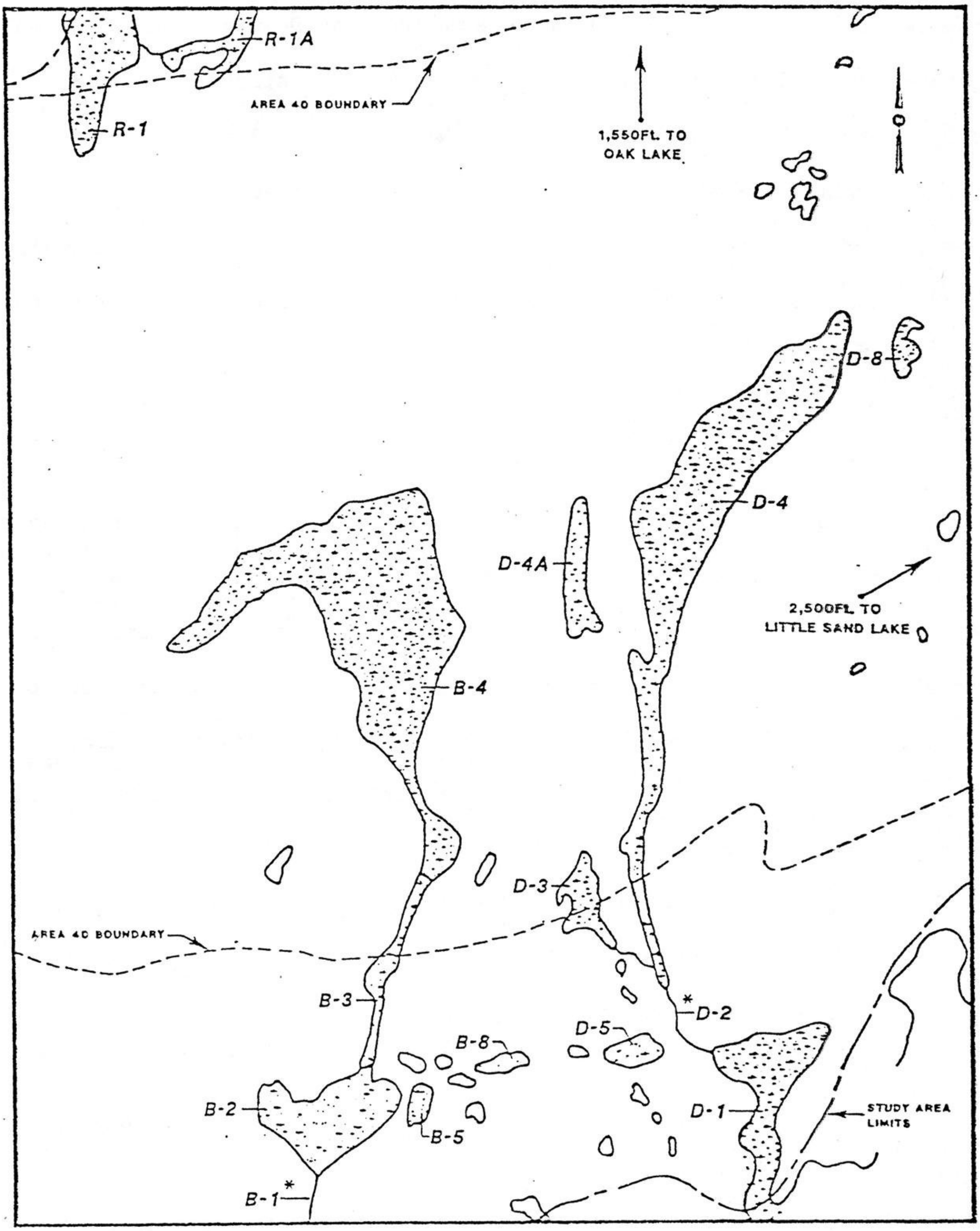

Figure 6.1-2. Wetlands of special interest associated with Candidate Tailings Disposal Area 40 (*wetlands not of special interest).

wetlands in valleys on semi-closed basins. Wetland D4 was a large, densely vegetated wetland which contained organic soils. It stored water and slowly released it downstream to wetland D2. Wetland D2 contained a rapidly flowing intermittent stream and connected wetlands D4 and D1. Wetland D3 was smaller in area than D4 and was connected to D4 by a small ephemeral stream. As a hydrologic system, these wetlands had moderate to high hydrologic value.

Wetland D4A - Wetland D4A was a small (.74 ha [1.87 acres]) deciduous swamp with a dense tree layer consisting of green ash, red maple and poplar, and a shrub layer dominated by speckled alder. Prominent species in the herbaceous layer included wool-grass and blue-joint grass. This wetland was isolated in an upland hardwood forest. The condition of the edge, vegetative life forms and structure provided low to moderate potential for wildlife habitat and for the socio-cultural considerations, and there was no crop potential.

Wetland D4A was located on glacial till in a linear, slight depression where surface water collects. It had no inlet or outlet and was of little hydrologic value.

Wetland D5 - Wetland D5 was a small (<.40 ha [<1 acre]) dense bog which contained a floating mat of vegetation dominated by leather-leaf and sphagnum, with willow and cranberry also abundant. Cattail occurred in patches where shrub growth was low in density. Wetland D5 was surrounded by a mixed upland forest, and was not accessible by road. There was no known crop value, and the characteristics of vegetation in the wetland provided minimal wildlife habitat and socio-cultural opportunities.

Wetland D5 occurred in a kettle hole formed in stratified sand and gravel. It had no inlet or outlet and occurred in a small watershed. It was not part of a riparian system and had low hydrologic value.

<u>Wetland D8</u> - Wetland D8 was a small (<.40 ha [<1 acre]), low density deciduous swamp with a small coniferous component. In the deciduous portion the tree layer was dominated by green ash and red maple, whereas balsam fir and black spruce were predominant in the coniferous component. In the shrub layer, mountain holly was most common. This wetland was surrounded by an upland hardwood forest, and was inaccessible by road. Its small size, poor vegetative structure and life form variability provided limited wildlife habitat and socio-cultural opportunities. There was no known crop value.

Wetland D8 was located in a kettle hole that occurred in stratified sand and gravel. It had a small watershed with no outlet or inlet. The hydrologic functions of this wetland were low.

<u>Wetlands B4, B3 and B2</u> - Wetlands B4, B3, and B2 were a connected system that flowed into wetland B1 and out of the study area. Wetland B4, the largest in the system, was a dense mixed coniferous/deciduous swamp having a small shrub swamp component. Hemlock, red maple and yellow birch dominated the tree layer in the mixed swamp and speckled alder was most prominent in the shrub swamp. Wetland B3, a streamside wetland, was a deciduous swamp with a low density tree layer dominated by

balsam poplar, red maple and basswood and a ground cover of spring beauty (Claytonia virginiana) and rue-anemone (Anemonella thalictroides). Wetland B2 was a high density coniferous swamp with a small shrub swamp component. The wooded swamp was dominated by white cedar, black spruce and hemlock, and the shrub swamp by speckled alder and mountain holly. Wetland B1 was a low density narrow, streamside wetland that flowed out of the study area. The vegetated portion was narrow and red maple and mountain maple (Acer spicatum) were most prominent in the tree layer with a shrub layer of hazelnut and red raspberry (Rubus idaeus var. strigosus). This wetland system was without road access and was surrounded by a mixed upland forest. There was no known crop potential in any of the wetlands, but in wetlands B4 and B2 the edge conditions, life form variability and vegetative structure provided favorable wildlife habitat and opportunities for socio-cultural uses. Wetlands B3 and B1 were less valuable as wildlife habitat and for socio-cultural opportunities because of low vegetative density and poor structure.

This interconnected system of wetlands began with Wetland B4 which occurred in a broad flat basin between hills consisting of till. Water flowed into B3 from B4 via a small ephemeral stream. The stream flowed in a defined channel over till into B2. Wetland B2 was a kettle hole in stratified sand and gravel. This riparian system generated enough surface water flow so that Wetland B1 appeared to be a perennial stream. Wetland B4 was the most important wetland of this system due to its large size and high soil storage capacity. Wetland B2 was similar but smaller in size. Overall this system had moderate to high hydrologic value.

Wetland B5 - Wetland B5 was a small (.20 ha [0.5 acre]) coniferous swamp with a high density tree layer dominated by black spruce, and a shrub layer consisting mainly of gooseberry, mountain maple, Labrador tea and highbush blueberry. This wetland was isolated in a mixed upland forest. Structural variability and vegetative density were favorable, but the importance of this wetland for wildlife habitat and for socio-cultural opportunities was moderate because of its small size. There was no known crop value.

Wetland B5 had no inlet or outlet and was located in a kettle hole in stratified sand and gravel, similar to wetlands D1, B8, D5, and B2. Wetland B5 had a small watershed and because it was not part of a riparian system, hydrologic functions were low.

Wetland B8 - Wetland B8 was a small (.20 ha [0.5 acre]) deciduous swamp. Vegetative density was low in this community and the tree layer was composed of balsam poplar, red maple and paper birch. The shrub layer consisted mainly of shadbush (*Amelanchier laevis*) and mountain holly. Wetland B8 was surrounded by an upland hardwood forest, and was inaccessible by road. There was no known crop value. The major characteristics of this wetland, including small size, poor structure and low plant density, were of limited value as wildlife habitat or for socio-cultural considerations.

Wetland B8 was located in a kettle hole in stratified sand and gravel. It had no inlet or outlet and had a small watershed. It was not part of a riparian system and had low hydrologic value.

Wetlands R3, R1A and R1 - Wetlands R3, R1A and R1 were a connected system that flowed from Oak Lake out of the study area. Wetland R3, the largest and most diverse of the three wetlands, formed the perimeter of Oak Lake. It was predominantly shallow marsh, but also contained shrub swamp and wooded swamp components. The marsh was dominated by blue-joint grass and meadowsweet, whereas the shrub swamp component consisted of a floating mat of vegetation in the shallower areas dominated by alder and leatherleaf. Leading dominants in the deciduous swamp were American elm and red maple. Wetland R1A was a deciduous swamp with a dense overstory of basswood, red maple, white ash and balsam poplar. The herbaceous layer consisted mainly of spring beauty. Wetland R1 was a mixed coniferous and deciduous swamp with a dense tree layer of red maple, yellow birch, green ash and poplar. This system was surrounded by a mixed upland forest. Edge conditions, life form variability and structure provided favorable conditions for wildlife habitat and socio-cultural opportunities although there was no known crop value. Wetland R3 was an important part of the system because of its class richness and its proximity to Oak Lake.

Oak Lake and the fringing wetland, R3, were located in a large kettle hole. To the west, the surficial geologic deposits consisted predominantly of stratified sand and gravel, and to the east, glacial till. This wetland provided moderate protection of the shoreline from wave and ice erosion. A man-made channel connected wetland R3 to R1A, through a low mound of sand and gravel. Before the channel was constructed, Oak Lake had no outlet. Wetland R3 connected wetland R5 to Oak Lake.

Wetland R1A occurred in a valley, probably a melt-water channel, located on stratified sand and gravel. The northeastern half of this wetland was broad and nearly flat but its southwestern portion was narrow and steep. A defined stream channel was evident throughout most of the wetland. This channel discharged into wetland R1 down a steep boulder-covered slope and appeared to be ephemeral. Wetland R1 was the southern end of a much larger wetland most of which was outside the study area. It was a broad slightly sloping valley which received runoff and water from R1A. Two small kettle holes occurred in the wetland where surface water occurred most of the year. This riparian system of wetlands had moderate to high value for hydrologic functions.

Wetlands of Special Interest - Access Road Corridor

Wetlands of special interest in and near the proposed access road corridor are presented in Figure 6.1-3. (R8 not shown; see Figure 4.3-1.)

Wetland R8 - Wetland R8 was a shrub swamp dominated by a dense stand of speckled alder, with willow, leatherleaf and mountain holly also abundant. The herbaceous layer consisted primarily of wool-grass and sedge. This wetland was surrounded by upland hardwood forest, and road access was nearby. Edge characteristics and vegetative structure of this wetland provided wildlife habitat and socio-cultural opportunities, although there was no known crop potential.

Wetland R8, an irregularly shaped depression in till, was a perched water table wetland. It had a small watershed and a low water budget. There was no inlet or outlet. Wetland R8 was not part of a riparian system and had low hydrologic value.

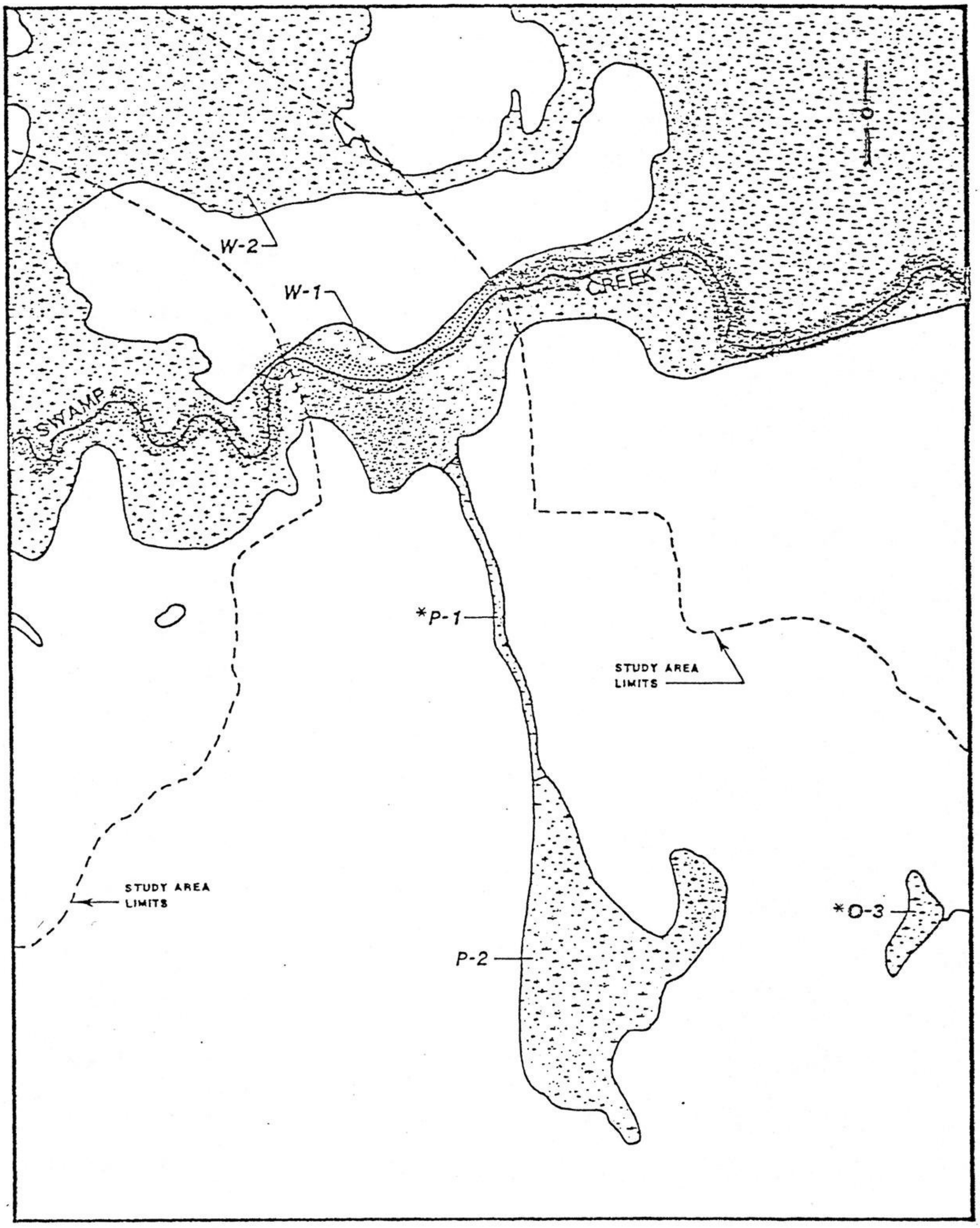

Figure 6.1-3. Wetlands of special interest associated with the proposed Access Road Corridor (*wetlands not of special interest).

Wetland W1 - Wetland W1 was part of a dense coniferous swamp that bordered Swamp Creek and which continued beyond the study area boundary. The predominant tree species were balsam fir, white cedar and black spruce, and in the shrub layer speckled alder and bush honeysuckle (Diervilla lonicera) were most common. This wetland lacked road access and was bordered by mixed upland forest. Vegetative structure, the amount of edge and life form variability within this wetland coupled with its connection to Swamp Creek provided favorable wildlife habitat and socio-cultural opportunities, with the exception of known crop potential.

Wetland W1 occurred in a melt-water channel cut into stratified sand and gravel. It was a water table wetland discharging into Swamp Creek. The north side of the wetland abutted a kame delta while the south side abutted outwash sand and gravel. This wetland was a small part of the Swamp Creek wetland system and was narrower with a slightly steeper gradient to Swamp Creek than the segments located further upstream or downstream. Wetland W1 had high hydrologic value.

Wetland W2 - Wetland W2 was part of a dense coniferous swamp in close proximity to Swamp Creek which continued beyond the study area and contained a shrub swamp component. The tree layer in the swamp was characterized by white cedar, black spruce and balsam fir and the dominant shrub was gooseberry. Speckled alder was the most prominent component of the shrub swamp and marsh marigold (Caltha palustris), cleavers bedstraw (Galium sp.) and meadow rue (Thalictrum polygamum) were predominant in the ground layer. Wetland W2 was bordered by mixed upland forest and was not accessible by road. There was no known crop value. The vegetative characteristics of this wetland provided good wildlife habitat and opportunities for socio-cultural uses.

Wetland W2 was contiguous with wetlands adjacent to Swamp Creek downstream from wetland W1. This wetland occupied a broad flat valley and was surrounded and underlain by stratified sand and gravel deposits. Organic peat soils averaged 1.37 m (4.5 feet) deep in the wetland. Two small streams, which appeared to be perennial, flowed through the wetland toward Swamp Creek. This wetland was a water table wetland and part of a regional discharge area. Wetland W2 was important in maintaining the hydrologic functions of the Swamp Creek wetlands.

Wetlands of Special Interest - Railroad Corridor

Wetlands of special interest in and near the proposed railroad spurline corridor are presented in Figure 6.1-4.

Wetlands T1, T2 and T3 - Wetlands T1, T2 and T3 were located in the railroad corridor near County Road Q. They were not connected and each was <.80 ha (<2 acres) in size. Wetland T1 was a bog with a tree layer of tamarack and black spruce, and a shrub layer of leatherleaf and Labrador tea. Wetland T2, the most diverse of the three, was a dense shrub swamp with an associated bog which occupied approximately one-third of the total area. The predominant shrub species were willow, Labrador tea, leatherleaf, highbush blueberry and black spruce. The herbaceous layer was mainly blue-joint grass, and the wetland surface was vegetated by patches

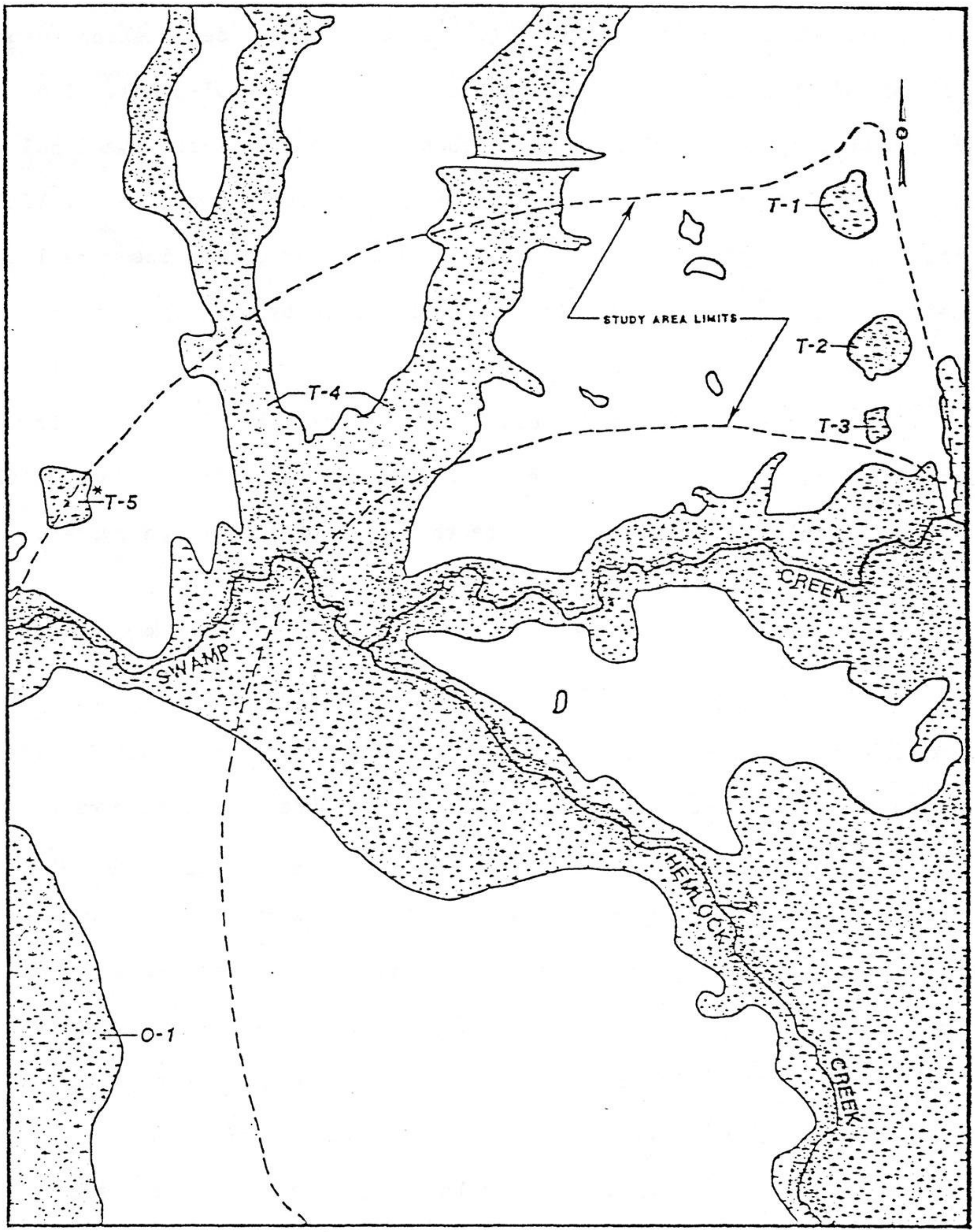

Figure 6.1-4. Wetlands of special interest associated with the proposed Railroad Spurline Corridor; F13 and F114 are not shown on this figure (*Wetland not of special interest).

of sphagnum. Wetland T3 was a small (.1 ha [0.25 acre]) dense shrub swamp of willow and leatherleaf, with an herbaceous cover of wool-grass. There was no known crop potential for any of these wetlands. Vegetative density, structure and life form variability in wetland T2 provided moderate wildlife habitat and socio-cultural opportunities. These characteristics were less evident in wetlands T1 and T3 which were surrounded by both open fields and upland hardwood and mixed forest.

Wetlands T1, T2 and T3 were located in kettle holes in outwash stratified sand and gravel and each was a water table wetland. None of the wetlands had inlets or outlets nor were they part of a riparian system. They had little value for hydrologic functions.

Wetland T4 - This wetland was a moderately dense coniferous swamp with an associated shrub swamp component that continued outside the study area. White cedar, balsam fir and black spruce were most prominent in the tree layer of the swamp and goldthread (Coptis groenlandica) and sphagnum occurred in the ground layer. The shrub swamp component was dominated by speckled alder with a ground cover of marsh marigold. This wetland was surrounded by mixed upland forest and lacked road access. The variety of plant species and life forms, amount of edge, and proximity to Swamp Creek were favorable conditions that provided wildlife habitat and socio-cultural opportunities, although known crop potential was lacking.

Swamp Creek flowed through this wetland and two small creeks flowed south through the northern portion of the wetland into Swamp Creek. Wetland T4 occurred in a location where two southward flowing melt-water channels converged and is just downstream from the confluence of Hemlock

Creek and Swamp Creek. Organic deposits were approximately 1.21 m (4 feet) deep throughout the wetland. This wetland was a water table wetland. Because of its association with the Swamp Creek wetland system, wetland T4 had high hydrologic value.

Wetland O1 - Wetland O1 was a large wetland that drained into Swamp Creek. This wetland was a coniferous swamp with a dense tree layer of balsam fir, black spruce and white cedar, and a ground cover of goldthread and sphagnum. Wetland O1 was surrounded by mixed upland forest and was isolated. Vegetative structure and low life form variability provided minimal wildlife habitat; however, this wetland's large size enhanced its habitat quality. Overall, wetland O1 provided moderate wildlife habitat and socio-cultural opportunities, and there was no known crop potential.

This large, flat wetland, a major portion of which occurred outside the study area, eventually discharged to Swamp Creek. Ephemeral flow from wetland O3 was the only source of incoming surface water to wetland O1. The large size and flat physiographic features of this wetland, plus its connection to Swamp Creek, provided moderate to high hydrologic value.

Wetland F13 - Wetland F13 was a dense, isolated coniferous swamp approximately .40 ha (1 acre) in size. The tree layer was composed of white cedar, black spruce and balsam fir, and the shrub layer was dominated by sheep laurel (Kalmia angustifolia). This wetland was surrounded by a mixed upland forest. Despite its relatively small size, life form variability and vegetative structural diversity provided good wildlife habitat and socio-cultural opportunities, although there was no known crop potential.

This small wetland was located in a kettle hole in stratified sand and gravel which gives rise to a potential recharge value, but the small size and perched water table condition of the wetland reduced this recharge value. The wetland had neither an inlet nor outlet and was not part of a riparian system, which resulted in a low watershed value.

Wetland F114 - Wetland F114 was a small (<.12 ha [<0.3 acre]) unconnected, low density shallow marsh. Sedges and sphagnum were most prominent, with scattered red maple saplings, American elm, willow and black spruce also present. This wetland was accessible by road and surrounded by both open areas and upland hardwood forest. Although small, the presence of open water in this wetland and the surrounding vegetative types provided wildlife habitat and socio-cultural opportunities. There was no known crop potential.

Hydrologically, wetland F114 was not part of a riparian system and had no inlet or outlet. It was a kettle hole in stratified sand and gravel; consequently, it had no value in supporting downstream hydrologic systems and very little watershed value.

Wetlands of Special Interest - Mine/Mill Site

Wetlands of special interest associated with the Mine/Mill site are presented in Figure 6.1-5.

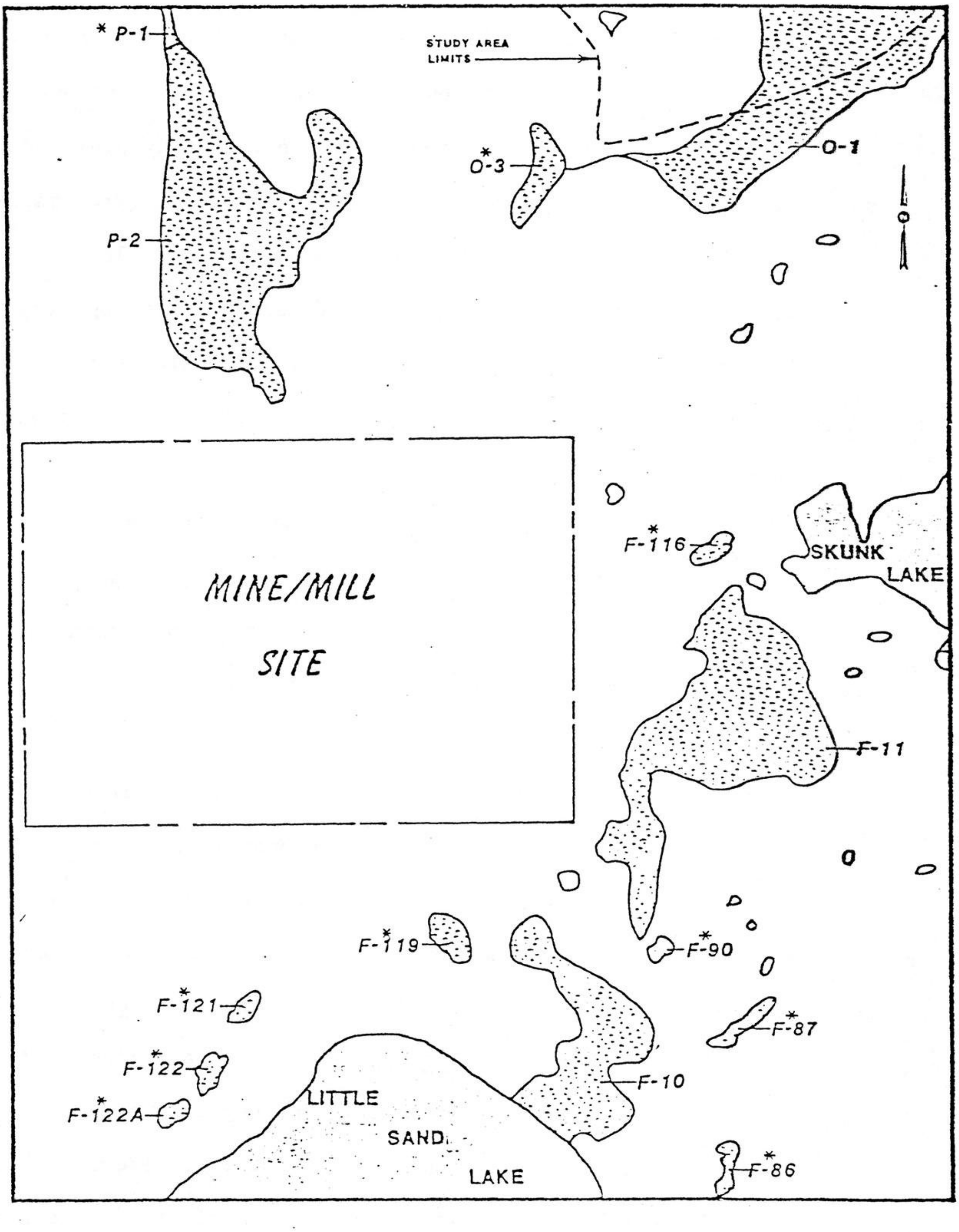

Figure 6.1-5. Wetlands of special interest associated with the Mine/Mill Site (*wetlands not of special interest).

Wetland P2 - Wetland P2 was one of three wetlands (including P1 and W1) in a connected system that flowed into Swamp Creek. Wetland P2 was part of a coniferous swamp that continued outside the study area and had a dense tree layer of black spruce, white cedar, balsam fir, red maple and poplar, and a shrub layer dominated by gooseberry. This wetland lacked access and was surrounded by a mixed upland forest. Although there was no known crop potential, the vegetative structure and life form variability provided moderate wildlife habitat and other socio-cultural opportunities.

This large wetland is the headwaters of the wetland system (P1 and P2) that flows northward to Swamp Creek. Wetland P2 supports the hydrology of P1 and contributes to W1. It had no inlet and was part of a riparian system with a moderate watershed value.

Wetland F11 - Wetland F11 was connected with wetland F10, which flowed into Little Sand Lake, by means of an undefined channel. Like wetland F10, this wetland was also a dense coniferous swamp and had a tree layer of black spruce, balsam fir and white cedar. The shrub layer contained sheep laurel and the ground cover consisted of bunchberry (Cornus canadensis), sphagnum and twinflower (Linnaea borealis). Wetland F11 was surrounded by mixed upland forest and was accessible by road. The vegetative characteristics of wetland F11 were similar to those in wetland F10; however, F10 provided better wildlife habitat because it bordered Little Sand Lake and was not accessible by road. There was no known crop potential in wetland F11.

Wetland F11 was intermediate in the watershed of wetlands F10 and F11 leading to Little Sand Lake. The wetland had an outlet through a road culvert which flows southward to wetland F10 and eventually to Little Sand Lake. It was part of a riparian system and had moderate watershed value.

6.1.2 Quantitative Field Inventory

In the following subsections, the results of the quantitative investigations are discussed for vegetation, herpetofauna, avifauna and mammals, in wetlands representative of each of five wetland types in the study area. Wetlands that may be directly affected by project activities were included in these studies. These wetlands and the transects where the studies were performed are shown in Table 3.5-2 and Figure 4.4-1. Results of the investigations of threatened and endangered plants and wildlife in 127 wetlands in the study area are also presented.

6.1.2.1 Vegetation - Vegetation in the major wetland types of the study area was representative of the regional wetland types of northern Wisconsin. These types included aquatic bed, shallow marsh, shrub swamp, bog, deciduous swamp and coniferous swamp. The black spruce/tamarack coniferous swamp was the most common wetland type in the study area and was represented by many large wetlands; the largest contiguous areas of this type occurred along Swamp Creek. Green ash/aspen deciduous swamps also were common, but many were small (<.40 ha [<1 acre]) and scattered throughout the uplands. Shallow marsh, shrub swamp and bog were less common, but there was a sufficient number of each type to select representative areas for quantitative sampling.

In the following discussion, data are presented from each of the wetland communities sampled. Vegetation transect data were combined to facilitate the discussion, and data for individual community transects are presented in Appendix J, Tables J-1 through J-16.

Sedge/Blue-Joint Grass Shallow Marsh - Marshes in the study area were dominated by dense extensive patches of sedges (59 percent cover), and blue-joint grass (28 percent cover) (Table 6.1-2). A marsh with this composition conforms to the southern sedge meadow or the wet prairie described by Curtis (1959). In addition to the dominants, smaller proportions (<1 percent) of other marsh emergents were found including steeplebush, wool-grass, manna grass, and goldenrod (Solidago sp.). Sphagnum formed broken patches at the soil surface, with a cover of 27 percent. Plant species richness in these marshes (eight species) was lower than in the other wetland types sampled.

Alder Shrub Swamp - The shrub swamp communities were dominated by dense multiple-stemmed speckled alder, which had an importance value of .67 (Table 6.1-3). Based on Curtis' descriptions of Wisconsin shrub swamps (Curtis, 1959), alder was frequently the predominant species. Red maple saplings were secondary in importance (importance value .24), with fewer numbers of mountain holly (importance value .22), and yellow birch (importance value .16). There were 15 other species of shrubs scattered throughout this type with importance values of .10 or less (Table 6.1-3).

Table 6.1-2. Summary of phytosociological characteristics of three marsh communities (Transects 6, 7 and 15; 15 plots sampled) in the study area.

SPECIES[a]	NUMBER OF POINTS	SOCIABILITY[b] A	B	C	D	E	PERCENT MEAN COVER	RELATIVE FREQUENCY	IMPORTANCE[c] VALUE
HERB LAYER									
Sedges (*Carex* sp.)	12	-	-	12	-	-	59.00	.400	.400
Blue-joint grass	7	-	2	5	-	-	27.67	.233	.233
Sphagnum moss	6	-	-	-	4	2	26.67	.200	.200
Steeplebush	1	-	1	-	-	-	0.33	.033	.033
Wool-grass	1	1	-	-	-	-	0.03	.033	.033
Manna grass	1	1	-	-	-	-	0.03	.033	.033
Goldenrod	1	1	-	-	-	-	0.03	.033	.033
Wild Strawberry	1	-	1	-	-	-	0.03	.033	.033
TOTAL	30							.998	.998

[a]Scientific names are listed in Appendix J.

[b]Sociability conditions are:
- A - solitary, growing singly
- B - growing in small groups of a few individuals
- C - large group of many individuals; small scattered patches
- D - patches or a broken mat
- E - extensive mat almost completely covering entire plot

[c]For the herb layer the importance value equals relative frequency.

Table 6.1-3. Summary of phytosociological characteristics of three shrub swamp communities (Transects 3, 11 and 13; 13 plots sampled) in the study area.

SPECIES[a]	NUMBER OF POINTS	NUMBER OF STEMS	SOCIABILITY[b] A	B	C	D	E	PERCENT MEAN COVER	RELATIVE DENSITY	RELATIVE FREQUENCY	IMPORTANCE VALUE[c]
SHRUB LAYER											
Speckled alder	8	138	1	7	-	-	-	27.69	.484	.190	.674
Red maple	6	29	4	2	-	-	-	5.23	.102	.143	.245
Mountain holly	2	48	-	2	-	-	-	3.62	.168	.048	.216
Yellow birch	5	11	2	3	-	-	-	2.54	.039	.119	.158
Green ash	3	9	3	-	-	-	-	2.54	.032	.071	.103
Willow	3	7	2	1	-	-	-	0.65	.025	.071	.096
Highbush blueberry	1	12	-	1	-	-	-	0.38	.042	.024	.066
Bramble	2	4	2	-	-	-	-	0.42	.014	.048	.062
Balsam fir	2	3	2	-	-	-	-	1.15	.011	.048	.059
Bebb's willow	1	6	-	1	-	-	-	0.77	.021	.024	.045
Large cranberry	1	6	-	1	-	-	-	0.04	.021	.024	.045
Gooseberry	1	3	-	1	-	-	-	0.15	.011	.024	.035
Poplar	1	2	1	-	-	-	-	0.38	.007	.024	.031
Red raspberry	1	2	1	-	-	-	-	0.15	.007	.024	.031
Black spruce	1	1	1	-	-	-	-	0.23	.004	.024	.028
Beaked hazelnut	1	1	1	-	-	-	-	0.23	.004	.024	.028
Winterberry	1	1	1	-	-	-	-	0.15	.004	.024	.028
Mountain maple	1	1	1	-	-	-	-	0.04	.004	.024	.028
Mountain ash	1	1	1	-	-	-	-	0.03	.004	.024	.028
TOTAL	42	285							100.4	100.2	200.6
HERB LAYER											
Sphagnum moss	12	-	-	1	1	7	3	49.23	-	.194	.194
Sedges	9	-	2	3	4	-	-	10.62	-	.145	.145
Blue-joint grass	5	-	1	2	2	-	-	6.58	-	.081	.081
Violet	4	-	1	3	-	-	-	3.12	-	.065	.065
Canada mayflower	4	-	3	1	-	-	-	1.04	-	.065	.065
Marsh bedstraw	4	-	4	-	-	-	-	0.35	-	.065	.065
Jewelweed	3	-	3	-	-	-	-	0.31	-	.048	.048
River horsetail	3	-	3	-	-	-	-	0.12	-	.048	.048
Clintonia	2	-	1	1	-	-	-	0.42	-	.032	.032
Starflower	2	-	2	-	-	-	-	0.08	-	.032	.032
Bugleweed	2	-	2	-	-	-	-	0.08	-	.032	.032
Water-mat	1	-	-	-	1	-	-	2.31	-	.016	.016
Marsh marigold	1	-	-	1	-	-	-	0.38	-	.016	.016
Iris	1	-	1	-	-	-	-	0.23	-	.016	.016
Thistle	1	-	1	-	-	-	-	0.23	-	.016	.016
Pickerel weed	1	-	1	-	-	-	-	0.23	-	.016	.016
Marginal shieldfern	1	-	1	-	-	-	-	0.04	-	.016	.016
Grass	1	-	1	-	-	-	-	0.04	-	.016	.016
Sensitive fern	1	-	1	-	-	-	-	0.04	-	.016	.016
Goldenrod	1	-	1	-	-	-	-	0.04	-	.016	.016
Goldthread	1	-	1	-	-	-	-	0.04	-	.016	.016
Twinflower	1	-	1	-	-	-	-	0.04	-	.016	.016
Bunchberry	1	-	1	-	-	-	-	0.04	-	.016	.016
TOTAL	62									.999	.999

[a]Scientific names are listed in Appendix J.

[b]Sociability conditions are described in Table 6.1-2.

[c]For the shrub layer the importance value equals the total of relative density and relative frequency.

The herb layer was generally sparse, most of the species (with the exception of sphagnum and sedges) having less than 7 percent cover except in openings (Table 6.1-3). Large patches of sphagnum provided 49 percent cover at the ground surface. Sedges and blue-joint grass were predominant (importance values .14 and .08, respectively). Twenty other species, including violet (Viola sp.), Canada mayflower (Maianthemum canadense), and marsh bedstraw (Galium palustre), occurred in lesser numbers and had importance values of .06 or less. Species richness in the shrub swamp (42 species) was higher than in all other wetland types sampled except the deciduous swamp, but evenness was low due to the predominance of alder.

Green Ash/Aspen Deciduous Swamp - The deciduous swamps in the study area were characteristic of the wet southern hardwoods and wet-mesic southern hardwoods described by Curtis (1959). This wetland community consisted of a closed canopy ranging in height from 9.14 to 15.2 m (30 to 50 feet). The dominant species were green ash with an importance value of .69, quaking aspen (importance value .56), American elm (importance value .54) and red maple (importance value .54) (Table 6.1-4). Scattered in lower numbers throughout the tree layer with importance values <.10 were other tree species including balsam fir, yellow birch and paper birch.

Species in the shrub layer were typically low in density with a cover of less than 9 percent. Dominant species included speckled alder (importance value .36) and saplings of some overstory species such as green ash (importance value .24) and red maple (importance value .23). Fourteen other species occurred as scattered individuals throughout this

Table 6.1-4. Summary of phytosociological characteristics of three deciduous swamp communities (Transects 1, 5 and 12; 15 plots sampled) in the study area.

SPECIES[a]	NUMBER OF POINTS	NUMBER OF STEMS	CANOPY CLASS[b]					PERCENT				
			C	CD	SD	S		MEAN COVER	RELATIVE DOMINANCE	RELATIVE DENSITY	RELATIVE FREQUENCY	IMPORTANCE VALUE[c]
TREE LAYER												
Green ash	15	15	0	11	5	0		-	.198	.267	.228	.693
Quaking aspen	11	11	2	6	1	2		-	.237	.183	.143	.563
American elm	9	9	2	4	2	1		-	.194	.150	.200	.544
Red maple	12	12	1	7	4	0		-	.143	.200	.200	.543
Bur oak	6	6	0	5	1	0		-	.136	.100	.086	.322
Balsam fir	2	2	0	2	0	0		-	.028	.033	.029	.090
Hemlock	1	1	0	0	1	0		-	.019	.017	.029	.065
Yellow birch	1	1	0	1	0	0		-	.019	.017	.029	.065
Paper birch	1	1	0	1	0	0		-	.016	.017	.029	.062
Sugar maple	1	1	0	0	1	0		-	.009	.017	.029	.055
TOTAL	59	59							99.9	100.1	100.2	300.2
			SOCIABILITY[d]									
			A	B	C	D	E					
SHRUB LAYER												
Speckled alder	5	46	1	4	-	-	-	8.80	-	.246	.113	.359
Green ash	6	19	6	-	-	-	-	0.97	-	.102	.136	.238
Red maple	6	17	4	2	-	-	-	2.13	-	.091	.135	.227
Poplar	4	13	4	-	-	-	-	0.43	-	.070	.091	.161
Mountain holly	2	18	-	2	-	-	-	2.00	-	.096	.045	.141
Red raspberry	4	9	4	-	-	-	-	0.23	-	.048	.091	.139
Winterberry	1	18	1	-	-	-	-	3.33	-	.096	.023	.119
American elm	2	11	2	-	-	-	-	0.70	-	.059	.045	.104
Beaked hazelnut	2	8	2	-	-	-	-	0.70	-	.043	.045	.058
Black raspberry	2	4	2	-	-	-	-	0.20	-	.021	.045	.066
Black cherry	2	3	1	1	-	-	-	0.23	-	.016	.045	.061
Gooseberry	2	3	1	1	-	-	-	0.07	-	.016	.045	.061
Sugar maple	1	5	1	-	-	-	-	0.03	-	.027	.023	.050
Bush honeysuckle	1	2	0	1	-	-	-	0.03	-	.011	.023	.034
Mountain ash	1	2	1	-	-	-	-	0.13	-	.011	.023	.034
White ash	1	1	1	-	-	-	-	0.20	-	.005	.023	.028
Basswood	1	1	1	-	-	-	-	0.20	-	.005	.023	.028
TOTAL	43	180								99.3	99.4	198.7
HERB LAYER												
Sedge	13	-	-	10	3	-	-	7.90	-	-	.176	.176
Sphagnum moss	9	-	-	-	6	3	-	16.67	-	-	.122	.122
Canada mayflower	9	-	6	3	-	-	-	3.10	-	-	.122	.122
Bugleweed	5	-	3	2	-	-	-	0.93	-	-	.067	.067
Violets	4	-	2	2	-	-	-	0.30	-	-	.054	.054
Grasses	4	-	-	4	-	-	-	0.93	-	-	.054	.054
Jewelweed	3	-	3	-	-	-	-	0.20	-	-	.041	.041
Iris	3	-	2	1	-	-	-	0.57	-	-	.041	.041
Starflower	3	-	3	-	-	-	-	0.10	-	-	.041	.041
Clintonia	3	-	2	1	-	-	-	0.20	-	-	.041	.041
Goldthread	3	-	3	-	-	-	-	0.10	-	-	.041	.041
Horsetail	2	-	2	-	-	-	-	0.37	-	-	.027	.027
Bunchberry	2	-	2	-	-	-	-	0.37	-	-	.027	.027
Spinulose shieldfern	2	-	2	-	-	-	-	0.07	-	-	.027	.027
Blue-joint	2	-	1	-	1	-	-	0.03	-	-	.027	.027
Spring beauty	1	-	-	1	-	-	-	0.13	-	-	.014	.014
Thistle	1	-	1	-	-	-	-	0.03	-	-	.014	.014
Marsh bedstraw	1	-	1	-	-	-	-	0.03	-	-	.014	.014
Shining clubmoss	1	-	-	1	-	-	-	0.33	-	-	.014	.014
Woodrush	1	-	-	-	1	-	-	0.03	-	-	.014	.014
Bracken	1	-	1	-	-	-	-	0.03	-	-	.014	.014
Dutchman's breeches	1	-	-	1	-	-	-	0.27	-	-	.014	.014
TOTAL	74										100.6	100.6

[a]Scientific names are listed in Appendix J.

[b]Canopy classes: D=dominant, CD=codominant, SD=subdominant, S=suppressed.

[c]For the tree layer the importance value equals the total of relative dominance, relative density and relative frequency; for the shrub layer the importance value equals the total of relative density and relative frequency; for the herb layer the importance value equals relative frequency.

[d]Sociability conditions are described in Table 6.1-2.

layer with importance values of .16 or less including mountain holly, winterberry, gooseberry and bush honeysuckle.

Most plants in the herb layer were low in density (<8 percent cover) and primarily consisted of sedges (importance value .18) and Canada mayflower (importance value .12). Less common wetland herbs such as blue-joint grass, jewelweed, and goldthread were scattered throughout the ground layer; sphagnum was present in scattered patches at the ground surface providing 17 percent cover. Plant species richness in the deciduous swamp (44 species) was higher than in all other wetland types sampled.

Leatherleaf Bog - Bogs in the study area were characterized by a floating mat of sphagnum and dense, anastomosing roots of heath plants. The most prevalent shrubs were leatherleaf (importance value .81) and Labrador tea (importance value .22), which formed a dense continuous mat (Table 6.1-5). The predominance of heath species is typical of the species composition of Wisconsin bog communities as described by Curtis (1959). Other shrubs in this layer included large cranberry (importance value .30) and bog laurel (importance value .20), which also were part of the bog mat. Bog rosemary (*Andromeda glaucophylla*), sapling tamarack, black spruce and willow were less common and had importance values of .12 or less.

The herb layer contained patches of sedges (importance value .34) and scattered pitcher plant, cottongrass and clintonia (*Clintonia borealis*), the latter three species having importance values of .07 or less. Large patches of sphagnum provided an almost continuous cover (94 percent) at the ground surface. Plant species richness in the bog communi-

Table 6.1-5. Summary of phytosociological characteristics of three bog communities (Transects 4, 10 and 14; 14 plots sampled) in the study area.

SPECIES[a]	NUMBER OF POINTS	NUMBER OF STEMS	SOCIABILITY[b] A	B	C	D	E	PERCENT MEAN COVER	RELATIVE DENSITY	RELATIVE FREQUENCY	IMPORTANCE[c] VALUE
SHRUB LAYER											
Leatherleaf	14	1015	3	1	10	-	-	30.93	.576	.233	.809
Large cranberry	11	209	1	10	-	-	-	2.89	.119	.183	.302
Labrador tea	3	300	-	-	3	-	-	12.86	.170	.050	.222
Bog laurel	9	93	9	-	-	-	-	2.57	.053	.150	.203
Bog rosemary	5	73	4	-	1	-	-	1.75	.041	.083	.124
Tamarack	6	24	5	1	-	-	-	6.36	.014	.100	.114
Black spruce	5	15	5	-	-	-	-	6.07	.009	.083	.092
Highbush blueberry	4	26	2	2	-	-	-	1.68	.015	.067	.082
Willow	2	6	2	-	-	-	-	0.07	.003	.033	.036
Paper birch	1	1	1	-	-	-	-	0.36	.001	.017	.018
TOTAL	60	1762							100.1	99.9	200.2
HERB LAYER											
Sphagnum moss	14	-	-	-	-	5	9	93.71	-	.483	.483
Sedges (*Carex* spp.)	10	-	-	4	6	-	-	18.61	-	.345	.345
Pitcher plant	2	-	2	-	-	-	-	0.07	-	.069	.069
Cotton grass	2	-	2	-	-	-	-	0.07	-	.069	.069
Clintonia	1	-	1	-	-	-	-	0.04	-	.034	.034
TOTAL	29									100	100

[a] Scientific names are listed in Appendix J.

[b] Sociability conditions are described in Table 6.1-2.

[c] For the shrub layer, the importance value equals the total of relative density and relative frequency.

ties (15 species) was lower than in all other wetland types sampled except marsh because of the predominance of a few species in both layers.

<u>Black Spruce/Tamarack Coniferous Swamp</u> - The coniferous swamps in the study area were composed of a 9.1 to 12.2 m (30 to 40 foot) canopy which ranged from irregular and broken to closed. The dominant species were tamarack (importance value 1.19) and black spruce (importance value 1.10) (Table 6.1-6). On the basis of species composition, this type conforms closely with Curtis' wet northern forest classification (Curtis, 1959). Species of secondary importance included hemlock, balsam fir, white cedar and various hardwoods having importance values <.32.

Plants in the shrub layer had a cover of 12 percent or less, and were composed of large patches of Labrador tea (importance value .49) with lower proportions of leatherleaf (importance value .20), and large cranberry (importance value .23). Mountain holly, highbush blueberry, winterberry and black spruce were scattered throughout the shrub layer and had importance values of .21 or less.

The ground surface was covered by large patches of sphagnum (65 percent cover) which supported a scattered, low density (<6 percent) ground layer of Canada mayflower, cinnamon fern (<u>Osmunda</u> <u>cinnamomea</u>), sedge, goldthread and bunchberry. Plant species richness in the coniferous swamp (30 species) was intermediate between the marsh and bog communities with 8 and 15 species, respectively, and the shrub swamp and deciduous swamp communities with 42 and 44 species, respectively.

Table 6.1-6. Summary of phytosociological characteristics of four coniferous swamp communities (Transects 2, 16, 17 and 18; 19 plots sampled) in the study area.

SPECIES[a]	NUMBER OF POINTS	NUMBER OF STEMS	CANOPY CLASS[b]					PERCENT				
			D	CD	SD	S		MEAN COVER	RELATIVE DOMINANCE	RELATIVE DENSITY	RELATIVE FREQUENCY	IMPORTANCE VALUE[c]
TREE LAYER												
Tamarack	26	26	5	14	9	2		-	.479	.400	.308	1.187
Black spruce	32	32	2	15	13	2		-	.290	.426	.384	1.100
Hemlock	6	6	-	3	1	2		-	.110	.080	.128	0.318
Balsam fir	3	3	-	1	2	-		-	.017	.040	.077	0.134
Red maple	2	2	1	1	-	-		-	.036	.027	.051	0.114
White cedar	1	1	-	1	-	-		-	.048	.013	.026	0.087
Yellow birch	1	1	-	-	-	1		-	.020	.013	.026	0.059
TOTAL	71	71							100	99.9	100	299.2
			SOCIABILITY[d]									
			A	B	C	D	E					
SHRUB LAYER												
Labrador tea	8	358	2	3	3	-	-	12.11	-	.381	.108	.489
Large cranberry	5	156	-	4	1	-	-	1.08	-	.166	.068	.234
Mountain holly	10	71	5	5	-	-	-	7.05	-	.076	.135	.211
Leatherleaf	5	129	2	2	1	-	-	3.24	-	.137	.068	.205
Highbush blueberry	8	83	7	1	-	-	-	2.63	-	.088	.108	.196
Black spruce	12	27	10	2	-	-	-	6.58	-	.029	.162	.191
Winterberry	6	30	3	3	-	-	-	0.66	-	.032	.081	.113
Speckled alder	4	43	1	3	-	-	-	5.53	-	.046	.054	.100
Bog laurel	4	15	3	1	-	-	-	0.24	-	.016	.054	.070
Red maple	3	8	2	1	-	-	-	1.08	-	.009	.041	.051
Tamarack	2	3	2	-	-	-	-	0.05	-	.003	.027	.030
Balsam fir	2	2	2	-	-	-	-	0.37	-	.002	.027	.029
Gooseberry	1	8	1	-	-	-	-	0.37	-	.009	.014	.023
Shadbush	1	3	-	1	-	-	-	0.21	-	.008	.014	.017
Willow	1	1	1	-	-	-	-	.26	-	.001	.014	.015
Yellow birch	1	1	1	-	-	-	-	.11	-	.001	.014	.015
Black chokeberry	1	1	1	-	-	-	-	.03	-	.001	.014	.015
TOTAL	74	939								100.5	100.3	200.4
HERB LAYER												
Sphagnum moss	19	-	-	-	1	13	5	65.26	-	-	.297	.297
Canada mayflower	10	-	9	1	-	-	-	0.63	-	-	.156	.156
Cinnamon fern	9	-	5	4	-	-	-	0.79	-	-	.141	.141
Sedges	8	-	1	6	1	-	-	5.16	-	-	.125	.125
Goldthread	7	-	4	3	-	-	-	0.26	-	-	.109	.109
Bunchberry	5	-	5	-	-	-	-	0.21	-	-	.078	.078
Starflower	2	-	2	-	-	-	-	0.05	-	-	.031	.031
Iris	1	-	1	-	-	-	-	0.03	-	-	.016	.016
Goldenrod	1	-	1	-	-	-	-	0.03	-	-	.016	.016
Crested woodfern	1	-	1	-	-	-	-	0.03	-	-	.016	.016
Wood sorrel	1	-	1	-	-	-	-	0.03	-	-	.016	.016
TOTAL	64										100.1	100.1

[a] Scientific names are listed in Appendix J.

[b] Canopy classes: D=dominant, CD=codominant, SD=subdominant, S=suppressed.

[c] For the tree layer the importance value equals the total of relative dominance, relative density and relative frequency; for the shrub layer the importance value equals the total of relative density and relative frequency; for the herb layer the importance value equals relative frequency.

[d] Sociability conditions are described in Table 6.1-2.

6.1.2.2 Herpetofauna

General Surveys - The results of the general surveys for amphibians and reptiles in each wetland type are shown in Table 6.1-7 (see page 6.1-59 for results of spotted salamander surveys. The most commonly observed species were American toad, spring peeper, western chorus frog and wood frog. Less commonly observed species included the mink frog, gray treefrog, green frog, painted turtle and garter snake. Only one blue-spotted salamander was observed in the study area. No leopard frogs were observed within the study area, however, several were heard calling from a pond north of Little Sand Lake Road, 457.2 m (1500 feet) west of the study area boundary.

Marsh habitats serve many amphibian species for all or part of their larval life stage (Vogt, 1981). A breeding congress of American toads was observed in the marsh fringing Deep Hole Lake on May 23, 1981. Other breeding anurans observed included spring peepers, western chorus frogs and green frogs. Painted turtles and the egg masses of the spotted salamander were also observed in the marsh surrounding Skunk Lake (F12). Aquatic bed habitats on and immediately adjacent to the study area provided habitat for western chorus, mink and leopard frogs.

Shrub swamps, especially those along stream courses, were utilized to a lesser degree as breeding areas for amphibians. Adult green and wood frogs, a garter-snake and numerous adult American toads were observed in shrub swamp communities which are utilized as feeding habitats by these species.

Many of the bogs in the study area were surrounded by "moats" of open water, such as the one surrounding bog F16. Herpetofauna observed in

Table 6.1-7. Summary of herpetofaunal utilization of wetlands in the study area, April-June 1981.

WETLAND TYPE	SPECIES	LIFE STAGE	WETLAND LOCATION
Deciduous Swamp	Spotted salamander	adult and egg masses	F16
	Blue-spotted salamander	adult	F16
	American toad	adult	F15
	Spring peeper	adult	F15
	Gray treefrog	adult	F15
	Wood frog	adult	F15, F16
Shrub Swamp	American toad	adult	F39, M1
	Green frog	adult	F39
	Wood frog	adult	F39, M1
	Garter snake	adult	(Upland Deciduous Forest)
Bog (including water perimeter)	Spotted salamander	egg masses	F16
	Garter snake	adult	F16
	Painted turtle	adult	F16
	Spring peeper	adult	F16
	Wood frog	adult	F16, F28*
Coniferous Swamp	None	---	
Marsh	Spotted salamander	egg masses	F12
	American toad	adult	F12
	Spring peeper	adult	F12, F15
	Western chorus frog	adult	F12, F15
	Green frog	adult	F12
	Painted turtle	adult	F12
Aquatic Bed	Western chorus frog	adult	F12
	Mink frog	adult	M1
	Leopard frog	adult	F12

*Wetland of special interest.

the bog communities included spring peepers, wood frogs and a painted turtle. Marshall and Buell (1955) reported distinct zones of amphibian distribution in major vegetational zones surrounding a bog in northwestern Minnesota. Species reported in this study corroborate the observations made in bogs in the study area.

Searches conducted in wetlands F11 and F60, both coniferous swamps, revealed no reptiles or amphibians. Most of the substrate in these wetlands was dominated by sphagnum moss and peat which provided poor habitat for the species that are common in the study area.

Adult wood frogs, spring peepers and gray treefrogs were commonly observed feeding in the deciduous swamps as well as in the surrounding upland deciduous forests. Deciduous swamps are used for breeding early in the spring by wood frogs and spring peepers, and then later by gray treefrogs (Vogt, 1981). Egg masses of both the spotted and blue-spotted salamander were also observed in this habitat.

In summary, two species of reptiles and 10 species of amphibians were observed utilizing the wetlands in the study area. The two most important habitats were marshes and deciduous swamps, each of which supported six species. No amphibians or reptiles were observed in coniferous swamps.

6.1.2.3 Avifauna - Estimates of species diversity, richness, equitability and total density are summarized in Table 6.1-8 for the May and June surveys. Density estimates by individual species are given in Tables 6.1-9 and 6.1-10. Actual numbers of birds observed along transects in each wetland type are presented in Appendix J, Tables J-17 and J-18. High values for any of these four parameters indicate a valuable avian

Table 6.1-8. Summary of species diversity, richness, equitability, and total bird density for each of the wetlands surveyed, May-June 1981.

<table>
<tr><th></th><th colspan="11">WETLAND TYPE</th></tr>
<tr><th></th><th>AQUATIC BED</th><th colspan="2">MARSH</th><th colspan="2">SHRUB SWAMP</th><th colspan="2">BOG</th><th colspan="2">CONIFEROUS SWAMP</th><th colspan="2">DECIDUOUS SWAMP</th></tr>
<tr><th>WETLAND:</th><th>F12</th><th>F15</th><th>F12</th><th>F39</th><th>M1</th><th>F16</th><th>F28</th><th>F60</th><th>F11</th><th>F57</th><th>F15</th></tr>
<tr><th>TRANSECT NO.:</th><th>8</th><th>6</th><th>9</th><th>3</th><th>11</th><th>4</th><th>10</th><th>2</th><th>7</th><th>1</th><th>5</th></tr>
<tr><td>PARAMETERS</td><td colspan="11"></td></tr>
<tr><td>MAY</td><td colspan="11"></td></tr>
<tr><td>Species Diversity (H')</td><td>2.782</td><td>1.645</td><td>2.502</td><td>2.257</td><td>2.705</td><td>2.911</td><td>2.307</td><td>2.473</td><td>2.127</td><td>2.428</td><td>1.652</td></tr>
<tr><td></td><td></td><td colspan="2">2.658*</td><td colspan="2">2.866</td><td colspan="2">2.947</td><td colspan="2">2.512</td><td colspan="2">2.507</td></tr>
<tr><td>Species Richness</td><td>21</td><td>7</td><td>17</td><td>14</td><td>18</td><td>25</td><td>21</td><td>17</td><td>14</td><td>15</td><td>10</td></tr>
<tr><td></td><td></td><td colspan="2">20</td><td colspan="2">25</td><td colspan="2">32</td><td colspan="2">23</td><td colspan="2">19</td></tr>
<tr><td>Equitability (E)</td><td>.914</td><td>.845</td><td>.883</td><td>.855</td><td>.936</td><td>.904</td><td>.748</td><td>.873</td><td>.806</td><td>.897</td><td>.717</td></tr>
<tr><td></td><td></td><td colspan="2">.887</td><td colspan="2">.890</td><td colspan="2">.850</td><td colspan="2">.801</td><td colspan="2">.851</td></tr>
<tr><td>Total Density (Birds/Hectare)</td><td>-</td><td>6.49</td><td>-</td><td>12.35</td><td>23.67</td><td>15.02</td><td>13.81</td><td>13.64</td><td>19.36</td><td>13.20</td><td>12.74</td></tr>
<tr><td></td><td></td><td colspan="2">-</td><td colspan="2">18.01</td><td colspan="2">14.41</td><td colspan="2">16.50</td><td colspan="2">12.97</td></tr>
<tr><td>JUNE</td><td colspan="11"></td></tr>
<tr><td>Species Diversity (H')</td><td>3.019</td><td>2.095</td><td>3.010</td><td>2.366</td><td>2.842</td><td>2.044</td><td>3.040</td><td>2.995</td><td>2.905</td><td>2.733</td><td>2.152</td></tr>
<tr><td></td><td></td><td colspan="2">3.082</td><td colspan="2">3.127</td><td colspan="2">3.088</td><td colspan="2">3.182</td><td colspan="2">2.896</td></tr>
<tr><td>Species Richness</td><td>25</td><td>11</td><td>28</td><td>12</td><td>20</td><td>11</td><td>25</td><td>24</td><td>23</td><td>17</td><td>11</td></tr>
<tr><td></td><td></td><td colspan="2">31</td><td colspan="2">28</td><td colspan="2">31</td><td colspan="2">33</td><td colspan="2">24</td></tr>
<tr><td>Equitability (E)</td><td>.938</td><td>.873</td><td>.903</td><td>.952</td><td>.949</td><td>.852</td><td>.944</td><td>.943</td><td>.926</td><td>.965</td><td>.898</td></tr>
<tr><td></td><td></td><td colspan="2">.897</td><td colspan="2">.938</td><td colspan="2">.899</td><td colspan="2">.910</td><td colspan="2">.911</td></tr>
<tr><td>Total Density (Birds/Hectare)</td><td>-</td><td>7.34</td><td>-</td><td>7.04</td><td>21.78</td><td>4.03</td><td>16.64</td><td>7.90</td><td>19.15</td><td>8.09</td><td>6.01</td></tr>
<tr><td></td><td></td><td colspan="2">-</td><td colspan="2">14.41</td><td colspan="2">10.33</td><td colspan="2">13.53</td><td colspan="2">7.05</td></tr>
<tr><td>MAY/JUNE AVERAGE</td><td colspan="11"></td></tr>
<tr><td>Species Diversity (H')</td><td>3.198</td><td>2.303</td><td>3.070</td><td>2.667</td><td>3.169</td><td>2.920</td><td>2.973</td><td>3.099</td><td>2.890</td><td>2.923</td><td>2.205</td></tr>
<tr><td></td><td></td><td colspan="2">3.177</td><td colspan="2">3.324</td><td colspan="2">3.252</td><td colspan="2">3.146</td><td colspan="2">2.999</td></tr>
<tr><td>Species Richness</td><td>34</td><td>16</td><td>32</td><td>21</td><td>30</td><td>29</td><td>32</td><td>31</td><td>29</td><td>25</td><td>17</td></tr>
<tr><td></td><td></td><td colspan="2">36</td><td colspan="2">40</td><td colspan="2">41</td><td colspan="2">41</td><td colspan="2">32</td></tr>
<tr><td>Equitability (E)</td><td>.907</td><td>.831</td><td>.886</td><td>.876</td><td>.932</td><td>.867</td><td>.858</td><td>.902</td><td>.858</td><td>.908</td><td>.778</td></tr>
<tr><td></td><td></td><td colspan="2">.886</td><td colspan="2">.901</td><td colspan="2">.876</td><td colspan="2">.847</td><td colspan="2">.865</td></tr>
<tr><td>Average Density (Birds/Hectare)</td><td>-</td><td>6.92</td><td>-</td><td>9.69</td><td>22.73</td><td>9.52</td><td>15.22</td><td>10.77</td><td>19.26</td><td>10.65</td><td>9.38</td></tr>
<tr><td></td><td></td><td colspan="2">-</td><td colspan="2">16.21</td><td colspan="2">12.36</td><td colspan="2">15.02</td><td colspan="2">10.01</td></tr>
</table>

*Values shown between columns are a mean for that parameter based on combined data for those two transects.

Table 6.1-9. Densities of birds in number per acre (.404 ha) observed along transects in five wetland communities in May 1981. Densities from listening post stations are not included.

	WETLAND TYPE								
	DECIDUOUS SWAMP		SHRUB SWAMP		CONIFEROUS SWAMP		BOG		MARSH
SPECIES TRANSECT NO:	1	5	3	11	2	7	4	10	6
Common loon	.009	-	-	-	-	-	-	-	-
American bittern	-	-	-	5.445	-	-	-	-	-
Mallard	-	-	-	-	-	-	.168	1.105	-
Black duck	-	-	-	-	-	-	-	.124	-
Cooper's hawk	-	-	-	-	1.008	-	-	-	-
Osprey	-	*	-	-	-	-	-	-	-
Ruffed grouse	-	-	.218	-	.045	.099	-	-	-
Solitary sandpiper	-	.267	-	-	-	-	.042	-	-
Belted kingfisher	-	-	.054	.197	-	-	-	-	-
Common flicker	-	-	-	-	-	-	-	.048	-
Pileated woodpecker	-	-	-	-	-	-	-	.036	-
Yellow-bellied sapsucker	-	-	-	.290	-	-	.051	-	-
Hairy woodpecker	-	.036	-	.182	*	.045	.838	-	-
Downy woodpecker	.061	-	.109	-	-	.068	*	.143	-
Great crested flycatcher	-	-	-	-	-	.182	-	.036	-
Least flycatcher	.182	2.149	.218	-	-	-	.042	-	1.296
Tree swallow	-	-	-	-	-	.136	-	-	-
Blue jay	.091	-	.495	.054	.091	.408	.072	.072	.132
Northern raven	-	-	-	-	-	-	.021	-	-
American crow	-	-	-	-	-	-	.008	-	-
Black-capped chickadee	1.163	.182	.573	1.489	2.647	.756	.032	.573	-
White-breasted nuthatch	-	-	-	-	.121	-	.014	-	.158
Red-breasted nuthatch	-	-	-	.136	-	.091	-	-	-
American robin	.413	1.008	.073	-	-	-	.092	-	.503
Hermit thrush	-	-	-	-	-	.027	.007	-	-
Veery	.605	.045	.871	-	.023	-	-	-	-
Ruby-crowned kinglet	-	-	-	.454	-	-	-	-	-
Black and white warbler	.558	-	.073	.068	.191	.681	.042	.382	-
Golden-winged warbler	-	-	-	-	.023	-	-	.811	-
Nashville warbler	.471	-	1.601	.303	.363	2.443	.157	.287	-
Black-throated blue warbler	-	-	-	.068	-	-	-	-	-
Yellow rump warbler	-	-	-	-	.403	-	.084	.521	-
Black-throated green warbler	.061	-	-	-	-	-	.021	.036	-
Chestnut-sided warbler	.030	-	-	.091	-	-	-	.191	-
Ovenbird	.045	.045	.556	.068	.018	-	.206	.127	.066
Northern waterthrush	-	-	-	-	.069	-	-	-	-
Red-winged blackbird	-	.519	.109	.218	-	-	.056	.573	-
Common grackle	-	-	-	*	-	-	-	-	-
Brown-headed cowbird	-	-	-	-	.454	1.361	-	-	-
Scarlet tanager	-	-	*	-	-	-	-	.048	-
Rose-breasted grosbeak	-	-	.048	-	.023	-	.008	.048	-
Evening grosbeak	.363	-	-	.068	.045	.182	.251	-	-
Purple finch	-	-	-	.091	*	-	.007	.048	-
American goldfinch	-	-	-	-	-	-	.042	*	-
White-throated sparrow	.778	-	-	-	-	1.361	.010	.382	.113
Song sparrow	.605	.908	-	.363	-	-	3.808	-	.358
Total Density/birds/acre	5.344	5.159	4.998	9.585	5.524	7.840	6.079	5.591	2.626
birds/hectare	13.20	12.74	12.35	23.67	13.64	19.36	15.02	13.81	6.49

*observed but density undetermined.

Table 6.1-10. Densities of birds in number per acre (.404 ha) observed along transects in five wetland communities in June 1981. Densities from listening post stations are not included.

	WETLAND TYPE								
	DECIDUOUS SWAMP		SHRUB SWAMP		CONIFEROUS SWAMP		BOG		MARSH
SPECIES TRANSECT NO:	1	5	3	11	2	7	4	10	6
Common loon	.024	-	-	-	.012	-	-	.019	-
Black duck	-	-	-	-	-	-	-	-	.224
Broad-winged hawk	-	.807	-	-	-	-	-	-	-
Ruffed grouse	.807	-	-	-	.484	-	-	-	-
Yellow-billed cuckoo	-	-	-	-	-	-	-	-	.053
Barred owl	-	.040	-	-	-	-	-	-	-
Chimney swift	-	.346	.073	-	-	-	-	.955	.322
Common flicker	-	-	-	.096	.040	-	-	.318	-
Pileated woodpecker	-	-	.032	-	-	-	-	-	-
Yellow-bellied sapsucker	-	-	-	-	-	.242	.465	-	-
Hairy woodpecker	.269	-	-	.590	.242	.061	-	.478	-
Downy woodpecker	-	-	-	.091	-	-	-	.038	-
Eastern kingbird	-	-	-	.726	-	-	-	.112	-
Great crested flycatcher	-	.030	-	.227	.088	.220	-	-	.066
Yellow-bellied flycatcher	-	-	-	-	.247	-	-	-	-
Least flycatcher	-	.454	-	-	-	-	-	-	.308
Olive-sided flycatcher	-	-	-	-	-	.121	-	-	-
Blue jay	.048	.048	.187	.605	.169	.540	-	.127	-
American crow	-	-	-	.085	.030	.073	-	.425	-
Black-capped chickadee	.076	-	.097	.403	-	.789	-	.318	-
Red breasted nuthatch	-	-	-	.121	-	-	-	-	-
Gray catbird	-	-	-	-	.061	-	-	-	-
American robin	-	-	-	.420	-	.303	-	-	-
Hermit thrush	-	-	.104	-	.099	.207	.022	.096	.038
Veery	.141	.186	.449	-	-	-	.103	-	-
Cedar waxwing	-	-	-	-	-	.840	-	-	-
Red-eyed vireo	.125	.233	.407	.091	.121	.349	.164	.278	.110
Black and white warbler	.346	-	-	.279	.138	.454	-	.813	-
Golden-winged warbler	-	-	.605	-	-	-	-	.119	-
Tennessee warbler	-	-	-	-	.055	-	-	-	-
Nashville warbler	.230	-	-	-	.536	.622	-	.244	-
Yellow rump warbler	.121	-	-	.454	.121	.263	-	.182	-
Black-throated green warbler	-	.048	-	.073	-	-	.022	-	-
Chestnut-sided warbler	-	-	-	.443	.024	-	.043	-	-
Ovenbird	.043	.173	.229	.104	.048	.091	.234	.239	-
Northern waterthrush	-	-	-	-	.113	-	-	-	-
Mourning warbler	-	-	-	.519	-	.454	.279	-	-
Common yellowthroat	-	-	-	.590	.108	.191	-	.048	.283
Canada warbler	-	-	-	-	.030	-	-	.450	-
Red-winged blackbird	.061	-	-	-	-	-	-	.096	-
Northern oriole	.346	-	-	.052	-	-	-	-	-
Common grackle	.151	-	.121	-	-	-	-	-	-
Brown-headed cowbird	.242	-	.182	-	.230	-	-	-	-
Scarlet tanager	-	-	-	-	-	-	-	.264	-
Rose-breasted grosbeak	.161	-	.363	-	.035	.073	.019	.076	.377
Indigo bunting	.086	-	-	-	-	.091	-	-	-
Purple finch	-	-	-	.726	-	.182	-	.048	-
American goldfinch	-	-	-	-	-	-	.037	-	.165
Chipping sparrow	-	-	-	-	.048	.202	-	.239	-
White-throated sparrow	-	-	-	-	.121	1.077	-	.415	-
Song sparrow	-	.067	-	-	-	.308	.245	.338	1.335
Total Density birds/acre	3.277	2.432	2.849	8.818	3.200	7.753	1.633	6.735	2.973
birds/hectare	8.09	6.01	7.04	21.78	7.90	19.15	4.03	16.64	7.34

habitat, since they directly relate to the actual usage of each wetland type by birds.

In each of the six wetland types, values for diversity, richness, equitability and bird density were similar. All wetland types were used by migrant species during the May census, and by breeding birds during the June census. The lack of type specificity by breeding birds is common for communities that vary so widely in the extent of vertical development, as did the wetland types on the site. Studies of habitat suitability by Kendeigh (1974) and MacArthur and MacArthur (1961) have shown that land areas with high foliage-height diversity, such as forested swamps, have higher avian diversity than areas where vegetation is restricted to only one layer. However, habitats with permanent open water such as marshes have a higher bird species diversity than those without water (MacArthur, 1964). The size of the wetland also influences these parameters. Birds frequently obtain a major portion of their life cycle requirements from areas larger than a hectare (several acres) of land. The marsh and aquatic bed transects and listening stations, although chosen to be in the most representative type available, were within 200 to 400 m (656 to 1312 feet) of other habitat types, notably upland areas. Thus the species diversity of these wetlands, and consequently their value, was greatly enhanced by interspersion of upland and wetland types. In this respect, these parameters more accurately reflect the degree of interspersion of the many relatively small habitats in the study area rather than the characteristics of a given habitat type.

Comparisons of the avifaunal communities in the various wetland types during May and June are shown in Tables 6.1-11 and 6.1-12, respec-

Table 6.1-11. Similarity index values (upper right-hand corner of table) and number of species shared in common (lower left-hand corner) for the avifaunal communities in the wetlands surveyed in May. Boxed values are for comparing wetlands of the same classification type.

		WETLAND TYPE										
		Aquatic Bed	Marsh		Shrub Swamp		Bog		Coniferous Swamp		Deciduous Swamp	
	Wetland No.	F12	F15	F12	F39	M1	F16	F28	F60	F11	F57	F15
	Transect No.	8	6	9	3	11	4	10	2	7	1	5
WETLAND TYPE/NO.												
Aquatic Bed	F12	21	.21	.74	.46	.41	.57	.52	.42	.46	.39	.19
Marsh	F15	3	7	.33	.38	.24	.44	.21	.25	.19	.55	.47
	F12	14	4	17	.39	.51	.57	.53	.35	.45	.44	.30
Shrub Swamp	F39	8	4	6	14	.44	.51	.51	.52	.43	.62	.50
	M1	8	3	9	7	18	.51	.41	.46	.44	.49	.36
Bog	F16	13	7	12	10	11	25	.61	.52	.46	.60	.46
	F28	11	3	10	9	8	14	21	.46	.40	.50	.19
Coniferous Swamp	F60	8	3	6	8	8	11	9	17	.52	.44	.30
	F11	8	2	7	6	7	9	7	8	14	.48	.17
Deciduous Swamp	F57	7	6	7	9	8	12	9	7	7	15	.48
	F15	3	4	4	6	5	8	3	4	2	6	10

Table 6.1-12. Similarity index values (upper right-hand corner of table) and number of species shared in common (lower left-hand corner) for the avifaunal communities in the wetlands surveyed in June. Boxed values are for comparing wetlands of the same classification type.

		WETLAND TYPE										
		Aquatic Bed	Marsh		Shrub Swamp		Bog		Coniferous Swamp		Deciduous Swamp	
	Wetland No.	F12	F15	F12	F39	M1	F16	F28	F60	F11	F57	F15
	Transect No.	8	6	9	3	11	4	10	2	7	1	5
WETLAND TYPE/NO.												
Aquatic Bed	F12	25	.44	.64	.38	.58	.39	.68	.57	.67	.43	.33
Marsh	F15	8	11	.41	.35	.19	.55	.33	.29	.35	.14	.46
	F12	17	8	28	.35	.50	.31	.53	.42	.63	.44	.31
Shrub Swamp	F39	7	4	7	12	.25	.44	.43	.33	.34	.53	.44
	M1	13	3	12	4	20	.32	.58	.50	.61	.38	.32
Bog	F16	7	6	6	5	5	11	.28	.29	.41	.29	.46
	F28	17	6	14	8	13	5	25	.65	.67	.52	.28
Coniferous Swamp	F60	14	5	11	6	11	5	16	24	.60	.49	.23
	F11	16	6	16	6	13	7	16	14	23	.50	.29
Deciduous Swamp	F57	9	2	10	8	7	4	11	10	10	17	.29
	F15	6	5	6	5	5	5	5	4	5	4	11

tively. The similarity indices (range 0 to 1.0) show which transects (wetlands) had the most similar species lists. Values below 0.5 indicate dissimilarity for that pair of transects. Values above 0.5 and especially those above 0.6 denote great similarity. These tables also present the data from which the indices were calculated. For example, the data under "Bog" F16 and F28 show that 25 species were recorded in all the replicates of F16 in May and 21 species in F28. These numbers are presented in the table where the row and column cross for a given wetland. The number of species common to both wetlands (14) is given in the lower left hand corner. The index value (.61) is at the upper right corner. The data for any two transects can be visualized by drawing a rectangular box around the columns and rows that include the two transects.

The bird species similarities were not always in agreement with habitat vegetative similarity. The highest value (.74), in fact, occurred in May between the aquatic bed and the marsh listening stations both located at Skunk Lake (F12). Proximity to other habitats may have influenced the transect data as much or more than the wetland type present. Several wetland types were unusually low in similarity in both May and June, as indicated by values <0.5; these included (1) shrub swamp transects 3 and 11, (2) marsh transects 6 and 9, and (3) deciduous swamp transects 1 and 5.

The similarity and diversity indices equate all species equally. One species is regarded as being as desirable as another, e.g., a winter wren (Troglodytes troglodytes) is taken to provide as much numerical diversity as a robin (Turdus migratorius). Although no parameter shows one wetland type to be of higher value than another, the species lists clearly show that certain species of birds occur more often in given wetland types than in others.

Based on the densities of birds observed along transects (Table 6.1-9), the five most abundant species found during the May 1981 surveys in bogs F16 and F28, in decreasing order of abundance, were song sparrow (Melospiza melodia), mallard (Anas platyrhynchos), hairy woodpecker (Picoides villosus), red-winged blackbird (Agelaius phoeniceus) and yellow-rumped warbler (Dendroica coronata). During June, the most common species (Table 6.1-10) were song sparrow, black and white warbler, chimney swift (Chaetura pelagica), ovenbird and hairy woodpecker. These data are similar to results presented by Landin (1979) and to the list of indicator species for bogs in the north central United States developed by Anderson (1979).

During the May surveys, the five most abundant species in the two coniferous swamp areas surveyed (F11 and F60) were black-capped chickadee, Nashville warbler (Vermivora ruficapilla), cowbird (Molothrus ater), black and white warbler, and evening grosbeak. In June they were white-throated sparrow, Nashville warbler, blue jay, black and white warbler, and red-eyed vireo.

In the two deciduous swamps (F15 and F57) the most abundant species in May were least flycatcher (Empidonax minimus), black-capped chickadee, robin, song sparrow and white-throated sparrow, whereas in June, they were broad-winged hawk (Buteo platypterus), ruffed grouse, least flycatcher, northern oriole (Icterus galbula) and red-eyed vireo. These results are consistent with habitat preferences noted by Peterson (1980) for these species.

In the shrub swamp type, surveys were conducted in wetlands F39 and M1. In the combined May surveys for these two areas, the five most abundant species were American bittern (Botaurus lentiginosus), black-capped chickadee, Nashville warbler, veery (Catharus fuscescens) and ovenbird. In June, they were blue jay, evening grosbeak, eastern kingbird (Tyrannus tyrannus), golden-winged warbler (Vermivora chrysoptera) and hairy woodpecker.

Two marsh areas were surveyed, portions of wetlands F12 and F15. In both May and June, the red-winged blackbird and song sparrow were the most common species observed in F12, whereas in F15 they were the least flycatcher and robin in May and song sparrow and least flycatcher in June. The findings for F15 reflect the influence of the surrounding wooded swamp habitat. Wetland F12 also included an aquatic bed. The five most common species recorded for this habitat in May were: mallard, tree swallow (Iridoprocne bicolor), Nashville warbler, red-winged blackbird, and purple finch (Carpodacus purpureus); and in June, robin, red-winged blackbird, ovenbird, great crested flycatcher, and American goldfinch (Carduelis tristis). These results also reflect the influence of surrounding habitat on bird species diversity.

6.1.2.4 Mammals - The results of the live trapping surveys of small and medium-sized mammals are summarized in Tables 6.1-13 and 6.1-14. Eleven species were captured in the four wetland types sampled. The deciduous swamp type had the greatest species richness with a total of seven species trapped. In the area dominated by mature bur oaks (F15), white footed mice (Peromyscus leucopus) were the most abundant species (11.4/ha [28.2/acre]) and comprised 50 percent of all captures. The relative abundance of mast (e.g., acorns) probably accounted for the

Table 6.1-13. Summary of small and medium-sized mammal captures (number caught per 100 trap nights) by wetland habitat type, June 1981. Actual number caught is shown in parentheses.

	WETLAND TYPE							
	DECIDUOUS SWAMP		CONIFEROUS SWAMP		SHRUB SWAMP		BOG	
SPECIES WETLAND:	YOUNG F57	MATURE F15	MIXED F60	HOMOGENOUS F11	CREEKSIDE F29	CREEKSIDE M1	MAT F16	WOODED F28
Masked shrew	1.8(1)	(0)	(0)	(0)	5.4(3)	6.3(2)	(0)	6.3(2)
Short-tailed shrew	1.8(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Eastern chipmunk	1.8(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Least chipmunk	(0)	(0)	1.8(1)	(0)	(0)	(0)	(0)	(0)
Woodland deer mouse	(0)	3.1(1)	7.1(4)	(0)	1.8(1)	(0)	(0)	(0)
White-footed mouse	(0)	9.4(3)	(0)	(0)	(0)	(0)	(0)	(0)
Southern red-backed vole	3.6(2)	(0)	7.1(4)	(0)	1.8(1)	(0)	(0)	3.1(1)
Meadow vole	(0)	(0)	5.4(3)	(0)	(0)	6.3(2)	1.9(1)	(0)
Meadow jumping mouse	5.4(3)	6.3(2)	1.8(1)	(0)	1.8(1)	6.3(2)	(0)	(0)
Woodland jumping mouse	(0)	(0)	(0)	4.2(1)	(0)	(0)	(0)	(0)
Striped skunk	(0)	(0)	(0)	(0)	12.5(1)	(0)	(0)	(0)

Table 6.1-14. The relative abundance in percent of small and medium-sized mammal species trapped in each of the wetland types, June 1981. Density in number per hectare (2.47 acres) is shown in parentheses.

	WETLAND TYPE							
	DECIDUOUS SWAMP		CONIFEROUS SWAMP		SHRUB SWAMP		BOG	
SPECIES WETLAND:	YOUNG F57	MATURE F15	MIXED F60	HOMOGENOUS F11	CREEKSIDE F39	CREEKSIDE M1	MAT F15	WOODED F2S
Masked shrew	12.5(+)*	(0)	(0)	(0)	23.5(+)	33.3(+)	(0)	67.0(+)
Short-tailed shrew	12.5(+)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Eastern chipmunk	12.5(+)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Least chipmunk	(0)	(0)	7.8(+)	(0)	(0)	(0)	(0)	(0)
Woodland deer mouse	(0)	19.0(+)	30.6(3.0)	(0)	7.7(+)	(0)	(0)	(0)
White-footed mouse	(0)	50.0(11.4)	(0)	(0)	(0)	(0)	(0)	(0)
Southern red-backed vole	25.0(+)	(0)	30.6(4.1)	(0)	7.7(+)	(0)	(0)	33.0(+)
Meadow vole	(0)	(0)	23.3(9.4)	(0)	(0)	33.3(+)	100.0(+)	(0)
Meadow jumping mouse	37.5(+)	33.5(+)	7.8(+)	(0)	7.7(+)	33.3(5.7)	(0)	(0)
Woodland jumping mouse	(0)	(0)	(0)	100.0(+)	(0)	(0)	(0)	(0)
Striped skunk	(0)	(0)	(0)	(0)	53.6(+)	(0)	(0)	(0)

*Present, but insufficient number caught to calculate density.

presence of both the white-footed mouse and woodland deer mouse in that area, as both are primarily seed eaters. Their absence in the less mature hardwood swamp (F57) supports this contention. The meadow jumping mouse was the second most abundant species and was typically caught in areas of dense herbaceous ground cover, normally at the wetland edge or where sunlight penetrated to the forest floor. Southern red-backed voles were common in the young deciduous swamp (F57) but not in the mature one (F15). Burt (1957) reported that this species prefers damp forest floors and conifer swamps, especially where there are decaying logs and stumps. Their absence from the mature deciduous swamp can be attributed to the relatively "clean" ground layer and its seasonal dryness. Both the masked shrew and short-tailed shrew were trapped only in F57. The eastern chipmunk was observed in the mature deciduous swamp (F15); however, it was caught only near the edge of F57.

Six species were trapped in the two coniferous swamps (F60 and F11). The woodland deer mouse and southern red-backed vole were captured most frequently and had densities of 3.0 and 4.1/ha (7.4 and 10.1/acre), respectively. These densities were similar to those reported by Dames and Moore (1981d) in earlier studies of coniferous swamps. Deer mice were typically caught in the drier portions of the swamp, normally along its edge. Southern red-backed voles were caught in the wettest portions of the interior of the swamp. The least chipmunk (Eutamias minimus) was also trapped in the interior of the conifer-mixed hardwoods swamp (F60). In contrast to the eastern chipmunk, the least chipmunk inhabits forests dominated by conifers (Burt, 1957). All of the meadow voles (Microtus pennsylvanicus) caught within the coniferous-mixed hardwood swamp were juveniles and presumably were dispersing from more suitable habitat on the periphery of the swamp. One meadow jumping mouse was caught along a small outlet stream at the edge of the swamp. The woodland jumping mouse was the only species trapped in the more homogeneous coniferous swamp, F11 (predominantly black spruce and tamarack). Dames and Moore (1981d) trapped the following species, in order of decreasing abundance, in a coniferous swamp in the site area: red-backed vole, woodland deer mouse, masked shrew, Peromyscus spp., snowshoe hare, least chipmunk and northern flying squirrel (Glaucomys sabrinus).

Six species were caught in the shrub swamps. The masked shrew was the most common species with 5.4 and 6.3 captures per 100 trap nights in F39 and M1, respectively. Meadow jumping mice were also captured in both areas in the dense herbaceous growth along the small streams in each. In swamp M1 their density was estimated at 5.7/ha (14.1/acre). The woodland deer mouse and red-backed vole were also trapped in this wetland type but in relatively low numbers. One striped skunk (Mephitis mephitis) was captured in F39.

Only three mammal species were collected in the bog community. An immature meadow vole was caught in F16 where the transect extended across the sphagnum mat and only scattered small trees were present. Two masked shrews were caught in the interior of bog F28 which was entirely wooded (predominantly tamarack) and one southern red-backed vole was captured along the wetland-upland edge of this wetland. Masked, pygmy (Microsorex hoyi) and short-tailed shrews were also caught in pitfall traps set along the upland border of bog F16 during the April 1981 salamander survey.

No mammal trapping was conducted in the marsh and aquatic bed wetland because of its wet condition during the June 1981 survey period. For this same reason, none of these areas would have been suitable for most small and medium-sized mammals. Their edges, however, would presumably attract a wide variety of upland species as well as species such as the raccoon (Procyon lotor) which would forage in the shallow water. Muskrats were common in the study area, although no large colonies existed. Beavers were largely restricted to a few specific wetlands in the study area (e.g., south of Little Sand Lake and the east shore of Deep Hole Lake) or just off its boundary (e.g., near Ground Hemlock Lake).

A summary of all other evidence of mammalian species associated with wetlands is given in Appendix J, Table J-19. The information indicates that larger species such as white-tailed deer and black bear utilize these wetland areas. Sign of the coyote (Canis latrans) also was observed in the deciduous swamp and shrub-swamp.

6.1.3 Threatened and Endangered Species

Assessment of the threatened and endangered status of plant and wildlife species in the study area was based on the Wisconsin Endangered and Threatened Species List (Wisconsin Department of Natural Resources Office of Endangered and Nongame Species). All species appearing on the Federal list that have been reported for Wisconsin are also included. This list is presented in Appendix K, Table K-1.

6.1.3.1 Vegetation - No plant species were observed in the study area that are listed on the Wisconsin Endangered and Threatened Species List, including Federal species listed for the state.

6.1.3.2 Herpetofauna - The only state-listed threatened species found in the study area was the spotted salamander; however, the DNR is presently proposing to remove this species from the threatened amphibian list (DNR Public Hearing, April 16, 1982). In their studies of the spotted salamander, Dames and Moore (1980) provided evidence that this species is more common in northern Wisconsin than its special status would indicate. Spotted salamanders or their eggs were found in 11 ponds in the study area during the surveys conducted by Dames and Moore (1980). Pitfall trapping for salamanders in wetland F16, a bog, during April and May 1981 resulted in the capture of nine adult spotted salamanders and one blue-spotted salamander. Of the nine spotted salamanders caught and released, two were in pitfall traps at the ends of the drift fences, and seven were in pitfall traps on the water side of the fences. This indicates that the adults were probably returning to the uplands after completing their egg-laying activities.

Breeding spotted salamanders utilize only habitats where substantial open water exists which is deep enough to ensure a month of immersion of the egg mass at low temperatures (Bishop, 1947). The results of searches for egg masses of this species are presented in Table 6.1-15. Some of the egg masses found were deep green in color from algal growth and were ready to hatch. Others were in a much earlier stage of development. These results suggest that two major breeding periods occurred in

Table 6.1-15. Results of systematic searches for spotted salamander egg masses, April-May 1981.

WETLAND TYPE	DATE	NUMBER OF EGG MASSES[a]	CENSUS DISTANCE (METERS)	EGG MASSES/ 30.5 m[b]	LOCATION[c]
Deciduous swamp	4-29-81	30	61	15.0	Near fence
		9	137	2.0	F16
	4-30-81	4	24	5.0	Borrow pit south of Sand Lake Road
		2	9	6.7	Ditch north of F11
	5-01-81	2	15	4.0	Ditch west of Duck Lake
Marsh	4-28-81	0	152	0	F15
	4-30-81	0	24	0	North side of Sand Lake Road
		0	30	0	North side of Sand Lake Road
		56	1128	1.5	Skunk Lake, F12
Bog	4-29-81	421	56	22.8	Perimeter of F16
Coniferous swamp sphagnum mat	4-29-81	0	122	0	West side of Hemlock Lake Road
	4-30-81	0	244	0	F11
Streamside shrub swamp	4-29-81	0	91	0	East side of Hemlock Lake Road

[a]Total number seen along entire distance of census.

[b]Mean number seen per 30.5 m (100 feet) of shoreline.

[c]The locations of these observations are shown in Figure 4.4-1.

1981, one in early April and another in late April just prior to the present study. Presumably, the adults trapped in the present study were returning to the uplands after breeding in this second period.

Although the coniferous swamps provided both flowing and stationary open water, no salamander eggs were observed in this wetland type. Streamside shrub swamp habitats were also devoid of egg masses. Shallow marsh and aquatic bed areas were frequently devoid of eggs, but the 1128 m (3700 feet) perimeter of Skunk Lake (F12) contained 56 egg masses, or 1.5 egg masses per 30 m (98.4 feet). Lakes of this size are seldom used for egg laying over most of the range of the spotted salamander because of high water temperatures at the end of the larval development period, and because of the presence of predatory fish in most permanent water bodies of this size (Bishop, 1947). The results indicated that marsh habitats in the study area were apparently under utilized.

Bog mats have little or no open water and are too acidic to be suitable for egg laying by this species (Pough and Wilson, 1974). Surprisingly, the highest concentration of egg masses found in the study area was in the open water moat surrounding bog F16. A total of 421 egg masses was censused in the 565 m (1853 foot) perimeter of this bog, with an average of approximately 23 masses per 30 m (98.4 feet). The highest concentrations of eggs were found where the water was 0.5 to 1.0 m (1.6 to 3.3 feet) deep and where the moat between the deciduous forest edge and the floating bog mat was widest. In situ water tests showed that the surface water in the moat had a pH of 6.0 whereas the pH of the water in the bog mat 3 to 5 m (9.8 to 16.4 feet) away varied between 4.1 and 4.5. Thus the eggs in the moat were exposed to substantially less acidic conditions than in the bog mat.

6.1.3.3 Avifauna - The results of the avifauna surveys produced no conclusive findings with respect to use of the study area by threatened or endangered bird species. An osprey (Pandion haliaetus) was recorded soaring over the deciduous swamp F15 in the May survey. The bird was not utilizing the wetland at the time of the observation. No other ospreys were observed during the field work.

A Coopers hawk (Accipiter cooperii) was observed on both May 12 and 13 in the conifer swamp F60; however, it is not a wetland species but is characteristic of mixed upland forests. The species is listed as threatened by the DNR although it is generally increasing in numbers in many parts of its range (Tate, 1981).

6.1.3.4 Mammals - No evidence was found of threatened or endangered mammals utilizing the study area.

6.2 MODEL RESULTS FOR WETLANDS

Of 224 wetlands delineated in the study area, 97 were smaller than .10 ha (0.25 acre) and were mapped but were not inventoried or assessed. These wetlands were not inventoried because many of the elements that give rise to wetland functions are either absent or too poorly defined to measure in such small wetlands. Of the 127 wetlands inventoried there were 14 shallow marshes, 12 shrub swamps, 44 deciduous swamps, 11 bogs, 34 coniferous swamps, two aquatic beds and 10 streamside wetlands. Model data for the 127 wetlands are presented by watershed in ascending numerical order with the unnormalized scores for the 10 models in Table 6.2-1 and the normalized scores in Table 6.2-2. Wetlands of special interest are denoted with an asterisk.

6.2.1 Unnormalized Data

Of the 10 functional models, no one model, apart from the other nine, has the capability to define the total value of a wetland. Each model was designed to assess only a specific function. The model range and mean and the range and mean of the actual scores are presented for each functional model in Table 6.2-1. To combine and rank scores, these parameters were also totalled to yield a minimum, maximum and mean. The model parameters will provide a basis for assessing wetlands data in a regional context in Section 6.3, whereas the range and mean of the actual scores will lend a study area perspective to the assessment of this data. Because of wide differences in model minima and maxima, the contributions of the unnormalized scores to the total score are unequal. For example,

Table 6.2-1. Unnormalized results of 10 functional models for 127 wetlands in the study area.

		FUNCTIONAL MODELS										
WETLAND NO.	WETLAND TYPE	BIOLOGICAL FUNCTION	HYDROLOGIC SUPPORT FUNCTION	GROUNDWATER FUNCTION	STORM AND FLOODWATER STORAGE FUNCTION	SHORELINE PROTECTION FUNCTION	WATER QUALITY MAINTENANCE FUNCTION	CULTURAL AND ECONOMIC FUNCTION	RECREATIONAL FUNCTION	AESTHETICS FUNCTION	EDUCATION FUNCTION	TOTAL
A1	SH[a]	74	8	29	87	0	68	27	32	35	10	370
A2	CS[b]	64	39	36	81	0	52	43	27	31	7	380
A3	DS[c]	49	12	36	90	0	62	39	24	31	7	350
B1	SW[d]	56	32	42	58	3	47	11	23	27	7	306
B2*	CS	96	53	45	97	0	80	51	43	28	10	503
B3*	DS	71	31	42	71	15	48	39	36	33	7	393
B4*	CS	92	48	33	99	0	68	51	46	31	10	478
B5*	CS	75	8	40	90	0	69	35	28	25	7	377
B8*	DS	58	8	38	79	0	63	31	25	33	7	342
D1*	CS	100	53	43	98	19	77	57	47	37	18	549
D2	SW	48	22	39	57	3	33	11	26	31	7	277
D3*	DS	65	44	30	95	0	64	39	30	28	7	402
D4*	CS	92	47	31	100	0	69	51	40	31	10	471
D4A*	DS	61	12	32	95	0	67	39	26	28	7	367
D5*	B[e]	55	8	40	90	0	62	23	22	39	7	346
D8*	DS	57	8	31	86	0	58	31	25	33	7	336
D18	DS	48	8	31	88	0	59	31	20	25	7	317
F1	SW	83	41	54	61	5	55	27	33	33	10	400
F2	SH	141	59	54	81	11	77	63	65	50	10	611
F4	CS	97	52	41	95	19	72	54	45	28	10	502
F5	CS	81	12	43	96	0	66	49	34	31	15	427
F6	SW	56	44	35	77	5	60	11	20	19	7	334
F7	SH	129	19	42	98	0	82	87	64	62	10	593
F8	DS	60	8	38	84	0	62	31	22	31	10	346
F9	CS	99	52	46	90	27	70	54	55	34	14	541
F10*	CS	101	57	45	103	29	76	51	53	28	10	553
F11*	CS	78	48	42	100	0	73	57	42	31	15	486
F12	SH	107	20	46	104	18	81	43	55	32	10	516
F13*	CS	67	12	43	100	0	69	43	30	31	7	402
F15	DS	96	19	46	98	0	67	53	40	37	18	474
F16	B	74	16	46	106	0	70	53	37	40	18	460
F17	DS	59	12	32	95	0	67	39	26	28	7	365
F18	CS	96	53	46	99	0	77	51	41	31	10	504
F19	SH	105	58	46	97	22	86	46	67	50	14	591
F21	SH	100	53	40	95	22	83	41	59	44	18	555
F22	DS	57	44	39	88	0	63	45	32	37	15	420
F23*	SH	104	66	44	106	22	89	43	59	38	10	581
F24	SW	56	27	35	69	5	47	17	25	30	15	326
F25*	DS	70	45	31	97	0	71	45	35	40	18	452
F26	SW	52	30	30	58	4	37	11	18	16	7	263
F27*	DS	57	44	30	91	0	61	45	32	40	18	418
F28*	B	104	61	43	103	21	74	83	64	71	10	634
F29*	SS[f]	115	44	29	96	0	77	55	43	39	10	508
F30	SW	53	22	30	56	4	36	11	21	27	7	267

Table 6.2-1. (continued)

WETLAND NO.	WETLAND TYPE	FUNCTIONAL MODELS: BIOLOGICAL FUNCTION	HYDROLOGIC SUPPORT FUNCTION	GROUNDWATER FUNCTION	STORM AND FLOODWATER STORAGE FUNCTION	SHORELINE PROTECTION FUNCTION	WATER QUALITY MAINTENANCE FUNCTION	CULTURAL AND ECONOMIC FUNCTION	RECREATIONAL FUNCTION	AESTHETICS FUNCTION	EDUCATION FUNCTION	TOTAL
F31*	CS	83	48	31	98	0	69	51	38	34	10	462
F32*	DS	35	8	29	91	0	63	31	20	28	7	312
F33	DS	52	39	32	82	0	54	39	26	28	7	359
F34	DS	47	9	29	81	0	51	31	20	28	7	303
F35	CS	82	12	34	100	0	69	49	34	34	15	429
F36	DS	62	13	32	85	0	55	45	28	34	15	369
F37	SM	131	61	47	98	20	96	66	67	50	14	650
F38	SW	53	29	35	59	3	42	11	21	27	7	287
F39	SS	89	49	41	102	0	84	39	35	21	7	467
F40	SM	132	49	43	94	0	82	73	60	50	18	601
F42	SS	64	8	38	91	0	70	23	23	32	7	357
F43	B	64	12	43	98	0	69	31	24	36	7	384
F45	B	69	8	40	90	0	62	23	23	39	10	364
F46	CS	68	12	43	96	0	66	49	36	31	15	416
F48	CS	62	8	40	96	0	65	35	25	25	7	363
F50	DS	52	8	40	92	0	62	31	20	28	7	340
F51	DS	55	8	40	84	0	57	31	26	37	7	345
F52	B	67	13	44	105	0	73	19	25	19	10	375
F53	CS	85	48	42	103	0	71	51	38	25	7	470
F54	B	71	12	43	98	0	69	31	27	33	7	391
F55	DS	53	8	38	83	0	58	31	26	40	7	344
F57*	DS	103	60	41	95	19	75	47	50	34	10	534
F58	SM	89	8	38	82	0	69	53	45	61	18	463
F60*	DS	93	49	34	101	0	75	57	42	40	18	509
F61*	DS	58	37	29	84	0	59	45	32	31	15	390
F62*	DS	76	48	32	94	0	70	53	39	37	18	467
F63*	CS	90	57	34	101	0	75	51	38	31	10	487
F64*	B	78	57	34	99	0	75	39	35	39	7	463
F65*	SS	116	52	29	94	0	75	55	43	39	10	513
F66*	CS	94	48	33	99	0	68	51	41	31	10	475
F69*	DS	59	44	30	95	0	64	45	32	34	15	418
F70*	DS	73	15	32	93	0	64	39	27	28	10	381
F72*	DS	58	13	32	89	0	58	39	24	28	7	348
F81*	AB[B]	58	20	29	77	4	50	17	24	37	15	331
F86	DS	53	8	38	97	0	63	37	24	34	15	369
F87	DS	53	8	38	97	0	63	37	24	34	15	369
F90	AB	52	20	42	73	3	50	17	24	36	15	333
F114*	SM	86	8	56	85	0	67	33	39	46	18	438
F116	CS	58	8	48	96	0	65	35	23	28	7	368
F119	CS	73	12	43	96	0	66	49	34	34	18	425
F121	CS	53	8	40	92	0	62	31	20	35	7	348
F122	DS	51	8	40	92	0	62	37	24	31	15	360
F122A	SS	75	8	40	88	0	66	29	30	44	18	398
F125	SS	84	8	40	66	0	65	53	42	60	18	436
F126	SM	67	12	43	102	0	74	35	36	32	7	408
F127	DS	70	6	29	88	0	59	31	26	33	7	349

Table 6.2-1. (continued)

WETLAND NO.	WETLAND TYPE	FUNCTIONAL MODELS: BIOLOGICAL FUNCTION	HYDROLOGIC SUPPORT FUNCTION	GROUNDWATER FUNCTION	STORM AND FLOODWATER STORAGE FUNCTION	SHORELINE PROTECTION FUNCTION	WATER QUALITY MAINTENANCE FUNCTION	CULTURAL AND ECONOMIC FUNCTION	RECREATIONAL FUNCTION	AESTHETICS FUNCTION	EDUCATION FUNCTION	TOTAL
G1	DS	51	8	40	92	0	62	31	22	28	7	341
H1	CS	86	16	27	104	0	73	51	34	31	10	442
I1	DS	75	8	38	89	0	62	37	30	42	18	399
J1	DS	44	8	38	89	0	58	31	26	43	7	344
K1	SW	74	22	30	59	6	42	37	31	40	18	359
K2	DS	85	49	34	101	0	75	57	42	37	18	498
K3	CS	77	48	31	102	0	72	57	42	34	15	478
K4	SS	67	8	31	88	0	66	29	30	44	18	381
K5	B	60	8	31	94	0	65	29	24	45	15	371
M1	SS	67	45	28	90	0	81	29	35	33	15	423
M2	SW	58	22	30	60	0	39	11	21	24	7	272
M3*	DS	74	44	28	98	0	68	39	31	31	10	423
M4	DS	57	8	29	85	0	59	31	23	36	7	335
M5	CS	81	44	30	95	0	64	49	38	37	18	456
M6	DS	65	40	27	81	0	61	31	24	28	7	364
N1	SS	79	8	38	91	0	74	29	30	44	18	411
O1*	CS	89	53	43	96	0	81	51	40	34	10	497
O3	DS	65	44	37	100	0	65	45	34	37	15	442
P1	DS	73	36	36	74	18	59	39	31	31	7	404
P2*	CS	85	48	33	103	0	71	51	38	31	7	467
R1*	DS	73	48	41	97	0	68	47	35	28	10	447
R1A*	DS	81	52	41	94	17	70	47	35	25	7	469
R3	SM	126	65	41	96	11	81	66	65	53	14	618
R5	CS	108	60	43	101	17	69	57	45	43	21	564
R7	DS	62	44	37	100	0	65	45	32	36	15	437
R7A	SS	84	12	43	108	0	77	37	31	30	15	437
R8*	SS	74	12	34	102	0	77	37	31	30	15	412
T1*	B	72	12	53	94	0	66	37	31	45	15	425
T2*	B	93	12	53	98	0	69	37	31	42	18	453
T3*	SS	80	8	50	94	0	70	29	27	27	15	400
T4*	CS	118	67	59	94	17	80	54	55	37	14	595
T5*	CS	78	12	41	95	0	67	43	30	31	7	404
W1*	CS	101	63	64	99	19	79	51	45	31	10	562
W2*	CS	102	57	56	96	19	79	51	41	31	10	542
X2	DS	68	8	29	89	0	62	31	26	33	7	353
X3	CS	94	48	33	99	0	68	51	41	34	10	478
X4	SM	64	8	29	95	0	74	29	29	35	7	370
Score Range		35-141	8-67	29-64	56-108	0-29	36-96	11-87	20-67	16-62	7-21	218-742
Score Mean		76	31	37	91	3.5	66	40	34	35	11	424.5
Model Range		29-158	6-67	20-68	29-123	3-32	18-98	11-87	10-71	9-66	7-24	142-794
Model Mean		93	36	44	76	17	58	54	40	37	15	470

[a]Shallow marsh; [b]Coniferous swamp; [c]Deciduous swamp; [d]Streamside wetland; [e]Bog; [f]Shrub swamp; [g]Aquatic bed

*Wetlands of special interest.

five models are used to evaluate watershed function and only one is used for biological function. The totals derived by combining unnormalized scores do not present an accurate impression of a wetland's total value.

6.2.2 Normalized Data

Normalization of the data attempts to equalize wetland functions (numerically) to provide a more accurate assessment of their combined value. For this report, biological and hydrological functions were considered of equal importance and each was weighted 40 percent; the remaining 20 percent was divided equally among the cultural and economic, recreational, aesthetics and educational function models. A description of the normalization procedure is presented in Appendix L. The normalized scores, separate and combined into a total for each wetland, are presented in Table 6.2-2. Minima, maxima, and means for the models and actual scores were not calculated because the assessment of data for each model was based on the unnormalized scores.

Table 6.2-2. Normalized results of 10 functional models for 127 wetlands in the study area.

		FUNCTIONAL MODELS									
WETLAND NO.	BIOLOGICAL FUNCTION	HYDROLOGIC SUPPORT FUNCTION	GROUNDWATER FUNCTION	STORM AND FLOODWATER STORAGE FUNCTION	SHORELINE PROTECTION FUNCTION	WATER QUALITY MAINTENANCE FUNCTION	CULTURAL AND ECONOMIC FUNCTION	RECREATIONAL FUNCTION	AESTHETICS FUNCTION	EDUCATION FUNCTION	TOTAL
A1	14.00	0.24	1.28	4.72	0.00	4.48	1.75	1.80	2.30	0.90	31.47
A2	10.80	3.60	2.24	4.24	0.00	3.04	3.50	1.40	1.95	0.00	30.77
A3	6.40	0.64	2.24	4.96	0.00	3.92	3.05	1.15	1.95	0.00	24.31
B1	8.40	2.80	3.12	2.40	0.00	2.56	0.00	1.05	1.60	0.00	21.93
B2*	20.80	5.12	3.52	5.52	0.00	5.52	4.35	2.70	1.65	0.90	50.08
B3*	13.20	2.72	3.12	3.44	2.32	2.64	3.05	2.15	2.00	0.00	34.74
B4*	19.60	4.56	1.84	5.68	0.00	4.48	4.35	2.45	1.95	0.90	45.81
B5*	14.40	0.24	2.80	4.96	0.00	4.56	2.60	1.50	1.40	0.00	32.46
B8*	8.80	0.24	2.56	4.08	0.00	4.00	2.15	1.25	2.10	0.00	25.18
D1*	22.00	5.12	3.20	5.60	3.68	5.28	5.00	3.05	2.45	3.25	58.63
D2	6.00	1.76	2.64	2.32	0.00	1.36	0.00	1.30	1.95	0.00	17.33
D3*	11.20	4.08	1.44	5.36	0.00	4.08	3.05	1.65	1.65	0.00	32.51
D4*	19.60	4.40	1.52	5.76	0.00	4.56	4.35	2.45	1.95	0.90	45.49
D4A*	10.00	0.64	1.68	5.36	0.00	4.32	3.05	1.30	1.65	0.00	28.00
D5*	8.00	0.24	2.80	4.96	0.00	3.92	1.30	1.00	2.65	0.00	24.87
D8*	8.80	0.24	1.52	4.64	0.00	3.52	2.15	1.25	2.10	0.00	24.22
D18	6.00	0.24	1.52	4.80	0.00	3.68	2.15	0.80	1.40	0.00	20.59
F1	16.80	3.76	4.80	2.64	0.00	3.28	1.75	1.90	1.95	0.90	37.78
F2	34.80	5.76	4.80	4.24	1.04	5.28	5.65	4.50	3.60	0.90	70.57
F4	21.20	4.96	2.96	5.36	3.68	4.80	3.50	2.85	1.65	0.90	51.86
F5	16.00	0.64	3.20	5.44	0.00	4.24	4.15	1.95	1.95	2.35	39.92
F6	8.40	4.08	2.08	3.92	0.00	3.76	0.00	0.80	0.90	0.00	23.94
F7	31.20	1.44	3.12	5.60	0.00	5.68	8.25	4.45	4.65	0.90	65.29
F8	9.60	0.24	2.56	4.48	0.00	3.92	2.15	1.00	1.95	0.90	26.80
F9	21.60	4.96	3.68	4.96	6.32	4.64	4.65	3.70	2.20	2.05	58.76
F10*	22.40	5.52	3.52	6.08	7.04	5.12	4.35	3.50	1.65	0.90	60.08
F11*	15.20	4.56	3.12	5.76	0.00	4.88	5.00	2.60	1.95	2.35	45.42
F12	24.00	1.52	3.68	6.16	3.36	5.60	3.50	3.70	2.00	0.90	54.42
F13*	11.60	0.64	3.20	5.76	0.00	4.56	3.50	1.65	1.95	0.00	32.86
F15	20.80	1.44	3.68	5.60	0.00	4.32	4.55	2.45	2.45	3.25	48.54
F16	14.00	1.12	3.68	6.32	0.00	4.64	4.55	2.20	2.70	3.25	42.46
F17	9.20	0.64	1.68	5.36	0.00	4.32	3.05	1.30	1.65	0.00	27.20
F18	20.80	5.12	3.68	5.68	0.00	5.28	4.35	2.55	1.95	0.90	50.31
F19	23.60	5.60	3.68	5.52	4.64	6.08	3.80	4.65	3.60	2.05	63.22
F21	22.00	5.12	2.80	5.36	4.64	5.76	3.25	4.00	3.05	3.25	59.23
F22	8.80	4.08	2.64	4.80	0.00	4.00	3.70	1.80	2.45	2.35	34.62
F23*	23.20	6.48	3.36	6.32	4.64	6.32	3.50	4.00	2.55	0.90	61.27
F24	8.40	2.24	2.08	3.28	0.00	2.56	0.65	1.25	1.85	2.35	24.66
F25*	12.80	4.24	1.52	5.52	0.00	4.72	3.70	2.05	2.70	3.25	40.50
F26	7.20	2.56	1.44	2.40	0.00	1.68	0.00	0.65	0.60	0.00	16.53
F27*	8.80	4.08	1.44	5.04	0.00	3.84	3.70	1.80	2.70	3.25	34.65
F28*	34.40	5.92	3.20	6.08	4.32	4.96	7.85	4.45	5.45	0.90	77.53
F29*	26.80	4.08	1.28	5.44	0.00	5.28	4.80	2.70	2.65	0.90	53.93
F30	7.60	1.76	1.44	2.24	0.00	1.60	0.00	0.90	1.60	0.00	17.14

Table 6.2-2. (continued)

WETLAND NO.	BIOLOGICAL FUNCTION	HYDROLOGIC SUPPORT FUNCTION	GROUNDWATER FUNCTION	STORM AND FLOODWATER STORAGE FUNCTION	SHORELINE PROTECTION FUNCTION	WATER QUALITY MAINTENANCE FUNCTION	CULTURAL AND ECONOMIC FUNCTION	RECREATIONAL FUNCTION	AESTHETICS FUNCTION	EDUCATION FUNCTION	TOTAL
	FUNCTIONAL MODELS										
F31*	16.80	4.56	1.52	5.60	0.00	4.56	4.35	2.30	2.20	0.90	42.79
F32*	7.60	0.24	1.78	5.04	0.00	4.00	2.15	0.80	1.65	0.00	22.76
F33	7.20	3.60	1.68	4.32	0.00	3.20	3.05	1.30	1.65	0.00	26.00
F34	5.60	0.32	1.28	4.24	0.00	2.96	2.15	0.80	1.65	0.00	19.00
F35	16.40	0.64	2.00	5.76	0.00	4.56	4.15	1.95	2.20	2.35	40.01
F36	10.40	0.72	1.68	4.56	0.00	3.28	3.70	1.50	2.20	2.35	30.39
F37	31.60	5.92	3.76	5.60	4.00	6.08	6.00	4.65	3.60	2.05	73.26
F38	7.60	2.48	2.08	2.48	0.00	2.16	0.00	0.90	1.60	0.00	19.30
F39	18.80	4.64	2.96	5.92	0.00	5.84	3.05	2.05	1.05	0.00	44.31
F40	32.00	4.64	3.20	5.28	0.00	5.68	6.75	4.10	3.60	3.25	68.50
F42	11.20	0.24	2.56	5.04	0.00	4.64	1.30	1.05	2.00	0.00	28.03
F43	10.80	0.64	3.20	5.60	0.00	4.56	2.15	1.15	2.35	0.00	30.45
F45	12.40	0.24	2.80	4.96	0.00	3.92	1.30	1.05	2.65	0.90	30.22
F46	12.00	0.64	3.20	5.44	0.00	4.24	4.15	2.15	1.95	2.35	36.12
F48	10.40	0.24	2.80	5.44	0.00	4.16	2.60	1.25	1.40	0.00	28.29
F50	7.20	0.24	2.80	5.12	0.00	3.92	2.15	0.80	1.65	0.00	23.88
F51	8.00	0.24	2.80	4.48	0.00	3.44	2.15	1.30	2.45	0.00	24.86
F52	11.60	0.72	3.36	6.24	0.00	4.88	0.85	1.25	0.90	0.90	30.70
F53	17.20	4.56	3.12	6.08	0.00	4.72	4.35	2.30	1.40	0.00	43.73
F54	13.20	0.64	3.20	5.60	0.00	4.56	2.15	1.40	2.10	0.00	32.85
F55	7.60	0.24	2.56	4.40	0.00	3.52	2.15	1.30	2.70	0.00	24.47
F57*	21.60	5.84	2.95	5.36	3.68	5.04	3.90	3.30	2.20	0.90	54.78
F58	18.80	0.24	2.56	4.32	0.00	4.56	4.55	2.85	4.55	3.25	45.68
F60*	20.00	4.64	2.00	5.84	0.00	5.04	5.00	2.60	2.70	3.25	51.07
F61*	8.80	3.36	1.28	4.48	0.00	3.68	3.70	1.80	1.95	2.35	31.40
F62*	14.40	4.56	1.68	5.28	0.00	4.64	4.55	2.40	2.45	3.25	43.21
F63*	18.80	5.57	2.00	5.84	0.00	5.04	4.35	3.20	1.95	0.90	46.70
F64*	15.20	5.52	2.00	5.68	0.00	5.04	3.05	2.05	2.65	0.00	41.19
F65*	26.80	4.96	1.28	5.28	0.00	5.04	4.80	2.70	2.65	0:90	54.41
F66*	20.00	4.56	1.84	5.68	0.00	4.48	4.35	2.55	1.95	0.90	46.31
F69*	9.20	4.08	1.44	5.36	0.00	4.08	3.70	1.80	2.20	2.35	34.21
F70*	13.60	0.96	1.68	5.20	0.00	4.08	3.05	1.40	1.65	0.90	32.52
F72*	8.80	0.72	1.68	4.88	0.00	3.52	3.05	1.15	1.65	0.00	25.45
F81*	8.80	1.52	1.28	3.92	0.00	2.88	0.65	1.15	2.45	2.35	25.00
F86	7.60	0.24	2.56	5.52	0.00	4.00	2.85	1.15	2.20	2.35	28.47
F87	7.60	0.24	2.56	5.52	0.00	4.00	2.85	1.15	2.20	2.35	28.47
F90	7.20	1.52	3.12	3.60	0.00	2.88	0.65	1.15	2.45	2.35	24.92
F114*	17.60	0.24	5.04	4.56	0.00	4.32	2.40	2.40	3.25	3.25	43.06
F116	8.80	0.24	3.92	5.44	0.00	4.16	2.60	1.05	1.65	0.00	27.86
F119	13.60	0.64	3.20	5.44	0.00	4.24	4.15	1.95	2.20	3.25	38.67
F121	7.60	0.24	2.80	5.12	0.00	3.92	2.15	0.80	1.40	0.00	24.03
F122	6.80	0.24	2.80	5.12	0.00	3.92	2.85	1.15	1.95	2.35	27.18
F122A	14.40	0.24	2.80	4.80	0.00	4.24	1.95	1.65	3.05	3.25	36.38
F125	17.20	0.24	2.80	4.64	0.00	4.16	4.55	2.60	4.45	3.25	43.89
F126	11.60	0.64	3.20	5.92	0.00	4.96	2.60	2.15	2.00	0.00	33.07
F127	12.80	0.00	1.28	4.80	0.00	3.68	2.15	1.30	2.10	0.00	28.11

Table 6.2-2. (continued)

WETLAND NO.	FUNCTIONAL MODELS: BIOLOGICAL FUNCTION	HYDROLOGIC SUPPORT FUNCTION	GROUNDWATER FUNCTION	STORM AND FLOODWATER STORAGE FUNCTION	SHORELINE PROTECTION FUNCTION	WATER QUALITY MAINTENANCE FUNCTION	CULTURAL AND ECONOMIC FUNCTION	RECREATIONAL FUNCTION	AESTHETICS FUNCTION	EDUCATION FUNCTION	TOTAL
G1	6.80	0.24	2.80	5.12	0.00	3.92	2.15	1.00	1.65	0.00	23.68
H1	17.60	1.12	2.40	6.16	0.00	4.88	4.35	1.95	1.95	0.90	41.31
I1	14.40	0.24	2.56	4.88	0.00	3.92	2.85	1.65	2.90	3.25	36.65
J1	4.80	0.24	2.56	4.88	0.00	3.52	2.15	1.30	3.00	0.00	22.45
K1	14.00	1.76	1.44	2.48	0.00	2.16	2.85	1.70	2.70	3.25	32.34
K2	17.20	4.64	2.00	5.84	0.00	5.04	5.00	2.60	2.45	3.25	48.02
K3	14.80	4.56	1.52	5.92	0.00	4.80	5.00	2.60	2.20	2.35	43.75
K4	11.60	0.24	1.52	4.80	0.00	4.24	1.95	1.65	3.05	3.25	32.30
K5	9.60	0.24	1.52	5.28	0.00	4.16	1.95	1.15	3.15	2.35	29.40
M1	11.60	4.24	1.12	4.96	0.00	5.60	1.95	2.05	2.10	2.35	35.97
M2	8.80	1.76	1.44	2.56	0.00	1.84	0.00	0.90	1.30	0.00	18.60
M3*	13.60	4.08	1.12	5.60	0.00	4.48	3.05	1.70	1.95	0.90	36.48
M4	8.80	0.24	1.28	4.56	0.00	3.68	2.15	1.05	2.35	0.00	24.11
M5	16.00	4.08	1.44	5.36	0.00	4.08	4.15	2.30	2.45	3.25	43.11
M6	11.20	3.68	0.96	4.24	0.00	3.84	2.15	1.15	1.65	0.00	28.87
N1	15.60	0.24	2.56	5.04	0.00	4.96	1.95	1.65	3.05	3.25	38.30
O1*	18.80	5.12	3.20	5.44	0.00	5.60	4.35	2.45	2.20	0.90	48.06
O3	11.20	4.08	2.40	5.76	0.00	4.16	3.70	1.95	2.45	2.35	38.05
P1	13.60	3.28	2.24	3.68	3.36	3.68	3.05	1.70	1.95	0.00	36.54
P2*	17.20	4.56	1.84	6.08	0.00	4.72	4.35	2.30	1.95	0.00	43.00
R1*	13.60	4.56	2.96	5.52	0.00	4.48	3.90	2.05	1.65	0.90	39.62
R1A*	16.00	4.96	2.96	5.28	3.04	4.64	3.90	2.05	1.40	0.00	44.23
R3	30.00	6.40	2.96	5.44	1.04	5.60	6.00	4.50	3.85	2.05	67.84
R5	24.40	5.84	3.20	5.84	3.04	4.56	5.00	2.85	3.00	4.10	61.83
R7	10.40	4.08	2.40	5.76	0.00	4.16	3.70	1.80	2.45	2.35	37.10
R7A	17.20	0.64	3.20	6.48	0.00	5.28	2.85	1.70	1.85	2.35	41.55
R8*	14.00	0.64	2.00	5.92	0.00	5.28	2.85	1.70	1.85	2.35	36.59
T1*	13.20	0.64	4.64	5.28	0.00	4.24	2.85	1.70	3.15	2.35	38.05
T2*	20.00	0.64	4.64	5.60	0.00	4.56	2.85	1.70	2.90	3.25	46.14
T3*	16.00	0.24	4.24	5.28	0.00	4.64	1.95	1.40	1.60	2.35	37.70
T4*	27.60	6.56	5.44	5.28	3.04	5.52	4.65	3.70	2.45	2.05	66.29
T5	15.20	0.64	2.96	5.36	0.00	4.32	3.50	1.65	1.95	0.00	35.58
W1*	22.40	6.16	6.16	5.68	3.68	5.44	4.35	2.85	1.95	0.90	59.57
W2*	22.80	5.52	5.04	5.44	3.68	5.44	4.35	2.55	1.95	0.90	57.67
X2	12.00	0.24	1.28	4.88	0.00	3.92	2.15	1.30	2.10	0.00	27.87
X3	20.00	4.56	1.84	5.68	0.00	4.48	4.35	2.55	2.20	0.90	46.56
X4	10.80	0.24	1.28	5.36	0.00	4.96	1.75	1.55	2.30	0.00	28.24

*wetlands of special interest

6.3 ANALYSIS OF MODEL RESULTS FOR WETLANDS OF SPECIAL INTEREST

The following analysis of model results is based on the means of the actual wetland scores to allow comparisons of wetlands in the study area. Since the models were developed to assess wetland functions in the northern Wisconsin region, scores for the wetlands of special interest were assessed in a regional context, by comparison with the model means. The mean was chosen as the basis for analysis of the results for the 10 models.

In the analysis of the 46 wetlands of special interest for each of the 10 models, certain elements were identified as having a key role in determining the scores received by a given wetland. These key elements are summarized in Table 6.3-1 with the wetlands arranged by type, and in descending order of total unnormalized scores. Roles of selected key elements of the biological, watershed and socio-cultural function models are discussed below.

6.3.1 Biological Function Model

The analysis of wetlands for the Biological Function Model showed an actual score range and mean of 35-141 and 76, respectively, and a model range and mean of 29-158 and 93, respectively. Of the 46 wetlands of special interest, 17 had scores greater than or equal to the model mean, and 33 had scores of 76 or higher. The scores for the wetlands of special interest are arranged in descending order in Table 6.3-2. Discussions of the quantitative studies of vegetation and wildlife have been included at the end of each of the following sections to show the relationship between the condition assignments in the wetland models and the

Table 6.3-1. Summary of key model elements used to rate and rank wetlands of special interest.

Wetland Type and Number		Wetland Score	Model Element: Class Richness	Interspersion	Surrounding Habitat	Water/Cover Ratio	% Bordering Open Water	Surficial Material	Hydrologic Position	Dominant Hydrologic Type	Hydrologic Connection	Size[a]
Shallow Marsh	F23	581	2	Med.	>90% of 2	100% cover	<33%	Sand & Gravel	Perched	5	Connected	Large
	F114	438	2	Med.	50-90% of 1	26-75% Scattered	0	Sand & Gravel	Water Table	6	Not Connected	Small
Shrub Swamp	F65	511	2	Med.	50-90% of 1	26-75% Scattered	0	Till	Perched	5	Connected	Med.
	F29	508	3	High	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Med.
	R8	412	1	High	50-90% of 1	100% cover	0	Till	Perched	6	Not Connected	Med.
	T3	400	1	High	>90% of 2	100% cover	0	Sand & Gravel	Water Table	6	Not Connected	Small
Deciduous Swamp	D1	542	2	High	50-90% of 1	100% cover		Sand & Gravel	Perched	5	Connected	Large
	F57	516	2	Med.	50-90% of 1	75% or <25% Scattered	67-100%	Sand & Gravel	Perched	5	Connected	Large
	R4	478	2	High	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Large
	D5	471	1	High	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Large
	R1A	469	1	High	50-90% of 1	100% cover	<33%	Sand & Gravel	Perched	5	Connected	Large
	F62	467	1	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Large
	F31	462	1	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Large
	F25	452	1	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Med.
	R1	447	1	Med.	50-90% of 1	100% cover	0	Sand & Gravel	Perched	5	Connected	Large
	[illegible]	423	1	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Med.
	F27	418	1	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Med.
	F69	418	1	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Med.
	D3	402	1	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Med.
	F61	390	1	Low	50-90% of 1	100% cover	0	Till	Perched	4	Connected	Med.
	F70	381	3	High	50-90% of 1	100% cover	0	Till	Perched	6	Not Connected	Med.
	D5A	367	1	Med.	50-90% of 1	100% cover	0	Till	Perched	6	Not Connected	Med.
	F72	348	1	Med.	50-90% of 1	100% cover	0	Till	Perched	6	Not Connected	Med.
	R8	347	1	Med.	50-90% of 1	26-75% Scattered	0	Sand & Gravel	Perched	6	Not Connected	Small
	D8	316	1	Med.	50-90% of 1	26-75% Scattered	0	Till	Perched	6	Not Connected	Small
	F12	312	1	Med.	50-90% of 1	100% cover	0	Till	Perched	6	Not Connected	Small
Bog	F63	461	1	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Large
	T2	451	2	High	>90% of 2	100% cover	0	Sand & Gravel	Water Table	6	Not Connected	Med.
	T1	425	1	Med.	>90% of 2	100% cover	0	Sand & Gravel	Water Table	6	Not Connected	Med.
	D5	356	1	Med.	50-90% of 1	100% cover	0	Sand & Gravel	Perched	6	Not Connected	Small
Coniferous Swamp	F28	634	2	High	50-90% of 1	26-75% Peripheral	67-100%	Sand & Gravel	Perched	5	Connected	Large
	T4	575	4	High	>90% of 2	100% cover	<33%	Sand & Gravel	Water Table	5	Connected	Large
	W1	562	2	Med.	50-90% of 1	100% cover	<33%	Sand & Gravel	Water Table	5	Connected	Large
	F10	553	2	High	50-90% of 1	100% cover	<33%	Sand & Gravel	Perched	5	Connected	Large
	W2	542	2	Med.	50-90% of 1	100% cover	<33%	Sand & Gravel	Water Table	5	Connected	Large
	F60	509	2	High	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Large
	R2	503	2	High	50-90% of 1	100% cover	0	Sand & Gravel	Perched	5	Connected	Large
	O1	497	2	Med.	50-90% of 1	100% cover	0	Sand & Gravel	Perched	5	Connected	Large
	F61	487	2	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Large
	F11	486	1	Low	50-90% of 1	100% cover	0	Sand & Gravel	Perched	5	Connected	Large
	F66	475	2	High	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Large
	P2	467	1	Med.	50-90% of 1	100% cover	0	Till	Perched	5	Connected	Large
	F13	402	1	Low	50-90% of 1	100% cover	0	Sand & Gravel	Perched	6	Not Connected	Med.
	R3	341	1	Med.	50-90% of 1	26-75% Peripheral	<33%	Sand & Gravel	Perched	2	Connected	Med.
	R5	337	1	High	50-90% of 1	100% cover	0	Sand & Gravel	Perched	6	Not Connected	Small
Aquatic Bed	F81	331	1	Low	50-90% of 1	75% or <25% Scattered	0	Till	Perched	6	Not Connected	Small

[a]Small: <.40 ha (1 acre)
Med.: 4.0-1.8 ha (1.1-4.5 acres)
Large: >1.8 ha (4.5 acres)

Table 6.3-2. Biological function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

T4	118	T2	93	F11	78	D4A	61
F65	116	F60	93	F62	76	F69	59
F29	115	B4	92	B5	75	B8	58
F23	104	D4	92	R8	74	F61	58
F28	104	F63	90	M3	74	F72	58
F57	103	O1	89	F70	73	F81	58
W2	102	F114	86	R1	73	D8	57
W1	101	P2	85	T1	72	F27	57
F10	101	F31	83	B3	71	D5	55
D1	100	R1A	81	F25	70	F32	35
B2	96	T3	80	F13	67		
F66	94	F64	78	D3	65		

Score Range:	35-141	Model Range:	29-158
Score Mean:	76	Model Mean:	93

___ Wetlands of special interest in Area 40.

--- Wetlands of special interest in Area 41.

actual field measurements. Quantitative studies were conducted in all wetland types except Aquatic Beds. These data are utilized to represent the basic ecological characteristics of all the wetlands of a given type (Mueller-Dombois and Ellenburg, 1974).

<u>Sedge/Blue-Joint Grass Shallow Marsh</u> - Of the 46 wetlands of special interest, two were shallow marshes (Table 6.3-1). An important factor contributing to the final scores for these wetlands was the high weightings given to Dominant Wetland Class as a model element and to shallow marshes as a condition. This element was assigned a high weighting because of the important role vegetation plays in determining wildlife habitat value (MacArthur and MacArthur, 1961; Weller and Spatcher, 1965). Shallow marsh was one of the most valuable classes because of the habitat provided for nesting birds and various mammals, particularly muskrats (Golet and Larson, 1974).

Size was also a heavily weighted element because as wetland size increases so does its value for wildlife production and use. Greater size results in greater insulation from human disturbance on the periphery, and a larger wetland tends to have greater habitat variety such that it would be more likely to fulfill all of a species' life cycle requirements than would a small wetland. Wetland F23 (1.87 ha [4.69 acres]), which was in the large size category, received a score of 104 which was above the model mean. Other conditions that were important in this wetland's score were moderate class and subclass richness, moderate vegetative interspersion, favorable surrounding habitat and favorable juxtaposition with respect to other wetlands.

Class and subclass richness are important elements because as the number of different classes and subclasses increases so does the variety of plant life forms which increases the potential for wildlife species variety (Weller and Spatcher, 1965). Vegetative interspersion played a key role because wildlife density and species variety are largely a function of vegetative life form variety and arrangement. Surrounding habitat condition is an important factor affecting the wildlife production of a wetland because the life cycle requirements of many species depend upon both wetland and upland habitats. Use of wetlands by upland wildlife has been described by Schitoskey and Linder (1979). They reported that structure and form of wetland vegetation are more important to upland wildlife than species composition. Weller and Spatcher (1965) also noted that structure rather than taxonomic composition of emergent marsh plants is of greater importance to nesting birds. Finally, wetland juxtaposition influenced the model score because wildlife production and use in a wetland are generally higher if it is located near other wetlands (Golet and Larson, 1974).

Wetland F114 scored somewhat lower (86) than wetland F23 because of its smaller size (.10 ha [.25 acre]), less diverse surrounding habitat and wetland juxtaposition. This wetland scored below the model mean because its value was diminished in the regional context because of its small size and other suboptimal conditions.

Quantitative sampling of plants was conducted in wetland F37 (Appendix J, Table J-13). The plot results revealed plant densities and diversity consistent with those observed during the wetland inventory. Quantitative investigations were conducted for birds in wetland F12.

Diversity was moderate to high (2.50 to 3.01) during the migratory (May) and breeding (June) periods in comparison with other wetlands in which similar studies were conducted (Table 6.1-8). This substantiates the model score assigned to this wetland, which was above the model mean.

Alder Shrub Swamp - Four shrub swamps were included in this analysis (Table 6.3-1), three of which scored higher than the mean of the actual wetland scores. One of the factors contributing to the relatively high scores for these three wetlands was the high weighting given to shrub swamp as a dominant class. Shrub swamps are valuable to songbirds for nesting habitat and as cover for wood duck fledglings (Golet and Larson, 1974). Alders provide brood cover for ruffed grouse (Godfrey, 1975) and cover for woodcock (Wishart and Biden, 1976).

Wetlands F29 and F65 had scores of 115 and 116, respectively, which were above the model mean. These scores were attributed to favorable conditions for wetland class and subclass richness, vegetative interspersion, surrounding habitat, and juxtaposition in relation to other wetlands; in addition, wetland F65 also had a favorable water/cover ratio. The latter element is an important contributing factor because the relative proportion of vegetative cover and open water in a wetland affects the composition and relative abundance of wildlife species (Weller and Spatcher, 1965). The medium size of these wetlands (1.4 and 1.0 ha [3.4 and 2.5 acres]) for wetlands F29 and F65, respectively, also contributed to the final scores.

Wetland T3 received a score of 80, which was above the actual mean but below the model mean, and wetland R8 scored 74, which was below the actual mean. The major factors responsible for these lower scores were low class and subclass richness, low water/cover ratio and unfavorable wetland juxtaposition. These wetlands had no important biological characteristics when contrasted with those in the region; consequently, both scored below the model mean.

Quantitative investigations were conducted in wetlands F39 and M1 for plants, birds, and small mammals. The plant data (Appendix J, Tables J-3 and J-9) for both wetlands support the high density, medium proportion of wildlife food plants (Martin et al., 1961) and medium species richness condition assignments in the model and their contributions to the total scores. Results of the quantitative studies for birds (Table 6.1-8) showed higher densities and diversity in wetland M1 for both the migratory and breeding period. During the migratory period bird density was 24/ha and diversity was 2.7 in wetland M1 compared to a density of 7/ha and a diversity of 2.3 in F39. During the breeding period the density and diversity values for M1 were 22 and 2.8, respectively, compared to values of 12 and 2.4 for F39. These data do not support the model ratings because other model elements were of greater importance in determining the final scores. Small mammal trapping revealed a higher species richness in wetland F39 (5), than in M1 (3) but not of a magnitude sufficient to support the model ratings.

Green Ash/Aspen Deciduous Swamp - Twenty deciduous swamps were among the wetlands of special interest (Table 6.3-1), seven of which had scores equal to or greater than the actual mean value. As a dominant class, deciduous swamp was not as heavily weighted nor as important in determining the final score as were the dominant classes for shallow marsh, shrub swamp and coniferous swamp. This is because the structural and compositional characteristics of the latter three types are more favorable from the standpoint of nesting and feeding opportunities for a larger variety of wildlife species than in a deciduous swamp.

Those wetlands which received the highest scores (B4 - 92, D1 - 100, D4 - 92 and F57 - 103) were all in the large size category (8.2 ha [20.6 acres]; >1.8 ha [>4.5 acres]; 6.8 ha [16.9 acres]; and 2.6 ha [6.4 acres], respectively) and had higher class and/or subclass richness than the other wetlands. Other favorable conditions which these wetlands had in common were high vegetative interspersion, favorable surrounding habitat and favorable juxtaposition in relation to other wetlands. Wetlands D1 and F57 scored above the model mean whereas wetlands B4 and D4 were both below the mean. Wetlands F31, F62 and R1A had scores of 83, 76 and 81, respectively, all equal to or greater than the actual mean but less than the model mean. The lower scores for these wetlands were primarily attributed to lower class richness, and less vegetative interspersion and density. The latter element, although not as heavily weighted as class richness and interspersion, influences biological function and is an indicator of primary production and potential density of wildlife.

Scores for the remaining 13 wetlands were all below the actual mean. The main reasons for their lower ranking were the lower values for wetland class and subclass richness, vegetative interspersion, water cover ratio and wetland juxtaposition. With the exception of wetlands D1 and F57 all of the above wetlands scored below the model mean. This demonstrated that compared to other wetlands in the region, only wetlands D1 and F57 were outstanding with respect to biological function.

Quantitative sampling of plants was conducted in wetlands D4, M3 and F15. The results of these studies (Appendix J, Tables J-14, J-10, and J-5) demonstrated that vegetative density was high and that plant species richness and the number of wildlife food plants (Mártin et al., 1961) were moderate which supported the condition assignments and their contributions to the scores. Quantitative investigations were also conducted in wetlands F15 and F57 for birds and small mammals. Results of these surveys showed higher bird densities and diversity for both migratory and breeding periods and higher mammal densities and diversity in wetland F57 (Tables 6.1-8 and 6.1-13). These results supported those of the model since wetland F57 scored seven points higher than F15.

<u>Leatherleaf Bog</u> - The wetlands of special interest included four bogs (Table 6.3-1), two of which had scores greater than the actual mean. As a dominant wetland class, bogs were weighted slightly higher than deciduous swamps, but both were assigned lower values than all other wetland types except streamside wetlands.

Wetland T2 (.7 ha [1.6 acres]), in the medium size category, received a score of 93, which was equal to the model mean. This wetland ranked higher than the other three bogs because wetland class and subclass richness, vegetative interspersion and surrounding habitat were more favorable. Wetland F64 (1.8 ha [4.5 acres]), also of medium size, scored 78, which was above the actual mean but below the model mean. This lower score was primarily attributed to poor class and subclass richness and only moderate interspersion. The other two bogs, D5 and T1, received scores of 55 and 72, respectively, which were below the actual mean. Less favorable class and subclass richness and wetland juxtaposition were the major factors contributing to these lower scores. In the regional context, only wetland T2 was distinguishable from other wetlands on the basis of conditions giving rise to biological function.

Quantitative plant investigations were conducted in wetland F16 and in F64. The data (Appendix J, Tables J-4 and J-12) revealed that vegetative density was high which supported the condition assignments on the wetland inventory sheets. Quantitative investigations were also conducted for birds and small mammals in wetland F16. Results of the bird studies showed high densities (15/ha) and diversity (2.9) compared to the other wetlands during the migration period but low to moderate values for these parameters during the June breeding period (4/ha and 2.0, respectively). The number of small mammal species trapped in this wetland was lower than in other wetlands. These data (Table 6.1-13) substantiate this wetland's model score which was below the actual mean.

<u>Black Spruce/Tamarack Coniferous Swamp</u> - Of the wetlands of special interest, 15 were coniferous swamps (Table 6.3-1), and 12 of these had scores greater than the mean. Dominant Wetland Class, as a model element, was a factor contributing to the scores of these 12 wetlands because of the high weighting given to coniferous swamp as a condition. Coniferous swamp received a high weighting because of its importance as habitat for northern songbirds (Golet and Larson, 1974), snowshoe hares (Burt, 1957) and winter habitat for deer (Verme, 1965).

Size was also an important factor in the final scores, and each of the 12 wetlands was in the large size category (>1.8 ha [>4.5 acres]).

The highest scoring wetlands were B2 (96), F10 (101), F28 (104), F60 (93), F66 (94), T4 (118), W1 (101), and W2 (102), all equal to or greater than the model mean. Other favorable conditions of these wetlands that contributed to their high score were class and subclass richness, vegetative interspersion, vegetative density and wetland juxtaposition. In addition wetland T4, with the highest score (118) contained four wetland classes and had the most favorable surrounding habitat conditions. Wetlands F11, F63, O1 and P2 scored below the model mean, primarily because vegetative interspersion and plant species variety were less favorable for wildlife. Also, poor class and subclass richness was an additional contributing factor for wetland F11. Plant species variety, although not as heavily weighted as many of the other elements, is related to the food available to wildlife and therefore serves as an indicator of wildlife production.

Wetlands B3, B5 and F13 scored below the actual mean. Wetland B5, a small wetland (.20 ha [.5 acres]), had poor class and subclass richness and moderately favorable wetland juxtaposition. Wetland B3 was medium in size (.70 ha [1.6 acres]) and had less vegetative interspersion and lower vegetative density. In wetland F13, vegetative interspersion was the lowest of the three in addition to its suboptimal conditions for all of the above elements. In comparison with other wetlands in the region, eight of the 15 conifer swamps of special interest had scores above the model mean for biological function.

Quantitative investigations for plants were conducted in wetlands F11, F60, F63 and F66 (Appendix J, Tables J-2, J-11, J-15, J-16 and J-17). Vegetative densities were high and plant species richness and wildlife food plant abundance were low to medium in these wetlands, which was in agreement with the condition assignments made during the wetland inventory. In addition, quantitative studies were also conducted for birds and small mammals in wetlands F11 and F60. The bird data reveal higher species diversity in F60, the higher scoring wetland, during the migration period (2.4 for F60, 2.1 for F11) and similar diversity indices in June, but total density in May and June was higher in F11 than in F60 (Table 6.1-7). The results of the mammal trapping demonstrated a greater number of species utilizing F60 (5) than F11 (1) which supports the model results.

Aquatic Bed - One of the wetlands of special interest was an aquatic bed (Table 6.3-1), which scored far below the actual mean. Although this type was heavily weighted as a dominant class, poor class richness, poor interspersion and small size were the major conditions responsible for the low score. No quantitative studies were conducted in aquatic beds.

6.3.2 Watershed Function Models

The watershed function consisted of five models; Hydrologic Support, Groundwater, Storm and Flood Water Storage, Shoreline Protection, and Water Quality Maintenance. Because these models are inter-related and contain many of the same elements, they were analyzed together in this section. This analysis was based on an actual mean of 31 for the hydrologic support function, 37 for the groundwater function, 91 for the storm and floodwater storage function, 3.5 for the shoreline protection function and 66 for the water quality maintenance function. The scores were also assessed in a regional context by comparison with the model means for each function.

To ensure continuity, the same dominant wetland vegetative classes were used in both the Biological and Watershed function models.

The actual data means computed as a result of this study were lower than the model means except for Storm and Flood Water Storage function and Water Quality Maintenance Models. The higher mean value for Storm and Flood Water Storage was attributed to the predominance of semi-closed and closed basin topographic situations in which most of the study area wetlands are found. This topographic position when combined with the dense vegetative types, organic soils and hydrologic conditions 6 and 5 also gave rise to high Water Quality Maintenance functions. These key elements and their conditions are shown in Table 6.3-1. Tables 6.3-3 through 6.3-7 present the model values for the wetlands of special interest for each of the five watershed functions.

Sedge/Blue-Joint Grass Shallow Marsh - Two wetlands of special interest, F23 and F114, were shallow marshes. Wetland F23 was connected to Deep Hole Lake and at one time it was a portion of the lake that became filled with organic soils and now supports a marsh community. It was an integral part of the lake's hydrology. Wetland F23 had values above or equal to the model mean for all five watershed functions. This was attributed to its connection with a lake, and being part of a riparian system, a very important part of assessing any wetland's watershed function (Novitski, 1978). Being part of a riparian system allows the wetland to contribute to the downstream aquatic ecosystems, giving rise to its hydrologic support function. Wetland F114 had predominantly low watershed functions because it lacked connection to a riparian system and was of medium size. Overall,

Table 6.3-3. Hydrologic support function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

T4	67	R1A	52	F27	44	T1	12
F23	66	F60	49	F29	44	T2	12
W1	63	B4	48	F69	44	B5	8
F28	61	F11	48	M3	44	B8	8
F10	57	F31	48	F61	37	D5	8
F63	57	F62	48	B3	31	D8	8
F64	57	F66	48	F81	20	F32	8
W2	57	P2	48	F70	15	F57	8
B2	53	R1	48	F72	13	F114	8
D1	53	D4	47	D4A	12	T3	8
O1	53	F25	45	F13	12		
F65	52	D3	44	R8	12		

Score Range:	8-67	Model Range:	6-67
Score Mean:	31	Model Mean:	36

___ Wetlands of special interest in Area 40.

--- Wetlands of special interest in Area 41.

Table 6.3-4. Ground water function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

W1	64	F28	43	F64	34	F31	31
T4	59	O1	43	R8	34	D3	30
W2	56	B3	42	B4	33	F27	30
F114	56	F11	42	F66	33	F69	30
T1	53	R1	41	P2	33	F29	29
T2	53	R1A	41	D4A	32	F32	29
T3	50	B5	40	F62	32	F61	29
B2	45	D5	40	F70	32	F65	29
F10	45	F57	40	F72	32	F81	29
F23	44	B8	38	D4	31	M3	28
D1	43	F60	34	D8	31		
F13	43	F63	34	F25	31		

Score Range:	29-64	Model Range:	20-68
Score Mean:	37	Model Mean:	44

___ Wetlands of special interest in Area 40.

--- Wetlands of special interest in Area 41.

Table 6.3-5. Storm and flood water storage function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

F23	106	W1	99	D3	95	D5	90
F10	103	B4	99	D4A	95	B5	90
F28	103	D1	98	F69	95	F72	89
P2	103	F31	98	F62	94	D8	86
R8	102	M3	98	F65	94	F114	85
F60	101	T2	98	R1A	94	F57	84
F63	101	B2	97	T1	94	F61	84
D4	100	F25	97	T3	94	B8	79
F11	100	R1	97	T4	94	F81	77
F13	100	F29	96	F70	93	B3	71
F64	99	O1	96	F27	91		
F66	99	W2	96	F32	91		

Score Range:	56-108	Model Range:	29-123
Score Mean:	91	Model Mean:	76

____ Wetlands of special interest in Area 40.

\- - - Wetlands of special interest in Area 41.

Table 6.3-6. Shoreline protection function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

F10	29	B5	0	F31	0	F72	0
F23	22	B8	0	F32	0	F114	0
F28	21	D3	0	F57	0	M3	0
D1	19	D4	0	F60	0	O1	0
W1	19	D4A	0	F61	0	P2	0
W2	19	D5	0	F62	0	R1	0
R1A	17	D8	0	F63	0	R8	0
T4	17	F11	0	F64	0	T1	0
B3	15	F13	0	F65	0	T2	0
F81	4	F25	0	F66	0	T3	0
B2	0	F27	0	F69	0		
B4	0	F29	0	F70	0		

Score Range:	0-29	Model Range:	3-32
Score Mean:	3.5	Model Mean:	17

___ Wetlands of special interest in Area 40.

\- - - Wetlands of special interest in Area 41.

Table 6.3-7. Water quality maintenance function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

F23	89	F64	75	F31	69	B8	63
O1	81	F65	75	T2	69	F32	63
B2	80	F28	74	B4	68	D5	62
T4	80	F11	73	F66	68	F27	61
W1	79	P2	71	M3	68	F61	59
W2	79	F25	71	R1	68	F72	58
D1	77	F62	70	D4A	67	D8	58
F29	77	R1A	70	F114	67	F57	57
R8	77	T3	70	T1	66	F81	50
F10	76	B5	69	D3	64	B3	48
F60	75	D4	69	F69	64		
F63	75	F13	69	F70	64		

Score Range:	36-96	Model Range:	18-98
Score Mean:	66	Model Mean:	58

___ Wetlands of special interest in Area 40.

\- - - Wetlands of special interest in Area 41.

the shallow marshes were the second most valuable wetland type from the standpoint of watershed functions, exceeded only by coniferous swamps.

Alder Shrub Swamp - Four shrub swamps were included in the wetlands of special interest: F29, F65, T3 and R8. These wetlands were categorized into two groups, those associated with streams (F29 and F65) and those that were isolated closed basins (T3 and R8) (Table 6.3-1). Wetlands F29 and F65 had inlet and outlet streams and were parts of riparian systems. These characteristics were responsible for their values for Hydrologic Support, Storm and Flood Water Storage, and Water Quality Maintenance functions being higher than both the model mean and the actual mean. These wetlands were located on glacial till soil, which has a poor recharge potential because of its low permeability (Motts and O'Brien, 1980) and consequently had low ground water functions as indicated by the low functional value in contrast to the actual and model means.

The two other wetlands, T3 and R8, were isolated closed basins and not part of a riparian system, which resulted in values below the mean for the Hydrologic Support function. Their Storm and Flood Water Storage and Water Quality Maintenance functions were high because they were closed basins and thus prevented flood water or contaminated water from passing downstream. Wetland T3 was above the actual and model means for the Ground Water function since it occurred on permeable sand and gravel and was a water table wetland (Motts and O'Brien, 1980) thereby having recharge potential. Wetland R8 had a low ground water function value since it was perched on glacial till and had little recharge potential. The shrub swamps were one of the poorest types for overall watershed functions, scoring higher than deciduous swamps, which had the lowest watershed function value.

<u>Green Ash/Aspen Deciduous Swamp</u> - Twenty deciduous swamps were included in the wetlands of special interest. Wetlands with values higher than the model mean for Hydrologic Support were wetlands D1, D3, D4, F25, F27, F31, F61, F62, F69, M3, R1, and R1A. All of these wetlands were parts of riparian systems, each having an outlet. None of the deciduous swamps had a score above the mean for the Ground Water function model. Those which had scores above the actual mean occurred on permeable stratified sand and gravel where recharge may be possible. All but wetland F32 had scores which were higher than the model mean for Storm and Flood Water storage. This is because of their occurrence in the upper part of the watershed where they may prevent downstream flooding by storing storm water near the source of runoff. Also, because most of these wetlands were semi-closed basins, water residence time was high and they were categorized as a hydrologic condition 5. Only wetlands D1 and R1A had a shoreline value since they were the only deciduous wooded swamps associated with continuous streams.

Deciduous swamps which had a higher Water Quality Maintenance score than the model mean included all but wetlands D8, F57, and F72. Wetland F57 was a streamside wetland and D8 and F72 were isolated wetlands having no outlet. The other deciduous swamps had high scores predominantly from their excellent water retention and to their having primarily hydrologic condition 5. Slow water movement through these swamps offers potential for interaction of contaminated water with the soil, vegetation, sunlight, and organisms to allow occurrence of the living filter function of the wetland.

As a wetland type, deciduous swamps had the lowest value for the watershed functions.

Leatherleaf Bog - Of the wetlands of special interest, four were bogs (D5, F64, T1 and T2). All of the bogs except F64 were kettle holes formed in stratified sand and gravel and had neither an inlet nor an outlet (Table 6.3-1). The exception, wetland F64, was a shallow kettle hole in glacial till having an inlet and an outlet, and was part of a riparian system. Thus, F64 was the only bog having a score higher than the mean for the Hydrologic Support model. Because wetlands T1 and T2 occurred on permeable sand and gravel and were water table wetlands having recharge potential, they had scores higher than the model mean for the Ground Water function. Wetland D5 was the only bog with a low score for the Storm and Flood Water Storage function because of its small size and perched hydrologic condition. Bogs were one of the poorest types for watershed function, scoring slightly higher than deciduous swamps.

Black Spruce/Tamarack Coniferous Swamp - Of the wetlands of special interest, 15 were coniferous swamps. In comparison to the other wetland vegetative types, the coniferous swamps had the highest overall watershed functions. Coniferous swamps scored well above the model mean for Hydrologic Support except for wetlands B5 and F13. Both of these wetlands were not part of riparian systems while all others were. Thus, they lacked the ability to contribute water to downstream aquatic ecosystems.

Table 6.3-8. Cultural/Economic function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

F28	83	B2	51	F61	45	T1	37
F60	57	B4	51	F69	45	T2	37
D1	57	D4	51	F23	43	B5	35
F11	57	P2	51	F13	43	F114	33
F29	55	W1	51	F64	39	F32	31
F65	55	W2	51	F70	39	D8	31
T4	54	O1	51	F72	39	B8	31
F62	53	F57	47	M3	39	D5	23
F10	51	R1	47	D4A	39	T3	21
F31	51	R1A	47	D3	39	F81	17
F63	51	F25	45	B3	39		
F66	51	F27	45	R8	37		

Score Range:	11-87	Model Range:	11-87
Score Mean:	40	Model Mean:	54

___ Wetlands of special interest in Area 40.

- - - Wetlands of special interest in Area 41.

partly blocked by road fill. These conditions were responsible for F81 scoring below the means for four of the five functions. This wetland scored above the actual mean only for the Shoreline Protection function.

6.3.3 Socio-Cultural Models

Data from the Cultural/Economic, Recreational, Aesthetics and Educational models were similar for most wetlands; therefore, the results from these models were combined under one heading. The analysis of wetlands of special interest was based on an actual mean of 40 for the Cultural-Economic function, 34 for the Recreational function, 35 for the Aesthetics function and 11 for the Educational function. The scores were also assessed in a regional context by comparison with the model means for each of the four functions. Because Dominant Wetland Class was a major element in all except the Educational model, the results are also presented by wetland type as in the Biological Function model. The model scores for each of the four socio-cultural functions are presented in Tables 6.3-8 through 6.3-11.

Sedge/Blue-Joint Grass Shallow Marsh - Of the 46 wetlands of special interest, two were shallow marshes (Table 6.3-1). Because of the high element and condition weightings assigned to Dominant Wetland Class and shallow marsh, respectively, the classification of a given wetland most influenced its final score in contrast to the other elements.

Wetlands F23 and F114 scored above the actual mean in three of the four models because of high class and subclass richness and their important biological values. However, in comparison with the model means, both wetlands were above the mean in only two of the models. Their values

Wetlands F60, F63, F66 and P2 had a low Ground Water Support function because their location on glacial till prevented recharge. The Ground Water Support function of the other 11 coniferous swamps was higher because each was located over stratified sand and gravel and had better recharge potential. All of the coniferous swamps scored higher than the model mean for Storm and Flood Water Storage. This was primarily because they were generally large, contained permeable peat soils for water storage, and were hydrologic condition type 5 (B5 was type 6). With the exception of wetland B5, which was a closed basin, they had all the characteristics necessary to retard and store inflowing water prior to its release downstream.

Coniferous swamps are generally associated with areas having a high water budget, such as are found along lakes and streams. Wetland F10 and F28 were adjacent to Little Sand Lake and Duck Lake, respectively, whereas T4, W1 and W2 were associated with Swamp Creek. These five wetlands were the only coniferous swamps having a Shoreline Protection value.

All of the coniferous swamps had a high Water Quality Maintenance function and scored above the model mean. The reason for this was the dense vegetative community, large size, peat soils, dominant hydrologic condition type of 5 and their being part of riparian systems. All these elements combine to retard inflowing water to the coniferous swamp, extend its residence time and thus allow the living filter function of the wetland to aid in discharging clean water to downstream areas.

Aquatic Bed - The wetlands of special interest included one aquatic bed, wetland F81. This wetland was not part of a riparian system and had no inlet or outlet. It was a small kettle hole perched on till and

Table 6.3-9. Recreational function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

F28	64	F66	41	R1	35	B5	28
F23	59	W2	41	R1A	35	F70	27
T4	55	D4	40	F27	32	T3	27
F10	53	O1	40	F61	32	D4A	26
D1	47	F62	39	F69	32	B8	25
B4	46	F114	39	M3	31	D8	25
W1	45	F31	38	R8	31	F72	24
B2	43	F63	38	T1	31	F81	24
F29	43	P2	38	T2	31	D5	22
F65	43	B3	36	D3	30	F32	20
F11	42	F25	35	F13	30		
F60	42	F64	35	F57	30		

Score Range:	20-67	Model Range:	10-71
Score Mean:	34	Model Mean:	40

___ Wetlands of special interest in Area 40.

--- Wetlands of special interest in Area 41.

Table 6.3-10. Aesthetic function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

F28	71	D1	37	D4	31	D3	28
F114	46	F62	37	F11	31	D4A	28
T1	45	F81	37	F13	31	F10	28
T2	42	T4	37	F61	31	F32	28
F25	40	F31	34	F63	31	F70	28
F27	40	F57	34	F66	31	F72	28
F60	40	F69	34	M3	31	R1	28
D5	39	O1	34	P2	31	T3	27
F29	39	B3	33	W1	31	B5	25
F64	39	B8	33	W2	31	R1A	25
F65	39	D8	33	R8	30		
F23	38	B4	31	B2	28		

Score Range:	16-62	Model Range:	9-66
Score Mean:	35	Model Mean:	37

___ Wetlands of special interest in Area 40.

--- Wetlands of special interest in Area 41.

Table 6.3-11. Education function values for wetlands of special interest. (1st column = wetland number and 2nd column = model value.)

D1	18	T1	15	F65	10	D3	7
F25	18	T3	15	F66	10	D4A	7
F27	18	T4	14	F70	10	D5	7
F60	18	B4	10	M3	10	D8	7
F62	18	D4	10	O1	10	F13	7
F114	18	F10	10	R1	10	F32	7
T2	18	F23	10	W1	10	F64	7
F11	15	F28	10	W2	10	F72	7
F61	15	F29	10	B2	7	P2	7
F69	15	F31	10	B3	7	R1A	7
F81	15	F57	10	B5	7		
R8	15	F63	10	B8	7		

Score Range:	7-21	Model Range:	4-24
Score Mean:	11	Model Mean:	15

___ Wetlands of special interest in Area 40.

\- - - Wetlands of special interest in Area 41.

were low in the regional context because elements such as percent open water and/or surface water association had less favorable conditions than those of wetlands in the region. In addition, F114 was small, which further reduced its value.

Alder Shrub Swamp - The wetlands of special interest included four shrub swamps (Table 6.3-1). Shrub swamp was not heavily weighted as a dominant class and contributed less to the final score than did shallow marsh.

Wetlands F29 and F65 had scores greater than or equal to the actual and model means in all except the Educational model. These high scores were attributable to favorable conditions for size, class and subclass richness, surface water connection, local scarcity and their important biological values. Wetlands R8 and T3 scored below the actual and model means in all except the Educational model. The scores for T3 were far below the means for the three models because of its small size, low class and subclass richness, lack of surface water connection and low score from the Biological function model. Both shrub swamps had relatively high scores for the Educational model because of their close proximity to a road.

Green Ash/Aspen Deciduous Swamp - Of the wetlands of special interest, 20 were deciduous swamps (Table 6.3-1). As a dominant class, the deciduous swamp was heavily weighted only in the Cultural/Economic model and overall, did not contribute as much to the final score as shallow marsh.

The most highly rated wetlands were D1, F25 and F62 which had scores greater than the actual mean in all four models. In addition, wetland D1 had scores equal to or greater than each of the four model means. All three wetlands were medium to large in size, associated with surface water, accessible by road, locally scarce and had favorable subclass richness and high scores from the Biological function model. Wetland F27 had scores equal to or greater than the mean in all but the Recreational model; the low score in this model was because of low scores from the Biological function model. Wetlands F25 and F62 scored below the model mean in the Cultural/Economic and Recreational models because the low percent surface water and less favorable type of surface water connection reduced their value in the regional context.

Wetlands B4, D4, F31, F57, F61, F69, R1 and R1A had scores above the actual mean in two of the four models. For all wetlands except F61 and F69 the scores were low in the Aesthetics and Education models and for these two wetlands, the low scoring models were Recreation and Aesthetics. The primary reasons were less favorable conditions with respect to surface water association, class and subclass richness, and low scores from the Biological function model. When compared to the model means, most of these wetlands scored above the mean in only one of the four models because they possessed no outstanding characteristics in contrast to wetlands in the region. Wetlands B8, D3, D4A, D8, F32, F70, F72 and M3 rated lowest with scores below the actual mean in all four models. The major factors contributing to the low ratings were unfavorable conditions with respect to size, class and subclass richness and local commonness in the majority of cases, and, in all cases, to poor surface water association, inaccessability and low scores for the Biological function model.

Leatherleaf Bog - Four bogs were among the wetlands of special interest (Table 6.3-1). Bog, as a dominant class, was heavily weighted only in the Aesthetics model and was low in value in the other models. Therefore, the overall contribution of this element to the final score was low to moderate.

Wetlands T1 and T2 scored above the actual and model mean in the Aesthetics and Educational models and wetland F64 had scores equal to or greater than the actual mean in the Recreational and Aesthetics models; F64 scored above the model mean only in the Aesthetics model. Wetland D5 scored above the actual and model means in the Aesthetics model. The primary causes of the overall low scores in the study area and in the region were low class and subclass richness, low percentage of open water and poor surface water connection.

Black Spruce/Tamarack Coniferous Swamp - Of the wetlands of special interest, 15 were coniferous swamps (Table 6.3-1). As a dominant class coniferous swamp was heavily weighted only in the Cultural/Economic Model and overall contribution of this element to the three other models was low to moderate.

Wetlands F60 and T4 rated the highest, with scores greater than the actual mean for all four models; F60 scored above four of the model means and T4 scored below the model mean in only the Educational model. These coniferous swamps were large in size and accessible by road, had high class and subclass richness, were locally scarce and had high biological value.

Wetland F28 scored below the mean only in the Educational model, and wetlands B2, F10, F63, F66, O1, P2, W1 and W2 had scores at or above the mean for the Cultural/Economic and Recreational models, because of their large size and high biological value. Their low scores in the other two models were primarily attributed to poor surface water association (except in F10) and inaccessibility. With the exception of F28, most of these wetlands were above the model mean in only one of the models. This demonstrates that, compared to other wetlands in the region, only wetlands F60 and T4 were outstanding in the Socio-Cultural functions.

Wetlands B3 and F13 scored below the mean in three of the models. This was mostly attributable to unfavorable conditions with respect to class and subclass richness, surface water association and accessability. Wetland B5 scored below the mean in all four models. Major contributing factors were small size, poor class and subclass richness, lack of surface water association, isolation, local commonness and low biological value.

Aquatic Bed - One aquatic bed was among the wetlands of special interest (Table 6.3-1). As a dominant class, this type was heavily weighted in all four models and the contribution of this element to the final score was high. This wetland scored above the actual mean in the Education and Aesthetics function models; the scores were equal to the model means for these two functions. The overall value of wetland F81 in both study area and regional contexts was low mainly because of low subclass richness and small size. The higher scores in the Education and Aesthetics function models were mainly from a large percent open water and good public access.

6.3.4 Summary of Model Results

Among the 46 wetlands of special interest, there were 18 which had total scores that were above the model mean. These wetlands are identified in Table 6.3-12. This demonstrated that these wetlands were important in the region, based on their capacities to perform biological, watershed and socio-cultural functions. These wetlands included 11 coniferous swamps, four deciduous swamps, two shrub swamps and a shallow marsh. The characteristics that distinguish these wetlands from others in the region on the basis of their functional values can be seen in summary Table 6.3-1. The majority of these wetlands were of large size, part of riparian systems or associated with a stream or open water, were associated with sand and gravel deposits and had large water budgets. These wetlands were associated either with Swamp Creek or with one of the study area lakes. Other factors contributing to the high functional value of these wetlands were a large amount of edge from high class richness and favorable surrounding habitat conditions.

The wetlands of special interest also included 10 which had total scores below the model mean but above the score mean; these wetlands are shown in Table 6.3-12. There were five deciduous swamps, one coniferous swamp, three bogs and a shallow marsh. On the basis of functional value these 10 wetlands were not important in the regional context but were valuable compared to other wetlands in the study area. Most of these wetlands were associated with till rather than sand and gravel, were of medium or small size, and had low class richness and interspersion (Table 6.3-1). Also, these 10 wetlands included a predominance of deciduous

Table 6.3-12. Wetlands of special interest with total scores above the actual or model mean. (1st column = wetland number, parentheses = wetland type and 2nd column = total value.)

F28	(CS)[a]	634	F29	(SS)	508	P2	(CS)	467
T4	(CS)	595	B2	(CS)	503	F64	(B)[b]	463
F23	(SM)[c]	581	O1	(CS)	497	F31	(DS)	462
W1	(CS)	562	F63	(CS)	487	T2	(B)	453
F10	(CS)	553	F11	(CS)	486	F25	(DS)	452
D1	(DS)[d]	549	B4	(DS)	478	R1	(DS)	447
W2	(CS)	542	F66	(CS)	475	F114	(SM)	438
F57	(DS)	534	D4	(DS)	471	T1	(B)	425
F65	(SS)[e]	513	R1A	(DS)	469			
F60	(CS)	509	F62	(DS)	467			

Model Mean: 470

Score Mean: 424.5

[a]CS = Coniferous swamp
[b]B = Bog
[c]SM = Shallow marsh
[d]DS = Deciduous swamp
[e]SS = Shrub swamp

swamps and bogs which are the two least favorable conditions for dominant wetland class. These factors were primarily responsible for the lower value of these 10 wetlands in the regional context.

6.4 COMBINED WETLAND RANKING

The combined scores for the 10 highest ranked wetlands within the study area are discussed below in the context of their functional values. Model and actual range and mean are presented for each model and for the total. A discussion of the unnormalized data is presented followed by a discussion of the effect of normalization on ranking of the top 10 wetlands.

6.4.1 Unnormalized Values

Of the top 10 wetlands, seven were shallow marshes, two were coniferous swamps and one was a bog. The 10 wetlands are arranged in descending order by total unnormalized score in Table 6.4-1. The characteristics of these wetlands that support their values are discussed and compared below by wetland type. The characteristics that played a key role in determining these scores are summarized in Table 6.3-1. Three of the top 10 wetlands, F23, F28 and T4, were of special interest because of their relationship to project activities (see Section 3.5).

Sedge/Blue-Joint Grass Shallow Marsh

Wetland F37 - Wetland F37, a large marsh (6.5 ha [16.2 acres]) bordering Deep Hole Lake, was the highest ranked wetland with a score of 650. This wetland scored considerably above the actual mean value in all 10 wetland models. The reasons for the high scores in the Biological function model and Socio-Cultural function models were principally related to the large size, number of wetland classes (3), the amount and kind of

Table 6.4-1. Unnormalized results of 10 functional models for the top 10 wetlands in the study area.

WETLAND NO.	WETLAND TYPE	FUNCTIONAL MODELS: BIOLOGICAL FUNCTION	HYDROLOGIC SUPPORT FUNCTION	GROUNDWATER FUNCTION	STORM AND FLOODWATER STORAGE FUNCTION	SHORELINE PROTECTION FUNCTION	WATER QUALITY MAINTENANCE FUNCTION	CULTURAL AND ECONOMIC FUNCTION	RECREATIONAL FUNCTION	AESTHETICS FUNCTION	EDUCATION FUNCTION	TOTAL
F37	SM[a]	131	61	47	98	20	96	66	67	50	14	650
F28	B[b]	104	61	43	103	21	74	83	64	71	10	634
R3	SM	126	65	41	96	11	81	66	65	53	14	618
F2	SM	141	59	54	81	11	77	63	65	50	10	611
F40	SM	132	49	43	94	0	82	73	60	50	18	601
T4	CS[c]	118	67	59	94	17	80	54	55	37	14	595
F7	SM	129	19	42	98	0	82	87	64	62	10	593
F19	SM	105	58	46	97	22	86	46	67	50	14	591
F23	SM	104	66	44	106	22	89	43	59	38	10	581
R5	CS	108	60	43	101	17	69	57	45	43	21	564
Score Range		35-141	8-7	29-64	56-108	0-29	36-96	11-87	20-67	16-62	7-21	218-742
Score Mean		76	31	37	91	3.5	66	40	34	35	11	424.5
Model Range		29-158	6-67	20-60	29-123	3-32	18-98	11-87	10-71	9-66	7-24	142-794
Model Mean		93	36	44	76	17	58	54	40	37	15	470

[a]Shallow marsh; [b]Bog; [c]Coniferous swamp

edge, and favorable water/cover interspersion. The juxtaposition of wetland F37 with other wetlands, its connection with Deep Hole Lake, and the adjacent large tracts of mixed upland forest present in the surrounding watershed further enhanced this wetland's value, particularly for wildlife. The results of quantitative investigations for birds conducted in marshes in the study area indicated 28 species utilized this type during the June breeding period. The number of species recorded in marshes was higher than in any other wetland type which supports the high scores received by the highest ranking seven marshes for the Biological function model.

Wetland F37 was part of a riparian system, was adjacent to a lake and had two outlets; these functional characteristics were the main reasons for the high watershed function score for this wetland.

Wetlands R3 and F2 - Wetlands R3 and F2 were both large (8.6 ha [21.4 acres] and 8.0 ha [19.9 acres], respectively) and bordered lakes. Wetland R3 scored above the mean in all 10 models and F2 scored above the mean in all except the Storm and Floodwater Storage and Educational function models. Their large size and connection with lakes were major factors contributing to the high scores for the Biological and Socio-Cultural function models. Interspersion of a variety of wetland vegetative types in wetlands R3 (3) and F2 (4) and the presence of scattered patches of open water increased the amount and kind of edge which enhanced their scores in the Biological and Socio-Cultural function models. These wetlands were connected to other wetlands and surrounded by upland forest, which further contributed to their high biological function. Good scenic qualities and recreational opportunities were characteristic of both wetlands and added important social values.

The large size of wetlands R3 and F2 and being part of riparian systems were major conditions responsible for the high watershed function scores. In addition, the association of wetland R3 with Oak Lake, and having a long hydraulic residence time were factors contributing to its watershed function. In contrast, the association of wetland F2 with a stream low in the watershed which received drainage from a very large watershed, presence of several beaver ponds, and being a water table wetland were the main factors which added to this wetland's ground water and hydrologic support function.

Wetlands F40 and F7 - Wetlands F40 and F7 were both large (3.5 ha [8.6 acres] and 8.6 ha [21.4 acres], respectively) but, in contrast to the three highest ranked marshes, did not border lakes. Wetland F40 scored above the mean in all except the Shoreline Protection function model and F7 scored below the mean in the Hydrologic Support function, Shoreline Protection function, and Education function models. Both wetlands scored high in the Biological Function model and in the other Socio-Cultural models because of their large size, and the length and kind of edge created by the interspersion of three wetland classes in F40 and in F7. In F40 the edge effect was further enhanced by scattered patches of open water. The juxtaposition of wetlands F40 and F7 with other wetlands and adjoining tracts of mixed upland forest in the surrounding watershed contributed to the wildlife and human use value of these wetlands. The socio-cultural value in wetlands F40 and F7 was also enhanced by their scenic qualities.

The watershed function of wetlands F40 and F7 contributed less to their scores than the Biological and Socio-Cultural functions. The main factors responsible for the watershed function of wetland F40 were its dominant hydrologic type (condition 5), large size and being part of a riparian system. In contrast F6, which ranked lower for watershed function, had poor hydrologic connection to downstream systems and lacked an inlet. However, its high score in the water quality maintenance function was attributable to a long hydraulic retention time and shallow marsh as a dominant wetland class.

Wetlands F19 and F23 - Wetlands F19 and F23 were two of three wetlands among the top 10 (including F37) that bordered Deep Hole Lake. Wetland F19 scored above the mean in all 10 models and F23 scored below the mean only in the Education function model. The large size of F19 and F23 (3.6 ha [9 acres] and 1.8 ha [4.6 acres], respectively) and their association with Deep Hole Lake were major factors in the high scores for Biological and Socio-Cultural functions. The value of F19 for wetland wildlife was also enhanced by scattered patches of open water. Juxtaposition with other wetlands was favorable for both wetlands and both were surrounded by a diversified cover pattern in the surrounding watershed. However, in contrast to the five highest ranking marshes vegetative interspersion and the amount of edge were not optimal and contributed less to the scores of F19 and F23. Visual aesthetics and recreational opportunities were high for both wetlands even though F23 lacked road access.

The watershed functions of wetlands F19 and F23 were somewhat more important to their overall scores than were the biological and socio-cultural functions. Association with Deep Hole Lake and being part of a riparian system were important elements contributing to the high watershed function of these wetlands.

Leatherleaf Bog - Wetland F28 was primarily a bog that surrounded Duck Lake, and was one of a chain of wetlands draining into Little Sand Lake. The scores for this wetland were above the mean in all but the Educational function model. One of the major factors contributing to this wetland's high scores in the Biological function and Socio-Cultural function models was its large size (26.3 ha [65 acres]). Vegetative interspersion and, therefore, the amount of edge was high in this wetland. Plant species variety and vegetative density were also high. The density observations in this wetland were substantiated by quantitative plant studies in other bogs in the study area (F16 and F64) in which leatherleaf, the dominant plant, occurred in an average density of 100 stems per 3 m^2 plot. This wetland bordered Duck Lake along most of the wetland's southeast perimeter. This condition greatly enhanced wildlife habitat value. The juxtaposition of other wetlands and a large tract of mixed forest in the surrounding watershed, coupled with its large size, provided secluded habitat for wildlife. Results of the quantitative bird studies showed species richness (25) was higher during the May migration period than in any other wetland type. Fewer species were recorded during the breeding period, which indicated that the bog is more heavily used as a resting and feeding area during migration, particularly by waterfowl. Several hundred greater scaup (*Aythya marila*) were observed during the spring field survey. Visual aesthetic qualities and recreational potential were also high although road access was limited to one location on the southwest side of the wetland.

This wetland's high value for watershed function was attributed to its size, association with Duck Lake and being part of a riparian system. Topographically, wetland F28 was a closed basin which also contributed to its high value.

Coniferous Swamp - Wetlands R5 and T4 scored above the mean in all 10 models. Both were large wetlands (4.2 ha [10.3 acres] and 18.0 ha [44.7 acres], respectively) which was a major factor contributing to the high scores in the Biological function and Socio-Cultural function models. In addition, wetland T4 bordered Swamp Creek which further enhanced its value, particularly for wildlife. Other major contributing factors were the degree of interspersion among the wetland classes (3 in R5 and 4 in T4) and the abundance of edge between the different classes. Juxtaposition with other wetlands and a diversified cover pattern of mixed and open land in the watersheds of both R5 and T4 further enhanced their value. Results of quantitative sampling for birds showed 25 species utilized this wetland type during the June breeding period, which was exceeded only by the number observed in shallow marsh. These results support the high scores for wetlands R5 and T4 for biological function. The scenic qualities of these wetlands and nearby road access provided opportunities for human use.

The contributions of the watershed function of wetlands T4 and R5 to their scores was partly attributable to being part of a riparian system. In addition, T4 adjoined Swamp Creek, was a water table wetland and had three inlets which contributed to its watershed function. In contrast, R5 contained a through flowing stream, and discharged into a wetland adjacent to Oak Lake.

6.4.2 Normalized Values

The normalization process to bring the scores of all 10 models within the 0-100 range and the assignment of weightings to each model had little effect on the ranking of the top 10 wetlands. The status of the 10 highest ranked wetlands did not change and their positions relative to each other shifted only slightly (Table 6.4-2).

Table 6.4-2. Normalized results of 10 functional models for the top 10 wetlands in the study area.

WETLAND NO.	FUNCTIONAL MODELS: BIOLOGICAL FUNCTION	HYDROLOGIC SUPPORT FUNCTION	GROUNDWATER FUNCTION	STORM AND FLOODWATER STORAGE FUNCTION	SHORELINE PROTECTION FUNCTION	WATER QUALITY MAINTENANCE FUNCTION	CULTURAL AND ECONOMIC FUNCTION	RECREATIONAL FUNCTION	AESTHETICS FUNCTION	EDUCATION FUNCTION	TOTAL
F28	34.40	5.92	1.20	6.08	4.32	4.96	7.85	4.45	5.45	0.90	77.53
F37	31.60	5.92	3.76	5.60	4.00	6.08	6.00	4.65	3.60	2.05	73.26
F2	34.80	5.76	4.80	4.24	1.04	5.28	5.65	4.50	3.60	0.90	70.57
F40	32.00	4.64	3.20	5.28	0.00	5.68	6.75	4.10	3.60	3.25	68.50
R3	30.00	6.40	2.96	5.44	1.04	5.60	6.00	4.50	3.85	2.05	67.84
T4	27.60	6.56	5.44	5.28	3.04	5.52	4.65	3.70	2.45	2.05	66.29
F7	31.20	1.44	3.12	5.60	0.00	5.68	8.25	4.45	4.65	0.90	65.29
F19	23.60	5.60	3.68	5.52	4.62	6.08	3.80	4.65	3.60	2.05	63.22
R5	24.40	5.84	3.20	5.84	3.04	4.56	5.00	2.85	3.00	4.10	61.83
F23	23.20	6.48	3.36	6.32	4.64	6.32	3.50	4.00	2.55	0.90	61.27

6.5 REGIONAL CONTEXT EVALUATION

In general, the topography of the study area was higher than adjacent areas. Hemlock and Swamp creeks partly encircled the study area forming lowlands to the east and north, respectively. To the west, low flat glacial outwash plains sloped to Swamp Creek and Pickerel Creek. To the south were lowlands and wetlands with surface water drainage to Rolling Stone Lake. All water from the study area eventually reached the Wolf River. The study area wetlands occurred in this topographic and hydrologic regional setting.

To relate the study area wetlands to the other wetlands found in the region, the frequency of occurrence was determined for wetland types in the study area as a percentage of those found in the region. The results of this comparison are presented in Table 6.5-1. The representation of a given wetland type in the study area versus the total for the region provides an indication of the "regional scarcity" of the wetland types identified.

Wetlands in the study area constituted 1.5 percent of the total area of wetlands estimated for the region. The study area (2431 ha [6018 acres]) comprised 2.0 percent of the regional area (121,967 ha [301,900 acres]). Of the vegetation types in the region, 19.8 percent (24,100 ha [59,655 acres]) were classified as wetlands, and the 356 ha (882 acres) of wetlands in the study area represent only 0.3 percent of the total land area in the region.

These data indicate that wetlands are common in the region, forming approximately 20 percent of the total land area. Coniferous swamp was the most common type (10,453 ha [25,873 acres]), while aquatic bed was the least common (317 ha [785 acres]). When combined, deciduous and

Table 6.5-1. Regional scarcity expressed as the percentage of wetlands in the study area versus those in the region.

WETLAND TYPE	AREA OF WETLANDS PHOTOTYPED IN THE REGION		PHOTOTYPED WETLANDS AS A PERCENTAGE OF THE TOTAL REGIONAL AREA	ESTIMATED AREA OF WETLANDS IN THE REGION		ACREAGE OF WETLANDS IN THE STUDY AREA		STUDY AREA WETLANDS AS A PERCENTAGE OF THE REGIONAL AREA WETLANDS
	Hectares	Acres	Percent	Hectares	Acres	Hectares	Acres	Percent
Shrub swamp	1,650	4,084	3.3	7,073	10,083	34	84	0.8
Bog	786	1,947	1.6	1,939	4,800	45	111	2.3
Aquatic bed	129	320	0.3	317	785	1.6	4	0.5
Deciduous swamp	2,604	6,446	5.3	6,440	15,940	48	120	0.8
Coniferous swamp	4,228	10,467	8.6	10,453	25,873	193	478	1.8
Marsh	356	881	0.7	878	3,174	34	84	3.9
Total	9,754	2,145	19.8	24,100	59,655	356	882	1.5

Total land area of the region: 121,967 ha (301,900 acres).
Total land in the study area: 2,431 ha (6,018 acres).

coniferous swamp constituted 16,893 ha (41,813 acres) of the area classified as wetlands, which was approximately two-thirds of the regional wetland area.

The analysis of data from the 10 function models in a regional context was based partly on comparison of the scores with the model means but also to a large measure, on regional scarcity. With respect to functional value, the regional importance of a high scoring coniferous swamp located in the study area was considerably less than the occurrence of a high scoring wetland type such as shallow marsh which was less well represented in the region. The model scores, therefore, are not absolute, but should be evaluated in the context of the regional scarcity of the dominant type relative to that of the other types, and to wetland functions in a site specific context.

6.6 AQUATIC STUDY AREAS, SANCTUARIES, AND REFUGES WITHIN THE STUDY AREA

No federal or state designated wild rivers or state scientific areas are located adjacent to or within the study area. Forest County heritage areas were cited as follows: Conner Forest Industries owns, as forest cropland and subsequently as a forest resource, the southern one-third of Section 6 (T34N, R13E) (University of Wisconsin CRYP Program, 1977), along the southern border of the study area, just south of Deep Hole Lake and the western portion of Section 4, at the southeast corner of the study area. County lands also constitute an important resource. Forest County holdings in the study area include Section 29 (T34N, R13E) in the northeast corner of the study area. Other Forest County lands include the northeast corner of Section 30 at the northern border of the study area, and the extreme southwest corner of Section 28 on the eastern border of the study area. In addition, Langlade County owns public land in Sections 1 and 2 (T34N, R12E) within the study area. These resources are summarized in Table 6.6-1. These public areas are valuable not only for their forest resources but also as hunting areas.

Important water resources in or nearby (1.6 km [1 mile]) the study area include Swamp Creek and Hemlock Creek. These water bodies are listed as Class II trout streams (Wisconsin Department Natural Resources, 1980).

The historic and cultural resources located in or adjacent to the wetland study area have been described by Salzer and Birmingham (1978), Overstreet and Brazeau (1982) and MacDonald and Mack Partnership (1982). The aesthetic or scenic qualities of the area have been discussed by Dames and Moore (1981e). Two sites, identified as prehistoric habitation areas, were located near wetlands R3 and R5 adjacent to Oak Lake. No other sites of cultural, historic, or scenic importance were identified in the study area.

Table 6.6-1. Important natural resource lands in the region of the study area.

OWNER	TOWNSHIP/RANGE	SECTION	AREA hectares	AREA acres	RESOURCE
Conner Forest Industries	T34N,R13E	4	89	220	Forest Cropland
		6	129	320	Forest Cropland
Forest County	T35N,R13E	28	6.4	16	Forest Cropland & Public Hunting
		29	174	430	Forest Cropland & Public Hunting
		30	36	90	Forest Cropland & Public Hunting
Langlade County	T34N,R13E	1	178	440	Forest Cropland & Public Hunting
		2	56	140	Forest Cropland & Public Hunting

7.0 QUALITY ASSURANCE

Procedures audits of the Wetlands Assessment were conducted throughout the investigation by NAI's Quality Assurance Manager to insure that standard operating and quality control procedures were workable and familiar to all persons performing each task. Quality control tests were administered to field personnel to ascertain their capabilities in performing the field tasks, which were audited in the field. For each task, checklists were prepared against which performance was evaluated for deficiencies and accuracy; deficiencies were resolved before each task was completed. Data traceability (chain of custody) was insured by means of field card submittal forms and sample control labels. These audits were based on NAI's Technical Procedures Manual and Quality Assurance Manual, both available for review upon request.

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