ORNITHOLOGICAL STUDIES ON AND NEAR CROWN LEASE 17, NORTHEASTERN ALBERTA, JUNE-OCTOBER 1984

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FOREWORD

The following report describes the terrestrial and water bird populations in the vicinity of the Syncrude Mildred Lake facility in 1984. This study, conducted after 6 years of operation, is a follow-up to several pre-construction studies conducted by Syncrude and was designed to determine the changes, if any, in bird populations in the area surrounding the plant.

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ORNITHOLOGICAL STUDIES ON AND NEAR CROWN LEASE 17, NORTHEASTERN ALBERTA, JUNE-OCTOBER 1984

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EXECUTIVE SUMMARY

Syncrude Canada Ltd. requested that a study of ornithological research be conducted on and near Crown Lease 17, northeastern Alberta, where its bitumen mining, extraction and upgrading plant is in operation. The overall objectives of this study were to (1) determine the abundance and diversity of terrestrial breeding birds present in the principal natural vegetation types previously identified in the western part of Crown Lease 17 and in previously cleared areas that have since been revegetated, and (2) conduct waterbird inventories on the major waterbodies on and near Lease 17, similar to those conducted prior to and during construction of the plant, and to determine what changes, if any, have occurred in the distribution and numbers of waterbirds in the region since the inception of the development.

TERRESTRIAL BREEDING BIRD POPULATIONS ON LEASE 17

The specific objectives of this part of the study were to document the terrestrial bird community on the western part of Lease 17, to determine if the major vegetation types present there support higher or lower densities of breeding birds than in any other parts of the boreal forest, and to determine if they provide habitat for any uncommon or rare species. Two study plots were established in each of the three major vegetation types in the western portion of Lease 17: black spruce-Labrador tea, aspen-white spruce and white spruce-aspen. These habitats together included almost 80% of the vegetation in the area. Plots were not established in any of the five minor vegetation types on the lease because of their general inaccessibility and because these types typically occurred as small-sized units. In addition to the three major habitats, study plots were also established in an area of land reclaimed by Syncrude adjacent to Poplar Creek Reservoir, 11 km south of Lease 17, and in jack pine forest at the Alberta Oil Sands Environmental Research Program (AOSERP) camp, in the eastern part of Lease 17. Most of the plots varied in size from 18 ha to 20 ha.

Censuses of the bird populations on the nine study plots were conducted by the territorial mapping (spot-map) method. This is the method employed in the American Birds annual breeding bird censuses and in Canadian breeding

bird studies, and is recommended as the standard census method by the International Bird Census Committee (I.B.C.C.). The mapping method involves the repeated censusing of a plot throughout the breeding season. During each census, an observer walks a standard route along predetermined grid lines, and marks on a map every contact with a bird. After each plot visit, all data are transferred to composite species maps.

After the plot visits had been terminated and the composite maps for each species on each plot had been prepared, the number of territories of each species on each plot was evaluated. The population density was considered to be the number of territorial males per unit size of plot (generally 20.0 ha). In addition, four indices of community structure were calculated for each of the vegetation types sampled. These measures were $\hat{S}$, the number of species in a vegetation type; DI, the dominance index; H', the Shannon-Wiener index of species diversity; and J', an index of equitability. For each of these measures, the basic unit considered was the number of territories of each species on the plots.

Territories of 42 species of birds were recognized on the nine census plots and densities of territorial males ranged from 133 males/100 ha on the jack pine plot to 770 males/100 ha on one of the aspen-white spruce plots. An additional 23 species were recorded but not in sufficient frequency to warrant their being judged territorial. It is probable that most, if not all, of these species nest on the plots or in nearby areas. All species recorded were common inhabitants of the boreal forest biome. The numerically dominant species recorded during the breeding bird censuses, in descending order of abundance, were the Tennessee warbler, least flycatcher, American redstart, ovenbird, Swainson's thrush, chipping sparrow and palm warbler. Somewhat different bird communities, both in terms of species composition and overall numbers, were evident among the various vegetation types. Nevertheless, few of the more common species were restricted to only one vegetation type and many species occurred in several of them. Densities of several of the common species did, however, vary substantially between the two compositionally similar vegetation types (aspen-white spruce, white spruce-aspen) and even between plots in the same vegetation type.

A total of 34 species of birds were recorded on the two black spruce-Labrador tea plots: 22 were considered to be territorial. The overall density of territorial males was 233 males/100 ha. The two most common species in this vegetation type were the palm warbler and the Tennessee warbler. A total of 35 species were recorded on the two aspen-white spruce plots, including 25 species of territorial males. The densities of territorial males on these plots were 355 males/100 ha and 770 males/100 ha. Almost 50% of the latter value consisted of two species: the least flycatcher and the American redstart. Other common species included the ovenbird, Swainson's thrush, Tennessee warbler, red-eyed vireo, black-and-white warbler, solitary vireo, American robin and white-throated sparrow. A total of 31 species were recorded on the two plots in the white spruce-aspen vegetation type, including 20 territorial species. The densities of territorial males on these plots were 254 males/100 ha and 364 males/100 ha. The Tennessee warbler was by far the most common species present--110 territorial males/100 ha. Other common species included the chipping sparrow, hermit thrush and ovenbird. Sixteen species of birds were recorded on the jack pine plot; eight of these were considered to be territorial. The overall density was 133 territorial males/100 ha. The American robin and the chipping sparrow were the most common species. A total of 13 species were recorded in the revegetation plots along Poplar Creek Reservoir. Seven species were considered to be territorial. The Savannah sparrow and the Le Conte's sparrow were the most common species.

The number of species ($\hat{S}$) was highest in aspen-white spruce and was also high in white spruce-aspen. The species diversity (H') and the equitability (J') were higher in the black spruce-Labrador tea vegetation type than in either of the two mixed-wood habitats. Species diversities in jack pine and the revegetation area were substantially lower than in the major forest vegetation types. Unlike the other forest habitats, which have a shrub understory, jack pine is essentially a single-layered habitat with little or no understory. Such habitats have much lower diversities than multi-layered habitats. In addition to being a single-layered habitat, the jack pine plot was small. Fewer species would be expected on a small plot than a large plot, regardless of the habitat type.

The abundances and diversities of the bird populations present in the vegetation types that were sampled are characteristic of the boreal forest region. Virtually all of the species recorded, including those with territories and those that could not be considered territorial, have breeding ranges that extend, in appropriate habitat, throughout Canada. As well, densities of territorial males in the vegetation types sampled are typical of those occurring throughout the boreal forest region. It is notable that few of the species that were recorded were confined to only one of the vegetation types sampled in this study. Undoubtedly, there are several species of birds that breed in the forests on the western part of Lease 17 that we did not record. Such species are likely present both in vegetation types that we sampled and in those that we did not sample. However, even with an increase in the overall species richness and, possibly, density of territorial males as a consequence of the inclusion of more census plots and of more vegetation types, the conclusions from this study would not be altered. The breeding bird community of the western part of Lease 17 is similar both in diversity and in density to that throughout the remainder of the boreal forest region of western Canada.

WATERBIRD NUMBERS ON MAJOR WATERBODIES ON AND NEAR LEASE 17

The specific objectives of this part of the study were to document the numbers and distributions of waterbirds on waterbodies on or adjacent to Lease 17 during the breeding, post-breeding, moulting and migration periods of 1984, and to compare the data collected in 1984 with those of previous surveys in 1974, 1975 and 1977, to determine whether there have been any changes in composition, abundance or distribution over the 11-year period. A total of 37 waterbodies on or near Lease 17 were surveyed in 1984; most of these had been surveyed for waterbirds in at least one year between 1974 and 1977. They included four waterbodies from the Beaver Creek Diversion System (Beaver Creek Reservoir, Ruth Marsh, Ruth Lake, Poplar Creek Reservoir), two waterbodies from the Fresh Water Supply System (Lower Camp Sedimentation Basin, Mildred Lake), 28 borrow pits and small waterbodies created by development of Lease 17 (collectively called the Syncrude Site Water Areas [SSWAs]), and three waterbodies unmodified by development (Loon Pond, Horseshoe Lake, Saline Lake). Waterbodies were surveyed every 10 days,

beginning (weather permitting) on the 6th, 16th and 26th of each month, from 6 June to 6 October. Waterbodies were surveyed by canoe, motorboat or telescope and binoculars, depending on the size of the waterbody and accessibility to the water area.

Results in 1984

A total of 60 species of waterbirds were observed during surveys from 10 June to 9 October 1984. About 95% of the waterbirds counted during the study were grebes, ducks, coots or shorebirds. Total numbers of waterbirds recorded per survey ranged from lows of 1300-1500 birds in early June, the period of nesting and early hatching for most waterbirds, to highs of 3800-4700 birds from early August to mid September, the period of pre-migration and autumn migration for most waterbirds.

Information about the productivity of waterbirds in the study area in 1984 is provided by numbers of breeding pairs observed and numbers of broods recorded. Brood data indicate that diving ducks, dabbling ducks, coots and grebes were the most productive groups in the study area. The American coot, common goldeneye, red-necked grebe, ring-necked duck and American wigeon were the species with the largest number of broods counted. Over 70% of all coot broods were recorded on Horseshoe Lake, whereas a similar percentage of common goldeneye broods were recorded on Saline Lake. Red-necked grebe broods were seen primarily on Poplar Creek and Beaver Creek reservoirs, whereas ring-necked duck broods and wigeon broods were widespread throughout the study area.

The red-necked grebe was by far the most abundant of the three species of **grebes** recorded in the study area; a minimum of 30 broods of this species were seen. Pied-billed grebes and horned grebes also nested on or near Lease 17. Numbers of grebes seen during waterbody surveys remained similar from June through August. In early September, there was a small influx of migrant horned and red-necked grebes, but by mid September most had departed.

Numbers of **dabbling ducks** recorded during the waterbody surveys varied from about 600 birds per survey in June to over 2500 per survey in late August. There appeared to be two peaks in numbers present, a small one in

late June and early July, and a large one in August. The first peak may have represented the presence of small groups of pre-moulting birds (primarily mallards and American wigeons but also blue-winged teal, gadwalls and northern shovelers) gathering to moult or stopping en route to moulting lakes farther north; these ducks were present mainly on Beaver and Poplar Creek reservoirs, with smaller numbers on Horseshoe Lake. The second peak of dabbling ducks lasted throughout August. This increase likely consisted of post-moulting birds, post-nesting hens, young-of-the-year and, at least in late August, some early migrants. The most abundant species then present were mallard, American wigeon, green-winged teal and blue-winged teal. Six species of dabbling ducks nested in the study area in 1984. Based on numbers of broods and numbers of breeding pairs observed, American wigeon was the most common nesting species, followed by mallard, blue-winged teal, green-winged teal, northern pintail and northern shoveler.

The numbers of **diving ducks** counted during waterbody surveys remained relatively constant from mid June until the end of August. However, numbers increased substantially in the first week of September. This increase presumably represented an influx of autumn migrants. Variable but relatively large numbers of diving ducks were present throughout September but few were counted in early October. The most abundant migrant diving ducks were scaup, which passed through in September. Moderate numbers of buffleheads and ring-necked ducks were also present during September. Six species of diving ducks nested in the study area in 1984. Based on numbers of broods and numbers of breeding pairs observed, common goldeneyes, ring-necked ducks and buffleheads were the most common breeders.

The numbers of **shorebirds** recorded during waterbody surveys remained fairly constant through June. Numbers increased in July, partly because of the addition of young birds but mainly because of the arrival of transients. The largest numbers of shorebirds were present from early to mid August. Nesting behaviour was observed for yellowlegs, spotted sandpiper and killdeer. The two yellowlegs species and the spotted sandpiper were the most abundant breeding species seen during waterbody surveys. Small unidentified sandpipers ('peeps'), dowitchers and pectoral sandpipers were the most common transients.

Similar numbers of **American coots** were seen during each survey from early June to late July. Coots nested in the study area; a minimum of two nests and 50 broods were seen. Numbers increased in August as young-of-the-year birds became independent. Many migrant coots apparently arrived in the study area in early September and close to 1300 individuals were seen in early September. By mid September many coots had left the area and numbers continued to decrease through late September and early October.

Small numbers of **gulls** were present in the study area from June to early October but nesting evidence was found only for Bonaparte's gulls. Bonaparte's gulls had left the study area by mid September. California and/or herring gulls were present throughout the study period but ring-billed gulls were recorded only after mid August. **Black terns** and **common terns** both nested in the study area, but black terns were much more abundant. Numbers of terns increased in late July and early August, as juveniles began to fly. No terns were seen after the end of August.

The **common loon** was the only loon species observed during waterbody surveys. One brood was seen. Numbers of loons seen remained similar from June through late August. Numbers were much lower in September and early October. **American bitterns** were seen regularly until late September and probably nested in the area. **Great blue herons** were seen primarily in August and September. A few **Canada geese** were present throughout the summer and two broods were seen. Three **sandhill cranes** were seen in early June.

Changes in Waterbird Numbers Between 1974 and 1984

Between 1975 and 1984, numbers of adult waterbirds in the study area have doubled during the breeding period (early and mid summer). This increase was due primarily to the presence of birds on the waterbodies created by the Syncrude development. Numbers of birds have decreased on all the original waterbodies present prior to the development, except Horseshoe Lake. Between 1975 and 1977, numbers of adult waterbirds recorded during the breeding period increased by a factor of five. The greatest increases were in numbers of dabbling ducks, terns and coots. Increases in the waterbird population were presumably due to an increase in the amount of utilizable

aquatic habitat, mainly as a result of the creation of new impoundments, and to severe drought conditions in the prairie pothole region.

Numbers of broods in the study area increased 1.6-fold from 1975 to 1977 and 1.2-fold from 1975 to 1984. Broods in 1977 were slightly more numerous on the original waterbodies present prior to the Syncrude development. In 1984, broods were slightly more numerous on the new waterbodies created by the development and were not evenly dispersed on the original ones. Horseshoe Lake supported over 80% of the broods seen on the original waterbodies in 1984. A higher proportion of the broods than of the adult waterbirds were recorded on the original waterbodies. The increase in the number of broods observed only partially reflected the increase in the number of adults observed between 1975 and 1984. The largest increases were in numbers of coot and grebe broods, and in dabbling duck, tern and coot adults. Dabbling ducks showed the lowest increase in productivity compared to their increase in adult numbers. This may reflect the fact that dabbling ducks are the main group affected and displaced by drought conditions in the prairies, and drought-displaced birds are less productive. Most of the non-productive dabbling ducks were observed on the new waterbodies.

Numbers of migrants in the study area during late summer and autumn are strongly influenced by waterbird migration patterns, which depend on breeding success in northern Canada and regional weather patterns. The number of waterbirds in the study area during the migration period in 1975 was 2.3 times higher than in 1974, and in 1984 was slightly lower than in 1975. In 1984, waterbirds were concentrated on the new waterbodies in late summer, but were equally distributed between the original and new waterbodies in autumn.

CONCLUSIONS

1. The terrestrial breeding bird community present in the vegetation types in the western part of Lease 17 is similar both in density and in diversity to that throughout the remainder of the boreal forest region of western Canada.

2. No rare or uncommon terrestrial breeding bird species are likely to occur in the principal vegetation types in the western part of Lease 17.

3. The waterbodies on and near Lease 17 provide habitat for breeding, moulting and staging by a large number of waterbird species.

4. Numbers of waterbirds present during the breeding season (early and mid summer) on the waterbodies on and near Lease 17 have increased since the oil sands development. Numbers of terns, ducks and coots have shown the largest increases. These increases are likely due to an increase in the amount of utilizable aquatic habitat, mainly as a result of the creation of new impoundments, and to severe drought conditions in the prairie pothole region.

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CHAPTER 1. INTRODUCTION

In 1974, Syncrude Canada Ltd. initiated the construction of a bitumen mining, extraction and upgrading plant on Crown Lease 17, which is located about 40 km north of Fort McMurray, Alberta, in the Athabasca Oil Sands deposit. Construction was completed in 1978 and since then the plant has been operational. In the spring of 1984, Syncrude awarded LGL Ltd. a contract to conduct a program of ornithological research during 1984 in the habitats on and near Crown Lease 17. Much of the previous ornithological work funded by Syncrude was conducted by LGL Ltd. (Sharp et al. 1975; Smith et al. 1975; Sharp and Richardson 1976; Ward and Sharp 1976; Ward et al. 1976; Ward 1978; Ward and Hollingdale 1978). The ornithological research during 1984 was designed to provide Syncrude with information necessary to determine what effects, if any, six years of project activities have had on terrestrial and water-associated birds on and near Lease 17, and to help predict any changes that may occur as a result of any future developments on Lease 17 or in adjacent areas. The program had two principal objectives:

1. to determine the abundance and diversity of terrestrial birds present in the principal natural vegetation types previously identified in the western part of Lease 17 and in previously cleared areas that have since been revegetated by Syncrude; and

2. to conduct waterbird inventories on the major waterbodies on and near Lease 17, similar to those conducted prior to and during construction of the project, and to determine what changes, if any, have occurred in the distribution and numbers of waterbirds in the region since the inception of the project.

This report presents the results of the ornithological studies conducted in 1984 in two major chapters. Chapter 2 describes the abundance and diversity of the terrestrial breeding bird community in the western part of Lease 17. Chapter 3 describes the distribution and numbers of waterbirds present in the area and compares these numbers with those present in the mid 1970's. Chapter 4 presents the conclusions of the study. Chapter 5 is a single Literature Cited section for the entire report, including citations used in the subsequent appendices.

CHAPTER 2. TERRESTRIAL BREEDING BIRD POPULATIONS ON LEASE 17

2.1 INTRODUCTION

This chapter presents the results of an intensive study of terrestrial breeding bird densities, diversities and habitat preferences in several habitats present on and near Crown Lease 17. The objectives of the study were to document the terrestrial bird community on the western part of Lease 17, to determine if the major vegetation types present there support higher or lower densities of breeding birds than in other parts of the boreal forest, and to determine if they provide habitat for any uncommon or rare species.

Prior to this study, little detailed information was available concerning the numbers of species or their breeding densities (number of males/100 ha) in the forested habitats of Lease 17. Syncrude Canada Ltd. has established a bird surveillance program, which has been in operation since 1980. One aspect of this program is the collection of spot-census data at two locations in mixed-forest habitat along the West Interception Ditch. A spot census involves identification of bird species detected by observation or ear at various single points. Such data, however, do not provide estimates of the absolute abundance of the various species recorded. The only previous study directly comparable to the present study was that of Francis and Lumbis (1979), who conducted extensive plot studies of terrestrial birds in the forests between Fort MacKay and Bitumount, northeast of Lease 17, in 1976 and 1977.

2.2 STUDY AREA

The study area comprised the lands on and adjacent to the western half of Crown Lease 17 in northeastern Alberta. The lease is about 40 km north of Fort McMurray, Alberta, on the west side of the Athabasca River, in the vicinity of 57°N, 111°40'W. Most of the work was conducted in the western half of Lease 17, but plots were also established up to 11 km from the lease (see Methods).

The entire study area is in the 'Mixedwood Forest Section' of the Boreal Forest Region (Rowe 1972). The characteristic forests of this section include a mixture, in varying proportions, of trembling aspen, balsam poplar, white spruce and balsam fir[1]. Jack pine is present on drier sandy sites, whereas black spruce and tamarack muskeg are typical of the low-lying portions. Peterson and Levinsohn (1977) mapped the vegetation in the western portion of Lease 17 (west of the West Interception Ditch) on a 1:24,000 scale and identified eight vegetation types. Three of these--black spruce-Labrador tea, aspen-white spruce and white spruce-aspen--together occupy almost 80% of the western part of Lease 17. None of the other five types accounts for more than 7.5% of the total area.

A second portion of the study area was situated about 11 km southeast of the southern boundary of Lease 17. This is an area of reclamation, surrounding the southern half of Poplar Creek Reservoir. This land had been cleared during the winter of 1974-1975 and was subsequently re-seeded by Syncrude with a variety of forbs and grasses, including brome grass, wheat grass, alfalfa, timothy and sweet clover, and planted with spruce seedlings and aspen saplings.

2.3 METHODS

2.3.1 Plot Selection and Establishment

A principal objective of the study was to evaluate the abundance and diversity of terrestrial birds present in the principal vegetation types in the western part of Lease 17 and in an area of reclamation. Accordingly, breeding bird plots were established in each of the major vegetation types.

2.3.1.1 Plot Selection

Study plots were established in the three major vegetation types in the western portion of Lease 17: black spruce-Labrador tea, aspen-white spruce and white spruce-aspen. Details of the vegetational characteristics of these

[1] Scientific names of plant species mentioned in this report are given in Appendix A.

types are presented in Peterson and Levinsohn (1977). These three habitats together include almost 80% of the vegetation in the area. Survey plots were not established in any of the five minor vegetation types because of their general inaccessibility and because these types typically occur as small-sized units. None of the minor vegetation types represented more than 7.5% of the total area. In addition to the three major habitats, study plots were also established in the area of reclaimed land adjacent to Poplar Creek Reservoir, 11 km southeast of Lease 17, and in jack pine forest at the Alberta Oil Sands Environmental Research Program (AOSERP) camp, in the eastern part of Lease 17. Although jack pine is not present in the western portion of Lease 17 (Peterson and Levinsohn 1977), it constitutes a component of the habitat on Lease 22 to the north (D. Reid, Hardy Assoc. Ltd., [1978] pers. comm.).

Black Spruce-Labrador Tea

This vegetation type, also called muskeg, constitutes 35% of the western portion of Lease 17 and is the most common of the types identified by Peterson and Levinsohn (1977). Two study plots were established in this vegetation type; both were along the western side of the West Interception Ditch (Figure 2.1). Both plots measured 400 m x 500 m (20.0 ha).

Plot 84-3.--This plot was set out near the boundary between Leases 17 and 22 (Figure 2.1). However, only about 83% of the plot was actually covered by muskeg. A narrow finger of willow-reed grass extending through the centre of the plot covered about 12% of the plot, and a small aspen-white spruce stand constituted the remaining 5% (Appendix B-3). Both of these last two types were present in units too small to have been mapped by Peterson and Levinsohn (1977).

Plot 84-5.--This plot was established about 1 km north of the southern boundary of Lease 17 (Figure 2.1). With the exception of about 0.9 ha of willow-reed grass, the vegetation on the plot was representative of the black spruce-Labrador tea vegetation type described by Peterson and Levinsohn (1977) (Appendix B-5).

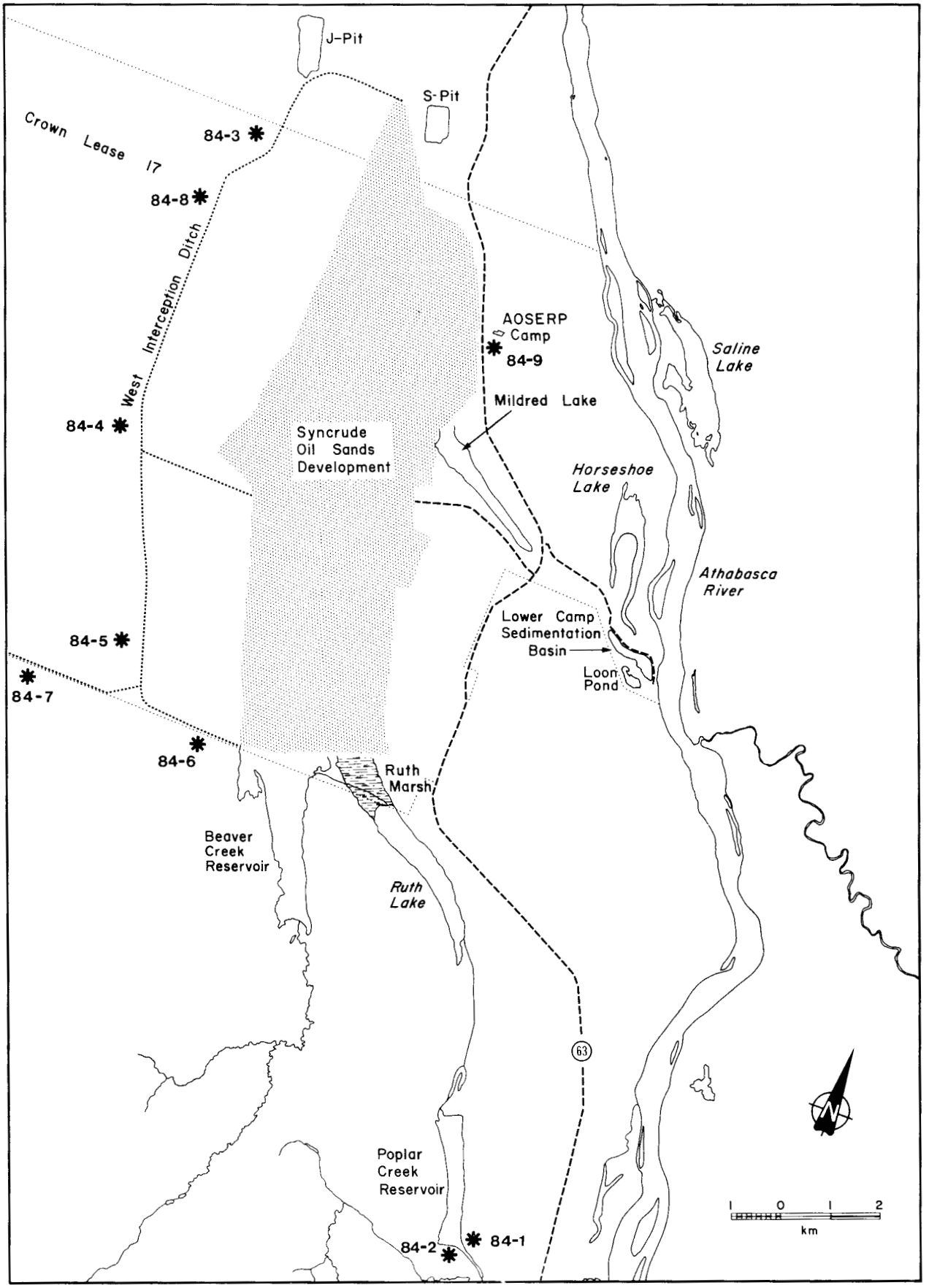

Figure 2.1 Map of the study area, showing locations of breeding bird census plots, June 1984.

Aspen-White Spruce

This vegetation type occupies 26% of the western part of Lease 17, and is the second most common habitat in that area (Peterson and Levinsohn 1977). Two study plots were established in this habitat along the west side of the West Interception Ditch. Each plot measured 400 m x 500 m (20.0 ha).

Plot 84-4.--This plot was established about midway along the West Interception Ditch, just north of its intersection with the 24th Base Line. Although considered as aspen-white spruce (Peterson and Levinsohn 1977), the forested area (about 90% of plot) was almost entirely dense stands of pure aspen. White spruce was rare, and, when present, was mostly young (less than 1 m high) growth. Small units of willow-reed grass were present in low-lying wet areas and constituted most of the remaining habitat. Several cutlines were scattered throughout the plot (Appendix B-4).

Plot 84-8.--This plot was located in the northern part of Lease 17. The vegetational composition of the aspen-white spruce was generally similar to that described for the habitat in Peterson and Levinsohn (1977), and this habitat covered about 91% of the plot. A low-lying wet area of willow-reed grass, including a substantial component of alder, traversed the plot and constituted most of the remainder of the vegetation. A small natural clearing and a cutline were also present (Appendix B-8).

White Spruce-Aspen

This vegetation type occupies about 18% of the western portion of Lease 17 and is the third most common habitat in the lease (Peterson and Levinsohn 1977). No sufficiently large units of this vegetation type were accessible in Lease 17; consequently the two plots established to sample the vegetation type were located in a large unit along the south side of the southern boundary of the lease (Figure 2.1). Both plots were 500 m in length and 35-400 m in width.

Plot 84-6.--This plot totalled 19.5 ha in size. The vegetation was generally representative of that described for white spruce-aspen in Peterson and Levinsohn (1977), with the exception of a low-lying willow-reed grass

unit that occupied about 4% of the plot. Two cutlines were also present (Appendix B-6).

Plot 84-7.--This plot totalled 18.5 ha in size. With the exception of a narrow cutline bisecting the plot (Appendix B-7), the vegetation was typical of the white spruce-aspen vegetation type described by Peterson and Levinsohn (1977).

Poplar Creek Reclamation Area

The lands adjacent to Poplar Creek Reservoir were cleared in 1974-1975 and subsequently revegetated by Syncrude. Two census plots were established in this revegetated area.

Plot 84-1.--This plot was located along the eastern side of Poplar Creek Reservoir and totalled 18.4 ha in area. It included virtually all of the reclaimed area along the eastern side of Poplar Creek Reservoir. The primary vegetation, constituting about 90% of the total area of the plot, was a dense mixture of several species of grasses and forbs, including brome grass, wheat grass, alfalfa, timothy and sweet clover. The height of this vegetation averaged about 1-1.6 m. Young trembling aspen, averaging less than 3 m in height, occupied the remainder of the area (Appendix B-1).

Plot 84-2.--A small plot, totalling 6.5 ha in area, was established on the western side of Poplar Creek Reservoir. The vegetation consisted entirely of forbs and grasses (species composition as on Plot 84-1) and varied from 1 to 2 m in height (Appendix B-2).

Jack Pine

Although jack pine was not identified as a vegetation type in the western part of Lease 17 (Peterson and Levinsohn 1977), recent surveys indicate that this species is a component of the vegetational mosaic on Lease 22, which is immediately north of Lease 17 (D. Reid, Hardy Assoc. [1978] Ltd., pers. comm.). However, Lease 22 is inaccessible by road and, consequently, a census plot could not be established there. Instead, a plot

in jack pine forest (Plot 84-9) was set out in a small area of similar habitat on Lease 17. This plot was at the AOSERP camp along Highway 63 on the eastern side of the lease (Figure 2.1). The plot totalled 8.25 ha in area. Most of the plot consisted of mature jack pine with no understory; there was, however, an occasional trembling aspen with understory alder or serviceberry (Appendix B-9).

2.3.1.2 Establishment of Plots

After the locations of the plots had been selected, the plots were measured and mapped. All plots were constructed to be as near as practical to a square (i.e. 400 m x 500 m for a 20.0 ha plot) to reduce the amount of edge effect. Plots were marked off into 50 m by 50 m grids by four people using compasses and measured lengths of rope. The larger plots each required about one day to measure and map.

2.3.2 Census Techniques

Censuses of the bird populations on the nine study plots were conducted by the territorial mapping (spot-map) method. This method was first described by Williams (1936); it is the method employed in the American Birds annual breeding bird censuses and in Canadian breeding bird studies (Erskine 1971, 1972a, 1976, 1980), and is recommended as the standard census method by the International Bird Census Committee (I.B.C.C. 1970). It is the principal technique for estimating densities of small non-flocking terrestrial birds (Emlen 1971); density values are obtained by determining for each species the number of territories encompassed within the study plot.

The following section briefly describes the procedures used to census the avian population on Lease 17. Specific details of the procedures for the mapping method are presented in I.B.C.C. (1970).

The mapping method involves the repeated censusing of a plot throughout the breeding season. On each plot, an observer walked a standard route along the grid lines, which were 50 m apart. Thus, points between the grid lines were no more than 25 m away from the observer's path. Start and end points

of the route were alternated for each visit. All censuses of a plot were conducted by the same observer.

Each contact with a bird was marked by a code on a map of the plot (visit map) to identify the bird's location. A separate visit map was used for each visit to the plot. Different codes were used to signify singing males, non-singing males, non-singing birds, aggressive encounters between birds, movements of birds and locations of nests. Simultaneous detections ("contemporary contacts") of two different individuals of one species were particularly important, and could be used to define boundaries between adjacent territories and in assessment of the number of territories. After each plot visit, the field data were transferred to species maps. A separate map (composite map) was used for each species on each plot. The calculations of numbers of territories were based on these maps (see below).

All plots were censused nine or ten times, with the exception of Plot 84-4 (aspen-white spruce) and Plot 84-7 (white spruce-aspen). Because of logistical difficulties, these two plots were censused five and four times, respectively. Censuses on the other seven plots included eight or nine morning censuses and one evening census. Morning censuses were done between 04:00 and 09:00 and evening censuses were done between 19:00 and 22:00 MDT. Each census required three to five hours for completion. All censuses were done between 2 June and 28 June.

2.3.2.1 Limitations and Biases of the Mapping Method

The mapping method is the traditional and possibly most widely used procedure to sample forest breeding bird populations quantitatively, both in Europe and North America (Robbins 1978). The methodology has become relatively standardized (I.B.C.C. 1970) and has been used with confidence by many researchers (e.g., Stewart et al. 1952; Williamson 1964, 1971). Although used as a census technique (in which all animals are considered to be counted--cf. Overton 1971), the technique does have inherent limitations and biases such that the end count will rarely indicate the true breeding population. This section briefly summarizes some of the limitations and biases of the mapping method.

As outlined in I.B.C.C. (1970), the mapping method is applicable only to territorial and non-colonial passerines and other species with similar dispersion mechanisms and distribution patterns. For such groups, an underlying assumption of the method is that each song registration represents a territorial male; it is further assumed that each male represents one breeding pair and that the singing intensity of the male and the boundaries of his territory delineated by the registrations are constant over the course of the study. However, in some passerine species, a segment of the population consists of unmated males (Kendeigh 1944); such individuals may hold territories (Nolan 1978) or 'float' throughout the population (Smith 1978). Moreover, such individuals often sing more intensively than mated, territorial males (Nolan 1978). Territories of individuals of some species may move over the course of the breeding season (Wiens 1969; Nolan 1978). Varying proportions of the populations of some species are polygamous (Verner and Willson 1966; Nolan 1978). Although instances of the above-mentioned situations are often considered rare and consequently ignored in calculations of numbers of territories, Nolan (1978) found that only 45% of a study population of 135 territories of prairie warblers were occupied by a single monogamous pair throughout the nesting season.

Other factors involved in estimating numbers of singing males include variability in song frequency and intensity. There can be large differences in song frequency for different species, different individuals of the same species, different stages in the nesting season, time of day and weather conditions (Nolan 1978; Best 1981; Robbins 1981a,b). Since about 90% of the detection cues used in the mapping method are aural (Cyr 1981; pers. obs.), the problem of observer bias, both in terms of hearing ability and ability to separate species, is very real (Ramsay and Scott 1981; Robbins and Stallcup 1981; Bart and Herrick 1984; Bart and Schoultz 1984). There is also great variation in the audibility of songs among species. Ovenbirds, ruby-crowned kinglets and thrushes have loud songs that can be identified and located at a considerable distance, whereas others, such as bay-breasted warblers and orange-crowned warblers, have high-pitched songs that attenuate rapidly and are exceedingly difficult to locate. Mayfield (1981) provides a thorough discussion of the problems in estimating population size through counts of singing males. In general, the problems identified in this paragraph can be largely overcome by repeated coverage of each plot.

Other limitations of the mapping method involve the size of the plot surveyed. Some species have very large territories, which may be multiples of the total plot size. If the entire plot is counted as one territory, rather than as a part of a territory, overestimation of population density can result. Similarly, if plots are too small, an overestimated density can result. In addition, even for a large number of song registrations on a sufficiently large plot, interpretational biases may influence the calculation of numbers of territories (cf. Best 1975; Robbins 1978).

2.3.3 Treatment of Data

2.3.3.1 Indices of Abundance

After the plot visits had been terminated and the composite maps for each species on each plot had been prepared, the number of territories of each species on each plot was evaluated. This was done by the observer who censused the plot, using standard guidelines regarding the minimum number of registrations necessary (three for plots visited nine or ten times) and the problem of clusters along the edge of the plot (I.B.C.C. 1970). Knowledge of both the plot and the species' territory size, habitat requirements and general territorial behaviour was also taken into account. The population density was considered as the number of territorial males per unit size of plot (generally 20.0 ha). For ease of comparison with other studies, these values are also expressed as number of territorial males per 100 ha.

The check method (Seierstad et al. 1969) of estimating the number of territories present but never detected was not applied. Most of the plots were censused with sufficient intensity to ensure that few territories were likely to have been missed. Moreover, this method has not been generally applied to comparable studies of breeding bird populations (e.g., Erskine 1977; Francis and Lumbis 1979) and its application to the results of this study would preclude comparison of the results to these other studies.

2.3.3.2 Indices of Community Structure

The calculation of indices of community structure provides a basis for comparison of different habitats that takes into account both the number of species present ('species richness') and the relative abundances of these species ('evenness'). A variety of parameters and indices of community structure, each with its own uses and limitations, have been developed (e.g., Simpson 1949; Pielou 1966, 1975; Lloyd et al. 1968; Whittaker 1972; Peet 1974). Four common measures of community structure for each of the vegetation types sampled were calculated for this study. These measures are:

1. S, the number of bird species detected in a vegetation type. This is a simple and direct measure of the diversity of a community or vegetation type. However, there is no way of knowing when all species in the community or vegetation type have been included. Thus because S is never known exactly, $\hat{S}$ (the number of species observed) is used as an estimator of S. The value of $\hat{S}$ depends on size of the area sampled.

2. DI, the dominance index (McNaughton and Wolf 1970). It is the proportion of the total number of individuals made up by the two most abundant species. Thus,

$$DI = (n_1 + n_2)/N,$$

where n_1 and n_2 represent the number of individuals of the two most abundant species and N represents the total number of individuals in the habitat or community. The extent to which a habitat is numerically dominated by the two most abundant species is an indirect measure of the evenness of the bird community in that habitat. In general, the dominance index tends to decrease with increasing evenness.

3. H', Shannon-Wiener index of species diversity (Shannon and Weaver 1949). It is calculated from the formula

$$H' = -\sum p_i \ln p_i,$$

where p_i is the proportion of the total number of individuals in the community made up of species i. This index takes into account both the species richness component and the evenness component (see below) of the community, and increases with increasing values of both components. The value of H' tends to stabilize at a maximum value after a sufficiently large sample has been taken (Järvinen and Väisänen 1973).

4. J', an index of equitability. This represents the evenness component of H'; it is calculated by the formula

$$J' = H'/H'_{max},$$

where H'_{max} is the value of H' when all species are equally abundant. H'_{max} is estimated by $\ln \hat{S}$ (Sheldon 1969; Kricher 1972).

For each of the measures, the basic unit considered was the number of territories of each species on the plots. Species that were considered to be non-territorial, either because of an insufficient number of contacts or because of their behaviours (e.g., gray jay), were not included in the calculations.

2.4 RESULTS

2.4.1 Indices of Abundance

Table 2.1 presents the number of territories of each bird species recorded on each of the nine census plots, as well as the total number of territories in all forest habitats combined. Also included in the table are species that were seen during visits to the plots but which were not recorded sufficiently frequently to be judged territorial (see Section 2.3). The gray jay[1] was recorded regularly on all forest plots. However, this species had finished nesting prior to the beginning of the censuses (we noted many young-of-the-year during the censuses), and individuals wandered widely throughout the plots. Thus, territorial boundaries could not be drawn for sightings of this species. Carbyn (1971) commented on the difficulties in applying standard survey methods to gray jays.

Territories of 42 species of birds were recognized on the nine census plots and densities of territorial males ranged from 133/100 ha on the jack pine plot to 770/100 ha on one of the aspen-white spruce plots. An additional 23 species were recorded but not in sufficient frequency to warrant their being judged territorial. It is probable that most, if not all, of these species nest on the plots or in nearby areas. All species

[1] Scientific names of bird species recorded during the study are presented in Appendix C.

Table 2.1. Numbers of territories of birds in five vegetation types on and near Crown Lease 17, northeastern Alberta, June 1984. (+) indicates that the species was recorded bu could not be considered territorial. (-) indicates that the species was not recorded.

Species	Black spruce-Labrador tea		Aspen-white spruce		White spruce-aspen		Jack pine	All forest habitats	Reclamation area	
	Plot 84-3 20.0 ha 9 visits	Plot 84-5 20.0 ha 9 visits	Plot 84-4 20.0 ha 5 visits	Plot 84-8 20.0 ha 9 visits	Plot 84-6 19.5 ha 9 visits	Plot 84-7 18.5 ha 4 visits	Plot 84-9 8.25 ha 9 visits	126.25 ha	Plot 84-1 18.4 ha 9 visits	Plot 84- 6.5 ha 10 visit
Northern harrier	-	-	-	-	-	-	-	-	+	1
Sharp-shinned hawk	-	-	-	+	-	-	-	+	-	-
American kestrel	-	+	-	-	-	-	-	+	-	-
Spruce grouse	-	-	-	-	-	-	+	+	-	-
Ruffed grouse	-	-	-	1	+	-	-	1	-	-
Yellowlegs spp.	+	1	-	-	+	-	-	1	-	-
Bonaparte's gull	-	+	-	-	-	-	-	+	-	-
Great horned owl	-	-	-	-	-	-	+	+	-	-
Common nighthawk	-	+	-	-	-	-	1	1	-	-
Yellow-bellied sapsucker	-	-	-	-	-	2	-	2	-	-
Hairy woodpecker	-	+	-	+	-	-	-	+	-	-
Black-backed woodpecker	-	-	-	-	-	+	-	+	-	-
Northern flicker	-	+	+	-	-	+	-	+	-	-
Pileated woodpecker	-	-	-	-	-	1	-	1	-	-
Western wood-pewee	-	-	-	-	+	-	-	+	-	-
Yellow-bellied flycatcher	+	-	-	-	-	-	-	+	-	-
Alder flycatcher	3	-	-	1	2	+	-	6	4	-
Least flycatcher	-	-	9	38	+	1	+	48	-	-
Eastern phoebe	1	-	-	-	-	-	-	1	-	-
Gray jay	+	+	+	+	+	+	+	+	-	-
Black-capped chickadee	+	-	+	2	+	1	1	4	-	-
Boreal chickadee	1	2	-	-	2	1	-	6	-	-
Red-breasted nuthatch	+	1	-	-	+	1	-	2	-	-
Ruby-crowned kinglet	1	2	-	+	-	-	-	3	-	-
Veery	-	-	-	+	-	-	-	+	-	-
Swainson's thrush	-	1	6	11	4	7	-	29	-	-
Hermit thrush	2	2	2	+	7	1	1	15	-	-
American robin	+	1	+	4	2	+	3	10	+	-
Waxwing spp.	-	-	-	-	-	-	+	+	+	-
Solitary vireo	-	-	8	6	+	+	-	14	-	-
Warbling vireo	-	-	1	-	-	-	-	1	-	-
Philadelphia vireo	-	-	-	1	+	-	-	1	-	-
Red-eyed vireo	-	-	1	8	4	+	1	14	+	-
Tennessee warbler	13	3	11	11	22	19	+	79	-	-
Orange-crowned warbler	-	+	-	-	-	-	-	+	-	-
Yellow warbler	-	-	-	3	-	-	-	3	-	-
Magnolia warbler	1	+	1	-	-	-	-	2	-	-
Yellow-rumped warbler	3	2	-	-	1	-	-	6	-	-
Palm warbler	7	18	-	-	-	-	-	25	-	-
Bay-breasted warbler	-	-	-	+	-	-	-	+	-	-
Black-and-white warbler	2	-	4	7	4	1	-	18	-	-
American redstart	-	-	9	37	+	-	-	46	-	-
Ovenbird	1	-	11	15	8	-	1	36	+	-
Northern waterthrush	+	-	-	-	-	-	-	+	-	-
Connecticut warbler	-	-	1	-	-	-	-	1	-	-
Common yellowthroat	1	1	-	1	-	-	-	3	-	-
Wilson's warbler	3	1	-	-	1	-	-	5	-	-
Western tanager	-	-	-	+	-	3	+	3	-	-
Rose-breasted grosbeak	-	-	2	1	1	1	-	5	-	-
Chipping sparrow	4	5	+	1	10	6	2	28	1	-
Clay-colored sparrow	1	-	-	-	-	-	-	1	6	1
Savannah sparrow	-	-	-	-	-	-	-	-	7	8
Le Conte's sparrow	-	-	-	-	-	-	-	-	6	5
Song sparrow	-	-	-	-	-	-	-	-	+	-
Lincoln's sparrow	1	-	-	-	-	-	-	1	2	-
White-throated sparrow	3	-	4	4	3	2	-	16	-	-
Dark-eyed junco	4	1	-	1	-	-	1	7	-	-
Red-winged blackbird	-	-	-	-	-	-	-	-	-	+
Rusty blackbird	-	-	-	-	+	-	-	+	-	-
Brown-headed cowbird	-	-	+	+	-	-	+	+	-	-
Northern oriole	-	-	-	1	-	-	-	1	-	-
Pine grosbeak	+	-	-	-	-	-	-	+	-	-
Purple finch	-	-	1	-	-	-	-	1	-	-
Crossbill spp.	+	+	-	+	-	-	-	+	-	-
Pine siskin	-	-	-	-	+	-	-	+	-	-
TOTAL SPECIES	27	23	21	30	26	21	16	60	12	5
NO. SPECIES OF TERRITORIAL MALES	18	14	15	20	14	14	8	39	6	4
NO. TERRITORIAL MALES	52	41	71	154	71	47	11	447	26	15
TERRITORIAL MALES/100 ha	260	205	355	770	364	254	133	354	141	231

recorded were common inhabitants of the boreal forest biome. The numerically dominant species recorded during the breeding bird censuses, in descending order of abundance, were the Tennessee warbler, least flycatcher, American redstart, ovenbird, Swainson's thrush, chipping sparrow and palm warbler.

Somewhat different bird communities, both in terms of species composition and overall numbers, were evident among the various vegetation types. Nevertheless, few of the more common species were restricted to only one vegetation type and many species occurred in several of them. Densities of several of the common species did, however, vary substantially between the two compositionally similar vegetation types (aspen-white spruce, white spruce-aspen) and even between plots in the same vegetation type. The bird communities in each of the vegetation types are discussed in the following sections.

2.4.1.1 Black Spruce-Labrador Tea

A total of 34 species of birds were recorded on the two muskeg plots; twenty-two were considered to be territorial. The overall density of territorial males was 233 males/100 ha (Table 2.1). The somewhat higher numbers of species and territorial males on Plot 84-3 (Table 2.1) were presumably due to the greater heterogeneity of the vegetation on that plot; as described above, this plot included elements of both the willow-reed grass and aspen-white spruce vegetation types.

The two most common species in black spruce-Labrador tea were the palm warbler (63 males/100 ha), and the Tennessee warbler (40 males/100 ha). The former is a characteristic species of muskeg habitat (e.g., Salt and Salt 1976). On both plots, Tennessee warblers were noted exclusively in the willow-reed grass areas. Other commonly observed species included the chipping sparrow (23 males/100 ha) and the yellow-rumped warbler and dark-eyed junco (each 13 males/100 ha), all of which are typically found in muskeg areas. Species that were recorded as territorial but which are probably unrepresentative of black spruce-Labrador tea vegetation include black-and-white warbler, ovenbird, common yellowthroat, Wilson's warbler and clay-colored sparrow. All of these were detected in the non-muskeg elements of the plots.

2.4.1.2 Aspen-White Spruce

A total of 35 species were recorded on the two aspen-white spruce plots, including 25 species of territorial males. On one of the plots (Plot 84-4), only five visits were made, substantially fewer than the 10 visits recommended by I.B.C.C. (1970) as the minimum number necessary to census a forest habitat. DesGranges (1980), however, calculated that over 92% of the bird population present on a plot has been detected after four visits. Because of the uncertain accuracy of the data collected on Plot 84-4, the data from the two aspen-white spruce plots are considered separately.

The density of territorial males on the completely-censused aspen-white spruce plot was 770 males/100 ha. Almost 50% of this total consisted of two species: the least flycatcher (190 males/100 ha) and the American redstart (185 males/100 ha). Other common species included the ovenbird (75 males/100 ha), Swainson's thrush and Tennessee warbler (each with 55 males/100 ha), red-eyed vireo (35 males/100 ha), black-and-white warbler, solitary vireo, American robin and white-throated sparrow (Table 2.1).

Although less confidence can be placed in the data from Plot 84-4, inspection of Table 2.1 shows that the species that were most numerous on Plot 84-8 were also numerically dominant on Plot 84-4. The extraordinarily high densities of least flycatchers and American redstarts were not noted but most of the other species were present in numbers similar to those on Plot 84-8. Five species not detected or considered territorial on Plot 84-8 were judged to be territorial (i.e. detected during at least two of the five visits [cf. I.B.C.C. 1970]) on Plot 84-4: hermit thrush, warbling vireo, magnolia warbler, Connecticut warbler and purple finch.

2.4.1.3 White Spruce-Aspen

A total of 31 species were recorded on the two plots in the white spruce-aspen vegetation type, including 20 territorial species. As with Plot 84-4 in the aspen-white spruce, the number of visits to Plot 84-7 in white spruce-aspen was less than recommended to assume complete documentation of the breeding population of the plot. Thus, the data from Plot 84-6, where a

sufficient number of visits was made, are considered separately from those of Plot 84-7 in evaluation of the avian population in white spruce-aspen.

The density of territorial males in the completely-censused white spruce-aspen plot was 364 males/100 ha. The Tennessee warbler was by far the most common species present--110 territorial males/100 ha. This species was present throughout the plot, both in white spruce-aspen and in the narrow band of willow-reed grass that cut through the plot. Other species that were common on the plot included the chipping sparrow, hermit thrush and ovenbird.

Several species not recorded on Plot 84-6 were considered to be territorial (i.e. detected during three of the four visits) on Plot 84-7. These species included the pileated woodpecker, yellow-bellied sapsucker, and western tanager. In addition, the least flycatcher, black-capped chickadee and red-breasted nuthatch were territorial on Plot 84-7, but were detected only infrequently on Plot 84-6.

2.4.1.4 Jack Pine

Sixteen species of birds were recorded on the small plot established in jack pine vegetation; eight of these were considered to have breeding territories. The overall density was 133 territorial males/100 ha. The American robin (36 males/100 ha) and the chipping sparrow (24 males/100 ha) were the most common species. The red-eyed vireo and ovenbird were detected only where trembling aspen was present.

2.4.1.5 Poplar Creek Reclamation Area

A total of 13 species were recorded in the revegetation plots along Poplar Creek Reservoir. Seven species were considered to be territorial. Of the passerines, the alder flycatcher (16 males/100 ha), Lincoln's sparrow (8 males/100 ha) and the clay-colored sparrow (28 males/100 ha) were recorded only or primarily in the young aspen trees, whereas the other sparrow species (see Table 2.1) were recorded only in the grass/forb vegetation. Savannah sparrows (60 males/100 ha) and Le Conte's sparrows (44 males/100 ha) were the most common species in this low vegetation. Birds in the revegetated areas frequently used our survey stakes as song posts.

2.4.2 Indices of Community Structure

Table 2.2 presents the values of the four measures of community structure calculated for each of the five vegetation types censused. Because of the wide variation in sample size among vegetation types (from 8.25 ha in jack pine to 40.0 ha in black spruce-Labrador tea), and the large differences in numbers of individuals recorded in the various vegetation types, any comparisons among the vegetation types should be done with caution. Nevertheless, some general comments can be made about the indices.

Table 2.2. Indices of avian community structure for five vegetation types sampled on and near Crown Lease 17, northeastern Alberta, June 1984.

Vegetation type	Area sampled (ha)	No. individuals detected	$\hat{S}$	DI	H'	J'
Black spruce-Labrador tea	40.0	93	22	0.44	2.51	0.81
Aspen-white spruce	40.0	225	25	0.41	2.43	0.76
White spruce-aspen	38.0	118	20	0.48	2.31	0.77
Jack pine	8.25	11	8	0.45	1.97	0.95
Reclamation area	24.9	41	7	0.65	1.58	0.81

The number of species ($\hat{S}$) was highest in aspen-white spruce, and was also high in white spruce-aspen. It is possible that the values for this index in these vegetation types would have been higher if a complete complement of visits had been made to all four plots in these types. The species diversity (H') was higher in the black spruce-Labrador tea (muskeg) vegetation type than in either of the two mixed-woods habitats, a reflection of the higher value of the evenness component (as measured by J') in the muskeg. This difference in equitability is also reflected in the number of common species (those constituting 2% or more of the total number of individuals in a vegetation type--Richardson and Thompson 1974): 13 of the 22 species in muskeg were considered common species, but only nine of 25 and 10 of 20 were common in the aspen-white spruce and white spruce-aspen, respectively.

Species diversities in jack pine and the revegetation area were substantially lower than in the major forest vegetation types. Unlike the other forest habitats, which have a shrub understory, jack pine is essentially a single-layered habitat with little or no understory. Previous studies (e.g., Tramer 1969; Karr and Roth 1971; Kricher 1973; Willson 1974; McLaren and McLaren 1978; Eagles 1981) have shown that single-layered habitats have much lower diversities than multi-layered habitats. In addition to being a single-layered habitat, the jack pine plot was small. Fewer species would be expected on a small plot than on a large plot, regardless of the habitat type.

2.5 DISCUSSION

2.5.1 Comparisons With Other Studies

The results of the breeding bird censuses provide an indication of the number of territorial species and the densities of territorial males in each of the vegetation types sampled in Lease 17. In the previous sections, various measures of bird communities were compared among the vegetation types. Generally speaking, densities were higher in the mixed-forest vegetation types than in black spruce-Labrador tea, which were in turn higher than those in jack pine. However, the censuses do not by themselves provide an indication of the importance of the habitat on Lease 17 to the bird community there, compared to other areas of the boreal forest. It is useful to compare the results of this study with other breeding bird plot studies conducted in the boreal forest, both in northern Alberta and throughout Canada, to attempt to determine if the principal vegetation types on Lease 17 support unusual densities of breeding birds relative to other parts of the boreal forest, or if they provide habitat for any uncommon or rare species.

As discussed earlier, no single census method can provide precise data on the numbers and densities of breeding birds in a habitat or area. The mapping method is considered to be superior to strip or transect methods in evaluating breeding bird densities (Erskine 1977; Robbins 1978; Franzreb 1981), despite its limitations and biases. Generally speaking, such problems become smaller as the study areas (i.e. plots) become larger. On the other

hand, the increased reliability of the data from large plots must be balanced off by the decreasing likelihood of a homogeneous habitat throughout such plots, and a concomitant decrease in the value of the data as a catalogue of the avian community of a particular habitat. It is important to bear in mind these factors in any comparison of plot studies.

In addition, it is important to recognize that breeding bird populations fluctuate from year to year. Consequently, any conclusions based on the results of a single season's breeding bird census in a habitat, or on comparisons of the results of two or more such censuses, must be tempered by the understanding that densities in that habitat may be quite different in subsequent seasons. Francis and Lumbis (1979) noted a net decline in total population density (territorial males/100 ha) of 27% on a plot in northeastern Alberta during successive seasons. This decline included decreases of up to 80% for some species and increases of up to 38% for others. Such changes may reflect a redistribution of birds on a local scale due to factors such as habitat saturation or increase in food supply (e.g., a spruce budworm [Choristoneura fumiferana] outbreak), or may reflect a change in the size of the population caused by, for example, severe climatic or other conditions in wintering areas (cf. Erskine 1977; Finney et al. 1978).

Table 2.3 presents information concerning breeding bird plot censuses in the four boreal forest habitats sampled during this study. The plots on the reclamation area are in a unique vegetational mosaic and there are no previous studies in the boreal forest region with which their breeding bird populations can be properly compared. The study most geographically comparable to this study is that of Francis and Lumbis (1979), who conducted a series of breeding bird plot censuses in a variety of forested and open habitats 16-55 km north of the present study area in 1976 and 1977. Their procedure followed, for the most part, the recommendations of I.B.C.C. (1970) and was similar to the methods used in this study. Their plots varied from 16 ha to 50 ha in size (average 31 ha); most included several different habitats or vegetation types. Depending on the type of habitat and the degree of vegetational heterogeneity, Francis and Lumbis recorded 7-36 breeding species and 67-545 territorial males/100 ha on the plots.

Table 2.3. Comparison of results of breeding bird plot censuses conducted in the boreal forest region of Canada.

		This study	Francis and Lumbis (1979)	Western boreal forest (American Birds)	Eastern boreal forest (Erskine 1977)
Black spruce-Labrador tea	No. plots (size [ha])	2 (20)	1[a] (30)	2 (23-35)	8[b]
	No. species	23-27	33-36	7-19	20
	No. breeding species (range[c])	22 (14-18)	33 (29-30)	16 (6-12)	19 (n/a)
	No. males/100 ha	205-260	418-571	34-212	24-465
Aspen-white spruce	No. plots (size [ha])	2 (20)	3 (32.5-42.5)	7 (13.3-19.3)	6[b]
	No. species	21-30	16-45	12-34	27
	No. breeding species (range)	25 (15-20)	45 (11-36)	41 (8-25)	27 (n/a)
	No. males/100 ha	355-770	142-515	156-594	337-672
White spruce-aspen	No. plots (size [ha])	2 (18.5-19.5)		3 (17.5-19.5)	7[b]
	No. species	21-26		10-30	26
	No. breeding species (range)	20 (14-14)		37 (8-26)	26 (n/a)
	No. males/100 ha	254-364		106-430	232-765
Jack Pine	No. plots (size [ha])	1 (8.3)	2 (35)	1 (16)	8[b]
	No. species	16	12-12	9	26
	No. breeding species (range)	8	13 (7-9)	7	22 (n/a)
	No. males/100 ha	133	67-86	113	84-188

[a] One plot censused in both 1976 and 1977.
[b] "Most plots were 10-20 ha in size" (Erskine 1977:21).
[c] Range of value on individual plots or years.

The results of this study have also been compared with the results of breeding bird plot censuses that are conducted annually in the boreal forest (Erskine 1971, 1972a, 1976, 1980). Most of the plots censused under this program are 10-20 ha in size. Many of the censuses conducted prior to 1976 have been summarized in Erskine (1977). All have been reported in the annual issues of American Birds. The results of those studies conducted in the boreal forest of western Canada (Manitoba to northeastern British Columbia) were examined according to the detailed vegetation description of the plots given in American Birds; the data from the plot censuses in eastern Canada are taken from Erskine (1977).

A comparison of the results of this study can also be made with the data collected during spot censuses by personnel of Syncrude Canada Ltd., at least for the mixed-forest habitats that were sampled. As mentioned above, such data do not provide indices of abundance that are comparable to those calculated during this study; they do, however, provide information concerning the species of birds present.

The following sections present a detailed comparison, arranged by vegetation type, of this study's results with those of previous studies.

2.5.1.1 Black Spruce-Labrador Tea

Numbers of all species, species of territorial males, and territorial males/100 ha may vary widely in this habitat. The values from Francis and Lumbis (1979) are probably substantial overestimates of the actual average values for muskeg. Their muskeg plot actually included five different habitats: black spruce muskeg, willow muskeg, tamarack fen, willow fen and mature mixed aspen-spruce forest. Consequently, comparisons of species richness and densities derived from this study with those of Francis and Lumbis are not very useful. The study that is perhaps most comparable is a census conducted by Erskine (1973) on a 23.4 ha black spruce forest plot in western Saskatchewan, about 370 km southeast of the present study area. Erskine recorded 19 species, 12 species of territorial males, and 185 territorial males/100 ha on that plot. Given the inevitable differences in vegetational composition on the plots and in observer abilities and survey

conditions (cf. Erskine 1973), the results of the censuses of the present study are remarkably similar to that of Erskine's. The only species recorded by Erskine (1973) that was not detected during the censuses on Lease 17 was the Cape May warbler (Dendroica tigrina), a species which nests locally in northern Alberta (Salt and Salt 1976) and whose numbers in any particular area can fluctuate widely from year to year (Morris et al. 1958). All species recorded during the censuses on Lease 17 were also recorded during the American Birds censuses.

2.5.1.2 Aspen-White Spruce; White Spruce-Aspen

These two vegetation types are compositionally and, to a lesser degree, physiognomically quite similar and are often not considered to be different by reporters of bird censuses. Consequently, they are discussed together here.

Aspen-white spruce supports the largest number of species and highest density of territorial males of all habitats surveyed on Lease 17. Values of these variables in white spruce-aspen are slightly lower. The very high number of territorial males in one of the aspen-white spruce plots (Plot 84-8) and the resultant large discrepancy with the corresponding value on the other plot (Plot 84-4) is in large part a function of the extremely high densities of least flycatchers and American redstarts on Plot 84-8. In addition, the incomplete complement of visits to one of the plots in each vegetation type may have resulted in an underestimate of the number of species present (i.e. species richness) and density of territorial males in these vegetation types. Nevertheless, the values from this study are quite similar to those calculated from the other plot censuses (Table 2.3). The higher values for total number of species and number of species of territorial males from the plots censused by Francis and Lumbis (1979) are attributable to the very diverse vegetational mosaics on their plots. Up to eight different vegetation types were present on each of their three plots in this habitat. Similarly, the higher species richness value recorded for the group of American Birds censuses is likely a reflection of the large number (seven) of plots included in Table 2.3.

Densities of territorial males in each of the two vegetation types were similar in all four groups of censuses. Densities in white spruce-aspen tended to be slightly lower than in aspen-white spruce, although a great degree of overlap is evident. Nine species of territorial males[1] recorded by Francis and Lumbis (1979) were not recorded in these two mixed-forest vegetation types during this study. However, all are characteristic of habitats not present on our plots or are local or scarce nesting residents in northern Alberta (Salt and Salt 1976). On the other hand, no species were recorded in these vegetation types that were not also recorded by Francis and Lumbis (1979). The Canada warbler was the only species recorded during spot censuses by personnel of Syncrude Canada Ltd. that was not recorded during this study. They also noted that the Tennessee warbler was among the most common passerine species in spruce-aspen forests on Lease 17.

The data presented in Table 2.3 for the eastern boreal forest should be viewed with caution. The values for the aspen-white spruce vegetation type taken from Erskine (1977) include data from plots in forests dominated by aspen or birch, with no reference as to what tree species, if any, were co-dominant or sub-dominant. Similarly, data for the white spruce-aspen vegetation type are from plots in forests dominated by spruce, with no reference to any co-dominant or sub-dominant species. Nevertheless, species richness and density values from Erskine (1977) are quite comparable to those derived from this study.

It is also worth noting that densities of up to 770 territorial males/100 ha (as calculated from this study), although perhaps high in the context of the boreal forests of western Canada, can be low in comparison to parts of the boreal forest in eastern Canada. Welsh and Fillman (1980) recorded densities of up to 2005 males/100 ha in mixed-woods habitat in northern Ontario.

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[1] Eastern phoebe, winter wren (Troglodytes troglodytes), orange-crowned warbler, Cape May warbler, northern waterthrush, mourning warbler (Oporornis philadelphia), Canada warbler (Wilsonia canadensis), song sparrow, Lincoln's sparrow.

2.5.1.3 Jack Pine

As with the other three forest vegetation types surveyed, values for species richness and densities of territorial males in jack pine are comparable with those of other plot censuses in this habitat. The high density recorded in this study compared to densities found by Francis and Lumbis (1979) may be an artifact caused by the small size of the plot; as described earlier, small plots can result in an overestimate of the population density (cf. Eagles 1981). The numbers of species of territorial males were virtually identical on the plot censused on Lease 17, on those of Francis and Lumbis, and on a plot censused in northern Manitoba as part of the American Birds census (Table 3.2). Species composition was also similar, with the exception of the yellow-rumped warbler, a common species in most forests with a coniferous element. This species was not recorded on the Lease 17 plot but was the most numerous on the plots of Francis and Lumbis. With the exception of the spruce grouse and great horned owl, both of which are common and widespread forest species, none of the species recorded in jack pine was restricted to this vegetation type.

Densities of territorial males in jack pine forests of eastern Canada tend to be similar to or slightly higher than those recorded in northern Alberta. The larger numbers of species and species of territorial males on the eastern Canadian plots is undoubtedly a reflection of the much higher number of plots censused. Nevertheless, it appears that jack pine supports an impoverished avifauna in comparison with the other forest vegetation types sampled.

2.5.2 Breeding Bird Populations in Reclaimed Areas

As stated above, there are no previous plot censuses of breeding bird populations in reclaimed areas in the boreal forest region with which the results of the present study can be compared, and few studies of any kind of bird populations in such areas. Whitmore (1980) conducted plot censuses of breeding birds in sparse grasslands on reclaimed surface mines in West Virginia over a three-year period. He recorded two to six species of territorial passerines and densities of 41-219 males/100 ha. The highest

values were recorded in the last year of the study. In another study, Krementz and Sauer (1982) recorded 11 species, including one breeding species, on partially reclaimed mine spoil in Wyoming. Both of these studies indicated that ground-feeding species (e.g., sparrows) were the most numerous species in the reclaimed area, undoubtedly a result of the lack of vertical heterogeneity in the vegetation.

The censuses of the present study produced similar findings. Savannah sparrows and Le Conte's sparrows were the most numerous species on the plots (occupying 26 of the 41 territories identified) and, with the exception of one chipping sparrow, were the only passerine species present in the portions of the plots where trees were absent. All other passerine species, including both territorial and non-territorial species, were present exclusively or primarily in the area of young aspen growth. It is thus apparent that the forbs and grasses that were used to revegetate the cleared lands support a small number of species in breeding densities that are considerably lower than those present in forested areas. The evolution of this single-layered habitat into a treed habitat will likely eliminate the grassland species but will result in an overall higher number of species and a higher breeding density of the local avian community.

2.5.3 Breeding Bird Populations on Lease 17

The area of the western half of Lease 17 (west of the West Interception Ditch) is about 9250 hectares. In this study, 118 hectares (1.3%) of the three principal vegetation types occurring in this area--black spruce-Labrador tea, aspen-white spruce, and white spruce-aspen--were censused, which together constitute about 80% of the total vegetation in the area (Peterson and Levinsohn 1977). These three vegetation types, together with jack pine, a vegetation type not present on the western part of Lease 17 but which has been identified as a component of the forest mosaic on adjacent Lease 22, are characteristic habitats of the boreal forest in Canada (Rowe 1972), a biome that encompasses about 6.5 million km^2. In addition, five other vegetation types were identified on the western part of Lease 17 by Peterson and Levinsohn (1977), but were inaccessible or present in amounts

too small to sample. These habitats, too, are characteristic of the boreal forest region.

Similarly, the bird populations present in the vegetation types that were sampled are characteristic of the boreal forest region. Virtually all of the species recorded, including those with territories and those which could not be considered territorial, have breeding ranges that extend, in appropriate habitat, throughout Canada (cf. Godfrey 1966). Exceptions such as the western wood pewee and the western tanager are widespread in suitable habitat through western Canada (Flack 1976; Salt and Salt 1976). As well, densities of territorial males in the vegetation types sampled are typical of those occurring throughout the boreal forest region. It is also notable that few of the species that were recorded were confined to only one of the vegetation types sampled in this study. Although this may be partly due to the virtual impossibility of establishing a large census plot in a completely homogeneous vegetation type, it is also possible that birds respond to a specific feature or features of the vegetation rather than to the broad habitat mosaic (Brewer 1967; McLaren 1975).

As stated above, five other vegetation types identified on the western part of Lease 17 were not systematically sampled during this study. One of them, **willow-reed grass,** was, however, present in small patches on several of our census plots. The presence of several species, often in high densities (e.g., Tennessee warbler), in such vegetation has been previously noted. **Aspen-birch,** which constitutes 7% of the vegetational mosaic on the western part of Lease 17, is primarily a transitional stage between black spruce-Labrador tea and aspen-white spruce (Peterson and Levinsohn 1977). Elements of the avian communities of both of these two major vegetation types could thus be expected in aspen-birch. **Balsam poplar-alder** constitutes about 6% of the habitat in the western part of Lease 17 and is restricted to the valley of the MacKay River. Francis and Lumbis (1979) sampled a similar riverine habitat in the floodplain of the Athabasca River. They recorded 25 species of territorial males with a total density of 545 males/100 ha. The most common species were least flycatcher, American redstart and red-eyed vireo, species which are typical of, and common in, most deciduous-dominant habitats. **Sedge-reed grass** constitutes about 4% of the total vegetation on

the western part of Lease 17. Francis and Lumbis (1979) also established a plot in this habitat. They recorded eight species and 479 territorial males/100 ha. All were commonly occurring species and almost 65% of the territorial males were either red-winged blackbirds or swamp sparrows (Melospiza georgiana). The fifth minor vegetation type is **black spruce-feathermoss** and represents 0.5% of the western part of Lease 17. It occurs for the most part in higher and drier sites surrounded by areas of black spruce-Labrador tea (Peterson and Levinsohn 1977), and has much the same avifauna as the muskeg habitat (cf. Francis and Lumbis 1979).

Undoubtedly, there are several species of birds that breed in the forests on the western part of Lease 17 that were not recorded during this study. As stated above, personnel of Syncrude Canada Ltd. have noted the presence of the Canada warbler. Such species are likely present both in the vegetation types that were sampled and in those that were not sampled. Species such as the olive-sided flycatcher (Contopus borealis), winter wren and black-throated green warbler (Dendroica virens) all presumably occur in the black spruce-Labrador tea or mixed spruce-aspen associations on Lease 17. Other species such as the mourning warbler and fox sparrow (Passerella iliaca) are likely to be found in appropriate scrub or riverine habitats that were not sampled in this study. However, even with an increase in the overall species richness and, possibly, density of territorial males as a consequence of the inclusion of more census plots and more vegetation types, the conclusions from this study would not be altered. The breeding bird community on the western part of Lease 17 is similar both in diversity and in density to that throughout the remainder of the boreal forest region of western Canada.

CHAPTER 3. WATERBIRD NUMBERS ON MAJOR WATERBODIES ON AND NEAR LEASE 17

3.1 INTRODUCTION

Crown Lease 17 is situated about 180 km south of the Peace-Athabasca Delta, a major staging, breeding and moulting area for waterbirds. Substantial numbers of migrating waterbirds pass through the Fort McMurray region, including Lease 17, in spring and autumn on their way to and from the delta. Prior to 1974, the Lease 17 area was not considered an important area for nesting waterfowl, at least relative to other western Canadian breeding areas such as the prairie potholes and the Peace-Athabasca Delta (Schick and Ambrock 1974).

The construction of Syncrude's oil sands plant on Lease 17 in the mid 1970's has resulted in an alteration of the configuration and number of waterbodies on and near the lease. Because of the possible impact on waterbird numbers and distributions due to these changes, Syncrude has conducted studies since the early 1970's to monitor any changes in abundance, diversity and distribution of the waterbird community. In 1971-1973, aerial surveys of waterbodies existing prior to development of the oil sands plant were conducted during migration (R.R.C.S. 1973). Sharp et al. (1975) conducted studies in 1974 to assess the importance of the area to breeding and moulting waterbirds. Sharp and Richardson (1976) evaluated the numbers, distributions and activities of waterbirds on Lease 17 in 1975, during the early stage of project development. They also documented the physical changes to the existing waterbodies caused by the development. In 1977, Ward and Hollingdale (1978) again documented numbers of nesting waterbirds and productivity of waterbirds in the Lease 17 area. By this time, all major changes to the waterbodies had been completed, including development of the Beaver Creek Diversion System, development of the Fresh Water Supply System and creation of the West Interception Ditch. Ward and Hollingdale (1978) found that, between 1974 and 1977, there had been substantial increases in the numbers of adult waterbirds present in the Lease 17 area during the nesting season and in the numbers of broods produced on the lease.

In addition to these studies, Syncrude has established a bird surveillance program which has been operational since 1980. One part of the program is to conduct spot censuses of several waterbodies to monitor local activity patterns, population levels and species composition of birds using these waterbodies. The data collected through this recent program are not directly comparable to those collected during lake surveys, due to differences in methods (telescope vs. canoe) and area of coverage (partial vs. total). However, the spot censuses do provide information on seasonal and annual variations in waterbird abundance in the early 1980's.

This chapter presents the results of a series of surveys conducted on several large and small waterbodies on and near Crown Lease 17 during the period June-October 1984. The main objectives of this study were:

1. to document the numbers and distribution of waterbirds on waterbodies on and adjacent to Lease 17 during the breeding, post-breeding, moulting and migration periods of 1984; and
2. to compare the data collected in 1984 with those from previous surveys in 1974, 1975 and 1977, to determine whether there have been any changes in composition, abundance or distribution of the waterbird community over the 11-year period.

3.2 METHODS

3.2.1 1984 Waterbody Surveys

A total of 37 waterbodies on and near Lease 17 were surveyed in 1984 (Figures 3.1 and 3.2); most of these had been surveyed for waterbirds in at least one year between 1974 and 1977. They included four waterbodies in the Beaver Creek Diversion System (Beaver Creek Reservoir, Ruth Marsh, Ruth Lake, Poplar Creek Reservoir), two waterbodies in the Fresh Water Supply System (Lower Camp Sedimentation Basin, Mildred Lake), 28 borrow pits and small waterbodies (including the West Interception Ditch, S-Pit and J-Pit) created by development of Lease 17 (collectively called the Syncrude Site Water Areas [SSWAs]), and three waterbodies unmodified by development (Loon Pond, Horseshoe Lake, Saline Lake). Waterbodies were surveyed every 10 days, beginning (weather permitting) on the 6th, 16th and 26th of each month, from 6 June to 6 October.

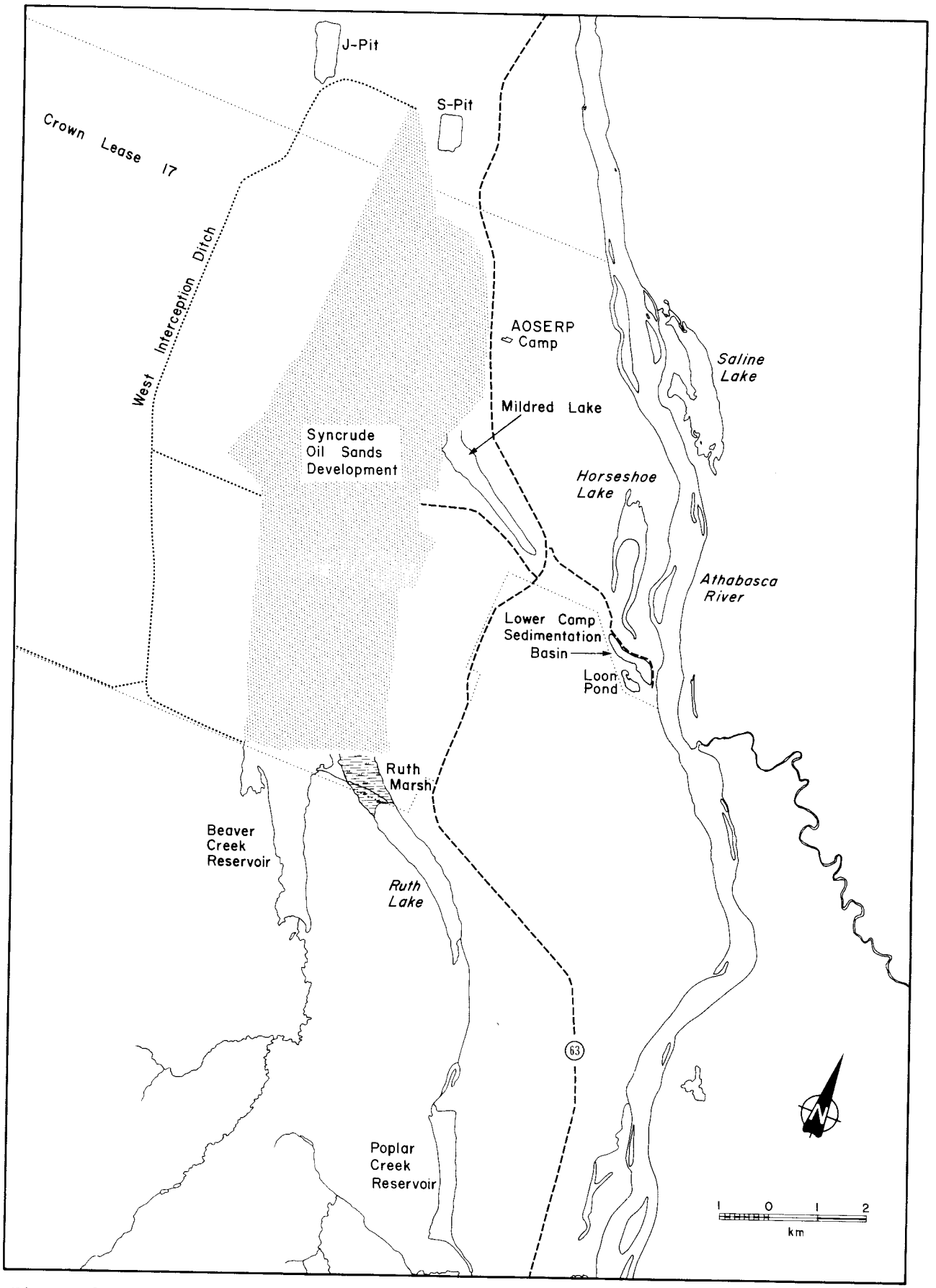

Figure 3.1 Map of the study area, showing locations of larger waterbodies surveyed in 1984.

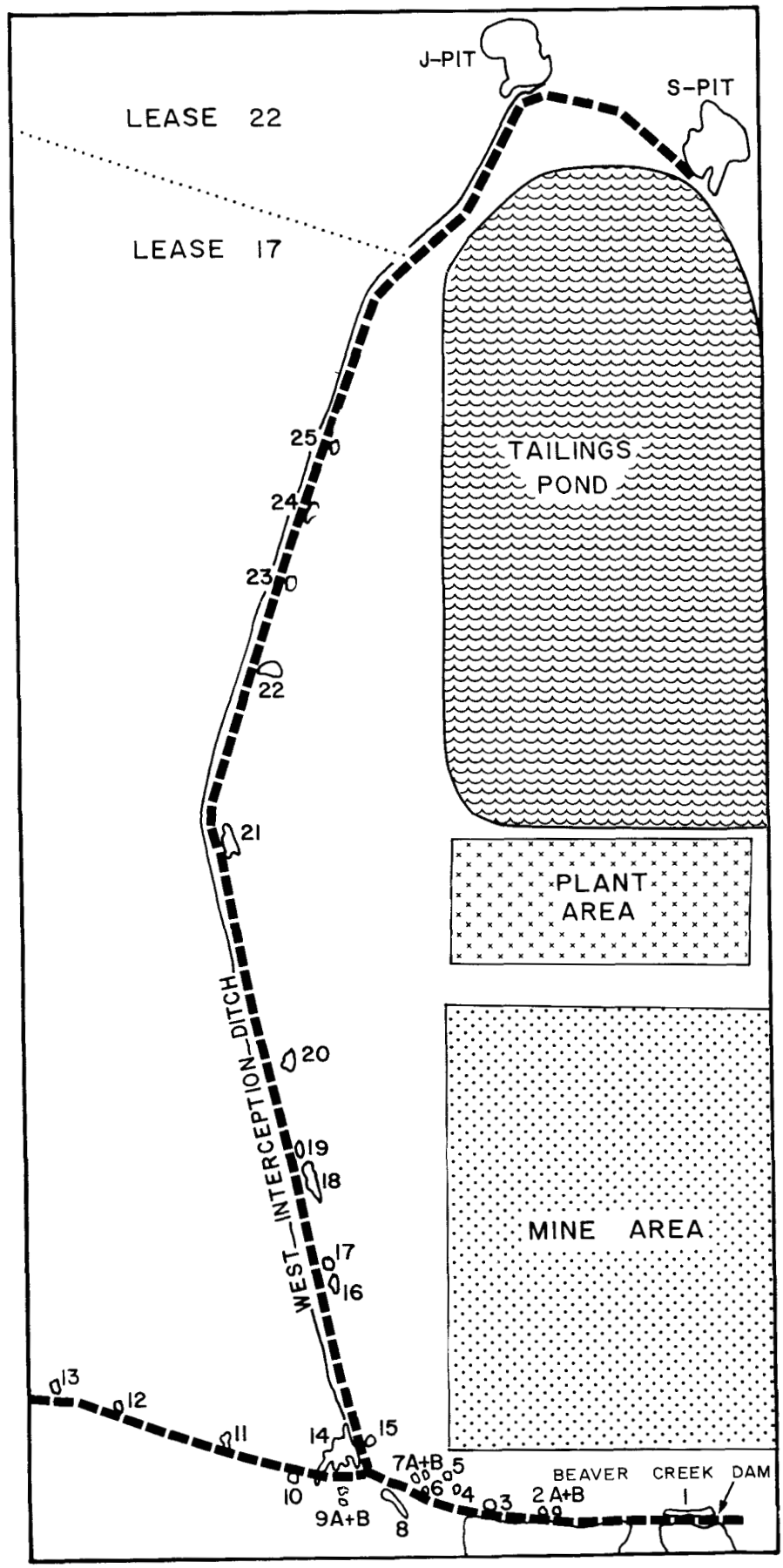

Figure 3.2 Locations of the Syncrude Site Water Areas on Lease 17 surveyed in 1984

Survey methods used during the 1984 waterbody inventories were patterned after those used in the previous Lease 17 waterbody inventories (1974--Sharp et al. 1975; 1975--Sharp and Richardson 1976; 1977--Ward and Hollingdale 1978). This was done to allow among-year comparisons of waterbird numbers and species diversities. Waterbodies were surveyed by canoe, motor boat, or telescope and binoculars, depending on the size of the waterbody and accessibility to the water area. The means used to survey each waterbody through the study period in 1984 are summarized in Appendix D. During canoe surveys, observers paddled around the entire perimeter of each waterbody, and maintained a distance of 5 to 20 m from the shoreline vegetation. A motor boat was used for early surveys on Mildred Lake, Poplar Creek Reservoir and Saline Lake to reduce the time required to conduct the surveys, but this technique could not be used when submergent vegetation reached such densities that it impeded progress. During telescope/binocular surveys, observers censused the waterbody from several viewpoints, as necessary, to ensure coverage of the entire surface.

The following information was recorded during surveys for each waterbird sighting: the waterbird species or group, the number of birds seen, and the age and sex category (when determined). Duck broods were classified according to the aging system described by Gollop and Marshall (1954).

The timing of waterbody surveys during the season and the selection of waterbodies to be surveyed varied somewhat over the years 1974, 1975, 1977 and 1984. The lakes surveyed each year are summarized in Table 3.1. The scheduling of, and methods used for, the inventories of the waterbodies are summarized for 1974 in Sharp et al. (1975), for 1975 in Sharp and Richardson (1976), and for 1977 in Ward and Hollingdale (1978).

3.2.2 Data Analyses

The numbers of each of the major waterbird species or groups recorded on each waterbody in 1984 are presented by survey period in the Results section (Section 3.4). The statuses of small water-associated species (e.g., red-winged blackbird, marsh wren, belted kingfisher) are discussed in Appendix C.

Table 3.1. Years in which waterbodies on and near Crown Lease 17, northeastern Alberta, were surveyed.

Waterbody	Year of Survey			
	1974	1975	1977	1984
Beaver Creek Reservoir[1]			X	X
Ruth Marsh[2]			X	X
Ruth Lake	X	X	X	X
Ruth Lake Diversion Canals				X
Poplar Creek Reservoir[1]			X	X
Mildred Lake	X	X	X	X
Lower Camp Sedimentation Basin[3]		X	X	X
Horseshoe Lake	X	X	X	X
Saline Lake	X			X
Syncrude Site Water Areas[4]	X	X		X
Loon Pond[5]	X	X	X	X

[1] Not present in 1974 and 1975.
[2] Resulted from the flooding of three Syncrude Site Water Areas that existed in 1974 and 1975.
[3] Not present in 1974.
[4] In 1984, these included the West Interception Ditch and 27 borrow pits and small natural waterbodies; these water areas were not the same as those surveyed in 1974 and 1975.
[5] Known as Lower Camp Pond in 1974.

For comparison with the results of previous years, waterbirds were grouped into taxonomic units (e.g., grebes, dabbling ducks, diving ducks), and the field season was divided into the same four time (seasonal) periods described by Sharp and Richardson (1976). These periods were early summer (16 June to 15 July), mid summer (16 July to 15 August), late summer (16 August to 15 September) and autumn (16 September to 15 October). Table 3.2 summarizes the time periods during which waterbody surveys were conducted in 1974, 1975, 1977 and 1984.

Table 3.2 Time periods and years during which waterbody surveys were conducted on and near Crown Lease 17, northeastern Alberta.

	Time Period			
Year	Early Summer	Mid Summer	Late Summer	Autumn
1974		X	X	X
1975	X	X	X	X
1977	X			
1984	X	X	X	X

3.3 DESCRIPTION OF WATERBODIES SURVEYED IN THE STUDY AREA

In 1984, surveys covered nine large waterbodies and 28 smaller water areas on and adjacent to Lease 17 (Figures 3.1 and 3.2). Three of the large waterbodies (Horseshoe Lake, Loon Pond, Saline Lake) have not been altered by development of Syncrude's oil sands plant, two were altered somewhat (Mildred Lake, Ruth Lake), and four were created as a result of the development (Beaver Creek Reservoir, Poplar Creek Reservoir, Ruth Marsh, Lower Camp Sedimentation Basin). The smaller water areas surveyed included 27 small pools and borrow pits located along the Beaver Creek dam and the West Interception Ditch, as well as the West Interception Ditch itself. Many of these waterbodies had been surveyed for waterbirds during previous studies (Table 3.1).

In this section, a description of the physical and biological characteristics of the above-mentioned waterbodies, and of the changes that have occurred in these characteristics since 1974, is presented. Those characteristics that are thought to define the importance of a waterbody as habitat for waterbirds are emphasized. These include the area, shoreline type and length of perimeter, depth, aquatic vegetation communities and aquatic organisms. The major changes in these characteristics for each waterbody are summarized in Table 3.3. The information is taken from Sharp et al. (1975), Sharp and Richardson (1976), Noton and Chymko (1978), Ward and Hollingdale (1978), Carmack and Killworth (1979) and Syncrude Canada Ltd. (1984).

3.3.1 Beaver Creek Reservoir

Beaver Creek Reservoir (Figure 3.1) was formed when the Beaver Creek dam, constructed to divert stream flow away from the area of project development, was closed in the autumn of 1975; the reservoir reached its planned maximum size in 1976. The reservoir receives water via two creeks from the south, from the West Interception Ditch and from the south mine sump; it is drained at its northeastern corner by a diversion canal into Ruth Lake. During surveys in 1974 and 1975, the site for Beaver Creek Reservoir had been cleared but not flooded; the area at that time contained six small SSWAs (Table 3.3).

The current physical and vegetational characteristics of Beaver Creek Reservoir have not changed since 1977 and are presented in Table 3.3. In general, flows through the reservoir are high in summer and low in winter, although annual variation is considerable as flowthrough is strongly dependent on regional rainfall. The banks of the reservoir are low-lying and gently sloping, except along the dam face on the northern shore. There are several shallow marshy areas dominated by sedge, bulrushes and cattails along the eastern shore, the northeastern corner, the southern shore and the southern part of the northwestern arm. The remainder of the shoreline is well-vegetated with forbs and shrubs, again with the exception of the rocky dam face on the northern shore. Numerically dominant species of submerged and floating vegetation include pondweed, hornwort, water-milfoil,

Table 3.3. Summary of major changes in characteristics of waterbodies on and near Crown Lease 17 (excluding Tailings Pond) as a result of the oil sands development.

Waterbodies	Area and Perimeter		Depth		Shoreline and Aquatic Vegetation Characteristics		Aquatic Organisms	
	1974-1975	1977-1984	1974-1975	1977-1984	1974-1975	1977-1984	1974-1975	1977-1984
Beaver Creek Reservoir (BCR)	- area of 12 ha formed by six SSWAs:33, 34, 39, 52, 54 and 59	- increase in area by 198 ha - perimeter of 9.2 km	-	- mean depth of 2.2 m; maximum depth of 5 m - water level fluctuates with drawdown and spring flooding	-	- emergent vegetation ranging from 1 to 60 m in width occurs around most of the lake except along the western and northern shores - slash and aquatic vegetation islands occur in southern and northwestern bays, and along the east-central shoreline (form several bays) - well developed submergents in areas up to 1.5 m deep	-	- benthic organisms dominated by chironomid larvae - fish species are the same as those found in RL and PCR; fish species and densities initially increased after inundation of of reservoir but later declined - densities of benthic invertebrates and fish lower than in RL but higher than in PCR
Ruth Marsh	- area of 62 ha formed by three SSWAs:35, 36 and 38	- increase in area by 8 ha	- shallow but exact depth not measured	- shallow but exact depth not measured	-	- in 1977, sparsely to densely vegetated with sedges and buckbean; in 1984, dense emergent vegetation over entire marsh except for approximately 8 ha of open water	- unknown	- unknown
Ruth Lake (RL) & Diversion Canals	- area of 140 ha - perimeter of 8 km	- same - area of north and south diversion canals is 11 ha	- mean depth of 1.2 m; maximum depth of 3.0 m	- same depth - water level fluctuates with autumn drawdown and spring flooding	- well developed shoreline and floating emergents and submergents - several vegetated islands in central region of the lake	- same	- moderate density of benthic invertebrates dominated by dipterans and crustaceans - two species of fish	- same composition and density of benthic invertebrates - fish species diversity and abundance increased after diversion but later declined - higher densities of benthic invertebrates and fish than BCR or PCR
Poplar Creek Reservoir (PCR)	-	- area of 150 ha - perimeter of 6 km	-	- mean depth of 3.5 m; maximum depth of 18 m - water level fluctuations of 1.0 m with autumn drawdown and spring flooding	-	- main marsh development along north shore, otherwise emergents are poorly developed - poorly developed submergents and emergents	-	- lower densities of benthic invertebrates and fish than either RL or BCR - fish species composition same as that for BCR and RL
Mildred Lake	- area of 138 ha - perimeter of 8 km	- increase in area by 12 ha - decrease in perimeter by 1 km	- shallow; maximum depth 7.0 m	- average depth increased by 1.0 m	- shoreline emergents moderately well developed with widest marsh on western shore - several floating islands of emergent vegetation	- decrease in abundance of emergents, although submergents still form extensive bands around lake - no vegetated islands - decrease in production of duckweeds and filamentous algae	- invertebrate population well developed especially leeches and snails - three species of fish	- only fish surveys conducted since impoundment

Continued...

Table 3.3. Concluded

Waterbodies	Area and Perimeter		Depth		Shoreline and Aquatic Vegetation Characteristics		Aquatic Organisms	
	1974–1975	1977–1984	1974–1975	1977–1984	1974–1975	1977–1984	1974–1975	1977–1984
Lower Camp Sedimentation Basin	– variable area and perimeter as basin was filled from 1974 to 1975, reaching maximum area in 1976	– area of 24 ha – perimeter of 2.7 km	– variable with filling of basin but generally shallow	– increase in water depth to mean of 3.0 m	– extensive growth of emergents that remained after clearing – moderate number of small slash islands	– emergents are poorly developed; few narrow bands limited to southern shore – no vegetated or unvegetated islands	– unknown	– unknown
Horseshoe Lake	– area of 100 ha – perimeter of 9.6 km	– same	– mean depth of <1.0 m except in southern arms where depth is slightly >1.0 m – fluctuating water levels due to construction of a canal to the Athabasca River at the northern end of the lake	– same depth	– extensive growth of emergents along shoreline, although width is variable with maximum development at northern end of lake – floating emergents and submergents densely cover most of lake	– same aquatic vegetation patterns except floating emergents and submergents increased in density	– invertebrate population apparently well developed especially leeches and snails	– same
Loon Pond	– area of 2.6 ha – perimeter of 1.6 km	– same	– steeply sloping bottom with maximum depth of 4.5 m	– same depth	– shoreline vegetation is variable; emergents not well developed	– wide patch of emergent growth developed along north shore	– unknown	– unknown
Saline Lake	– area of 190 ha – perimeter of 10 km	– same	– mean depth of 1.0 to 2.0 m	– same depth	– extensive marsh development and convolutions along northern, western and southern shores – submergents well developed over most of lake – several vegetated islands on southern third of lake	– same aquatic vegetation patterns	– unknown	– unknown
Syncrude Site Water Areas	– 25 waterbodies covered area of 118 ha (included those to be flooded for Beaver Creek Reservoir and Ruth Marsh)	– 27 waterbodies cover area of 37.0 ha, plus West Interception Ditch about 17 km in length	– mean depths of <1.0 m	– mean depths of <1.0 m except J-Pit	– variable	– variable	– unknown	– unknown

bladderwort and bur-reed. Shoreline vegetation comprises mostly aspen and willow and, to a lesser degree, alder.

In 1977, the benthic invertebrate community of Beaver Creek Reservoir was dominated by chironomid larvae. Densities were generally lowest in winter and early spring, and highest in late summer or early autumn. Densities were also lower than those in Ruth Lake but higher than those in Poplar Creek Reservoir. In 1981, the fish community comprised lake chub (Couesius plumbeus), fathead minnow (Pimephales promelas), white sucker (Catostomus commersoni) and brook stickleback (Culaea inconstans). Northern pike (Esox lucius) and longnose sucker (Catostomus catostomus) disappeared between 1977 and 1981. No data concerning aquatic organisms are available for 1984.

3.3.2 Ruth Lake and the Diversion Canals

Ruth Lake is located near the southeastern corner of Lease 17. The lake became part of the Beaver Creek Diversion System in 1975-1976, when two dredged canals joined it to Beaver Creek Reservoir and Poplar Creek Reservoir (see below) at its northern and southern ends, respectively. At this time, Ruth Lake was converted from a closed to an open drainage.

All the major changes in the physical characteristics of Ruth Lake were completed by 1977. These changes resulted in an increase in aquatic habitat as a result of canal flows and increased fluctuations in water levels in response to such fluctuations in the reservoirs. The physical characteristics of the lake are presented in Table 3.3.

The northern canal, which connects Ruth Lake to Beaver Creek Reservoir, is about 1.5 km in length (3.8 ha in area). The channel ranges from 15 to 30 m in width and has water depths from a few centimetres to 50 cm. The southern canal is about 3.5 km long (7.3 ha in area) and varies from 23 to 30 m in width. Water depths range from 1 to 30 cm.

Minor changes in the aquatic vegetation communities of Ruth Lake have occurred since the lake was integrated into the diversion system. Ruth Lake supports a well-developed submergent plant community that extends over the

whole waterbody, in a pattern similar to the pattern in 1974. Shoreline emergents are dominated by sedges, cattails, bulrushes and horsetails, and are most developed in extent and density at the southern end of the lake. Islands of emergents are present in the north-central area of the lake. The northern and southern canals are vegetated with sedges and some cattails. Pond lily is the dominant floating-leafed plant. Shoreline trees and shrubs, cleared from the area surrounding Ruth Lake in 1974-1975, have re-appeared; dominant species include aspen, willow and alder.

Similarly, there was little change in the benthic invertebrate populations of Ruth Lake between 1975 and 1977. The major groups of benthic organisms found were dipterans and crustaceans. In 1977, Ruth Lake had a higher standing crop of benthic invertebrates than either Beaver Creek Reservoir or Poplar Creek Reservoir. Fish species in the lake were the same as those found in Beaver Creek Reservoir (O'Neil 1982).

3.3.3 Ruth Marsh

Ruth Marsh is located between the northern shore of Ruth Lake and the Beaver Creek dam (Figure 3.1), and is part of the Beaver Creek Diversion System; the canal that connects Beaver Creek Reservoir to Ruth Lake runs through Ruth Marsh. Ruth Marsh was formed in 1975-1976.

Table 3.3 presents information about the physical and biological characteristics of Ruth Marsh. The vegetation is primarily a dense stand of cattails except for an open area of approximately 8 ha in the north-central and northwestern portions of the marsh. This area was covered by shallow water in June, July and September but was essentially dry in August. The invertebrate and fish populations in Ruth Marsh were inventoried in 1984 but these data are not yet available.

3.3.4 Poplar Creek Reservoir

Poplar Creek Reservoir (Figure 3.1) was also formed by the development of the Beaver Creek Diversion System in 1975. By summer 1976, it had reached its maximum planned size. The reservoir receives water from Ruth Lake and

channels it into Poplar Creek via a dredged canal, spillway and stilling basin.

The physical characteristics of Poplar Creek Reservoir have not changed since 1977 (Table 3.3). A bridge and causeway separate the southern third of the reservoir from the northern two-thirds. At its northern end, the basin of the reservoir has a gentle slope and the waters are relatively shallow (1 to 8 m). At the southern end of the reservoir, within the original stream ravine, the basin is much steeper and reservoir depths reach their maxima (12 to 18 m).

The pattern and composition of the aquatic vegetation communities in Poplar Creek Reservoir have not changed since 1977. In general, aquatic plants are confined to discontinuous, narrow bands along the shore because of the moderately sloping banks and depth. However, the boulder-covered dam face on the southern shore has not been colonized by aquatic plants, and the shallow northern end of the reservoir supports an extensive marsh (over 25 ha in area) of buckbean, cattails and some sedges, as well as several small low-lying islands vegetated by dead shrubs and forbs. Because it is relatively deep, Poplar Creek Reservoir may never develop an aquatic vegetation community comparable to that anticipated for the shallower Beaver Creek Reservoir.

The dredged canal at the southern end of the reservoir is about 0.9 km long and 1.8 ha in area. The shorelines of the canal are vegetated with narrow bands of emergents.

Total numbers of benthic invertebrates in Poplar Creek Reservoir in 1977 were very low throughout the spring, summer and early fall but increased two to five times by late fall. Densities of benthic invertebrates in Poplar Creek Reservoir were considerably lower than in either Beaver Creek Reservoir or Ruth Lake. Fish colonizing Poplar Creek Reservoir in 1981 were the same as those predominating in Ruth Lake and Beaver Creek Reservoir, and included fathead minnow, brook stickleback and white sucker (O'Neil 1982). Catch-per-unit-effort data in 1981 suggested that densities of fish increased substantially over the period following inundation, but that densities were

still considerably lower than those in either Ruth Lake or Beaver Creek Reservoir. Data from 1984 are not available.

3.3.5 Mildred Lake

Mildred Lake, located on the eastern side of the oil sands development (Figure 3.1), is a sedimentation basin for Syncrude's Fresh Water Supply System. It receives water from the Athabasca River, via the Lower Camp Sedimentation Basin, and supplies water through a pipeline and pumping station to the plant facilities. In 1975 a dike was constructed that divided Mildred Lake; the water level in the southern section was raised approximately 1 m in 1977 to create a reservoir, while the northern section was integrated into the Tailings Pond.

The changes in physical and vegetational features of Mildred Lake since its alteration are summarized in Table 3.3. Since 1977, these features have remained fairly stable. In general, emergent vegetation is restricted to narrow bands or small islands along the northeastern and northwestern shores. Cattails are dominant, although there are some large stands of bulrushes and sedges. The dike forming the northern shore of Mildred Lake is unvegetated, while the rest of the shoreline is covered by shrubs, primarily aspen and willow, with rose in the understory. Submergents are found throughout most of the lake, but pond lilies are not present. No information about invertebrate and fish populations is available.

In summary, the major changes to Mildred Lake as a result of its integration into the Fresh Water Supply System were an increase in its depth; conversion of Mildred Lake from an open to a closed, artificially-regulated drainage; and reduction in the amount of emergent vegetation, duckweed, algal growth and benthic invertebrates associated with aquatic vegetation.

3.3.6 Lower Camp Sedimentation Basin

The Lower Camp Sedimentation Basin, which is located adjacent to the Athabasca River near the Lower Camp Complex (Figure 3.1), is part of the Fresh Water Supply System, and serves as a storage and settling basin for water from the Athabasca River. Although the site was cleared and the dike

was constructed for the Lower Camp Sedimentation Basin in 1974-1975, the basin was not filled to its maximum size until late 1976.

The Lower Camp Sedimentation Basin, as it existed during the 1975 field season, was described by Sharp and Richardson (1976). The characteristics of the basin prior to and subsequent to its filling are presented in Table 3.3. Since the basin reached its maximum size in 1976, its physical and vegetational characteristics have not changed significantly. The basin's earthfill dikes have been reclaimed with grasses and forbs. In contrast to 1975, little emergent vegetation was present in the basin in 1984, although narrow bands of cattails and bulrushes were scattered along the southwestern shore. Submergent vegetation, invertebrates and fish have not been examined in the basin since its impoundment. The shoreline shrubs are composed primarily of willow, with some balsam poplar saplings.

3.3.7 Horseshoe Lake

Horseshoe Lake, which is located close to the Athabasca River on the eastern side of Lease 17 (Figure 3.1), has not been modified by the development of Syncrude's oil sands plant. Its physical characteristics, which have not changed significantly since it was first surveyed in 1974, are presented in Table 3.3.

There has been, however, an increase in the extent and density of emergents and submergents in Horseshoe Lake between 1974 and 1984. The emergents presently vary in width from about 5 m to more than 100 m, being narrowest along the western shore and widest along the northern shore; they are dominated by sedge, with a mixture of cattail, bulrush, bur-reed and arrowhead. Pond lilies, the main floating-leafed plant, occur in all but the southern arms and centre of the lake. Duckweed and some filamentous algae form mats along the shore; pondweeds and fine-leaved submergents are present throughout the lake. The lake has maintained a richer growth of aquatic vegetation than other waterbodies on Lease 17. No studies on the aquatic organisms have been conducted on Horseshoe Lake, although general observations indicate that the invertebrate population (e.g., leeches and snails) is well-developed.

3.3.8 Loon Pond

Loon Pond is located immediately to the south of the Lower Camp Complex (Figure 3.1). Its physical characteristics have remained unchanged between 1974 and 1984 (Table 3.3). The shoreline varies in slope, with patches of cattails occurring along gentle slopes, deciduous shrubs, forbs and deciduous or mixed forests on intermediate top-soiled slopes, and barelimestone or sparse shrub-forb layers on steep slopes.

Slight changes in aquatic vegetation patterns have occurred between 1974 and 1984. A wide band of emergents, mainly cattails and some sedges, has formed on the northern shore and vegetated floating islands, common in the early surveys, are no longer present. No studies on submergent vegetation or aquatic organisms have been conducted on Loon Pond.

3.3.9 Saline Lake

Saline Lake is situated on the eastern side of the Athabasca River, about 5 km east of the Tailings Pond. This lake has not been modified by development of Syncrude's oil sands project.

The physical and vegetational characteristics of Saline Lake have remained similar between 1974 and 1984 (Table 3.3). Aquatic vegetation on Saline Lake has not been surveyed in detail. In general, extensive marsh areas occur along the northern and northwestern shores; medium-width bands of emergents occur along the south and southwestern shores; dead willows extend into the two bays at the northern end of the lake; and deciduous or mixedwood forests extend to the water's edge along the rest of the shoreline. The emergents are a mixture of cattails and sedge, with tall grasses on the western shore. Several vegetated islands are located adjacent to the shorelines in the southern third of Saline Lake.

3.3.10 Syncrude Site Water Areas

The Syncrude Site Water Areas surveyed in 1984 are not the same as those water areas surveyed in 1974 or 1975. The 25 SSWAs inventoried in the early surveys are described in Sharp and Richardson (1976). The SSWAs surveyed in

1984 include the West Interception Ditch, two large borrow pits (J-Pit and S-Pit) and 25 small natural waterbodies and borrow pits created during project development (Figure 3.2).

The West Interception Ditch, which is an artificial stream about 17 km in length, is located about 3 km west of the original course of Beaver Creek, and lies roughly parallel to it. It is part of Syncrude's diversion system and was constructed in 1976 to carry the water of four small unnamed creeks that formerly drained into Beaver Creek, and surface run-off draining the muskeg terrain, north and south around the mining facilities.

The physical characteristics of the West Interception Ditch have been described by Tsui et al. (1977) and Retallack et al. (1981) and summarized by Syncrude Canada Ltd. (1984). It is a slow, shallow stream, ranging from 4 to 12 m in width. Peak discharges occur in June but decline over the summer, in some locations to zero. Ponds may occur where culverts partially obstruct the stream flow. The substrate is composed of mud, except where cobbles have been placed in the ditch. The stream banks are low and sloping, and are vegetated with dense grasses and forbs. The bottom of the ditch is filled along most of its length by cattails or sedges. The ditch has been colonized by a complex assemblage of benthic organisms, dominated by dipterans. Two species of fish are present: the fathead minnow and the more abundant brook stickleback.

J-Pit, which is located immediately northwest of the Tailings Pond (Figure 3.2), is an active clay borrow pit. The water area covers about 11.5 ha, has a perimeter of 1.6 km and a depth exceeding 5 m, and is surrounded by steep, unvegetated earthfill slopes. Emergent and terrestrial vegetation is absent except for occasional patches of cattails on the western shore. No information is available on the submergent vegetation or aquatic organisms in J-Pit.

S-Pit is located immediately north of the Tailings Pond (Figure 3.2), and is an active sand borrow pit. It is composed of a series of shallow pools (<0.5 m deep) separated by long, narrow sand spits and islands. It covers an area of about 8 ha and has a perimeter of 2.0 km. The shoreline is

largely unvegetated, except for patches of low, dense rushes on dry ground, scattered willows and scattered pockets of cattails. No information is available on aquatic organisms in S-Pit.

The 25 small waterbodies surveyed range in size from about 0.2 ha to 4.3 ha, and cover a total of about 17.5 ha. A description of the physical and vegetational characteristics of each of these waterbodies is given in Appendix E.

3.4 RESULTS

3.4.1 Waterbird Numbers and Distributions in 1984

A total of 60 species of waterbirds were observed during waterbody surveys on and near Lease 17 from 10 June to 9 October 1984. Most were members of one of seven waterbird groups: grebes (three species), dabbling ducks (nine species), diving ducks (12 species), coots (one species), shorebirds (20 species), gulls (four species) and terns (two species). The abundances and distributions of these groups, and of the individual species, are discussed in the following section. In addition to these groups, loons, pelicans, herons and bitterns, swans, geese, cranes and rails were also recorded.

3.4.1.1 Numbers, Seasonal Trends and Productivity of Waterbirds

About 95% of the waterbirds counted during the study were grebes, ducks, coots or shorebirds. The numbers of individuals of each of these waterbird groups seen during each survey throughout the study are summarized in Figure 3.3. Total numbers of waterbirds recorded per survey ranged from lows of 1300-1500 birds in early June, the period of nesting and early hatching for most waterbirds, to highs of 3800-4700 birds from early August to mid September, the period of pre-migration staging and autumn migration for most waterbirds. Dabbling ducks were the most abundant waterbirds recorded throughout the study, accounting for 52% of all observations. Dabbling ducks were followed in decreasing order of abundance by diving ducks, shorebirds

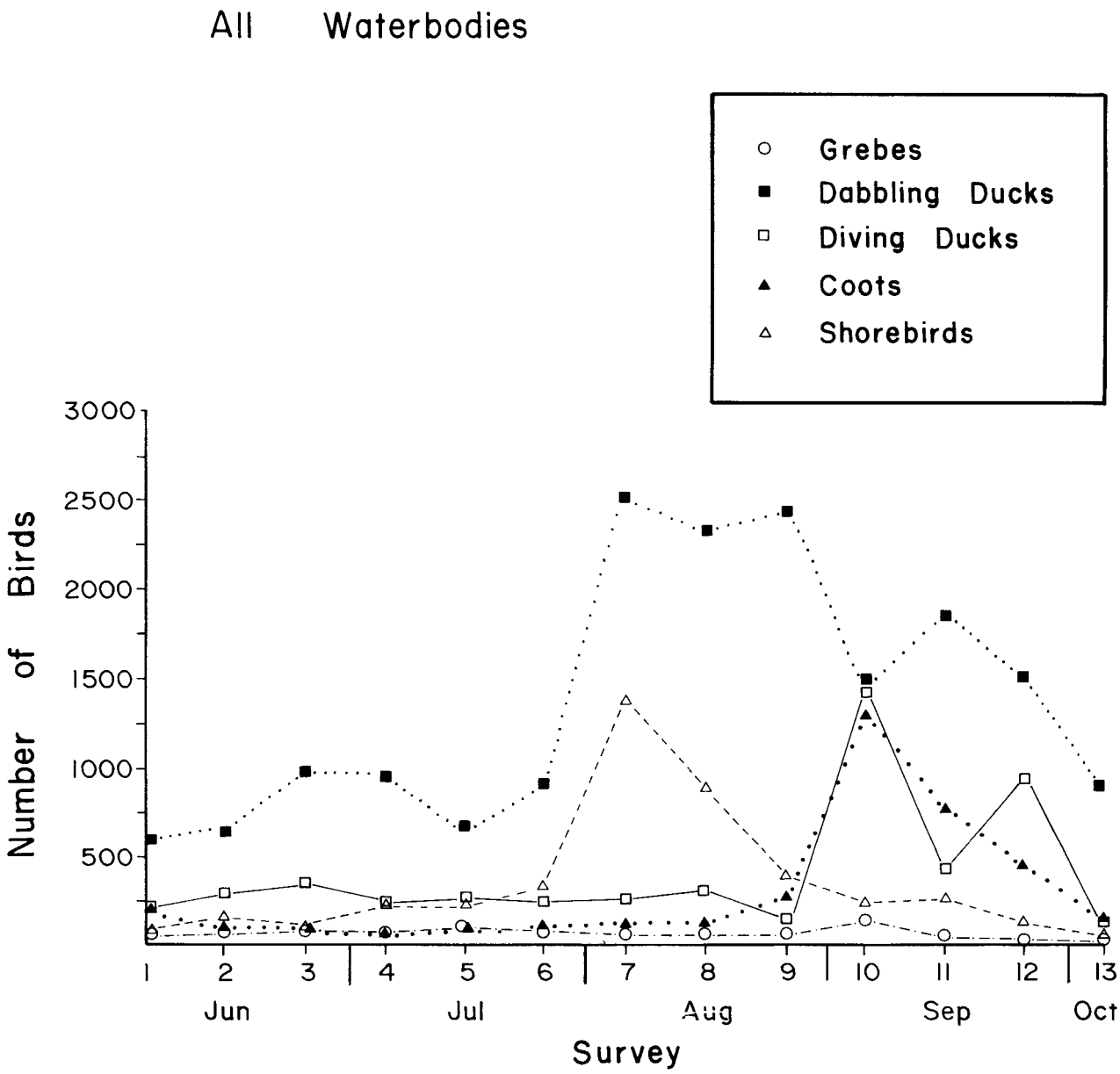

Figure 3.3 Numbers of individuals of five commonly observed waterbird groups recorded during waterbody surveys on and near Crown Lease 17, northeastern Alberta, June-October 1984.

and American coots. The numbers of individuals of all species of waterbirds seen during the waterbody surveys are presented in Table 3.4.

Information about the productivity of waterbirds in the study area in 1984 is provided by numbers of breeding pairs observed (Table 3.5) and numbers of broods recorded (Table 3.6). The breeding pair data provide estimates of the minimum number of breeding pairs of each species in the area; the brood data provide estimates of the minimum number of broods of each species. Number of breeding pairs was calculated as the maximum number of pairs observed for a species on a survey, while number of broods was calculated as the maximum number of broods observed on a survey, plus new broods, based on age, that were observed after that survey. Because waterbody surveys were started late in the nesting season (beginning in the third week of June on Saline Lake and in the second week of June on all other waterbodies), numbers of breeding pairs may be somewhat low and disproportionately biased toward late breeders, mostly diving ducks. Tallies of pairs of American coots are not included in Table 3.5 because numbers were inconsistently recorded. No breeding pair data were obtained for any of the other waterbird groups.

Brood data from the waterbodies (Table 3.6) indicate that diving ducks (103 broods), dabbling ducks (68 broods), coots (50 broods) and grebes (36 broods) were the most productive groups in the study area. The American coot, common goldeneye, red-necked grebe, ring-necked duck and American wigeon were the species with the largest number of broods counted. There were, however, some differences in the distribution of broods of these more common species. Over 70% of all coot broods were recorded on Horseshoe Lake, whereas a similar percentage of common goldeneye broods and over half the bufflehead broods were recorded on Saline Lake. Red-necked grebe broods were seen primarily on Poplar Creek and Beaver Creek reservoirs, whereas ring-necked duck broods and wigeon broods were widespread throughout the study area, each being recorded on nine of the waterbodies surveyed. We saw no broods of any of the waterbird groups not listed in Table 3.6.

In the following section, trends in numbers of the various waterbird species and groups observed are presented. These trends are shown in Figure 3.3 for the major waterbird groups.

Table 3.4. Numbers of waterbirds recorded during waterbody surveys on and near Crown Lease 17, northeastern Alberta, June-October 1984.

Species	Survey Number and Date													
	1[1] 10-15 Jun	2 18-22 Jun	3 26-30 Jun	4 9-13 Jul	5 17-21 Jul	6 26-30 Jul	7 6-10 Aug	8 16-19 Aug	9 26-30 Aug	10 6-10 Sep	11 16-20 Sep	12 26-29 Sep	13 6-9 Oct	All Survey
Common loon	19	17	20	22	13	19	17	12	16	4	8	4	5	17
Pied-billed grebe	1	1	0	1	0	3	0	0	0	0	5	0	2	1
Horned grebe	2	3	2	6	6	3	2	4	1	45	12	1	2	8
Red-necked grebe	51	61	82	65	86	71	49	52	53	89	20	12	5	69
American white pelican	0	0	0	0	0	0	0	0	0	0	0	2	1	
American bittern	2	1	2	4	1	2	0	4	3	5	1	0	0	2
Great blue heron	1	0	0	1	2	6	4	5	7	12	1	0	1	4
Tundra swan	0	0	0	0	0	0	0	0	0	0	0	0	6	
Greater white-fronted goose	0	0	0	0	0	0	0	0	5	0	0	0	3	
Canada goose	3	0	2	1	7	1	1	0	5	4	0	0	0	2
Green-winged teal	49	50	81	71	27	142	495	254	337	162	293	87	46	209
American black duck	0	0	0	0	0	0	0	0	1	0	0	0	0	
Mallard	211	158	261	289	164	415	1038	805	782	528	669	928	786	703
Northern pintail	10	7	33	16	3	2	30	336	332	82	83	10	3	94
Blue-winged teal	115	91	128	34	32	43	201	196	243	176	117	12	13	140
Cinnamon teal	0	0	1	0	0	0	0	0	0	0	0	0	0	
Teal spp.	4	3	0	0	0	10	43	20	21	9	1	3	2	11
Northern shoveler	46	51	61	60	12	12	123	40	54	87	62	21	8	63
Gadwall	17	30	21	75	16	61	18	4	6	21	14	26	35	34
American wigeon	137	286	395	393	381	227	462	602	583	498	611	420	38	503
Unid. dabbling duck	11	11	0	21	6	1	149	64	66	0	0	0	0	32
Canvasback	3	10	9	2	4	12	0	0	0	6	7	1	0	5
Redhead	0	32	2	23	13	0	0	0	0	5	0	0	2	7
Ring-necked duck	84	71	135	57	25	33	23	38	7	22	118	34	9	65
Scaup spp.	53	74	53	80	143	81	0	0	25	1200	200	829	71	2805
Surf scoter	0	0	0	0	0	0	0	0	0	1	0	0	1	2
White-winged scoter	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Common goldeneye	12	57	67	35	16	80	145	141	100	67	23	32	21	79
Bufflehead	28	41	65	47	46	32	69	43	40	99	44	25	9	58
Hooded merganser	0	0	0	0	0	0	0	0	0	0	0	22	2	24
Common merganser	0	1	0	0	0	0	0	0	0	5	8	0	0	14
Red-breasted merganser	0	0	0	0	0	0	0	0	0	0	3	0	0	
Merganser spp.	0	0	0	0	0	1	3	0	0	0	20	2	6	3
Ruddy duck	19	6	10	2	6	3	2	0	0	21	2	0	0	71
Unid. diving duck	0	0	0	0	14	0	0	64	23	1	0	0	0	102
Unid. duck	1	0	15	151	0	5	1	32	0	9	3	0	0	217
Sora	5	7	3	7	4	2	0	0	0	1	0	0	0	29
American coot	181	96	91	63	86	94	127	161	278	1297	771	479	163	3887
Sandhill crane	3	0	0	0	0	0	0	0	0	0	0	0	0	
Black-bellied plover	0	0	0	0	0	0	0	0	0	16	60	11	11	98
Lesser golden-plover	0	0	0	0	0	0	0	0	0	0	0	6	2	8
Mongolian plover	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Semipalmated plover	0	0	0	0	6	5	15	6	3	0	0	0	0	35
Killdeer	8	17	17	18	14	18	20	39	10	15	2	3	2	183
Yellowlegs spp.	34	50	53	56	63	142	467	329	235	70	37	31	22	1589
Solitary sandpiper	2	1	2	7	4	9	6	1	2	0	0	0	0	34
Spotted sandpiper	34	45	33	52	20	27	54	32	20	15	4	0	0	336
Sanderling	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Semipalmated sandpiper	0	0	0	14	17	4	16	0	3	1	1	0	0	56
Western sandpiper	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Least sandpiper	0	0	0	0	5	0	0	0	1	2	0	0	0	8
White-rumped sandpiper	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Baird's sandpiper	0	0	0	6	18	9	11	3	1	0	1	0	0	49
Unid. "peep" sandpiper	0	26	0	14	48	69	682	384	62	30	6	5	0	1326
Pectoral sandpiper	0	0	0	0	7	9	47	42	0	53	53	34	11	256
Stilt sandpiper	0	0	0	5	4	2	6	0	0	0	0	0	0	17
Dowitcher spp.	0	1	0	22	17	37	36	31	1	24	114	19	3	305
Common snipe	10	6	9	5	0	3	7	19	25	14	7	15	0	120
Wilson's phalarope	9	4	3	0	6	0	5	5	35	0	0	0	0	67
Bonaparte's gull	16	9	12	19	10	5	7	14	6	9	0	0	0	107
Ring-billed gull	0	2	0	0	0	0	0	0	21	18	36	10	13	100
California/herring gull	18	10	11	10	3	12	20	36	15	3	3	8	0	149
Common tern	4	10	7	4	11	5	0	0	0	0	0	0	0	41
Black tern	127	143	106	126	122	144	168	34	3	0	0	0	0	973
TOTAL BIRDS	1330	1492	1792	1887	1488	1862	4570	3852	3431	4726	3420	3093	1304	34,247

[1] Saline Lake not surveyed.

Table 3.5. Minimum numbers of breeding pairs of four waterbird groups recorded during waterbody surveys on and near Crown Lease 17, northeastern Alberta, June 1984.

Waterbird Groups	Waterbodies[1]														
							SSWA								
	BCR	PCR	RM	RLC	Ruth Lake	ML	WID	J-Pit	S-Pit	Others	LCSB	Loon Pond	Horseshoe Lake	Saline Lake	Total
Loons	-	2	-	-	2	-	-	-	-	1	-	-	-	-	5
Grebes	-	2	-	-	3	-	-	-	-	1	-	-	-	-	6
Dabbling Ducks	28	14	10	4	4	-	1	1	-	10	-	1	20	6	99
Diving Ducks	11	9	3	-	10	-	-	-	-	3	-	-	14	6	56
TOTAL	39	27	13	4	19	-	1	1	-	15	-	1	34	12	166

[1] BCR - Beaver Creek Reservoir
PCR - Poplar Creek Reservoir
RM - Ruth Marsh
RLC - Ruth Lake Diversion Canals
ML - Mildred Lake
WID - West Interception Ditch
SSWA - Syncrude Site Water Areas
LCSB - Lower Camp Sedimentation Basin

Table 3.6. Numbers of broods of waterbirds recorded during waterbody surveys on and near Crown Lease 17, northeastern Alberta, June-August 1984.

Bird Group	Species	Waterbodies[1]												
								SSWA						
		BCR	PCR	RM	RLC	Ruth Lake	ML	WID	Others	LCSB	Loon Pond	Horseshoe Lake	Saline Lake	Total
Loons	Common loon	-	1	-	-	-	-	-	-	-	-	-	-	1
Grebes	Red-necked grebe	8	14	-	-	2 (5 nests)	1	-	-	-	2	2	1	30
	Horned grebe	1	-	-	-	-	-	-	2	-	-	-	1	4
	Pied-billed grebe	-	(2 nests)	1	-	-	-	-	-	-	-	-	1	2
Geese	Canada goose	1	-	-	1	-	-	-	-	-	-	-	-	2
Dabbling Ducks	Green-winged teal	1	-	-	1	-	-	-	2	-	-	-	1	5
	Mallard	2	-	-	2	-	-	2	1	1	-	3	1	12
	Northern pintail	-	-	-	-	-	-	-	1	-	-	1	-	2
	Blue-winged teal	4	-	-	1	1	-	-	2	-	-	2	-	10
	Teal spp.	1	-	-	-	-	-	-	1	-	-	-	1	3
	Northern shoveler	1	-	-	-	-	-	-	1	-	-	-	-	2
	American wigeon	9	3	-	4	1	3	-	2	-	2	2	3	29
	Dabbling duck spp.	1	-	1	-	-	-	-	-	-	-	2	1	5
Diving Ducks	Canvasback	-	-	-	-	-	-	-	-	-	-	-	4	4
	Ring-necked duck	4	4	-	1	1	-	3	5	-	1	5	6	30
	Scaup spp.	-	-	-	-	-	-	-	-	-	-	-	1	1
	Common goldeneye	3	1	-	-	-	-	-	4	-	-	2	25	35
	Bufflehead	-	1	-	-	-	-	1	7	-	-	2	14	25
	Ruddy duck	1	-	-	-	-	-	-	1	-	-	5	1	8
Unid. Ducks		2	1	-	1	2	-	-	-	-	-	-	-	6
Coots	American coot	3	(2 nests)	1	-	2	-	-	5	-	-	36	3	50
TOTAL		42	25	3	11	9	4	6	34	1	5	62	64	266

1 BCR - Beaver Creek Reservoir
PCR - Poplar Creek Reservoir
RM - Ruth Marsh
RLC - Ruth Lake Diverson Canals
ML - Mildred Lake
WID - West Interception Ditch
LCSB - Lower Camp Sedimentation Basin
SSWA - Syncrude Site Water Areas

Grebes

The red-necked grebe was by far the most abundant of the three species of grebes recorded in the study area; 30 broods of this species were seen (Table 3.6). Pied-billed grebes (two broods seen) and horned grebes (four broods seen) also nested on or near Lease 17. Numbers of grebes seen during waterbody surveys remained similar from June through August (Table 3.4). In early September there was a small influx of migrant horned and red-necked grebes but by mid September most had departed.

Dabbling Ducks

Numbers of dabbling ducks recorded during the waterbody surveys varied from about 600 birds per survey in June to over 2500 birds per survey in late August. There appeared to be two peaks in numbers present, a small one in late June and early July, and a large one in August (Figure 3.3).

The first peak may have represented the presence of small groups of pre-moulting birds (primarily mallards and American wigeons but also blue-winged teal, gadwalls and northern shovelers) gathering to moult or stopping en route to moulting lakes farther north; these ducks were present mainly on Beaver and Poplar Creek reservoirs, with smaller numbers on Horseshoe Lake. This influx included 200-300 American wigeons, a concentration which was present on Beaver Creek Reservoir for three to four weeks.

The second peak of dabbling ducks lasted throughout August. This increase likely consisted of post-moulting birds, post-nesting hens, young-of-the-year and, at least in late August, some early migrants. The most abundant species then present in the study area, in order of decreasing numbers, were mallard, American wigeon, green-winged teal and blue-winged teal. Mallard numbers began increasing during the last survey in July, and remained high (650-950 birds per survey) through late September and early October. American wigeon, green-winged teal and blue-winged teal numbers all began to increase during the first survey in August. Wigeon numbers remained high through August and September (420-620 birds per survey). Green-winged teal numbers were highest in early August but had

decreased by the middle of that month, whereas blue-winged teal numbers increased through August, and then declined in September. In early October, mallards remained common, but numbers of other species were low (Table 3.4).

Six species of dabbling ducks nested in the study area in 1984. Based on numbers of broods (Table 3.6) and numbers of breeding pairs (Table 3.5) observed, the American wigeon was the most common nesting species, followed by mallard, blue-winged teal, green-winged teal, northern pintail and northern shoveler.

Diving Ducks

The numbers of diving ducks counted during waterbody surveys remained relatively constant from mid June until the end of August (195-350 individuals per survey--Figure 3.3). However, in the first week of September over 1400 diving ducks were observed. This increase presumably represented an influx of autumn migrants. Variable but relatively large numbers of diving ducks (400-950 per survey) were present throughout the rest of September but few were counted in early October (Figure 3.3).

The most abundant migrant diving ducks were scaup, which passed through in two apparent waves in early September (1200 scaup seen) and late September (829 seen). Moderate numbers of buffleheads were present during early September, whereas ring-necked duck numbers were greatest during mid September. Small numbers of mergansers were also present in mid to late September.

Six species of diving ducks nested in the study area in 1984. Based on numbers of broods (Table 3.6) and numbers of breeding pairs (Table 3.5) observed, common goldeneyes, ring-necked ducks and buffleheads were the most common breeders. As mentioned above, over 70% of the goldeneye broods and over 50% of the bufflehead broods were seen on Saline Lake. Ring-necked duck broods were more evenly distributed among the waterbodies surveyed. Ruddy ducks, scaup, canvasbacks and common mergansers (one brood seen on the MacKay River, in the western portion of Lease 17) also nested on or near Lease 17.

Shorebirds

The numbers of shorebirds recorded during waterbody surveys remained fairly constant through June. Numbers increased in July, partly because of the addition of young birds but mainly because of the arrival of transients. The largest numbers of shorebirds were present from early to mid August (Figure 3.3).

Eight species of shorebirds are reported to nest in the study area (see Appendix C), although either young birds or agitated behaviour of adults (indicating that a nest or young were nearby) were observed only for yellowlegs, spotted sandpiper and killdeer. The two yellowlegs species and the spotted sandpipers were the most abundant breeding species seen during waterbody surveys. A small influx of spotted sandpipers apparently occurred in early August. None was seen after mid September. Numbers of yellowlegs began to increase in late July and peaked in early to mid August.

Among the transient species, the small unidentified sandpipers ('peeps'[1]), dowitchers and pectoral sandpipers were most common. Numbers of peeps gradually increased during July and reached a peak in early and mid August. Most had left by late August. Short-billed dowitchers are reported to nest in the study area although we saw no evidence of nesting. Dowitchers, including both short-and long-billed, were present in moderate numbers in July and August and a small peak occurred in mid September. Pectoral sandpipers began to arrive from their arctic nesting areas in mid July and were present in moderate numbers until at least early October.

Coots

Similar numbers of American coots were seen during each survey from early June to late July (Figure 3.3). Coots nested in the study area; two nests and 50 broods were seen. Numbers increased in August as young-of-the-year birds became independent. Many migrant coots apparently arrived in the

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[1] 'Peeps' include semipalmated, western, least, white-rumped and Baird's sandpipers.

study area in early September and close to 1300 individuals were seen during the 6-10 September survey. Most were seen on Beaver Creek Reservoir (1020 birds) and Horseshoe Lake (225 birds). By mid September many coots had left the area and numbers continued to decrease through late September and early October.

Gulls and Terns

Small numbers of gulls were present in the study area from June to early October but nesting evidence (two nesting pairs) was found only for Bonaparte's gulls. Bonaparte's gulls had left the study area by mid September. California and/or herring gulls were present throughout the study period but ring-billed gulls appeared only in late August. Small numbers of ring-billed gulls were seen during each of the surveys from late August to early October.

Although black terns and common terns both nested in the study area, black terns were much more abundant than common terns (Table 3.4). Numbers of terns increased in late July and early August, as juveniles began to fly. Numbers then decreased sharply and no terns were seen after the end of August.

Other Species

The common loon was the only loon species observed during waterbody surveys. One brood was seen. Numbers of loons seen remained similar from June through late August. Numbers were much lower in September and early October. There was no evidence that loons were gathering on the waterbodies in the study area prior to migration.

Small numbers of several other species of waterbirds were present in the study area. American bitterns were seen regularly until mid September and probably nested in the area. Great blue herons were seen primarily in August and September. Three American white pelicans were recorded in late September and early October, and six tundra swans were recorded during the final survey in early October.

A few Canada geese were present throughout the summer and two broods were seen. No flocks of migrant Canada geese were seen on the waterbodies but two flocks of white-fronted geese (eight individuals) were seen on Poplar Creek and Beaver Creek reservoirs in late August and early October, respectively.

One rail species, the sora, was seen in the study area. Only one individual was recorded after late July, but soras were likely present into September. This species is very secretive and rarely calls after the breeding season. Three sandhill cranes were seen during the survey in early June but there was no evidence of nesting.

3.4.1.2 Distribution of Waterbirds

The distribution of waterbirds on each of the waterbodies surveyed on and near Lease 17 during the study is discussed below. Over 80% of all the waterbird sightings during the surveys were recorded on four waterbodies: Beaver Creek Reservoir, Saline Lake, Horseshoe Lake and Poplar Creek Reservoir.

Beaver Creek Reservoir

Beaver Creek Reservoir supported the highest waterbird numbers of all the waterbodies surveyed; almost 12,000 birds were recorded (Appendix F). Over 34% of all bird observations occurred there, although the reservoir accounted for only about 20% of the total water area surveyed. Included in these observations were 39 breeding duck pairs and 42 broods of 12 species of waterbirds (Tables 3.5, 3.6). Figure 3.4 illustrates the numbers of individuals of the commonly recorded waterbird groups observed during surveys on Beaver Creek Reservoir.

Beaver Creek Reservoir was important as a breeding area for dabbling ducks (particularly wigeons), red-necked grebes and diving ducks. Several pairs of loons were regularly seen on the reservoir. Few coots, however, appeared to have nested there, although this species was regularly seen. Coots became increasingly common after the end of July. Large numbers of

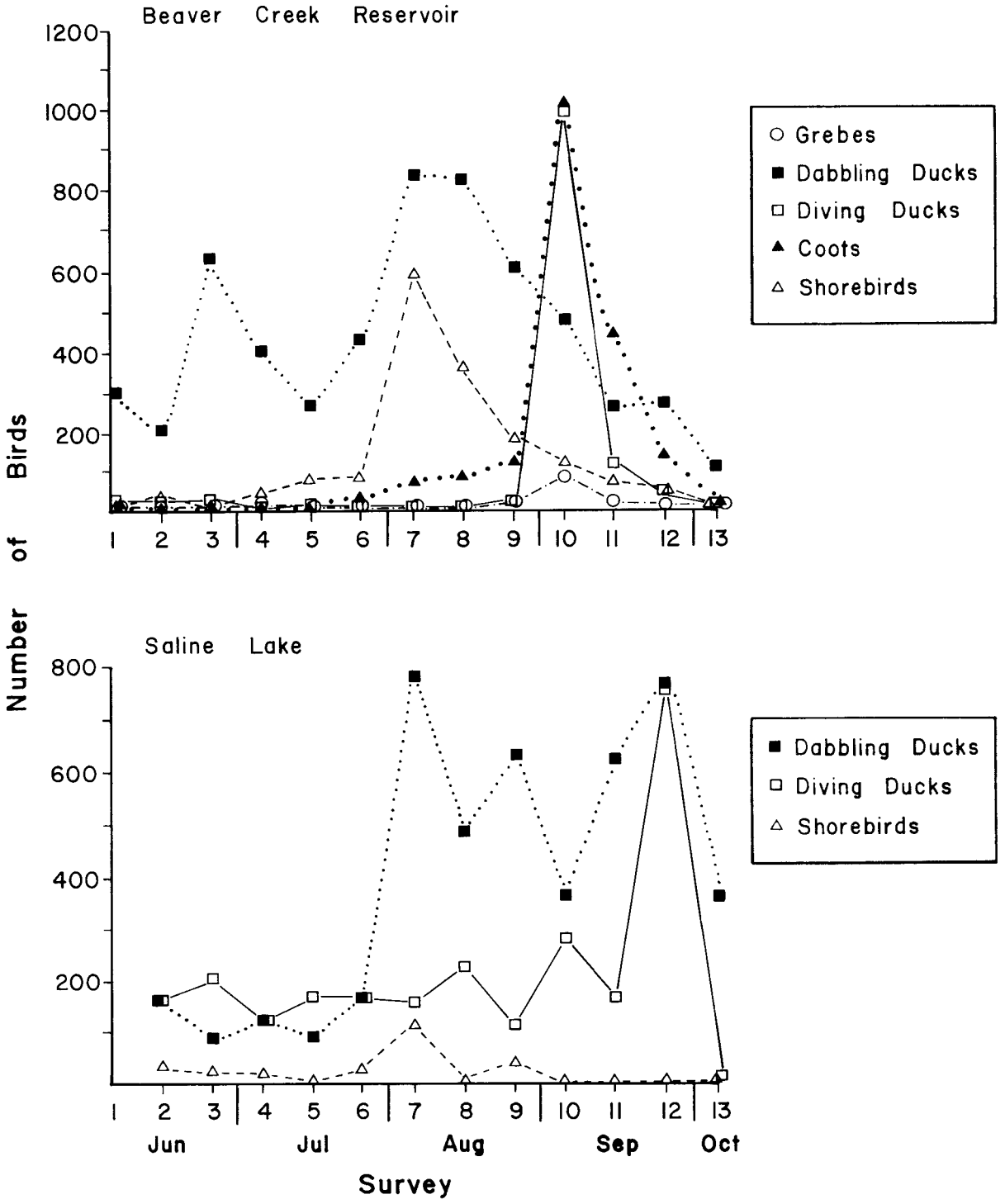

Figure 3.4 Numbers of individuals of commonly observed waterbird groups recorded during surveys on Beaver Creek Reservoir (top) and Saline Lake (bottom), June-October 1984.

wigeons, possibly individuals that were moving into and through the region to moulting areas, were present after late June. Flocks of mallards were also common on Beaver Creek Reservoir during the summer. During the post-moulting and autumn migration periods, the reservoir was an important stop-over area for several waterbird groups. Between 600 and 800 dabbling ducks were counted during each of three surveys in August: mallards were the most numerous of the dabblers, although wigeons, teal and pintails were also common. In early September, over 1000 diving ducks, primarily scaup, were counted. Numbers of American coots on the reservoir increased through August to a peak in early September, when over 1000 birds were counted. Several hundred shorebirds were counted during surveys in early and mid August; the large majority of these were yellowlegs and unidentified 'peeps'.

Saline Lake

Saline Lake had the second highest waterbird count of all the waterbodies surveyed: almost 8000 waterbirds were recorded, accounting for 23% of all bird observations (Appendix G). Saline Lake includes about 19% of the total water area surveyed. Sixty-four broods were observed, more than on any other waterbody, and 12 breeding pairs of ducks were recorded (Tables 3.6, 3.5). Figure 3.4 shows the numbers of individuals of the commonly observed waterbird groups recorded on Saline Lake.

Saline Lake was extremely important as a diving duck nesting area: almost 50% of the diving duck broods recorded were seen on this lake. Common goldeneye and bufflehead were the two most numerous species. Broods of 11 other species of waterbirds were recorded (Table 3.6).

During August and September, large flocks of waterfowl were present on Saline Lake. The large majority of these were dabbling ducks, especially wigeons, mallards and green-winged teal. Pintails were also common in August. Scaup became numerous in September, including over 700 seen on 28 September. In early October, mallards were still common, but few other species were present.

Few other species of waterbirds were common on Saline Lake. Black terns nested there and were seen regularly until mid August. Small flocks of shorebirds passed through in early August, and a few small groups of coots were present during August.

Horseshoe Lake

Horseshoe Lake had the third highest waterbird count of all the waterbodies surveyed: over 5000 waterbirds were recorded, accounting for 15% of all bird observations (Appendix H). Horseshoe Lake includes about 10% of the total water area surveyed. Thirty-four breeding pairs of ducks and 62 broods were recorded. Figure 3.5 illustrates the numbers of individuals of the commonly observed waterbird groups recorded on Horseshoe Lake.

Horseshoe Lake was important as a nesting area for American coots: almost 60% of the broods counted on the lake were of coots and over 70% of all coot broods counted were seen on this lake. Broods of the red-necked grebe and eight species of ducks were also recorded and at least one colony of black terns was present.

In August, numbers of dabbling ducks increased on Horseshoe Lake: most were mallards but blue-winged teal were also common. Almost 400 American wigeons were observed on the lake in mid September. Also in September, numbers of diving ducks, most of which were scaup, increased. Diving duck numbers, however, were never high on Horseshoe Lake relative to the other waterbodies. Between 200 and 310 coots were present on the lake throughout September. Few shorebirds were present. Numbers of birds present were lower in early October, although mallards and coots were still common.

Poplar Creek Reservoir

Poplar Creek Reservoir had the fourth highest waterbird count of all the waterbodies surveyed: about 3600 waterbirds were recorded, accounting for 11% of all observations (Appendix I). This reservoir included about 15% of the total water area surveyed. Twenty-seven breeding pairs and 25 broods were observed on the reservoir (Tables 3.5, 3.6). Figure 3.5 shows the numbers of

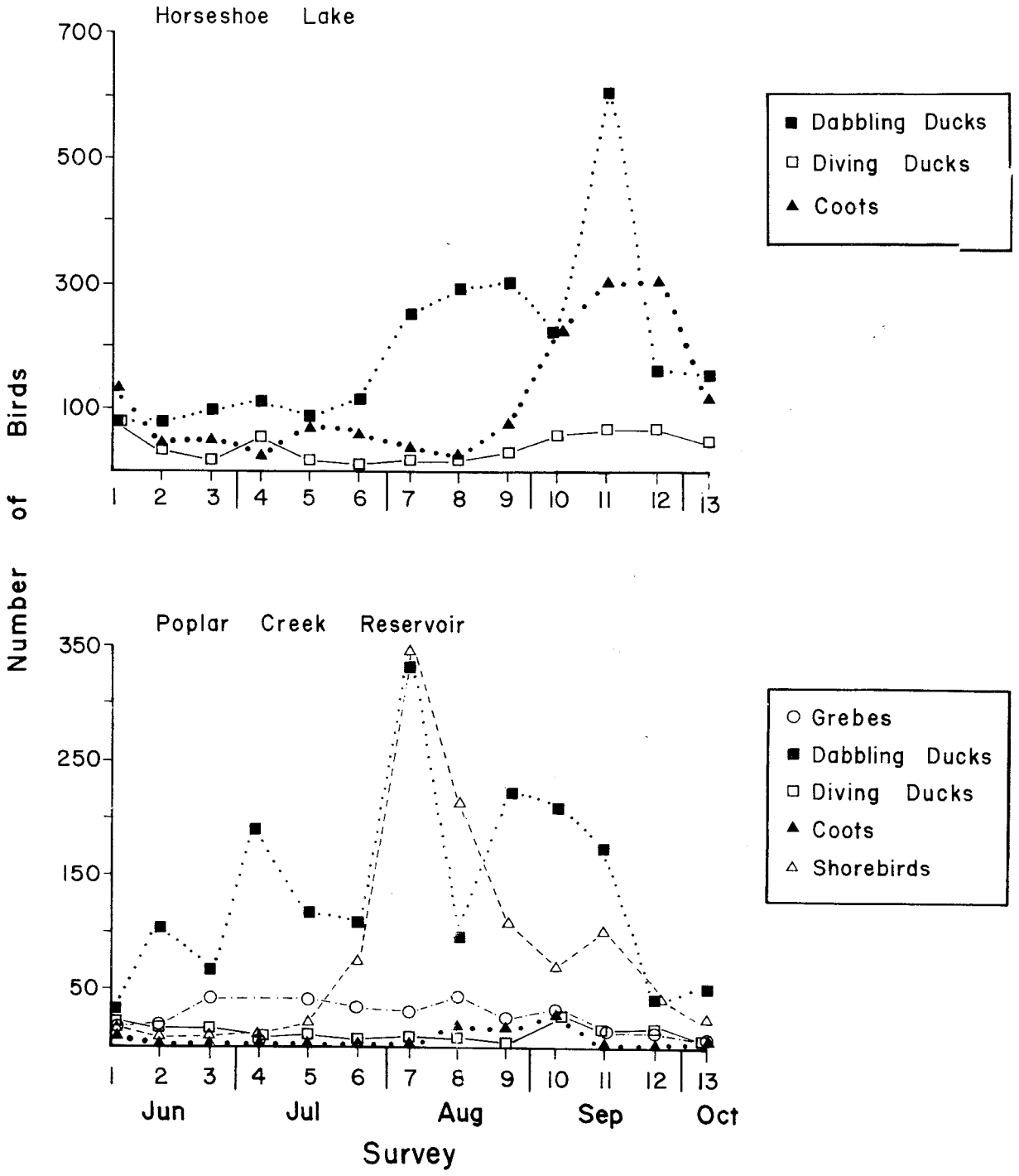

Figure 3.5 Numbers of individuals of commonly observed waterbird groups recorded during surveys on Horseshoe Lake (top) and Poplar Creek Reservoir (bottom), June-October 1984.

individuals of the commonly observed waterbird groups recorded during the surveys on Poplar Creek Reservoir.

Poplar Creek Reservoir was an important breeding area for red-necked grebes: 14 broods were counted. Common loons, pied-billed grebes, American coots and four species of ducks also nested there. Gatherings of red-necked grebes were present on the northern part of the reservoir throughout July and August.

Numbers of dabbling ducks increased on Poplar Creek Reservoir in August and September: green-winged teal, mallards, wigeons and shovelers were numerically dominant. Diving duck numbers were never high. Shorebirds were common in August: unidentified peeps were the most numerous, but yellowlegs, pectoral sandpipers and dowitchers were also common. Small groups of American coots were present in late August and early September.

The large majority of waterbird sightings on Poplar Creek Reservoir were at its northern end.

Ruth Lake and the Diversion Canals

Ruth Lake had the fifth highest waterbird count of all the waterbodies: over 2700 waterbirds were recorded, accounting for 8% of all observations (Appendix J). Ruth Lake includes about 14% of the total water area surveyed. Nineteen breeding pairs and nine broods were counted (Tables 3.5, 3.6). Figure 3.6 presents the numbers of individuals of the common waterbird groups recorded during the study on Ruth Lake.

Common loons, red-necked grebes, American coots, blue-winged teal, ring-necked ducks and black terns nested on Ruth Lake in 1984. Large numbers of dabbling ducks appeared in early August and were present, although in reduced numbers, until early October. The American wigeon and mallard were the most numerous species during this period, although the blue-winged teal and northern pintail were also common. Small numbers of diving ducks, primarily ring-necked ducks, scaup and buffleheads were present in late

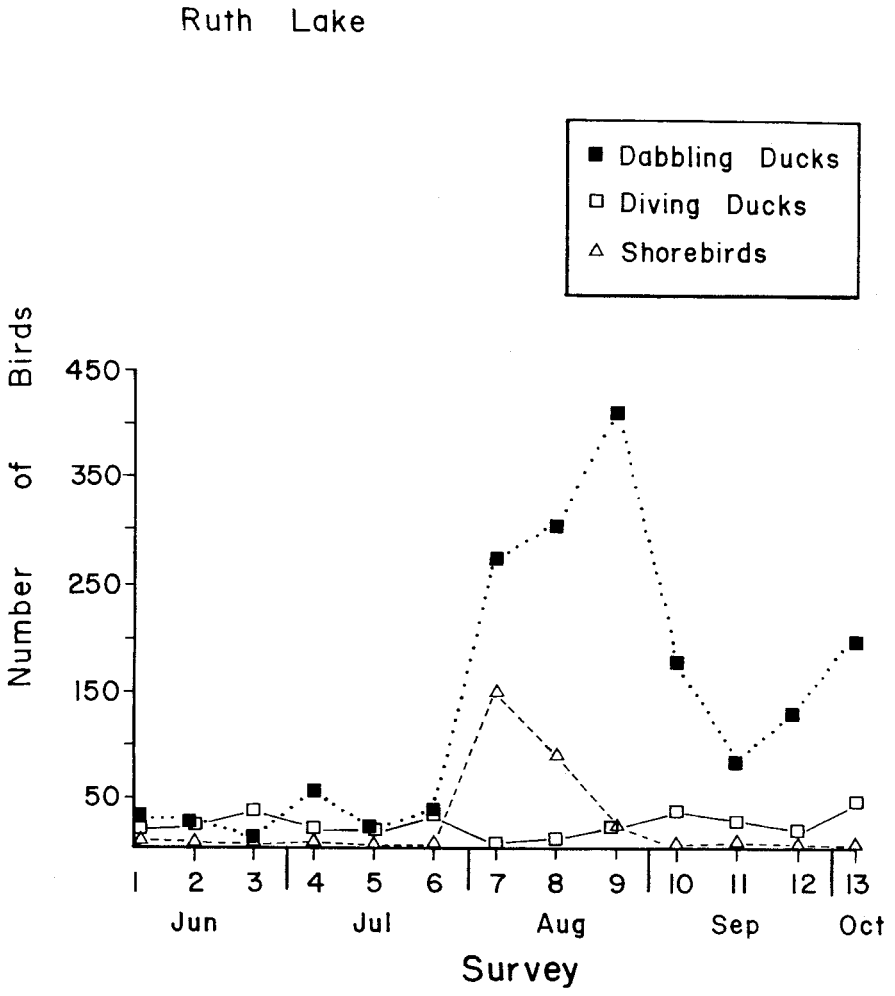

Figure 3.6 Numbers of individuals of commonly observed waterbird groups recorded during surveys on Ruth Lake, June-October 1984.

August and September. Shorebirds were common during the first half of August; most were yellowlegs or stilt sandpipers.

Almost 600 waterbirds were recorded on the Diversion Canals of Ruth Lake (Appendix K). Eleven broods were counted, including four species of dabbling ducks, Canada goose and ring-necked duck (Table 3.6). Several flocks of mallards were present in August and September and small numbers of 10 other duck species were also recorded at this time. Small numbers of yellowlegs were present in early August. The great majority of the waterbirds recorded on the Diversion Canals were seen on the north canal between Beaver Creek Reservoir and Ruth Lake.

Syncrude Site Water Areas

Almost 1800 waterbirds were recorded on the 28 Syncrude Site Water Areas, including the West Interception Ditch, S-Pit and J-Pit (Appendix L). This total represented 5% of all bird observations. These water areas included 4% of the total water area surveyed. Seventeen nesting pairs and 40 broods of 13 species were recorded on these waterbodies (Tables 3.5, 3.6). Based on numbers of broods, buffleheads, ring-necked ducks, American coots and common goldeneyes were the most common nesters. Most evidence of nesting on the SSWAs was recorded on the West Interception Ditch or on the small waterbodies along it and the Beaver Creek dam. A young spotted sandpiper was seen at J-Pit and killdeers were seen regularly during June and July at S-Pit. The SSWAs also supported at least two pairs of breeding Bonaparte's gulls.

S-Pit was used by waterbirds during migration. Flocks of shorebirds, primarily yellowlegs and 'peeps', were recorded in July and early August, and about 200 dabbling ducks, mostly green-winged teal, northern pintails and mallards were present in mid and late August. Low numbers of waterbirds were present on J-Pit during most of the study, but a few small flocks of ducks were recorded in September.

Other Waterbodies

Broods of pied-billed grebes, American coots and dabbling ducks were observed on **Ruth Marsh** during the surveys. The American wigeon and northern shoveler were the most common duck species recorded in June and July (Appendix M). Little water was present in the marsh in August, and consequently few birds were seen then. The birds that were present were mainly shorebirds. The water level rose in September; at this time small flocks of green-winged teal, mallards, blue-winged teal, northern shovelers and shorebirds were seen.

There was little use of **Mildred Lake** by waterbirds (Appendix N). This was one of the larger waterbodies surveyed, and included about 14% of the total water area surveyed. Three wigeon broods and one red-necked grebe brood were recorded (Table 3.6), and up to three common loons were seen regularly during June and July. Spotted sandpipers were also regularly observed during the nesting season. There was no significant increase in waterbird numbers on Mildred Lake after the nesting season, although five species of ducks were recorded there in late September.

Red-necked grebe, American wigeon and ring-necked duck broods were recorded on **Loon Pond**, and a mallard brood was seen on the **Lower Camp Sedimentation Basin.** With the exception of a mixed flock of yellowlegs, pectoral sandpipers and 'peeps' on a temporary mudflat in the basin in mid August and the occasional individual duck or loon, there were few waterbirds in either of these areas after the breeding season.

3.4.1.3 Summary

This section presents a brief summary comparing the numbers of the commonly observed waterbird groups on the various waterbodies on and near Lease 17 in 1984. The percentages of each waterbird group that were recorded on the waterbodies are presented in Table 3.7; also included is the percentage of the total area surveyed that was represented by each waterbody. A preference for or avoidance of a particular waterbody by a waterbird group may be inferred by comparing the percentage of that group against the percentage of the total area represented by the waterbody.

Table 3.7. Percentages of various waterbird groups recorded on waterbodies on and near Crown Lease 17, June-October 1984. Numbers in boldface indicate waterbody for which preference by a waterbird group is inferred.

	% total area[1]	Beaver Creek Reservoir (20)	Saline Lake (19)	Poplar Creek Reservoir (15)	Mildred Lake (15)	Ruth Lake (14)	Horseshoe Lake (10)	Syncrude Site Water Areas (4)	Others[2] (4)
Loons		**33**	2	**28**	14	14	0	**7**	2
Grebes		**34**	2	**37**	5	14	2	5	1
Dabbling Ducks	- breeding/moulting	**48**	13	13	<1	4	**12**	4	6
	- post-moult/migration	**26**	**31**	9	<1	12	**15**	**5**	2
Diving Ducks	- breeding/moulting	8	57	4	1	7	12	**8**	3
	- migration	**40**	**42**	2	<1	4	9	2	1
Coots	- breeding	**29**	8	3	0	1	**50**	4	5
	- migration	**59**	2	1	0	2	**35**	<1	<1
Shorebirds	- breeding	**28**	8	8	6	1	2	**35**	**12**
	- migration	**42**	5	**27**	2	7	2	**7**	**8**
Gulls		46	8	14	**16**	10	3	3	<1
Terns		7	11	**18**	1	**16**	**43**	<1	4

[1] Percent of total area surveyed represented by waterbody.
[2] Includes Ruth Lake Diversion Canals, Ruth Marsh, Loon Pond, Lower Camp Sedimentation Basin.

Inspection of Table 3.7 shows that Beaver Creek Reservoir appears to have been a preferred area for most waterbird groups in 1984. Only by diving ducks during the breeding and postbreeding periods and by terns was there no apparent preference. Saline Lake was preferred by diving ducks throughout the year and by post-moulting and migrating dabbling ducks, whereas Poplar Creek Reservoir supported high percentages of loons, grebes, migrating shorebirds and terns. Horseshoe Lake was an apparently favoured waterbody by terns, coots and, perhaps, dabbling ducks. The SSWAs and other smaller waterbodies (Ruth Marsh, Diversion Canals) were preferred breeding areas for shorebirds. On the other hand, Ruth Lake was not highly preferred by any of the waterbird groups and supported very low numbers of coots and breeding shorebirds, and Mildred Lake was apparently avoided by most groups except gulls and, perhaps, loons.

3.4.2 Comparisons of Waterbird Numbers, Distribution and Productivity Between 1974 and 1984

Inter-year comparisons of numbers of waterbirds on and near Lease 17 in 1974, 1975, 1977 and 1984 were made for four time periods: early summer (16 June-15 July), mid summer (16 July-15 August), late summer (16 August-15 September) and autumn (16 September-15 October). Comparisons were made using the average numbers of adult waterbirds observed on all waterbodies except Saline Lake on all surveys within each period. Data from Saline Lake are examined separately below. It should be noted, however, that the same waterbodies were not surveyed in all years (see Table 3.1). In 1974, only Horseshoe Lake, Ruth Lake, Mildred Lake, Loon Pond and the Syncrude Site Water Areas were present in the area; by 1975, the Lower Camp Sedimentation Basin had been developed; and in 1977 and 1984, Beaver Creek Reservoir, Poplar Creek Reservoir, the Diversion Canals and Ruth Marsh were also present. It should be noted that the SSWAs surveyed in 1984 were not the same as those surveyed in 1974 or 1975.

It should also be noted that the waterbody surveys were not conducted by the same observers over all years, or even within a single year. As well, there were differences in times and dates of surveys among years. Such differences undoubtedly contribute to the differences in the data between and

among years, although the degree to which they contribute is unknown. Nevertheless, such biases should be kept in mind when comparing the results of the surveys of the various years.

The average numbers of waterbirds observed in each of the seasonal periods in 1974, 1975, 1977 and 1984 are summarized in Table 3.8. Detailed comparisons among years for each of the periods are presented in the following sections. However, some general observations can be made.

In general, it appears that numbers of waterbirds in the study area have increased substantially in early and mid summer since the inception of the project and that present numbers in late summer and autumn are comparable to those in the mid 1970's. However, average numbers within a period vary markedly between years. In early summer, numbers in 1984 were 2.4 times higher than in 1975 but only one-half of those in 1977. In mid summer, numbers in 1974 and 1975 were similar but less than half of those in 1984. In late summer, numbers in 1975 were similar to those in 1984 and over three times higher than in 1974. In autumn, numbers in 1974 and 1984 were similar and about half of those in 1975.

Table 3.8. Average numbers of adult waterbirds observed in four periods during waterbody surveys on and near Crown Lease 17. The same waterbodies were not necessarily surveyed each year (see Table 3.1).

	Year			
Period	1974	1975	1977	1984
Early summer	-	563.6	2973.8	1346.0
Mid summer	734.8	916.2	-	2064.5
Late summer	991.6	2938.9	-	3226.7
Autumn	1494.0	2850.2	-	1704.0
TOTAL		7268.9		8341.2

It is also useful to compare differences in waterbird numbers on Saline Lake between 1974 and 1984. Saline Lake is on the eastern side of the Athabasca River and is presumed not to have been directly influenced by the construction and operation of the oil sands project. Comparisons of the data from 1974 with those of 1984 on this lake can aid in the evaluation of any differences observed on the waterbodies in the study area which are presumed to have been affected by the project's presence.

The average numbers of waterbirds observed on Saline Lake in 1974 and 1984 are summarized in Table 3.9. From the data in this table, two observations can be made regarding waterbird populations on Saline Lake:

Table 3.9. Average numbers of adult waterbirds observed in four periods during surveys on Saline Lake in 1974 and 1984.

	Early Summer	Mid Summer		Late Summer		Autumn	
Waterbird Group	1984	1974	1984	1974	1984	1974	1984
Loons	0.7	2.0	0.3	-	-	-	-
Grebes	1.0	13.0	0.7	2.0	4.3	-	-
Swans and geese	-	-	-	-	-	1.6	0.3
Dabbling ducks	121.3	87.0	345.0	205.5	496.7	215.6	585.3
Diving ducks	161.3	43.0	164.0	165.0	207.7	416.0	312.7
Unid. ducks	-	237.0	-	310.5	-	57.2	-
Rails	0.3	3.0	0.3	-	-	-	-
Coots	13.3	-	3.3	-	29.3	252.6	1.7
Shorebirds	21.0	59.0	48.3	15.0	17.7	1.6	-
Gulls	3.3	4.0	0.7	0.5	5.3	-	0.7
Terns	8.3	34.0	18.3	-	9.0	-	-
TOTAL	330.5	482.0	580.9	698.5	770.0	944.6	900.7

1. Average numbers of birds on Saline Lake in 1974 and 1984 were similar in all periods. This is in contrast to the substantially higher numbers in 1984 than in 1974 on the other waterbodies in mid and late summer.

2. Average numbers of birds on Saline Lake in 1984 increased throughout the study period. This is generally consistent with seasonal changes in average numbers of birds present on the other surveyed waterbodies in the study area, except for the autumn period: on the other waterbodies, average numbers of birds decreased in autumn (Table 3.8).

It thus appears that changes in the numbers of waterbirds present on the waterbodies on and near Lease 17 (except Saline Lake) between 1974 and 1984 at least partially reflect changes in habitat resulting from the Syncrude development. Changes in the numbers and distributions of waterbirds in the study area in each of the four seasonal periods are examined in detail in the following sections.

3.4.2.1 Early Summer (16 June-15 July)

Early summer is the period when most waterbirds in the study area are nesting; it is also the period when early migrant shorebirds and pre-moulting and moulting dabbling ducks enter the region. Surveys during this period were conducted in 1975, 1977 and 1984.

Numbers of Adult Waterbirds

The average number of waterbirds recorded in early summer 1984 was more than twice that recorded in 1975; the number in 1984, however, was less than one-half that recorded in 1977 (Table 3.8). The increase in numbers from 1975 to 1984 was due primarily to greater numbers of dabbling ducks, terns and coots (Table 3.10).

The proportions of the waterbird groups in the study area during early summer changed both between 1975 and 1977, the period of construction of the surface water diversion systems, and between 1977 and 1984, the seven-year post-construction period. In 1975, shorebirds were the most commonly recorded waterbirds, forming about 36% of the total average, followed by diving ducks (24%) and dabbling ducks (21%) (Table 3.10). By 1977, all bird

Table 3.10. Average numbers of major waterbird groups observed during early summer surveys on waterbodies on and near Crown Lease 17 in 1975, 1977 and 1984.

Waterbird Group	Horseshoe Lake			Mildred Lake			LCSB			Loon Pond			SSWA	
	1975[1]	1977[2]	1984[3]	1975	1977	1984	1975	1977	1984	1975	1977	1984	1975	1984
Loons	-	-	-	3.8	3.0	2.0	-	-	-	0.3	0.7	0.7	0.2	1.0
Grebes	2.0	5.3	1.3	13.2	18.6	5.0	0.1	0.3	-	0.5	0.3	2.0	-	2.0
Herons and bitterns	-	-	-	2.0	0.7	-	-	-	-	-	-	-	-	-
Swans and geese	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dabbling ducks	26.9	112.4	97.0	11.6	33.1	2.7	29.9	4.3	0.7	1.6	-	2.3	15.8	36.6
Diving ducks	65.2	107.9	34.7	26.6	18.6	1.7	2.4	11.0	4.0	1.3	6.0	1.0	0.6	24.7
Cranes	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-
Rails	7.3	23.3	0.7	1.4	-	0.3	0.4	-	-	-	-	-	3.6	3.0
Coots	12.0	42.0	41.0	-	24.7	-	-	5.7	-	-	4.7	-	0.1	4.0
Shorebirds	0.5	2.7	3.0	32.8	89.0	12.3	37.2	8.0	8.0	8.4	2.0	4.7	74.6	52.0
Gulls	1.1	-	-	17.8	9.9	3.7	0.1	-	-	-	-	-	1.6	2.0
Terns	3.8	16.3	74.3	-	29.0	0.7	0.1	-	-	-	-	1.3	-	1.7
TOTAL[6]	118.8	309.9	252.0	109.2	226.6	28.4	70.2	29.3	12.7	12.1	13.7	12.0	96.7	127.0

Waterbird Group	BCR		PCR		Ruth Lake			RM		RLC	All Waterbodies[5]		
	1977	1984	1977	1984	1975	1977	1984	1977	1984	1984	1975	1977	1984
Loons	5.0	7.0	2.0	4.3	6.2	4.3	3.7	0.7	-	0.3	10.5	15.7	19.0
Grebes	55.0	22.3	18.3	21.0	22.0	38.7	18.0	29.0	0.7	0.3	37.8	165.5	72.6
Herons and bitterns	0.3	1.3	-	0.3	-	1.0	-	0.3	-	1.0	2.0	2.3	2.6
Swans and geese	0.7	1.0	-	-	-	-	-	-	-	-	-	0.7	1.0
Dabbling ducks	709.7	420.0	208.3	118.0	31.2	144.2	32.0	131.6	36.0	9.0	117.0	1343.6	754.3
Diving ducks	59.0	23.0	38.9	12.0	38.0	46.7	26.0	18.0	4.0	1.3	134.1	306.1	132.4
Cranes	0.7	-	18.7	-	3.2	10.0	-	0.7	-	-	3.5	30.1	-
Rails	1.0	0.7	1.7	0.3	3.4	6.3	-	0.7	0.3	-	16.0	33.0	5.3
Coots	23.7	12.0	17.3	0.3	0.8	46.0	1.7	75.3	11.0	-	12.9	239.4	70.0
Shorebirds	143.9	38.7	51.3	10.3	46.6	25.7	2.0	44.0	3.0	6.0	200.1	366.6	140.0
Gulls	28.4	12.3	-	2.0	0.4	0.3	2.7	1.0	-	-	21.0	39.6	22.7
Terns	110.6	7.7	56.3	23.0	4.8	82.7	12.7	136.7	2.7	2.0	8.7	431.6	126.1
TOTAL[6]	1137.6	546.0	412.8	191.5	156.6	405.9	98.8	438.0	57.7	19.9	563.6	2973.8	1346.0

[1] From Sharp and Richardson (1976).
[2] From Ward and Hollingdale (1978).
[3] From present study.
[4] BCR - Beaver Creek Reservoir
SSWA - Syncrude Site Water Areas
LCSB - Lower Camp Sedimentation Basin
PCR - Poplar Creek Reservoir
RM - Ruth Marsh
RLC - Ruth Lake Diversion Canals
[5] Not including Saline Lake.
[6] Includes unidentified waterbirds.

groups had increased in numbers (except herons and bitterns), especially dabbling ducks, terns and coots. In 1977, dabbling ducks was the most commonly recorded waterbird group (45% of total) in the study area. During this two-year span, there was also a four-fold increase in numbers of grebes, and a ten-fold increase in numbers of cranes. In 1984, average numbers of waterbirds were much lower (Table 3.10), especially dabbling ducks, terns and shorebirds. However, dabbling ducks remained the dominant bird group (56% of total average), followed by shorebirds, diving ducks and terns (each about 10%).

The percent change in the numbers of the commonly observed waterbird groups in early summer over the years is graphed in Figure 3.7.

The species composition of some of the waterbird groups in early summer changed over the three survey years. The average numbers of the species commonly observed in the early summer are listed in Appendix O; using the data in this appendix, species composition changes between 1975 and 1984 can be summarized as follows:

1. The red-necked grebe was the most abundant of the four species of grebes observed in the study area. All species were most numerous in 1977; all species decreased to near pre-development numbers in 1984, except the red-necked grebe, which remained twice as abundant;

2. Eight species of dabbling ducks were recorded in the study area. The most abundant species in 1975 were the mallard, northern shoveler and American wigeon. Between 1975 and 1977, all dabblers increased in numbers, especially mallards and blue-winged teal; blue-winged teal was the second most abundant species in the study area in 1977. Between 1977 and 1984, all dabbling duck species, except the American wigeon, decreased in numbers. The wigeon was the most common species in 1984;

3. Ten species of diving ducks were observed in the study area. In all years, the ring-necked duck was the most abundant species, followed by scaup, bufflehead and common goldeneye. Ruddy ducks were also common in 1977. Fluctuations in numbers over the survey years were not as high for diving ducks as they were for dabbling ducks, although all divers showed minor peaks in abundance in 1977;

4. Sixteen species or species-pairs (e.g., yellowlegs, dowitcher) of shorebirds were identified in the study area. The most commonly counted species in all years were yellowlegs, spotted sandpiper and killdeer. Between 1975 and 1977, shorebird numbers increased somewhat, but 1984 numbers were below 1975 levels; and

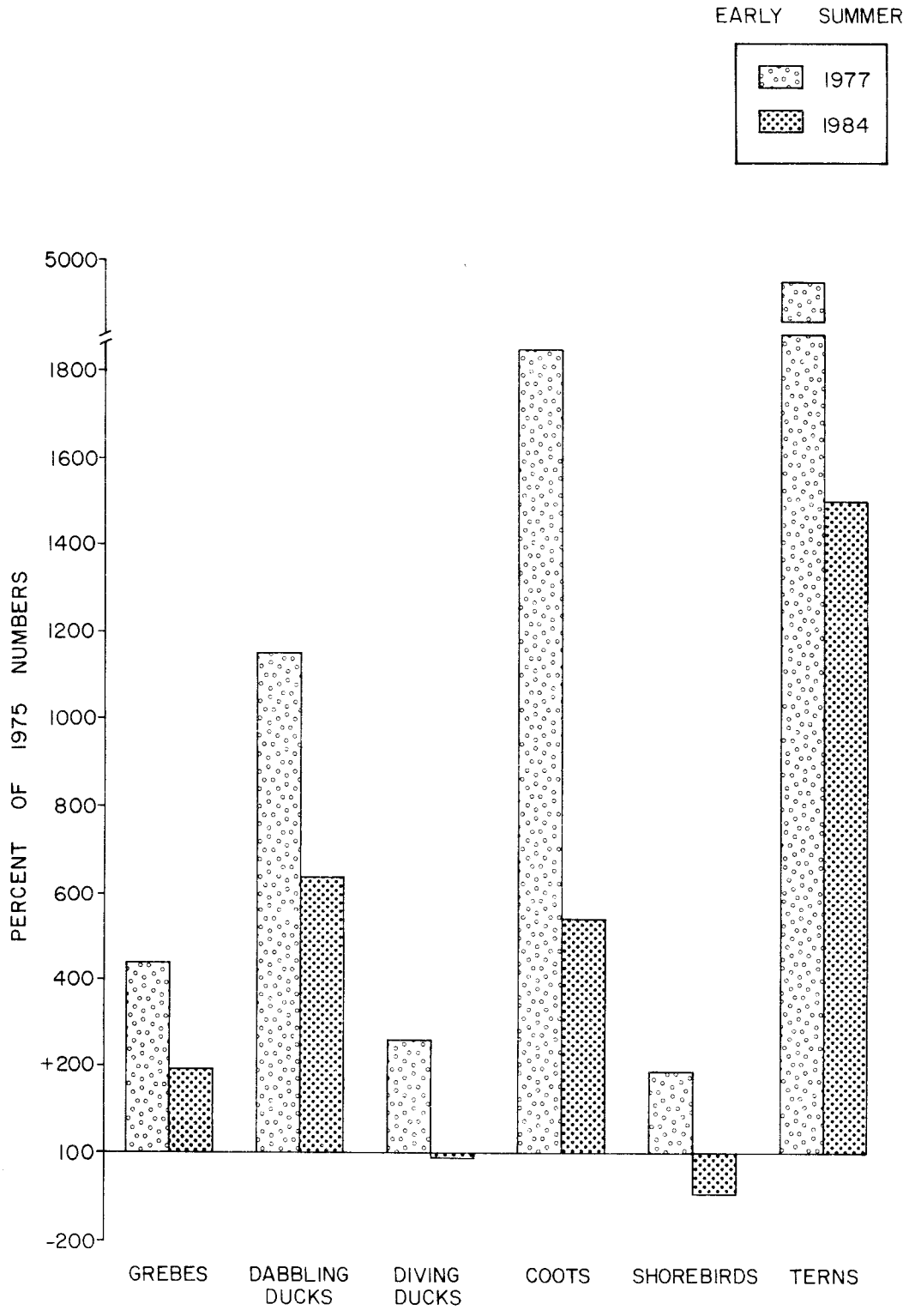

Figure 3.7 Percent change in numbers ot commonly observed waterbird groups in early summer between 1975 and 1984.

5. Two species of terns occurred in the study area. Black tern numbers were highest in 1977, and were lower in 1984 but at a level 13 times higher than the 1975 level. Common terns were first observed in 1977; numbers were slightly higher in 1984.

Distribution of Adult Waterbirds

The distributions of waterbird groups in the study area in early summer changed after initiation of the oil sands development. In 1977 and 1984, 68% and 71% of the average numbers of waterbirds, respectively, were observed on new water areas created as a result of the development (i.e. Beaver Creek Reservoir, Poplar Creek Reservoir, Ruth Marsh, the Ruth Marsh Diversion Canals, Lower Camp Sedimentation Basin and the SSWAs). These new areas include 53% of the total water area surveyed (excluding Saline Lake). In 1977, 78% of the dabbling ducks and 60%-70% of the grebes, shorebirds and terns were recorded on these new waterbodies; 40%-50% of the diving ducks and coots were counted on the new water areas. In 1984, 82%-84% of the dabbling ducks and shorebirds, 52%-64% of the grebes and diving ducks and less than 40% of the coots and terns were observed on the new waterbodies. Thus, the major difference between these two years appears to be a decrease in numbers of terns and coots on the new waterbodies. Considering the uncommon bird groups, in 1977 most cranes and gulls were recorded on the new waterbodies, whereas most rails, herons and bitterns were observed on the older water areas (Horseshoe Lake, Ruth Lake, Mildred Lake, Loon Pond). Loons were distributed evenly on both groups of waterbodies. In 1984, however, the large percentage of these groups were observed on the new water areas.

The proportions of waterbirds on the individual waterbodies varied between survey years. In 1975, 80% of the total average number of waterbirds were recorded on Ruth Lake, Horseshoe Lake, Mildred Lake and the Syncrude Site Water Areas; in 1977, these waterbodies were Beaver Creek Reservoir, Ruth Marsh, Poplar Creek Reservoir and Ruth Lake; and in 1984, these waterbodies were Beaver Creek Reservoir, Horseshoe Lake, Poplar Creek Reservoir and the SSWAs. Thus, the main changes in distribution between 1975 and 1984 were the presence of large numbers on Beaver Creek and Poplar Creek reservoirs and a decrease in numbers on Mildred Lake. The main change between 1977 and 1984 was a marked decrease in average numbers of waterbirds on most waterbodies.

Mid Summer (16 July-15 August)

Mid summer is the period when ducks are moulting, shorebirds are migrating south, and the young of many species are joining the adult population. Surveys were conducted during this period in 1974, 1975 and 1984.

Numbers of Adult Waterbirds

The average number of waterbirds recorded in the study area in mid summer was almost three times higher in 1984 than in 1974; numbers in 1974 and 1975 were similar (Table 3.11). Increases in overall average numbers between 1975 and 1984 were due primarily to greater numbers of dabbling ducks, shorebirds, terns and coots. There was, however, a substantial decrease in average numbers of diving ducks after 1974.

The proportions of the waterbird groups in the study area during mid summer changed markedly between 1975, when construction of the Beaver Creek Diversion System was started, and 1984. In 1974, prior to development of the diversion system, shorebirds were the most common by recorded bird group (40% of the total average), followed by dabbling and diving ducks (over 20% each). Changes in numbers were relatively minor between 1974 and 1975, except for a two-fold increase in dabbling duck numbers and a concomitant decrease in diving duck numbers. Between 1975 and 1984, dabbling duck numbers again increased, along with shorebirds, terns and coots. Dabbling ducks and shorebirds constituted 50% and 29%, respectively, of the total average number of waterbirds in 1984. Average numbers of grebes doubled between 1974 and 1984. Coots were not recorded in 1974 but were common in 1984.

The percent change in the numbers of the commonly observed waterbird groups in mid summer over the three years is graphed in Figure 3.8.

The species composition of some bird groups changed over the three survey years. The average numbers of the species commonly observed in mid summer surveys are listed in Appendix O. From this appendix the following

Table 3.11. Average numbers of major waterbird groups observed during mid summer surveys on waterbodies on and near Crown Lease 17 in 1974, 1975 and 1984.

Waterbird Group	Horseshoe Lake			Mildred Lake			LCSB[4]		Loon Pond			SSWA		
	1974[1]	1975[2]	1984[3]	1974	1975	1984	1975	1984	1974	1975	1984	1974	1975	1984
Loons	-	-	-	4.0	2.8	1.7	0.1	0.7	2.0	0.2	0.3	-	0.2	0.3
Grebes	0.8	1.4	1.0	1.0	15.2	3.7	-	-	5.0	-	2.0	-	0.1	2.7
Herons and bitterns	-	-	-	-	0.4	-	-	-	-	-	-	-	-	0.3
Swans and geese	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dabbling ducks	38.0	44.6	151.7	41.0	22.8	9.7	98.6	0.7	-	43.2	9.0	61.2	109.3	26.3
Diving ducks	13.8	25.0	13.7	58.8	20.4	1.7	11.1	0.7	-	0.2	1.7	3.2	2.3	21.0
Unid. ducks	10.5	2.8	-	19.5	-	-	0.1	-	-	-	-	2.3	1.9	-
Cranes	-	7.6	-	-	-	-	-	-	-	-	-	-	1.1	-
Rails	0.8	0.4	-	2.8	0.8	-	0.2	-	-	-	-	0.9	1.3	1.0
Coots	-	2.8	55.3	-	-	-	-	-	-	-	-	-	0.1	3.0
Shorebirds	26.3	9.6	22.0	18.5	51.4	20.7	36.7	1.7	19.0	7.8	3.3	221.9	137.1	67.0
Gulls	1.3	1.0	-	9.5	31.2	2.0	0.5	0.3	-	-	-	0.3	4.1	0.7
Terns	9.8	8.0	32.7	7.8	7.8	0.7	0.3	-	-	-	2.3	-	0.3	2.7
TOTAL	101.3	103.2	276.4	162.9	152.8	40.2	147.6	4.1	26.0	51.4	18.6	289.8	257.8	125.0

Waterbird Group	BCR	PCR	Ruth Lake			RM	RLC	All Waterbodies[5]		
	1984	1984	1974	1975	1984	1984	1984	1974	1975	1984
Loons	5.7	5.3	5.6	11.2	2.0	-	-	11.6	14.5	16.0
Grebes	14.0	33.3	29.2	29.0	15.3	0.3	0.3	36.0	45.7	72.6
Herons and bitterns	2.3	1.0	-	-	-	-	1.3	-	0.4	4.9
Swans and geese	2.7	-	-	-	-	-	0.3	-	-	3.0
Dabbling ducks	514.7	183.0	16.6	45.2	109.0	10.0	11.7	156.8	363.7	1025.8
Diving ducks	16.0	8.3	71.6	23.2	14.7	4.7	4.0	147.4	82.2	86.5
Unid. ducks	-	-	17.6	1.2	-	-	-	49.9	6.0	-
Cranes	-	-	-	11.6	-	-	-	-	20.3	-
Rails	0.3	-	0.2	0.2	0.3	-	-	4.7	2.9	1.6
Coots	36.0	0.3	-	0.2	1.0	3.3	-	-	3.1	98.9
Shorebirds	257.3	145.3	7.6	65.4	50.3	17.7	17.0	293.3	308.0	602.3
Gulls	9.3	3.3	0.2	0.4	3.0	-	0.3	11.3	37.2	18.9
Terns	14.3	31.3	6.2	15.8	40.0	1.3	8.7	23.8	32.2	134.0
TOTAL	872.6	411.1	154.8	203.4	235.6	37.3	43.6	734.8	916.2	2064.5

[1] From Sharp et al. (1975).
[2] From Sharp and Richardson (1976).
[3] From present study.
[4] LCSB - Lower Camp Sedimentation Basin
SSWA - Syncrude Site Water Areas
BCR - Beaver Creek Reservoir
PCR - Poplar Creek Reservoir
RM - Ruth Marsh
RLC - Ruth Lake Diversion Canals
[5] Not including Saline Lake.

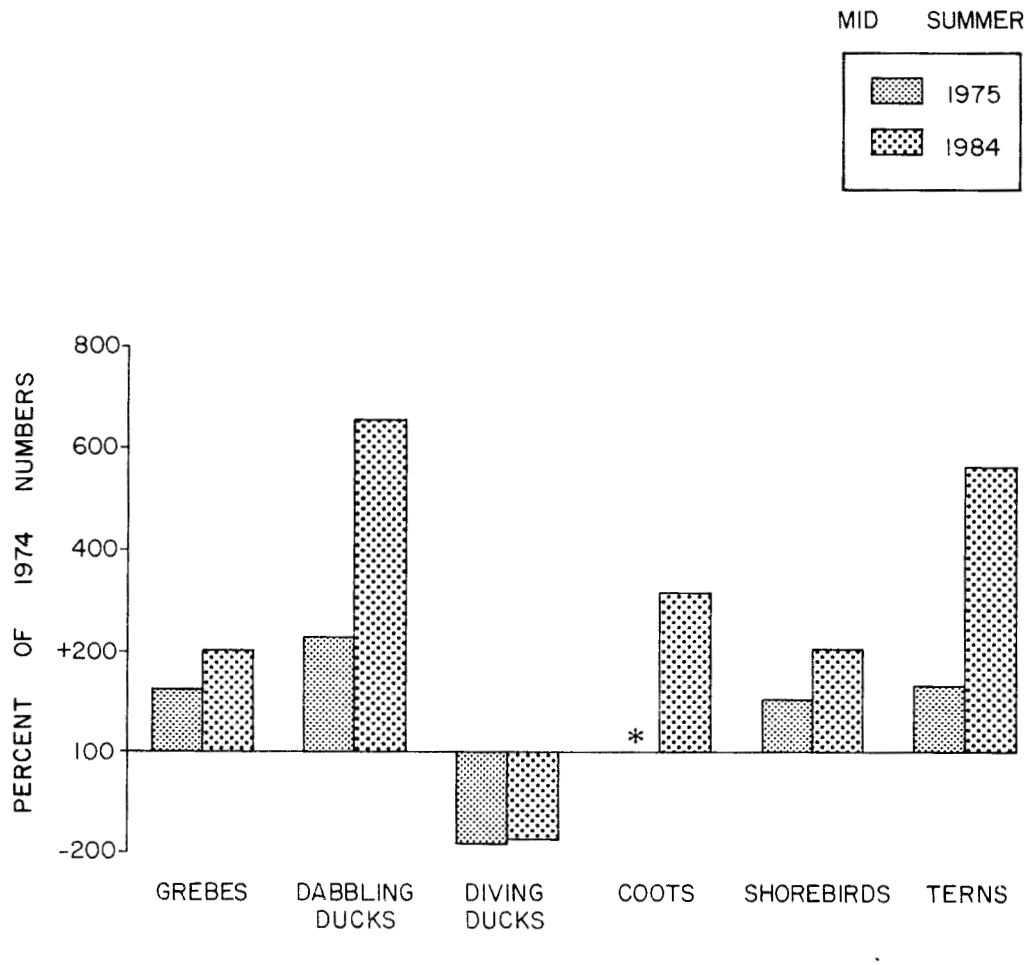

Figure 3.8 Percent change in numbers of commonly observed waterbird groups in mid summer between 1974 and 1984. '*' indicates no birds recorded in that year.

observations about changes in species composition between 1974 and 1984 can be made:

1. The red-necked grebe was the most numerous of the four species of grebes observed in the study area. This species doubled in numbers between 1974 and 1984;

2. Seven species of dabbling ducks were observed in the study area. The most abundant species in 1974 were the mallard, green-winged teal, northern pintail and American wigeon. Between 1974 and 1975, most species increased moderately in abundance, especially the green-winged teal, northern pintail, northern shoveler and mallard. In 1975, the green-winged teal was the most abundant species. Between 1975 and 1984, numbers of five species of dabblers increased (primarily American wigeon and mallard), while those of two species decreased (primarily northern pintail). As a result, mallards were more abundant than American wigeons and green-winged teal in 1984. Gadwalls were also more common in the study area in 1984;

3. Eight species of diving ducks were observed in the study area. Over the three survey years, average numbers of most species of diving ducks decreased or, at best, remained stable. However, numbers of scaup increased. The most abundant species in 1974 and 1975 was ring-necked duck, followed by bufflehead and common goldeneye; the most common species in 1984 were bufflehead, scaup and ring-necked duck; and

4. Twenty species or species-pairs of shorebirds were recorded in the study area. The main species present in all years were yellowlegs, pectoral sandpiper, spotted sandpiper and killdeer. The main changes in species composition were increases in numbers of yellowlegs between 1974 and 1975, and 1975 and 1984, and decreases in numbers of pectoral sandpipers over both time periods.

Distribution of Adult Waterbirds

In 1984, 72% of the waterbirds recorded in mid summer were on the water areas created as a result of the oil sands development (Table 3.11). Over 70% of the dabbling ducks and 84% of the shorebirds were recorded on these new waterbodies, whereas only 43-44% of the terns and coots were counted on them. Of the less abundant groups in the study area, 63% of the diving ducks, 70-75% of the grebes, loons and gulls, and 100% of the herons and bitterns were recorded on the new water areas. The new waterbodies include 53% of the total water area surveyed (excluding Saline Lake).

The proportions of waterbirds on the individual waterbodies varied between survey years. In 1974, 80% of the total average number of waterbirds were recorded on the Syncrude Site Water Areas, Mildred Lake and Ruth Lake; in 1975, these waterbodies were the above three plus the Lower Camp Sedimentation Basin; and in 1984, they were Beaver Creek Reservoir, Poplar Creek Reservoir, Horseshoe Lake and Ruth Lake. Thus, there appears to be little difference in the distribution of waterbirds between 1974 and 1975, except for the presence of substantial numbers on the Lower Camp Sedimentation Basin in 1975. The main changes between 1975 and 1984 were the presence of large numbers of waterbirds on Beaver Creek and Poplar Creek reservoirs, an increase in the numbers on Horseshoe Lake, and a large decrease in numbers present on Mildred Lake and the Lower Camp Sedimentation Basin.

3.4.2.3 Late Summer (16 August-15 September)

Late summer is the period when many waterbirds begin their migration south. Some duck species are in the middle of migration, while others are just beginning; coot migration is well underway and most shorebirds have already migrated south. Surveys were conducted during this period in 1974, 1975 and 1984.

Numbers of Adult Waterbirds

The average numbers of waterbirds recorded in the study area in late summer increased three-fold between 1974 and 1975, but were only slightly higher in 1984 than in 1975 (Table 3.12). Increases in abundance from 1974 to 1975 were due primarily to greater numbers of coots, dabbling ducks, diving ducks and shorebirds.

The proportions of the waterbird groups in the study area during late summer changed between 1974 and 1975, the first year of construction of the Beaver Creek Diversion System. In 1974, ducks included 92% of the total average number of waterbirds in the area; dabbling ducks were over four times as numerous as diving ducks. Although average numbers of ducks were higher in 1975, they constituted only 51% of the total waterbird numbers in that

Table 3.12. Average numbers of major waterbird groups observed during late summer surveys on waterbodies on and near Crown Lease 17 in 1974, 1975 and 1984.

	Horseshoe Lake			Mildred Lake			LCSB[4]		Loon Pond			SSWA		
Waterbird Group	1974[1]	1975[2]	1984[3]	1974	1975	1984	1975	1984	1974	1975	1984	1974	1975	1984
Loons	-	-	-	1.8	2.4	3.0	-	0.3	0.4	-	-	-	-	0.7
Grebes	-	-	1.3	3.0	7.8	1.7	-	-	-	-	0.7	-	0.1	1.7
Herons and bitterns	-	-	-	-	0.2	-	-	0.3	-	-	-	-	0.1	3.0
Swans and geese	-	0.3	-	-	-	-	-	-	-	-	-	-	13.0	-
Dabbling ducks	206.0	552.4	271.0	322.3	175.6	4.7	228.9	1.0	0.2	16.4	1.3	40.6	95.3	157.4
Diving ducks	13.3	149.7	36.0	81.0	83.8	1.0	7.9	0.7	0.6	0.5	0.7	0.2	6.9	12.1
Unid. ducks	90.3	1.5	-	101.0	1.2	-	0.1	-	0.1	0.2	-	-	-	-
Cranes	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-
Rails	-	-	-	-	-	-	-	-	-	-	-	0.2	0.1	0.3
Coots	3.0	1114.3	108.3	-	38.8	-	34.7	-	-	-	-	-	0.4	5.3
Shorebirds	-	3.7	0.3	1.0	77.0	6.3	14.0	23.7	0.1	2.8	0.7	39.3	53.8	42.1
Gulls	1.7	1.0	0.3	7.0	9.4	3.7	0.2	-	-	-	-	-	0.7	-
Terns	-	-	2.0	-	4.6	-	-	-	-	-	-	-	-	-
TOTAL	314.3	1822.9	419.2	517.1	400.8	20.4	285.8	26.0	1.4	19.9	3.4	80.3	171.3	222.6

	BCR	PCR	Ruth Lake			RM	RLC	All Waterbodies[5]		
Waterbird Group	1984	1984	1974	1975	1984	1984	1984	1974	1975	1984
Loons	3.3	3.0	2.8	3.6	1.3	-	-	5.0	6.0	11.6
Grebes	39.3	31.7	11.5	18.8	1.0	-	-	14.5	26.7	77.4
Herons and bitterns	3.3	3.7	-	0.2	0.7	-	1.0	-	0.5	12.0
Swans and geese	2.7	2.0	-	-	-	-	-	-	13.3	4.7
Dabbling ducks	639.3	174.0	6.5	19.6	297.3	23.7	36.7	575.6	1088.2	1606.4
Diving ducks	340.0	10.7	38.8	149.4	19.7	-	7.7	133.9	398.2	428.6
Unid. ducks	-	1.0	14.8	7.2	2.0	-	-	206.2	10.2	3.0
Cranes	-	1.0	0.8	3.4	-	-	-	0.8	4.3	-
Rails	-	-	-	-	-	-	-	0.2	0.1	0.3
Coots	416.3	18.7	-	25.6	0.7	-	-	3.0	1213.8	549.3
Shorebirds	232.3	129.7	3.3	7.2	37.3	6.3	14.0	43.7	158.5	492.7
Gulls	24.7	4.0	-	2.8	2.7	-	-	8.7	14.1	35.4
Terns	0.3	-	-	-	3.0	-	-	-	4.6	5.3
TOTAL	1701.5	378.5	78.5	237.8	365.7	30.0	59.4	991.6	2938.5	3226.7

[1] From Sharp et al. (1975).
[2] From Sharp and Richardson (1976).
[3] From present study.
[4] LCSB - Lower Camp Sedimentation Basin
SSWA - Syncrude Site Water Areas
BCR - Beaver Creek Reservoir
PCR - Poplar Creek Reservoir
RM - Ruth Marsh
RLC - Ruth Lake Diversion Canals
[5] Not including Saline Lake.

year. In 1975, coots accounted for 41% of the total waterbird numbers, followed by dabbling ducks (37%), diving ducks (14%) and shorebirds (5%). Between 1975 and 1984, the proportion of the groups present changed, although the total average number of waterbirds remained similar. Average numbers of coots decreased, while the average numbers of dabbling ducks, shorebirds and grebes increased. Thus, in 1984, dabbling ducks were the most common waterbird group (50% of the total number), followed by coots (17%) and shorebirds (15%).

The percent change in the numbers of the commonly observed waterbird groups in late summer over the three years is graphed in Figure 3.9.

The species composition of some bird groups changed over the three survey years. The average numbers of the species commonly observed in the late summer are listed in Appendix O; from this appendix, the following observations about changes in species composition between 1974 and 1984 can be made:

1. The red-necked grebe was the most abundant grebe species in all years, followed by the horned grebe. Numbers of red-necked grebes doubled both between 1974 and 1975, and between 1975 and 1984;

2. Eight species of dabbling ducks were recorded in the study area. The most abundant species in 1974 was the mallard, which included 84% of all dabbling ducks recorded. Between 1974 and 1975, and again between 1975 and 1984, the American wigeon increased in numbers to become the second most common species to the mallard in both 1975 and 1984. In 1984, numbers of green-winged and blue-winged teal were substantially higher than in 1975, whereas numbers of northern shovelers were much lower;

3. Ten species of diving ducks were recorded in the study area. Between 1974 and 1975, there was an increase in the numbers of most species; between 1975 and 1984, there was a general decrease in the abundance of most species (except scaups, whose numbers tripled). In all years, scaup were the most abundant diving ducks. Buffleheads, common goldeneyes and ring-necked ducks were also regularly recorded;

4. Twenty species or species-pairs of shorebirds were recorded in the study area. The yellowlegs and pectoral sandpiper were the dominant migrants in all three years. Between 1974 and 1975, most species of shorebirds increased in abundance, with the greatest increase recorded for the pectoral sandpiper, yellowlegs and dowitchers. Between 1975 and 1984, numbers of most species remained similar, although yellowlegs were substantially more abundant in the latter year.

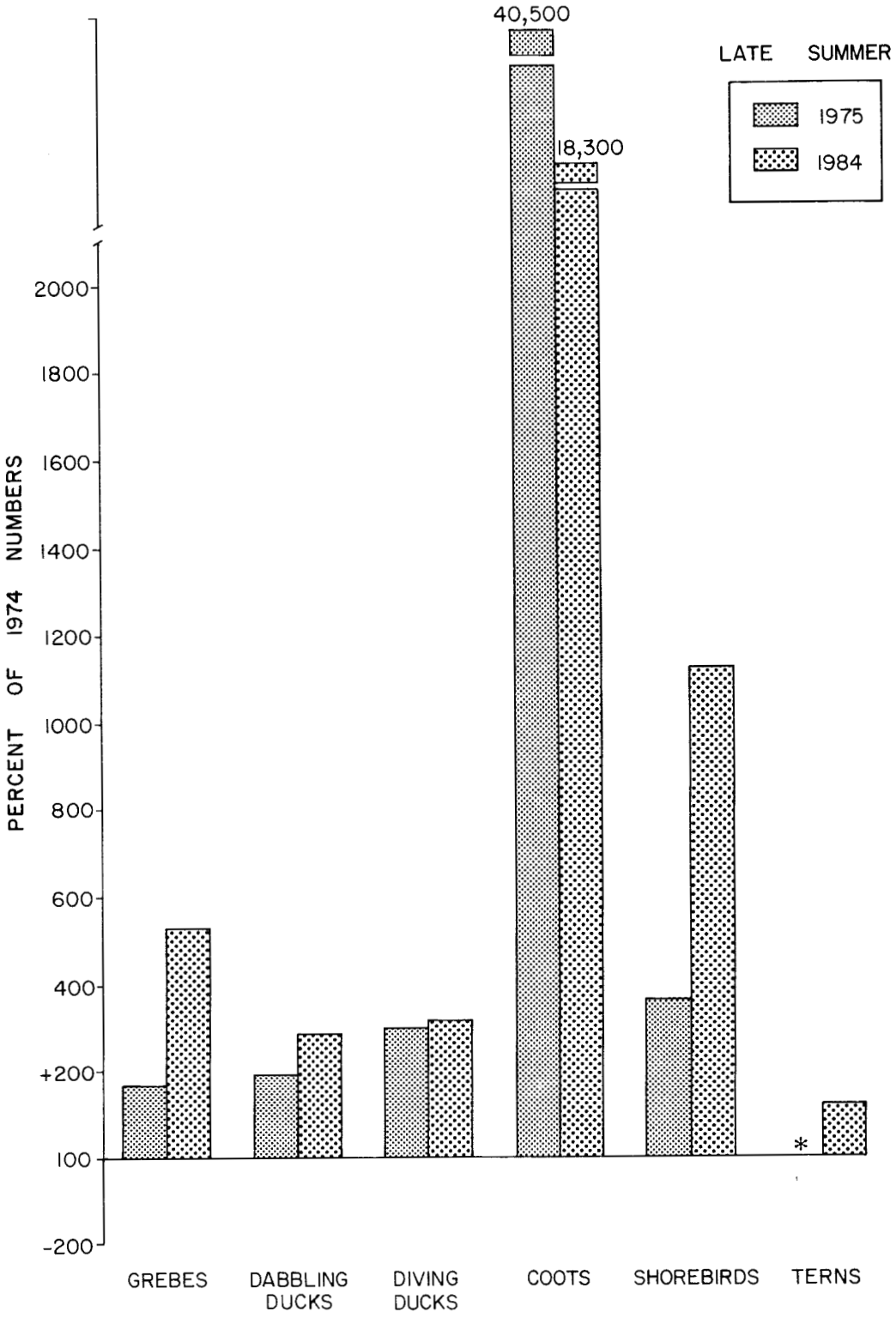

Figure 3.9 Percent change in numbers of commonly observed waterbird groups in late summer between 1974 and 1984.

Distribution of Adult Waterbirds

Waterbird distribution in late summer changed somewhat after the development of the oil sands project (Table 3.12). In 1984, 75% of the waterbirds were observed on new waterbodies created by the development, including over 64% of the dabbling ducks, 80% of the coots, 90% of the shorebirds and 87% of the diving ducks. Of the less numerous bird groups, over 90% of the grebes and gulls, and 94% of the herons and bitterns were recorded on new waterbodies. Loons were recorded in approximately equal numbers on both the older and new waterbodies, whereas 94% of the terns were recorded on the older waterbodies.

The proportions of waterbirds on the individual waterbodies varied among survey years. In 1974, 80% of the total average numbers of waterbirds were recorded on Mildred Lake and Horseshoe Lake; in 1975, these waterbodies were Horseshoe Lake, Mildred Lake and the Lower Camp Sedimentation Basin; and in 1984, they were Beaver Creek Reservoir, Horseshoe Lake, Poplar Creek Reservoir, and Ruth Lake. Thus, the main changes in distribution between 1974 and 1975 were a large increase in numbers, primarily of coots, on Horseshoe Lake and a decrease in numbers on Mildred Lake. The main changes between 1975 and 1984 were the presence of large numbers on Beaver Creek and Poplar Creek reservoirs, an increase in numbers on Ruth Lake, and a decrease in numbers on Horseshoe and Mildred lakes and the Lower Camp Sedimentation Basin.

3.4.2.4 Autumn (16 September-15 October)

Autumn is the period of migration for most species of waterbirds. Surveys were conducted during this period in 1974, 1975 and 1984.

Numbers of Adult Waterbirds

The average number of waterbirds recorded in the study area was almost twice as high in 1975 as in 1974, but was about 40% lower in 1984 than in 1975 (Table 3.13). The proportions of the waterbird groups in the study area during autumn also changed between 1974 and 1975, and between 1975 and 1984. In 1974, diving ducks was the most abundant bird group seen in the area (53%

Table 3.13. Average numbers of major waterbird groups observed during autumn surveys on waterbodies on and near Crown Lease 17 in 1974, 1975 and 1984.

Waterbird Group	Horseshoe Lake			Mildred Lake			LCSB[4]		Loon Pond			SSWA		
	1974[1]	1975[2]	1984[3]	1974	1975	1984	1975	1984	1974	1975	1984	1974	1975	1984
Loons	-	-	-	0.4	2.1	1.3	-	-	-	-	-	-	-	-
Grebes	-	3.3	0.3	2.3	2.9	2.3	-	-	0.1	-	-	-	-	-
Pelicans	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Herons and bitterns	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Swans and geese	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-
Dabbling ducks	290.4	205.3	307.7	108.9	51.9	5.7	22.9	1.0	0.7	19.1	0.7	4.7	18.7	34.4
Diving ducks	35.6	124.8	63.0	662.1	378.9	2.7	26.9	1.0	17.6	0.7	0.3	0.5	2.3	11.3
Unid. ducks	89.2	-	-	13.0	1.1	-	-	-	-	-	-	0.1	-	-
Cranes	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coots	86.0	1649.0	244.3	23.1	6.8	-	5.1	-	3.9	-	-	-	-	0.7
Shorebirds	0.2	0.3	8.7	-	6.6	0.7	0.8	0.7	-	-	-	15.3	8.8	16.3
Gulls	-	0.2	2.7	8.7	17.5	2.7	0.1	-	-	-	-	-	-	-
TOTAL	501.8	1982.9	626.7	818.5	467.8	15.4	55.8	2.7	22.3	19.8	1.3	20.6	30.1	62.7

Waterbird Group	BCR	PCR	Ruth Lake			RM	RLC	All Waterbodies[5]		
	1984	1984	1974	1975	1984	1984	1984	1974	1975	1984
Loons	2.0	2.3	0.4	0.3	-	-	-	0.8	2.4	5.6
Grebes	8.7	7.0	1.5	2.5	1.3	-	-	3.9	8.7	19.6
Pelicans	1.0	-	-	-	-	-	-	-	-	1.0
Herons and bitterns	-	0.3	-	-	-	-	-	0.2	-	0.3
Swans and geese	1.7	-	-	2.7	-	-	1.3	-	3.0	3.0
Dabbling ducks	223.7	99.3	7.8	14.9	137.0	24.0	11.3	412.7	332.8	844.8
Diving ducks	60.7	9.3	83.0	206.0	29.7	-	5.7	798.8	739.6	183.7
Unid. ducks	1.0	-	28.5	-	-	-	-	130.8	1.1	1.0
Cranes	-	-	0.2	-	-	-	-	0.2	-	-
Coots	208.0	1.0	9.0	66.4	14.7	-	0.7	122.0	1727.3	469.4
Shorebirds	51.0	57.0	-	1.0	1.3	15.3	2.0	15.5	17.5	153.3
Gulls	6.3	7.3	0.4	-	3.3	-	-	9.1	17.8	22.3
TOTAL	564.1	183.5	130.8	293.8	187.3	39.3	21.0	1494.0	2850.2	1704.0

[1] From Sharp et al. (1975).
[2] From Sharp and Richardson (1976).
[3] From present study.
[4] LCSB - Lower Camp Sedimentation Basin
SSWA - Syncrude Site Water Areas
BCR - Beaver Creek Reservoir
PCR - Poplar Creek Reservoir
RM - Ruth Marsh
RLC - Ruth Lake Diversion Canals
[5] Not including Saline Lake.

of total average), followed by dabbling ducks (28%) and coots (8%). In 1975, numbers of coots increased substantially and numbers of ducks (especially diving ducks) decreased, so that coots represented 61% of the total number of waterbirds, with smaller percentages of diving (26%) and dabbling (12%) ducks. In 1984, average numbers of coots and diving ducks were much lower, but average numbers of dabblers had increased substantially. As a consequence, dabbling ducks were the most common bird group in 1984 (50% of total), with lower percentages of coots (28%) and diving ducks (11%). Numbers of shorebirds were substantially higher in 1984.

The percent change in the numbers of the commonly observed waterbird groups in autumn over the three years is graphed in Figure 3.10.

The species composition of some bird groups changed over the three survey years. The average numbers of the species commonly observed in the autumn of 1974, 1975 and 1984 are listed in Appendix O; from this appendix, the following observations about changes in species composition between 1974 and 1984 can be made:

1. The red-necked grebe was the most abundant of the four species of grebes observed in the study area in all years, followed by the horned grebe in 1974 and 1984, and the eared grebe in 1975;

2. Seven species of dabbling ducks were recorded in the study area in autumn. The most abundant species in all three survey years was the mallard. Species numbers fluctuated between 1974 and 1975; all dabbling ducks, except the northern pintail, increased substantially in numbers between 1975 and 1984;

3. Twelve species of diving ducks were present in the study area in autumn. In 1974, 1975 and 1984, scaup were the most abundant diving ducks in the area, accounting for 84%, 66%, and 51% of this group, respectively. In 1975 and 1984, the next most common species was the ring-necked duck. The numbers of most species fluctuated between years; large changes were noted in numbers of scaup, which decreased from 1974 to 1984, and in numbers of ring-necked ducks, which increased in 1975 and decreased in 1984; and

4. Thirteen species of shorebirds were observed in the study area in autumn. Shorebird numbers were low; yellowlegs and pectoral sandpipers were abundant in all years. Total shorebird numbers increased between 1975 and 1984, with the greatest increases by dowitchers, pectoral sandpipers, yellowlegs and black-bellied plovers.

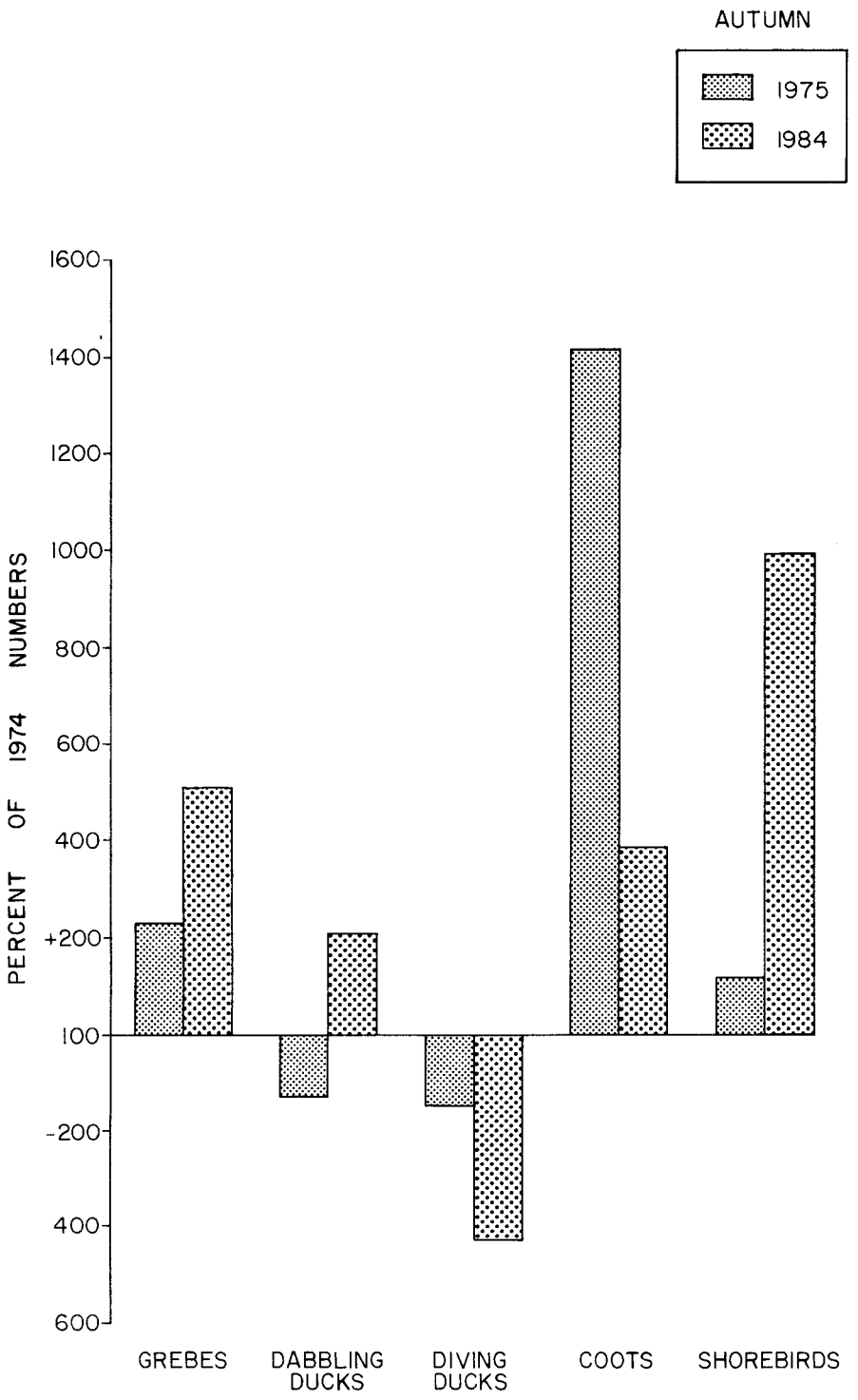

Figure 3.10 Percent change in numbers of commonly observed waterbird groups in autumn between 1974 and 1984.

Distribution of Adult Waterbirds

In 1984, 51% of the waterbirds recorded in autumn were on the waterbodies created as a result of the oil sands development (Table 3.13). As stated above, these waterbodies include 53% of the total water area surveyed (excluding Saline Lake). Over 93% of the shorebirds were recorded on the new waterbodies; however, average numbers of dabbling ducks, coots and diving ducks on the new waterbodies did not exceed 50% of their totals in the study area. These groups were most numerous on Horseshoe Lake. Of the less abundant groups, 79% of the grebes and loons and 61% of the gulls were observed on new water areas.

The distribution of waterbirds on individual waterbodies varied between survey years. In both 1974 and 1975, over 80% of the total average numbers of waterbirds were recorded on Mildred Lake and Horseshoe Lake; in 1984, these waterbodies were Horseshoe Lake, Beaver Creek Reservoir, Ruth Lake and Poplar Creek Reservoir. The major changes in distribution between 1974 and 1975 were a decrease in numbers on Mildred Lake and an increase in numbers on Horseshoe Lake and Ruth Lake. The main changes in distribution between 1975 and 1984 were a decrease in numbers on Ruth, Mildred and Horseshoe lakes and the presence of substantial numbers on Beaver Creek and Poplar Creek reservoirs.

3.4.2.5 Productivity

Inter-year comparisons of waterbird productivity in 1975, 1977, and 1984 are based on numbers of broods observed. Table 3.14 summarizes the numbers of broods of the various bird groups recorded in the three years, and Appendix P summarizes the numbers of broods of each species.

Although some brood information was obtained in 1974, it has not been used in the productivity analysis; the data were collected for only a limited period late in the season, and were, therefore, biased against early breeders, i.e., dabbling ducks. The total was thus unrealistically low. Moreover, comparisons among 1975, 1977 and 1984 should be viewed with caution. Surveys in 1977 and 1984 were not conducted as frequently as those

Table 3.14. Numbers of broods of major waterbird groups recorded during surveys of various waterbodies on and near Crown Lease 17 in 1975, 1977 and 1984.

Waterbird Group	Horseshoe Lake[4]			Mildred Lake			Loon Pond			SSWA	
	1975[1]	1977[2]	1984[3]	1975	1977	1984	1975	1977	1984	1975	1984
Loons	-	-	-	2	1	-	-	-	-	-	-
Grebes	1	5	2	5	7	1	-	-	2	-	2
Geese	-	-	-	-	-	-	-	-	-	-	-
Dabbling ducks	31	14	10	11	14	3	-	1	3	11	12
Diving ducks	24	16	14	32	18	-	1	2	1	2	21
Unid. ducks	-	2	-	-	1	-	-	-	-	-	-
Coots	9	8	36	1	10	-	-	-	-	-	5
TOTAL	65	45	62	51	51	4	1	3	6	13	40

Waterbird Group	BCR		PCR		Ruth Lake			RM		RLC	All Waterbodies[6]		
	1977	1984	1977	1984	1975	1977	1984	1977	1984	1984	1975	1977	1984
Loons	-	-	1	1	3	2	-	-	-	-	5	4	1
Grebes	7	9	12	14	17	20	2	17	1	-	23	68	33
Geese	-	1	-	-	-	-	-	-	-	1	-	-	2
Dabbling ducks	26	19	12	3	8	22	2	5	1	8	61	94	61
Diving ducks	4	8	7	6	9	6	1	-	-	1	68	53	52
Unid. ducks	5	2	1	1	-	3	2	-	-	1	-	12	6
Coots	-	3	2	-	-	11	2	3	1	-	10	34	47
TOTAL	42	42	35	25	37	64	9	25	3	11	167	265	202

[1] From Sharp and Richardson (1976).
[2] From Ward and Hollingdale (1978).
[3] From present study.
[4] Includes broods on LCSB
[5] BCR - Beaver Creek Reservoir
SSWA - Syncrude Site Water Areas
PCR - Polar Creek Reservoir
RM - Ruth Marsh
RLC - Ruth Lake Diversion Canals
[6] Not including Saline Lake.

in 1975; consequently, the likelihood of detecting all broods present was lower in these two years. In addition, surveys in 1977 extended only to mid July, so some late broods may not have been recorded.

The total numbers of broods observed during surveys in the study area (excluding Saline Lake) in 1975, 1977 and 1984 were 167, 265 and 202, respectively (Table 3.14). The fact that the search for broods was more thorough in 1975 suggests that many more broods were present in 1977 and 1984 than in 1975.

The proportions of observed broods of the various waterbird groups changed between 1975 and 1984 (Table 3.14). In 1975, most broods were diving ducks (41% of all broods), dabbling ducks (37%) and, to a lesser degree, grebes (14%). In 1977, dabbling duck and grebe broods were most common (35% and 26% of all broods, respectively), whereas both numbers and the proportions of diving duck broods were lower (20% of total). Coot broods were also regularly observed in 1977. In 1984, the numbers of broods of all groups except coots were lower than in 1977; the proportions of coot and diving duck broods were higher in 1984 than in 1977, whereas those of dabbling ducks and grebes were lower.

The number of broods of several species also varied markedly over the three survey years (Appendix P). Observed numbers of American coot broods increased from 10 to 47 and observed numbers of wigeon broods increased from 16 to 26. On the other hand, numbers of mallard and ring-necked duck broods decreased by similar amounts.

Most grebe broods were red-necked grebes in all years. However, in 1977, when a large number was recorded, all four grebe species were represented. Although the total number of grebe broods was much lower in 1984, the number of horned grebe broods was higher.

Dabbling duck broods comprised mainly mallard and American wigeon, with lower numbers of blue-winged teal and green-winged teal, in all three years. The increase in dabbling duck broods between 1975 and 1977 was composed mainly of increases of mallard and blue-winged teal broods; numbers of

green-winged teal broods were lower. The decrease in dabbler broods between 1977 and 1984 was primarily due to decreases in numbers of mallard and blue-winged teal broods; on the other hand, American wigeon broods increased in numbers between these years.

Diving duck broods decreased in abundance from 1975 to 1977, but were similar between 1977 and 1984. In all three years, over 50% of the broods were ring-necked ducks, and over 30% were common goldeneyes and buffleheads. Numbers of ruddy duck broods increased notably in 1984.

Based on brood observations, the breeding status of several species in the study area may have changed over the three survey years. Four species of waterbirds that had not been observed with broods in the study area in 1975 were observed with broods in 1977: eared grebe, horned grebe, gadwall and American avocet (Ward and Hollingdale 1978). In 1984, however, broods of only one of these species, the horned grebe, were recorded. In 1977, the pied-billed grebe and northern shoveler were considered to be common nesters (Ward and Hollingdale 1978). However, in 1984, few broods of either of these species were recorded. Canvasback broods were seen regularly in the study area in 1975, but were observed only on Saline Lake in 1984. Canada goose broods were observed in the study area for the first time in 1984.

The number of broods on individual waterbodies varied between survey years. In 1975, over 80% of the broods were observed on Horseshoe Lake, Mildred Lake and Ruth Lake; in 1977, these waterbodies were the above three plus Beaver Creek Reservoir and Poplar Creek Reservoir; in 1984, these waterbodies included Horseshoe Lake, Beaver Creek Reservoir, Syncrude Site Water Areas, and Poplar Creek Reservoir. The main changes in brood distribution between 1975 and 1984 were a large decrease in numbers on Mildred Lake and Ruth Lake and a substantial presence on Beaver Creek and Poplar Creek reservoirs and the SSWAs. The main changes between 1977 and 1984 were an increase in numbers on Horseshoe Lake and a substantial decrease in numbers on Mildred and Ruth lakes.

3.4.2.6 Summary

This section summarizes the changes in the numbers of adults and broods of the major waterbird groups over all seasonal periods over all years.

Grebes

Between 1975 and 1984, grebe numbers increased two-fold during the breeding season; however, numbers of broods increased only slightly. The increase in numbers of adults and broods was primarily due to higher numbers of red-necked grebes, although horned grebes also increased in abundance. Between 1975 and 1977, grebe numbers increased over four-fold. Although this increase was also primarily due to higher numbers of red-necked grebes, pied-billed grebe adults and broods were also fairly numerous in 1977. The numbers of grebes in 1984 were higher than those in 1975 from mid summer to autumn; the numbers of grebes in 1975 were higher than those in 1974 during all periods.

The distribution of adult and young grebes (primarily red-necked grebes) shifted between 1975 and 1984, from Ruth Lake and Mildred Lake to Beaver Creek and Poplar Creek reservoirs. Horned grebes were found primarily on the Syncrude Site Water Areas in 1984.

Dabbling Ducks

Between 1975 and 1984, numbers of dabbling ducks present during the breeding season increased by more than six times. Species composition changed somewhat during this span: in 1975 and 1977, mallards, shovelers and blue-winged teal were common but in 1984, numbers of these species were lower, while numbers of American wigeons were much higher. The changes in composition and abundance of broods between 1975, 1977 and 1984 paralleled those of adults.

The distribution of dabbling duck adults during the breeding season changed between 1975 and 1984. In 1975, the largest numbers were on Ruth Lake, the Lower Camp Sedimentation Basin, Horseshoe Lake and the Syncrude

Site Water Areas; in 1984, the largest numbers were on Beaver Creek Reservoir, Poplar Creek Reservoir and Horseshoe Lake. Although numbers increased over six-fold during this nine-year period, they remained constant on Ruth Lake and decreased on Mildred Lake. In 1975, most broods were seen on Horseshoe Lake, Mildred Lake and the Syncrude Site Water Areas. Numbers of broods on Horseshoe Lake, Mildred Lake and Ruth Lake were much lower in 1984; most broods were observed on Beaver Creek Reservoir, the SSWAs and Horseshoe Lake.

Movements (moulting, staging and migration) of dabbling ducks began near the end of the mid summer period, peaked in late summer and declined in autumn in all three survey years. Dabbling duck numbers remained two to three times higher in 1984 than in 1975 during much of these time periods. In 1974 and 1975, increases in numbers of green-winged teal, northern pintails and mallards in mid summer suggested that the area was used by these species as a moulting or post-moulting staging area. In 1984, high numbers at this time were due primarily to mallards and American wigeons. The most numerous species in all years was the mallard, with lesser numbers of green-winged teal, blue-winged teal, northern pintail and American wigeon. During the autumn migration period in 1974 and 1975, most dabblers concentrated on Mildred and Horseshoe lakes; in 1984, they were present on Beaver Creek Reservoir, Horseshoe Lake and Ruth Lake.

Diving Ducks

During the breeding season (early and mid summer), diving duck numbers showed the least change in abundance and composition of any bird group over the three survey years. Numbers of adults were similar in 1975 and 1984 (compared to the six-fold increase in dabblers). Brood numbers were similar in 1984 and 1975. Species composition of adult diving ducks did not change between years: the ring-necked duck was the most abundant species, followed by scaup, bufflehead and common goldeneye. Similarly, the most abundant broods were those of ring-necked ducks, common goldeneyes and buffleheads. During these periods, diving ducks were most numerous on Horseshoe and Ruth lakes in all years. They were also common on Mildred Lake in 1974 and 1975 but few were seen there in 1984. Diving ducks were common on Beaver Creek

Reservoir and Poplar Creek Reservoir in 1977 and 1984 and on the SSWAs in 1984.

The timing of the increase in numbers of diving ducks due to autumn migration differed in all three survey years. In 1974, the increase started during the autumn; in 1975 and 1984, it started in late summer, although in 1975 it was apparently extended and peaked in autumn. Total average numbers of diving ducks in autumn were lower in 1984 than in 1974 and 1975; this was primarily the result of fewer scaup that year. In all years, scaup was the most abundant migrant, followed by bufflehead, common goldeneye and ring-necked duck (although the observations of the last three species included local birds as well as northern migrants). The distribution of diving ducks in late summer and autumn in the study area changed slightly between 1975 and 1984. In 1975, this group was found primarily on Horseshoe and Ruth lakes in late summer, and on Ruth, Mildred and Horseshoe lakes in autumn. In 1984, diving ducks were common on Beaver Creek Reservoir during both periods along with Horseshoe and Ruth lakes in autumn, but few were ever seen on Mildred Lake.

Coots

American coot numbers increased five-fold during the breeding season between 1975 and 1984. The number of coot broods increased by a similar factor. Coot migration began in late summer and numbers remained high in autumn. Numbers at this time were by far the highest in 1975, surpassing those recorded in 1984 by three-fold, and those recorded in 1974 by over 20-fold.

During the breeding period in 1975, virtually all adult coots and coot broods were observed on Horseshoe Lake; in 1977, they were widespread on several waterbodies. In 1984, most were again seen on Horseshoe Lake, although adults were also observed on Beaver Creek Reservoir and Ruth Marsh, and broods were also regularly observed on the Syncrude Site Water Areas. During autumn migration in 1974 and 1975, coots were seen primarily on Horseshoe Lake; in 1984 they were seen primarily on Beaver Creek Reservoir and Horseshoe Lake.

Shorebirds

Shorebirds was the only major waterbird group to decrease in numbers during the breeding period between 1975 and 1984. Most shorebirds seen in this period were yellowlegs, killdeer and spotted sandpipers. Shorebird migration begins earlier than other bird groups. Numbers recorded peaked in mid summer, and decreased steadily during late summer and autumn in all years. During the migration period, numbers of shorebirds recorded were much higher in 1984 than in 1974 and 1975. Although waves of various species migrated through the study area, the main migrants in all three years were yellowlegs and pectoral sandpipers. Highest shorebird numbers were recorded on the Syncrude Site Water Areas and Mildred Lake in 1974 and 1975, and on Beaver Creek and Poplar Creek reservoirs in 1984.

Terns

Terns, primarily black terns, increased in abundance by more than 14 times during the breeding period between 1975 and 1984. Numbers of terns recorded in 1977 were over three times higher than in 1984. There was no evidence of significant numbers of transient terns in the study area in any year; terns move south as soon as the young are mature. The distribution of terns did not change significantly over the survey years; numbers in 1975 were highest on Ruth and Horseshoe lakes. In 1984, numbers were highest on Horseshoe Lake and Poplar Creek Reservoir. Numbers were high on Ruth Marsh in 1977.

3.4.3 Comparison of 1984 Results with Syncrude Spot Census Data

Since 1980 Syncrude Canada Ltd. has been conducting spot censuses on several of the waterbodies on and near Lease 17, including Beaver Creek Reservoir and Mildred Lake. Censuses are conducted from mid April to mid October each year. Observations of birds on these two waterbodies are obtained from three and two stations, respectively; all waterbirds observed within a 700 m radius of the stations are recorded. About 25% of the surface of Beaver Creek Reservoir and about 50% of the surface of Mildred Lake

are surveyed. These censuses do not provide data that are directly comparable to those collected during waterbody surveys because of differences in methodology (telescope on shore vs. observers in canoe) and in degree of coverage (partial vs. total). Nevertheless, the censuses can provide information on seasonal and yearly variations in waterbird numbers. Therefore, these data were examined to see if they reflect patterns of distribution and numbers similar to those noted during the waterbody surveys in 1984.

Data from the spot censuses on Beaver Creek Reservoir and Mildred Lake during early summer (16 June-15 July), mid summer (16 July-15 August) and late summer (16 August-15 September) are presented in Table 3.15, along with data from the waterbody surveys for the same periods. As expected, average numbers seen are much lower for the spot censuses, a result of the lower degree of coverage. Dabbling ducks are, in general, the most numerous of the various bird groups for both types of survey, although the less common groups vary between methods in their ranks and abundance. The large increase in numbers of dabbling ducks and shorebirds, especially on Beaver Creek Reservoir, in the first half of August was not reflected in the spot censuses. Nor were the relatively high numbers of shorebirds recorded during waterbody surveys noted during the spot censuses; this discrepancy is undoubtedly a reflection of the differences in methodology.

Data from the spot censuses conducted from 1980 to 1984 are presented in Appendices Q and R for Beaver Creek Reservoir and Mildred Lake, respectively. These data can provide information about variations in waterbird numbers over a period when waterbody surveys were not conducted. Inspection of the data indicates that on Beaver Creek Reservoir, waterbird numbers varied substantially among the years and among the seasonal periods; there is, however, an indication that numbers present during 1982 were lower than in any of the other four years. The numbers of waterbirds recorded on Mildred Lake have declined steadily throughout the five-year period, a decline which is evident in all waterbird groups and in most species.

Table 3.15. Average numbers of five major waterbird groups recorded during spot censuses and waterbody surveys on Beaver Creek Reservoir and Mildred Lake in 1984.

Beaver Creek Reservoir

Bird Group	Spot Censuses[1]			Waterbody Surveys[2]		
	Early Summer	Mid Summer	Late Summer	Early Summer	Mid Summer	Late Summer
Grebes	1.8	10.5	11.0	22.3	14.0	39.3
Dabbling ducks	46.7	18.1	35.8	420.0	514.7	639.3
Diving ducks	17.0	2.8	7.5	23.0	16.0	340.0
Unid. ducks	29.4	19.3	23.5	-	-	-
Coots	5.0	2.9	58.6	12.0	36.0	416.3
Shorebirds	2.4	16.2	22.5	38.7	257.3	232.3
Total	102.3	69.8	158.9	516.0	838.0	1667.2

Mildred Lake

Bird Group	Spot Censuses[1]			Waterbody Surveys[2]		
	Early Summer	Mid Summer	Late Summer	Early Summer	Mid Summer	Late Summer
Grebes	0.8	1.5	0.4	5.0	3.7	1.7
Dabbling ducks	3.2	2.3	2.8	2.7	9.7	4.7
Diving ducks	-	-	-	1.7	1.7	1.0
Unid. ducks	-	0.4	1.0	-	-	-
Coots	-	-	-	-	-	-
Shorebirds	-	-	-	12.3	20.7	6.3
Total	4.0	4.2	4.2	21.7	35.8	13.7

[1] From Syncrude Canada Ltd. (unpubl. data).
[2] From this study.

3.5 DISCUSSION

3.5.1 Changes in the Waterbird Community From 1974 to 1984

One of the major objectives of this study was to compare the data collected during waterbody surveys in 1974, 1975, 1977 and 1984 to determine what changes, if any, have occurred in the composition, abundance and distribution of the waterbird community over that 11-year period. In this section, we discuss the changes and possible reasons for those changes.

The waterbird community using the waterbodies on and near Lease 17 has changed, both in numbers and composition, since the development of the oil sands project. It is logical to assume that the presence of the project has been responsible for these changes, since a major consequence of the project was a substantial alteration in the amount and type of aquatic habitat available for waterbirds. Development of the project resulted in doubling the surface area of waterbodies in the study area, in changing the proportions of aquatic habitats preferred by various waterbird groups, and in changing the types of terrestrial habitat adjacent to several water areas. However, factors not associated with the oil sands development can also influence waterbird populations in the study area. One such major factor accounting for the annual variations in waterbird populations in the study area during the breeding/post-breeding period is the breeding conditions in the prairie pothole region of southern Canada and northern U.S.A. When drought occurs on the plains of North America, waterfowl can either home to traditional areas and rapidly fill the reduced amount of suitable habitat (Smith 1971), continue migrating to more northern latitudes (Hansen and McKnight 1964; Smith 1971; Pospahala et al. 1974; Derksen and Eldridge 1980), or immigrate to areas where water persists (Dzubin 1969; Sugden 1978; Jackson 1979; Kaminski and Prince 1981). Drought on the prairies will likely result in increased numbers and species diversity of waterbirds in the study area.

Other external factors can influence waterbird abundances during the autumn migration period. These include breeding success of populations in northern Canada and regional weather conditions. The first can affect the number of migrants and the timing of their passage through the study area,

and the second can influence the timing and speed of migration through the area. Data from the spot censuses conducted by Syncrude Canada Ltd. provide an indication of the inter-year and inter-season variations in waterbird numbers (Section 3.4.3), which, at least in part, reflect the influence of these external factors.

3.5.1.1 Changes in Waterbird Numbers and Productivity

Total numbers of adult waterbirds observed in the study area during the breeding period (mid June-mid July) were over five times higher in 1977 and over two times higher in 1984 than in 1975. A similar difference was noted between 1975 and 1984 for the post-breeding (mid July-mid August) period. During these periods the greatest increases in numbers were of dabbling ducks (primarily American wigeon, mallard, blue-winged teal and green-winged teal), terns and coots, although numbers of all groups were higher, at least in 1977. These increases in waterbird populations were likely the result of two events: a doubling of the amount of utilizable aquatic habitat, mainly as a result of the creation of new impoundments, and droughts in southern breeding areas in 1977 and 1984. The effects of these events on waterbird populations are discussed below.

Anderson and Glover (1967), McKnight and Low (1969) and Whitman (1974) demonstrated an increase in waterfowl production (breeding pairs and broods) on newly-created aquatic habitats. Whitman (1974) speculated that the increase was a response by breeding birds to newly-abundant invertebrate populations, whereas DiAngelo (1953) believed it was primarily due to the increased abundance of the pioneer, and highly preferred plant species, duckweed. Invertebrate numbers increase rapidly in an impoundment during the first and second years after flooding; this is in response to increased levels of dissolved nutrients that are released from decomposing terrestrial vegetation (Kadlec 1962; Whitman 1976). As the impoundment ages and nutrient levels in the water decrease (especially in the second and third years), the diversity and abundance of invertebrates stabilize. At this time, several invertebrate families that are important foods for waterfowl (Dytiscidae, Chironomidae, Corixidae, Planorbidae, Gyrinidae, Physidae and Lymnaeidae) are found in the impoundment. Natural marshes and impoundments greater than

seven years in age have fewer invertebrates that are commonly taken by ducks (Erpobdellidae, Glossiphoniidae, Oligochaeta--Whitman 1976).

Plant succession in an impoundment progresses away from duckweed and pondweed, which are desirable waterfowl plants, towards stable, rooted aquatics (sedges and cattails) which are low in food value for ducks (Low and Bellrose 1944; Whitman 1976). Sparse growth of emergents intermixed with submergents and floating leaf aquatics (a situation that provides abundant vegetational food, good brood cover and moderate to high densities of invertebrates) gradually changes to dense emergents with no submergent or floating leaf plants (a situation that provides low quality food and thick cover that restricts movements by broods). These characteristics and changes are reflected in the numbers of waterbirds recorded during the breeding season on the two major waterbodies created as a result of the Beaver Creek diversion: Beaver Creek Reservoir and Poplar Creek Reservoir. In 1977, Beaver Creek Reservoir and the northern end of Poplar Creek Reservoir were recently flooded and provided abundant cover and moderate to high densities of invertebrates and fish for waterbirds. Numbers of waterbirds were high in that year. However, waterbird numbers were much reduced in 1984 when the waterbodies had been in existence for at least seven years.

The second event that likely resulted in the high waterbird numbers and diversities in the study area in 1977 and 1984 was drought conditions in the pothole regions of the Canadian and/or American prairies. In 1977, drought was geographically widespread over southern Canada and much of the United States (Derksen and Eldridge 1980). Kaminski and Prince (1981, 1984) found high numbers of dabbler breeding pairs (especially of mallards and blue-winged teal) during surveys of Delta Marsh, Manitoba, in 1977, and suggested that this resulted from influxes of ducks displaced from drought-stricken habitats. Several other studies (e.g., Trauger and Stoudt 1978; Jackson 1979; Giroux 1981) documented similar trends for 1977. In 1984, duck breeding conditions were also extremely poor throughout the pothole regions of the prairies because of weather. (In fact, drought conditions have prevailed throughout the prairie-parkland region of Alberta since 1977 [Turner and Pryor 1984].) Numbers of adult ducks in southern Alberta in 1984 were 43.5% below the 10-year average, and numbers of duck

broods there were 75% below the 10-year average (Brace and Caswell 1984). The 1984 totals are all-time low levels for ducks in Alberta, particularly mallard, wigeon, pintail and lesser scaup (Turner and Pryor 1984).

As a consequence of the droughts, waterbird numbers in the study area were probably higher in 1977 and 1984 than they would normally be in non-drought years. Dabbling ducks accounted for a large part of the very high numbers of waterbirds in these two years. The increase in numbers of diving ducks was less noticeable and in fact was recorded only in 1977. Hansen and McKnight (1964) noted that numbers of scaup, buffleheads and common goldeneyes, the common diving ducks in the study area, should not be greatly affected by adverse conditions on the prairies because they are primarily northern breeders. In addition, the presence of several pothole-nesting species in the study area for the first time in 1977 (pied-billed grebe, eared grebe, redhead, American avocet) suggests that birds were forced northward by poor breeding conditions on the prairies.

Data collected from Saline Lake, a lake presumed not to have been influenced by development of the oil sands project, show that the size and composition of its waterbird population did not change appreciably from 1974 to 1984. However, on waterbodies created or altered by the Syncrude development, waterbird numbers and species composition changed over the period. This suggests that changes in waterbird populations on the development-affected lakes from 1974 to 1984 at least partially reflect changes in aquatic habitat, and are not simply normal annual fluctuations in numbers.

In summary, adult waterbirds in the study area during early and mid summer were more abundant in 1977 and 1984 than in 1975. This was partially due to the increase in the amount of aquatic habitat in the study area resulting from the development of the oil sands project. High numbers of breeding waterbirds were attracted to the newly-flooded impoundments which provided prime habitat conditions. In addition, waterbird numbers, particularly dabbling ducks, were high in 1977, and less so in 1984, because of poor breeding conditions in the southern prairies.

The increase in the number of broods observed in the study area between 1975 and 1984 only partially reflected the increase in the number of adult waterbirds. Numbers of broods increased by a factor of 1.6 between 1975 and 1977 and by a factor of 1.2 between 1975 and 1984, substantially less than the increases in numbers of adults. The greatest increases were in numbers of coot, grebe and dabbling duck broods. It must be noted that numbers of broods of shorebirds and rails are generally underestimated because they occur largely in vegetated shoreline areas where they are difficult to detect. As well, broods of gulls and terns remain at or near nests, and are often located in habitats inaccessible to canoes (Ward and Hollingdale 1978). Therefore, ignoring the bird groups whose broods are less detectable, the dabbling duck is the group with the lowest increase in numbers of broods compared to its increase in adult numbers. This may be explained by the fact that, although drought-displacement can inflate the numbers of breeding pairs in the study area, the reproductive output of the displaced birds may be low (Hansen and McKnight 1964; Derksen and Eldridge 1980). As stated above, dabbling ducks are the major waterbird group displaced as a result of drought on the prairies.

The numbers and composition of waterbirds in the study area during the late summer and autumn periods are strongly influenced by migration patterns, which are dependent on the breeding success of northern populations and the regional weather patterns. If breeding success is good, waterbird numbers in the study area may be high, reflecting increased numbers of young birds in the populations. Weather conditions and food supplies modify the timing of migration in late fall; fairly strong winds, falling temperatures, overcast skies and falling snow in northern areas can initiate mass movements of birds (Bellrose 1976).

The number of waterbirds in the study area during late summer and autumn in 1975 was over twice as high as in 1974 and somewhat higher than in 1984. However, a large proportion of the 1975 total were American coots; if this species is excluded from the totals, the numbers of birds in the study area were similar in 1974 and 1975, and somewhat higher in 1984. These figures suggest that numbers of migrant waterbirds in the study area have increased since the development of the oil sands project. However, it is not known if

the increase is apparent or real--that is, whether the higher numbers in 1984 represent normal annual variation, perhaps augmented by drought-displaced ducks, or whether the new waterbodies provide new attractive stopover sites for migrating birds.

3.5.1.2 Changes in Waterbird Distributions

Development of the oil sands plant on Lease 17 resulted in an alteration of the waterbody configuration on and near the lease. Prior to development, the water areas on and near the lease were Ruth Lake, Mildred Lake, Horseshoe Lake and Loon Pond. Development of the Fresh Water Supply System resulted in the creation of the Lower Camp Sedimentation Basin in 1975, and in the modification of Mildred Lake in 1977. Development of the Surface Water Diversion Systems resulted in the creation in 1976 of Beaver Creek Reservoir, Poplar Creek Reservoir, Ruth Marsh and the West Interception Ditch and several other SSWAs. Changes in waterbird distribution, both of adults and of broods, are apparent on both the newly created waterbodies and on the original ones.

Adult Waterbirds

Waterbirds have been disproportionately distributed on the new waterbodies since their creation in 1976-1977, at least during the summer periods. The new waterbodies represent 53% of the total water area surveyed (excluding Saline Lake), yet in early summer 1977 over 68% of the waterbirds were observed on them; in the summer of 1984, this figure was over 70%. During the autumn in 1984, 51% of the waterbirds were noted on the new waterbodies. During all seasons, the new waterbody with the highest numbers of waterbirds was Beaver Creek Reservoir, a reflection of its large size and attractive habitat characteristics (see Section 3.5.2).

The distribution of the bird groups on the waterbodies varied with seasonal period and year. In most seasons during all years, most of the waterbird groups were found on new water areas. However, coot numbers were higher on original water areas in early summer, although they were evenly distributed over the original and new waterbodies in the other seasons. Only

terns remained more numerous on the original waterbodies. Of the new waterbodies, only the Lower Camp Sedimentation Basin experienced a substantial decrease in numbers in summer over the last 10 years. In early to late summer 1975, this waterbody supported 10%-16% of the waterbird population (primarily shorebirds and dabbling ducks), although it included only 3% of the total area surveyed. However, in 1977 and 1984, this waterbody accounted for less than 1% of the total waterbird population.

A full understanding of the importance of the newly-created waterbodies to the waterbird community is only possible with a comparison of the waterbird populations on the original waterbodies prior to and after development of the new ones. Such a comparison will provide an indication of whether there has been a shift of waterbirds from original to new waterbodies or a general change in the population throughout the study area.

Between 1975 and 1977, the average number of waterbirds observed on the original waterbodies (Ruth Lake, Horseshoe Lake, Mildred Lake, Loon Pond) in early summer increased by a factor of 2.4; this compares with a 5.3-fold increase in numbers over the entire study area. In 1975 and 1984, early summer numbers on the original waterbodies were similar, compared to a 2.4-fold increase between these years over the entire study area. Thus, it seems that much of the increase in waterbird numbers since the oil sands development has been due to the presence of additional waterbirds in the newly created areas, rather than to a simple shift of birds from original to new waterbodies. Despite the similar numbers on the original waterbodies in 1975 and 1984, waterbird distribution on these lakes was different. Numbers were much lower on Mildred Lake and, to a lesser degree, Ruth Lake, and much higher on Horseshoe Lake. Horseshoe Lake attracted more dabbling ducks, terns and coots but fewer diving ducks in 1984. Most of the decrease on Ruth Lake was attributable to a large decrease in shorebird numbers, although numbers of most groups were reduced. Mildred Lake supported lower numbers of all waterbird groups in 1984.

In mid summer, the average numbers of waterbirds on the original waterbodies were similar in 1975 and 1984. A large increase in dabbling duck numbers was in part offset by a decrease in diving duck numbers. Numbers on

Horseshoe Lake more than doubled, while those on Mildred Lake decreased by three-quarters and those on Ruth Lake remained constant.

In late summer and autumn, the average number of waterbirds on original waterbodies decreased by two-thirds between 1975 and 1984. Numbers on Ruth Lake were similar, but those on Horseshoe Lake decreased by 75%, and those on Mildred Lake decreased by 95%. However, this overall decrease was in part due to a decrease in the numbers of coots on Horseshoe Lake. If coots are excluded from the totals, waterbird numbers on the original lakes between 1975 and 1984 decreased by one-half; this decrease was primarily due to fewer diving ducks. Waterbird numbers on Loon Pond were low in all seasonal periods in all years.

In summary, the numbers of waterbirds in the study area during early summer increased between 1975 and 1977; the increase was noted on both the original and new water areas, although it was primarily concentrated on the new areas. The numbers of waterbirds in the study area also increased during early and mid summer from 1975 to 1984 but this increase was almost wholly restricted to the newly created waterbodies. Numbers of waterbirds were lower on all of the original lakes except Horseshoe Lake. During late summer, waterbirds were concentrated on the newly created lakes and during autumn they were equally distributed over old and new waterbodies.

Broods

The distribution of broods did not always reflect the distribution of adult waterbirds. Although 68% and 71% of the adults were observed on new water areas in 1977 and 1984, only 38% and 60% of the broods, respectively, were so distributed. Thus, a higher proportion of non-breeders or unsuccessful breeders, primarily dabbling ducks, were present on the new water areas than on the original ones.

Between 1975 and 1977, the total number of broods observed on the original lakes did not change, although their distribution differed: brood numbers on Ruth Lake almost doubled, whereas those on Horseshoe Lake decreased 33% and those on Mildred Lake remained unchanged. Between 1975 and

1984, the total numbers of broods observed on the original lakes decreased by over 50%. As with adult birds, this decrease was uneven: the numbers of broods on Horseshoe Lake were comparable between years, those on Ruth Lake decreased by 75%, and those on Mildred Lake decreased by 92%. The result was that over 80% of the broods observed on the original waterbodies in 1984 were on Horseshoe Lake. Loon Pond supported few broods in any year.

In summary, broods in 1977 were slightly more numerous on the original lakes. In 1984, they were slightly more abundant on newly created lakes and were not evenly dispersed on the original lakes. Horseshoe Lake accounted for over 80% of the broods in 1984. Higher proportions of the broods than of the adult waterbirds were located on the original waterbodies.

3.5.2 Habitat Requirements of Waterbirds vs. Physical Characteristics of Waterbodies

The main factors that determine the use of a waterbody by waterbirds include availability of aquatic invertebrates, types, amount and distribution of aquatic vegetation, types of shoreline, area and depth. However, the habitat characteristics preferred by various waterbird groups vary. In this section, they are discussed for the six major waterbird groups recorded in 1984 (grebes, dabbling ducks, diving ducks, coots, shorebirds, terns), and then are briefly related to the physical characteristics of the waterbodies in the study area.

Red-necked grebes usually nest in loose colonies on shallow lakes (rarely less than 4 ha in size) that have some emergents. Their major food items are small fish, tadpoles, salamanders and invertebrates (Palmer 1962). Horned grebes nest on small, permanent wetlands with areas of at least 0.2 ha, depths of 1 to 2 m, stable water levels, a border of emergents as nesting cover and adequate supplies of small fish or aquatic invertebrates (i.e. insects, amphipods) (cf. Green et al. 1984).

Habitat requirements of **waterfowl** change with the chronology of the season. Duck breeding pair density and production vary with pond size (Patterson 1976; Weller 1979; Hudson 1983), invertebrate abundance (Swanson

and Meyer 1973; Joyner 1980; Murkin et al. 1982), and emergent-to-open water ratio (Weller and Fredrickson 1974; Kaminski and Prince 1981). Diving ducks generally select larger water areas than those used by dabbling ducks (Evans and Black 1956). Dabblers prefer to feed in areas where water depth is <30 cm and where submergents are near the surface (cf. Green et al. 1984). Diving duck feeding depths vary: scaup commonly feed in water depths up to 8 m, buffleheads in depths 2-3 m, and ring-necked ducks in depths <2 m (Erskine 1972b; Bellrose 1976). Dabbling duck diets are predominantly vegetable, with some animal material (i.e. invertebrates), while diving duck diets are, in general, the reverse. The abundance of invertebrates depends on the the level of nutrients, and on the amount, density and species of aquatic vegetation in the waterbody (Whitman 1976). Desirable plant foods include duckweed, pondweed, sedges, algae and seeds of submergent and emergent species (Bellrose 1976; Palmer 1976; Whitman 1976). Emergents and islands supply nesting cover and loafing sites (Drewien and Springer 1969; Krapu et al. 1979; Weller 1979; Murkin et al. 1982). Tree-nesting divers (bufflehead, common goldeneyes, some mergansers) require mature forest near a waterbody (Anonymous 1980).

Waterfowl brood use of waterbodies is influenced primarily by food (McKnight and Low 1969; Sugden 1973) and escape cover (Swanson and Meyer 1973; Patterson 1976). Hudson (1983) found that densities of dabbling duck broods in Montana were greatest on ponds of intermediate size (0.5 to 1.5 ha), with irregular shorelines and with at least 40% of the area less than 61 cm in depth; and with emergent vegetation covering at least 30% of the area, submerged vegetation at least 20% of the area and less than 10% of the shoreline bare. Lokemoen (1973) stated that optimum brood cover is flooded brush or emergent vegetation that allows broods to remain on the water with overhead protection.

The use of waterbodies by flightless, moulting adult ducks is a function of the dispersion and availability of energy resources (Patterson 1976; Courcelles and Bédard 1979) and of safety from predators (Gilmer et al. 1977). Dabblers use large, permanent shallow water areas, with extensive cover, adequate food and secluded land on which to preen (Gilmer et al. 1977). Divers use freshwater lakes of varying size (often greater than 50

ha) with frequent areas of open water, some emergents, high densities of preferred food and depths <5 m (cf. Green et al. 1984).

Ducks use large waterbodies during migration. Dabbling ducks prefer areas greater than 40 ha in area with low mudflats and unvegetated islands, low densities of emergents and good growth of pondweed (cf. Green et al. 1984). Diving ducks tend to congregate on lakes similar to moulting lakes (Godfrey 1966).

American coots establish breeding territories in shallow permanent or semi-permanent water interspersed with dense patches of emergent and abundant submergent vegetation (Johnsgard 1979). Coots are omnivorous and opportunistic in their feeding habits. The vegetable portion of their diet includes pondweed and water-milfoil; the animal portion includes small fish, tadpoles, snails, crustaceans and water insects (Bent 1926). Young coots feed primarily on animal foods.

All **shorebird** species, except phalaropes, are wading birds and generally occur along the shorelines of waterbodies or in shallow water (0-5 cm) interspersed with exposed saturated soil (Rundle and Fredrickson 1981). Phalaropes normally swim, taking food from the surface of the water (Salt and Salt 1976). In 1975, shorebirds in the study often occurred in shallow pools, on mudflats and on islands of lightly vegetated organic materials (Sharp and Richardson 1976).

Black terns are gregarious and frequently nest colonially; nests are built on floating mats among dense stands of emergents in shallow water (30-60 cm deep--cf. Green et al. 1984). Diets of young and adult terns consist of emergent insects, especially dragonflies, mayflies, grasshoppers, beetles and flies (Godfrey 1966; Johnsgard 1979).

Of the new impoundments created in the study area as a result of oil sands development, only Beaver Creek Reservoir and Poplar Creek Reservoir attracted substantial numbers of waterbirds. Both reservoirs were new impoundments in 1977 and covered the greatest areas (210 ha and 150 ha,

respectively) of any of the waterbodies surveyed (excluding Saline Lake). The marsh areas of Beaver Creek Reservoir and the northern end of Poplar Creek Reservoir provided abundant interspersed emergents and submergents, moderate to high densities of benthic invertebrates and fish, and a variety of depths (although Beaver Creek Reservoir was on average shallower than Poplar Creek Reservoir), which attracted breeding, moulting and migrating waterfowl, coots and grebes. The marsh on Poplar Creek Reservoir also attracted breeding terns. Floating mats of vegetation, located at the southwestern end of Beaver Creek Reservoir and at the northern end of Poplar Creek Reservoir, attracted substantial numbers of migrant shorebirds.

The Lower Camp Sedimentation Basin attracted few waterbirds in 1984, although it attracted shorebirds and dabbling ducks in 1975. This decrease was likely due to the scarcity of emergents and vegetated islands and a high degree of disturbance on the pond in 1984. Pirnie (1935) and Watson et al. (1973) found that disturbance can affect the use of an area by waterfowl, especially during the breeding period.

Ruth Marsh attracted moderate numbers of dabbling ducks, terns and coots in 1977, but very few birds in 1984. In 1977, Ruth Marsh provided shallow water feeding areas, loafing islands and adequate shelter for waterbirds. By 1984, the density of emergents had increased; emergents are of low food value and restrict the movement of birds (Whitman 1976). Although invertebrate and fish studies of Ruth Marsh have not been conducted, its low water level may limit the abundance of animal foods. There was no water in Ruth Marsh in August.

Waterbird numbers on all the original waterbodies, except Horseshoe Lake, during early and mid summer decreased between 1975 and 1984. This decrease may have been due to a reduction in the attractiveness of the original water areas, as well as to the availability of the more attractive new impoundments. Whitman (1976) found that breeding pairs and brood numbers on adjacent natural marshes decline rapidly as flooded impoundments become available.

In 1984, Horseshoe Lake continued to provide cover and food supplies that were attractive to dabbling ducks (also the ring-necked duck, which is similar to dabblers in its habits--Salt and Salt 1976) and coots. It is shallow (mean depth of <1 m), fairly large in area (100 ha), and has a extensive growths of emergents along the convoluted shoreline. It also has a well-developed floating-leafed plant community, submergents and invertebrate populations, and is exposed to little disturbance. Extensive marshes in the southwestern arm and along the northern end of the lake provide good nesting areas. Although plant succession has advanced on Horseshoe Lake between 1977 and 1984, the advance may have been slowed by two events: muskrat activity, which results in fragmentation and decomposition of aquatic vegetation and causes invertebrate populations to flourish temporarily (Weller 1978), and fluctuations in water levels as a result of the canal connecting the lake to the Athabasca River.

Ruth Lake attracted few nesters (numbers of dabbling ducks, grebes, and terns all decreased between 1975 and 1984) and, except for dabbling ducks, few staging and migrating birds in 1984. The reason for the decrease in waterbird numbers on Ruth Lake is uncertain. Syncrude Canada Ltd. (1984) noted that integration of Ruth Lake into the diversion system resulted in slight declines in the diversity of aquatic vegetation and in the density of aquatic invertebrates (although levels were higher than in either of the adjacent reservoirs). However, the rise in nutrient levels in the lake led to an increase in phytoplankton levels and population diversity. Water level fluctuations are no greater in Ruth Lake than in the two adjacent reservoirs, and disturbance levels were low. Sharp and Richardson (1976) suggested that clearing around Ruth Lake was responsible for the lower summer count of adult buffleheads in 1975 than in 1974 (the bufflehead is a tree-nester) and may have been responsible for the marked decrease in the apparent number of scaup broods (shrub communities are preferred nesting habitat of lesser scaup).

Mildred Lake supported very few waterbirds in 1984 compared to 1975; numbers of diving and dabbling ducks, loons and grebes had all decreased. As described earlier, the main changes in the physical and vegetational characteristics of Mildred Lake as a result of its integration into the Fresh Water Supply System were a reduction in favourable shoreline habitat

(decreases in vegetation islands, emergents, duckweed and pond scum, and in the associated invertebrates) and increases in water depth and level of disturbance. These changes reduced the attractiveness of the lake as waterbird habitat. No detailed studies of the invertebrate community or of the submergents, all of which substantially affect waterbird populations, have been conducted on Mildred Lake.

The Syncrude Site Water Areas provide a variety of habitats for waterbirds in 1984. They were mainly small ponds ranging in size from 0.2 to 4.3 ha, with variable depths from a few centimetres to several metres. Shoreline vegetation varied from none to extensive cattail/shrub vegetation. The shallow, sparsely-vegetated SSWAs were attractive to shorebirds in 1975. The SSWAs supported adult dabbling and diving ducks and shorebirds in 1984; a high proportion of the duck broods (40% of the diving ducks and 20% of the dabbling ducks) was observed there in 1984.

CHAPTER 4. CONCLUSIONS

In 1984, a program of ornithological research was conducted on and near Crown Lease 17, northeastern Alberta, where Syncrude's oil sands development is located. A large volume of data was obtained during the study and specific statements concerning the numbers and distribution of many bird species and species-groups and concerning the relative importance of the various terrestrial habitats and waterbodies in the study area have been made in this report. Such conclusions are not repeated here. However, from the point of view of the objectives of the study, outlined in Chapter 1 and in the Introductions to Chapters 2 and 3 of this report, four major conclusions can be made. These are:

1. The terrestrial breeding bird community present in the vegetation types in the western part of Lease 17 is similar both in density and in diversity to that throughout the remainder of the boreal forest region of western Canada.

2. No rare or uncommon terrestrial breeding bird species are likely to occur in the principal vegetation types in the western part of Lease 17.

3. The waterbodies on and near Lease 17 provide habitat for breeding, moulting and staging by a large number of waterbird species.

4. Numbers of waterbirds present on the waterbodies on and near Lease 17 have increased during the early and mid summer since the oil sands development. Numbers of terns, ducks and coots have shown the largest increases. These increases are likely due to an increase in the amount of utilizable aquatic habitat, mainly as a result of the creation of new impoundments, and to severe drought conditions in the prairie pothole region.

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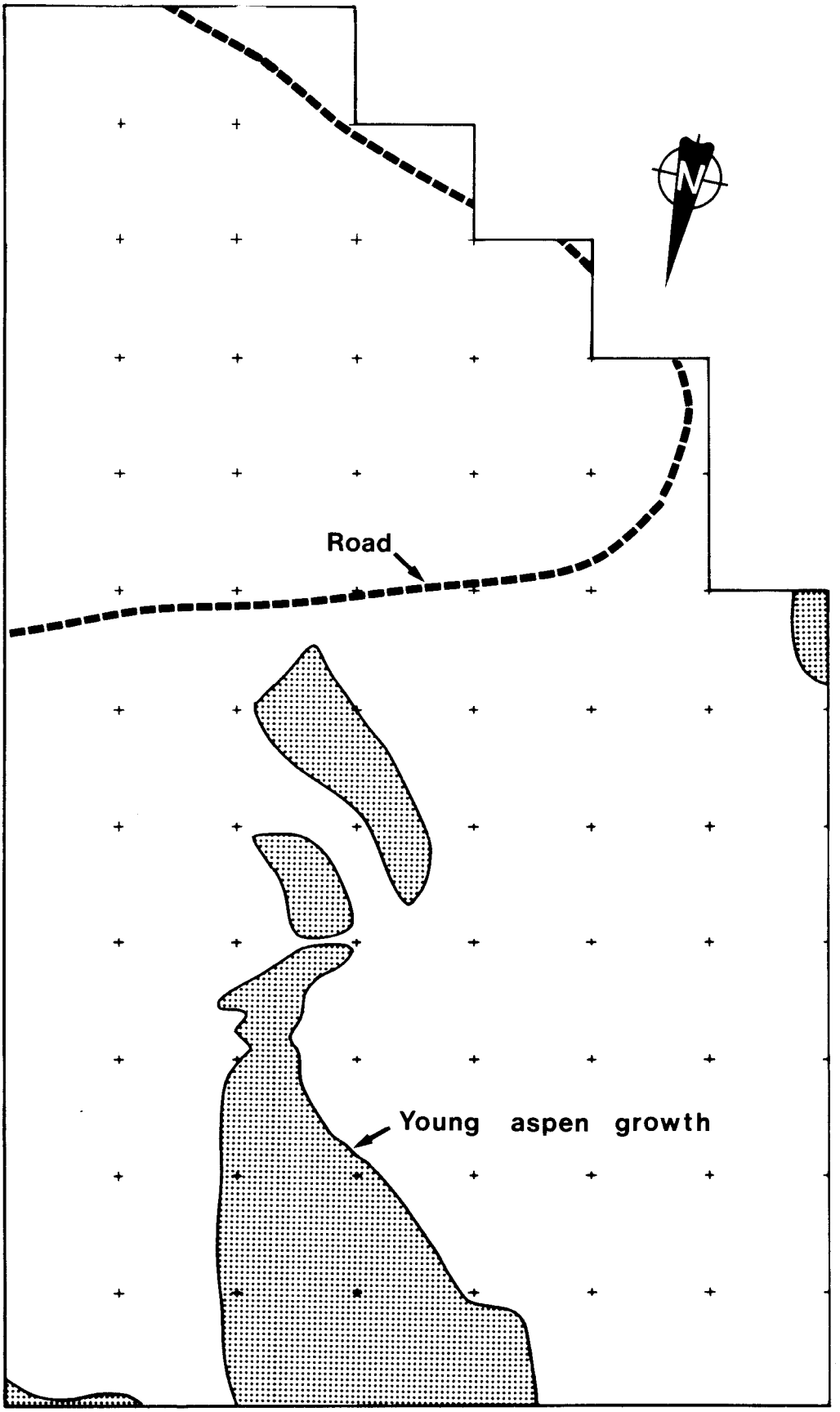
Appendix A. Scientific Names of Plant Species Mentioned in the Text.

Common Name	Scientific Name
Horsetail	*Equisetum* spp.
Jack pine	*Pinus banksiana*
Tamarack	*Larix laricina*
White spruce	*Picea glauca*
Black spruce	*Picea mariana*
Balsam fir	*Abies balsamea*
Cattail	*Typha* spp.
Bur-reed	*Sparganium* spp.
Pondweed	*Potamogeton berchtoldi*
Arrowhead	*Sagittaria* spp.
Brome grass	*Bromus* spp.
Wheat grass	*Agropyron* spp.
Timothy	*Phleum pratense*
Reed grass	*Calamagrostis canadensis*
Sedge	*Carex* spp.
Bulrush	*Scirpus* spp.
Duckweed	*Lemna* spp.
Rush	*Juncus* spp.
Trembling aspen	*Populus tremuloides*
Balsam poplar	*Populus balsamifera*
Willow	*Salix* spp.
Alder	*Alnus* spp.
Birch	*Betula* spp.
Hornwort	*Ceratophyllum demersum*
Pond lily	*Nuphar* spp.
Rose	*Rosa acicularis*
Serviceberry	*Amelanchier* spp.
Sweet clover	*Melilotus* spp.
Alfalfa	*Medicago sativa*
Water-milfoil	*Myriophyllum* spp.
Labrador tea	*Ledum groenlandicum*
Buckbean	*Menyanthes trifoliata*
Bladderwort	*Utricularia vulgaris*

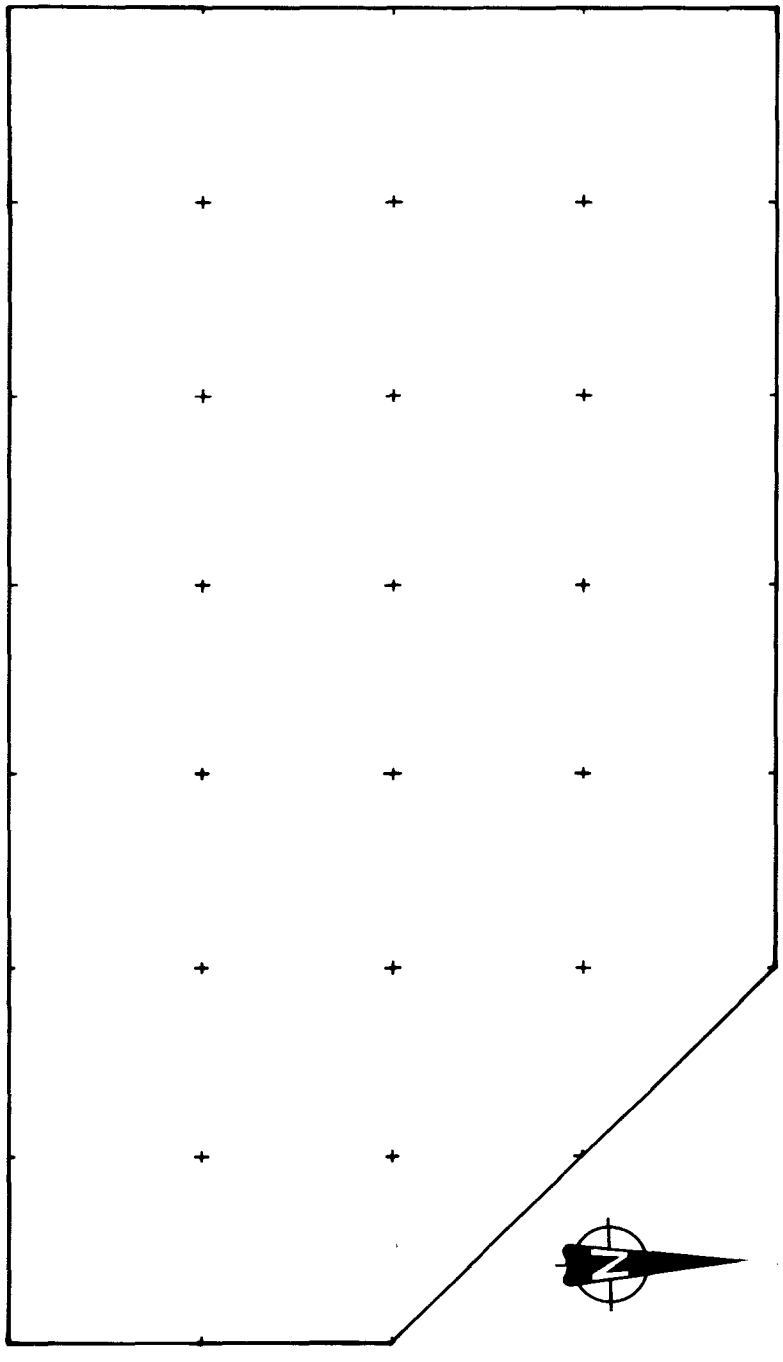
Appendix B. Maps of Plots Censused for Terrestrial Breeding Birds

Reclamation area Plot 84-1 Size 18.4 ha



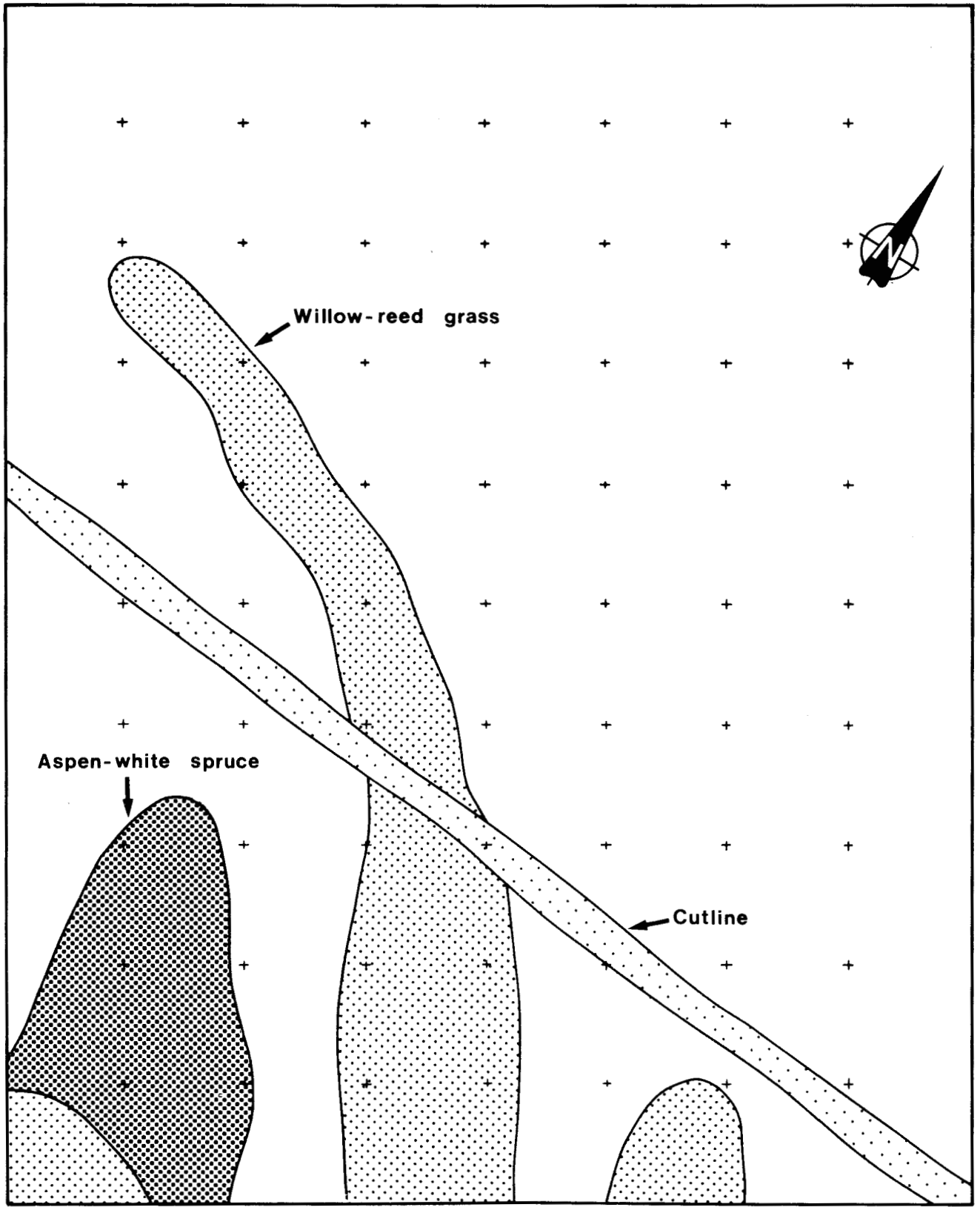
Appendix B-1.

Reclamation area Plot 84-2 Size 6.5 ha

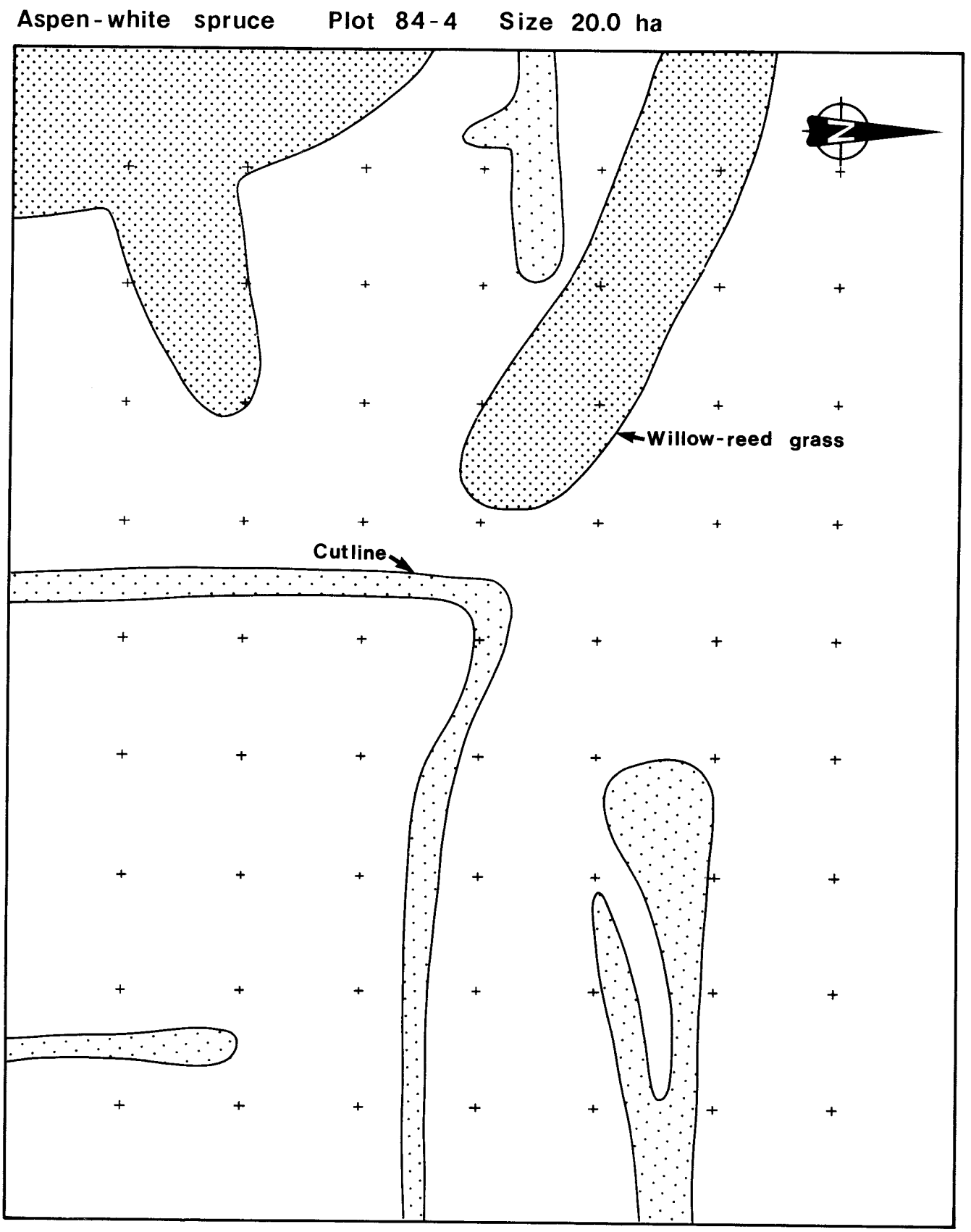


Appendix B-2.

Black spruce - Labrador tea Plot 84 - 3 Size 20.0 ha

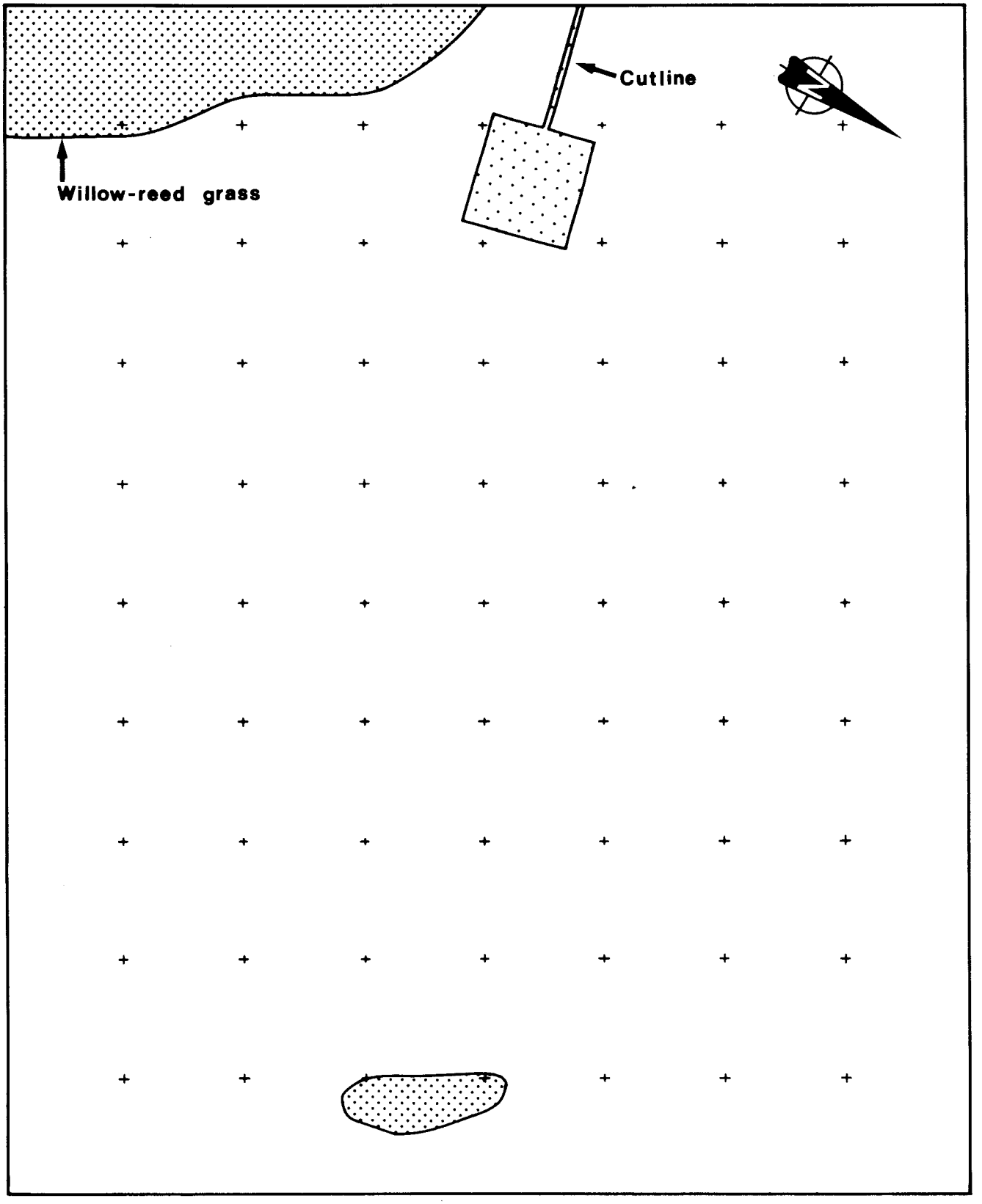


Appendix B-3.


Aspen-white spruce Plot 84-4 Size 20.0 ha
N
Willow-reed grass
Cutline

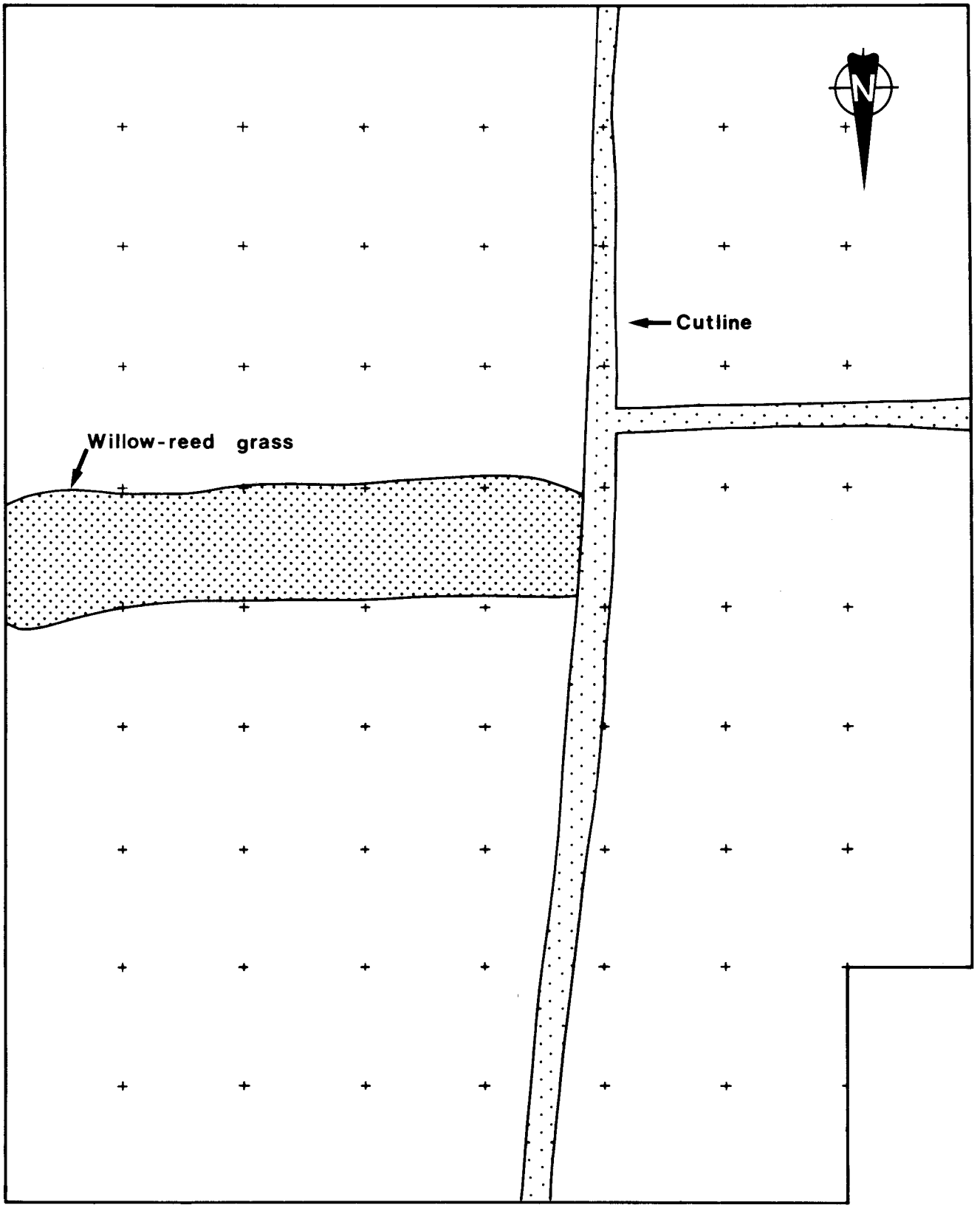
Appendix B-4.

Black spruce - Labrador tea Plot 84-5 Size 20.0 ha



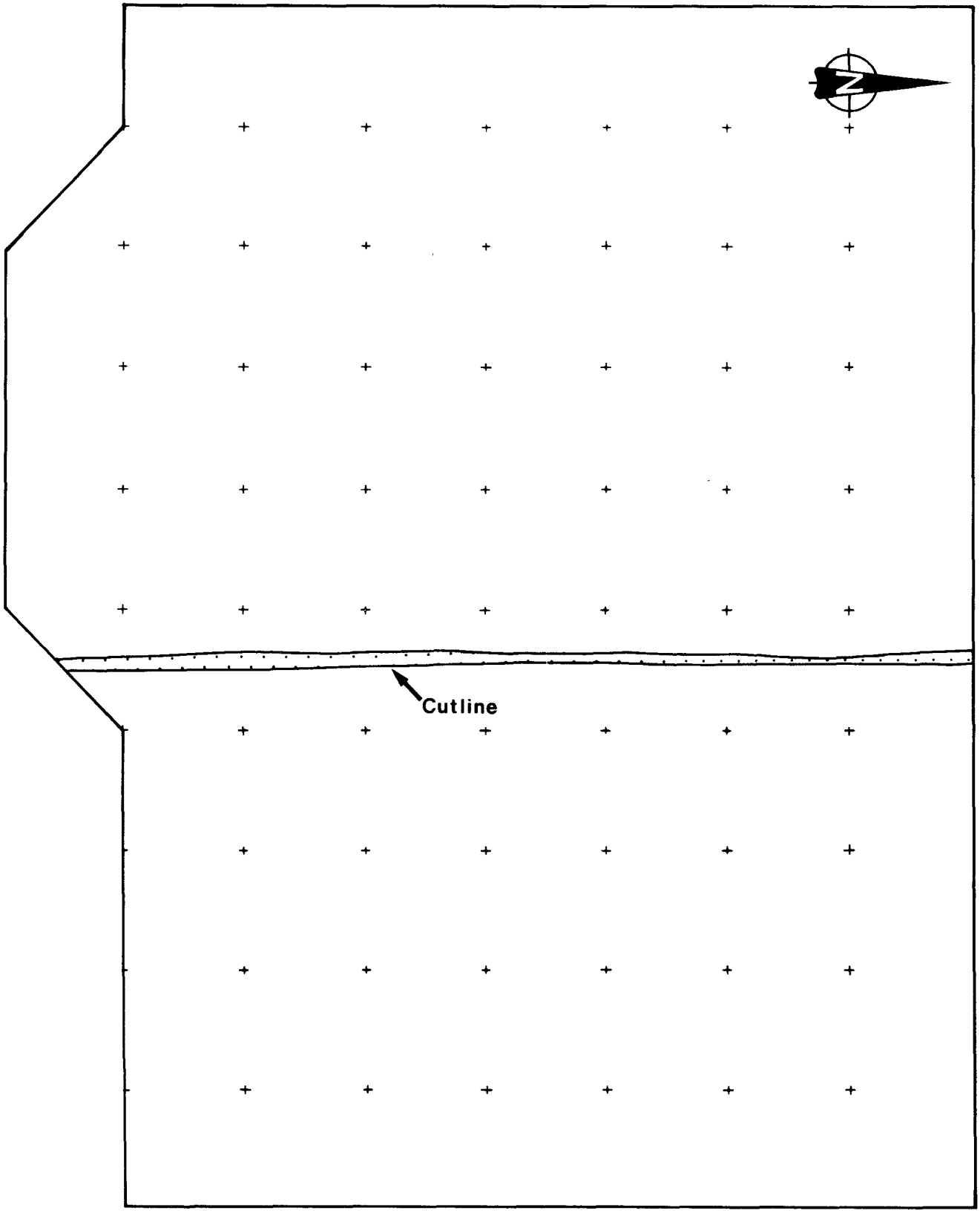
Appendix B-5.

White spruce-aspen Plot 84-6 Size 19.5 ha



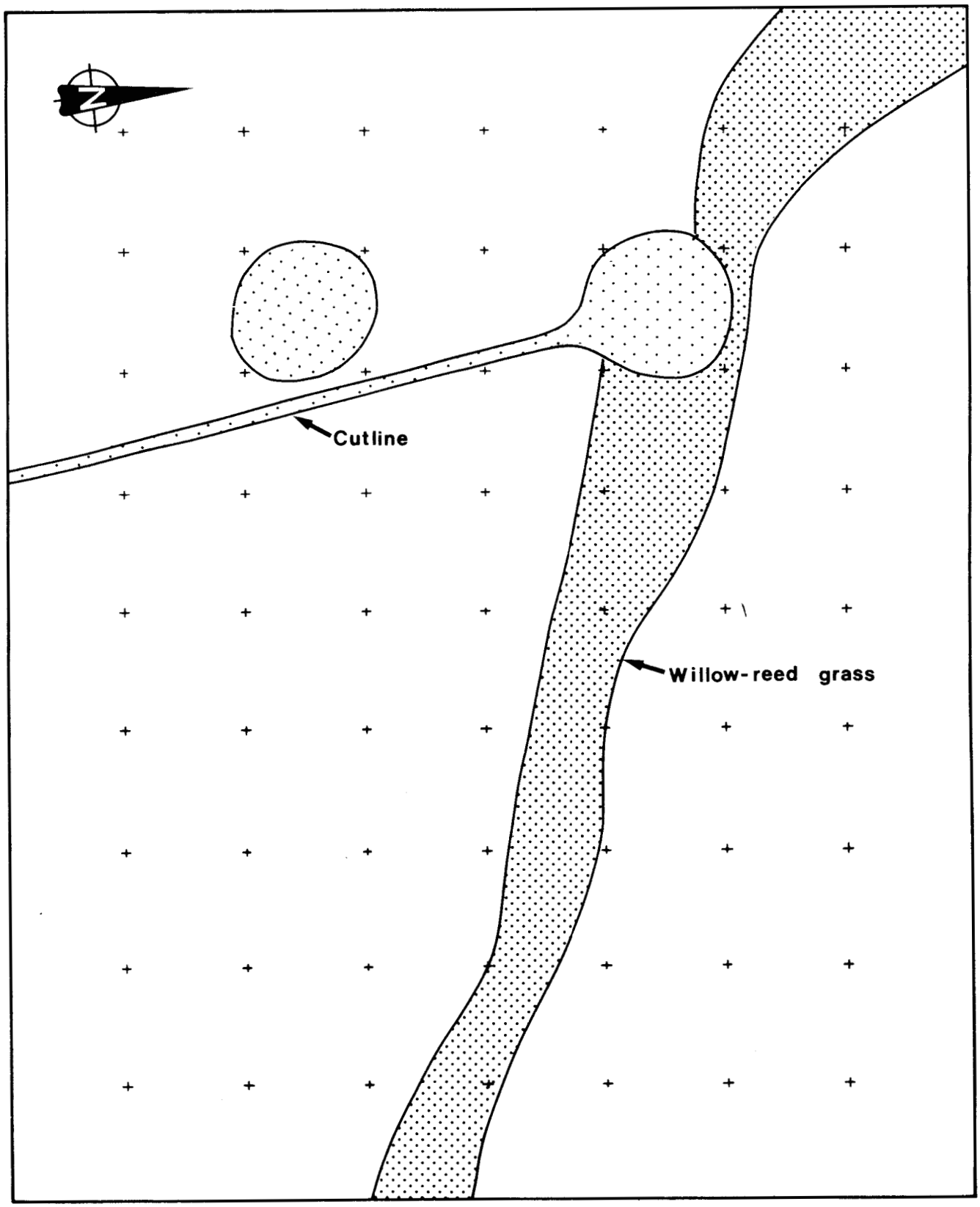
Appendix B-6.

White spruce - aspen Plot 84-7 Size 18.5 ha

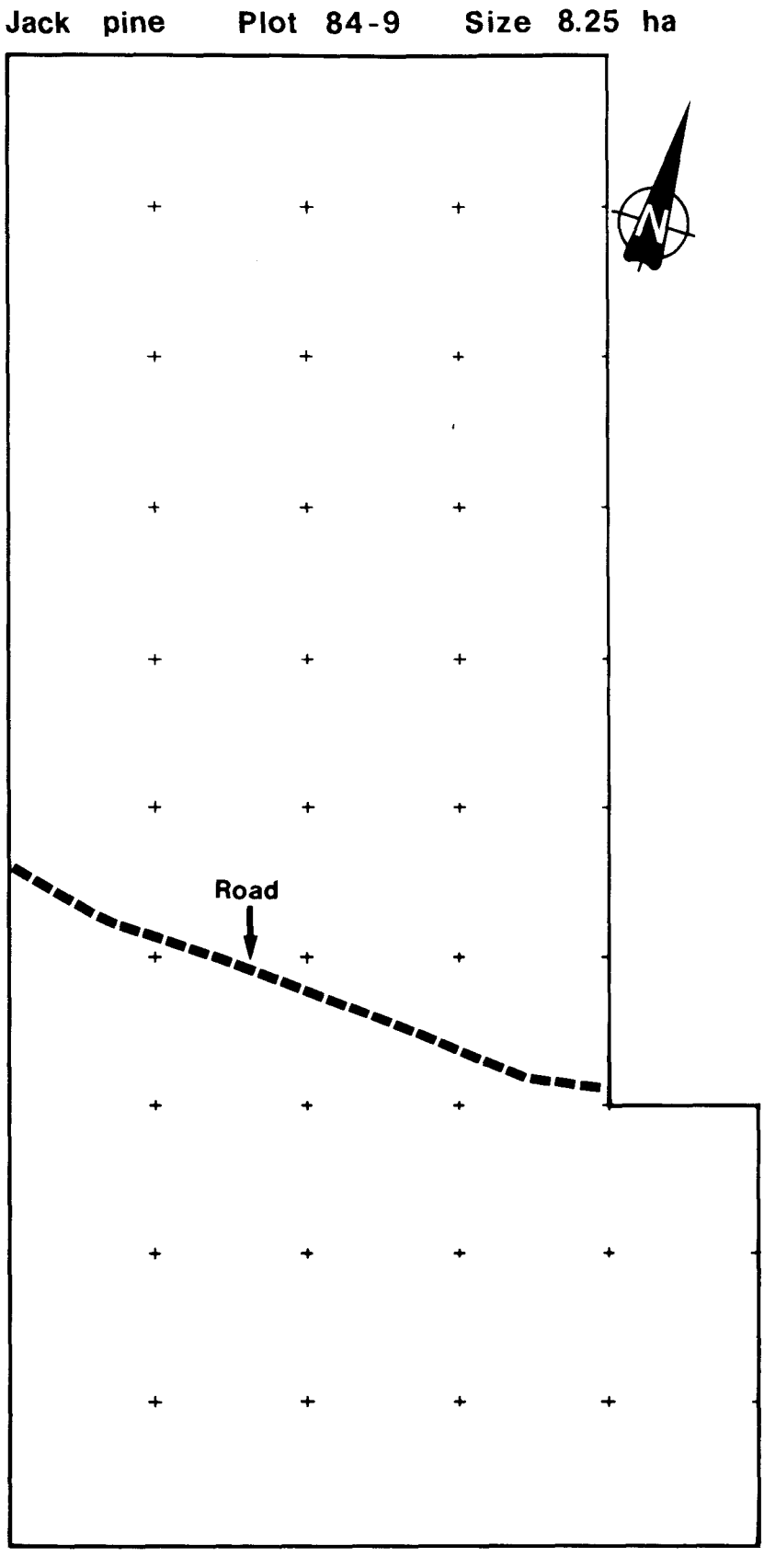


Appendix B-7.

Aspen-white spruce Plot 84-8 Size 20.0 ha



Appendix B-8.



Appendix B-9.

Appendix C. Annotated List of Bird Species Recorded in 1984

A total of 131 species or species-pairs of birds were recorded during the field work on and near Lease 17 in 1984. Included in this total are 65 species or species-pairs recorded during the breeding bird censuses and 70 species or species-pairs recorded during the waterbody surveys. This section briefly reviews the information gathered during this study for each of these species. For those species commonly recorded during the breeding bird censuses, we provide comparative information about their numbers and distribution as presented in Francis and Lumbis (1979) and in the American Birds annual breeding bird censuses (see also Section 2.5). For those species commonly recorded during the waterbody surveys, we present comparative data from waterbody surveys in 1974 (Sharp et al. 1975), 1975 (Sharp and Richardson 1976) and 1977 (Ward and Hollingdale 1978). Nomenclature and sequence of species are according to A.O.U. (1983).

Common Loon (Gavia immer). Recorded regularly on Beaver Creek and Poplar Creek reservoirs, Ruth Lake and Mildred Lake during all surveys from 9 June to 9 October. From 12 to 22 birds were seen per survey until the end of August but only 4-8 birds were seen per survey thereafter. During the early surveys most sightings were of pairs of birds, but flocks of up to seven birds were seen in late August. Breeding pairs of common loons were observed on Ruth Lake, Poplar Creek Reservoir, and a small waterbody along the West Interception Ditch; a brood was seen on Poplar Creek Reservoir. Nests and broods of this species were found on Mildred Lake and Ruth Lake in 1975 (Sharp and Richardson 1976).

Pied-billed Grebe (Podilymbus podiceps). Recorded during six of the 13 waterbody surveys. Individuals or pairs were seen on Saline Lake, Horseshoe Lake, Ruth Lake, Beaver Creek Reservoir and Poplar Creek Reservoir between 20 June and 20 September. Two nests were found on Poplar Creek Reservoir and a brood was seen on Ruth Marsh.

Horned Grebe (Podiceps auritus). Recorded during all waterbody surveys. One or two breeding pairs were seen regularly on the small numbered waterbodies along the West Interception Ditch from mid June to mid August and the occasional individual or breeding pair was seen on Saline Lake, Ruth Marsh and Beaver Creek Reservoir during this period. An apparent influx of horned grebes was observed on 18-20 September when almost 60 birds, or about 67% of the total number counted during the surveys, were recorded on Saline Lake, Mildred Lake and Beaver Creek Reservoir.

Red-necked Grebe (Podiceps grisegena). Commonly recorded during all surveys from 9 June to 10 September (50-90 individuals seen per survey), but numbers much lower thereafter (12-20 birds per survey). Almost 90% of approximately 700 grebes counted were on the Beaver Creek Reservoir-Ruth Lake-Poplar Creek Reservoir waterbody complex, with much smaller numbers on Mildred Lake and Horseshoe Lake. Loose flocks of 40-50 birds, possibly non-nesters, were present on the reservoirs in late August and early September. Thirty broods were observed, mostly on Beaver Creek and Poplar Creek reservoirs, but they were also seen on Horseshoe, Ruth, Mildred and Saline lakes and Loon Pond. Five nests were found on Ruth Lake. Nests and broods of red-necked grebes were noted on Mildred, Ruth and Horseshoe lakes in 1975 (Sharp and Richardson 1976).

American White Pelican (Pelecanus erythrorhynchos). Two birds seen on 27 September and an individual seen on 7 October on an island in Beaver Creek Reservoir.

American Bittern (Botaurus lentiginosus). Recorded in low numbers (not exceeding five) on 10 of the 13 waterbody surveys. They were seen from 12 June to 19 September, and only in the Beaver Creek Reservoir-Ruth Marsh-Poplar Creek Reservoir part of the study area.

Great Blue Heron (Ardea herodias). Recorded on 10 of the 13 waterbody surveys from 19 June to 9 October. Like the bittern, herons were seen in low numbers (maximum of five birds on any one waterbody) and primarily in the Beaver Creek Reservoir-Ruth Lake-Poplar Creek Reservoir area. On 6 September, eight birds were seen on a small waterbody along the West Interception Ditch.

Tundra Swan (Cygnus columbianus). Six individuals seen on Beaver Creek Reservoir (one bird), Saline Lake (one bird) and the north Diversion Canal (four birds) on 6-9 October.

Greater White-fronted Goose (Anser albifrons). A flock of five birds was seen at the north end of Poplar Creek Reservoir on 26 August, and a flock of three birds was seen on Beaver Creek Reservoir on 7 October.

Canada Goose (Branta canadensis). Recorded on eight of the 10 waterbody surveys from 10 June to 10 September. With the exception of single birds on J-Pit and Poplar Creek Reservoir, all birds were seen on Beaver Creek Reservoir or on the Diversion Canal leading out of it. Broods were seen on each of these last two waterbodies. All Canada geese seen appeared to be B. c. moffitti.

Green-winged Teal (Anas crecca). Common in study area. Based on numbers counted, the green-winged teal was the fourth most abundant duck species present during the study. Although recorded on all of the large waterbodies and many of the smaller ones, this species was most often seen on Beaver Creek Reservoir, Poplar Creek Reservoir and Saline Lake (78% of all observations). Broods were recorded on Beaver Creek Reservoir, Saline Lake, the north Diversion Canal and on two small ponds along the West Interception Ditch. Sharp and Richardson (1976) recorded broods on Ruth Lake and Mildred Lake.

Numbers of green-winged teal recorded per survey were less than 100 birds during June and early July. However, numbers counted increased in late July, and in early August almost 500 individuals were counted. Virtually all were either young birds, post-moulting adults or pre-moulting females. Several hundred birds were recorded regularly throughout August but numbers were lower in early September as birds migrated south. Migration continued throughout September and early October. An apparent wave of migrants was noted on 16-20 September when almost 300 green-winged teal were recorded.

American Black Duck (Anas rubripes). One seen among a flock of mallards on Poplar Creek Reservoir on 26 August. This species is a rare visitor to northern Alberta (Salt and Salt 1976).

Mallard (Anas platyrhynchos). Common in study area. This was the most commonly recorded species of waterfowl--over 7000 birds were counted during the surveys. Mallards were seen on all large waterbodies and on most of the small ones as well. The waterbodies where mallards were most commonly recorded were Beaver Creek Reservoir (34% of all mallards counted), Saline Lake (26%) and Horseshoe Lake (18%). Breeding pairs and broods were observed on these waterbodies and on the northern Diversion Canal, Lower Camp Sedimentation Basin and several of the SSWAs. Sharp and Richardson (1976) recorded broods on Mildred Lake and Ruth Lake.

Between 150 and 300 mallards were counted during each survey in June and early July but numbers increased in late July. An average of about 875 mallards were counted during each survey in August. Virtually all birds were in eclipse (non-breeding) plumage and could fly. Numbers were slightly lower in early September, but increased again in late September, presumably as migrants from northern areas moved into and through the study area.

Northern Pintail (Anas acuta). Regularly recorded during waterbody surveys, especially after the end of July. Almost 1000 birds were counted. Pintails were most commonly recorded on Saline Lake (35% of all birds counted), Beaver Creek Reservoir (21%) and Ruth Lake (12%), but were also recorded on most other waterbodies. Broods were recorded on Horseshoe Lake and on a small pond by the West Interception Ditch.

Pintails are one of the earliest nesting ducks and males leave the females very soon after incubation begins (Bellrose 1976). Thus the low numbers recorded during waterbody surveys in June and July (2-33 birds per survey) may not be indicative of the size of the nesting population. Much higher numbers were counted in mid and late August (about 330 birds per survey); virtually all of these birds could fly and were either young-of-year, post-moulting adults or pre-moulting females. Numbers were much lower in September as migrants moved out of the area, and few were present in early October.

Blue-winged Teal (Anas discors). Common in study area. The blue-winged teal was the fifth most commonly recorded waterfowl species (over 1400 counted). This species was recorded on most waterbodies in the study area; the highest counts were on Beaver Creek Reservoir (22% of total), Saline Lake and Horseshoe Lake (each 19%), Ruth Lake (15%) and Poplar Creek Reservoir (11%). Breeding pairs and broods were recorded on these waterbodies and on two of the small ponds along the West Interception Ditch.

Blue-winged teal were regularly seen during surveys in June and July. Over 125 birds were counted in late June; although many pairs were present, most of the birds seen were males, presumably gathering to moult. The much lower numbers seen in July (30-40 birds per survey) were composed mostly of females. Throughout August, several hundred blue-winged teal were present on each survey; virtually all were in eclipse plumage and could fly. Numbers counted decreased steadily throughout September and early October as birds migrated out of the study area.

Cinnamon Teal (Anas cyanoptera). One male seen on 28 June on Beaver Creek Reservoir. This species nests in southern Alberta (Salt and Salt 1976).

Northern Shoveler (Anas clypeata). Regularly recorded during all waterbody surveys. Between eight and 125 birds were seen during each survey. Shovelers were seen on all of the large waterbodies except Mildred Lake, and on many of the smaller ones; they were most commonly seen on Beaver Creek Reservoir (29% of total), Saline Lake (22%) and Poplar Creek Reservoir (21%). Broods were recorded on Beaver Creek Reservoir and one of the SSWAs. Sharp and Richardson (1976) also observed a brood on Horseshoe Lake.

Numbers of shovelers recorded during surveys were constant through June and early July (45-60 birds per survey) but decreased substantially in mid and late July, presumably a result of male birds either moving to other moulting areas or becoming more secretive as they moulted in the study area. Over 100 were counted in early August--all seen could fly and were in eclipse plumage--but numbers were much lower during the remainder of August and decreased through September and early October as migrants left the area.

Gadwall (Anas strepera). Recorded throughout the study until early October. Numbers counted generally varied from 4 to 35 birds per survey, although counts of 75 and 61 were made in early and late July, respectively. Gadwalls were recorded on most waterbodies in the study area, although numbers counted were highest on Beaver Creek Reservoir (44% of total), Poplar Creek Reservoir (17%) and Horseshoe Lake (11%). No evidence of nesting was noted. Gadwalls are uncommon nesters in northern Alberta (Salt and Salt 1976; Ward and Hollingdale 1978).

The generally low numbers of gadwalls recorded reflects its uncommon status in the study area, which is on the northern fringe of its breeding range. The higher than average numbers counted during surveys in July may have represented males gathering to moult.

American Wigeon (Anas americana). Common throughout study area. The American wigeon was the second most commonly recorded waterfowl species during the study--over 5000 birds were counted. It was seen on virtually all waterbodies and was most common on Beaver Creek Reservoir (33% of total counted), Saline Lake (27%), Horseshoe Lake (15%) and Ruth Lake (13%). Breeding pairs and broods were seen in these areas and on Mildred Lake, Loon Pond, Poplar Creek Reservoir, the Diversion Canals and several of the SSWAs.

Numbers of wigeons recorded during surveys in June and July varied from about 225 to 400 birds. The higher totals were in late June and early July and may have represented birds gathering to moult. No similar increase was noted in the study area in 1975 (Sharp and Richardson 1976). Numbers in the study area increased in early August and remained high through late September (420-610 birds seen per survey). Virtually all of the birds seen during these months were in eclipse plumage and could fly. Numbers were much lower in early October as migrants left the study area.

Canvasback (Aythya valisineria). Recorded in low numbers (maximum of 12 birds per survey) during waterbody surveys from 9 June to 30 July and 6-29 September. Virtually all of the birds seen in June and July, including four broods, were on Saline Lake; sightings in the study area were rare. Most of those seen in September (14 birds) were on Beaver Creek Reservoir and Ruth

Lake. Both males and females were seen. Canvasback broods were observed on Horseshoe Lake and Mildred Lake in 1975 (Sharp and Richardson 1976).

Redhead (Aythya americana). Recorded on Saline Lake during surveys from 20 June (the first time this lake was surveyed) to 11 July. Both males and females were seen. Flocks of 13, five and two birds were also seen in Ruth Marsh (17 July), Beaver Creek Reservoir (10 September) and Ruth Lake (7 October), respectively. Sharp et al. (1975) noted a brood on Ruth Lake in 1974.

Ring-necked Duck (Aythya collaris). Recorded on all surveys from June to early October. This species was seen on most waterbodies in the study area, and was most common on Saline Lake (27% of total count), Horseshoe Lake (18%), Ruth Lake (16%) and Beaver Creek Reservoir (14%). Breeding pairs and broods were seen on these waterbodies as well as Poplar Creek Reservoir and several of the smaller waterbodies and SSWAs.

Numbers of ring-necked ducks were highest in June (70-135 birds seen per survey), decreasing steadily through July and August. The decrease in numbers after June may have represented the movement of breeding males to moulting areas outside of the study area. Virtually all of the ring-necked ducks seen in July and August were females with broods. Numbers remained low in September and early October, although a count of over 115 birds in mid September, including over 60 on Saline Lake, may have represented a wave of transients. Sharp and Richardson (1976) noted an increase in ring-necked duck numbers in mid September during surveys in 1975.

Scaup (Aythya spp.). Greater scaup (A. marila) and lesser scaup (A. affinis) are similar in plumage and difficult to distinguish; hence, they are discussed together. Lesser scaup nest in the study area; greater scaup are transients (Salt and Salt 1976).

Over 2800 scaup were recorded during waterbody surveys. Although seen on many of the waterbodies, over 85% were recorded on Saline Lake and Beaver Creek Reservoir. Breeding pairs and broods were also present on these waterbodies; Sharp and Richardson (1976) recorded breeding pairs on Mildred Lake and Ruth Lake.

Scaup were regularly observed throughout the study area during surveys in June and July. However, very few were recorded during surveys in August, indicating that the waterbodies in the study area are not used by scaup during their wing moult in August (cf. Sharp and Richardson 1976). Large numbers of scaup had appeared by early September--1200 were counted during a survey on 6-9 September--and they were numerous in the study area throughout the month. Most of these migrants were in eclipse plumage. Over 90% of these birds were on Beaver Creek Reservoir and Saline Lake.

Surf Scoter (Melanitta perspicillata). One individual seen on 8 September on Mildred Lake and a second individual seen on 8 October on Poplar Creek Reservoir. Although the nesting range of this species is reported to include the study area (Bellrose 1976; Salt and Salt 1976), this species has been rarely recorded during surveys (cf. Sharp and Richardson 1976).

White-winged Scoter (Melanitta fusca). Two individuals seen on 18 June on Mildred Lake. Like the surf scoter, the nesting range of this species is believed to include the study area (Bellrose 1976; Salt and Salt 1976); however, data from the waterbody surveys suggest that white-winged scoters are scarce transients in the region (cf. Sharp and Richardson 1976).

Common Goldeneye (Bucephala clangula). Regularly recorded during all surveys. Although goldeneyes were seen on most of the waterbodies, the great majority of those counted (76%) were seen on Saline Lake. More broods were recorded of this species than of any other species of waterfowl; broods were seen on Saline Lake (25 of 35 broods recorded), Horseshoe Lake, Beaver Creek Reservoir, Poplar Creek Reservoir and several of the small waterbodies along the West Interception Ditch. Sharp and Richardson (1976) also recorded broods on Ruth Lake and Mildred Lake.

Numbers of common goldeneyes counted in the study area were generally constant in June and early July (35-70 birds per survey) before decreasing in mid July, possibly as breeding males moved to moulting areas. Numbers increased in late July and 100-150 goldeneyes were counted during surveys in August. Virtually all could fly and were in juvenile or eclipse plumage. Numbers decreased during September and early October, as migrants moved out of the study area.

Bufflehead (Bucephala albeola). Recorded during all surveys. Numbers seen per survey varied from 25-70 birds, except in early September when almost 100 individuals were counted. Buffleheads were widespread throughout the study area; they were most commonly recorded on Saline Lake (47% of total count), the SSWAs (16%), Horseshoe Lake (14%) and Beaver Creek Reservoir (11%). Broods were seen in these areas and on Poplar Creek Reservoir. Sharp and Richardson (1976) also recorded bufflehead broods on Mildred Lake and Ruth Lake.

The absence of large flocks of buffleheads during the summer indicates that the waterbodies in the study area are not favoured areas for moulting. The slight increase in numbers in early September may have represented a movement of early migrants from northern areas into the study area.

Hooded Merganser (Lophodytes cucullatus). Two flocks of 11 birds each seen on Beaver Creek Reservoir and Ruth Lake on 27 September. The sightings may have been of the same flock. Two birds were also seen on the latter site on 7 October. The status of this species in the study area is poorly known (cf. Salt and Salt 1976).

Common Merganser (Mergus merganser). Seen on Beaver Creek Reservoir on 10 September and 19 September (total of 13 birds). One individual was seen on Saline Lake on 20 June. Broods of this species were recorded on the MacKay River in 1984 and in the study area in 1975 (Sharp and Richardson 1976).

Red-breasted Merganser (Mergus serrator). A flock of three birds seen on Beaver Creek Reservoir on 19 September. Flocks of female mergansers, totalling 20 birds were also seen on the reservoir that day, and may have been either this species or common mergansers. Red-breasted mergansers are transients in the study area (Salt and Salt 1976).

Ruddy Duck (Oxyura jamaicensis). Recorded during nine of 11 waterbody surveys from 9 June to 19 September. Most sightings were of single birds including both males and females, and generally from two to 10 individuals per survey. Ruddy ducks were most often seen on Horseshoe Lake (including five broods) and Saline Lake (including one brood), particularly in June and

July. Other broods were seen on Beaver Creek Reservoir and an SSWA. Salt and Salt (1976) consider this species to be a scarce breeding resident in northern Alberta.

Osprey (Pandion haliaetus). One individual seen over Saline Lake on 20 September. This species is reported to breed throughout northern Alberta (Salt and Salt 1976).

Bald Eagle (Haliaeetus leucocephalus). A nest of this species was situated along the eastern shore of Saline Lake. Two young were fledged in mid August. Immature and adult birds were seen around Ruth Lake, Poplar Creek Reservoir and Mildred Lake in September.

Northern Harrier (Circus cyaneus). Regularly observed along the shorelines of many of the lakes that were surveyed. One nest was found on a reclamation plot near Poplar Creek Reservoir. It had five eggs on 26 May and five young on 26 June.

Sharp-shinned Hawk (Accipiter striatus). One seen flying through an aspen-white spruce plot on 22 June.

Golden Eagle (Aquila chrysaetos). One individual seen over Horseshoe Lake on 18 September. The breeding range of this species includes the study area (Salt and Salt 1976).

American Kestrel (Falco sparverius). One male seen three times in a black spruce-Labrador tea plot. It is probable that a portion of its territory lay within the plot. Kestrels were commonly seen in open habitats throughout the study area.

Spruce Grouse (Dendragapus canadensis). A female spruce grouse with two chicks was seen on one occasion on the jack pine plot. They were seen on the northern perimeter of the plot.

Ruffed Grouse (Bonasa umbellus). Heard drumming in both mixed-forest habitats. A female with five young was seen on 26 June in the centre of an aspen-white spruce plot, and a female with three young was seen on 23 June along the perimeter of a white spruce-aspen plot.

Sora (Porzana carolina). Individuals regularly seen during waterbody surveys from 19 June to 27 July. No more than seven birds were recorded on any one survey. Although they were recorded throughout the study area, most sightings were made on the small waterbodies along the West Interception Ditch. Only one sora was seen during surveys after the end of July. Sharp and Richardson (1976) found this species to be a regular nester in the study area.

American Coot (Fulica americana). Common in study area. Almost 3900 birds were counted during waterbody surveys, primarily on Beaver Creek Reservoir (52% of total) and Horseshoe Lake (38%). They were, however, present throughout the study area. Fifty broods were counted; 36 broods were seen on Horseshoe Lake, and 1-5 broods or nests were present on each of Ruth Lake, Beaver Creek Reservoir, Poplar Creek Reservoir, Ruth Marsh, Saline Lake and the SSWAs. Sharp and Richardson (1976) also recorded broods on Mildred Lake.

Numbers of coots recorded during the waterbody surveys remained constant through June and July (63-96 birds per survey). Numbers increased slightly in August as young-of-year birds became independent and early migrants from northern regions moved into the study area. A major wave of transients appeared in early September--almost 1300 birds were counted on 6-10 September, mostly on Beaver Creek Reservoir--and several hundred coots were recorded in the area during surveys throughout September. Sharp et al. (1975) and Sharp and Richardson (1976) also noted the presence of large numbers of coots in the study area, especially on Horseshoe Lake, in September.

Sandhill Crane (Grus canadensis). Three individuals seen along the shores of Poplar Creek and Beaver Creek reservoirs in mid June. Pairs of this species were heard and/or seen throughout the study area during the first half of August, and migrants were seen flying overhead in late August.

Sandhill cranes are summer residents in the study area, both as breeders and non-breeders (Sharp and Richardson 1976).

Black-bellied Plover (Pluvialis squatarola). Recorded during waterbody surveys in September and early October. Peak numbers (60 birds) were recorded during the survey on 16-20 September. Small numbers, not exceeding 20 birds, were recorded on the shores of most of the large waterbodies surveyed. This species is a transient in the study area (Salt and Salt 1976).

Lesser Golden-Plover (Pluvialis dominica). Recorded during the waterbody surveys on 26-29 September and 6-9 October, when eight birds were seen at S-Pit and Poplar Creek Reservoir. Only young-of-the-year birds migrate southward through the Prairie Provinces (Salt and Salt 1976).

Mongolian Plover (Charadrius mongolus). One individual seen at S-Pit during a waterbody survey on 18 June. This species is accidental in Canada (Salter et al., in prep.).

Semipalmated Plover (Charadrius semipalmatus). Recorded on waterbody surveys from 19 July to 20 August. This species was not commonly observed--the highest number on a single survey was 15 birds, on 6-10 August. With the exception of four birds seen at S-Pit, all semipalmated plovers were recorded on Beaver Creek Reservoir, Ruth Lake and Poplar Creek Reservoir. The semipalmated plover is a transient in the area.

Killdeer (Charadrius vociferus). Recorded during all waterbody surveys. Between 10 and 40 individuals were counted during each survey from June through August, primarily on Beaver Creek Reservoir, Poplar Creek Reservoir and S-Pit, although this species was present throughout the study area. Only the occasional killdeer was seen in September and early October. This species nests throughout the study area (Sharp and Richardson 1976).

Yellowlegs (Tringa spp.). Recorded on both black spruce-Labrador tea plots and in white spruce-aspen. Individuals were seen only once in the latter vegetation type and on black spruce-Labrador tea Plot 84-3, and were believed to have been lesser yellowlegs (T. flavipes). At least two greater yellow-

legs (T. melanoleuca) were seen regularly on black spruce-Labrador tea Plot 84-5. Francis and Lumbis (1979) recorded greater yellowlegs nesting densities of 1-3 pairs/100 ha in muskeg.

Yellowlegs were regularly recorded during all waterbody surveys. Both species were seen, although no systematic attempt was made to differentiate between them, particularly when they were present as mixed flocks. Numbers seen were generally constant throughout June and much of July (35-65 birds per survey) but increased in late July and August (200-500 birds per survey), before decreasing again in September to a level similar to that recorded in June. Yellowlegs were seen on all of the large waterbodies and many of the smaller ones; about half of the 1500 birds counted were on Beaver Creek Reservoir. Unlike their distribution in 1975, yellowlegs were rarely seen on Mildred Lake (two sightings totalling three birds in 1984).

Solitary Sandpiper (Tringa solitaria). Between one and nine individuals recorded during each survey from 9 June to 28 August. This species was most often seen on several of the small waterbodies near the West Interception Ditch and along the Diversion Canals north and south of Ruth Lake. Solitary sandpipers nest in appropriate habitat (wooded areas by ponds or lakes) throughout northern Alberta (Salt and Salt 1976).

Spotted Sandpiper (Actitis macularia). Commonly recorded during all waterbody surveys from 9 June to 19 September, although numbers seen decreased gradually after mid August. Between 20 and 55 birds were counted during each survey. This species was present on all waterbodies where a rocky, partially vegetated shoreline was present. This species is a common nesting resident in the study area (Salt and Salt 1976; Sharp and Richardson 1976).

Sanderling (Calidris alba). One individual seen at J-Pit on 26 September. This species is a transient in the study area (Salt and Salt 1976).

Small Shorebirds ('Peeps'). Several species of small shorebirds have similar habits, habitat preferences and autumn plumages and often can not be identified unless under excellent viewing conditions. Species in this group

which were identified during the waterbody surveys include the semipalmated sandpiper (Calidris pusilla), western sandpiper (C. mauri), least sandpiper (C. minutilla), white-rumped sandpiper (C. fuscicollis) and Baird's sandpiper (C. bairdii). All of these species are transients in the study area (Salt and Salt 1976). During the waterbody surveys, over 1400 peeps were recorded, only 8% of which were identified to species.

Peeps were recorded on 20 June (one flock of 25 birds on Saline Lake) and during all surveys from 9 July to 29 September. Between 14 and 70 peeps were counted during surveys in July, but over 1000 were recorded during the two surveys from 6 August to 20 August. Numbers seen decreased sharply in late August and by late September only one flock of five birds was observed. The large majority of the peeps recorded during the movement in the first half of August was seen on Beaver Creek and Poplar Creek reservoirs, although small flocks were present on most of the waterbodies surveyed.

Pectoral Sandpiper (Calidris melanotos). Recorded during waterbody surveys from 17 July to 9 October. Similar numbers (35-55 birds) were counted during surveys in September but numbers were lower in October. Like most other species of shorebirds, the large majority of the pectoral sandpipers seen were on Poplar Creek Reservoir and Beaver Creek Reservoir, with smaller numbers at S-Pit. This species is a transient in the study area (Salt and Salt 1976).

Stilt Sandpiper (Calidris himantopus). Recorded in small numbers (less than six per survey) during surveys from 9 July to 10 August. This species was recorded at Poplar Creek Reservoir, Ruth Lake, Mildred Lake, S-Pit and on the small waterbodies along the West Interception Ditch. Stilt sandpipers are transients in the study area (Salt and Salt 1976).

Dowitchers (Limnodromus spp.). Two species of dowitchers occur in the study area. The short-billed dowitcher (L. griseus) is reported to breed throughout northern Alberta and the long-billed dowitcher (L. scolopaceus) is a transient (Salt and Salt 1976). Dowitchers were recorded during waterbody surveys from 9 July to 9 October. Numbers counted per survey were generally constant, with the exception of 16-19 September when over 100 dowitchers were

counted. Most were seen at Beaver Creek Reservoir and Poplar Creek Reservoir, although during the influx in September large flocks were also present at Horseshoe Lake and Ruth Marsh.

Common Snipe (Gallinago gallinago). Recorded on 11 of the 12 waterbody surveys from 10 June to 29 September. The small number of individuals seen during surveys in June and July (less than 10 per survey) were primarily at Beaver Creek Reservoir and several of the small waterbodies along the West Interception Ditch. Numbers seen increased slightly in mid and late August, with small flocks present on Beaver Creek and Poplar Creek reservoirs, and decreased again in September. Common snipes nest in the study area (Sharp and Richardson 1976).

Wilson's Phalarope (Phalaropus tricolor). Recorded on seven of the nine waterbody surveys from 9 June to 30 August. This species was widespread in low numbers (less than eight birds on a single survey) and was recorded on most of the waterbodies in the study area. A flock of 30 Wilson's phalaropes was seen on Saline Lake on 26 August. This species appears to be an uncommon nesting resident in the study area (Salt and Salt 1976; Sharp and Richardson 1976).

Bonaparte's Gull (Larus philadelphia). Recorded twice flying over a black spruce-Labrador tea plot. A pair was seen near this plot on several occasions and frequently screamed at the observer's approach.

Bonaparte's gulls were recorded during all waterbody surveys until mid September. Between five and 19 birds were seen on any one survey. Most sightings were on Beaver Creek Reservoir, although individuals were present on most of the other waterbodies in the study areas as well. Young-of-the-year were seen on two of the SSWAs in late July and flocks of young-of-year birds were seen on Saline Lake in early August. Sharp and Richardson (1976) found nesting Bonaparte's gulls on most of the waterbodies that they surveyed in the study area.

Ring-billed Gull (Larus delawarensis). With the exception of a pair seen in mid June, recorded on all waterbody surveys only after 16 August. Between 10 and 35 birds were counted per survey, primarily on Beaver Creek and Poplar Creeks reservoirs, Ruth Lake, Mildred Lake and Saline Lake. Although the breeding range of this species is reported to include the study area (Salt and Salt 1976), there is no evidence of its nesting there (cf. Sharp and Richardson 1976; Francis and Lumbis 1979). Almost 94% of the ring-billed gulls recorded during waterbody surveys by Sharp and Richardson (1976) were seen after 11 August.

California/Herring Gull (Larus californicus/argentatus). These two species are similar in appearance, and no attempt was made to differentiate between them. These gulls were seen on all waterbody censuses, but were nowhere numerous. Numbers seen were similar throughout June and July and peaked on 16-20 August, when 36 individuals were counted. The great majority of California/herring gulls were seen on Beaver Creek Reservoir, Poplar Creek Reservoir, Ruth Lake and Mildred Lake. Both California gulls and herring gulls are reported to nest in the study area (Salt and Salt 1976), although Sharp and Richardson (1976) found no evidence of nesting.

Common Tern (Sterna hirundo). Recorded during waterbody surveys from 9 June to 30 July, but not seen thereafter. This species was seen primarily on Beaver Creek and Poplar Creek reservoirs with occasional sightings on Ruth Lake and Mildred Lake. The common tern breeds locally throughout northern Alberta; one nest was found on Beaver Creek Reservoir.

Black Tern (Chlidonias niger). Recorded commonly on waterbody surveys from 9 June to 10 August (average of 130 birds seen per survey), but numbers decreased sharply after mid August and none were recorded after the beginning of September. This species was most numerous on Horseshoe Lake, where at least one colony was situated; other colonies were found on Poplar Creek Reservoir and Saline Lake. Sharp and Richardson (1976) noted a colony near Ruth Lake.

Great Horned Owl (Bubo virginianus). One seen flying through the jack pine plot. An individual was also seen in similar habitat about 1 km north of the plot on 22 August.

Common Nighthawk (Chordeiles minor). Seen in black spruce-Labrador tea and in jack pine. An individual was flushed off a muskeg plot on 23 June, possibly a nesting bird, and a nest with ten eggs was found on the jack pine plot on 22 June. Common nighthawks were commonly observed over the jack pine forests surrounding the AOSERP camp in August. Francis and Lumbis (1979) noted that this species breeds in a variety of habitats in northeast Alberta but prefers jack pine; they reported a density of 5 males/100 ha in such habitat.

Belted Kingfisher (Ceryle alcyon). One to four individuals seen during each of the waterbody surveys from 16 August-29 September. Individuals were seen on Saline Lake, Mildred Lake and the Lower Camp Sedimentation Basin. The breeding range of this species includes the study area (Salt and Salt 1976).

Yellow-bellied Sapsucker (Sphyrapicus varius). Recorded only in white spruce-aspen (5 males/100 ha). Francis and Lumbis noted that this species prefers mixed habitats; they recorded densities of 4-24 males/100 ha. Densities of 5-16 males/100 ha were recorded during American Birds censuses.

Hairy Woodpecker (Picoides villosus). Recorded irregularly in black spruce-Labrador tea and in aspen-white spruce, but not in sufficient frequency to be considered territorial. Francis and Lumbis (1979) recorded 2-6 males/100 ha in deciduous-dominated plots and 3 males/100 ha in muskeg.

Black-backed Woodpecker (Picoides arcticus). Recorded once in white spruce-aspen. Francis and Lumbis (1979) found this species to be uncommon in their study area and obtained no breeding data.

Northern Flicker (Colaptes auratus). Recorded in black spruce-Labrador tea, white spruce-aspen and aspen-white spruce, but no nesting territories were substantiated. Francis and Lumbis (1979) recorded densities of 3 males/100 ha and 2-8 males/100 ha in muskeg and mixed-forest habitat, respectively.

Pileated Woodpecker (Dryocopus pileatus). Recorded in white spruce-aspen (3 males/100 ha). Francis and Lumbis (1979) recorded a density of 2 males/100 ha in mature mixed forest.

Western Wood-Pewee (Contopus sordidulus). Recorded in both white spruce-aspen plots (but in only one during censuses), but no territories were substantiated. Francis and Lumbis (1979) recorded this species in both muskeg and mixed forest; recorded densities were 3-15 males/100 ha and 4-7 males/100 ha in those habitats, respectively. During American Birds censuses, densities of 5 males/100 ha in aspen-spruce forest and 31 males/100 ha in spruce-aspen forests were recorded.

Yellow-bellied Flycatcher (Empidonax flaviventris). Recorded only once in black spruce-Labrador tea vegetation. The low numbers of detections of this species is surprising. Francis and Lumbis (1979) recorded 3-7 and 8-10 males/100 ha in muskeg and mixed forests, respectively, and up to 23 males/100 ha were recorded during American Birds censuses. McLaren and McLaren (1978) noted that this was one of the most common species in the boreal forests in northern Ontario.

Alder Flycatcher (Empidonax alnorum). Recorded in black spruce-Labrador tea (8 males/100 ha), aspen-white spruce (3 males/100 ha), white spruce-aspen (5 males/100 ha) and on the revegetation plots (16 males/100 ha). All of the territories in the last habitat were in the young trembling aspen vegetation. Francis and Lumbis (1979) recorded 4-15 males/100 ha in muskeg and 3-19 males/100 ha in other, primarily non-tree, canopied riparian willow or alder habitats. Carbyn (1971) recorded 10 males/100 ha in black spruce-larch scrub south of Great Slave Lake. This species has been recorded (non-territorial) in aspen-spruce habitats during American Birds censuses.

Least Flycatcher (Empidonax minimus). Recorded in aspen-white spruce (118 males/100 ha) and in white spruce-aspen (3 males/100 ha); also heard (once) in an area of aspen in the jack pine plot. Francis and Lumbis (1979) recorded densities of 4-107 males/100 ha in aspen and aspen-dominated forests, and Erskine (1977) reported densities of up to 94 males/100 ha in western aspen forests. There may be large differences in numbers of territorial males in this species among parts of apparently suitable habitat and among years at the same site. Davis (1959) considered that least flycatchers formed definite colonies, occurring very densely in one area, while being completely absent in nearby areas of similar and apparently suitable vegetation. Sherry (1979) recorded 115-270 males/100 ha in a

six-year study on a hardwood forest plot in New Hampshire. In our study, the highest density (190 males/100 ha) was on the plot where there was little or no coniferous vegetation.

Eastern Phoebe (Sayornis phoebe). Recorded in the black spruce-Labrador tea vegetation type (3 males/100 ha). This species is more common around man-made clearings and buildings than in forests. No phoebes were recorded by Francis and Lumbis (1979) during their work in northeast Alberta.

Eastern Kingbird (Tyrannus tyrannus). Not recorded during breeding bird surveys. Seen occasionally along the shoreline of several of the lakes (Saline Lake, Horseshoe Lake, Beaver Creek Reservoir) during waterbody surveys. Francis and Lumbis (1979) recorded this species in tamarack muskeg (7 males/100 ha).

Gray Jay (Perisoreus canadensis). Recorded in all forest vegetation types during censuses. Both adults and young-of-year were observed, but since this species nested prior to the commencement of the study, no index of abundance could be obtained. The gray jay is a common species throughout coniferous-dominated forests (Godfrey 1966; Salt and Salt 1976; Francis and Lumbis 1979).

Common Raven (Corvus corax). Recorded throughout study area, although not on any of the breeding bird plots. Ravens were regularly seen around the garbage dump along the West Interception Ditch.

Black-capped Chickadee (Parus atricapillus). Recorded territorially in aspen-white spruce (5 males/100 ha), white spruce-aspen (3 males/100 ha) and jack pine (12 males/100 ha), and seen occasionally in black spruce-Labrador tea. Similar densities were recorded by Francis and Lumbis (1979) in deciduous and mixed woods and in muskeg (1-5 males/100 ha). Densities varied from 3 to 11 males/100 ha during American Birds censuses.

Boreal Chickadee (Parus hudsonicus). Recorded in black spruce-Labrador tea (8 males/100 ha) and in white spruce-aspen (8 males/100 ha). Francis and Lumbis (1979) noted this species to be common in coniferous-dominated

habitats (2-9 males/100 ha). During American Birds censuses, densities averaged 4 territories/100 ha in muskeg, and 3-6 males/100 ha in spruce-aspen forests. Carbyn (1971) recorded 10 males/100 ha in black spruce-larch (muskeg) south of Great Slave Lake.

Red-breasted Nuthatch (Sitta canadensis). Recorded in black spruce-Labrador tea and in white spruce-aspen (each 3 males/100 ha). Francis and Lumbis (1979) recorded this species only in mixed forest with a coniferous dominant (3-11 males/100 ha). Densities of 3-17 males/100 ha were recorded during American Birds censuses.

Marsh Wren (Cistothorus palustris). Regularly recorded during most waterbody surveys from 9 June to 29 September. Between 14 and 30 individuals were detected during most surveys. The large majority of those recorded were on Beaver Creek Reservoir and Horseshoe Lake, where there are extensive areas of cattail and bulrush marshes, but the species was present on many of the other waterbodies where marsh vegetation was present. As virtually all of the detections of marsh wrens were by aural cue, few birds were recorded after the end of July. Sharp and Richardson (1976) documented the nesting of this species on Horseshoe Lake.

Ruby-crowned Kinglet (Regulus calendula). Recorded in black spruce-Labrador tea (8 males/100 ha). Francis and Lumbis (1979) recorded this species in both mixed (coniferous-dominated) forest (2-3 males/100 ha) and in muskeg (7-22 males/100 ha). Densities of up to 72 males/100 ha have been recorded in northeast British Columbia during American Birds censuses.

Veery (Catharus fuscescens). One individual recorded on one occasion in aspen-white spruce. The normal breeding range of this species is south of the study area (Salt and Salt 1976). Francis and Lumbis (1979) heard two singing males during their study in northeast Alberta.

Swainson's Thrush (Catharus ustulatus). Recorded in black spruce-Labrador tea (3 males/100 ha), white spruce-aspen (43 males/100 ha), and aspen-white spruce (29 males/100 ha). Francis and Lumbis (1979) found this species to be widespread in muskeg (8-19 males/100 ha), mixed forests (10-52 males/100 ha)

and also in jack pine forest (6-7 males/100 ha). Similar densities were recorded during American Birds censuses.

Hermit Thrush (Catharus guttatus). Widespread. Recorded in black spruce-Labrador tea (10 males/100 ha), aspen-white spruce (5 males/100 ha), white spruce-aspen (21 males/100 ha) and in jack pine (12 males/100 ha). Francis and Lumbis (1979) also noted this species in a wide variety of habitats, including muskeg, mixed forests and pure aspens (5, 3-10 and 14 males/100 ha, respectively). Hermit thrushes were also recorded in a wide variety of vegetation types during American Birds censuses, although densities were generally lower, not exceeding 7 males/100 ha.

American Robin (Turdus migratorius). Recorded in all four forest habitats: black spruce-Labrador tea (3 males/100 ha), aspen-white spruce (10 males/100 ha), white spruce-aspen (5 males/100 ha) and jack pine (36 males/100 ha). Francis and Lumbis (1979) recorded robins only in mixed forests and in jack pine (7-9 and 1 males/100 ha, respectively); during American Birds censuses they were recorded in both mixed forests and muskeg (2-11 and 5 males/100 ha, respectively).

Waxwings (Bombycilla spp.). Both Bohemian waxwings (B. garrulus) and cedar waxwings (B. cedrorum) nest in the study area, although little is known about their abundance. During our study, a flock of cedar waxwings was seen in the young aspen growth on one of the plots in the reclamation area and a single cedar waxwing was seen in the jack pine forest. Neither species nests until July and consequently we have no data on nesting. Francis and Lumbis (1979) similarly recorded only flocks of wandering cedar waxwings.

Solitary Vireo (Vireo solitarius). Recorded in mixed forests: aspen-white spruce (18 males/100 ha) and white spruce-aspen (heard twice on one plot). Francis and Lumbis (1979) noted this species in muskeg, jack pine and mixed woods (3, 4 and 5-13 males/100 ha, respectively), and it was seen during American Birds censuses in white spruce-aspen forests (17 males/100 ha).

Warbling Vireo (Vireo gilvus). Recorded only in aspen-white spruce (3 males/100 ha). Francis and Lumbis (1979) recorded this species in deciduous and mixed forests in densities of 3-6 males/100 ha. However, high densities were recorded during American Birds censuses in aspen-spruce forests in northern British Columbia (23-25 males/100 ha).

Philadelphia Vireo (Vireo philadelphicus). Recorded in aspen-white spruce (3 males/100 ha) and white spruce-aspen (not judged as territorial). Francis and Lumbis (1979) found wide differences in densities during their study (2-34 males/100 ha), although all were recorded in mainly deciduous habitats where a coniferous element was rare or absent. Philadelphia vireos were recorded in aspen-spruce habitat during American Birds censuses (6 males/100 ha). Rice (1978) noted that the average territory of the Philadelphia vireo in a northern Ontario aspen forest was about 0.3 ha.

Red-eyed Vireo (Vireo olivaceus). Recorded in aspen-white spruce (23 males/100 ha) and in white spruce-aspen (5 males/100 ha). This species was also seen in the aspen growth on the plot in the jack pine forest (12 males/100 ha) and was recorded once in the young aspen growth on a plot in the reclamation area. This species can be abundant in deciduous or deciduous-dominant habitats. Francis and Lumbis (1979) recorded densities of up to 49 males/100 ha, and densities of up to 126 males/100 ha were recorded during American Birds censuses. Francis and Lumbis also noted red-eyed vireos in muskeg habitat (3 males/100 ha).

Tennessee Warbler (Vermivora peregrina). Possibly the most common songbird in the study area. Recorded in black spruce-Labrador tea (40 males/100 ha), aspen-white spruce (55 males/100 ha), white spruce-aspen (108 males/100 ha), and also heard on the plot in jack pine. Since many of the individuals on the plots were recorded in the small patches of willow-reed grass habitat, the actual density in that vegetation type is likely to be substantially higher than those presented above. Francis and Lumbis (1979) recorded densities of up to 103 males/100 ha in aspen-spruce forests and up to 84 males/100 ha in muskeg. Densities from American Birds censuses included 39 males/100 ha in muskeg (where alder swales were present) and up to 71 males/100 ha in aspen-white spruce forest.

Orange-crowned Warbler (Vermivora celata). Recorded only in black spruce-Labrador tea (non-territorial) during this study. Francis and Lumbis (1979) recorded this species in mixed forests (1-9 males/100 ha) and in muskeg (3-15 males/100 ha). Salt and Salt (1976) state that the orange-crowned warbler breeds locally throughout northern Alberta. It may be absent from many areas: none were recorded during the American Birds censuses in western boreal forests.

Yellow Warbler (Dendroica petechia). Recorded only in aspen-white spruce (8 males/100 ha). All territories were either near the edge of the plot, within 100 m of the West Interception Ditch, or in a patch of willow-alder scrub. Francis and Lumbis (1979) found this species almost exclusively in edge or other open habitats (2-53 males/100 ha).

Magnolia Warbler (Dendroica magnolia). Recorded in black spruce-Labrador tea and in aspen-white spruce (both 3 males/100 ha). The low numbers recorded and the complete absence of this species in white spruce-aspen forest was surprising, although Francis and Lumbis (1979) also concluded that it was uncommon in the coniferous habitats in their study area (1-19 males/100 ha). Densities in spruce-aspen habitats ranged up to 49 males/100 ha during the American Birds censuses; in eastern Canadian mixed forests, densities of up to 250 males/100 ha have been recorded (Welsh and Fillman 1980).

Yellow-rumped Warbler (Dendroica coronata). Recorded in black spruce-Labrador tea (13 males/100 ha) and in white spruce-aspen (3 males/100 ha). This species is common and widespread and likely to occur in any habitat with a coniferous element. Francis and Lumbis (1979) recorded densities of 5-74 males/100 ha on plots with such habitat. During American Birds censuses, densities of 6-19 males/100 ha were recorded in spruce-aspen forests and 20-58 males/100 ha in muskeg. Densities of 68-98 males/100 ha have been recorded in spruce forests in Maine (Morse 1976).

Palm Warbler (Dendroica palmarum). Recorded only in black spruce-Labrador tea (63 males/100 ha). This habitat preference was also noted by Francis and Lumbis (1979) who recorded 5-68 males/100 ha on black spruce and muskeg plots. Palm warblers were recorded only in muskeg plots during the American Bird censuses (11-14 males/100 ha).

Bay-breasted Warbler (Dendroica castanea). Heard (once) on an aspen-white spruce plot. Francis and Lumbis (1979) recorded this species on plots where coniferous forests were dominant (4-19 males/100 ha). Densities during American Birds censuses ranged from 4 males/100 ha in muskeg to 13-63 males/100 ha in spruce-aspen. Erskine (1977) reported densities of 158 males/100 ha in spruce budworm-infested forests in western Ontario.

Black-and-white Warbler (Mniotilta varia). Recorded in black spruce-Labrador tea (5 males/100 ha), in aspen-white spruce (28 males/100 ha) and white spruce-aspen (13 males/100 ha). One of the territories on the muskeg plot was actually in an area of aspen-white spruce. Francis and Lumbis (1979) also recorded this species in muskeg (9-14 males/100 ha) and in mixed forests (2-33 males/100 ha). Densities in the latter habitat recorded during American Birds censuses varied from 7 to 19 males/100 ha.

American Redstart (Setophaga ruticilla). Abundant in aspen-white spruce (115 males/100 ha), but recorded only casually (i.e. non-territorially) in white spruce-aspen. Francis and Lumbis (1979) found this species to be most numerous in willow scrub (46-70 males/100 ha), although it was present in aspen and aspen-spruce forests as well (3-6 males/100 ha). Densities in aspen-spruce forests during American Birds censuses varied from 11 to 63 males/100 ha. Redstarts may be more numerous in eastern forests. Sherry (1979) recorded 60-145 males/100 ha in deciduous forests in New Hampshire and Morse (1976) recorded 90-175 males/100 ha in a spruce forest in Maine.

Ovenbird (Seiurus aurocapillus). Recorded in black spruce-Labrador tea (3 males/100 ha), aspen-white spruce (65 males/100 ha), white spruce-aspen (21 males/100 ha) and in jack pine (12 males/100 ha). The territories on the muskeg and jack pine plots were in areas where deciduous trees (aspen) were present. Francis and Lumbis (1979) recorded densities of 18-138 males/100 ha in deciduous and mixed forests and 3-12 males/100 ha in willow and poplar scrub. During American Bird censuses, densities in aspen-spruce habitats varied from 5 to 163 males/100 ha.

Northern Waterthrush (Seiurus noveboracensis). Recorded (non-territorial) in black spruce-Labrador tea. This species prefers deciduous or mixed vegetation adjacent to water, so it is not surprising that it was rarely recorded during our study. In its preferred habitat, densities of 6-44 males/100 ha were recorded by Francis and Lumbis (1979).

Connecticut Warbler (Oporornis agilis). Recorded only in aspen-white spruce (3 males/100 ha). Francis and Lumbis (1979) noted territorial males on plots with an aspen-jack pine vegetational element. This species appears to be scarce in and around the study area; although Godfrey (1966) includes Fort McMurray in its breeding range, Salt (1973) and Salt and Salt (1976) state that the northern limit of breeding is about 275 km to the south.

Common Yellowthroat (Geothlypis trichas). Recorded in black spruce-Labrador tea (in the willow-reed grass vegetation) (5 territories/100 ha) and in aspen-white spruce (3 males/100 ha). Francis and Lumbis (1979) recorded similarly low densities in fens and muskeg (5-8 males/100 ha). This species is most common in open or edge situations, often near water, so our lack of records is not surprising.

Wilson's Warbler (Wilsonia pusilla). Recorded in black spruce-Labrador tea (10 males/100 ha) and in white spruce-aspen (3 males/100 ha). In both vegetation types, territories were centred in areas of willow-reed grass. Francis and Lumbis (1979) also noted that willow thickets were an important component of the vegetation on the plots on which this species was recorded (2-52 males/100 ha). Proximity to water may be an important determinant of territory location (Salt 1973; Salt and Salt 1976).

Western Tanager (Piranga ludoviciana). Recorded in white spruce-aspen (8 males/100 ha); also heard in plots in aspen-white spruce and jack pine habitats. Francis and Lumbis (1979) recorded densities of 5-19 males/100 ha in mixed habitats, and densities in mixed forest vegetation during American Birds censuses varied from 6-16 males/100 ha.

Rose-breasted Grosbeak (Pheucticus ludovicianus). Recorded in aspen-white spruce (8 males/100 ha) and white spruce-aspen (5 males/100 ha). Similar densities in such vegetation were recorded by Francis and Lumbis (1979) (3-9 males/100 ha) and during American Birds censuses (3-7 males/100 ha). A density of 15 males/100 ha was recorded by Francis and Lumbis in a closed, pure aspen stand.

Chipping Sparrow (Spizella passerina). Widespread. Recorded in black spruce-Labrador tea (23 males/100 ha), aspen-white spruce (3 males/100 ha), white spruce-aspen (42 males/100 ha), jack pine (24 males/100 ha), and in the revegetated areas (4 males/100 ha). Francis and Lumbis (1979) also found this species to be ubiquitous and common, occurring in a variety of habitats throughout their study area, in densities from 2 to 62 males/100 ha. Densities during American Birds censuses varied from 4 to 31 males/100 ha in muskeg, jack pine and spruce-aspen habitats.

Clay-colored Sparrow (Spizella pallida). Recorded on the plots in the reclamation area (28 males/100 ha) and also in black spruce-Labrador tea (3 males/100 ha), where a nest with young was found. Francis and Lumbis (1979) found this species to be common in muskeg (31-46 males/100 ha). Salt and Salt (1976) state that clay-colored sparrows may be found in dry, low shrubbery.

Savannah Sparrow (Passerculus sandwichensis). Recorded only in the revegetation plots near Poplar Creek Reservoir (60 males/100 ha). Francis and Lumbis (1979) recorded this species only on their muskeg plots (18 males/100 ha). Salt and Salt (1976) state that any long-grass meadow or open area is appropriate habitat for savannah sparrows.

Le Conte's Sparrow (Ammodramus leconteii). Recorded only on the revegetation plots (28 males/100 ha). Francis and Lumbis (1979) noted that this species was restricted to water-saturated habitats, including fens, bogs and muskeg, in their study area (2-38 males/100 ha); such habitats are completely different than that in which it was recorded in our study. Salt and Salt (1976) also indicate that Le Conte's sparrows inhabit wetter parts of bogs and grassy sites.

Song Sparrow (Melospiza melodia). Recorded only on the revegetation plots, but not in sufficient frequency to be judged territorial. Francis and Lumbis (1979) recorded this species in willow thickets and edges, primarily riparian in nature (11-35 males/100 ha). Song sparrows have also been recorded in mixed spruce-aspen forests during American Birds censuses (10-17 males/100 ha).

Lincoln's sparrow (Melospiza lincolnii). Recorded in black spruce-Labrador tea (3 males/100 ha) and in the reclamation area (8 males/100 ha). Territories in both of these vegetation types were located in areas of willow or alder growth. Francis and Lumbis (1979) also noted this species in such habitat, in densities of 5-50 males/100 ha. They also recorded Lincoln's sparrows in mixed forests (1-5 males/100 ha) and in open (treeless) bog (122 males/100 ha). Densities of 3-6 males/100 ha were recorded in muskeg habitat during American Birds censuses.

White-throated Sparrow (Zonotrichia albicollis). Recorded in black spruce-Labrador tea, aspen-white spruce and white spruce-aspen (8, 20 and 13 males/100 ha, respectively). Francis and Lumbis (1979) recorded similar densities of this species in the mixed habitats, and 55 males/100 ha in muskeg; they also recorded up to 65 males/100 ha in tall willow along a river. Densities during American Birds censuses varied from 4 males/100 ha in muskeg to 14 males/100 ha in white spruce-aspen.

Dark-eyed Junco (Junco hyemalis). Recorded in black spruce-Labrador tea (13 males/100 ha), aspen-white spruce (3 males/100 ha), white spruce-aspen (13 males/100 ha) and jack pine (12 males/100 ha). Francis and Lumbis (1979) also found this species in all forested habitats with a coniferous element (3-13 males/100 ha). Similarly, densities during American Birds censuses in these habitats ranged from 6 to 80 males/100 ha.

Red-winged Blackbird (Agelaius phoeniceus). During breeding bird censuses, recorded (non-territorially) only on one of the revegetation plots. During waterbody surveys, however, this species was regularly recorded along the shorelines, especially where cattails or bulrushes were predominant. The largest numbers were counted from mid June to mid July along Beaver Creek

Reservoir (350 birds) and Ruth Lake (180 birds). Numbers recorded during waterbody surveys decreased substantially after the end of July. Nesting data for red-winged blackbirds in the study area are presented in Sharp and Richardson (1976).

Yellow-headed Blackbird (Xanthocephalus xanthocephalus). Recorded in the cattail and bulrush marshes during waterbody surveys of Saline Lake, Beaver Creek Reservoir, Poplar Creek Reservoir, Ruth Lake, Ruth Marsh and Horseshoe Lake. No more than 30 birds were ever counted on a particular waterbody during a survey. Francis and Lumbis (1979) also considered this species to be uncommon.

Rusty Blackbird (Euphagus carolinus). Seen once in white spruce-aspen. Francis and Lumbis (1979) considered this species to have been uncommon in their study area, recording it only in muskeg (5 males/100 ha). Although rusty blackbirds are considered to nest along the borders of streams and lakes, it was rarely recorded during the waterbody surveys in the study area during the nesting season. However, flocks of rusty blackbirds were recorded on most of the waterbodies during the surveys from 16-28 September. They were most common on Saline Lake (e.g., 166 counted on 28 September).

Brewer's Blackbird (Euphagus cyanocephalus). Recorded only during a waterbody survey on Poplar Creek Reservoir (two birds on 19 June). Although this species is not considered to nest in the region (Salt and Salt 1976), Sharp and Richardson (1976) recorded territorial males on Lease 17. Brewer's blackbirds were regularly seen in the roadside vegetation in the study area.

Common Grackle (Quiscalus quiscula). Uncommonly recorded in marshy areas during waterbody surveys. The maximum seen on a waterbody during any one survey was six birds. Common grackles often nest in tall conifers in wet areas, and often in loose colonies (Salt and Salt 1976). Francis and Lumbis (1979) recorded this species only on a plot in sedge fen (39 males/100 ha).

Brown-headed Cowbird (Molothrus ater). Recorded in the aspen-white spruce and jack pine vegetation types. Since this species is a parasitic layer and non-territorial, no estimate of its breeding status could be obtained.

Francis and Lumbis (1979) considered it to be uncommon in their study area. Cowbirds were occasionally seen in marshes along the shores of some lakes during the waterbody surveys.

Northern Oriole (Icterus galbula). Recorded in aspen-white spruce (3 males/100 ha). A male and female were seen together on one occasion. This species is considered to be a wanderer in this area, its northern breeding limit being about 275 km to the south.

Pine Grosbeak (Pinicola enucleator). On 10 June, a flock of 12 pine grosbeaks flew over one of the black spruce-Labrador tea plots and a single male and single female were seen separately on the same plot. This species is not considered to nest in the study area (Salt and Salt 1976), and was not recorded by Francis and Lumbis (1979).

Purple Finch (Carpodacus purpureus). Recorded in aspen-white spruce (3 males/100 ha). Francis and Lumbis (1979) recorded a density in mixed forest of 3 males/100 ha and in muskeg of 5 males/100 ha. Salt and Salt (1976) consider the purple finch to be a local breeder in northern Alberta.

Crossbills (Loxia spp.). Both red crossbills (Loxia curvirostra) and white-winged crossbills (L. leucoptera) nest in the study area (Salt and Salt 1976). Flocks of crossbills (8-20 birds) were seen flying over black spruce-Labrador tea and aspen-white spruce during this study. One flock was identified as white-winged crossbills. There is no information on the status or numbers of the nesting populations in the study area, although singing males were recorded by Francis and Lumbis (1979).

Pine Siskin (Carduelis pinus). Recorded (non-territorial) in white spruce-aspen. Francis and Lumbis (1979) recorded singing males in a pine-dominated mixed forest but could not provide evidence of nesting. Salt and Salt (1976) state that the species nests throughout the region.

Appendix D. Methods Used to Survey Waterbodies On and Near Crown Lease 17, Northeastern Alberta, in 1984.

Waterbody	Survey Number and Method[1,2]												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Beaver Creek Reservoir	C	C	C	C	C	C	C	C	C	C	C	C	C
Poplar Creek Reservoir	C	C	M	M	M	C	C	C	C	C	C	C	C
Ruth Marsh	S	S	S	S	S	S	S	S	S	S	S	S	S
Ruth Lake and Diversion Canals	C	C	C	C	C	C	C	C	C	C	C	C	C
Mildred Lake	M	M	M	M	M	M	C/M	C/M	C/M	M	M	M	M
Loon Pond	S	S	S	S	S	S	S	S	S	S	S	S	S
Syncrude Site Water Areas	S	S	S	S	S	S	S	S	S	S	S	S	S
Lower Camp Sedimentation Basin	S	S	S	S	S	S	S	S	S	S	S	S	S
Horseshoe Lake	C	C	C	C	C	C	C	C	C	C	C	C	C
Saline Lake	Not surveyed	C	M	M	M	C	C	C	C	C	C	C	C

1 C = Canoe
M = Motor boat
S = Telescope/binoculars from shore

2 See text for dates of surveys.

Appendix E. Physical and Vegetational Characteristics of the Syncrude Site Water Areas (SSWAs). Locations of the waterbodies are presented in Figure 3.2.

SSWA 1. Long narrow waterbody between Beaver Creek Dam and mine dike. Heavy growth of cattails with some sedge and willow. Beaver dam at one end. Area of about 0.8 ha.

SSWA 2A/B. Excavated pits between Beaver Creek Dam and mine dike. Mainly grassy/weedy banks, but some clumps of cattails. Area of about 1.2 ha.

SSWA 3. Pit as above, with narrow ring of cattails and willows bordering one narrow arm. Area of about 0.3 ha.

SSWA 4. Excavated pit with weedy shoreline; clumps of cattails. Area of about 0.3 ha.

SSWA 5. Deep new borrow pit, unvegetated. Area of about 0.4 ha.

SSWA 6. Shallow scrape with indistinct shoreline. Cattails, some rushes, and sedges throughout. Scattered willows on bank. Area of about 0.4 ha.

SSWA 7A. Small pit adjacent to and north of 7B. Steep woody banks, small clumps of cattails. Area of about 0.3 ha.

SSWA 7B. Deep excavated pit with steep, mostly unvegetated banks. No emergents. Area of about 0.3 ha.

SSWA 8. Beaver pond in sedge meadow with scattered willows. Ringed by narrow band of cattails. Area of about 2.5 ha.

SSWA 9A. Beaver pond with extensive cattail marsh on three sides (all sides except dam). Area of about 0.3 ha.

SSWA 9B. Beaver pond below 9A. Emergents, mainly sedges, with extensive clumps of cattails. Area of about 0.3 ha.

SSWA 10. Shallow borrow pit with indistinct shoreline. Surrounded by cattails with some extending into centre. Area of about 0.2 ha.

SSWA 11. Borrow pit ringed by cattails. Area of about 0.3 ha.

SSWA 12. Borrow pit ringed by cattails. Horseshoe-shaped with weed-covered hump in centre. Area of about 0.3 ha.

SSWA 13. Borrow pit ringed by cattails. Area of about 0.2 ha.

Continued...

Appendix E. Continued.

SSWA 14.	Beaver pond in mixed woods. Mixed cattail/sedge along parts of shore; also alder and aspen regeneration. Area of about 4.5 ha.
SSWA 15-23.	Borrow pits ringed by cattails. Total area of about 4.3 ha.
SSWA 24.	Small borrow pit nearly filled in by cattails. Area of about 0.3 ha.
SSWA 25.	Borrow pit ringed by cattails. Area of about 0.3 ha.

Appendix F. Numbers of waterbirds recorded during waterbody surveys on Beaver Creek Reservoir, June-October 1984.

Species	Survey Number and Date													
	1 15 Jun	2 22 Jun	3 28 Jun	4 13 Jul	5 21 Jul	6 30 Jul	7 10 Aug	8 18 Aug	9 28 Aug	10 10 Sep	11 19 Sep	12 27 Sep	13 7 Oct	All Surveys
Common loon	4	6	6	9	5	8	4	4	4	2	4	1	1	58
Pied-billed grebe	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Horned grebe	0	0	0	2	1	0	1	0	1	33	8	1	2	49
Red-necked grebe	19	19	20	26	20	13	7	9	19	56	9	2	2	221
American white pelican	0	0	0	0	0	0	0	0	0	0	0	2	1	3
American bittern	1	1	1	2	0	0	0	1	1	5	1	0	0	13
Great blue heron	0	0	0	0	1	5	1	1	2	0	0	0	1	11
Tundra swan	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Greater white-fronted goose	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Canada goose	0	0	2	1	6	1	1	0	5	3	0	0	0	19
Green-winged teal	24	18	34	35	5	15	161	44	79	89	47	24	2	577
Mallard	162	67	183	82	72	214	333	388	295	160	153	208	105	2422
Northern pintail	6	1	23	5	0	0	2	83	65	8	7	1	0	201
Blue-winged teal	29	9	52	4	7	23	80	44	21	20	15	2	3	309
Cinnamon teal	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Teal spp.	4	2	0	0	0	9	27	10	17	3	0	3	0	75
Northern shoveler	25	15	37	2	1	5	13	2	14	42	15	11	5	187
Gadwall	7	3	13	31	9	43	13	0	1	13	5	11	2	151
American wigeon	35	87	295	250	178	127	207	204	75	146	29	23	0	1656
Unid. dabbling duck	11	11	0	0	0	0	0	52	43	0	0	0	0	117
Canvasback	1	2	0	0	0	0	0	0	0	4	6	0	0	13
Redhead	0	0	0	0	0	0	0	0	0	5	0	0	0	5
Ring-necked duck	30	6	24	8	4	3	6	2	0	3	3	3	1	93
Scaup spp.	0	12	0	0	7	6	0	0	13	936	83	27	0	1084
Common goldeneye	2	0	0	1	1	3	7	0	3	8	0	2	0	27
Bufflehead	0	9	7	0	0	0	7	7	7	20	2	7	0	66
Hooded merganser	0	0	0	0	0	0	0	0	0	0	0	11	0	11
Common merganser	0	0	0	0	0	0	0	0	0	1	8	0	0	9
Red-breasted merganser	0	0	0	0	0	0	0	0	0	0	3	0	0	3
Merganser spp.	0	0	0	0	0	0	0	0	0	0	18	2	6	26
Ruddy duck	0	0	0	0	0	0	0	0	0	11	0	0	0	11
Unid. diving duck	0	0	0	0	4	0	0	0	0	0	0	0	0	4
Unid. duck	0	0	1	151	0	5	1	30	0	0	3	0	0	191
Sora	1	1	1	0	1	0	0	0	0	0	0	0	0	4
American coot	21	11	13	12	0	28	80	97	132	1020	451	147	26	2038
Sandhill crane	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Black-bellied plover	0	0	0	0	0	0	0	0	0	5	19	3	1	28
Semipalmated plover	0	0	0	0	0	0	15	6	0	0	0	0	0	21
Killdeer	1	1	0	5	3	4	7	20	6	11	0	0	0	58
Yellowlegs spp.	10	32	17	12	26	35	223	148	124	43	19	24	11	724
Solitary sandpiper	0	0	0	0	0	1	0	0	1	0	0	0	0	2
Spotted sandpiper	4	8	1	5	1	5	13	2	7	2	1	0	0	49
Semipalmated sandpiper	0	0	0	5	7	0	3	0	0	1	0	0	0	16
Least sandpiper	0	0	0	0	4	0	0	0	0	2	0	0	0	6
Baird's sandpiper	0	0	0	3	7	0	0	3	0	0	0	0	0	13
Unid. "peep" sandpiper	0	0	0	10	27	29	291	170	33	3	5	0	0	568
Pectoral sandpiper	0	0	0	0	3	5	28	5	0	31	12	8	1	93
Dowitcher spp.	0	0	0	14	8	7	10	8	0	21	23	16	1	108
Common snipe	4	0	2	1	0	3	7	7	24	14	5	4	0	71
Bonaparte's gull	0	3	9	6	7	2	5	7	0	9	0	0	0	48
Ring-billed gull	0	2	0	0	0	0	0	0	20	8	13	1	1	45
California/herring gull	5	9	5	3	0	4	10	30	0	0	3	1	0	70
Common tern	3	9	3	1	2	2	0	0	0	0	0	0	0	20
Black tern	0	0	5	5	8	0	31	1	0	0	0	0	0	50
TOTAL WATERBIRDS	411	344	755	691	425	605	1594	1385	1012	2738	972	545	176	11,653

Appendix G. Numbers of waterbirds recorded during waterbody surveys on Saline Lake, June-October 1984.

Species	Survey Number and Date													All Surveys
	1[a]	2 20 Jun	3 28 Jun	4 11 Jul	5 19 Jul	6 28 Jul	7 9 Aug	8 17 Aug	9 25 Aug	10 8 Sep	11 20 Sep	12 28 Sep	13 9 Oct	
Common loon	-	2	0	0	0	0	1	0	0	0	0	0	0	3
Pied-billed grebe	-	0	0	1	0	0	0	0	0	0	0	0	0	1
Horned grebe	-	2	0	0	1	0	0	0	0	12	0	0	0	15
Red-necked grebe	-	0	0	0	1	0	0	0	1	0	0	0	0	2
Tundra swan	-	0	0	0	0	0	0	0	0	0	0	0	1	1
Green-winged teal	-	10	2	7	0	30	151	50	120	1	127	14	3	515
Mallard	-	36	21	23	28	81	314	67	82	120	285	419	328	1804
Northern pintail	-	4	5	3	1	2	19	122	109	29	28	5	1	328
Blue-winged teal	-	12	10	5	5	1	50	71	56	41	19	2	0	272
Northern shoveler	-	2	2	11	3	5	50	19	12	20	17	0	0	141
Gadwall	-	13	6	9	0	0	1	0	0	0	4	0	0	33
American wigeon	-	81	37	64	44	46	51	152	235	156	144	332	28	1370
Unid. dabbling duck	-	0	0	1	3	1	149	8	20	0	0	0	0	182
Canvasback	-	8	8	2	4	12	0	0	0	2	0	0	0	36
Redhead	-	32	2	23	0	0	0	0	0	0	0	0	0	57
Ring-necked duck	-	0	61	11	4	13	7	12	0	0	62	5	0	175
Scaup spp.	-	52	39	37	119	48	0	0	1	195	80	730	0	1301
Common goldeneye	-	48	58	23	8	73	124	124	87	31	13	9	8	606
Bufflehead	-	19	27	22	25	21	25	29	20	56	11	16	3	274
Common merganser	-	1	0	0	0	0	0	0	0	0	0	0	0	1
Ruddy duck	-	3	7	1	3	0	0	0	0	0	1	0	0	15
Unid. diving duck	-	0	0	0	6	0	0	64	2	0	0	0	0	72
Unid. duck	-	0	12	0	0	0	0	0	0	0	0	0	0	12
Sora	-	1	0	0	0	1	0	0	0	0	0	0	0	2
American coot	-	22	14	4	2	0	8	20	48	20	2	3	0	143
Killdeer	-	0	0	1	0	0	0	0	0	0	0	0	0	1
Yellowlegs spp.	-	4	18	7	0	18	30	0	6	0	0	0	0	83
Spotted sandpiper	-	0	0	3	3	2	9	6	4	0	0	0	0	27
Least sandpiper	-	0	0	0	0	0	0	0	1	0	0	0	0	1
Unid. "peep" sandpiper	-	25	0	0	0	0	69	0	0	0	0	0	0	94
Stilt sandpiper	-	0	0	0	0	0	3	0	0	0	0	0	0	3
Dowitcher spp.	-	0	0	3	0	6	3	0	1	0	0	0	0	13
Wilson's phalarope	-	2	0	0	1	0	1	5	30	0	0	0	0	39
Bonaparte's gull	-	1	1	3	0	0	2	7	6	0	0	0	0	20
Ring-billed gull	-	0	0	0	0	0	0	0	0	0	2	0	0	2
California/herring gull	-	5	0	0	0	0	0	0	3	0	0	0	0	8
Black tern	-	10	5	10	19	10	26	27	0	0	0	0	0	107
TOTAL WATERBIRDS	-	395	335	274	280	370	1093	783	844	683	795	1535	372	7759

[a] Not surveyed.

Appendix H. Numbers of waterbirds recorded during waterbody surveys on Horseshoe Lake, June-October 1984.

Species	Survey Number and Date													
	1 13 Jun	2 21 Jun	3 29 Jun	4 12 Jul	5 20 Jul	6 29 Jul	7 10 Aug	8 16 Aug	9 26 Aug	10 9 Sep	11 18 Sep	12 28 Sep	13 8 Oct	All Surveys
Pied-billed grebe	0	0	0	0	0	2	0	0	0	0	0	0	0	2
Horned grebe	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Red-necked grebe	4	0	2	2	0	1	0	0	3	0	0	0	0	12
Green-winged teal	0	2	7	7	12	46	5	2	5	2	30	2	0	120
Mallard	15	14	24	73	39	45	194	197	181	116	141	116	120	1275
Northern pintail	0	0	2	0	0	0	0	0	28	10	17	0	0	57
Blue-winged teal	12	20	26	5	3	10	28	45	79	16	28	2	9	283
Teal spp.	0	0	0	0	0	0	10	0	0	0	0	0	0	10
Northern shoveler	0	2	1	3	0	0	1	0	1	0	2	0	0	10
Gadwall	0	2	0	0	0	0	0	0	0	4	3	9	19	37
American wigeon	54	41	38	24	31	13	16	45	7	72	383	35	7	766
Unid. dabbling duck	0	0	0	0	2	0	0	2	1	0	0	0	0	5
Canvasback	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Ring-necked duck	9	29	7	12	7	4	1	13	1	8	10	7	7	115
Scaup spp.	40	0	0	35	0	0	0	0	0	38	26	59	38	236
Common goldeneye	4	3	1	1	1	0	2	6	2	1	4	2	0	27
Bufflehead	11	1	6	8	3	1	12	0	6	2	28	1	6	85
Ruddy duck	13	0	0	0	1	3	2	0	0	10	1	0	0	30
Unid. diving duck	0	0	0	0	4	0	0	0	20	1	0	0	0	25
Unid. duck	0	0	0	0	0	0	0	2	0	0	0	0	0	2
Sora	0	1	0	1	0	0	0	0	0	0	0	0	0	2
American coot	137	46	52	25	71	58	37	23	77	225	307	307	119	1484
Killdeer	0	1	2	0	0	0	0	0	0	0	0	0	0	3
Yellowlegs spp.	0	1	0	0	3	27	10	0	0	0	0	0	0	41
Solitary sandpiper	0	0	0	0	0	2	0	0	0	0	0	0	0	2
Spotted sandpiper	0	1	0	0	0	0	2	1	0	0	0	0	0	4
Unid. "peep" sandpiper	0	0	0	0	0	19	2	0	0	0	0	0	0	21
Dowitcher spp.	0	0	0	0	0	1	0	0	0	0	25	0	0	26
Common snipe	0	1	1	2	0	0	0	0	0	0	0	1	0	5
Wilson's phalarope	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Ring-billed gull	0	0	0	0	0	0	0	0	0	0	1	0	7	8
California/herring gull	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Black tern	104	92	60	71	59	28	11	6	0	0	0	0	0	431
TOTAL WATERBIRDS	404	257	230	269	236	258	333	342	411	506	1006	541	332	5125

Appendix I. Numbers of waterbirds recorded during waterbody surveys on Poplar Creek Reservoir, June-October 1984.

Species	Survey Number and Date													
	1 11 Jun	2 19 Jun	3 27 Jun	4 10 Jul	5 18 Jul	6 27 Jul	7 8 Aug	8 19 Aug	9 26 Aug	10 7 Sep	11 20 Sep	12 29 Sep	13 10 Oct	All Surveys
Common loon	5	2	6	5	4	5	7	2	6	1	1	3	3	50
Pied-billed grebe	1	0	0	0	0	0	0	0	0	0	2	0	0	3
Red-necked grebe	16	19	39	5	38	32	30	40	24	31	8	8	3	293
American bittern	0	0	0	0	0	0	0	3	2	0	0	0	0	5
Great blue heron	0	0	0	1	1	0	2	4	2	0	1	0	0	11
Greater white-fronted goose	0	0	0	0	0	0	0	0	5	0	0	0	0	5
Canada goose	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Green-winged teal	0	4	13	15	0	46	144	46	55	19	84	32	41	499
American black duck	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Mallard	4	32	15	69	4	24	69	21	107	33	40	21	16	455
Northern pintail	0	0	2	7	0	0	0	13	25	18	4	4	1	74
Blue-winged teal	11	11	20	4	7	4	36	1	20	33	5	4	1	157
Northern shoveler	2	10	6	38	0	0	47	3	0	1	24	2	0	133
Gadwall	2	6	2	25	1	18	3	0	0	3	0	0	0	60
American wigeon	13	41	6	8	100	14	32	7	12	101	14	5	0	353
Unid. dabbling duck	0	0	0	20	0	0	0	2	1	0	0	0	0	23
Ring-necked duck	10	3	10	3	3	5	5	6	0	2	7	0	0	54
Scaup spp.	11	8	2	4	7	0	0	0	1	13	0	1	0	47
Surf scoter	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Common goldeneye	0	1	0	1	0	0	2	0	0	8	4	12	0	28
Bufflehead	0	1	1	0	1	0	2	2	0	0	0	1	0	8
Merganser spp.	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Ruddy duck	0	1	1	0	0	0	0	0	0	0	0	0	0	2
Unid. duck	0	0	0	0	0	0	0	0	0	3	0	0	0	3
Sora	1	1	0	0	0	0	0	0	0	0	0	0	0	2
American coot	9	1	0	0	0	0	1	15	14	27	0	1	2	70
Sandhill crane	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Black-bellied plover	0	0	0	0	0	0	0	0	0	1	3	1	3	8
Lesser golden-plover	0	0	0	0	0	0	0	0	0	0	0	2	2	4
Semipalmated plover	0	0	0	0	4	2	0	0	0	0	0	0	0	6
Killdeer	2	2	2	1	0	4	8	18	4	2	0	3	1	47
Yellowlegs spp.	7	3	4	6	2	8	42	39	78	13	9	4	7	222
Solitary sandpiper	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Spotted sandpiper	6	4	2	4	3	7	3	9	5	3	0	0	0	46
Semipalmated sandpiper	0	0	0	0	0	2	13	0	0	0	0	0	0	15
Western sandpiper	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Baird's sandpiper	0	0	0	0	7	3	10	0	0	0	1	0	0	21
Unid. "peep" sandpiper	0	0	0	0	0	21	233	100	21	27	0	0	0	402
Pectoral sandpiper	0	0	0	0	0	1	16	12	0	22	41	26	10	128
Stilt sandpiper	0	0	0	0	0	1	2	0	0	0	0	0	0	3
Dowitcher spp.	0	0	0	0	1	23	18	21	0	1	45	3	1	113
Common snipe	0	1	2	0	0	0	0	12	1	0	0	10	0	26
Wilson's phalarope	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Bonaparte's gull	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Ring-billed gull	0	0	0	0	0	0	0	0	1	5	8	9	5	28
California/herring gull	0	0	2	1	0	3	7	4	2	0	0	1	0	20
Common tern	0	0	0	3	8	2	0	0	0	0	0	0	0	13
Black tern	20	28	29	9	5	57	22	0	0	0	0	0	0	170
TOTAL WATERBIRDS	123	179	164	232	197	283	754	380	387	368	303	153	97	3620

Appendix J. Numbers of waterbirds recorded during waterbody surveys on Ruth Lake, June-October 1984.

Species	Survey Number and Date													All Surveys
	1 12 Jun	2 19 Jun	3 27 Jun	4 10 Jul	5 18 Jul	6 27 Jul	7 8 Aug	8 18 Aug	9 28 Aug	10 7 Sep	11 19 Sep	12 27 Sep	13 7 Oct	
Common loon	4	4	2	5	2	2	2	2	2	0	0	0	0	25
Pied-billed grebe	0	0	0	0	0	0	0	0	0	0	1	0	2	3
Red-necked grebe	6	17	14	23	18	20	8	0	2	1	1	0	0	110
Great blue heron	0	0	0	0	0	0	0	0	0	2	0	0	0	2
Green-winged teal	3	1	0	2	2	0	15	9	7	12	0	0	0	51
Mallard	10	2	7	27	8	31	92	56	35	69	14	102	176	629
Northern pintail	0	0	0	1	0	0	4	16	53	12	26	0	1	113
Blue-winged teal	12	14	2	2	4	1	3	29	56	54	37	1	0	215
Teal spp.	0	1	0	0	0	1	0	10	4	3	0	0	0	19
Northern shoveler	2	5	1	3	0	0	12	10	13	6	0	6	3	61
Gadwall	0	0	0	0	0	0	1	2	5	0	0	1	13	22
American wigeon	5	4	2	22	5	4	144	172	237	22	7	21	3	648
Unid. dabbling duck	0	0	0	0	1	0	0	0	1	0	0	0	0	2
Canvasback	0	0	0	0	0	0	0	0	0	0	1	1	0	2
Redhead	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Ring-necked duck	17	22	23	17	1	0	0	0	1	3	19	2	0	105
Scaup spp.	0	0	12	1	10	27	0	0	10	17	6	0	33	116
Common goldeneye	0	0	0	0	3	0	0	4	1	7	0	0	12	27
Bufflehead	1	0	2	0	0	3	0	2	4	10	0	0	0	22
Hooded merganser	0	0	0	0	0	0	0	0	0	0	0	11	2	13
Ruddy duck	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Unid. duck	1	0	2	0	0	0	0	0	0	6	0	0	0	9
Sora	0	0	0	0	0	1	0	0	0	0	0	0	0	1
American coot	0	1	0	4	3	0	0	0	1	1	9	20	15	54
Semipalmated plover	0	0	0	0	0	0	0	0	3	0	0	0	0	3
Killdeer	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Yellowlegs spp.	3	1	1	1	0	0	124	46	16	1	1	1	0	195
Solitary sandpiper	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Spotted sandpiper	1	1	0	1	0	0	0	0	0	0	0	0	0	3
White-rumped sandpiper	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Unid. "peep" sandpiper	0	0	0	0	0	0	17	44	2	0	0	0	0	63
Stilt sandpiper	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Dowitcher spp.	0	0	0	0	0	0	3	0	0	0	0	0	0	3
Common snipe	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Wilson's phalarope	0	0	0	0	0	0	4	0	0	0	0	0	0	4
Bonaparte's gull	1	0	1	1	2	0	0	0	0	0	0	0	0	5
Ring-billed gull	0	0	0	0	0	0	0	0	0	4	9	0	0	13
California/herring gull	0	1	3	2	0	3	2	1	1	2	0	1	0	16
Common tern	0	1	2	0	0	0	0	0	0	0	0	0	0	3
Black tern	0	10	3	22	22	45	53	0	3	0	0	0	0	158
TOTAL WATERBIRDS	67	86	78	134	83	139	486	403	457	232	133	167	262	2725

Appendix K. Numbers of waterbirds recorded during waterbody surveys on the Diversion Canals north and south of Ruth Lake, June-October 1984.

Species	Survey Number and Date													All Surveys
	1 12 Jun	2 19 Jun	3 27&28 Jun	4 10&13 Jul	5 18&21 Jul	6 27 Jul	7 8&10 Aug	8 18 Aug	9 28 Aug	10 7&10 Sep	11 19 Sep	12 27 Sep	13 7 Oct	
Common loon	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Red-necked grebe	0	0	0	1	1	0	0	0	0	0	0	0	0	2
American bittern	0	0	1	2	1	2	0	0	0	0	0	0	0	6
Great blue heron	0	0	0	0	0	1	0	0	1	2	0	0	0	4
Tundra swan	0	0	0	0	0	0	0	0	0	0	0	0	4	4
Canada goose	2	0	0	0	1	0	0	0	0	0	0	0	0	3
Green-winged teal	17	0	1	0	0	0	3	2	4	0	0	0	0	27
Mallard	10	0	0	2	1	1	20	59	13	9	7	10	3	135
Northern pintail	4	0	1	0	0	0	0	0	0	0	0	0	0	5
Blue-winged teal	36	9	1	0	2	0	0	4	3	2	8	0	0	65
Teal spp.	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Northern shoveler	14	2	0	0	0	0	0	2	1	5	3	0	0	27
Gadwall	5	0	0	0	0	0	0	0	0	0	1	0	1	7
American wigeon	19	6	2	3	7	1	0	5	1	0	0	0	0	44
Ring-necked duck	5	1	1	0	1	1	0	0	0	2	5	1	0	17
Scaup spp.	2	2	0	0	0	0	0	0	0	1	0	0	0	5
Common goldeneye	0	0	0	0	0	0	3	5	4	6	2	6	1	27
Bufflehead	0	0	0	0	0	0	3	0	0	1	2	0	0	6
Common merganser	0	0	0	0	0	0	0	0	0	4	0	0	0	4
Merganser spp.	0	0	0	0	0	1	3	0	0	0	0	0	0	4
Ruddy duck	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Sora	1	0	0	0	0	0	0	0	0	0	0	0	0	1
American coot	2	0	0	0	0	0	0	0	0	0	0	1	1	4
Yellowlegs spp.	12	2	0	8	3	12	28	23	4	4	1	0	3	100
Solitary sandpiper	0	0	0	3	1	1	3	0	1	0	0	0	0	9
Spotted sandpiper	5	1	1	1	0	0	3	2	2	3	0	0	0	18
Unid. "peep" sandpiper	0	0	0	0	0	0	0	3	0	0	0	0	0	3
Common snipe	0	1	0	1	0	0	0	0	0	0	2	0	0	4
Wilson's phalarope	3	0	0	0	0	0	0	0	0	0	0	0	0	3
Bonaparte's gull	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Common tern	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Black tern	2	3	1	1	0	1	25	0	0	0	0	0	0	33
TOTAL WATERBIRDS	140	27	10	23	18	22	91	105	34	39	32	18	13	572

Appendix L. Numbers of waterbirds recorded during waterbody surveys on the Syncrude Site Water Areas, June-October 1984.

Species	Survey Number and Date													
	1 10&12 Jun	2 18&21 Jun	3 26&27 Jun	4 9&12 Jul	5 17&20 Jul	6 26&29 Jul	7 7&9 Aug	8 16&17 Aug	9 25 Aug	10 6&9 Sep	11 16&17 Sep	12 26 Sep	13 6 Oct	All Surveys
Common loon	3	2	3	0	0	2	0	1	1	0	0	0	0	12
Horned grebe	2	1	2	3	4	3	1	4	0	0	0	0	0	20
Red-necked grebe	2	2	2	2	2	2	2	2	1	0	0	0	0	17
Great blue heron	0	0	0	0	0	0	1	0	1	8	0	0	0	10
Canada goose	1	0	0	0	0	0	0	0	0	0	0	0	1	3
Green-winged teal	4	8	7	2	4	5	15	101	69	8	3	2	0	228
Mallard	10	5	7	12	10	13	12	8	69	8	11	27	25	217
Northern pintail	0	1	0	0	2	0	3	102	52	0	0	0	0	160
Blue-winged teal	15	12	13	13	4	4	1	2	8	0	0	0	0	72
Teal spp.	0	0	0	0	0	0	6	0	0	0	0	0	0	6
Northern shoveler	1	3	4	3	1	1	0	4	13	3	0	0	0	33
Gadwall	3	4	0	7	6	0	0	1	0	0	1	5	0	27
American wigeon	10	9	4	3	1	11	7	15	13	0	29	0	0	102
Ring-necked duck	4	3	7	5	5	7	3	5	4	4	10	11	1	69
Scaup spp.	0	0	0	0	0	0	0	0	0	0	4	10	0	14
Common goldeneye	6	5	7	9	3	3	6	1	2	6	0	0	0	48
Bufflehead	16	10	18	13	17	6	16	3	3	10	1	0	0	113
Ruddy duck	0	0	0	0	2	0	0	0	0	0	0	0	0	2
Sora	2	2	2	5	3	0	0	0	0	1	0	0	0	15
American coot	5	3	1	8	7	1	1	6	6	4	2	0	0	44
Black-bellied plover	0	0	0	0	0	0	0	0	0	8	22	7	7	44
Lesser golden-plover	0	0	0	0	0	0	0	0	0	0	0	4	0	4
Mongolian plover	0	1	0	0	0	0	0	0	0	0	0	0	0	5
Semipalmated plover	0	0	0	0	2	3	0	0	0	0	0	0	0	1
Killdeer	5	12	9	11	10	9	5	1	0	0	0	0	1	63
Yellowlegs spp.	2	4	7	16	22	27	10	38	5	5	3	1	0	140
Solitary sandpiper	2	1	2	4	2	4	3	1	0	0	0	0	0	19
Spotted sandpiper	8	17	15	24	11	8	12	6	0	1	0	0	0	102
Sanderling	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Semipalmated sandpiper	0	0	0	9	10	2	0	0	3	0	1	0	0	25
Least sandpiper	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Baird's sandpiper	0	0	0	0	4	6	1	0	1	0	0	0	0	12
Unid. "peep" sandpiper	0	1	0	4	21	0	4	34	6	0	1	0	0	71
Pectoral sandpiper	0	0	0	0	4	3	1	10	0	0	0	0	0	18
Stilt sandpiper	0	0	0	0	4	1	0	0	0	0	0	0	0	5
Dowitcher spp.	0	1	0	5	4	0	2	2	0	0	1	0	1	16
Common snipe	5	3	2	1	0	0	0	0	0	0	0	0	0	11
Wilson's phalarope	1	4	3	0	5	0	0	0	5	0	0	0	0	18
Bonaparte's gull	2	4	0	2	0	2	0	0	0	0	0	0	0	10
Black tern	0	0	3	2	5	3	0	0	0	0	0	0	0	13
TOTAL WATERBIRDS	109	118	118	163	176	126	112	347	262	66	89	68	35	1789

Appendix M. Numbers of waterbirds recorded during waterbody surveys on Ruth Marsh, June-October 1984.

Species	Survey Number and Date													All Surveys
	1 12 Jun	2 20 Jun	3 26 Jun	4 9 Jul	5 17 Jul	6 26 Jul	7 7 Aug	8 17 Aug	9 25 Aug	10 6 Sep	11 16 Sep	12 26 Sep	13 6 Oct	
Pied-billed grebe	0	1	0	0	0	1	0	0	0	0	0	0	0	2
Horned grebe	0	0	0	1	0	0	0	0	0	0	0	0	0	1
American bittern	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Green-winged teal	0	7	17	3	4	0	1	0	0	28	2	13	0	75
Mallard	0	2	4	1	0	4	0	3	0	12	18	14	11	69
Northern pintail	0	1	0	0	0	0	2	0	0	3	1	0	0	7
Blue-winged teal	0	3	4	1	0	0	0	0	0	10	5	0	0	23
Teal spp.	0	0	0	0	0	0	0	0	0	3	0	0	2	5
Northern shoveler	2	12	10	0	7	1	0	0	0	10	1	0	0	43
Gadwall	0	2	0	3	0	0	0	1	0	0	0	0	0	6
American wigeon	1	16	10	12	10	1	0	0	0	1	5	0	0	56
Canvasback	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Redhead	0	0	0	0	13	0	0	0	0	0	0	0	0	13
Ring-necked duck	9	7	0	1	0	0	0	0	0	0	0	0	0	17
Bufflehead	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Ruddy duck	4	1	2	1	0	0	0	0	0	0	0	0	0	8
Sora	0	1	0	0	0	0	0	0	0	0	0	0	0	1
American coot	7	12	11	10	3	7	0	0	0	0	0	0	0	50
Black-bellied plover	0	0	0	0	0	0	0	0	0	2	15	0	0	17
Killdeer	0	0	0	0	1	1	0	0	0	2	0	0	0	4
Yellowlegs spp.	0	1	5	2	7	15	0	4	2	4	4	1	1	46
Spotted sandpiper	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Unid. "peep" sandpiper	0	0	0	0	0	0	25	3	0	0	0	5	0	33
Dowitcher spp.	0	0	0	0	4	0	0	0	0	2	20	0	0	26
Common snipe	1	0	1	0	0	0	0	0	0	0	0	0	0	2
Common tern	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Black tern	1	0	0	6	4	0	0	0	0	0	0	0	0	11
TOTAL WATERBIRDS	29	65	66	41	53	30	28	11	2	77	71	33	14	520

Appendix N. Numbers of waterbirds recorded during waterbody surveys on Mildred Lake, June-October 1984.

Species	Survey Number and Date													
	1 10 Jun	2 18 Jun	3 26 Jun	4 9 Jul	5 17 Jul	6 26 Jul	7 7 Aug	8 17 Aug	9 25 Aug	10 8 Sep	11 18 Sep	12 26 Sep	13 6 Oct	All Surveys
Common loon	3	1	2	3	2	1	2	3	2	1	3	0	1	24
Horned grebe	4	4	5	6	6	3	2	1	3	0	3	0	0	3
Red-necked grebe	1	0	0	0	0	0	0	0	0	1	2	2	0	39
Great blue heron	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Green-winged teal	1	0	0	0	0	0	0	0	0	1	0	0	0	2
Mallard	0	0	0	0	0	2	4	4	0	0	0	10	0	20
Northern pintail	0	0	0	0	0	0	0	0	0	2	0	0	0	2
Blue-winged teal	0	0	0	0	0	0	3	0	0	0	0	1	0	4
Northern shoveler	0	0	0	0	0	0	0	0	0	0	0	2	0	2
Gadwall	0	0	0	0	0	0	0	0	0	1	0	0	0	1
American wigeon	0	1	0	7	5	10	5	2	3	0	0	4	0	37
Ring-necked duck	0	0	0	0	0	0	1	0	1	0	2	5	0	9
Scaup spp.	0	0	0	3	0	0	0	0	0	0	1	0	0	4
Surf scoter	0	0	0	0	0	0	0	0	0	1	0	0	0	1
White-winged scoter	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Common goldeneye	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Bufflehead	0	0	0	0	0	0	3	0	0	0	0	0	0	3
Unid. diving duck	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Sora	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Yellowlegs spp.	0	0	0	2	0	0	0	1	0	0	0	0	0	3
Spotted sandpiper	7	8	10	9	0	2	12	6	2	5	2	0	0	63
Baird's sandpiper	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Unid. "peep" sandpiper	0	0	0	0	0	0	46	5	0	0	0	0	0	51
Pectoral sandpiper	0	0	0	0	0	0	2	0	0	0	0	0	0	2
Stilt sandpiper	0	0	0	5	0	0	0	0	0	0	0	0	0	5
Bonaparte's gull	13	1	1	4	1	0	0	0	0	0	0	0	0	20
Ring-billed gull	0	0	0	0	0	0	0	0	0	1	3	0	0	4
California/herring gull	8	0	1	4	2	2	1	1	9	0	0	5	0	33
Common tern	1	0	0	2	1	1	0	0	0	0	0	0	0	5
TOTAL WATERBIRDS	38	17	19	49	17	22	81	23	21	13	16	29	1	346

Appendix O. Average numbers of adult waterbird species observed during surveys of various waterbodies in 1974, 1975, 1977 and 1984.

	Early Summer			Mid Summer			Late Summer			Autumn		
Species	1975	1977	1984	1974	1975	1984	1974	1975	1984	1974	1975	1984
Common loon	10.5	15.7	18.7	11.6	14.5	16.0	4.7	6.0	10.6	0.7	2.4	5.7
Pied-billed grebe	-	23.5	0.3	-	0.1	1.0	-	0.2	-	0.2	-	2.3
Horned grebe	1.0	45.3	3.0	0.4	1.0	3.4	1.8	0.4	12.6	1.4	0.3	5.0
Eared grebe	0.1	0.7	-	0.3	-	-	-	0.3	-	-	3.5	-
Red-necked grebe	36.7	96.0	69.3	34.0	42.8	68.2	11.0	25.8	64.4	1.7	4.8	12.3
American white pelican	-	-	-	-	-	-	-	-	-	-	-	1.0
American bittern	1.8	2.3	2.3	-	0.4	1.0	-	0.3	3.0	0.2	-	0.3
Great blue heron	0.2	-	0.3	-	-	3.9	-	0.2	8.0	-	-	1.0
Tundra swan	-	-	-	-	-	-	-	-	-	-	-	1.7
Greater white-fronted goose	-	-	-	-	-	-	-	0.3	1.7	-	0.3	1.0
Snow goose	-	-	-	-	-	-	-	0.6	-	-	-	-
Canada goose	-	0.7	1.0	-	-	2.6	-	12.3	2.0	-	2.7	0.3
Green-winged teal	15.3	114.0	61.1	47.4	109.2	161.0	25.1	79.2	194.9	2.7	20.8	94.0
American black duck	-	-	-	-	-	-	-	-	0.3	-	-	-
Mallard	41.0	332.2	225.0	72.6	99.0	397.9	482.0	378.0	615.4	204.4	180.2	450.3
Northern pintail	1.4	39.0	15.0	17.6	54.7	4.3	36.2	118.1	163.4	14.0	22.1	20.7
Blue-winged teal	12.7	245.3	75.3	0.9	9.8	73.5	3.0	32.2	148.9	11.8	1.9	40.3
Cinnamon teal	-	-	0.3	-	-	-	-	-	-	-	-	-
Northern shoveler	22.6	235.7	52.3	4.6	40.5	29.7	2.9	112.5	43.2	1.9	16.6	24.7
Gadwall	0.4	64.1	32.8	0.7	0.2	31.3	-	0.2	9.2	0.2	-	23.7
American wigeon	18.4	186.9	297.7	11.3	23.4	309.8	6.2	220.9	380.0	35.5	80.4	188.3
Canvasback	1.3	-	1.0	0.3	1.0	-	-	-	1.3	2.0	-	2.7
Redhead	-	22.2	-	-	0.3	4.3	0.3	0.2	1.7	0.1	0.1	0.7
Ring-necked duck	59.4	87.6	63.8	38.8	29.8	18.6	2.4	94.3	18.3	4.2	130.7	31.3
Scaup spp.	31.9	41.8	26.4	-	13.3	18.9	47.2	116.1	343.0	671.0	486.4	93.3
Surf scoter	-	-	-	-	-	-	-	-	0.3	0.3	0.9	0.3
White-winged scoter	-	0.3	0.3	-	-	-	-	-	-	3.3	0.6	-
Common goldeneye	8.9	20.3	10.0	-	16.2	12.0	-	68.9	22.1	-	36.9	15.3
Bufflehead	18.8	19.7	28.3	26.4	16.0	25.2	21.2	57.0	25.7	15.5	43.3	16.0
Hooded merganser	-	-	-	-	-	-	-	-	-	-	-	8.0
Common merganser	0.3	0.7	-	-	0.4	-	-	0.4	1.6	-	-	2.7
Red-breasted merganser	-	1.3	-	-	-	-	0.5	0.2	-	-	0.4	1.0
Ruddy duck	0.5	20.3	2.3	-	0.8	2.6	0.5	1.4	7.0	4.5	0.3	0.3
Sora	16.0	33.0	5.3	5.6	2.9	1.6	0.3	0.1	0.3	-	-	-
American coot	12.9	239.4	70.0	-	3.1	98.9	3.0	1213.8	549.3	121.9	1727.3	469.3
Sandhill crane	3.5	30.1	-	-	20.3	-	0.8	4.3	-	-	-	-
Whooping crane	-	-	-	-	-	-	0.3	-	-	0.3	-	-
Black-bellied plover	-	-	-	0.1	0.2	-	0.3	5.7	5.3	0.2	0.9	27.3
Lesser golden-plover	0.1	-	-	0.5	-	-	0.2	3.1	-	-	0.4	2.7
Mongolian plover	-	-	0.3	-	-	-	-	-	-	-	-	-
Semipalmated plover	-	-	-	4.6	0.8	8.6	1.9	2.1	2.0	-	-	-
Killdeer	28.4	65.7	17.0	14.6	20.5	17.3	1.5	8.4	21.3	0.1	-	2.3
American avocet	-	9.3	-	-	-	-	-	-	-	-	-	-
Yellowlegs spp.	98.7	131.4	43.3	83.4	129.8	207.9	7.4	30.3	208.8	1.2	6.6	30.0
Solitary sandpiper	5.0	-	3.3	4.2	1.4	6.2	0.2	0.3	0.9	-	-	-
Spotted sandpiper	24.1	65.0	42.3	19.6	22.6	29.1	3.3	9.5	18.9	-	0.3	1.3
Upland sandpiper	-	-	-	-	-	-	-	0.1	-	-	0.2	-
Hudsonian godwit	-	2.0	-	-	-	-	-	-	-	-	-	-
Ruddy turnstone	-	-	-	-	-	-	0.1	-	-	-	-	-
Sanderling	-	-	-	-	4.8	-	-	3.9	-	-	0.2	0.3
Semipalmated sandpiper	0.7	20.0	4.7	11.2	6.1	12.3	0.9	2.5	0.3	-	-	0.3
Western sandpiper	-	-	-	-	-	0.3	-	-	-	-	-	-
Least sandpiper	1.5	3.0	-	12.1	8.2	1.6	3.8	9.6	0.7	0.2	-	-
White-rumped sandpiper	-	-	-	-	0.3	0.3	-	-	-	-	-	-
Baird's sandpiper	1.0	0.3	2.0	4.1	5.2	12.7	1.1	3.4	1.3	-	-	0.3
Pectoral sandpiper	1.4	9.3	-	46.7	29.7	21.1	11.3	42.4	31.6	2.3	5.5	32.7
Stilt sandpiper	1.4	-	1.7	7.4	0.9	2.0	0.3	-	-	-	-	-
Buff-breasted sandpiper	-	-	-	-	0.1	-	0.2	0.3	-	-	-	-
Dowitcher spp.	0.8	6.3	6.7	11.9	9.2	26.9	3.0	13.9	18.4	0.6	1.0	45.3
Common snipe	14.5	13.3	6.6	4.8	11.3	3.3	1.6	4.0	19.3	1.0	0.4	6.3
Wilson's phalarope	0.4	19.3	2.3	0.4	2.8	1.6	0.9	0.1	1.3	-	-	-
Red-necked phalarope	0.3	-	-	7.1	3.1	-	0.2	0.9	-	-	-	-
Bonaparte's gull	5.1	5.6	11.7	8.8	6.5	6.0	0.3	0.4	5.3	9.1	-	-
Mew gull	-	0.7	-	-	-	-	-	0.5	-	-	-	-
Ring-billed gull	-	3.0	0.7	-	-	-	-	0.4	12.9	-	1.3	19.0
California/herring gull	0.4	-	10.4	-	1.0	11.7	-	0.3	16.9	-	1.1	3.7
Glaucous gull	-	-	-	-	-	-	-	-	-	-	0.1	-
Common tern	-	2.3	8.0	-	-	5.3	-	0.2	-	-	-	-
Black tern	8.7	429.3	116.2	23.8	32.1	126.3	-	1.8	3.3	-	-	-

Appendix P. Numbers of broods of waterbirds observed on and near Crown Lease 17 in 1975, 1977 and 1984.

	Horseshoe Lake[4]			Mildred Lake			Loon Pond			SSWA[5]	
Waterbirds	1975[1]	1977[2]	1984[3]	1975	1977	1984	1975	1977	1984	1975	1984
Common loon	-	-	-	2	1	-	-	-	-	-	-
Pied-billed grebe	-	2	-	-	-	-	-	-	-	-	-
Horned grebe	-	-	-	-	1	-	-	-	-	-	2
Red-necked grebe	1	1	2	5	6	1	-	-	2	-	-
Eared grebe	-	1	-	-	-	-	-	-	-	-	-
Unid. grebe	-	1	-	-	-	-	-	-	-	-	-
Canada goose	-	-	-	-	-	-	-	-	-	-	-
Green-winged teal	3	-	-	1	1	-	-	-	-	7	2
Mallard	12	7	3	4	8	-	-	-	1	-	3
Northern pintail	2	-	1	-	1	-	-	-	-	1	1
Blue-winged teal	6	1	2	1	1	-	-	-	-	-	2
Teal spp.	-	-	-	-	-	-	-	-	-	-	1
Northern shoveler	-	-	-	-	-	-	-	-	-	1	1
Gadwall	-	-	-	-	-	-	-	-	-	-	-
American wigeon	8	5	2	5	2	3	-	-	2	2	2
Unid. dabbling duck	-	1	2	-	1	-	-	1	-	-	-
Canvasback	3	-	-	2	-	-	-	-	-	-	-
Ring-necked duck	9	4	5	24	18	-	1	2	1	-	8
Scaup spp.	-	-	-	1	-	-	-	-	-	-	-
Common goldeneye	8	9	2	2	-	-	-	-	-	2	4
Bufflehead	4	1	2	2	-	-	-	-	-	-	8
Unid. Bucephala	-	1	-	-	-	-	-	-	-	-	-
Common merganser	-	-	-	1	-	-	-	-	-	-	-
Ruddy duck	-	-	5	-	-	-	-	-	-	-	1
Unid. diving duck	-	1	-	-	-	-	-	-	-	-	-
Unid. duck	-	2	-	-	1	-	-	-	-	-	-
American coot	9	8	36	1	10	-	-	-	-	-	5
TOTAL	65	45	62	51	51	4	1	3	6	13	40

	BCR		PCR		Ruth Lake			Ruth Marsh		RLC	All Waterbodies[6]		
Waterbirds	1977	1984	1977	1984	1975	1977	1984	1977	1984	1984	1975	1977	1984
Common loon	-	-	1	1	3	2	-	-	-	-	5	4	1
Pied-billed grebe	1	-	1	2E[7]	-	2	-	12	1	-	-	18	1
Horned grebe	-	1	-	-	-	-	-	-	-	-	-	1	3
Red-necked grebe	5	8	11	14	17	17	2	3	-	-	23	43	29
Eared grebe	1	-	-	-	-	-	-	-	-	-	-	1	-
Unid. grebe	1	-	-	-	-	1	-	2	-	-	-	5	-
Canada goose	-	1	-	-	-	-	-	-	-	1	-	-	2
Green-winged teal	3	1	1	-	-	-	-	-	-	1	11	5	4
Mallard	8	2	4	-	7	11	-	1	-	2	23	39	11
Northern pintail	-	-	-	-	-	-	-	-	-	-	3	1	2
Blue-winged teal	2	4	5	-	-	5	1	1	-	1	7	15	10
Teal spp.	-	1	-	-	-	1	-	-	-	-	-	1	2
Northern shoveler	7	1	-	-	-	1	-	-	-	-	1	8	2
Gadwall	-	-	-	-	-	1	-	-	-	-	-	1	-
American wigeon	3	9	1	3	1	3	1	-	-	4	16	14	26
Unid. dabbling duck	3	1	1	-	-	-	-	3	1	-	-	10	4
Canvasback	-	-	-	-	-	-	-	-	-	-	5	-	-
Ring-necked duck	1	4	2	4	5	3	1	-	-	1	39	30	24
Scaup spp.	-	-	-	-	-	1	-	-	-	-	1	1	-
Common goldeneye	3	3	2	1	2	-	-	-	-	-	14	14	10
Bufflehead	-	-	3	1	2	1	-	-	-	-	8	5	11
Unid. Bucephala	-	-	-	-	-	-	-	-	-	-	-	1	-
Common merganser	-	-	-	-	-	-	-	-	-	-	1	-	1[8]
Ruddy duck	-	1	-	-	-	1	-	-	-	-	-	1	7
Unid. diving duck	-	-	-	-	-	-	-	-	-	-	-	1	-
Unid. duck	5	2	1	1	-	3	2	-	-	1	-	12	6
American coot	-	3	2	2E	-	11	2	3	1	-	10	34	47
TOTAL	42	42	35	25	37	64	9	25	3	11	167	265	203

[1] From Sharp and Richardson (1976).
[2] From Ward and Hollingdale (1978).
[3] Present study.
[4] Includes broods observed on Lower Camp Sedimentation Basin.
[5] SSWA - Syncrude Site Water Areas
BCR - Beaver Creek Reservoir
PCR - Poplar Creek Reservoir
RLC - Ruth Lake Diversion Canals
[6] Not including Saline Lake.
[7] E - eggs
[8] Seen on MacKay River.

Appendix Q. Average numbers of waterbirds recorded during spot censuses by Syncrude Canada Ltd. on Mildred Lake from 1980 to 1984.

	Early Summer					Mid Summer					Late Summer					Autumn			
Species	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984	1980	1981	1982	1983
Common loon	0.6	0.3	0.4	0.7	0.7	0.8	0.3	0.2	0.6	0.7	0.4	0.3	0.1	0.9	0.3	0.4	-	0.1	0.1
Pied-billed grebe	-	0.1	0.4	-	0.1	0.1	0.6	1.9	0.3	0.8	2.9	1.8	3.4	0.5	1.5	1.6	2.1	1.8	0.2
Horned grebe	-	0.4	-	-	-	-	0.4	-	-	-	0.4	1.0	-	-	0.6	0.8	0.3	0.3	0.3
Eared grebe	0.1	-	-	-	-	0.3	0.3	0.3	-	-	-	0.4	-	-	0.4	1.0	0.4	-	-
Red-necked grebe	4.3	6.1	6.9	11.4	1.7	5.8	11.5	11.2	14.9	9.7	3.6	7.5	4.1	5.2	8.4	0.3	0.7	0.6	1.1
Grebe spp.	-	0.3	-	-	-	-	1.0	-	-	-	1.3	0.9	-	-	-	0.5	1.1	0.1	0.1
Double-crested cormorant	-	-	0.1	-	-	-	0.04	-	-	-	0.9	0.3	-	-	-	-	-	-	-
American bittern	-	-	0.1	-	-	00.1	-	0.2	-	-	-	0.2	-	0.03	0.03	-	0.03	-	-
Great blue heron	-	0.2	0.1	0.2	0.2	-	0.5	0.1	0.1	0.1	0.03	0.8	0.1	0.2	0.2	-	0.03	-	-
Tundra swan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	-
Greater white-fronted goose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.4	-	0.1	-	-
Snow goose	-	-	0.1	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-
Canada goose	-	-	-	0.5	1.1	-	-	-	1.1	-	1.9	0.4	5.2	1.8	14.5	0.2	-	5.5	-
Goose spp.	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Green-winged teal	2.1	1.2	0.3	0.7	2.6	3.1	0.1	-	-	-	1.0	0.1	0.2	-	-	0.3	0.1	-	-
Mallard	5.8	9.0	10.2	11.1	2.8	7.9	7.3	10.0	26.3	6.1	4.9	12.8	7.7	8.7	8.3	0.7	15.4	5.1	4.6
Northern pintail	0.9	0.5	0.2	0.3	1.0	1.7	0.6	0.4	-	-	2.4	3.5	0.2	0.03	0.9	-	1.3	-	-
Blue-winged teal	3.8	4.6	0.7	1.3	2.8	1.7	4.5	-	0.04	0.3	0.4	0.1	-	0.2	-	0.1	-	-	-
Cinnamon teal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	-
Teal spp.	0.5	2.0	0.4	0.4	-	4.4	1.8	0.1	1.5	0.5	2.3	0.5	0.2	0.4	-	0.1	0.9	-	0.2
American wigeon	37.5	24.4	15.0	24.0	29.1	16.3	8.9	8.8	42.7	9.9	8.9	4.7	5.2	28.9	17.1	0.6	1.7	-	0.7
Gadwall	1.6	1.6	1.9	0.7	-	3.2	0.6	3.8	0.3	-	2.8	0.4	0.6	0.1	1.9	0.9	0.1	0.4	-
Northern shoveler	3.8	1.9	2.0	1.6	7.8	1.1	0.5	0.4	0.7	-	0.3	0.3	0.1	0.1	2.2	-	0.03	-	-
Unid. dabbling duck	1.2	18.4	18.7	2.7	0.7	10.9	78.6	22.6	13.0	1.2	8.1	40.4	4.8	6.4	3.9	0.4	9.4	3.2	2.5
Canvasback	0.1	0.4	0.1	0.1	0.3	-	-	0.4	0.5	-	-	-	0.6	0.6	0.3	-	-	0.7	0.04
Redhead	-	1.6	0.1	0.1	-	-	-	0.6	0.4	-	-	0.3	0.1	0.2	0.1	-	0.3	-	0.04
Ring-necked duck	0.8	0.5	0.1	0.5	-	2.1	0.5	0.4	1.3	-	0.4	1.2	0.3	1.3	-	0.1	0.1	0.2	0.4
Greater scaup	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lesser scaup	-	-	0.2	-	16.4	-	-	0.4	-	1.2	-	-	0.3	-	3.4	-	0.1	-	-
Scaup spp.	0.3	0.2	0.1	0.9	-	-	-	0.4	1.2	-	-	0.8	3.7	2.7	-	-	0.5	0.3	0.9
Surf scoter	-	-	-	0.04	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-
White-winged scoter	-	0.1	-	0.04	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common goldeneye	-	0.5	-	0.1	-	-	0.1	0.3	0.04	0.4	0.4	0.1	0.2	0.9	0.5	0.4	0.3	1.0	-
Bufflehead	0.4	-	0.3	0.7	-	0.3	0.3	0.1	0.3	0.1	0.1	0.4	0.1	0.5	0.2	0.1	0.1	0.1	0.4
Common merganser	-	-	-	-	-	0.2	-	-	-	-	0.2	0.2	-	0.1	-	1.9	0.6	0.6	0.4
Red-breasted merganser	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.03	0.1
Merganser spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	1.1	2.2
Ruddy duck	-	0.3	0.1	0.1	0.2	0.1	-	0.1	-	-	-	0.2	-	0.1	0.2	-	-	-	-
Unid. diving duck	0.8	0.1	-	-	-	2.4	1.4	1.3	0.6	1.2	1.5	1.0	1.1	0.8	2.9	0.2	0.2	1.1	2.2
Unid. duck	27.8	2.6	9.1	7.8	29.4	22.1	4.1	8.0	25.7	19.3	11.9	2.3	3.8	20.6	23.4	0.9	0.8	1.1	6.7
Sora	-	-	-	0.04	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
American coot	5.9	15.8	9.1	0.9	5.0	6.3	55.9	16.5	0.9	2.9	22.5	33.7	20.4	3.1	58.6	4.1	16.6	0.7	3.4
Sandhill crane	-	-	-	-	0.1	0.1	0.2	-	-	-	-	-	-	0.1	3.6	-	0.1	-	-
Black-bellied plover	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	0.4	-	-	-	-
Lesser golden-plover	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	3.0	-	-	-	-
Semipalmated plover	-	-	-	-	0.04	-	-	-	-	-	0.1	0.1	-	0.03	0.3	-	0.03	-	0.04
Killdeer	1.3	0.8	0.7	0.5	0.2	1.2	0.04	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.03	-	-	0.1	-
Plover spp.	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-
Greater yellowlegs	1.5	0.7	0.2	0.2	0.3	2.7	0.2	0.4	0.7	1.0	0.9	0.1	0.4	0.1	0.4	0.2	-	0.4	0.3
Lesser yellowlegs	2.0	0.3	-	0.3	0.4	3.1	0.5	0.1	1.3	0.2	1.0	0.1	-	0.2	0.7	1.0	0.03	0.03	0.04
Yellowlegs spp.	-	2.2	0.2	0.7	1.1	-	4.1	-	2.2	4.1	-	2.2	0.5	1.5	3.7	-	1.2	1.4	0.1
Solitary sandpiper	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Spotted sandpiper	-	-	0.3	0.5	0.1	-	-	0.1	0.1	0.2	-	-	-	0.1	-	-	-	-	-
Upland sandpiper	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	-
Hudsonian godwit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
Marbled godwit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
Ruddy turnstone	-	-	-	-	-	-	-	0.4	-	0.1	-	-	-	-	-	-	-	-	-
Sanderling	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-
Semipalmated sandpiper	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Western sandpiper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	-
Least sandpiper	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-
White-rumped sandpiper	-	-	-	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baird's sandpiper	-	0.2	-	-	-	-	-	-	-	-	0.03	0.03	-	-	-	-	-	-	-
Unid. 'peep' sandpiper	0.2	0.2	-	0.2	-	0.8	0.4	-	1.2	-	0.6	1.3	0.2	-	-	-	0.1	-	-
Pectoral sandpiper	-	-	-	-	-	0.1	0.1	-	0.04	-	0.03	0.5	-	-	-	-	0.03	-	-
Dunlin	-	-	-	-	-	-	-	-	-	-	0.03	-	-	-	-	-	-	-	-
Sandpiper spp.	0.9	0.9	-	-	-	1.0	0.4	0.1	0.2	-	0.1	0.4	-	2.0	-	-	0.1	-	0.04
Short-billed dowitcher	-	-	-	-	-	-	-	-	-	-	0.3	0.6	-	-	-	-	-	-	-
Long-billed dowitcher	-	-	-	-	0.4	-	-	-	-	2.1	-	-	-	-	0.5	0.3	-	-	-
Dowitcher spp.	0.2	-	0.2	-	-	0.3	0.3	0.1	-	0.1	0.1	1.6	0.3	0.03	-	-	1.5	-	-
Common snipe	0.3	0.1	-	0.1	-	0.5	-	-	-	-	0.2	2.0	-	-	-	-	0.03	-	-
Wilson's phalarope	1.2	0.2	0.1	-	-	1.1	0.3	0.1	-	0.1	0.1	-	-	-	0.6	-	-	-	0.04
Red-necked phalarope	-	-	0.1	-	-	-	-	-	0.2	-	-	-	-	0.2	0.2	-	-	-	-
Phalarope spp.	-	-	-	-	-	0.3	0.5	-	0.04	-	-	0.1	-	-	-	-	0.1	-	-
Unid. shorebirds	3.8	0.3	1.8	0.8	-	4.7	2.3	1.2	7.6	8.4	2.0	1.4	1.4	15.4	12.5	0.7	0.6	0.9	0.6
Franklin's gull	0.3	-	-	-	0.9	0.1	-	0.3	-	0.2	-	-	-	-	0.1	-	-	-	-
Bonaparte's gull	-	0.2	0.1	0.3	-	-	0.2	-	-	-	-	-	-	-	0.03	-	-	-	-
Unid. black-headed gull	0.1	0.3	0.3	0.2	0.3	-	0.1	0.1	0.4	0.8	-	-	-	0.2	0.03	-	-	0.03	-
Ring-billed gull	-	0.1	0.2	0.6	0.3	0.3	-	0.1	0.1	0.1	-	-	-	0.1	0.9	-	0.3	-	0.04
California gull	-	-	-	0.3	0.5	0.2	-	-	0.7	0.6	0.03	0.1	-	-	-	-	-	-	-
Herring gull	-	-	0.1	0.2	0.3	0.3	-	-	0.2	-	-	-	-	-	-	-	-	-	-
Unid. white-headed gull	2.7	0.7	0.8	2.6	2.2	0.8	1.4	0.4	0.7	0.7	0.3	2.5	0.2	3.4	2.4	0.1	1.1	0.5	0.3
Common tern	0.4	0.8	1.8	1.6	0.1	0.1	0.6	4.2	1.6	0.9	-	0.03	-	-	0.3	-	0.03	-	0.1
Black tern	1.2	4.4	1.7	1.9	0.3	1.6	2.4	1.6	1.4	0.9	0.03	-	-	0.1	0.06	-	-	-	-
Tern spp.	-	-	-	-	-	-	-	-	0.4	0.9	-	-	-	-	1.4	-	-	-	-

Appendix R. Average numbers of waterbirds recorded during spot censuses by Syncrude Canada Ltd. on Mildred Lake from 1980 to 1984.

	Early Summer					Mid Summer					Late Summer					Autumn			
Species	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984	1980	1981	1982	1983
Common loon	1.1	1.3	1.5	1.5	0.5	0.8	2.1	1.6	2.6	1.4	1.3	0.7	0.8	1.0	0.7	0.6	0.3	0.8	0.1
Pied-billed grebe	-	-	-	-	-	-	-	-	-	-	0.04	0.4	-	-	-	0.1	0.4	-	-
Horned grebe	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	0.3	-	-	-
Eared grebe	-	-	-	-	-	1.0	-	-	-	-	-	-	-	-	-	0.3	0.1	-	-
Red-necked grebe	3.1	2.7	0.6	1.1	0.8	3.3	2.6	0.8	2.1	1.5	2.5	2.9	0.1	1.0	0.4	1.0	0.7	-	0.2
Grebe spp.	-	-	-	-	-	-	1.0	-	-	-	-	0.9	-	-	-	0.3	0.3	-	-
White pelican	-	-	0.1	-	0.1	-	-	-	-	0.4	-	0.3	-	-	-	-	-	-	-
Double-crested cormorant	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	0.1
American bittern	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Great blue heron	-	-	-	0.1	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-
Greater white-fronted goose	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	0.1	-	-	-
Canada goose	-	-	-	-	-	-	-	-	-	-	-	6.5	0.1	1.8	-	-	7.6	-	-
Green-winged teal	0.3	-	-	-	-	0.2	-	-	0.4	-	-	0.4	-	-	-	-	-	-	-
Mallard	4.1	-	1.4	0.3	-	0.7	1.3	2.1	4.2	-	0.1	1.4	0.1	2.6	-	0.1	4.6	0.1	0.3
Northern pintail	-	-	-	-	-	-	-	-	-	-	-	1.3	-	-	-	-	0.2	-	-
Blue-winged teal	0.4	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Teal spp.	0.3	-	-	-	-	-	0.5	-	-	-	-	1.3	-	-	1.0	-	-	-	-
Northern shoveler	-	-	-	-	0.8	-	-	-	-	-	0.04	-	-	-	0.1	-	-	-	-
Gadwall	-	-	-	0.6	-	0.2	-	0.6	-	-	-	0.3	-	-	0.1	-	0.2	-	-
American wigeon	0.4	0.6	0.2	0.4	2.3	0.6	0.1	0.5	4.2	2.3	-	1.1	0.1	2.8	1.6	-	0.6	-	-
Unid. dabbling duck	0.5	1.3	3.8	-	-	0.2	9.1	1.3	0.3	-	0.5	16.3	0.2	0.1	-	0.3	2.5	-	-
Redhead	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
Ring-necked duck	0.8	-	0.1	-	-	0.4	1.1	0.4	-	-	0.04	0.5	-	0.2	-	0.1	0.2	-	-
Lesser scaup	-	-	-	-	-	0.1	-	0.4	-	-	-	-	-	-	-	-	-	-	-
Scaup spp.	-	-	-	-	-	-	0.9	-	0.1	-	-	1.3	0.4	0.3	-	0.3	0.9	0.1	-
Surf scoter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-
White-winged scoter	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common goldeneye	0.1	-	-	-	-	-	0.3	-	0.1	-	0.5	-	-	0.1	-	0.4	-	-	0.1
Bufflehead	-	-	0.4	0.3	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-
Red-breasted merganser	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Merganser spp.	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ruddy duck	-	-	-	-	-	-	-	-	-	-	-	1.4	-	-	-	-	-	-	-
Unid. diving duck	-	1.7	0.5	-	-	1.7	1.5	0.1	0.5	-	1.2	1.6	0.2	-	-	3.1	2.8	-	-
Unid. duck	3.6	1.4	-	0.6	-	5.7	0.6	0.5	2.7	0.4	1.9	1.6	7.7	0.9	1.0	0.6	0.3	0.2	0.5
Sora	-	-	-	0.1	-	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-
American coot	0.3	-	-	-	-	0.1	-	-	-	-	0.1	27.6	-	-	-	0.8	2.3	-	-
Sandhill crane	-	-	-	-	-	-	-	-	-	-	-	-	0.8	-	-	-	-	-	-
Black-bellied plover	-	-	-	-	-	-	0.1	-	-	-	0.1	-	-	-	-	0.1	-	-	-
Lesser golden-plover	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-
Semipalmated plover	-	-	0.1	-	-	-	-	0.1	-	-	0.04	-	-	-	-	-	-	-	-
Killdeer	2.4	0.3	0.4	0.1	-	0.4	0.6	0.2	0.2	-	0.2	0.3	-	-	-	-	-	0.1	-
Plover spp.	0.1	-	-	-	-	0.1	-	-	-	-	0.5	-	-	-	-	-	-	-	-
Greater yellowlegs	2.9	0.3	0.1	-	-	0.5	-	-	-	-	0.7	-	-	0.1	-	0.1	-	-	-
Lesser yellowlegs	4.1	0.3	0.1	-	-	2.2	-	-	-	-	1.2	-	-	-	-	0.1	-	-	-
Yellowlegs spp.	-	0.9	-	-	-	-	4.5	-	-	-	-	1.3	-	-	-	-	0.2	-	-
Spotted sandpiper	-	-	0.5	0.2	-	-	-	-	0.1	-	-	-	-	0.1	-	-	-	-	-
Sanderling	-	-	-	0.1	-	-	0.5	-	0.3	-	-	0.1	-	0.1	-	-	-	-	-
Semipalmated sandpiper	-	-	-	-	-	0.1	-	0.2	0.2	-	-	-	-	-	-	-	-	-	-
Western sandpiper	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-
Least sandpiper	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-
Baird's sandpiper	-	-	-	-	-	-	0.1	-	-	-	0.04	-	-	-	-	-	-	-	-
Unid. 'peep' sandpiper	0.4	-	-	-	-	0.5	4.1	0.4	0.3	-	0.4	2.7	0.1	0.1	-	0.2	-	-	-
Pectoral sandpiper	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-
Sandpiper spp.	1.5	0.9	-	-	-	1.3	2.0	-	0.3	-	0.5	0.3	-	0.1	-	0.1	-	-	-
Long-billed dowitcher	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Dowitcher spp.	-	-	-	-	-	0.4	0.6	-	-	-	-	-	-	-	-	-	-	-	-
Common snipe	0.1	-	-	-	-	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-
Wilson's phalarope	-	-	-	-	-	-	-	-	-	-	0.3	0.4	-	-	-	-	-	-	-
Red-necked phalarope	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-
Unid. shorebird	1.4	0.9	0.7	-	-	1.1	0.5	0.6	3.8	-	1.1	-	0.1	0.4	-	0.4	0.1	-	0.2
Franklin's gull	0.1	-	-	-	1.4	-	-	-	0.1	0.7	-	-	-	-	-	-	-	-	-
Bonaparte's gull	-	0.1	0.5	0.2	0.3	-	-	1.6	-	-	0.04	-	-	-	-	-	-	-	-
Unid. black-headed gull	1.6	2.3	-	0.4	-	0.8	0.1	0.4	0.2	-	0.1	0.1	-	-	-	2.8	-	-	-
Ring-billed gull	-	-	4.5	-	-	-	-	1.8	0.3	-	-	-	0.1	0.3	0.1	-	-	-	0.2
California gull	-	-	0.3	-	1.3	-	-	-	0.1	1.1	-	-	-	0.2	-	3.8	-	-	1.1
Herring gull	0.1	-	1.1	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-
Unid. white-headed gull	15.0	13.4	6.1	2.2	0.8	6.7	3.6	0.4	3.8	0.6	7.9	5.6	5.9	0.8	3.7	3.5	0.3	0.1	1.0
Common tern	0.8	0.6	0.5	0.1	-	0.9	1.8	1.4	0.8	-	0.1	0.2	-	-	-	-	-	-	-
Black tern	-	0.3	-	-	-	0.5	-	-	0.4	-	-	-	-	-	-	-	-	-	-
Tern spp.	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-

Conditions of Use

McLaren, P.L. and J.A. Smith, 1985. Ornithological studies on and near Crown Lease 17, northeastern Alberta, June-October 1984. Syncrude Canada Ltd., Edmonton, Alberta. Environmental Research Monograph 1985-1. 175 pp.