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REPORT ON

WILDLIFE BASELINE CONDITIONS FOR PROJECT MILLENNIUM

Submitted to:

Suncor Energy Inc., Oil Sands

April 1998

972-2205

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April 23, 1998

Proj. No. 972-2205

Mr. Martin Holysh
Senior Environmental Specialist
Sustainable Development
Suncor Energy Inc., Oil Sands
P.O. Box 4001
Fort McMurray, AB
T3H 3E3

RE: Final Report on the Wildlife Baseline Conditions for Project Millennium

Dear Martin

Attached are five copies of the Wildlife Baseline Conditions for Project Millennium.

This report summarizes the findings from wildlife surveys carried out from January through July 1997, in the Project Millennium Local Study Area. The wildlife surveys were also designed to augment and complement other regional studies by meeting the following objectives:

1. determine the relative use of different vegetation communities by ungulates, waterfowl, upland game birds, breeding birds, raptors and amphibians; and

2. determine suitability of the area for ungulates, breeding birds, waterfowl and amphibians.

Furthermore, results on ungulates and furbearers from winter track count surveys was also incorporated where relevant.

If you have any additional questions about the report, please contact either Marilyn Collard at 299-5654 or me at 299-5640.

Yours very truly,

GOLDER ASSOCIATES LTD.

Shan McKeon

for John R. Gulley, M.Sc., P. Biol.
Oil Sands Project Director

attachments (5)

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ABSTRACT

From January through July 1997, surveys were conducted to determine the relative use of different vegetation communities by wildlife species inhabiting the Suncor Project Millennium development area.

Winter track count and early summer browse/pellet group count surveys indicated that the relative abundance of moose and deer was low compared to other areas of northern Alberta. Within vegetation communities, no difference in habitat use could be detected, but at the landscape level, ungulates utilized riparian areas significantly more than escarpment and upland communities. In late winter (e.g., March), moose moved to the upland areas. Preferred browse material (e.g., red osier dogwood, willow) was relatively uncommon, a condition which may have caused limited use of this area by moose.

Winter track count data suggested that the relative abundance of most of the larger furbearers (e.g., wolves, coyotes, wolverines, and lynx) was low in the Local Study Area (LSA). Red squirrels preferred low-bush cranberry white spruce (d3) over lichen-jack pine (a1), Labrador tea/horsetail-white spruce-black spruce (h1) and deciduous and mixedwood low-bush cranberry (d1, d2). At the landscape level, squirrels showed a preference for riparian areas. Snowshoe hares preferred low-bush cranberry-aspen poplar-white spruce (d2) and Labrador tea/horsetail white spruce-black spruce (h1). Hares avoided lichen-jack pine (a1), low-bush cranberry-white spruce (d3) and aspen poplar (d1) and wooded fens (FTNN). At the landscape level, snowshoe hares preferred upland habitats.

Tracks were detected for wolves, coyotes, fishers, marten, weasels and mink. Few wolf tracks were recorded and a habitat preference for wolves could not be determined. Wolves did show a preference for upland areas and avoided escarpment. Coyotes preferred disturbed areas (CIU), wooded fens (FTNN) and wooded bogs (BTNN). Coyotes and red foxes did not show a landscape preference. Martens preferred low-bush cranberry-white spruce (d3), and fishers avoided lichen-jackpine (a1), low-bush cranberry-white spruce (d3) and aspen poplar (d1), and Labrador tea/subhygric-white spruce-black spruce (h1). Weasels avoided riparian shrubland (shrub) and open, shallow water (WONN). Martens preferred escarpment areas, fishers preferred riparian areas, and weasels avoided escarpment areas. Mink were not recorded during the Steepbank River survey. In the Upland Lease 29 survey, mink preferred riparian shrubland (shrub). Mink were also observed on Shipyard Lake. No river otter tracks were observed. Lynx tracks were only observed during the Steepbank River surveys. Lynx showed a preference for riparian areas.

The spring waterfowl survey indicated that abundance was low, probably due to the scarcity of non-flowing waterbodies, the preferred wetlands for breeding and staging waterfowl. Important waterbodies included the Athabasca River and Shipyard Lake. The Athabasca River is important for staging waterfowl, as the waters are too fast for most species for breeding purposes. Although species diversity was moderate, the low relative abundance of species may be due to the limited amount and size of quality breeding habitat areas.

A breeding bird survey detected 79 species within 318 point counts in the LSA. Although species diversity was moderate, the relative abundance of species was low, likely due to the limited amount and size of quality breeding habitats. For example, 60% of the bird species recorded had less than 10 detections. In addition, species diversity and richness were significantly greater in the dogwood-balsam poplar-aspen poplar (d1) community than in the mixed softwood and black spruce bogs (a1, b1, g1). Most studies in the RSA have found that species abundance, richness and diversity were greater in upland hardwood and mixedwood habitats than softwood community types associated with bog-fen complexes.

Few raptors were detected during the field surveys. A bald eagle nest was recorded along the Athabasca River near Shipyard Lake. As well, red-tailed hawks were recorded near Shipyard Lake. Great gray owls were recorded in a wooded swamp (STNN), in a riparian area along the Steepbank River and the confluence with the Athabasca River, and in a lichen-jack pine (a1) stand.

Two species of amphibians were detected in the LSA, the boreal chorus frog and the wood frog. Calling frogs were heard at Shipyard Lake, beaver ponds, and semi-permanent and permanent wetlands associated with fens and bogs.

Results indicated that many of the wildlife species occupying the LSA were strongly associated with riparian habitats. However, the importance of escarpment and upland habitats cannot be discounted.

Key Words: ecosystem-based management, environmental baseline, moose, furbearers, grouse, oil sands, raptors, amphibians, breeding birds, waterfowl.

ACKNOWLEDGMENTS

This study was conducted for Suncor Energy Inc. under the direction of Don Klym and Martin Holysh.

Winter field work was conducted by Ken Allen, Ryan Benson, Chris Bjornson, Chris Briggs, Tony Calverley, Marilyn Collard, Tanis Dirks, Lorne Gould, Kelly Gurski, Trina Hoffarth, Derek Melton, Michael Raine, and Craig Schell. Spring and summer field work was conducted by Tony Calverley, Marilyn Collard, Kelly Gurski, Sheldon Kowalchuk, Rob Olson, Jason Sharp and Don Weidl. Data entry was conducted by Dana Dalmer, Ricci Fox, Zane Gulley, Kelly Gurski and Trina Hoffarth. Database management services were provided by Rhys Yarranton, while quality control/quality assurance was conducted by Lorne Gould. Data analysis was performed by John Virgl. Report writing was conducted by Marilyn Collard, with assistance from Sheldon Kowalchuk, Rob Olson, and Jason Sharp. The report was edited for content by John Gulley and Derek Melton. Word processing was done by Maureen Myers and Megan Brown.

EXECUTIVE SUMMARY

This document reports on the findings from wildlife surveys carried out from January through July 1997, on and adjacent to Suncor Energy Inc.'s (Suncor) Project Millennium development area in support of an Environmental Impact Assessment (EIA). Studies were conducted within the mine development area, or Local Study area (LSA), as well as areas in the immediate vicinity. The studies were designed to augment and complement other regional studies. Objectives of the studies were to:

1. determine the relative use of different vegetation communities (i.e., habitats) by ungulates, waterfowl, upland game birds, breeding birds, raptors and amphibians; and

2. determine the suitability of the area for ungulates, breeding birds, waterfowl and amphibians. Results on ungulates and furbearers from the winter track count surveys (Golder 1997a) were incorporated where relevant.

Data collected were then used to complete this environmental baseline report for Project Millennium.

Winter track counts indicated that the relative abundance of moose and deer was low relative to other areas of northern Alberta. This agrees with the results of aerial surveys conducted in the past that determined overall moose densities in the area to range from 0.09 to 0.10 moose per km^2. Winter track count surveys determined that moose utilized riparian areas more than escarpment and upland areas.

Winter track count data suggest that the relative abundance of most of the larger furbearers (e.g., coyotes, lynx, wolves, wolverines) was low in the study area. Red squirrels preferred low-bush cranberry-white spruce (d3) over lichen-jack pine (a1), Labrador tea/horsetail-white spruce-black spruce (h1) and deciduous and mixedwood low-bush cranberry (d1, d2). At the landscape level, squirrels showed a preference for riparian areas. Snowshoe hares preferred low-bush cranberry-aspen poplar-white spruce (d2) and Labrador tea/horsetail-white spruce-black spruce (h1). Hares avoided lichen-jack pine (a1), low-bush cranberry-white spruce (d3) and aspen poplar (d1), and wooded fens (FTNN). At the landscape level, snowshoe hares preferred upland habitats.

Tracks were detected for wolves, coyotes, fishers, marten, weasels and mink. Few wolf tracks were recorded and a habitat preference for wolves could not be determined. Wolves did show a preference for upland areas and avoided escarpment. Coyotes preferred disturbed areas (CIU), wooded fens (FTNN) and wooded bogs (BTNN). Coyotes and red foxes did not show a landscape preference. Martens preferred low-bush cranberry-white spruce (d3), and fishers avoided lichen-jack pine (a1), low-bush cranberry-white spruce (d3) and aspen poplar (d1), and Labrador tea/subhygric-white spruce-black spruce (h1). Weasels avoided riparian shrubland (shrub) and open, shallow water (WONN). Martens preferred escarpment areas, fishers preferred riparian areas, and weasels avoided escarpment areas. Mink were not recorded during the Steepbank River survey. In the Upland Lease 29 survey, mink preferred riparian shrubland (shrub). Mink were also observed on Shipyard Lake. No river otter tracks were observed. Lynx tracks were only observed during the Steepbank River surveys. Lynx showed a preference for riparian areas.

The abundance of grouse, beavers and muskrats was also low, which may be associated with the limited amount of suitable habitat. Total track counts for grouse species in the Upland Lease 29 study area were 45.88 tracks/km-track day in February. Analysis indicated that grouse preferred wooded fens (FTNN).

The spring waterfowl survey indicated that abundance was low, probably due to the scarcity of non-flowing waterbodies, the preferred wetlands for breeding and staging waterfowl. Important waterbodies included the Athabasca River and Shipyard Lake. The Athabasca River is important for staging waterfowl, as the waters are too fast for most species for breeding purposes. Although species diversity was moderate, the low relative abundance of species may be due to the limited amount and size of quality breeding habitat areas.

A total of 18 species of waterfowl were observed during the spring survey. Lesser scaup were the most abundant. Other species that were moderately abundant included mallards, blue-winged teals, buffleheads and ringed-neck ducks. However, compared to other areas in the region (e.g., Kearl Lake), abundance of waterfowl in the LSA was low. Although the few non-flowing waterbodies within the LSA are probably used as staging areas for migrating waterfowl, poor quality nesting and brood-rearing habitat likely result in low juvenile recruitment in the area.

A breeding bird survey detected 79 species within 318 point counts in the LSA. Although species diversity was moderate, the relative abundance of species was low, likely due to the limited amount and size of quality breeding habitats. For example, 60% of the bird species recorded had less than 10 detections. In addition, species diversity and richness were significantly greater in the dogwood-balsam poplar-aspen poplar (d1) community than in the mixed softwood and black spruce bogs (a1, b1, g1). Most studies in the RSA have found that species abundance, richness and diversity were greater in upland hardwood and mixedwood habitats than softwood community types associated with bog-fen complexes.

Few raptors were detected during the field surveys. A bald eagle nest was recorded along the Athabasca River near Shipyard Lake. As well, red-tailed hawks were recorded near Shipyard Lake. Great gray owls were recorded in a wooded swamp (STNN), in a riparian area along the

Steepbank River and the confluence with the Athabasca River, and in a lichen-jack pine (a1) stand.

Two species of amphibians, boreal chorus frogs and wood frogs, were detected in the LSA. Many types of habitats were used by calling frogs including large bodies of water (e.g., Shipyard Lake), beaver ponds, and both semi-permanent and permanent wetlands with fens and bogs.

Overall results of the field surveys indicated that many of the wildlife species occupying the study area were associated with riparian habitats. Current empirical and theoretical investigations have also stressed the importance of riparian habitats to species diversity and persistence at the landscape level.

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1. INTRODUCTION

Suncor Energy Inc., Oil Sands (Suncor) is planning the expansion of its oil sands mining operations south of the Steepbank River. This development is known as Project Millennium. The area is located approximately 75 km north of Fort McMurray and on the east side of the Athabasca River (Figure 1). As part of an Environmental Impact Assessment (EIA) for the project, Suncor is required to assess the impacts of further development on wildlife (i.e., mammals, birds, amphibians and reptiles). Baseline information concerning these wildlife groups is required for impact assessment, mitigation planning, closure design and monitoring recommendations.

During the past two decades, several baseline studies have been carried out within the regional study area (RSA):

- the wildlife component of the Alsands EIA (1978);
- the Alberta Oil Sands Environmental Research Program (AOSERP) from 1975 to 1984;
- the Other Six Leases Operations (OSLO) baseline inventory;
- wildlife surveys conducted by Westworth, Brusnyk and Associates (1996a) in support of the Steepbank Mine EIA;
- wildlife surveys conducted by Fort McKay Environmental Services (1996) and wildlife habitat modelling conducted by AXYS (1996a) in support of an EIA for the Aurora Mine (BOVAR 1996a);
- Alsands survey conducted by Fort McKay Environment Services (1997), and
- wildlife surveys and wildlife habitat modelling conducted by Golder (1998a) in support of an EIA for the Shell Muskeg River Mine Project.

Information collected for the Alsands EIA included resource surveys in 1973 on Lease 13 (Shell 1975). A number of Syncrude documents are also available from this period (e.g., Renewable Resources Consulting Services 1972, Penner 1976). Studies have also been conducted as part of EIAs for other industrial activities in the region, including those for the OSLO project. As well, Alberta Fish and Wildlife has conducted moose surveys within the region during 1993-94 (cited in Westworth, Brusnyk and Associates 1996b).

Most of the data collected and/or discussed during the AOSERP program were of a regional nature. Reviews of wildlife populations and habitat requirements included those for insectivorous animals (Ealey et al. 1979), small mammals (Green 1979), terrestrial birds (Francis and Lumbis 1979), waterfowl (Hennan and Munson 1979), amphibians and reptiles (Roberts et al. 1979) and black bears (Penner et al. 1980). Surveys and research studies included aerial surveys and winter track counts for aquatic mammals (Searing 1979), a woodland caribou study in the Birch Mountains (Fuller and Keith 1980), a moose study in the Fort Hills area (Nowlin 1978), a

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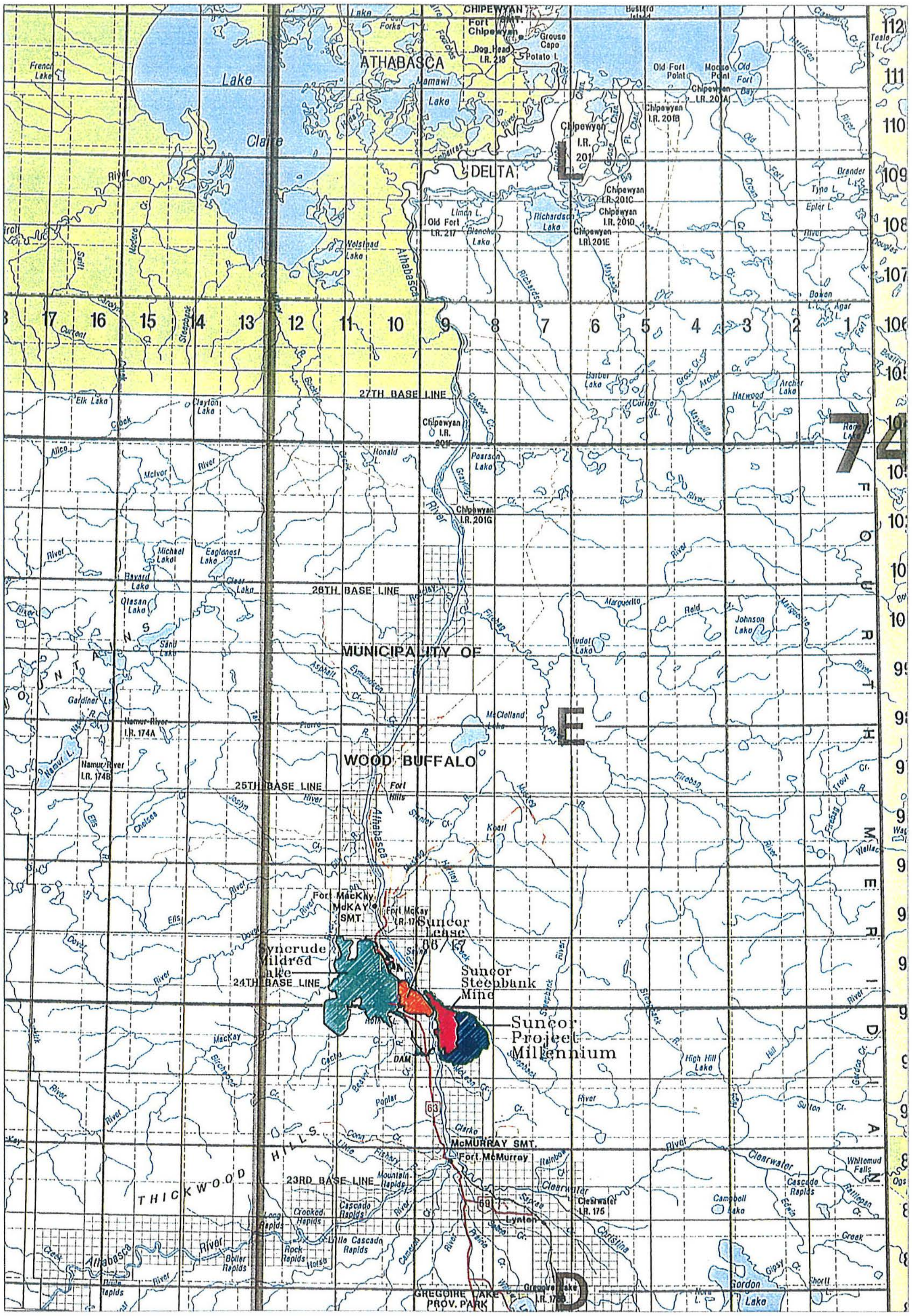

0 10 20 30 40 50km

SCALE 1:1,250,000 (Approx.)

REFERENCE

SCANNED IMAGE OF ALBERTA ENVIRONMENTAL PROTECTION PROVINCIAL BASE MAP 1997, ORIGINAL SCALE 1:1,000,000

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LOCATION OF PROJECT MILLENNIUM

23 Mar. 1998	Figure 1	DRAWN BY: CG

black bear study that was ended prematurely (Blair Rippen, pers. comm.) and a wolf study (Penner 1976). Aerial surveys for moose were also conducted within Lease 13 by Salter et al. (1986) and Eccles and Duncan (1988).

Previous studies in the area are of interest from a pre-development, historical perspective, but more recent information is required to assess current baseline conditions in the Project Millennium study area. For this study, an ecosystem-based management approach for assessing the impact of the development on wildlife in the development area was adopted. Species, and the communities formed by species assemblages, are tightly coupled with the characteristics of particular habitats (i.e., plant communities and physical attributes). It is the interaction among habitat types and wildlife communities that produces the type of ecosystem present in the environment. Consequently, linking habitat type with species associations is fundamental to forming an ecosystem-based management plan.

Oil sands developments can affect wildlife species and communities through direct loss of habitat, fragmentation of habitat, changes to habitat characteristics, disturbance, direct mortality and increased access to remote areas. Obtaining baseline information on the habitat requirements of species is essential for determining the impact of the development on wildlife. Predicting the influence of the development on population size is more difficult as other factors such as natural and human predation and disease also contribute to changes in population size. Therefore, it is Suncor's intention to use baseline data collected from this and other studies to determine species-habitat associations, and not to focus the EIA on impacts to wildlife populations.

As it is nearly impossible to study all species within an area, species representative of public and scientific values can be chosen for management purposes. Species selected in this fashion are referred to as Management Indicator Species (MIS) (Salwasser and Unkel 1981), Valued Ecosystem Components (VECs) (Sadar 1994), key species, and various other terms. They will be termed Key Indicator Resources (KIRs) for the purposes of this EIA, following the terminology of the Aurora EIA (BOVAR 1996b) and the Shell Muskeg River Mine Project EIA (Golder 1998a). Species chosen as KIRs for the Steepbank and Aurora mine EIAs were selected based on a scoring of system which included the following:

- national or provincial status (e.g., endangered, threatened, rare);
- commercial and subsistence economic importance;
- non-consumptive importance; and
- ecological importance (BOVAR 1996b, Westworth, Brusnyk and Associates 1996a).

Rather than repeat this process, the Project Millennium study included a review of the selection process and adopted the KIRs used for the Aurora and Steepbank Mine EIAs. Following review of this list by Alberta Environmental Protection (AEP) personnel, two additional KIRs were selected: the western tanager and the pileated woodpecker. Table 1 shows the reasons behind the selection of specific KIRs. Full details of the KIR selection process are found in BOVAR (1996b) and Westworth (1996a).

Table 1 Key Indicator Resources and the Selection Rationale

KIR	Selection Rationale
moose	economic importance, early successional species
fisher	use of late seral stages, economic importance, carnivore
beaver	economic importance, semi-aquatic habits
black bear	economic importance, carnivore
red-backed vole	importance in food chain
snowshoe hare	importance in food chain
dabbling ducks	importance in food chain, economic and recreational importance
ruffed grouse	economic and recreational importance
Cape May warbler	use of white spruce forests, neotropical migrant
western tanager	use of open forest mixedwood, neotropical migrant
pileated woodpecker	use of late seral stages, large diameter trees and snags
great gray owl	raptor, use of wetlands

This report compiles information from several independent field studies in the local study area (LSA) and compares the results with other investigations in similar ecosystems and community types. Field studies for the Suncor EIA included:

- winter track counts, snow depth surveys and a winter owl survey (Golder 1997a);
- spring ungulate fecal pellet group count and browse use/availability surveys;
- spring waterfowl surveys;
- spring raptor nest survey;
- spring amphibian survey; and
- summer breeding bird surveys.

The information from the above assessments was then used to develop mitigation measures and to assess impacts of Project Millennium on wildlife.

The results of the literature review and field programs will be presented and discussed using the following wildlife assemblages:

- ungulates
- terrestrial furbearers
- semi-aquatic furbearers
- small mammals
- waterfowl
- upland gamebirds
- breeding birds
- raptors
- reptiles and amphibians

Emphasis will be placed on KIRs within each assemblage where appropriate. Each wildlife group and/or KIR is discussed in terms of its status and distribution, habitat associations, habitat modelling results and factors that act to limit their populations. Habitat modelling results for KIRs are presented in a separate document (Golder 1998d).

2. OBJECTIVES

The principal objective of this report is to provide baseline wildlife data for the Project Millennium area. Field work was focused on areas and species groups not sampled for the Steepbank Mine EIA. Data from field programs were used to determine the importance of various vegetation types as wildlife habitat for the KIR species. Specific objectives of the field programs were to determine:

- the relative abundance of and vegetation community use by ungulates during winter and early summer (Golder 1997a and this report);
- the relative of abundance and vegetation community use by furbearers during the winter (Golder 1997a);
- the relative use of the Athabasca and Steepbank river valleys by ungulates and furbearers (Golder 1997a and this report);
- the status of breeding and migrating waterfowl species;
- the relative abundance of, and vegetation community use by great gray owls, boreal owls and ruffed grouse (Golder 1997a);
- the relative abundance, species richness, species diversity and species-vegetation community assemblages for breeding birds; and
- the status of amphibians.

These data provide the basis for the Project Millennium EIA with respect to wildlife.

3. STUDY AREAS

3.1 LOCAL STUDY AREA

The local study area (LSA) was established to include the project footprint and 0.5 km buffer around the footprint (Figure 2). A buffer of 0.5 km was selected for the LSA as it met the maximum zone of disturbance (0.5 km) for wildlife used in the Aurora Mine EIA (BOVAR 1996a), the Muskeg River Mine Project EIA (Golder 1998a), the Steepbank River Mine EIA (Westworth, Brusnyk and Associates 1996a), and this assessment. The LSA was not surrounded by a 0.5 km buffer on the north and west sides, instead the Athabasca and Steepbank rivers were thought to act as natural barriers. The LSAs were identical for soils, vegetation, ecological land classification (ELC) units and wildlife.

The Project Millennium local study area encompasses 16,181 ha.

Study areas for the various field campaigns differed depending on whether similar surveys had previously been conducted within the area, and on decisions regarding the final development design. The project footprint, and hence the LSA, was not finalized until March 1998.

All of the LSA was the focus of the waterfowl surveys, songbird surveys, pellet group and browse surveys, and amphibian surveys since such studies had not been done within the study area. Difficulty with access reduced the areas available for surveying. Winter track count surveys for ungulate and furbearer distribution and habitat use were mainly conducted along the Steepbank River, the uplands north of the Steepbank River, and Shipyard Lake to compliment previous work. Westworth, Brusnyk and Associates (1996b) had previously completed winter track count surveys in the LSA. Likewise, the owl surveys were conducted entirely north of the Steepbank River.

3.1.1 Vegetation Community Types Sampled

For all wildlife studies, vegetation community types were classified according to Beckingham and Archibald (1996) and Vitt et al. (1997). These vegetation community types, or ecosite phases, are described in detail in Golder (1998b).

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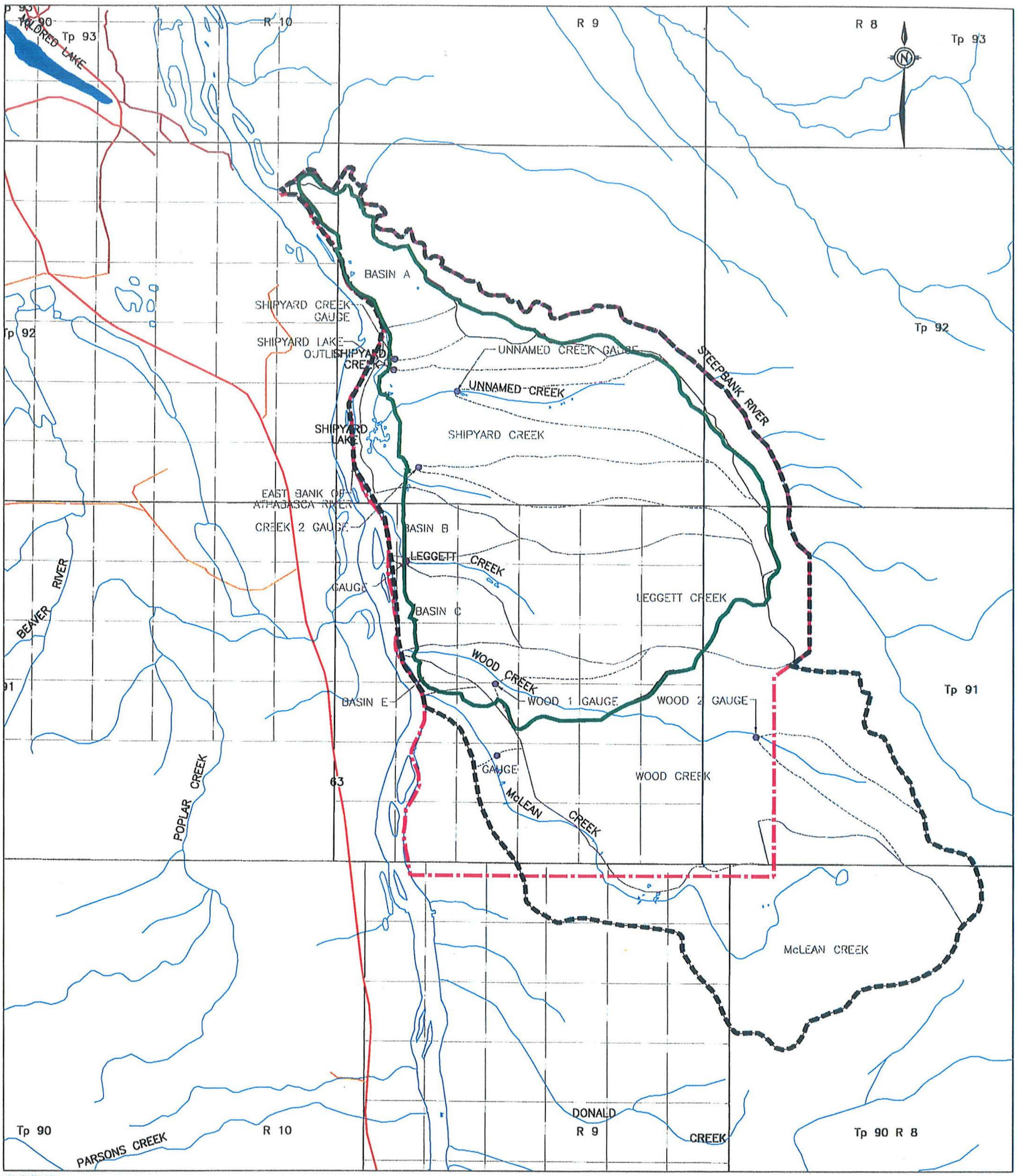

LEGEND

- EAST BANK MINING AREA
- LOCAL DRAINAGE BASIN
- LOCAL DRAINAGE SUB BASIN
- LOCAL BASIN GAUGE
- LOCAL STUDY AREA FOR TERRESTRIAL AND ARCHEAOLOGY
- LOCAL STUDY AREA FOR HYDROLOGY, HYDROGEOLOGY, WATER QUALITY AND AQUATICS

REFERENCE

DIGITAL DATA SETS 74D AND 74E RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997.
MINE PLAN SUPPLIED BY SUNCOR ENERGY, MAR 1998.
DATUM IS IN NAD83 UTM

0 1 2 3 4 5km
SCALE 1:150,000

SUNCOR ENERGY

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LOCAL STUDY AREAS FOR WATER COMPONENTS AND TERRESTRIAL

23 Mar. 1998	Figure 2	DRAWN BY: RFM

3.1.2 Landscape

For the winter track counts, three landform types were investigated at the landscape level. The first landform type was designated as escarpment. Escarpments are found along the Athabasca and Steepbank rivers. The second landform type was termed riparian and was composed of those vegetation community types adjacent to the creeks and rivers of the LSA. The third landform type, designated as upland, was composed of the remaining land area of the LSA, including wetlands. These landform types are defined in Golder (1998c).

3.2 REGIONAL STUDY AREA

A regional study area (RSA) for wildlife was selected to correspond with the RSA for vegetation and ELCs (see Golder 1997b, c; Figure 3). The boundaries for the RSA were developed in consultation with Suncor, Syncrude Canada Limited, Shell Canada Ltd., and other stakeholders, and considered a number of biophysical criteria, including watershed boundaries, ecological boundaries (based on ecological land classification criteria) and the regional airshed (based on existing air emission and deposition data). In total, the RSA encompassed 2,428,750 ha.

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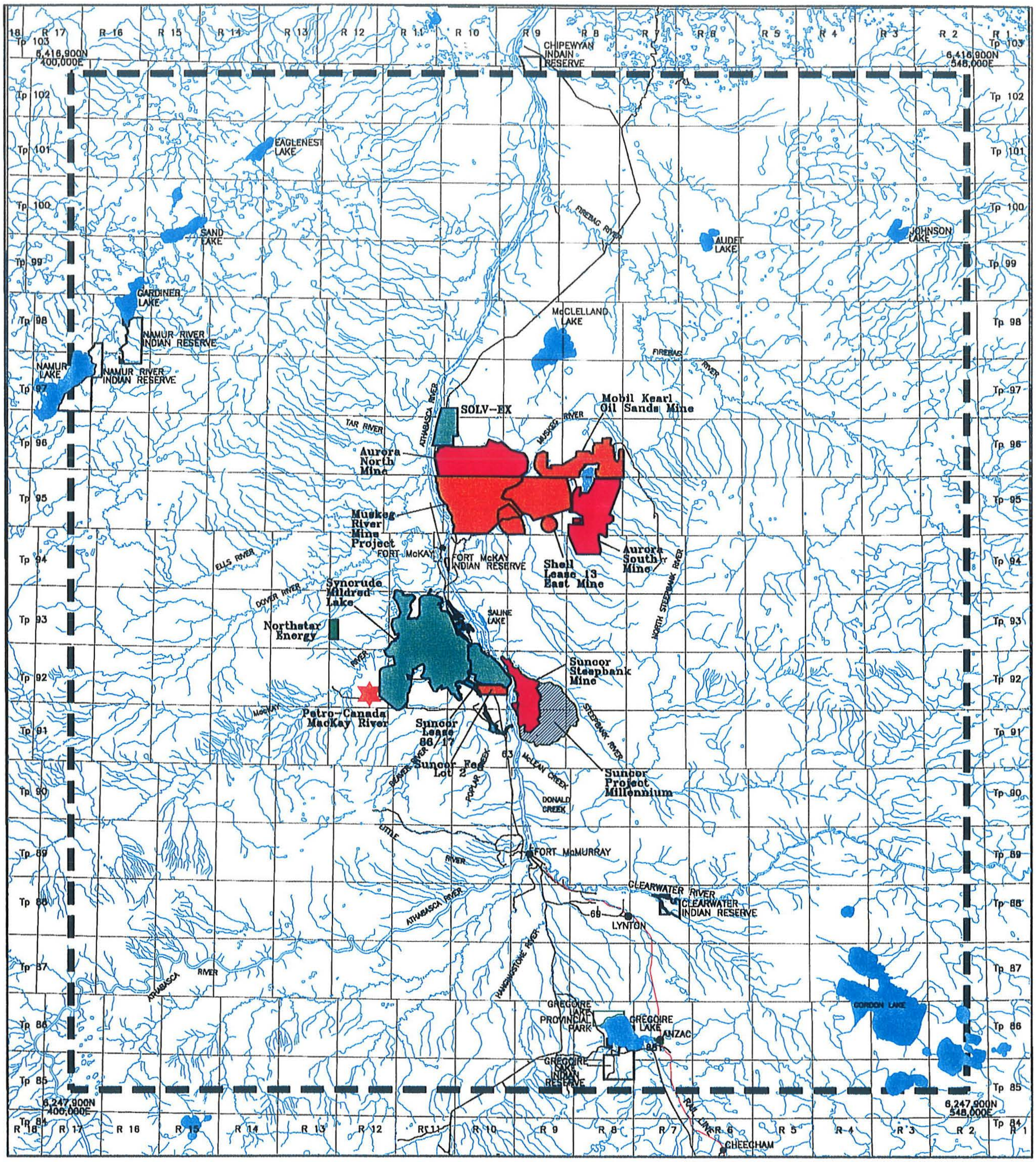

LEGEND

- EXISTING DEVELOPMENTS
- APPROVED DEVELOPMENTS
- PLANNED DEVELOPMENTS
- PROJECT MILLENNIUM
- REGIONAL STUDY AREA BOUNDARY
- ROADWAYS

0 10 20 30 40 50km

SCALE 1:1,000,000

REFERENCE

DIGITAL DATA SETS 74D, 74E, 74I
84A AND 84H FROM RESOURCE DATA DIVISION
ALBERTA ENVIRONMENTAL PROTECTION, 1997.
DATUM IS IN NAD83 UTM PROJECTION

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REGIONAL STUDY AREA

23 Mar. 1998	Figure 3	DRAWN BY: RFM/CG

4. METHODS

For all wildlife studies, a literature review was incorporated to augment the information available on wildlife species and communities. Information from the literature was also used to compare and contrast results of other studies with the patterns obtained from this study. Some KIRs (e.g., the black bear) were not studied in the field while others (e.g., the ruffed grouse and pileated woodpecker) were studied incidentally to studies of other species.

4.1 WINTER TRACK COUNT SURVEYS

Winter track counts were conducted January 23 to 27, February 21 to 24 and March 29 to 30, 1997. The January and February surveys included transects along the Steepbank River, Shipyard Lake and in an upland area of Lease 29 (Figure 4). Transects were not conducted in the upland area in March. Detailed methodology is provided in Golder (1997a).

4.2 UNGULATE SUMMER BROWSE AND PELLET GROUP SURVEY

4.2.1 Field Methods

The survey was conducted between May 9 and 16, 1997. Survey effort was interspersed across the proposed Steepbank Mine site to the extent possible given the relative inaccessibility of much of the LSA (Figure 5). Air photos were used to identify vegetation community types for sampling. Two parallel transects, 100 m in length and separated by a minimum distance of 10 m, were established within each sampling site. Each transect contained five sampling stations, spaced at 25 m intervals. Sampling stations were circular with a diameter of 5 m. Each transect was located at least 200 m from any road, and 10 m from habitat margins (to limit possible edge effects). A total of 50 paired transects were surveyed during the study.

For each sampling station, all potential browse species were identified and an estimate of percent cover (amount of browse available) was recorded. Plants were inspected for recent browsing activity and the proportion of material browsed (percent browsed) was estimated.

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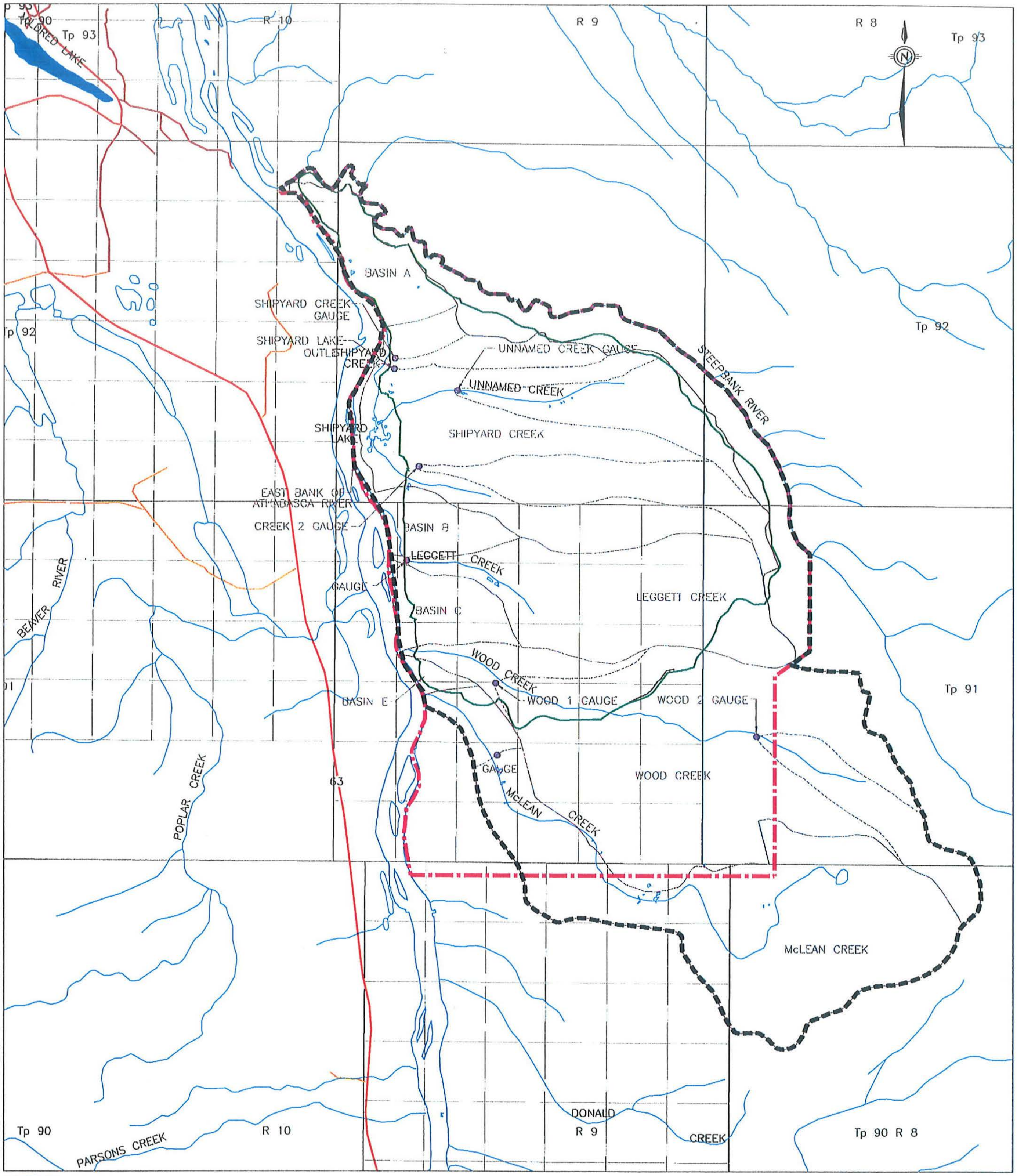

LEGEND

- EAST BANK MINING AREA
- LOCAL DRAINAGE BASIN
- LOCAL DRAINAGE SUB BASIN
- LOCAL BASIN GAUGE
- LOCAL STUDY AREA FOR TERRESTRIAL AND ARCHEAOLOGY
- LOCAL STUDY AREA FOR HYDROLOGY, HYDROGEOLOGY, WATER QUALITY AND AQUATICS

REFERENCE

DIGITAL DATA SETS 74D AND 74E RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997.
MINE PLAN SUPPLIED BY SUNCOR ENERGY, MAR 1998.
DATUM IS IN NAD83 UTM

0 1 2 3 4 5km

SCALE 1:150,000

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LOCAL STUDY AREA FOR PROJECT MILLENNIUM WETLANDS/TERRESTRIAL BASELINE

26. Mar. 1998	Figure 4	DRAWN BY: CG

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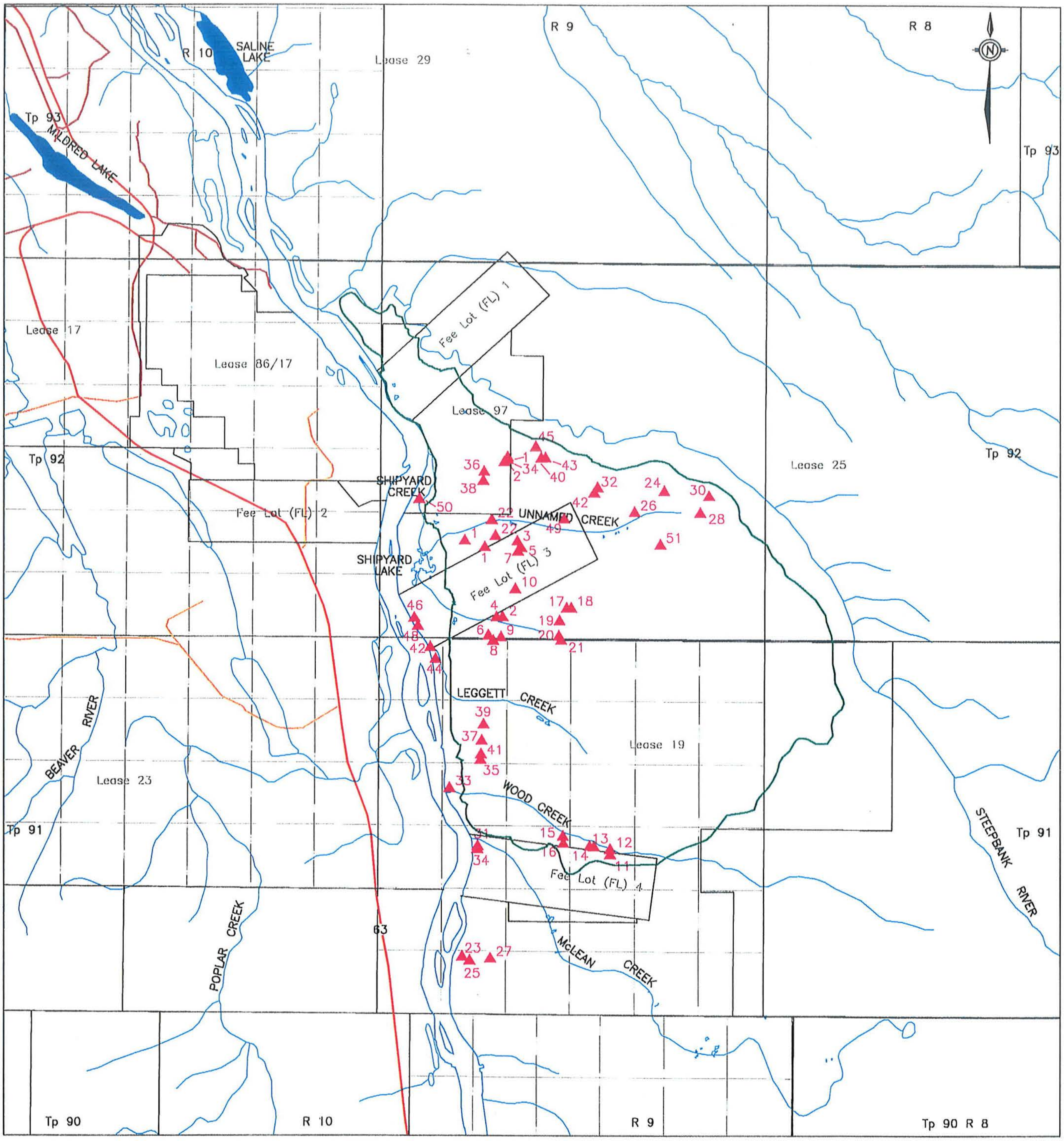

LEGEND

▲12 UNGULATES

EAST BANK MINING AREA

REFERENCE

DIGITAL DATA SETS 74D AND 74E RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997.
MINE PLAN SUPPLIED BY SUNCOR ENERGY, MAR 1998.
DATUM IS IN NAD83 UTM

0 1 2 3 4 5km
SCALE 1:150,000

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TRANSECT LOCATIONS OF THE UNGULATE BROWSE AND PELLET GROUP SURVEY

23 Mar. 1998	Figure 5	DRAWN BY: TM

Ungulate pellet groups, defined as an association of six or more pellets, were counted within a 2 m strip along each transect (1 m on each side of the transect). Pellet groups were identified by species (i.e., moose or deer). Density of pellet groups was expressed as the mean (± 1 Standard Error; SE) of the number of pellet groups observed per 400 m^2 (i.e., number per area of paired transect).

A total of 19 vegetation communities were sampled. These were later pooled into 11 subgroups to increase the power of the statistical tests (Section 4.2.2). These vegetation community types are presented in Table 2.

Table 2 Vegetation Community Types in the Project Millennium Browse-Pellet Study Area

Vegetation Community Type[a]
i1 (treed bog) FTNN (wooded fen, no internal lawns) FONS (open, non-patterned shrubby fen)
b2 (blueberry-aspen poplar-paper birch) b3 (blueberry-aspen poplar-white spruce) d1 (low-bush cranberry-aspen poplar)
d2 (low-bush cranberry-aspen poplar-white spruce)
d3 (low-bush cranberry-white spruce)
e1 (dogwood-balsam poplar-aspen poplar)
FFNN (forested fen, no internal lawns)
STNN (wooded swamp, no internal lawns)
e2 (dogwood-balsam poplar-white spruce) e3 (dogwood-white spruce) f2 (horsetail-balsam poplar-white spruce)
a1 (lichen-jack pine) b1 (blueberry-jack pine-aspen poplar) g1 (Labrador tea-subhygric)
CC (cutblock - open shrubland)
SFNN (forested swamp, no internal lawns)

[a] From Beckingham and Archibald (1996) and Vitt et al. (1997).

4.2.2 Statistical Analysis

Analysis of variance (ANOVA) was used to determine if the availability of browse material (percent browse) differed among vegetation community types. Data were subjected to the arcsine transformation before statistical analysis (Zar 1984).

Observed and expected frequencies of habitat use were calculated from the average proportion of plant material browsed and available, respectively, within sampling stations along each transect. Hence, browse availability and use were used as an index of habitat (vegetation community type) use.

The Chi-square (χ^2) goodness-of-fit test, with Yates correction, was used to analyze the effect of habitat type on browse availability and use.

As mentioned above, several similar vegetation community types were pooled to increase the power of the statistical tests. These vegetation community types included:

- b2 (blueberry-aspen poplar-paper birch) + b3 (blueberry-aspen poplar-white spruce) + d1 (low-bush cranberry-aspen poplar);
- a1 (lichen-jack pine) + b1 (blueberry-jack pine-aspen poplar) + g1 (Labrador tea-subhygric);
- e2 (dogwood-balsam poplar-white spruce) + e3 (dogwood-white spruce) + f2 (horsetail-balsam poplar-white spruce); and
- i1 (treed bog) + FTNN (wooded fen, no internal lawns) + FONS (open, non-patterned shrubby fen).

4.3 WATERFOWL SURVEYS

4.3.1 Field Methods

The waterfowl aerial survey was conducted on May 14, 1997 using a Bell 206 Jet Ranger helicopter. Mid to late-May surveys have been used in the area by the Canadian Wildlife Service in the past. The survey was completed by flying at speeds which ranged from 130 to 160 km/hour, at altitudes of approximately 100 m above ground level and lower when conditions allowed. The aerial survey began at 6:30 a.m. and concluded at 8:05 a.m. The weather conditions consisted of 100% cloud cover, which restricted the amount of sunlight penetration and allowed satisfactory viewing conditions. There was no precipitation, and the wind was approximately 20 km/h in an easterly direction.

The surveys was conducted by three observers. One observer was situated in the front seat to observe birds directly in front of the helicopter as well as on that particular side of the aircraft for each wetlands. A second observer sat on the opposite side of the helicopter and relayed all observations to a third observer. The third person recorded all of the observations and observed when possible. Communication between observers ensured that birds were not counted twice.

The survey included the visual observations of any waterfowl that were situated on, or flew from the wetlands in the LSA. Other bird species observed during the aerial survey were also recorded. Areas surveyed included the Athabasca River, Steepbank River, Leggett Creek, Wood Creek, McLean Creek, Shipyard Lake, Ruth Lake, Beaver Creek Reservoir, and Wetlands 4 and 5 (Figure 6). The Athabasca River was divided into

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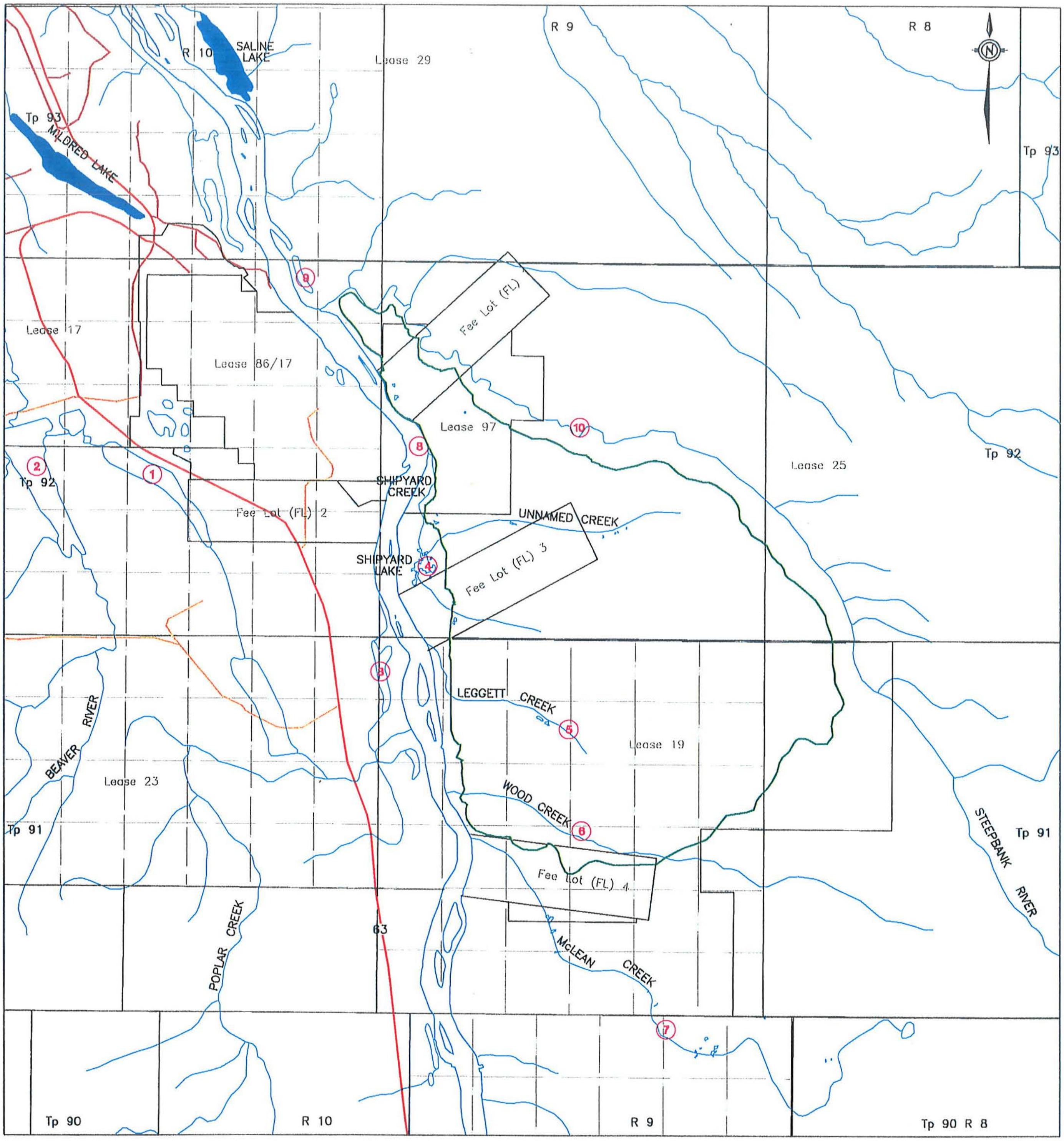

LEGEND

1. RUTH LAKE
2. BEAVER CREEK RESERVOIR
3. POND WEST OF HIGH ISLAND
4. SHIPYARD LAKE
5. LEGGETT CREEK
6. WOOD CREEK
7. McLEAN CREEK
8. ATHABASCA RIVER
9. POND NW OF ATHABASCA AND STEEPBANK CONFLUENCE
10. STEEPBANK RIVER

— EAST BANK MINING AREA

REFERENCE

DIGITAL DATA SETS 74D AND 74E RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997.
MINE PLAN SUPPLIED BY SUNCOR ENERGY, MAR 1998.
DATUM IS IN NAD83 UTM

0 1 2 3 4 5km
SCALE 1:150,000

SUNCOR ENERGY

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LOCATIONS OF SPRING WATERFOWL SURVEY

23 Mar. 1998	Figure 6	DRAWN BY: DC

two halves due to its relatively large width. Thus, the Athabasca River was flown in two segments.

Observed waterfowl were recorded according to their breeding status. Birds were recorded as lone drakes (LD), flocked drakes (FD), pairs (P), groups (G), and hens (H) (*see Glossary*). For most species, estimating the total number of individuals involved the following assumptions and calculations. The number of lone drakes was multiplied by 2 because it was assumed that the hen was on the nest. The number of flocked drakes was also multiplied by 2 because these birds were assumed to have mated earlier in the breeding season. These assumptions and calculations were not used to estimate the number of redhead, scaup, ring-necked and ruddy ducks as the sex ratio in these species is typically male biased (Dale Caswell, CWS Winnipeg, pers. comm).

No statistical analyses were conducted on the waterfowl data.

4.4 BREEDING BIRD SURVEY

4.4.1 Field Methods

Point counts were conducted between June 23 and July 2, 1997. Point count locations are shown in Figure 7. Survey effort was interspersed across the Project Millennium site due to the relative inaccessibility of much of the area. Most major vegetation community types were surveyed.

Breeding bird surveys were conducted using standard point-count methods. For each vegetation community type, 2-5 point-count stations were established in a linear orientation (Ralph 1993). These stations were spaced 250 m apart to avoid sampling the same birds twice. Additionally, point counts were conducted at least 50 m from the edge of the habitat to ensure that birds inhabiting other habitats than the one being surveyed were not counted. The location of each point-count station was referenced using the global positioning system (GPS).

Observations were divided into those less than 50 m from the observer and those greater than 50 m away, but still within the particular habitat. Only those observations within 50 m have been utilized in the analysis of the data; those within 50 m to 100 m have been utilized for species presence/absence data within the Suncor LSA. Due to the low number of detections for many species, point counts were pooled into their respective vegetation community types. A total of 19 vegetation community types were sampled at 318 sites (Table 3). However, to increase the power of statistical analyses of richness and diversity, several vegetation community types were pooled, resulting in 11 combined vegetation types.

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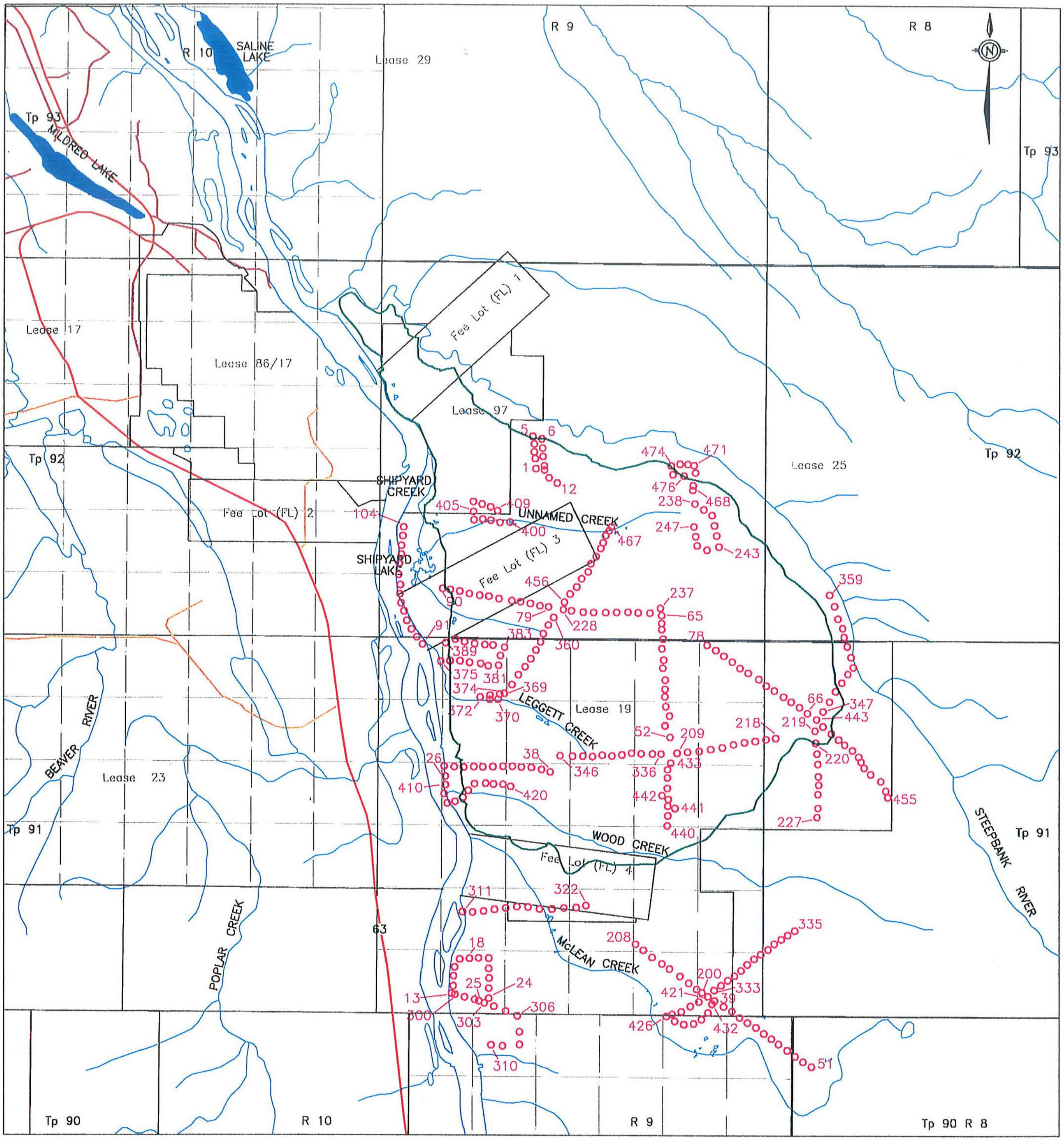

LEGEND

o92 BIRD LOCATIONS

EAST BANK MINING AREA

REFERENCE

DIGITAL DATA SETS 74D AND 74E RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997.
MINE PLAN SUPPLIED BY SUNCOR ENERGY, MAR 1998.
DATUM IS IN NAD83 UTM

0 1 2 3 4 5km

SCALE 1:150,000

SUNCOR ENERGY

Project Millennium
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LOCATIONS OF BREEDING BIRD SURVEY PLOTS

23 Mar. 1998	Figure 7	DRAWN BY: TM

Table 3 Number of Breeding Bird Point Counts for Each Vegetation Community Type in the Project Millennium Study Area

Vegetation Community Type [a]	Number of Point Counts [b]
i1 (treed bog), FTNN (wooded fen, no internal lawns) FONS (open, non-patterned shrubby fen)	146
b2 (blueberry-aspen poplar-paper birch), b3 (blueberry-aspen poplar-white spruce), d1 (low-bush cranberry-aspen poplar)	56
d2 (low-bush cranberry-aspen poplar-white spruce)	25
d3 (low-bush cranberry-white spruce)	23
e1 (dogwood-balsam poplar-aspen poplar)	20
FFNN (forested fen, no internal lawns)	14
STNN (wooded swamp, no internal lawns)	10
e2 (dogwood-balsam poplar-white spruce) e3 (dogwood-white spruce) f2 (horsetail-balsam poplar-white spruce)	8
a1 (lichen-jack pine) b1 (blueberry-jack pine-aspen poplar) g1 (Labrador tea-subhygric)	7
CC (cutblock-open shrubland)	5
SFNN (forested swamp, no internal lawns)	4

(a) From Beckingham and Archibald (1996) and Vitt et al. 1997.
(b) Number of replicates for each vegetation community type.

Surveys began approximately a half-hour before sunrise and continued until approximately 10:00 a.m. Sampling began 1 minute after the observer arrived at the station to allow the birds to settle after the observer's approach. All birds observed or heard within a 10 minute sampling period were recorded. Observations were divided into those recorded in the first three minutes of the survey and those in the remaining seven minutes. This allows comparison and exchange of data with the North American Breeding Bird Survey. Surveys were not conducted during high winds (e.g., Beaufort Scale >5; trees in leaf sway) or inclement weather, which would reduce the likelihood of identifying species.

Species flying through or above the canopy were also recorded; however, these observations have not been included in the analysis. The movements of the identified species were carefully monitored to minimize the probability of recounting the birds within the same or adjacent plot.

4.4.2 Statistical Analysis

The Shannon Index was used to calculate species diversity for each vegetation community type. Non-parametric analysis of variance (Kruskal-Wallis, χ^2 approximation) was used to compare species diversity or richness among vegetation community types. All bird species detected in the Suncor LSA were used in the analysis of species diversity and richness.

When sample size is adequate, two-way indicator species analysis (TWINSPAN) is often performed to classify bird species and habitat communities (i.e., vegetation community types). However, while the number of species detected was high, the number of individuals detected was too low to warrant an ordination analysis such as TWINSPAN. Therefore, a descriptive, non-statistical presentation of bird species habitat associations was used instead.

4.5 RAPTOR SURVEYS

4.5.1 Hawks, Eagles and Falcons

A survey for raptor nests was conducted concurrently during the aerial waterfowl survey (Section 4.3). Attention was focused on the peripheral areas surrounding wetlands. Observed nests were located on a 1:50,000 map of the LSA.

4.5.2 Owls

Owl surveys were conducted during the evenings of March 27 and 28, 1997. Methods are provided in Golder (1997a). Sample locations are shown in Figure 8.

4.6 AMPHIBIAN SURVEYS

4.6.1 Field Methods

The amphibian surveys were conducted between May 9 and 27, 1997. Survey effort was interspersed across the Project Millennium area to the extent possible given the relative inaccessibility of much of the area (Figure 9). Wetlands within most major ELC units were surveyed.

Prior to the survey dates, aerial photographs were studied to identify wetlands sample sites. Upon arrival at the study area, it was determined that a majority of the LSA was covered with temporary pools and standing water. Rather than attempting to sample discreet wetlands, it was decided that a series of transects would be sampled, with permanent wetlands sampled opportunistically.

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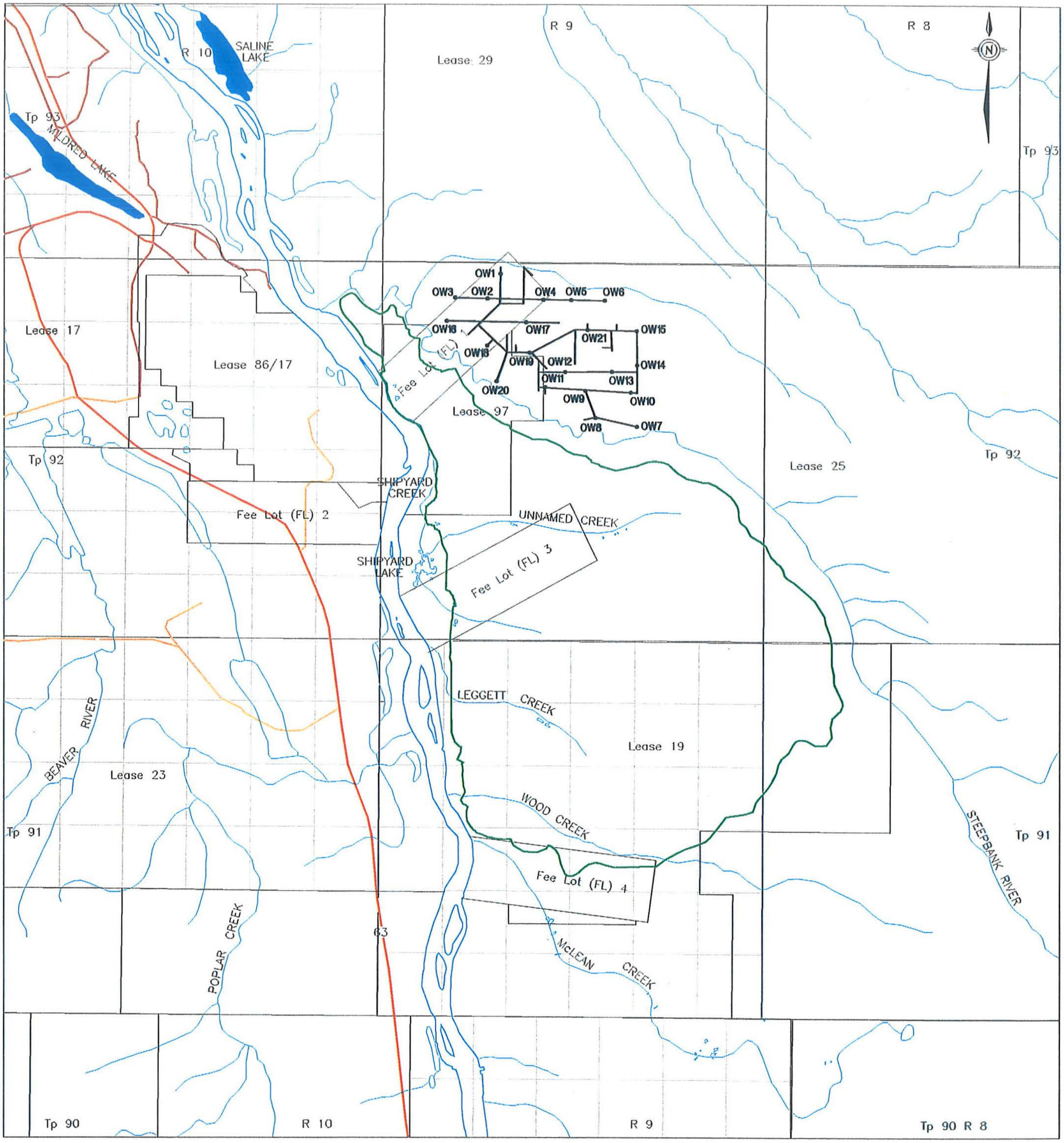

LEGEND

TRANSECT LINE

OW17 OWL PLOT SURVEY NUMBER

EAST BANK MINING AREA

REFERENCE

DIGITAL DATA SETS 74D AND 74E RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997.
MINE PLAN SUPPLIED BY SUNCOR ENERGY, MAR 1998.
DATUM IS IN NAD83 UTM

0 1 2 3 4 5km

SCALE 1:150,000

SUNCOR ENERGY

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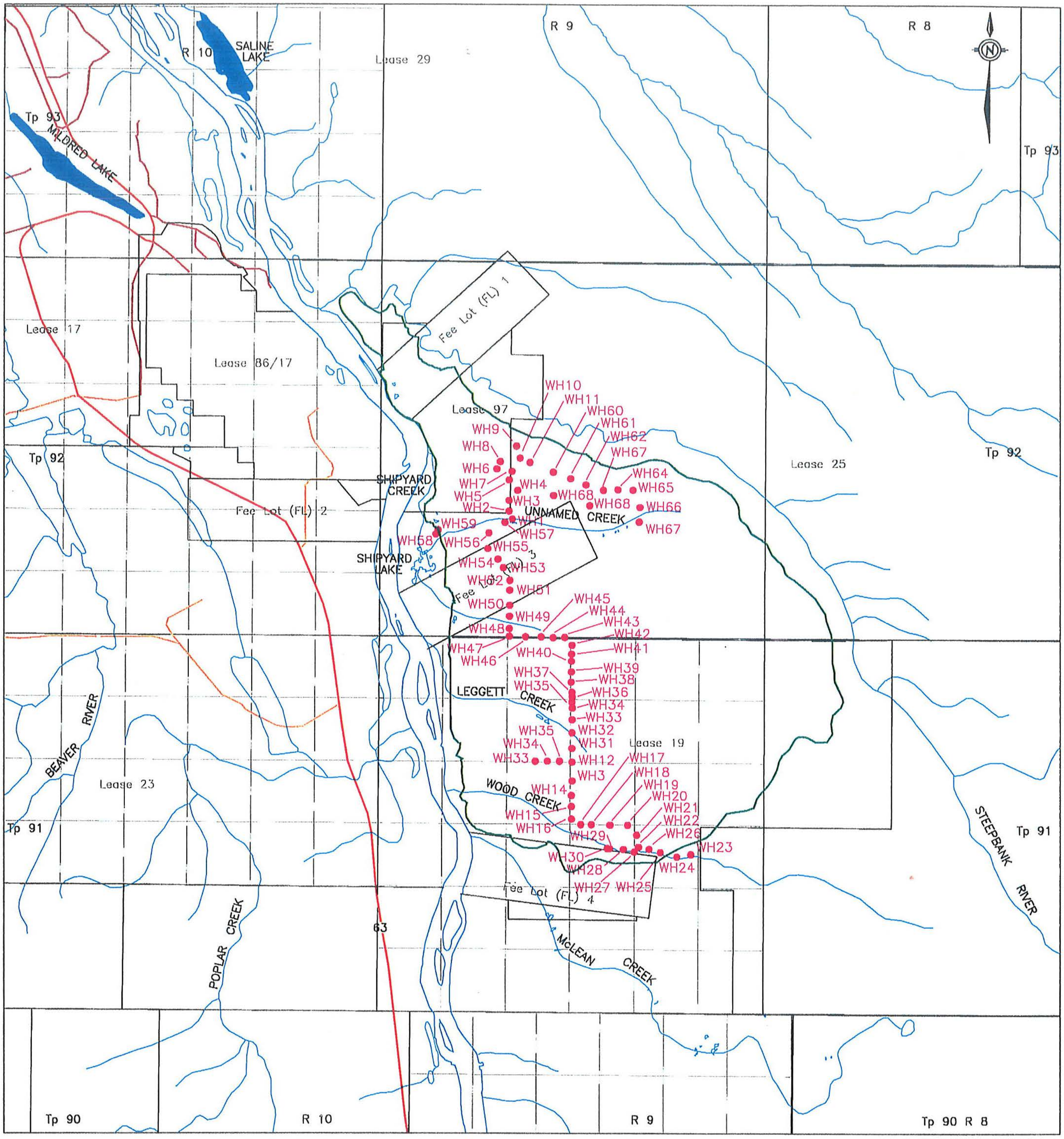
OWL SURVEY PLOT LOCATIONS

23 Mar. 1998	Figure 8	DRAWN BY: RFM/BGM

J:\1997\2205\7500\frogs.dwg



LEGEND

WH9 FROG LOCATIONS

EAST BANK MINING AREA

SUNCOR ENERGY

Project Millennium
Taking Suncor Into the 21st Century

LOCATIONS OF AMPHIBIAN SURVEY SITES

REFERENCE
DIGITAL DATA SETS 74D AND 74E RESOURCE DATA DIVISION, ALBERTA ENVIRONMENTAL PROTECTION, 1997.
MINE PLAN SUPPLIED BY SUNCOR ENERGY, MAR 1998.
DATUM IS IN NAD83 UTM

0 1 2 3 4 5km
SCALE 1:150,000

23 Mar. 1998	Figure 9	DRAWN BY: TM

Survey transects were established along cutlines within the proposed development area. Sample points were separated by a minimum of 400 m to avoid detecting the same calls twice. Surveys were conducted between sunset and sunrise, and were rescheduled if temperatures approached 0 °C.

At each sample point, a site description was recorded to delineate the wetland types, as follows:

- transect point - no adjacent wetlands;
- permanent pond - adjacent permanent wetlands, including dammed creeks; and,
- semi-permanent pond - adjacent wetlands, thought to be temporary.

Transect points were established systematically along access trails while ponds were surveyed opportunistically wherever they were encountered. Following the site description, a one minute 'quiet' period was observed to encourage disturbed amphibians to resume calling. After the quiet period, a five minute auditory survey was conducted. Calls for each amphibian species were ranked using a typical call index (Heyer et. al. 1994):

- 0: no calls;
- 1: space between calls, individuals can be counted;
- 2: some overlapping of calls, but individuals can still be counted; and,
- 3: constant, continuous overlapping calls (i.e., a full chorus).

Calls were further divided on the basis of location. Individual numbers were recorded for adjacent wetlands and, where possible, surrounding wetlands at the discretion of the observers.

Amphibians respond to environmental conditions, including temperature and rainfall. For this reason, weather conditions (air and water temperatures, wind speed and cloud cover/precipitation) were recorded at each site. Surveys were discontinued if air/water temperatures or wind conditions were judged to interfere with amphibian calls or call perception.

Upon completion of the survey, GPS coordinates were recorded to provide data for map preparation. After a period of approximately one week, a second visit was made to each survey site. This was done to minimize temporal error caused by surveying wetlands too early or too late, and to minimize poor results due to questionable weather conditions.

4.7 HABITAT SUITABILITY MODELLING

Habitat Suitability Index (HSI) models were used to assess the baseline habitat conditions for KIRs in the LSA and RSA (Golder 1998d). Models were adapted from AXYS (1996a), Westworth (1996a) and Golder (1998e). A brief description of the HSI process follows, with a more detailed description of the process and models provided in Golder (1998d).

4.7.1 Theory and Use Of HSI Models

HSI models are analytical tools for determining the relative potential of an area to support individuals (or populations) of a wildlife species. They are frequently used to quantify potential habitat losses and gains for wildlife species as a result of various land use activities. HSI models were initially developed by wildlife managers in the United States in the 1970s when the focus for wildlife management shifted from monitoring individuals to monitoring habitat. Concurrently, the use of computer technology was expanding to allow managers to apply habitat concepts in much larger areas. By the early 1980s, a standard set of protocols for the development and use of HSI models had been published (U.S. Fish and Wildlife Service 1981). Although largely ignored in Canada until the late 1980s, an environmentally conscious public pushed the need for habitat information to the forefront of many company planning processes. Today, many EIAs use HSI modelling to determine the potential impacts of project activities on wildlife resources.

4.7.2 Background

HSI models are used to evaluate the potential of an area to support a wildlife species, based on a number of known or assumed relationships between elements of habitat structure and their ability to support a species' biological needs (e.g., food, cover, reproduction). These relationships are then combined mathematically into models. They are referred to as index models because the rating they provide is a relative value ranging from 0 to 1, where 0 indicates that an area is unsuitable and 1 indicates optimum suitability. Often, HSI values for each habitat type are multiplied by the area (ha) of the habitat type or area under consideration to determine the number of habitat units (HU) for each wildlife species.

HSI models cannot provide information about abundance and other demographic characteristics of wildlife populations and cannot be used as a substitute for population data. They are appropriate, however, for the following purposes:

- determining a ranking of the capability of a single habitat area to support various wildlife species, such that management plans can reflect the needs of wildlife in the area, or so a baseline status of wildlife habitat is known before habitat modifications;

- comparing different habitat types or areas to determine where various wildlife species are most likely to be affected by land management activities, or to plan for areas that are highest priority for protection; and
- comparing the same area at different times by predicting changes to the habitat structure as a result of industrial activity and/or natural succession.

5. RESULTS AND DISCUSSION

5.1 UNGULATES

5.1.1 Moose

5.1.1.1 Status and Distribution

Several aerial and winter track count surveys have been conducted in the oil sands area of northeastern Alberta in the last 25 years. Early estimates of moose density were 0.09/km^2 for the Lease 13 area (Shell 1975), and 0.31/km^2 for the larger Alsands area (Bibaud and Archer 1973). Current estimates for the Lease 12, 13 and 34 (Aurora North) areas are approximately 0.10/km^2 (Westworth, Brusnyk and Associates 1996c), indicating that moose populations in the Lease 13 area have remained low and relatively stable. Low moose densities may reflect the shortage of preferred winter habitat (deciduous and mixedwood forest) in the general oil sands development area (BOVAR 1996b). Prime moose habitat with minimal hunting mortality, such as the Peace Athabasca Delta, can support moose populations of 0.4 to 1 moose/km^2 (Telfer 1984).

5.1.1.2 Habitat

Analysis of the browse data collected in this study indicated that the average percent browse available to ungulates was not statistically different among vegetation community types ($F_{5,40} = 2.293$, $P = 0.064$). Similarly, there was no difference in the use of different vegetation community types by ungulates ($\chi^2 = 2.08$, $P > 0.50$). Therefore, ungulates tended to use vegetation communities in proportion to the supply of each vegetation community within the LSA (Table 4). Browse data collected could not be uniquely attributed to either moose or deer. Although some habitats appeared to be preferred (e.g., dogwood-balsam poplar-aspen poplar), or avoided (e.g., fens), the lack of statistical significance was likely due to the limited number of browse observations and the large number of habitats analyzed.

Table 4 Mean Browse Available and Expected and Observed Proportion of Browse Used by Ungulates Among Vegetation Community Types

Vegetation Community[a]	N[b]	Percent Browse Available	Expected Proportion Used	Observed Proportion Used
b2 (blueberry-aspen poplar-paper birch) b3 (blueberry-aspen poplar-white spruce) d1 (low-bush cranberry-aspen poplar)	11	10.7	0.018	0.311
d2 (low-bush cranberry-aspen poplar-white spruce)	5	8.3	0.014	0.078
d3 (low-bush cranberry-white spruce)	7	7.8	0.013	0.264
e1 (dogwood-balsam poplar-aspen poplar)	4	18.8	0.032	0.960
e2 (dogwood-balsam poplar-white spruce) e3 (dogwood-white spruce)	3	14.6	0.025	1.116
i1 (treed bog), FTNN (wooded fen, no internal lawns) FONS (open, non-patterned shrubby fen)	16	15.5	0.027	0.406

[a] From Beckingham and Archibald (1996) and Vitt et al. (1997).
[b] N = Number of replicates for each vegetation community type.

Availability of browse was greatest in the e1 (dogwood-balsam poplar-aspen poplar) vegetation community, followed by the combined wetlands sites (i1, FTNN, FONS), the combined e2 and e3 sites, the combined b2, b3 and d1 sites, d2 and d3 vegetation communities (Table 4). Except for the combined wetlands sites (i1, FTNN, FONS), these habitats contain preferred browse material such as willow, red-osier dogwood and Saskatoon, and also provided good cover. The dogwood sites (e1, e2, and e3), in particular, were heavily browsed by ungulates. Although the combined wetlands sites had a large amount of plant material available, most of the shrubs (e.g., cinquefoil and bog birch) were not preferred forage and likely received limited use by ungulates.

Winter track count and fecal pellet surveys confirmed the presence of moose as the dominant ungulate species in the study area. However, the frequency of moose tracks and pellet groups detected among vegetation community types was too low to warrant statistical analysis. Of the moose tracks observed, the greatest number was recorded in the riparian shrubland (shrub) (0.35 tracks/km-track day).

Previous studies in the oil sands area confirmed the selection of deciduous forest, mixedwood forest and riparian areas by moose. Alsands (1978), Westworth (1979, 1980) and Westworth, Brusnyk and Associates (1996b) found moose were most often associated with aspen and mixedwood forests during the winter. During aerial surveys, Westworth (1979) found that 67% of moose observations occurred in deciduous and mixedwood habitat. A later study by Skinner and Westworth (1981), using both aerial and winter track count surveys, also showed that moose preferred riparian shrub areas.

Moose are generalist species with broad habitat requirements (Jackson et al. 1991). Although generalists, they require several habitat types in close proximity to prosper on a year round basis. Early seral stage forest in juxtaposition with mature forest and waterbodies provides a diverse mix of habitat that is ideal for moose (Peek et al. 1976; Hamilton et al. 1980; Monthey 1984). Large areas dominated by even-aged stands of mature coniferous forest lack the vegetative diversity to support large populations of moose.

Availability of preferred food species largely determines habitat selection by moose, but is seasonally variable depending on their nutritional needs. Compared to other ungulates, moose respond more to food availability than to cover requirements (Kearney and Gilbert 1976; Telfer 1978b; Rounds 1981). However, the majority of moose foraging occurs within 100 m of suitable cover (Hamilton et al. 1980; OMNR 1984).

Deciduous plants represent the most important food source for moose throughout the year (Telfer 1978a; Crête 1988; Timmerman and McNichol 1988). Since deciduous plants are most abundant in hardwood dominated vegetation communities, regenerating forest, and riparian areas, these habitat types are critical for moose to meet their energetic requirements (Vallee et al. 1976; Bangs and Bailey 1985; Jackson et al. 1991). Moose are seldom far from water during the summer. Aquatic plants, relief from heat stress and insects, and security from predators, all draw moose to riparian habitats (Jackson et al. 1991).

5.1.1.3 Habitat Modelling

AXYS (1996a) compiled habitat suitability ratings for moose within the Syncrude local and regional study areas. Within the Syncrude LSA, aspen-dominated and edge communities were identified as prime habitat. These habitat types accounted for 8% of the local area. A further 30% of the local area was identified as moderate quality habitat. At the regional scale, 17% of the area was identified as high quality habitat and 40% was moderate. Similar to the analysis at the local level, prime habitat was associated with deciduous forest stands.

The model used by AXYS was also used for the Muskeg River Mine Project EIA study. It is described in Golder (1998e), with background details found in AXYS (1996a). A total of 4,679 HUs occur within the Shell Lease 13. Of these, 20% were classified as low quality, 32% as moderate quality and 48% as high quality habitat.

The model used by AXYS (1996a) and Golder (1998e) was used for this study as well. The model and results for the Project Millennium LSA and RSA are described in Golder (1998d).

5.1.1.4 Landform Types

Riparian areas typically exhibit a high diversity of shrub species, some or all of which may be favoured as browse by ungulates. At the habitat level, upland vegetation community types, such as aspen and mixedwood forests, may provide similar diversity and abundance of preferred browse species to riparian areas. On Shell Lease 13, browse and fecal pellet studies indicated that relative use of the riparian landform was greater than for the upland landform (Golder 1998a). Winter track counts for this study indicated that moose use riparian areas in January and February and move to upland areas in March. Therefore, at the landscape level, riparian areas appeared to represent prime habitat for moose in the regional area. However, upland areas may be seasonally important.

In previous studies, moose were shown to prefer browsing in riparian areas, particularly when the surrounding upland areas consisted of peatland or conifer habitat (Westworth 1980). Riparian areas also provide moose and other ungulates with quality habitat for calving (Cederlund et al. 1987). High and variable density of vegetation cover within riparian habitats decreases the risk of predation on calves.

In addition to providing quality forage and calving habitat for moose, riparian areas also serve as travel corridors for ungulates (Brewster 1988). Travel corridors can be important for seasonal migration between habitats as well as facilitating dispersal of individuals across the landscape. Westworth (1980) and Westworth, Brusnyk and Associates (1996b) showed that moose often use riparian habitats for foraging and travel routes during seasonal shifts in habitat use. AOSERP studies using radio-telemetry (Hauge and Keith 1981), found that many moose (62%) made seasonal, short range movements in response to changing snow conditions. These moose moved an average of 6 km to winter range when snow conditions became thick and soft in December and January. Thirty-eight percent of the radio-collared moose made greater movements (i.e., more than 20 km) between summer ranges in the Birch Mountains and/or the Muskeg Mountain area and winter ranges near the Fort Hills and the Athabasca River. Movements along or parallel to the Athabasca River valley were not evident.

5.1.1.5 Limiting Factors

Moose populations are essentially limited by human or natural predation and competition for resources (Messier 1994). Thus, habitat selection by moose is a function of the availability and quality of food, and cover from predators. The two major causes of moose mortality are predation by wolves and humans (Hauge and Keith 1978). Wolf presence in the oil sands region is thought to be low due to low prey abundance (BOVAR 1996b). Human hunter access in the region, conversely, has increased and could partially account for low moose numbers (BOVAR 1996b).

Increased access and cutting of the forest has also resulted in the range expansion of white-tailed deer. White-tailed deer are known carriers of brainworm, a parasitic nematode. Although the parasite is benign in deer, it is fatal in moose and caribou (Anderson and Strelive 1968). However, the presence of this mortality agent in the moose population of the Suncor LSA is currently unknown.

5.1.2 Deer and Other Ungulates

5.1.2.1 Status and Distribution

Mule deer are traditional residents of the western boreal forest and are most frequently associated with cleared or disturbed habitat. Populations are generally small and localized. At one time white-tailed deer were not found in the oil sands area. Recent changes to access and creation of open habitat for this species has resulted in a northern range expansion (BOVAR 1996b). Both mule deer (Alsands 1978) and white-tailed deer (Westworth 1980) have been observed during aerial surveys. Westworth, Brusnyk and Associates (1996c) estimated white-tailed deer populations on the Lease 12, 13 and 34 areas at $0.08/km^2$.

Woodland caribou, and possibly elk, were residents of the oil sands area in the past. Caribou exist at low densities 60 km northwest of the Aurora Mine site, while elk are restricted to the Athabasca River south of Fort McMurray (BOVAR 1996b).

5.1.2.2 Habitat

In general, high quality white-tailed deer habitat consists of spatially heterogeneous areas (Runge and Wobeser 1975) containing a variety of forage species in proximity to areas that provide suitable cover from weather, predators and insects. Like moose, deer benefit from abundant browse and cover along watercourses, and may use them as travel corridors during seasonal or dispersal movements (Brewster 1988). Essentially, white-tailed deer have the same habitat requirements as moose. An exception is that moose are more tolerant of areas with up to 60 cm of snow, while white-tailed deer are hindered by snow depths in excess of only 20 cm (Kelsall and Prescott 1971).

The majority of deer tracks found within Shell leases were found in cleared peatlands and aspen forest (Westworth, Brusnyk and Associates 1996b). Westworth (1980) also noted the presence of deer in regenerating areas.

Deer browse could not be differentiated from moose browse during the 1997 Suncor browse study. It is expected that the majority of the browse/ use recorded was due to moose, as the number of deer in the area appeared extremely low (i.e., few deer tracks were detected during the Suncor winter track count survey, and fecal pellet observations were too few to warrant analysis among vegetation community types). Although no habitat preferences could be drawn from the Suncor browse and pellet count survey, it is expected that any deer present in the LSA would be found primarily in early regenerating or open stands with abundant deciduous browse.

5.1.2.3 Landform Types

Deer, like moose, preferred riparian areas over upland and escarpment landforms (Golder 1997a). Deer benefit from abundant browse and cover along watercourses, and may use them as travel corridors during seasonal or dispersal movements (Brewster 1988).

5.1.2.4 Limiting Factors

Deer may be limited by the availability of suitable habitat, winter conditions (snowfall and temperature) and predation (natural and human). Because white-tailed deer are at the northern limit of their range in the oil sands area, they will ultimately be limited by winter weather conditions (i.e., snow depth, temperatures). Nevertheless, activities that produce early regenerative stands will likely benefit deer populations by increasing food availability. Therefore, the production of regeneration habitat within the Suncor LSA and surrounding areas will likely be associated with an increase in deer abundance. However, the increase in abundance may be limited by mortality from wolves and hunters.

5.2 TERRESTRIAL FURBEARERS

5.2.1 Canids: Wolves, Coyotes and Foxes

5.2.1.1 Status and Distribution

Wolves, coyotes and foxes are all found in the boreal forest. Previous studies have found the coyote to be the most abundant large carnivore in the oil sands area. Track densities during winter track count surveys have ranged from a low of 0.09 tracks/km-track-day (Westworth, Brusnyk and Associates 1996c) in the Lease 12, 13 and 34 areas, to a high of 0.29 tracks/km-track-day (Alsands 1978) for the general Syncrude Lease area. Golder (1998a) recorded 0.10 tracks/km-track day for coyotes in March of 1997 on the Shell Lease 13 study site. Winter track counts for this study recorded 1.32 tracks/km-track day in January and 5.87 tracks/km-track day in February for coyotes (Golder 1997a).

Due to low population sizes and large home ranges, low track densities for wolves were previously recorded in the RSA. Track densities range from 0.01 tracks/km-track-day for the Lease 88 and 89 area (Skinner and Westworth 1981), to 0.05 tracks/km-track-day for the Lease 12, 13 and 34 area (Westworth, Brusnyk and Associates 1996c). Earlier estimates of density for the Lease 17 and 22 area were 1 wolf/100 km^2 (Westworth

1979). A study in northeastern Alberta estimated wolf density at 11.1 wolves/1000 km^2 (Fuller and Keith 1980). Wolf track densities for the study area for the month of March were 22.81 tracks/km-track day for the Steepbank River area . No wolf tracks were seen in the Upland Lease 29 area.

Foxes, like wolves, are uncommon in the oil sands area and occur at low densities. Track densities range from 0.01 tracks/km-track-day in the Lease 12, 13 and 34 area (Westworth, Brusnyk and Associates 1996c), to 0.08 tracks/km-track-day in the Lease 88 and 89 area (Skinner and Westworth 1981). No fox tracks were recorded during the 1997 winter field work.

5.2.1.2 Habitat

Coyotes are generalist predators that tend to prefer cleared and agricultural fringe sites, while avoiding densely forested areas (Boyd 1977). Previous studies found a preference for riparian white spruce areas and cleared peatlands (Skinner and Westworth 1981; Westworth, Brusnyk and Associates 1996b, 1996c). The 1997 winter track count survey indicated that coyote tracks were most often detected in disturbed areas (CIU) (4.31 tracks/km-track-day), wooded fens (FTNN) (1.56 tracks/km-track-day) and wooded bogs (BTNN) (1.32 tracks/km-track-day).

Wolves also tend to prefer open areas, avoiding heavy coniferous cover in winter (Penner 1976). No wolf tracks were encountered in the upland study transects during the winter track count survey, thus habitat preferences for wolves could not be determined.

Red foxes, like coyotes and wolves, prefer semi-open country, and are more commonly found in grassland regions (Banfield 1987). Previous studies have discovered tracks in jack pine and riparian white spruce areas (Skinner and Westworth 1981) and near garbage dumps (Alsands 1978). Red fox tracks were only recorded during the Steepbank River surveys. Thus, habitat preferences for red foxes could not be determined for this study.

5.2.1.3 Landform Types

Riparian areas can provide habitat and movement corridors for all three species of canids. Generalists, like coyotes and foxes, prefer to concentrate foraging activities in habitats that provide a wide array of potential food items (e.g., insects, berries, plants, small mammals; Bekoff 1977). The high structural diversity of riparian zones is typically associated with such foraging opportunities. While neither coyotes or red foxes showed a landscape preference during the winter track count surveys, few coyote or fox tracks were recorded.

Wolf movement is often concentrated along rivers and paths and landforms such as escarpments (Penner 1976). Although wolves will use riparian habitat for hunting and travelling during winter, hunting success of wolves is likely greater in upland habitat. High snow accumulation in riparian, and other open areas, would make travel for deer and moose difficult and cause them to use closed conifer and mixedwood communities with less snow (see Section 5.1). These habitats would also have a less dense shrub layer and increase the chance of wolves sighting and capturing prey. In fragmented landscapes, streams and rivers (e.g., Steepbank and Athabasca rivers) may provide safe travel corridors for wolves searching for moose and deer in patchy habitat. Few wolf tracks were recorded during the winter track count surveys. Wolves did show a preference for upland areas and avoided the escarpment in January.

5.2.1.4 Limiting Factors

Canids in the area are limited by the presence of open habitat, food resources, competition and human disturbance. Wolf density is tied directly to the ungulate density (Messier 1994). Moose and deer density in the oil sands area is fairly low, resulting in low wolf numbers. Although coyotes are more general in their diet, their densities have been shown to fluctuate in response to changes in snowshoe hare and microtine rodent populations (Nellis and Keith 1976; Todd 1978). Red foxes will also prey on hares and rodents, but have not shown a dependence on either species.

Although there is little niche overlap among foxes, wolves and coyotes, species interactions do occur. Wolves may kill coyotes within their territory (Fuller and Keith 1980). Of greater significance for the three species is the influence of anthropogenic disturbance on populations. Coyotes and foxes are expected to respond favourably to small-scale disturbances that create open or edge habitat. Wolves, however, tend to avoid areas disturbed by humans. Complete loss of habitat, such as that caused by oil sands development, is expected to reduce the number of canids in the immediate area.

5.2.2 Terrestrial Mustelids: Wolverines, Fishers, Martens and Weasels

5.2.2.1 Status and Distribution

Wolverines, due to their solitary nature and large home range (100-900 km^2; Banci 1994), are considered to be the most uncommon carnivore in the oil sands area. Skinner and Westworth (1981) found a track density of 0.005 tracks/km-track-day for the Lease 88 and 89 area. No tracks were observed for the Aurora EIA (Westworth, Brusnyk and Associates 1996b). No wolverine tracks were observed in the winter track count surveys for this project or for the Shell Muskeg River Mine Project EIA (Golder 1998a). Estimated population density for the Lease 17 area was calculated to be 0.08 animals/100 km^2 (Westworth 1979).

Fishers, although relatively more numerous, are similarly considered uncommon in the area. Track densities for the Lease 12, 13 and 34 area were 0.02 tracks/km-track-day (Westworth, Brusnyk and Associates 1996c). Fisher track densities during the Steepbank River winter track counts were fairly high with densities of 25.58 tracks/km-track day in January, 37.35 tracks/km-track day in February, and 2.56 tracks/km-track day in March. In the Upland Lease 29 surveys, fisher track density was recorded at 22.17 tracks/km-track day in February (Golder 1997a). A density of 0.43 fishers/100 km^2, based on trapping data was estimated for the Fort McMurray area (Westworth 1979).

Westworth (1979) classified martens as scarce in the Lease 17 area. Recently, Westworth, Brusnyk and Associates (1996c) reported that track densities for the Lease 12, 13 and 34 areas were 0.15 tracks/km-track-day, suggesting a possible resurgence of martens in the area. Marten were recorded at densities of 14.47, 11.06, and 18.32 tracks/km-track day in January, February, and March of the Steepbank River surveys. In the Upland Lease 29 surveys, marten densities were recorded at 5.68 tracks/km-track day in January and 181.07 tracks/km-track day in February (Golder 1997a). These high numbers may be indicative of the continued resurgence of marten.

Weasels are the most common carnivores in the oil sands area. Ermines are considered abundant and least weasels uncommon, although the inability to distinguish the species based on tracks makes this speculative. Combined track densities for the two species were 1.14 tracks/km-track-day for the Lease 88 and 89 areas, and 1.22 tracks/km-track-day for the Lease 12, 13 and 34 areas (Westworth, Brusnyk and Associates 1996c). A track density of 1.12 tracks/km-track-day was recorded in 1997 in the Shell Lease 13 area (Golder 1998a). Weasels were recorded at 30.52 tracks/km-track day in January and 29.02 tracks/km-track day in February for the Steepbank River surveys. No weasel tracks were recorded in March during that survey. In the Upland Lease 29 surveys, weasel tracks were recorded at 6.63 and 61.63 tracks/km-track day in January and February, respectively.

5.2.2.2 Habitat

Due to the large size of a wolverine's home range, occasional use of the study area by wolverines cannot be discounted, although recent wildlife surveys within the oil sands area have failed to record the species. Wolverines are thought to prefer undisturbed areas of coniferous forest (Pasitschniak-Arts and Larivière 1995). However, no tracks were found during the 1997 winter track count survey, and habitat preferences could not be determined.

Martens and fishers are thought to prefer middle to late stage coniferous forests (Buskirk and Ruggiero 1994, Powell and Zielinski 1994). Inventory work on Lease 12, 13 and 34 (Westworth, Brusnyk and Associates 1996c) showed that fisher tracks were found in greatest frequency in riparian balsam poplar forest. In the Upland Lease 29 study area, fisher avoided lichen-jack pine (a1), low-bush cranberry-white spruce (d3), low-bush cranberry-aspen poplar (d1) and Labrador tea-subhygric-white spruce-black spruce (h1). Chi-square analysis suggested that martens preferred low-bush cranberry-white spruce (d3).

The ermine and least weasel prefer riparian, deciduous and early successional habitats, due in part to the abundance of small mammal prey usually found in these areas (Banfield 1987). Contradictory results were found in previous track count surveys. Westworth and Brusnyk (1982) found the majority of tracks in black spruce muskeg, riparian white spruce and mixedwood areas. Westworth, Brusnyk and Associates (1996c) found a preference for open tamarack/bog-birch, black spruce/tamarack and cleared peatlands in the Lease 12, 13 and 34 areas. The Shell Lease 13 winter track count survey found a preference for closed mixedwood-white spruce-dominant (Golder 1998a). In the Upland Lease 29 surveys, weasels avoided riparian shrubland (shrub) and open, shallow water (WONN) in January. Weasels showed no preference in February.

5.2.2.3 Habitat Modelling

Habitat suitability indices for fishers were calculated by AXYS (1996a) for the Syncrude study areas. Highly suitable habitat was found in 13% of the regional area, primarily in deciduous and mixedwood vegetation community types. Moderate habitat, including peatland, mixedwood, mixed conifer, white spruce, jack pine and wetland types, was found in 69% of the local area. Marginal habitat was found in 6% of the Syncrude study area, and consisted of wetlands, peatland and disturbed/herb-grass vegetation community types.

Golder (1998e) used the AXYS (1996a) model to map habitat suitability for fishers for the Shell Muskeg River Mine Project EIA. A total of 4,798 HUs were mapped for the study area. Of these, 46% were high quality habitat, 49% were moderate quality habitat and 5% were low quality habitat.

The model used by AXYS (1996a) and Golder (1998e) was used for this study as well. The model and results for the LSA and RSA are described in Golder (1998d).

5.2.2.4 Landform Types

Riparian areas typically provide good habitat for several species of small mammals, and subsequently are favoured by weasel species. For this study, weasels avoided escarpment in January, but showed no landscape preference in February or March. Wolverines, fishers and martens are expected to occasionally forage in riparian areas, although mature coniferous forest is considered prime habitat. Analysis at the landform level suggested that martens prefer escarpment. Fishers preferred riparian areas in January and upland areas in February. Fishers showed no preference in March. Riparian areas, however, must still be recognized as potential dispersal corridors, particularly in disturbed landscapes.

5.2.2.5 Limiting Factors

The prime limiting factor for all mustelid species is the availability of suitable habitat (quality den sites and food resources). The larger mustelids (wolverines, fishers and martens) rely on middle to late stage coniferous forests (Pasitschniak-Arts and Larivière 1995). Further, wolverines are thought to be particularly sensitive to human disturbance, avoiding disturbed areas if possible (Banci 1994). However, predation on weasels can also be a significant mortality agent and subsequently, limit population size. All mustelid species in the oil sands area are trapped for their fur. Martens and fishers are relatively easy to trap and have been extirpated from other areas due to over-trapping.

5.2.3 Lynx

5.2.3.1 Status and Distribution

Lynx are not considered abundant in the oil sands area. Lynx typically have large home ranges (8.3-51.0 km^2, Koehler and Aubry 1994), making detection within the boundaries of a particular study area difficult. Penner (1976) found a density of 0.002 tracks/km-track-day in Lease 17 in 1976. A higher than expected density of 0.06 tracks/km-track-day was found in Leases 88 and 89 in 1980 to 1981 (Skinner and Westworth 1981). No lynx were observed in the Shell Lease 13 area in the early 1970s (Shell 1975), and no lynx tracks were recorded in the Shell Lease 13 area in 1997 (Golder 1998a). Lynx tracks were recorded at a density of 2.52 and 1.27 tracks/km-track day during January and February, respectively, of the Steepbank River surveys. Lynx tracks were not recorded in the Upland Lease 29 surveys.

5.2.3.2 Habitat

Previous observations were made in black spruce muskeg (Skinner and Westworth 1981) and in black spruce (Penner 1976). Lynx are thought to prefer dense climax boreal forest, although their distribution is tied to that of their most common food, the snowshoe hare (Skinner and Westworth 1981).

5.2.3.3 Landform Types

Lynx showed a preference for riparian areas during the February Steepbank River surveys. Lynx tracks were not observed in January, and lynx showed no preference in March. Lynx are believed to show no preference or avoidance for upland or riparian areas, and are expected to use both as they are encountered. Riparian habitat, however, may provide suitable travel routes for dispersing individuals or animals expanding their home range.

5.2.3.4 Limiting Factors

Although lynx will take other food items, they are considered obligate consumers of snowshoe hares. Hares and lynx exhibit a 9-to-11 year population cycle, featuring significant peaks and troughs (Boutin et al. 1995). Large changes in population size from year to year may help explain the large differences in track count study results in the oil sands area. Beyond habitat and food availability, lynx presence is also influenced by human activity and trapping pressure. Lynx prefer large areas of remote wilderness, and tend to avoid contact with humans (Koehler and Aubry 1994).

5.2.4 Black Bears

5.2.4.1 Status and Distribution

Black bears are relatively common in the oil sands area, with populations remaining fairly stable from year to year. Fuller and Keith (1977) estimated bear density to be 25-50/100 km^2. Young and Ruff (1982) provided a lower estimate of bear density (18-25/100 km^2), based on habitat availability and densities recorded previously for the Cold Lake, Alberta area.

5.2.4.2 Habitat

Since black bears hibernate during the winter, no tracks were expected or recorded during the winter track count surveys. Bears are omnivores, and rely on a variety of foods. Food and shrub diversity is generally higher in deciduous stands or recently disturbed areas. For this reason, bears are most often found in aspen or mixedwood stands (Banfield 1987).

5.2.4.3 Habitat Modelling

Habitat suitability indices for black bears were calculated by AXYS (1996a), for the Syncrude study areas. They found that 15% of the Syncrude local area (mainly trembling aspen and mixedwood) provided prime habitat for black bears. A further 47% of the area (trembling aspen/white spruce, white spruce and jack pine/black spruce) provided moderate habitat, while 32% (mainly willow shrub lands and bogs and fens) provided marginal habitat.

The Shell Muskeg River Mine Project EIA study area was mapped for black bear habitat suitability using the AXYS (1996a) model (Golder 1998e). A total of 3,809 HUs were mapped for the LSA. Of these 51% were mapped as high quality habitat, 28% was moderate quality habitat and 21% was low quality habitat.

The model used by AXYS (1996a) and Golder (1998e) was used for this study as well. The model and results for the Project Millennium LSA and RSA are described in Golder (1998d).

5.2.4.4 Landform Types

Black bears use many different areas throughout the year. Horsetails, grasses and sedges, and aspen buds are important spring foods, while berries and nuts are important before hibernation (Rogers et al. 1987). Availability of these foods is quite often highest in riparian areas so bears can be expected to use riparian zones to a high degree. Riparian habitat may also facilitate dispersal and provide cover for individuals moving among habitats in search of food, particularly in disturbed landscapes.

5.2.4.5 Limiting Factors

Black bears are limited by the availability of den sites and food, and by intraspecific and human predation. Construction of new roads into the area could lead to an eventual increase in hunting pressure if access is not controlled. Black bears can also become habituated to garbage and handouts, which often leads to their destruction as "nuisance" animals.

5.3 SEMI-AQUATIC FURBEARERS

5.3.1 Beavers and Muskrats

5.3.1.1 Status and Distribution

Beavers are large aquatic rodents found throughout the boreal forest and parkland region. Penner (1976) estimated beaver density in the Lease 17 region to be 1.9 animals/km^2. Beaver density on the east side of the Athabasca River is thought to be lower, due to less favourable habitat. Skinner and Westworth (1981) recorded 0.11 colonies/km^2 during an aerial survey of the Lease 88 and 89 areas. Based on an estimate of 6.3 beavers/lodge (Searing 1979), this would yield an estimate of 0.69 beavers/km^2. Surveys within the Aurora Mine LSA determined a density of 0.09 colonies and food caches per km^2 (Fort McKay Environment Services 1996). Half the active beaver lodges recorded during that study were found within the Alsands reclamation site. Drainage canals were constructed during site abandonment, and beavers have since occupied these canals to feed on the aspen, alder and willow shrubs that have regenerated on the site. Syncrude, however, recently drained some of these canals in preparation for their Aurora North development activities. Active beaver lodges have been reported on Shipyard Lake (Golder 1996), and an active lodge was seen along the Unnamed Creek during the amphibian surveys.

Muskrats are smaller aquatic rodents, common in marshes and other waterbodies throughout the parkland and boreal forest region (Banfield

1987). Two separate areas in Lease 17 were found to have densities of 2.5 muskrats/ha and 0.3 muskrats/ha (Penner 1976). Density of muskrats on the east side of the Athabasca River is thought to be lower, due to poorer quality habitat. During an aerial survey of Leases 88 and 89, Skinner and Westworth (1981) recorded 0.03 muskrat houses/km^2. However, no muskrat houses or pushups were observed during a November 1995 study of the Aurora Mine area (Fort McKay Environment Services Ltd. 1996). No muskrat houses or push-ups were observed during the course of the Project Millennium surveys.

5.3.1.2 Habitat

Beavers prefer relatively deep waterbodies near stands of early deciduous vegetation. Preferred food includes aspen, birch and willow (Banfield 1987). The LSA is dominated by conifer bogs and fens, and provides generally poor habitat. Beavers are expected along creeks and in marshy areas near aspen stands.

Muskrats also prefer waterbodies with relatively deep water. Good muskrat habitat is provided by waterbodies (most often marshes) with a well-developed zone of emergent plants, which are used for food and lodge construction (Banfield 1987). Wetlands in the LSA area are generally shrubby bogs rather then marshes. For this reason, the LSA is thought to be poor quality habitat for muskrats.

5.3.1.3 Habitat Modelling

A beaver habitat model modified from Westworth, Brusnyk and Associates (1996a) was used to map habitat suitability for the Shell Muskeg River Mine Project EIA (Golder 1998a). A total of 1,424 HUs was determined to occur within the local study area. Of these, the vast majority (91%) were high quality habitat. Eight percent was classified as moderate habitat, and only 1% was classified as low quality habitat.

The model used by AXYS (1996a) and Golder (1998e) was used for this study as well. The model and results for the Project Millennium LSA and RSA are described in Golder (1998d).

5.3.1.4 Landform Types

Riparian areas are critical to beaver and muskrat populations. Upland areas are used occasionally for dispersal. Loss of riparian areas will effectively reduce beaver and muskrat populations.

5.3.1.5 Limiting Factors

Beaver and muskrat populations are limited by the availability of habitat and food, and by predation. Beavers are preyed on most often by wolves, while muskrats are preyed on most often by minks. Both beavers and muskrats are trapped for their fur.

5.3.2 River Otters and Mink

5.3.2.1 Status and Distribution

Current and historic local abundance of river otters in the oil sands area is low. Westworth (1979) estimated otter density for the Lease 17 area to be 0.17/100 km^2. Track count densities ranged from 0.01 tracks/km-track-day (Skinner and Westworth 1981) on the Leases 88 and 89 area to 0.02 tracks/km-track-day (Westworth, Brusnyk and Associates 1996c) on the Lease 12, 13 and 34 area. Golder (1998a) recorded river otter track density at 0.01 tracks/km-track day on the Shell Lease 13 study area. River otters were not recorded in this study.

Mink are considered common along watercourses in the oil sands area. Pelts collected in the Fort McMurray area for the years 1970-1975 were twice the provincial average (Westworth 1979). Track count densities have ranged from 0.1 tracks/km-track-day on Leases 17, 88 and 89 (Penner 1976; Skinner and Westworth 1981) to 0.22 tracks/km-track-day for Leases 12, 13 and 34 (Westworth, Brusnyk and Associates 1996c). Only 0.03 tracks/km-track-day were recorded for minks during the Shell Lease 13 winter track count survey (Golder 1998a). Mink were not observed during the Steepbank River survey. In the Upland Lease 29 survey, mink were recorded at a density of 10.47 tracks/km-track day. Mink tracks were also recorded at Shipyard Lake.

5.3.2.2 Habitat

River otters are aquatic carnivores that feed almost exclusively on fish in streams and lakes. Tracks are most frequently encountered along the shores of deep lakes, rivers and large marshes (Banfield 1987). Previous studies have recorded tracks along the Muskeg and Athabasca rivers (Alsands 1978; Skinner and Westworth 1981; Westworth, Brusnyk and Associates 1996b). No river otter tracks were observed during this study.

Mink are semi-aquatic carnivores that hunt in and along watercourses. They are found most commonly along stream banks, lakeshores, forest edges and large marshes (Banfield 1987). Previous studies have found that most tracks were within riparian shrub and riparian white spruce communities (Skinner and Westworth 1981; Westworth, Brusnyk and Associates 1996b). In the Upland Lease 29 study, mink preferred riparian shrubland (shrub).

5.3.2.3 Landform Types

River otters and mink rely on riparian zones almost exclusively. Riparian zones represent prime habitat for foraging for river otters and mink. In addition, riparian habitats provide optimum (i.e., good cover and available food) travel routes for dispersal and movement of individuals between populations. However, upland areas may be important for dispersal or for travelling between streams and rivers. As previously mentioned, no mink or river otter tracks were observed during the Steepbank River surveys, thus landscape preferences could not be determined.

5.3.2.4 Limiting Factors

Mink and river otters are limited by the presence of suitable habitat, predation, food resources and trapping. Preservation of riparian areas and maintenance of water quality should ensure persistent populations of river otter and mink.

5.4 SMALL MAMMALS

5.4.1 Red-Backed Voles

5.4.1.1 Status and Distribution

The red-backed vole is one of the most common and abundant small rodents found throughout most of the forested areas of Alberta (Smith 1993). In northern Alberta, red-backed voles occupy a variety of boreal habitats, using both ground and shrub layers for food and cover (AXYS 1996a). The red-backed vole is a diurnal species that remains active throughout the year with regular cyclic fluctuations in population numbers occurring every 4 to 5 years (Green 1979). Summer 1977 population density estimates for the red-backed vole in mixedwood habitat ranged from 9.3 to 19.1 animals/ha (Westworth 1979). In 1980, Westworth and Skinner estimated that red-backed vole populations varied between 8.6 and 19.7 animals/ha within the Syncrude Mildred Lake leases (AXYS 1996a).

5.4.1.2 Habitat

Aspen and mixed white spruce-jack pine communities provide prime habitat for red-backed voles (AXYS 1996a). Green (1980) also described balsam poplar, aspen and jack pine communities as providing high quality habitats for the red-backed vole. Golder (1998a) reported that the abundance of red-backed voles within the Shell Lease 13 study area was greatest in wetlands, riparian and coniferous habitats. These habitats were associated with moderate to high levels of structural and compositional variation on the ground. Such habitats generally have abundant food and cover, and a relatively stable micro-climate (Carey and Johnson 1995).

5.4.1.3 Habitat Modelling

Habitat modelling was conducted for the Shell Muskeg River Mine Project area using the model outlined in Golder (1998e), adapted from AXYS

(1996a). For that project, 5,469 HUs mapped for the LSA. The majority of the HUs were moderate quality habitat (77%).

The model used by AXYS (1996a) and Golder (1998e) was used for this study as well. The model and results for the Project Millennium LSA and RSA are described in Golder (1998d).

5.4.1.4 Landform Types

Red-backed voles are strongly associated with wetlands and riparian habitats, which is likely a function of available food and cover within these vegetation community types (Golder 1998a). Wetlands and riparian habitats also serve as refuges and movement corridors during dispersal (Dickson and Williamson 1988, Gibbs 1993). The elimination of these habitat types, particularly in disturbed landscapes, often increases the risk of predation for dispersing individuals and can slow down the recolonization rate of suitable habitat patches, or isolate local populations. As local populations become small and isolated, the probability of temporary local extinction events increases (Hanski 1996).

5.4.1.5 Limiting Factors

The distribution of the red-backed vole is affected by the amount of cover provided by vegetation, debris and litter, water availability and interspecific competition (Green 1979). Red-backed voles are important prey species for several carnivores and raptors. The association with vegetation, debris and litter has been attributed to protection from these predators (Green 1979, AXYS 1996a). Water availability is important because of the vole's relatively high daily intake of water. Although the red-backed vole and meadow vole are able to persist in grassland or forested areas, red-backed voles are superior competitors in forested areas while meadow voles out compete red-backed voles for resources in grassland habitats (Green 1979).

5.4.2 Snowshoe Hares and Red Squirrels

5.4.2.1 Status and Distribution

Snowshoe hares are common throughout the oil sands area, and usually provide the majority of observations during track count surveys. Populations of snowshoe hares generally fluctuate on a 9 to 11-year cycle, leading to large variations in track count data from year to year (Boutin et al. 1995). Figures from years near the trough of the population cycle display track densities of 2.94 tracks/km-track-day (Syncrude 1973) and 3.53 tracks/km-track-day (Westworth, Brusnyk and Associates 1996b). In years of peak populations, densities can be 8-10 times higher. For example, Skinner and Westworth (1981) estimated track count frequencies at 21.15 tracks/km-track-day, and this study produced estimates of 22.36 tracks/km-track-day.

Red squirrel observations from track counts in the oil sands area are usually second only to snowshoe hares. Early surveys of Lease 17 (Alsands 1978) and Leases 88 and 89 (Skinner and Westworth 1981) yielded densities of 2.33 and 2.08 tracks/km-track-day, respectively. An estimate of 1.19 squirrels/ha, based upon a midden study (*see Glossary)* in Lease 17, was made by Penner (1976). A more recent track count survey yielded a density of 0.63 tracks/km-track-day (Westworth, Brusnyk and Associates 1996b), suggesting a drop in squirrel numbers. However, in this study, densities of up to 1,077 tracks/km-track-day were recorded during the Steepbank River surveys.

5.4.2.2 Habitat

Snowshoe hares are most often found in areas with a well developed shrub layer. Observations made at the peak of the snowshoe hare cycle were most often made in riparian white spruce, mixedwood, and black spruce muskeg areas (Skinner and Westworth 1981), all areas with a prominent shrub component. For the current study, hares were found to prefer low-bush cranberry-aspen poplar-white spruce (d2) and Labrador tea/horsetail-white spruce-black spruce (h1) and to avoid lichen-jack pine (a1), low-bush cranberry-white spruce (d3), low-bush cranberry-aspen poplar (d1) and wooded fens (FTNN).

Red squirrels rely on conifer cones for the majority of their food supply, and are subsequently found in conifer-dominated forests. Earlier studies found that red squirrels were most often found in upland white spruce and riparian white spruce areas (Alsands 1978; Skinner and Westworth 1981; Westworth, Brusnyk and Associates 1996b). Red squirrels in the Lease 13 winter track count survey showed a similar, significant preference for these habitat types (Golder 1998a). In this study, red squirrels were found to prefer low-bush cranberry-white spruce (d3) and to avoid lichen-jack pine (a1), Labrador tea/horsetail-white spruce-black spruce (h1), low-bush cranberry-aspen poplar (d1) and low-bush cranberry-white spruce-aspen poplar (d2).

5.4.2.3 Habitat Modelling

Habitat suitability indices for snowshoe hares were calculated by AXYS (1996a) for the Syncrude study areas. Highly suitable hare habitat in the regional study area was divided among several vegetation community types (peatlands, deciduous, white spruce, mixedwood and wetlands/shrub), and accounted for 37% of the area. Moderate habitat was found in 18% of the area and was divided amongst peatlands, mixedwood and conifer forests. Marginal habitat types, including pine, wetlands, peatland and disturbed/grass-herb, accounted for 8% of the local area.

Snowshoe hare habitat modelling was conducted for the Shell Muskeg River Mine EIA using a model adapted from AXYS (1996a) (see Golder

1998e). A total of 5,320 HUs were mapped for the LSA. Of these, 29% represented high quality habitat, 65% moderate and 6% low.

The model used by Axys (1996a) and Golder (1998e) was used for this study as well. The model and results for the LSA and RSA are described in Golder (1998d).

5.4.2.4 Landform Types

Riparian shrub and riparian white spruce areas can provide important alternative habitat for snowshoe hares and red squirrels, particularly in areas where there is substantial loss of suitable upland habitat. Riparian areas may also be used as dispersal corridors, especially in highly fragmented landscapes. Animals with low vagility (ability to disperse long distances in open habitat), such as snowshoe hares and red squirrels, may depend on riparian areas to maintain gene flow between local populations in fragmented landscapes. For both snowshoe hares and red squirrels, analysis indicated a significant difference in the relative use of riparian, escarpment and upland vegetation communities. Snowshoe hares preferred upland areas, while red squirrels preferred escarpment. Although upland communities represent quality habitats for survival and reproduction at the habitat level for both species, riparian areas and escarpments may represent movement corridors at the landform level.

5.4.2.5 Limiting Factors

Populations of red squirrels and snowshoe hares are limited by the availability of habitat, food and predation. Major predators of snowshoe hares are lynx, coyotes and fishers. Major predators of red squirrels are fishers and martens.

5.5 WATERFOWL

Waterfowl in the LSA can be categorized as dabblers or divers. Dabbling ducks feed on aquatic insects and plant material on the surface and within the first 20 to 30 cm of the water column. Diving ducks, in contrast, forage deeper in the water column, thus enabling them to exploit different food resources.

5.5.1.1 Status and Distribution

Thirteen species of waterfowl as well as 5 other waterbirds were observed during the aerial survey. This is comparable to the studies conducted for Shell on Lease 13 (Golder 1998a), but much lower than other studies in the regional area (Bovar 1996b). Twenty-four species of waterfowl were recorded on Lease 86 in 1981 (Gulley 1982). McLaren and Smith (1984) recorded 60 species of waterfowl and waterbirds in a study on Lease 17. Lack of significant staging and breeding areas in the study area accounts for the low numbers of waterfowl. Waterfowl are dependent on quality habitat to satisfy their different requirements throughout the year. The habitat located on the Steepbank Mine study area is not prime habitat for breeding waterfowl. There are relatively few non-flowing waterbodies which are the preferred wetlands required for breeding purposes. The nesting cover surrounding the wetlands is also poor.

Lesser scaup were the most abundant waterfowl species recorded during aerial surveys in 1997. Other species observed in relatively large numbers were mallards, blue-winged teals, ring-necked ducks and buffleheads (Table 5). Hennan & Munson (1979) reported that mallards, American wigeons, green-winged teals, blue-winged teals, northern shovelers, northern pintails, and gadwalls were all common in the AOSERP study area. Common divers included scaup, ring-necked ducks, buffleheads, and common goldeneyes

5.5.1.2 Habitat

Hennan and Munson (1979) reported that spring staging and breeding pairs preferred emergent vegetation edge combined with shrub habitat in the vicinity of the edge. Divers preferred emergent vegetation/shrub; wet meadow/coniferous forest; emergent vegetation/wet meadow; and emergent vegetation/mixed forest.

The migration of waterfowl through the LSA may be an indication that the nesting habitat is limited or insufficient to meet the requirements of many species. The lack of suitable nesting habitat for both ground nesting and over-water nesting species may be the main reason for the low density of waterfowl in the LSA. With the exception of Shipyard Lake, most of the wetlands did not have much emergent vegetation, which is required for over-water nesting species for nest construction as well as shelter. Although the density of waterfowl on the LSA was relatively low, observations indicated that the wetlands do support breeding populations, and provide a staging area for migrating waterfowl.

Table 5 Estimated Number of Individuals From the 1997 Spring Aerial Survey in the LSA

Waterbird	Breeding Status LD[a]	LH[a]	FD[a]	P[a]	GB[a]	Estimated Number
Mallard	9	0	4	3	13	45
Gadwall	1	0	0	1	0	4
American wigeon	3	0	0	8	0	22
Green-winged teal	2	0	0	10	0	24
Blue-winged teal	6	1	0	14	15	55
Northern pintail	1	0	0	0	0	2
Northern shoveler	1	0	0	2	0	6
Lesser scaup	8	0	0	15	175	213
Ring-necked duck	8	0	0	17	6	48
Common goldeneye	5	0	0	3	0	16
Bufflehead	19	1	0	4	0	46
Canvasback	2	0	0	2	0	8
Redhead	1	0	0	2	0	5
Canada goose	---	---	---	---	---	1
American coot	---	---	---	---	---	15
Common loon	---	---	---	---	---	10
Western grebe	---	---	---	---	---	NR[b]
Red-necked grebe	---	---	---	---	---	6
Common snipe	---	---	---	---	---	NR
Yellowlegs species	---	---	---	---	---	NR
Great blue heron	---	---	---	---	---	6
Unidentified gulls	---	---	---	---	---	220
Total	66	2	4	81	209	752

[a] LD = Lone drake, LH = Lone hen, FD = Flocked drake, P = Pair, GB = Grouped bird.
[b] NR = not recorded.

5.5.1.3 Habitat Modelling

A habitat model for dabbling ducks (Westworth, Brusnyk and Associates 1996a) was adapted to map habitat suitability for the Project Millennium LSA and RSA (Golder 1998d).

5.5.1.4 Landform Types

The spring aerial survey results suggested that most waterfowl preferred non-flowing waterbodies, especially permanent natural wetlands (e.g., beaver ponds and natural basins), with the exception of the Athabasca River. Few observations of waterfowl were recorded for the Steepbank River and Wood and McLean creeks. The Steepbank River has a fast current, which would be unsuitable for staging birds, or for raising young. As well, Wood and McLean creeks lack large areas of permanent open water. The Athabasca River did provide important habitat for a variety of waterfowl species, especially lesser scaup, which were probably migrating through the area. The islands in the river can be used as resting sites for birds. The migration of birds through the study area is probably an indication that nesting habitat is insufficient and is not preferred by many species.

5.5.1.5 Limiting Factors

Waterfowl populations are primarily limited by the availability of suitable nesting and brood-rearing habitat. Nesting success is a function of duck density, predator density and cover from exposure to predators and weather. For ducks that nest in upland habitat, suitable nesting habitat must have adequate cover (e.g., grass and shrub habitat). In addition, ponds with abundant emergent vegetation (providing cover from predators) must be adjacent to nesting habitat for successful rearing of broods. For ducks that nest over water, nesting and brood-rearing success will depend partially on cover from emergent vegetation. Cavity nesters, such as common goldeneyes and buffleheads, depend on large-diameter snags near slow-moving streams or ponds.

5.6 UPLAND GAMEBIRDS

Three species of upland gamebirds potentially occur in LSA; spruce, ruffed and sharp-tailed grouse. Willow ptarmigan may also be found infrequently in the area. However, due to the difficulty involved in identifying grouse tracks to each species, all three species were combined for analysis. The discussion focuses on the ruffed grouse, which was chosen as a KIR.

5.6.1.1 Status and Distribution

The ruffed grouse is common throughout the deciduous and mixedwood forests of North America. They are year-round residents, and are considered the second most abundant upland game bird in the Athabasca region after the spruce grouse (Francis and Lumbis 1979). Ruffed grouse density in northeastern Alberta ranges from 0.02 individuals/km^2 in poor quality aspen/jack pine and young black spruce habitat, to 0.32 and 0.46 grouse/km^2 in aspen and bottomland willow habitat (Francis and Lumbis 1979). Grouse track observations were made during the winter track count survey. Up to 6.82 tracks/km-track-day were recorded during the Steepbank River surveys. Up to 45.88 tracks/km-track day were recorded in the Upland Lease 29 surveys.

5.6.1.2 Habitat

Ruffed grouse distribution is tied to deciduous and mixedwood forest, particularly those seral stages that possess a well-developed shrub component (Bergerud and Gratson 1988). Young grouse feed almost exclusively on insects, but forage on plant matter as they mature (Ehrlich et al. 1988). Adults feed on berries and sedges during the summer, fruiting shrubs in the fall and buds, twigs and catkins in the winter (Edminster 1954). Berry-producing shrubs and forbs are typically more abundant in deciduous and mixedwood stands. In addition to providing forage, deciduous stands are also used for cover during and after the breeding season.

Grouse showed a preference for wooded fens during the Upland Lease 29 surveys. Fewer tracks than expected were found in the lichen jack pine (a1), low-bush cranberry (d1, d2, d3), and wood bog (BTNN) plant community types.

5.6.1.3 Habitat Modelling

AXYS (1996a) developed a habitat suitability model for the ruffed grouse, based on habitat and forage preferences. Highly suitable grouse habitat was considered to occur in stands with a high percentage of deciduous trees, with diameter at breast heights (dbh) of 15 cm or greater, and a canopy closure of between 70 and 80%. Shrub densities of 51-70%, particularly of favoured shrubs (aspen and willow and berry producers) were identified as important in the understorey.

AXYS (1996a) found that 17% of the Syncrude area (consisting of mixedwood and deciduous forest vegetation community types) consisted of highly suitable habitat. A further 3% (white spruce type) contained moderate habitat and 43% (peatland, jack pine and mixed conifer forest, wetlands and disturbed/herb grass types) consisted of marginal habitat.

Ruffed grouse habitat modelling was conducted for the Shell Muskeg River Mine EIA (Golder 1998e) A total of 3,305 HUs was mapped for the local area, including 11.9% high quality habitat, 8.2% moderate habitat and 75% low habitat.

The AXYS (1996a) ruffed grouse model was adapted for use in this EIA (Golder 1998d).

5.6.1.4 Landform Types

Grouse showed no landscape preference during the Steepbank River surveys. Grouse may limit their use of escarpments and riparian habitats during the winter, and riparian areas may become important secondary habitat when prime upland habitat is not available (Golder 1998b). Riparian areas may also provide travel corridors for grouse, particularly when upland habitat is lost or extremely fragmented.

5.6.1.5 Limiting Factors

Ruffed grouse are typically limited by habitat availability and predation. Ruffed grouse are preyed on by northern goshawks and other birds of prey, and by a variety of carnivores including wolves, coyotes, foxes, lynx, fishers and martens. Grouse populations are subject to periodic and drastic fluctuations, the cause of which is poorly understood (Godfrey 1986). Ruffed grouse are also hunted within the oil sands area.

5.7 BREEDING BIRDS

5.7.1.1 Status and Distribution

The boreal forest of Canada has one of the highest diversities of breeding birds north of Mexico (Robbins et al. 1986). In terms of total number of species, approximately 72% of the total vertebrate fauna of the mixedwood boreal forest of western and northern Canada consists of avian species (Semenchuk 1992). A total of 252 avian species has been recorded in the western boreal forest (Semenchuk 1992). Thus, the boreal forest represents an important ecosystem for sustaining breeding populations of North American birds. Such diversity is a result of the wide variety of niches available to breeding birds in the boreal forest.

The majority of the birds found in the Project Millennium LSA are migrants, many of which winter south of the continental United States. Over the past few decades, many migrant populations have declined. Because the mixedwood zone in North America represents important breeding habitat for birds, it is necessary to determine habitat-species associations (Titterington et al. 1979, Robbins et al. 1989a, Semenchuk 1992). Habitat loss in the tropics has also been suggested as a contributing factor in the decline of neotropical migrant populations (Askins et al. 1990, Diamond 1991, Hagan and Johnston 1992, Askins 1993, Petit et al. 1995). In addition, several other potential mortality factors such as collisions with vehicles and windows of buildings, and increased predation from domestic cats are potentially responsible for declining populations. It has also been suggested that species with the most marked declines require large areas of mature forest cover for breeding and wintering (Robbins et al. 1989b). Because successful breeding is critical to the survival of a species, habitat loss in the breeding grounds (e.g., boreal forest) is a concern.

5.7.1.2 Habitat

Bird species abundance, richness and diversity depends on many environmental factors and the scale at which a bird community is considered. Some species of birds have general habitat requirements that allow them to exploit many different types of habitats (e.g., yellow-rumped warblers, Tennessee warblers, gray jays). These generalist species are capable of using more marginal habitat if preferred habitat is in short supply (Askins and Philbrick 1987; Villard and Taylor 1994). For example, if human-related or natural disturbance causes a decrease in local habitat availability, generalist species are often able to emigrate into other habitats and maintain population persistence within the landscape.

In contrast, bird species with specialized habitat requirements (e.g., Cape May warblers, Connecticut warblers) are less able to use alternate habitat types (Villard and Taylor 1994). These specialized species, although under less competition for resources from other species within their preferred habitat, are less able to adapt their behaviour to a changing environment.

Specialized species tend to occur only in specific habitat types, and if disturbance alters those preferred habitats, those species will be negatively affected at the stand level. If disturbance occurs over a very large spatial scale, these specialized species may become locally or regionally extirpated. The maintenance of habitat heterogeneity at the landscape level is, therefore, critical in the conservation of species richness and diversity.

A total of 79 bird species were detected at 318 point counts across 19 vegetation communities (pooled into 11 vegetation types) within the Suncor LSA (Table 6). Approximately 60% of the species recorded had less than 10 detections, suggesting that, although diversity was high, the relative abundance of species was quite moderate. Mean richness ranged from 2.17 $\pm$ 0.40 (jack pine dominated communities) to 4.40 $\pm$ 0.40 (dogwood-balsam poplar-aspen poplar) and mean diversity ranged from 0.67 $\pm$ 0.22 (jack pine dominated communities) to 1.36 $\pm$ 0.11 (dogwood-balsam poplar-aspen poplar) (Table 7). There was no statistically significant difference in bird species richness or diversity between vegetation communities ($F10,297 = 1.561$, $P > 0.1$).

Table 6 Total Number of Bird Species Detections

Full Name	Species	Number	Full Name	Species	Number
Tennessee warbler	TEWA	95	olive-sided flycatcher	OSFL	7
palm warbler	PAWA	93	Philadelphia vireo	PHVI	6
chipping sparrow	CHSP	92	solitary sandpiper	SOSA	6
yellow-rumped warbler	YRWA	78	western tanager	WETA	6
white-throated sparrow	WTSP	77	northern waterthrush	NOWA	6
ovenbird	OVEN	70	yellow-bellied sapsucker	YBSA	5
gray jay	GRJA	63	swamp sparrow	SWSP	4
dark-eyed junco	DEJU	59	Cape May warbler	CMWA	4
ruby-crowned kinglet	RCKI	42	song sparrow	SOSP	3
red-eyed vireo	REVI	37	black-throated green warbler	BTNW	3
magnolia warbler	MNWA	34	warbler		
Canada warbler	CAWA	30	white-winged crossbill	WWCR	3
Lincoln's sparrow	LISP	27	three-toed woodpecker	TTWO	3
Swainson's thrush	SWTH	27	common snipe	COSN	3
boreal chickadee	BOCH	23	red-winged blackbird	RWBB	3
hermit thrush	HETH	20	golden-crowned kinglet	GCKI	3
bay-breasted warbler	BBWA	20	hairy woodpecker	HAWO	3
least flycatcher	LEFL	19	greater yellowlegs	GRYE	3
cedar waxwing	CEWX	18	pine siskin	PISI	2
red-breasted nuthatch	RBNU	18	western wood-pewee	WWPE	2
black-and-white warbler	BAWW	17	black-capped chickadee	BCCH	2
common yellowthroat	COYE	16	red-necked grebe	RNGR	1
chestnut-sided warbler	CSWA	16	yellow warbler	YWAR	1
yellow-bellied flycatcher	YBFL	15	house wren	HOWR	1
mourning warbler	MOWA	15	black-backed woodpecker	BBWO	1
alder flycatcher	ALFL	14	brown-headed cowbird	BHCO	1
Wilson's warbler	WIWA	14	clay-coloured sparrow	CCSP	1
rose-breasted grosbeak	RBGR	11	blackpoll warbler	BLPW	1
winter wren	WIWR	11	spruce grouse	SPGR	1
orange-crowned warbler	OCWA	11	brown creeper	BRCR	1
American robin	AMRO	10	downy woodpecker	DOWO	1
American redstart	AMRE	9	LeConte's sparrow	LCSP	1
northern flicker	NOFL	9	common goldeneye	COGO	1
solitary vireo	SOVI	9	Connecticut warbler	CONW	1
evening grosbeak	EVGR	7	blackburnian warbler	BLBW	1

Table 7 Bird Species Richness and Diversity(Mean ± 1 Standard Error) for Vegetation Communities

Vegetation Community Type[a]	Number of Point Counts[b]	Richness	Diversity
i1 (treed bog) FTNN (wooded fen, no internal lawns) FONS (open, non-patterned shrubby fen)	145	3.57 ± 0.16	1.10 ± 0.05
b2 (blueberry-aspen poplar-paper birch) b3 (blueberry-aspen poplar-white spruce) d1 (low bush cranberry-aspen poplar)	51	3.12 ± 0.21	0.98 ± 0.08
d2 (low-bush cranberry-aspen poplar-white spruce)	23	3.35 ± 0.35	1.07 ± 0.12
d3 (low-bush cranberry-white spruce)	22	4.05 ± 0.36	1.28 ± 0.11
e1 (dogwood-balsam poplar-aspen poplar)	20	4.40 ± 0.40	1.36 ± 0.11
FFNN (forested fen, no internal lawns)	14	3.29 ± 0.40	1.07 ± 0.13
STNN (wooded swamp, no internal lawns)	10	3.70 ± 0.45	1.21 ± 0.16
e2 (dogwood-balsam poplar-white spruce) e3 (dogwood-white spruce) f2 (horsetail-balsam poplar-white spruce)	8	3.88 ± 0.86	1.11 ± 0.28
a1 (lichen-jack pine) b1 (blueberry-jack pine-aspen poplar) g1 (Labrador tea-subhygric)	6	2.17 ± 0.40	0.67 ± 0.22
CC (cutblock - open shrubland)	5	2.60 ± 0.51	0.83 ± 0.23
SFNN (forested swamp, no internal lawns)	4	2.75 ± 0.85	0.82 ± 0.32

(a) From Beckingham and Archibald (1996) and Vitt et al. (1997).
(b) Number of replicates for each vegetation community type.

5.7.1.3 Classification of Birds and Vegetation Community Types

Due to low bird abundance, a TWINSPAN analysis could not be conducted. Thus, bird use of vegetation communities was determined by plotting the number of individuals of each species found in each vegetation community type (see Figure 10).

Figure 10 (a-k) Number of Individual Birds Found Within Each Vegetation Community Type

Figure 10a Vegetation Community FONS, FTNN, i1 n=145

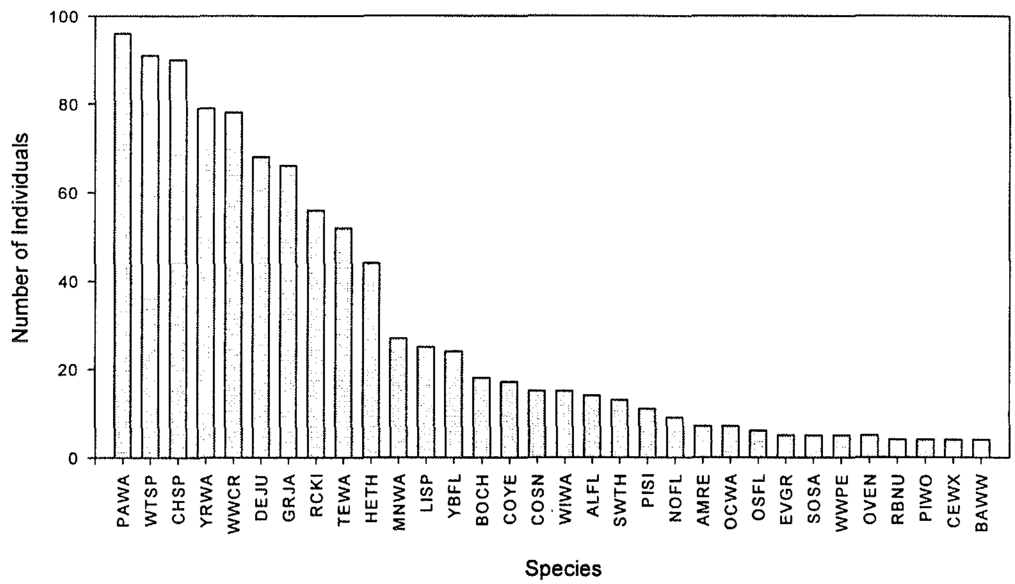


Figure 10b Vegetation Community b2, b3, d1 n=51

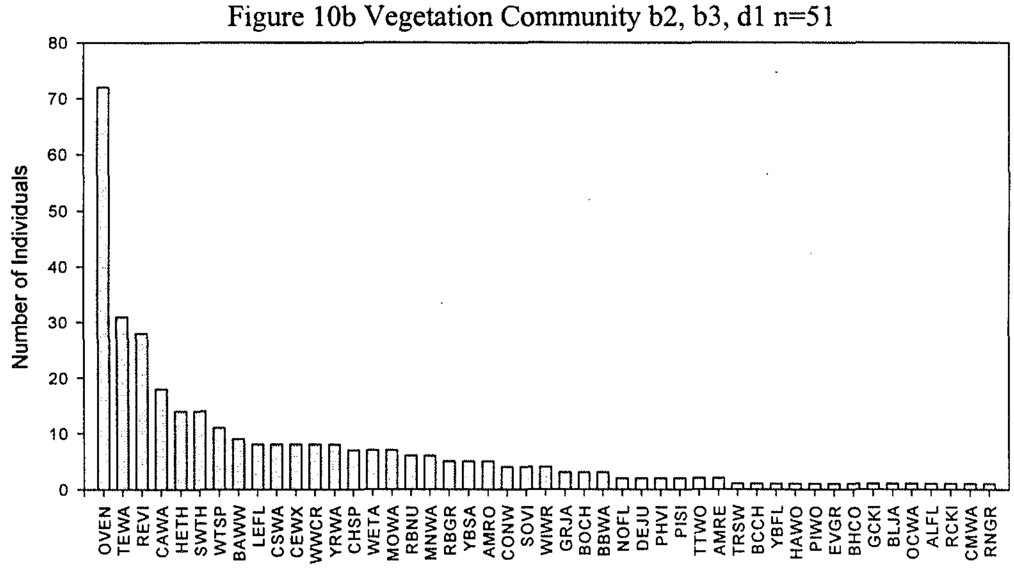


Figure 10c Vegetation Community d2 n=23

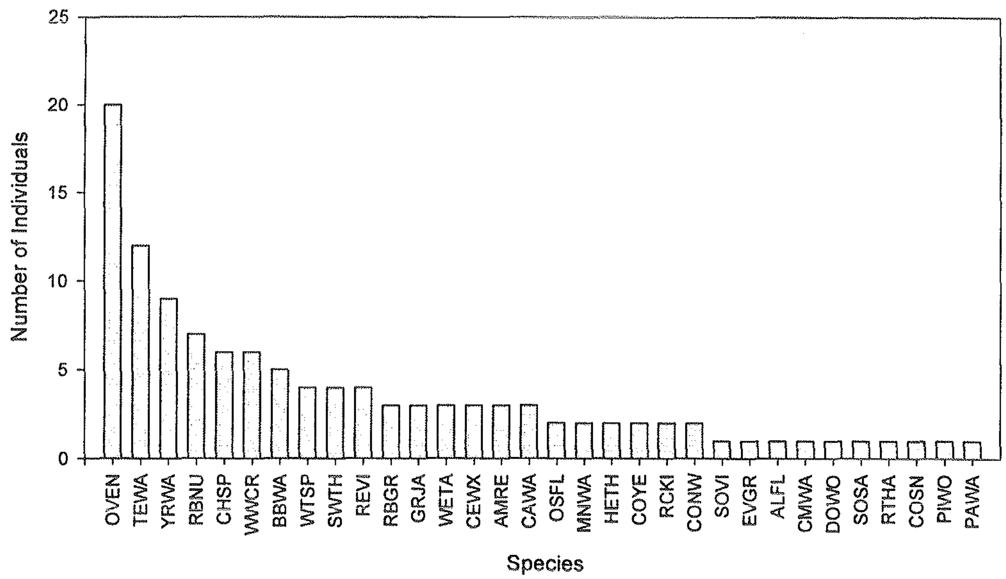


Figure 10d Vegetation Community d3 n=22

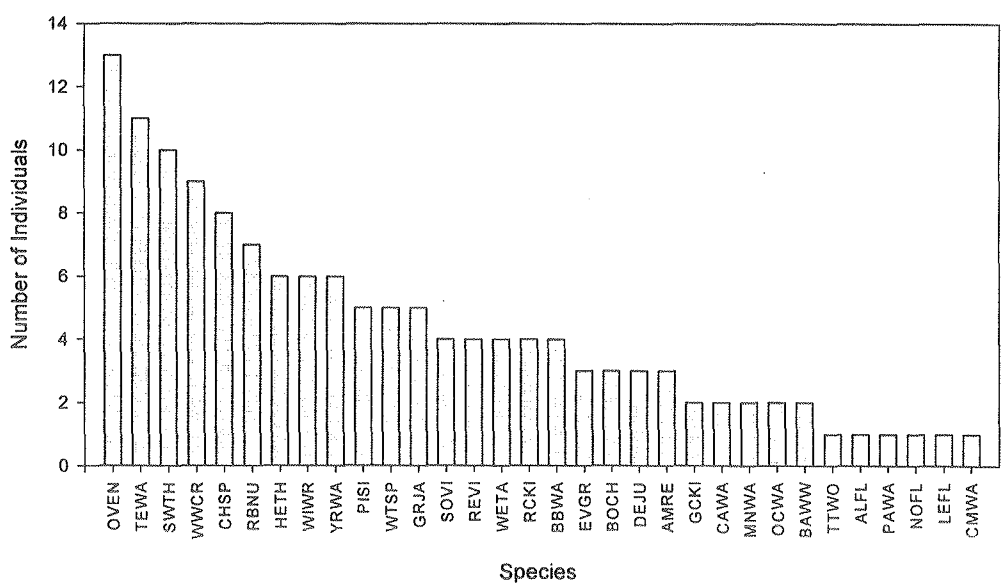


Figure 10e Vegetation Community e1 n=20

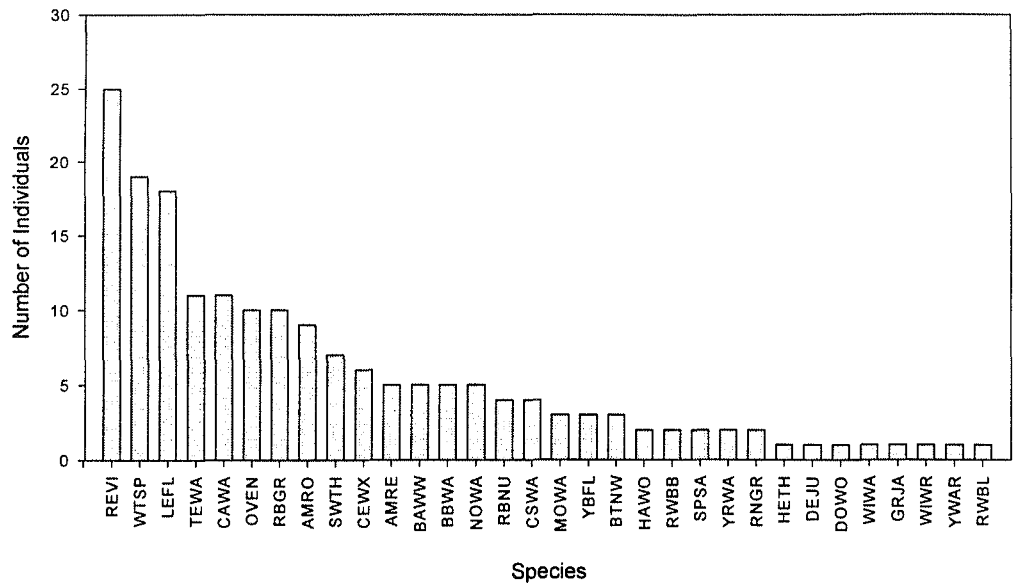


Figure 10f Vegetation Community FFNN n=14

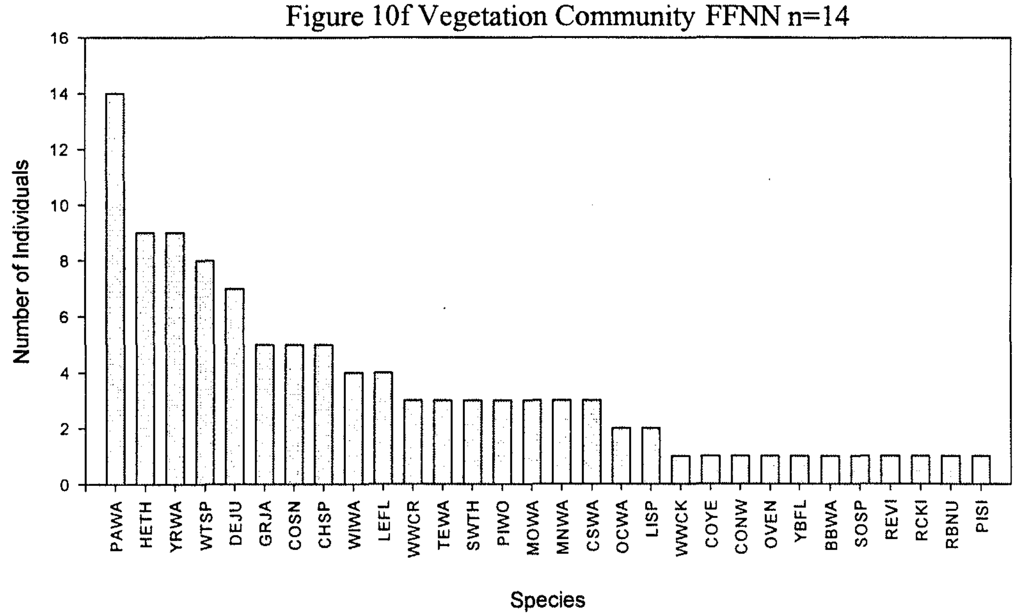


Figure 10g Vegetation Community STNN n=10

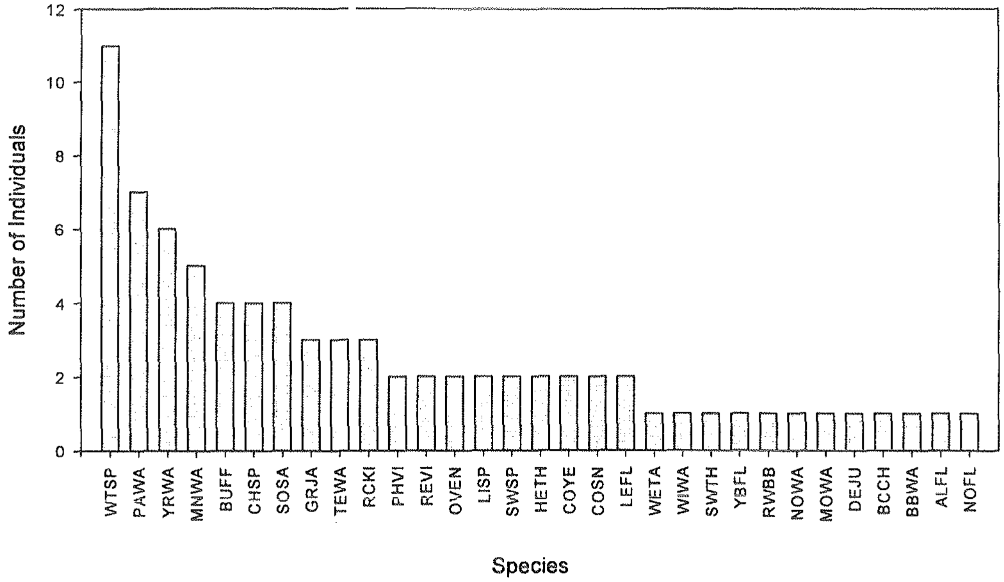


Figure 10h Vegetation Community e2, e3, f2 n=8

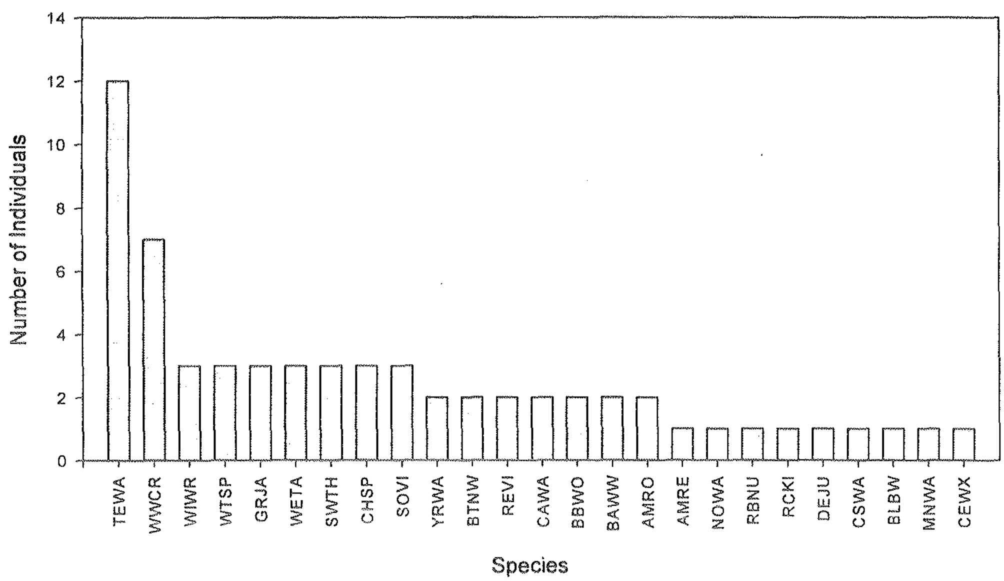


Figure 10i Vegetation Community a1, b1, g1 n=6

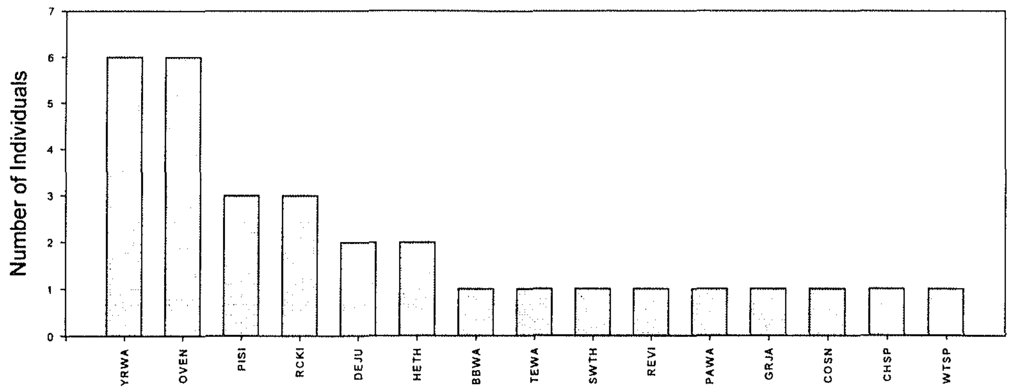


Figure 10-j Vegetation Community CC n=5

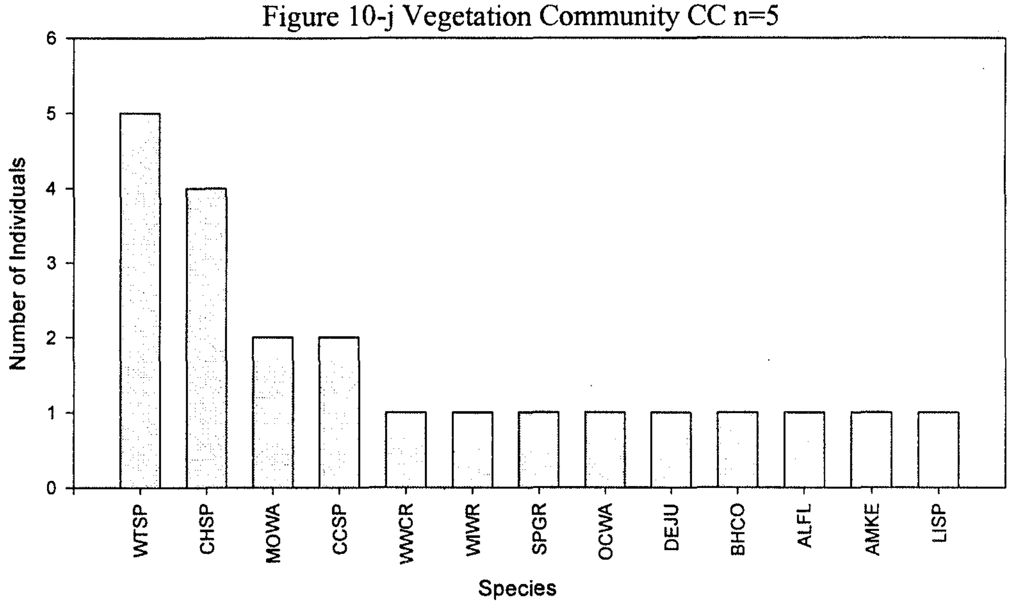
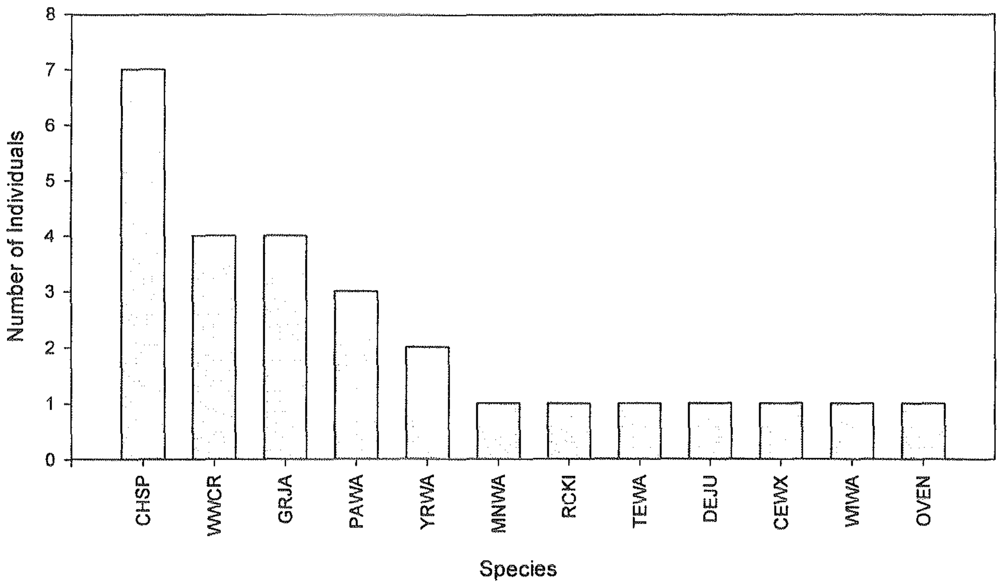


Figure 10k Vegetation Community SFNN n=4



Bird species strongly associated with the wetlands community types (e.g., i1, FTNN, FONS, FFNN, STNN, and SFNN) included palm warblers, white-throated sparrows, chipping sparrows, yellow-rumped warblers, white-winged crossbills, dark-eyed juncoes, gray jays, ruby-crowned kinglets, Tennessee warblers, hermit thrushes, magnolia warblers, Lincoln's sparrows, Wilson's warblers, least flycatchers and yellow-bellied flycatchers (Figure 10 (a-k)). Common snipes and solitary sandpipers were also recorded.

Bird species associated with riparian community types (e.g., e1, e2, e3, and f2) included red-eyed vireos, white-throated sparrows, white-winged crossbills, winter wrens, least flycatchers, Tennessee warblers, Canada warblers, ovenbirds, rose-breasted grosbeaks, American robins, western tanagers, solitary vireos, white Swainson's thrushes, cedar waxwings, American redstarts, black-and-white warblers, bay-breasted warblers and northern waterthrushes.

Bird species associated with the upland hardwood, softwood and mixedwood stands (e.g., b2, b3, d1, d2, d3) included ovenbirds, Tennessee warblers, red-eyed vireos, Canada warblers, hermit thrushes, white Swainson's thrushes, yellow-rumped warblers, red-breasted nuthatches, chipping sparrows, white-winged crossbills, bay-breasted warblers, winter wrens and pine siskins.

Bird species associated with mixed softwood and closed black spruce bogs (e.g., a1, b1, g1) included yellow-rumped warblers, ovenbirds, pine siskins, ruby-crowned kinglets, dark-eyed juncos, hermit thrushes, bay-breasted warblers, Tennessee warblers, white Swainson's thrushes, red-eyed vireos and gray jays.

Bird species associated with cutblocks or open shrubland (i.e., CC) included white-throated sparrows, chipping sparrows, mourning warblers, clay-coloured sparrows, white-winged crossbills, winter wrens, orange-crowned warblers, brown-headed cowbirds and alder flycatchers. Spruce grouse and American kestrels were also recorded.

Species richness and diversity was greatest in the dogwood-balsam poplar-aspen poplar (e1) stand, a riparian community type. High richness and diversity was also seen in the low-bush cranberry-white spruce (d3), an upland softwood community. The lowest richness and diversity was seen in the mixed softwood and closed black spruce bogs, including lichen-jack pine (a1), blueberry-jack pine-aspen poplar (b1) and Labrador tea subhygric (g1). These results are similar to other studies of species-habitat associations. Generally, studies have found that species abundance, richness and diversity were greater in upland hardwood and mixedwood habitats than softwood communities associated with bog-fen complexes (Niemi and Hanowski 1984, Morgan and Freedman 1986, Westworth and Telfer 1993, Scheick et al. 1995).

5.7.4 Landform Types

The breeding bird surveys were not specifically designed to investigate bird use of landforms. Other studies have shown that habitats supporting structurally diverse shrub communities, such as riparian forests, are typically associated with rich and diverse bird assemblages (Gates and Giffen 1991, Westworth, Brusnyk and Associates 1996d). Similar results can be expected at the landscape level. The Athabasca River, west of the LSA, is a substantial river system in northeastern Alberta, and likely serves as an important travel corridor for a large number of avian species, particularly during migration. In addition to providing breeding habitat, riparian and forest habitats adjacent to the Athabasca River may be important staging areas for species migrating to more northern latitudes.

Disturbance to adjacent upland habitat removes previously established corridors for migration and dispersal. Such disturbance makes current riparian reserves important as movement corridors for both adult and juvenile birds. Machtans et al. (1996) showed that birds will travel through riparian zones more frequently than adjacent stands that have been disturbed. In areas where there is significant disturbance, riparian corridors may be the only mechanism for the exchange of individuals between populations as well as dispersal across the landscape.

5.7.1.5 Limiting Factors

Like most vertebrates, breeding birds are limited by factors influencing habitat availability and suitability. Loss of habitat translates to a reduction in population size, which may decrease the richness and diversity of the local bird community. Disturbance typically alters habitat suitability by changing food resources, predation risk and intra- and interspecific competition. However, as previously mentioned, responses to disturbance are species-specific and depend on the adaptability (i.e., generalist vs. specialist) of species.

Isolation of particular habitats through disturbance is known as fragmentation. Typically, most disturbances, both natural and human-induced, change pre-disturbance communities to early seral stages. The result is the fragmentation of mature habitat and the creation of patches of early seral stage forest. Generally, old growth specialist species, like many of the wood warblers, incur negative effects while early seral stage specialists, such as most of the sparrows, benefit from disturbance. Thus, there is a perpetual dynamic between forest succession (which may be viewed as a source of fragmentation) and the bird species associated with changing habitats.

5.7.2 Cape May Warbler

5.7.2.1 Status and Distribution

Based on the number of detections during surveys, the number of Cape May warblers in the LSA appears to be low (Table 6). Although the distribution of breeding pairs ranges from northeastern British Columbia to Newfoundland and Maine, local abundance can also vary between relatively uncommon and common (PÖYRY 1992). During winter, the species inhabits forests of southern Florida and the Caribbean islands.

5.7.2.2 Habitat

Prime habitat for Cape May warblers consists of late stage coniferous stands with good canopy closure. Mature white spruce is preferred for nesting sites, but these birds will also nest in balsam fir, black spruce and tamarack (PÖYRY 1992). Cape May warblers were recorded in the upland hardwood, softwood and mixedwood stands (e.g., b2, b3, d1, d2, d3). Westworth, Brusnyk and Associates (1996d) also found that Cape May warblers were associated with closed mixedwood and white spruce stands.

5.7.2.3 Habitat Modelling

Based on a habitat suitability index model used for the Syncrude lease, AXYS (1996a) found that only 1% of that local study area was prime habitat (closed white spruce), 45% was moderate (jack pine-black spruce, black spruce), and 48% was marginal (aspen, mixedwood). Similarly, at the regional scale, 3% of the area was rated prime habitat, 49% was moderate and 46% was marginal.

Cape May warbler habitat modelling was conducted for the Shell Muskeg River Mine project (Golder 1998e). A total of 1,583 HUs were mapped for the local area, including 3.5% high suitability habitat, 8.9% moderate habitat, 45.6% low habitat and 41.9% unsuitable habitat.

The model used by AXYS (1996a) and Golder (1998e) was used for this study as well. The model and results for the LSA and RSA are described in Golder (1998d).

5.7.2.4 Limiting Factors

Cape May warbler numbers are low within the RSA, probably because this is the northwestern extent of their range. (Semenchuk 1992). The key factor limiting population size of Cape May warblers is likely the availability of prime habitat. Although there appears to be enough moderate habitat to support a larger population of Cape May warblers than is currently present, estimates of demographic variables, such as juvenile recruitment and adult survival, for the different vegetation community types are not known. Other factors, like food availability and predation may be influencing all habitats equally. For example, if food resources are temporarily low across the entire landscape, then suitability with respect to food abundance would be similar among all habitats. In addition, small populations are sensitive to random environmental and demographic fluctuations, particularly in environments where the availability of prime habitat is low (Hanski 1996, Pulliam 1996). In other words, the low abundance of Cape May warblers may be a result of the interaction among population size, temporal fluctuations in environmental conditions and supply of prime habitat.

5.7.3 Western Tanager

5.7.3.1 Status and Distribution

The western tanager is a summer resident of the boreal, interior and coastal forests of British Columbia, Alberta and Saskatchewan. Winters are spent in Mexico and Costa Rica (Ehrlich et al. 1988). Although restricted to particular habitat types, it is common throughout most of its range. Western tanagers were recorded by Westworth, Brusnyk and Associates (1996d) as part of a breeding bird survey conducted in the Suncor LSA.

5.7.3.2 Habitat

The diet of western tanagers consists of approximately 80% insects and 20% fruits (Bent 1958, Semenchuk 1992). Insects are caught on the wing or gleaned from foliage (Ehrlich et al. 1988). Cup nests are constructed in coniferous, and rarely, deciduous trees (Godfrey 1986). Suitable foraging and nesting habitat typically is found in open coniferous and mixedwood forests (Godfrey 1986). They nest high in the canopy of trees with near-horizontal branches, up to 15 m (Semenchuk 1992). They usually feed in the higher portions of trees or among bushes, but will also catch insects aerially.

This species is widely distributed but uncommon throughout most of northern Alberta. The western tanager prefers open mixedwood forest or pure coniferous boreal forests (Peterson 1961), but is occasionally found in pure deciduous stands in Alberta (Semenchuk 1992). Western tanagers are generally found in montane pine or aspen forests of the western national parks (Holroyd and Van Tighem 1983).

Western tanagers were recorded in four habitat types on the Suncor LSA during 1995 (Westworth, Brusnyk and Associates 1996d). The majority of records were made in mixedwood and coniferous vegetation communities with an estimated density of 0.18 individuals/ha. Western tanagers were also recorded in habitats dominated by aspen (0.06/ha) and jack pine (densities negligible). In the LSA, western tanagers were mainly detected in upland hardwood, softwood and mixed stands (b2, b3, d1, d2, d3). One western tanager was recorded in a wooded swamp (STNN). Golder (1998a) detected three western tanagers in vegetation communities associated with riparian habitat.

5.7.3.3 Habitat Modelling

A habitat model for the western tanager was created for the Shell Muskeg River Mine Project EIA (Golder 1998e) and is used here. This model was created using a literature review and expert judgement. The model had not been reviewed by a species expert or regulatory staff at the time of this report.

5.7.3.4 Landform Types

Western tanagers use white spruce stands. These are often associated with upland and riparian areas. As stated above, tanagers were mainly found in the upland hardwood, softwood and mixedwood stands.

5.7.3.5 Limiting Factors

Western tanagers are preyed on by a variety of animals. In their northern breeding ranges, tanager nests are sometimes parasitized by brown-headed cowbirds (Bent 1958; Skutch 1989). Young are preyed upon by various Corvid (crow family) species (Skutch 1989). Adult tanagers are preyed on by a variety of raptors. Bent (1958) recorded an incidence of predation by a sharp-shinned hawk, while Skutch (1989) lists screech owls, long-eared owls and short-eared owls as potential predators.

While parasitism and predation certainly occur, western tanagers may also be limited by the availability of suitable habitat. An estimated 56% of the RSA is composed of peatlands, wetlands and disturbed or sparsely vegetated areas (BOVAR 1996b), all habitats considered unsuitable for western tanagers. The remaining 44% is divided among coniferous, deciduous and mixedwood communities of various seral stages, some of which should provide suitable habitat for breeding western tanagers.

5.7.4 Pileated Woodpecker

5.7.4.1 Status and Distribution

The pileated woodpecker is widely distributed across North America, and in Alberta is found mainly in the boreal forest, Foothills and Rocky Mountain regions (Semenchuk 1992). During the winter periods, this species can be found farther south and east of these areas, but is not usually found in agricultural areas. Currently, the population in Alberta is considered stable (Semenchuk 1992). Pileated woodpeckers have been previously recorded in the oil sands region of northeastern Alberta, with observations in 14.3% of the terrestrial point counts (or 0.14 mean individuals per count) in the Suncor Lease area (Westworth, Brusnyk and Associates 1996d).

Pileated woodpeckers are year-round residents and defend their territories throughout the year (Bull and Meslow 1988). There is strong site fidelity to home range as the pair will occupy the same home range for many years, provided adequate resources are available (Bull and Jackson 1995). In areas with high densities of suitable foraging and nesting habitat, home range size will be smaller than in areas with fewer resources (Renken and Wiggers 1989).

5.7.4.2 Habitat

Pileated woodpeckers require mature to old growth, dense-canopied forests, particularly mixed and deciduous woods, for nesting, roosting and foraging. Unlike other woodpeckers, this species rarely occurs in burns (Semenchuk 1992). Due to their large body size and since they are primary cavity nesters, pileated woodpeckers require large-diameter snags to construct nesting and roosting cavities. This species usually excavates standing snags and decayed trees of >20 cm dbh (Bull 1987, Harestad and Keisker 1989, Renken and Wiggers 1989, Bull and Jackson 1995).

This species also excavates roosting cavities, which are important for protection against thermal extremes and predators and are most often used at night and during inclement weather (Bull and Jackson 1995). Roosting cavities differ from nesting cavities in that they are most often located in rotting trees and snags that are easily excavated, whereas nesting cavities are often located in partially decayed or live trees. Roosting trees often have several entrance holes that are connected by a continuous hollow chamber within the rotting tree, allowing for escape from predators.

Pileated woodpeckers forage primarily on carpenter ants and wood-boring beetle larvae, but will feed on fruits and nuts when available (Hoyt 1957; Bull and Jackson 1995). Diet is dependent on food availability rather than food preference (Bull et al. 1986). Foraging substrates consist of decaying large diameter woody debris such as downed logs and stumps, as well as standing dead snags (Mannan 1984; Millar 1992). Foraging areas are often within mature or old stands that contain a large volume of coarse woody debris and dense understorey vegetation. This species has also been known to forage in younger stands if suitable nest trees are available within the home range (Bull and Meslow 1988).

Population density is related to the density of large-diameter snags that provide nesting and foraging substrate (Renken and Wiggers 1989). With high volumes of stumps and logs available to house insects, more individuals per unit area will be able to obtain adequate food with little interference. A dense canopy closure with high basal area allows pileated woodpeckers to better avoid predators and also provides suitable micro-habitat for insect production.

5.7.4.3 Habitat Modelling

Pileated woodpecker habitat modelling was conducted for the Shell Muskeg River Mine Project EIA (Golder 1998e). A total of 3,403 HUs were mapped for the local area, including 21.7% high suitability, 6% moderate, 45.6% low and 26.7% unsuitable habitat.

A habitat model, adapted from Golder (1997b), and used for the Shell Muskeg River Mine Project EIA (Golder 1998a), was used for the Project Millennium EIA (Golder 1998d).

5.7.4.4 Landform Types

The breeding bird survey was not designed to look at landform use by birds. However, it is likely that pileated woodpeckers frequent riparian areas where large, mature to old growth trees (e.g., white spruce/mixedwood) are often found.

5.7.4.5 Limiting Factors

Due to the specialized habitat requirements of this species, their distribution is limited by the availability of large-diameter coarse woody debris found in mature forested areas. The Manitoba Forestry Wildlife Management Project (1994) stated that contiguous blocks of habitat for at least three pairs of woodpeckers should be preserved if maintenance of pileated woodpeckers is desired. Based on breeding territories, this translates to minimum area of 750 ha.

5.8 RAPTORS

5.8.1 Hawks, Eagles and Falcons

5.8.1.1 Status and Distribution

One raptor nest was located during the waterfowl aerial survey (Figure 6), between the Athabasca River and Shipyard lake. The nest was determined to be active. At the time of the survey, a bald eagle was observed on the nest. Observers were unable to determine the reproductive stage without disturbing the bird. A red-tailed hawk was observed at Shipyard Lake. During the course of other field investigations, some incidental sightings of red-tailed hawks were recorded, but generally, observations of diurnal raptors were rare in the LSA. Similar results were obtained for the Aurora mine area study. In that study, seven bald eagles, five northern harriers and six red-tailed hawks were observed during a two-day survey (AXYS 1996b). As well, Westworth, Brusnyk and Associates (1996d) observed a broad-winged hawk, a northern goshawk, a northern harrier and a bald eagle during their spring aerial surveys. Other raptor sightings included a red-tailed hawk in open black spruce/Labrador tea, a northern harrier in closed shrubland, and two sharp-shinned hawks and an American kestrel adjacent to an aspen cutblock (Westworth Brusnyk and Associates 1996d).

5.8.2 Owls

5.8.2.1 Status and Distribution

Twenty-one census stations were visited during the March 1997 survey (Figure 8). Although the survey was conducted within the suggested period for such work, spring weather conditions at the time of the survey were not ideal. Spring snowstorms with snow, blowing snow and high winds were common during the survey period. These conditions limit the range of the song playback tapes for calling owls and hinder the surveyor's ability to hear or see the responding owls (Smith 1987).

Over the course of the sampling period, one great gray owl responded to the song playback tapes. The owl was heard from a station situated in wooded swamp (STNN). Prior to travelling to the survey locations, a great gray owl was heard calling in the riparian area at the confluence of the Athabasca and Steepbank rivers. A great gray owl was observed during the winter track counts in a lichen-jack pine (a1) stand. No great horned owl or boreal owl vocalizations were recorded.

5.8.3 Great Gray Owl

5.8.3.1 Status and Distribution

The great gray owl is a year-round resident of the boreal forest in North America and Eurasia. Although widespread, it is considered uncommon throughout its range and was formerly listed as vulnerable by COSEWIC (1997) and by Alberta Environmental Protection, Fish and Wildlife Division (AEP 1996). Great gray owls primarily prey on small mammals, and their populations are tied to the populations of their prey (Duncan 1992). Great gray owls have been documented in the oil sands area. Three owls were sighted in 1988 in the Aurora area (BOVAR 1996). Four owls were sighted on or near the Shell Lease 13 area in 1997 (Golder 1998a). Great gray owls were recorded in a wooded swamp (STNN), a lichen-jack pine (a1) stand, and in a riparian area in the winter study area, north of the Steepbank River.

5.8.3.2 Habitat

Great gray owls rely on relatively open habitat. Owls breed and hunt in open coniferous, deciduous and mixedwood forests, interspersed with muskegs, marshes and wet meadows (Semenchuk 1992). The availability of nest sites and foraging habitat appears to be critical for great gray owls (Nero 1980, Mikkola 1983). They nest on old hawk and raven nests, or on the top of broken snags or stumps (Duncan 1992). The owls hunt from perches. Foraging habitats include moist forest openings and open herbaceous forests (Anderson 1987). Bogs and clear cuts are also used by great gray owls while hunting (Nero 1980).

5.8.3.3 Habitat Modelling

AXYS (1996a) derived a habitat model for the great gray owl, based on breeding and foraging preferences. High quality breeding habitat was identified as mature, primarily deciduous stands of trees, with canopy closures in excess of 35%. Great gray owls do not build their own nests, but rely on old hawk and raven nests, most often found in poplar and trembling aspen stands (AXYS 1996a).

The foraging habitat index included a component for shrub density (which is thought to decrease hunting success) and two components related to favoured prey of the great gray owl. Microtine rodents (particularly *Microtus* spp.) are favoured almost to the exclusion of other prey. Prime vole habitat was identified with high graminoid ground cover and high soil moisture (AXYS 1996a).

AXYS (1996a) concluded that 24% of the Syncrude regional study area comprised high quality habitat for great gray owls. The prime habitat was for the most part associated with edge habitats adjacent to fens. Moderate habitat, which comprised 23% of the Syncrude study area, was divided among disturbed herb/grass, peatland and wetlands vegetation community types. Marginal habitat made up the remainder and was divided among deciduous, mixedwood, jack pine, white spruce and mixed coniferous types.

The model used by AXYS (1996a) and Golder (1998e) was used for this study as well. The model and results for the Project Millennium LSA and RSA are described in Golder (1998d).

5.8.3.4 Landform Types

No data concerning the use of landforms by great gray owls were obtained from the literature, other than they frequent bogs and fens (Duncan 1994). Due to the open grassy areas found along the margins of some stream types and the high rodent populations usually found in such areas, riparian zones must also be considered good habitat for great gray owls.

5.8.3.5 Limiting Factors

Great gray owls are limited by availability and competition for suitable nesting and foraging habitat and by predation. Open, abandoned nests of this type are also favoured by great horned owls and other owls and raptors, who may compete with the great gray owls (Voous 1988). Competition with other owl species for microtine rodents also occurs, but is likely only limiting for great gray owls when the rodents are at low points in the population cycle (Mikkola 1983).

As adults, great gray owls are occasionally preyed on by great horned owls and lynx (Duncan 1987). Juveniles are preyed upon by northern goshawks, great horned owls and occasionally red-tailed hawks (Duncan 1987, Bull et al. 1988, Bull and Henjum 1990).

5.9 REPTILES AND AMPHIBIANS

5.9.1 Amphibians

5.9.1.1 Status and Distribution

As in the 1996 herpetofauna survey of the Suncor Steepbank Study Area (Westworth, Brusnyk and Associates 1996e), the 1997 herpetofauna survey only revealed two species: boreal chorus frogs and wood frogs. Canadian toads, boreal toads, leopard frogs and red-sided garter snakes were not detected. Small sample sizes precluded a statistical analysis of the 1997 data. Therefore, only a descriptive presentation of the data was warranted.

Boreal chorus frogs and wood frogs were found in similar proportions both at the actual survey sites and in the areas surrounding the survey sites (Figure 11). Both wood frogs and boreal chorus frogs were found in 46%

of the 13 wetlands surveyed (Table 8). Likewise, wood frogs and boreal chorus frogs were found in similarly low proportions at the 55 transect points surveyed (Table 8). While both wood frogs and boreal chorus frogs were detected at all 4 semi-permanent wetlands, these species were only heard calling at 2 of 9 permanent wetlands (Table 8).

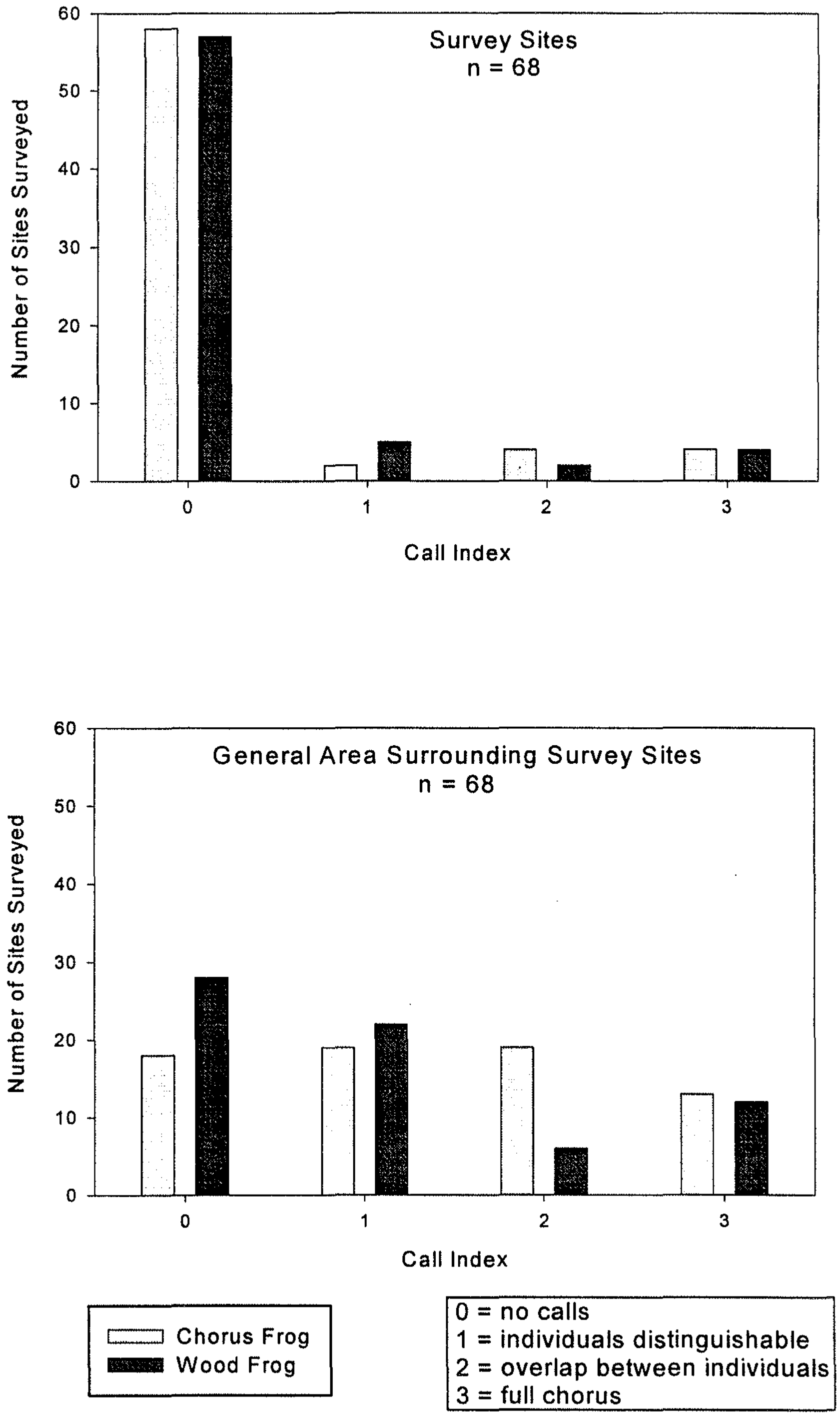
Table 8 Results of Call Index Surveys at Three Types of Sites

	Survey Site Type											
	Transect point				Semi-permanent Wetlands				Permanent Wetlands			
Call Index[a]	0	1	2	3	0	1	2	3	0	1	2	3
Boreal Chorus Frog	51	2	2	0	0	0	1	3	7	0	1	1
Wood Frog	50	4	1	0	0	0	0	4	7	1	1	0

(a) 0 = no calls
1 = individuals distinguishable
2 = overlap between individuals
3 = full chorus

Calling by boreal chorus frogs and wood frogs was widespread across the study area. Many types of habitats were utilized by calling frogs including large bodies of water such as Shipyard Lake (Figure 11), beaver ponds, and both semi-permanent and permanent wetlands within fens and bogs. Breeding by both species of amphibians was confirmed through incidental observations of egg masses at some sites.

Figure 11 Frequency of Boreal Chorus and Wood Frog Call Indices for Survey Sites and the General Study Area



The Canadian toad is likely present in the LSA (Roberts et al. 1979). The red-sided garter snake may also be present; records for this species include observations at Kearl Lake to the east and the Birch Mountains (Roberts et al. 1979). Amphibian species can be good biodiversity indicators (e.g., Heyer et al. 1994) and may also be sensitive receptors for wildlife health issues.

The 1997 herpetofauna survey of the LSA revealed an abundant and widespread population of wood frogs and boreal chorus frogs, as found by Roberts and Lewin (1979) in the same region (AOSERP study area). However, while these two species were found in similar proportions during the 1997 study, Roberts and Lewin (1979) found that wood frogs (Figure 12) were clearly more abundant than boreal chorus frogs. In contrast to the 1997 survey and Roberts and Lewin (1979), the 1996 survey of the LSA (Westworth, Brusnyk and Associates 1996e) demonstrated that boreal chorus frogs were the most commonly encountered amphibian species. However, the 1996 survey was conducted after the peak calling period for wood frogs, while both this study and Roberts and Lewin (1979) study involved multiple visits which overlapped with the peak of the wood frog calling period. Consequently, the 1996 survey may have underestimated the proportion of wood frogs in the amphibian population.

Although Roberts and Lewin (1979) found that Canadian toads were common in the Fort McMurray area during their 1977 study (i.e., toads found at 9 of 18 sites), no evidence of Canadian toads was discovered in either the 1996 or 1997 surveys of the LSA. Habitat that appears to be generally suitable for Canadian toads is present in the LSA; however, the preferred grassy meadow habitat of these toads is not common. Alternatively, it is possible that Canadian toad populations are declining in Alberta, despite the availability of seemingly suitable habitat (Roberts 1995).

No evidence of leopard frogs was discovered during the 1977 (Roberts and Lewin 1979), 1996 or 1997 studies of the region, although they have been recorded in the area (Harper 1931). Leopard frog populations crashed across much of North America, including the three prairie provinces, in the mid 1970s. Declines were linked to the appearance of redleg, a response to a normally benign bacteria that occurs when populations are under stress (Corn 1994). Although populations in many areas are recovering, the reasons for the declines are still largely a mystery (Bishop and Petit 1992).

The red sided garter snake was not detected during the 1977 (Roberts and Lewin 1979), 1996 or 1997 studies of the region. This species likely exists in the region (Russell and Bauer 1993) but probably survives in small, isolated populations associated with overwintering sites.

5.9.1.2 Habitat

Amphibians, in the course of a lifetime, utilize the resources found in both aquatic and terrestrial systems. In addition, most terrestrial amphibians, particularly those in the temperate zone (i.e., northeastern Alberta), utilize different habitat resources in the course of a year, migrating to each one in turn and quite often showing remarkable site fidelity (Sinsch 1990). Amphibians require secure hibernation sites, breeding sites and summer ranges rich in food items, as well as safe migration pathways. Although all boreal amphibians undergo these migrations, the habitat requirements of each species are unique (Table 9).

Table 9 Amphibian Habitat Requirements

	BREEDING	SUMMER HABITAT	HIBERNATION
Boreal Chorus Frog	Favours temporary ponds, will use more permanent sites under some conditions.	Near water margins; under leaf litter, prone to desiccation. Establishes home range.	Under stumps, leaf litter. Glycoprotectant, can survive temperatures as low as -6°C.
Wood Frog	Uses natural ponds, pits, stream back waters. Will breed in bogs. Early breeders, rapid metamorphosis. Site fidelity.	Moist terrestrial habitat. Prefers canopy closure, wet litter. Moves to lowland bogs after breeding. Establishes home range. Site fidelity.	Under stumps, leaf litter. Glycoprotectant, can survive temperatures as low as -6°C. Site fidelity. Dry, upland sites favoured.
Leopard Frog	Requires more permanent ponds. Needs emergent vegetation (cattails, bulrushes). Slow metamorphosis.	Wet soil and vegetation. Pond margins, wet meadows near breeding/hibernation areas. Small home range.	Fairly deep still or slow-moving water. Usually not the same pond as the breeding site.
Canadian Toad	Wide range of breeding habitats: lake margins, slow streams, ponds. Site fidelity.	Waters edge (including lakes and streams), tends to avoid forests. Most stay by breeding areas. Establishes home range.	Burrows in loose earth, under frostline. Communal areas. Site fidelity.

Source: Bellis 1962, Bellis 1965, Berven and Grudzien 1990, Breckenridge and Tester 1961, Cook 1978, Cunjak 1986, Dole 1965, Dole 1971, EAG 1983, Emery et al. 1972, Heatwole 1961, Hodge 1976, Kelleher and Tester 1969, Kramer 1974, Kuyt 1991, MacArthur and Dandy 1982, Roberts and Lewin 1979, Russell and Bauer 1993, Schmid 1982, Stebbins 1985.

Within the Suncor study area, suitable habitat appears to be abundantly available for most of the species of amphibians expected to occur, with the exception of the leopard frog. The cattail or bulrush dominated permanent ponds favored by leopard frogs are not common within the LSA. However, a wide range of semi-permanent and permanent wetlands are widely distributed across the study area, many of which provide high quality habitat for boreal chorus frogs, wood frogs and Canadian toads.

Although the larger permanent wetlands may not generally represent optimal amphibian habitat (Westworth, Brusnyk and Associates 1996e), Shipyard Lake contained an abundant population of actively calling boreal chorus frogs and wood frogs during the 1997 survey. In contrast to the 1996 survey of the LSA, boreal chorus frogs and wood frogs were commonly found to use beaver ponds. This type of yearly variation in habitat use is possible given that amphibians are sensitive to environmental conditions, which may change from year to year. The type and quantity of submergent and emergent vegetation present, pH, air and water temperatures, and water levels are all examples of environmental conditions which can change over time, affecting habitat use patterns by amphibians (Russell and Bauer 1993, Bishop et al. 1994, de Maynadier and Hunter 1995).

5.9.1.3 Limiting Factors

Amphibians utilize resources found in both aquatic and terrestrial systems. They require secure hibernation sites, breeding sites and summer ranges rich in food items, as well as safe migration pathways. Fish, aquatic insects, snakes and other amphibians may feed on tadpoles, which are prone to heavy predation (Russell and Bauer 1993). Adults are preyed on by a variety of species, including herons, cranes, river otters, mink and snakes.

The indirect effects of human activities have a significant impact on amphibians. Loss of habitat, the application of pesticides and herbicides, air pollution and water pollution may all affect amphibians.

5.10 VULNERABLE, THREATENED AND ENDANGERED SPECIES

Species with vulnerable, threatened or endangered status according to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 1997) or listed on the Province's blue or red list (AEP 1996) that may occur within the LSA are described in the following sections.

5.10.1 Mammals

The wolverine is considered at risk by the Province (blue-listed) and vulnerable by COSEWIC. AEP (1996) estimates that up to 1,000 wolverines may occur within the province. No wolverine tracks were observed during 1996 (Westworth, Brusnyk and Associates 1996b) or 1997 (Golder 1997a) winter track count studies.

Woodland caribou are listed as vulnerable by COSEWIC and blue-listed by the Alberta. However, no woodland caribou are known to reside in the LSA.

5.10.2 Birds

Red-listed bird species that may occur within the LSA are the peregrine falcon and the whooping crane (AEP 1996). These species are also listed as endangered by COSEWIC (1997). The peregrine falcon was not observed during 1997 field surveys, but is known to nest in the Fort Chipewyan-Lake Athabasca area (Munson et al. 1980). The whooping crane only nests in Wood Buffalo National Park and was observed migrating within Lease 17 in small numbers in 1973-75 (McLaren and Smith 1984).

Blue-listed bird species that potentially occur within the LSA include the bay-breasted warbler, black-throated green warbler, Cape May warbler, and the short-eared owl (AEP 1996). COSEWIC (1997) considers the short-eared owl to be vulnerable but does not list the other blue-listed species. It should be noted that the blue list in Alberta is not a threatened species list; rather, it suggests species that may be at risk of extirpation in the province.

The bay-breasted warbler is blue-listed by AEP (1996) due to its dependency on old growth habitats and its unknown population status. The black-throated green warbler has similar old growth habitat requirements to the bay-breasted warbler. Both species were considered in this EIA to be represented by the Cape May warbler and the pileated woodpecker.

The status of the Cape May warbler, a KIR for this EIA, is discussed in Section 5.7. It is listed by AEP (1996) due to its dependency on old growth forests for breeding and its neotropical migratory habits. Habitat on its wintering grounds is under development pressures.

Two short eared owls were observed by AXYS (1996a) within the Aurora LSA during a 1995 survey. Golder Associates (1997a) did not record any during a late winter owl survey, possibly due to the fact that these owls may migrate out of the area for the winter (Semenchuk 1992). AEP (1996) states that the irruptive nature (*see Glossary*) of the population of short-eared owls makes them a difficult species to monitor.

5.10.3 Amphibians

No COSEWIC-listed species of amphibians occur within the LSA. However, the Canadian toad, which has been red-listed by AEP, likely occurs within the LSA, although no toads were recorded.

5.11 INTRODUCED SPECIES

The wood bison is an introduced species that was present in the area before increased colonization of the area by man. Wood bison are currently found in the RSA as a part of a Syncrude Canada Ltd. research project at their Mildred Lake Site.

6. BIODIVERSITY

It has been suggested that management for biodiversity should be the fundamental goal for management of public and private lands and that a "no net loss" of biodiversity should be an objective for resource managers (Noss and Cooperrider 1994). While the suitability of biodiversity as a worthwhile subject for study is easy to recognize, how to study it is another matter.

As biodiversity is such an important issue, it is important that it be well defined. This is particularly true in an EIA for activities on a relatively large land base where there is a large potential to impact biodiversity. Biodiversity has been defined in many ways. It should be thought of as more than just species richness in an area. It can include spatial and temporal diversity of plant and/or animal communities at the landscape level, structural diversity at the community level, species level, and genetic level. One widely used definition of biodiversity is from Noss and Cooperrider (1994):

"the variety of life and its processes; it includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting."

A description of biodiversity must include reference to the scale at which the diversity is being described (Kananaugh and Iacobelli 1993). Noss and Cooperrider (1994) state that there are 4 levels of biodiversity that must be considered:

- landscapes (regional);
- communities (e.g., ELC units);
- species; and
- genes.

In addition, each scale of biodiversity can be described in terms of its composition, structure and function (Table 10). Composition can refer to the number and kind of species in an area, the genetic make up of a population and the variety of habitat types within a landscape. Structure can refer to the vertical and horizontal layering of a forest, the abundance and distribution of snags and deadfall, or the distribution of forest patches across a landscape. Function refers to the climatic, geological, hydrological, ecological and evolutionary processes that occur within each scale of biodiversity.

Table 10 Potential Biodiversity Indicators for Project Millennium

	Composition	Structure	Function
Landscape	• ELC unit abundance and distribution	• patch size • patch shape connectivity	• natural disturbance regimes
Community	• relative abundance, frequency, richness and diversity of species	• snag density • canopy cover	• nutrient cycling rates • predation rates
Species	• abundance • density	• population structure • range	• population dynamics • life history
Gene	• allelic diversity • presence of rare alleles	• heterozygosity • polymorphism	• inbreeding depression • gene flow

As biodiversity is such a complex issue, indicators should be used to measure it. Table 10 presents some possible biodiversity indicators at each of the four levels and three components of biodiversity. A manager need not study all 12 cells within this matrix. Rather, if biodiversity can be assessed at the landscape and community levels, and for composition and structure, then it can be reasonably assumed that biodiversity for all 12 cells is accounted for (P. Duinker, Lakehead University, pers. comm.). These four cells that should be measured are shaded in Table 10. Each of the four levels of biodiversity are described further below.

6.1 LANDSCAPE LEVEL BIODIVERSITY

Biodiversity at the landscape level refers to the pattern of vegetation and wildlife species communities distributed across the landscape (Noss and Cooperrider 1994). Rowe (1993) argues that landforms are the key to ecosystems and hence, to biodiversity. Thus there is a need to use a geographical context when describing ecosystems. One must look at landforms, soils, air and climate in addition to living organisms. Together, they are more important than their sum.

The use of landscape units as a framework for the setting of landscape level biodiversity objectives is considered by Kananaugh and Iacobelli (1993) to be the best ecological framework for the conservation of biodiversity. Such landscape units are enduring features of the earth's surface, versus the more ephemeral biotic features such as forest cover or vertebrate species. The ELC developed for Project Millennium uses a combination of terrain, soils, vegetation and moisture regime features to map landscape units.

6.1.1 Fragmentation

One ecological principle that should be considered at the landscape level is the effect of fragmentation on ecosystems. Fragmentation refers to the process of dividing a large contiguous habitat into a number of smaller units. This has the result of increasing the amount of edge in the habitat, decreasing the amounts of habitat interior and increasing the distance between habitat patches.

6.1.2 Movement Corridors

The blockage of wildlife movement corridors is becoming an ever increasing concern amongst the public and conservation biologists. Soule (1991) defined a conservation (wildlife) corridor as a "linear landscape feature that facilitates the biologically effective transport of animals between larger patches of habitat". With increasing development pressure and fragmentation of wildlife habitat, species are often confined to such patches of habitat or "habitat islands". The objective in planning for conservation corridors is to allow for sufficient movement between habitat islands such that a species can persist in the region.

If the project does create any barrier(s) to movement, it could result in: (1) decreased gene flow between segments of a population; (2) preclusion of movement to critical habitat such as summer range, winter range and denning areas; or (3) localized extinctions due to restricted movement. Any of these conditions would result in reduced biodiversity within the region.

Good surrogates for measuring biodiversity at the landscape level include ELC unit abundance and distribution (for composition) and ELC patch size, shape and connectivity (for structure: Table 10).

6.2 COMMUNITY LEVEL BIODIVERSITY

Biodiversity must be considered at the community level, as well as the landscape level. A community refers to all the organisms, including plants, wildlife, insects and microbes that live together in an area and interact together. For example, a single ecosection patch can be considered to be a community. Diversity within a patch can include structural measures, such as abundance and density of standing dead trees or woody debris, or age class diversity; compositional measures, such as species richness; and functional measures, such as the intensity of disturbance events (Noss 1995). Management at the community level means paying attention to ecological processes such as fire and hydrological and nutrient cycling (Noss and Cooperrider 1994).

Good surrogates for measuring biodiversity at the community level include the relative abundance, frequency, richness and diversity of species within ELC units (for composition) and HSI variables that are important for the KIRs for the LSA (e.g., snag density and canopy cover; for structure: Table 10).

6.3 SPECIES LEVEL BIODIVERSITY

Species diversity is what most people think of when they think of biodiversity (Noss and Cooperrider 1994). While most vertebrates on the earth have been identified, many, if not most, invertebrates, microbes and bacteria have yet to be discovered. Organisms not yet discovered may outnumber named species by an order of magnitude.

Single species management has long been the goal of most wildlife agencies. In general, high profile species that are valued by society or by a specific segment of society, such as hunters, were managed to ensure that viable populations were maintained or enhanced. Single species have also been selected as management indicator species, whereby the health of a number of species with similar habitat requirements is thought to be represented by one species. Another concept used by managers is that of the keystone species, which is a species that plays an integral, if not controlling, role in an ecosystem (Paine 1966). Thus, by managing for, or monitoring, a single species, the health of an ecosystem can be maintained. At the species level of biodiversity, measures of demographic integrity, such as abundance, and sex ratio and age distribution are considered important.

6.4 APPROACH USED TO MEASURE WILDLIFE BIODIVERSITY

Biodiversity for wildlife was assessed using all four cells shaded in Table 10. A discussion of landscape level indicators and structural components at the community level is provided in the ELC report (Golder 1998d). The remainder of this section focuses on composition at the community level.

A biodiversity habitat model was developed to address wildlife species-level diversity and then link these values to habitat types in an attempt to understand community level diversity. The goal of biodiversity analysis for the EIA is to assess current levels of diversity and then predict any changes associated with the development impacts, reclamation and closure. Then, the maintenance of biodiversity can be incorporated into development and reclamation/closure planning.

A habitat-based approach was used to quantify baseline species composition at the community level. Wildlife diversity was first measured by species richness in habitat types. These values were then used to create a relative richness index which is the ratio of species richness in each habitat type to the maximum species richness among all habitat types.

Vegetation communities were rated as to their species richness based on the number of species found, or expected to be found, within a unit relative to other units (Table 11). A richness index was developed, as follows:

Richness Index = (Number of Species in the Community)/(Maximum Number in Any Community)

Table 11 Number Of Species Found or Expected to be Found Per Broad Vegetation Type

Broad Vegetation Type	Mammal	Bird	Reptile/ Amphibian
Open Water	8	63	0
Jack Pine Forest	21	48	2
Mixedwood Forest	27	81	2
Black and White Spruce Forest	25	57	2
Aspen (Poplar) Forest	20	67	2
Graminoid/Shrubby Fen	16	70	4
Riparian	18	97	4
Marsh	10	78	4
Wooded Fen/Bog	28	112	4
Birch	20	67	2

This was done to allow comparison with the rankings for HSI scores, which also range from 0 to 1.0 (Golder 1998f). The relative richness values (Table 12) were then assigned to each habitat type throughout the study areas, multiplied by the area in hectares and summed to determine richness habitat units (HUs) (Table 13).

Table 12 Relative Richness Index Values By Forest Type

Group	Name	Mammal	Bird	Amphibian/Reptile
A	Open Water	0.29	0.56	0.00
B	Jack Pine Forest	0.75	0.43	0.50
C	Mixedwood Forest	0.96	0.72	0.50
D	Black and White Spruce Forest	0.89	0.51	0.50
E	Aspen (Poplar) Forest	0.71	0.60	0.50
F	Graminoid/Shrubby Fen	0.57	0.63	1.00
G	Riparian	0.64	0.87	1.00
H	Marsh	0.36	0.70	1.00
I	Wooded Fen/Bog	1.00	1.00	1.00
J	Birch	0.71	0.60	0.50

The relative richness of species per forest type (Table 12) indicates that wooded fens and bogs (1.0), mixedwood forests (0.96) and spruce forests (0.89) had the highest richness indices for mammals. For birds, the highest richness values were for wooded fens and bogs (1.0), riparian areas (0.87) and mixedwood forests (0.72). For reptiles and amphibians, the highest richness values were for graminoid/shrubby fens (1.0), riparian areas (1.0), marshes (1.0) and wooded fens and bogs (1.0).

The above richness values were then assigned to each of the vegetation phases present in the LSA (Table 13). This was done by matching overstorey species composition in the broad vegetation classes to the ecological phases. The disturbance vegetation values were then chosen based on professional judgement.

Table 13 Richness Index Values for the Project Millennium Local Study Area

Phase	Description	Mammal	Bird	Amphibian/Reptile
a1	Lichen-jack pine	0.75	0.43	0.50
AIG	Gravel pits	0.00	0.00	0.00
AIH	Roads and rights of ways	0.25	0.25	0.00
b1	Blueberry-jack pine-aspen poplar	0.75	0.43	0.50
b2	Blueberry-aspen poplar(paper birch)	0.71	0.60	0.50
b3	Blueberry-aspen poplar-white spruce	0.96	0.72	0.50
b4	Blueberry-white spruce-jack pine	0.89	0.51	0.50
BFNN	Wooded bog (tree cover >70%)	1.00	1.00	1.00
BTNN	Wooded bog (tree cover >10% and ≤70%)	1.00	1.00	1.00
c1	Labrador tea - mesic jack pine-black spruce	0.75	0.43	0.50
CIP	Revegetated industrial lands	0.25	0.25	0.00
CIW	Well sites - vegetated	0.25	0.00	0.00
d1	Low-bush cranberry-aspen poplar	0.71	0.60	0.50
d2	Low-bush cranberry-aspen poplar-white spruce	0.96	0.72	0.50
d3	Low-bush cranberry-white spruce	0.89	0.51	0.50
e1	Dogwood-balsam poplar-aspen poplar	0.71	0.60	0.50
e2	Dogwood-balsam poplar-white aspen	0.96	0.72	0.50
e3	Dogwood-white spruce	0.89	0.51	0.50
FFNN	Wooded fen (tree cover >70%)	1.00	1.00	1.00
FONG	Graminoid fen	0.57	0.63	1.00
FONS	Shrubby fen	0.57	0.63	1.00
FTNN	Wooded fen (tree cover >10% and ≤70%)	1.00	1.00	1.00
g1	Labrador tea - subhygric black spruce-jack pine	0.89	0.51	0.50
h1	Labrador tea/horsetail-white spruce-black spruce	0.89	0.51	0.50
HG/CC	Herbacious graminoid cutblock	0.25	0.25	0.00
MONG	Graminoid marsh	0.57	0.63	1.00
MONS	Shrubby marsh	0.36	0.70	1.00
NMC	Cutbanks	0.00	0.00	0.00
NMS	Sand	0.00	0.00	0.00
NWF	Flooded area	0.00	0.00	0.00
NWL	Lake	0.29	0.56	0.00
NWR	River	0.29	0.56	0.00
Black Spruce/Larch	Black spruce - larch complexes	0.89	0.51	0.50
SFNN	Swamp (tree cover >70%)	0.64	0.87	1.00
Shrub	Shrubland	0.57	0.63	1.00
SONS	Swamp (deciduous shrub)	0.64	0.87	1.00
STNN	Swamp (tree cover >10% and ≤70%)	0.64	0.87	1.00
WONN	Shallow open water	0.29	0.56	0.00

6.4.1 Relative Species Richness Index Summaries

The relative richness of a community type is the ratio of species richness in one type compared to the maximum value of species richness among all types. The richness index ranges from 0 - 1, and is used to indicate high, medium, and low community or landscape types, using the same criteria as used in HSI modelling (Golder 1998f):

Rank	Value Range
No Richness	0.00
Low	0.01 - 0.33
Moderate	0.34 - 0.66
High	0.67 - 1.00

The area of each vegetation type was multiplied by the index value to determine richness Habitat Units (HUs). These units are then summed to determine total richness habitat of the study area. The advantage of this approach is that the change in species richness during impact and closure phases of the project can also be predicted and compared to these baseline values.

6.5 BIODIVERSITY RESULTS

The area of each vegetation type within the LSA is provided in Table 14, while the number of biodiversity HUs per vegetation type within the Millennium Project LSA are shown in Table 15. A comparison of biodiversity HUs by low, medium and high potential is provided in Table 16.

Table 14 Area of Each Forest Type Within the LSA

Phase	LSA (ha)	Phase	LSA (ha)
a1	1	FONS	426
AIG	0	FTNN	6,010
AIH	5	g1	1
b1	226	h1	59
b2	28	HG/CC	170
b3	60	MONG	107
b4	50	MONS	211
BFNN	26	NMC	33
BTNN	20	NMR	0
c1	1	NMS	1
CIP	12	NWF	6
CIW	5	NWL	20
d1	3,348	NWR	79
d2	588	Sb/Lt	20
d3	941	SFNN	687
e1	212	Shrub	131
e2	63	SONS	161
e3	127	STNN	1,359
FFNN	966	WONN	15
FONG	4		
Total			**16,181**

Note: Totals nay not add up due to rounding of numbers.

A total of 13,441 mammal, 12,996 bird and 12,971 reptile/amphibian biodiversity HUs were calculated for the LSA (Tables 15 and 16). For mammals, areas with particularly high diversity potential included low-bush cranberry-white spruce (d1) and wooded fens (FTNN). For birds, areas with particularly high diversity potential included wooded fens (FTNN), swamps (STNN), and low-bush cranberry-white spruce (d1). The same results were seen for amphibians and reptiles. Areas with low potential for diversity included the following for all taxonomic groups:

- lichen-jack pine (a1);
- gravel pits (AIG);
- roads and right-of-ways (AIH);
- Labrador tea-mesic-jack pine-black spruce (c1);
- revegetated industrial lands (CIP);
- vegetated well sites (CIW);
- graminoid fens (FONG);
- Labrador tea-subhygric-black spruce-jack pine (g1);

- cutbanks (NMC);
- sand (NMS);
- flooded areas (NWF);
- lakes (NWL); and
- shallow open water (WONN).

Table 15 Number of Biodiversity HUs Within the LSA for Each Taxonomic Group

Phase	Mammals LSA HUs	Birds LSA HUs	Reptiles and Amphibians LSA HUs
a1	0	0	0
AIG	0	0	0
AIH	1	1	0
b1	170	97	113
b2	20	17	14
b3	57	43	30
b4	45	26	25
BFNN	26	26	26
BTNN	20	20	20
c1	0	0	0
CIP	3	3	0
CIW	1	0	0
d1	2,377	2,009	1,674
d2	564	423	294
d3	837	480	470
e1	150	127	106
e2	60	45	31
e3	113	65	64
FFNN	966	966	966
FONG	2	2	4
FONS	243	268	426
FTNN	6,010	6,010	6,010
g1	1	0	0
h1	53	30	30
HG/CC	43	43	0
MONG	61	67	107
MONS	76	148	211
NMC	0	0	0
NMR	0	0	0
NMS	0	0	0
NWF	0	0	0
NWL	6	11	0
NWR	23	44	0
Sb/Lt	18	10	10
SFNN	440	598	687
Shrub	75	82	131
SONS	103	140	161
STNN	870	1,182	1,359
WONN	4	9	0
Total	**13,441**	**12,996**	**12,971**

Table 16 Number of Biodiversity HUs Within the Project Millennium LSA

Mammal Habitat Areas	LSA
Mammal Habitat Units	
Low	81
Moderate	1,869
High	11,491
Total	**13,441**
Bird Habitat Units	
Low	47
Moderate	3,347
High	9,602
Total	**12,996**
Reptile/Amphibian Habitat Units	
Low	0
Moderate	2,863
High	10,108
Total	**12,971**

Thus, it appears that the LSA contains an abundance of areas with moderate to high potential for diversity.

7. CLOSURE

We trust this report presents the information you require. Should any portion of the report require clarification, please contact the undersigned.

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APPENDIX I

SPECIES LISTS

Common Name	Scientific Name
BIRD SPECIES	
Gaviiformes	
Common loon	*Gavia immer*
Podicipediformes	
Pied-billed grebe	*Podilymbus podiceps*
Horned grebe	*Podiceps auritus*
Red-necked grebe	*Podiceps grisegena*
Pelecaniformes	
White pelican	*Pelecanus erythrorhynchos*
Double-crested cormorant	*Phalacrocorax auritis*
Ciconiformes	
American bittern	*Botaurus lentiginosus*
Great blue heron	*Ardea herodias*
Anseriformes	
Tundra swan	*Cygnus columbianus*
Trumpeter swan	*Cygnus buccinator*
Greater white-fronted goose	*Anser albifrons*
Snow goose	*Chen caerulescens*
Ross' goose	*Chen rossii barnacle goose*
Canada goose	*Branta canadensis*
Green-winged teal	*Anas crecca*
Mallard	*Anas platyrhynchos*
Northern pintail	*Anas acuta*
Blue-winged teal	*Anas discors*
Cinnamon teal	*Anas cyanoptera*
Northern shoveler	*Anas clypeata*
Gadwall	*Anas strepera*
American wigeon	*Anas americana*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Ring-necked duck	*Aythya collaris*
Greater scaup	*Aythya marila*
Lesser scaup	*Aythya affinis*
Common goldeneye	*Bucephala clangula*
Bufflehead	*Bucephala albeola*
Hooded merganser	*Lophodytes cuculatus*
Common merganser	*Mergus merganser*
Red-breasted merganser	*Mergus serrator*
Rudy duck	*Oxyura jamaicensis*

Common Name	Scientific Name
Falconiformes	
Osprey	*Pandion haliaetus*
Bald eagle	*Haliaeetuus leucocephalus*
Northern harrier	*Circus cyaneus*
Sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*Accipiter cooperi*
Golden eagle	*Aquila chrysaetos*
Northern goshawk	*Accipiter gentilis*
Broad-winged hawk	*Buteo platypterus*
Swainson's hawk	*Buteo swainsoni*
Red-tailed hawk	*Buteo jamaicensis*
Rough-legged hawk	*Buteo lagopus*
American kestrel	*Falco sparverius*
Merlin	*Falco columarius*
Peregrine falcon	*Falco peregrinus*
Galliformes	
Spruce grouse	*Dendragapus canadensis*
Sharp-tailed grouse	*Pedioecetes phasianellus*
Willow ptarmigan	*Lagopus lagopus*
Ruffed grouse	*Bonasa umbellus*
Gruiformes	
Sora rail	*Porzana carolina*
American coot	*Fulica americana*
Sandhill crane	*Grus canadensis*
Whooping crane	*Grus americana*
Charadriiformes	
Black-bellied plover	*Pluvialis squatarola*
Lesser golden plover	*Pluvialis dominica*
Semipalmated plover	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*
Greater yellowlegs	*Tringa melanoleuca*
Lesser yellowlegs	*Tringa flavipes*
Solitary sandpiper	*Tringa solitaria*
Spotted sandpiper	*Actitis macularia*
Whimbrel	*Numenius phaeopus*
Hudsonian godwit	*Limosa haemastica*
Sanderling	*Calidris alba*
Semipalmated sandpiper	*Calidris pusilla*
Western sandpiper	*Calidris mauri*
Least sandpiper	*Calidris minutilla*
White-rumped sandpiper	*Calidris fuscicollis*
Baird's sandpiper	*Calidris bairdii*

Common Name	Scientific Name
Pectoral sandpiper	*Calidris melanotos*
Short-billed dowitcher	*Limnodromus griseus*
Long-billed dowitcher	*Limnodromus scolopaceus*
Common snipe	*Capella gallinago*
Wilson's phalarope	*Phalaropus tricolor*
Bonaparte's gull	*Larus philadelphia*
Ring-billed gull	*Larus delawarensis*
Herring gull	*Larus argentatus*
California gull	*Larus californicus*
Franklin's gull	*Larus pipixcan*
Common tern	*Sterna hirundo*
Black tern	*Chlidonias niger*
Strigiformes	
Great horned owl	*Bubo virginianus*
Snowy owl	*Nyctea scandiaca*
Northern hawk-owl	*Surnia ulula*
Long-eared owl	*Asio flammeus*
Boreal owl	*Aegolius funereus*
Great gray owl	*Strix nebulosa*
Barred owl	*Strix varia*
Caprimulgiformes	
Common nighthawk	*Chordeiles minor*
Coraciiformes	
Belted kingfisher	*Ceryle alcyon*
Piciformes	
Yellow bellied sapsucker	*Sphyrapicus varius*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Picoides villosus*
Northern three-toed woodpecker	*Picoides tridactylus*
Black-backed woodpecker	*Picoides arcticus*
Northern flicker	*Colaptes auratus*
Pileated woodpecker	*Dryocopus pileatus*
Passeriformes	
Olive-sided flycatcher	*Nuttalornis borealis*
Western wood-peewee	*Contopus sordidulus*
Yellow-bellied flycatcher	*Empidonax flaviventris*
Alder flycatcher	*Empidonax alnorum*
Least flycatcher	*Empidonax minimus*

Common Name	Scientific Name
Eastern kingbird	*Tyrannus tyrannus*
Bank swallow	*Riparia riparia*
Barn swallow	*Hirundo rustica*
Tree swallow	*Iridoprocne bicolor*
Gray jay	*Perisoreus canadensis*
Blue jay	*Cyanocitta cristata*
Black-billed magpie	*Pica pica*
American crow	*Corvus brachyrhynchos*
Common raven	*Corvus corax*
Black-capped chickadee	*Parus atricapillus*
Boreal chickadee	*Parus hudsonicus*
Red-breasted nuthatch	*Sitta canadensis*
Brown creeper	*Certhia familiaris*
Winter wren	*Troglodytes troglodytes*
Marsh wren	*Cistothorus palustris*
Golden-crowned kinglet	*Regulus satrapa*
Ruby-crowned kinglet	*Regulus calendula*
Veery	*Catharus fuscescens*
Swainson's thrush	*Catharus ustulatus*
Hermit thrush	*Catharus guttatus*
American robin	*Turdus migratorius*
Bohemian waxwing	*Bombycilla garrulus*
Cedar waxwing	*Bombycilla cedorum*
Solitary vireo	*Vireo solitarius*
Warbling vireo	*Vireo gilvus*
Philadelphia vireo	*Vireo philadelphicus*
Red-eyed vireo	*Vireo olivaceous*
Tennessee warbler	*Vermivora peregrina*
Orange-crowned warbler	*Vermivora celata*
Yellow warbler	*Dendroica petechia*
Magnolia warbler	*Dendroica magnolia*
Cape May warbler	*Dendroica tigrina*
Yellow-rumped warbler	*Dendroica coronata*
Palm warbler	*Dendroica palmarum*
Black-throated green warbler	*Dendroica virens*
Bay-breasted warbler	*Dendroica castanea*
Blackpoll warbler	*Dendroica striata*
American redstart	*Stenophaga ruticilla*
Ovenbird	*Seiurus aurocapillus*
Northern waterthrush	*Seiurus noveboracensis*
Common yellowthroat	*Dendroica coronata*

Common Name	Scientific Name
Canada warbler	*Wilsonia canadensis*
Wilson's warbler	*Wilsonia pusilla*
Western tanager	*Piranga ludoviciana*
Rose-beaked grosbeak	*Pheucticus ludovicianus*
American tree sparrow	*Spizella arborea*
Chipping sparrow	*Spizella passerina*
Clay-colored sparrow	*Spizella pallida*
Savannah sparrow	*Passerculus sandwichensis*
Leconte's sparrow	*Ammospiza leconteii*
Fox sparrow	*Paserella iliaca*
Song sparrow	*Melospiza melodia*
Lincoln's sparrow	*Melospiza lincolnii*
Swamp sparrow	*Melospiza georgiana*
White-throated sparrow	*Zonotrichia albicollis*
Dark-eyed junco	*Junco hyemalis*
Lapland longspur	*Calarius lapponicus*
Snow bunting	*Plectrophenax nivalis*
Red-winged blackbird	*Agelaius phoeniceus*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Brewer's blackbird	*Euphagus cyanocephalus*
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
Northern oriole	*Icterus galbula*
Pine grosbeak	*Pinicola enucleator*
Purple finch	*Carpodacus purpureus*
Red-winged crossbill	*Loxia curvirostra*
White-winged crossbill	*Loxia leucoptera*
Common redpoll	*Carduelis flammea*
Pine siskin	*Carduelis pinus*
Evening grosbeak	*Coccothraustes vespertinus*

MAMMALS

Common Name	Scientific Name
Insectivora	
Masked shrew	*Sorex cinereus*
Wandering shrew	*Sorex vagrans*
Water shrew	*Sorex palustris*
Arctic shrew	*Sorex arcticus*
Pygmy shrew	*Sorex hoyi*
Chiroptera	
Little brown bat	*Myotis lucifugus*

Common Name	Scientific Name
Silver-haired bat	*Lasionycteris noctivagans*
Big brown bat	*Eptesicus fuscus*
Hoary bat	*Lasiurus cinereus*
Keen *myotis*	*Myotis keeni*
Lagomorpha	
Snowshoe hare	*Lepus americanus*
Rodenita	
Woodchuck	*Marmota monax*
Least chipmunk	*Tamius minimus*
Red squirrel	*Tamiasciurius hudsonicus*
Northern flying squirrel	*Glaucomys sabrinus*
Beaver	*Castor canadensis*
Deer mouse	*Peromyscus maniculatus*
Red-backed vole	*Clethrionomys gapperi*
Heather vole	*Phenacomys intermedius*
Meadow vole	*Microtus pennsylvanicus*
Muskrat	*Ondatra zibethicus*
Meadow jumping mouse	*Zapus hudsonicus*
Porcupine	*Erethizon dorsatum*
Carnivora	
Coyote	*Canis latrans*
Wolf	*Canis lupus*
Red fox	*Vulpes vulpes*
Black bear	*Ursus americanus*
Marten	*Martes americana*
Fisher	*Martes pennanti*
Ermine	*Mustela erminea*
Least weasel	*Mustela nivalis*
River otter	*Lutra canadensis*
Mink	*Mustela vison*
Wolverine	*Gulo gulo*
Lynx	*Lynx canadensis*
Artiodactyla	
Mule deer	*Odocoileus hemionus*
White-tailed deer	*Odocoileus viginianus*
Moose	*Alces alces*

Common Name	Scientific Name
Woodland caribou	*Caribou tarandus*
Bison	*Bison bison*
Salientia	
Canadian toad	*Bufo hemiophrys*
Western toad	*Bufo boreas*
Boreal chorus frog	*Pseudacris triseriata*
Wood frog	*Rana sylvatica*
Squamata	
Red-sided garter snake	*Thamnophis sirtalis*

Source: Bovar 1996(a)

APPENDIX II

GLOSSARY

GLOSSARY

Carnivore	Flesh-eating mammals, especially those of the order Carnivora. Many species in this group are valuable furbearers. Examples within the RSA include coyotes, marten, wolverines and Canada lynx.
Flocked drakes	The total number of males observed with one or more other males (no females present). Flocked drakes of all species numbering 5 or more per grouping will be treated as a "group".
Furbearer	An animal that bears fur, especially of a commercially desired quality.
Grouped birds	The total number of individuals, both male and female, observed in company which cannot be separated into singles and pairs at the time of observation.
Herbivore	Plant-eating animals. Examples within the RSA include snowshoe hares, red squirrels, red-backed voles, moose and deer.
Irruptive	Capable of undergoing a sudden upsurge in numbers, especially when natural checks and balances are disturbed (e.g., short-eared owl populations).
Lone drakes	The total number of lone males observed.
Lone hens	The total number of lone hens observed (redhead, scaup, ring-necked duck and ruddy duck only). Due to the distorted sex ratio and the social structure in these particular species, the hens are counted (Caswell 1997 pers. comm.).
Midden	Caches of conifer cones, may also contain refuse dumps of conifer cone scales; generally characteristic of red squirrel territories.
Pairs	The total number of male and female groupings observed.
Total indicated birds	The total number of birds observed on the aerial transect with allowances for hens not observed with single and flocked drakes. Total indicated birds is calculated by multiplying lone drakes by 2, flocked drakes by 2, the number of pairs by 2, and grouped birds by 1. In the case of redhead, scaup, ring-necked duck, and ruddy duck, lone and flocked drakes and lone hens are multiplied by 1 in determining total indicated birds.
Ungulate	Any of the group (Ungulata) consisting of the hoofed mammals of which most are herbivorous. Examples within the RSA include moose, deer and woodland caribou.

APPENDIX III

SPECIES USE OF VEGETATION COMMUNITIES

Table 1. Potential Use of Vegetation Communities by Bird Species

Common Name	open water	jack pine forest	mixed wood forest	black and white spruce forest	aspen (poplar) forest	graminoid fen/shrubby	riparian	marsh	wooded fens or bogs	aspen-paper birch forest
red-throated loon	x									
arctic loon	x									
common loon	x						x			
pied-billed grebe	x						x	x		
horned grebe	x						x	x	x	
red-necked grebe	x						x	x		
eared grebe	x							x		
western grebe	x									
American white pelican	x						x			
double-crested cormorant	x						x	x		
American bittern						x	x	x	x	
great blue heron	x		x	x	x	x	x	x		x
great egret	x					x		x		
tundra swan	x									
trumpeter swan	x									
goose	x									
snow goose	x									
Ross' goose	x									
Canada goose	x						x		x	
wood duck	x					x		x		
green-winged teal	x					x	x	x	x	
American black duck	x					x		x		
mallard	x				x	x	x	x	x	x
northern pintail	x					x	x	x	x	
blue-winged teal	x					x	x	x	x	
cinnamon teal	x					x		x		
northern shoveler	x					x	x	x	x	
gadwall	x					x	x	x	x	
Eurasian wigeon	x					x		x		
American wigeon	x					x	x	x	x	
canvasback	x					x	x	x	x	
redhead	x					x	x	x	x	
ring-necked duck	x					x	x	x	x	
greater scaup	x					x		x		
lesser scaup	x					x	x	x	x	
harlequin duck										
oldsquaw	x									
surf scoter	x					x		x		
white-winged scoter	x					x		x		
common goldeneye	x				x	x	x	x		x
Barrow's goldeneye	x					x		x		
bufflehead	x				x	x	x	x		x
hooded merganser	x					x	x	x	x	
common merganser	x					x	x	x		
red-breasted merganser	x					x	x	x		
ruddy duck	x						x	x	x	
osprey	x						x		x	
bald eagle	x				x		x			x
northern harrier						x	x	x	x	
sharp-shinned hawk		x	x	x	x				x	x
Cooper's hawk										
northern goshawk			x							
broad-winged hawk			x		x				x	x
Swainson's hawk										
red-tailed hawk		x	x	x	x					x
rough-legged hawk		x								
golden eagle									x	
American kestrel			x		x		x			x
merlin							x		x	
peregrine falcon	x						x	x	x	
gyrfalcon		x								
spruce grouse		x	x	x					x	
willow ptarmigan		x								
ruffed grouse			x		x					x

Table 1. Potential Use of Vegetation Communities by Bird Species

Common Name	open water	jack pine forest	mixed wood forest	black and white spruce forest	aspen (poplar) forest	graminoid fen/shrubby	riparian	marsh	wooded fens or bogs	aspen-paper birch forest
sharp-tailed grouse							x		x	
sora					X	x	x	x	x	X
American coot	x					x	x	x	x	
sandhill crane						x	x	x	x	
whooping crane										
black-bellied plover										
lesser golden plover										
semipalmated plover							x			
killdeer							x		x	
American avocet	x							x		
greater yellowlegs						x		x	y	
lesser yellowlegs						x		x	x	
solitary sandpiper						x	x	x	x	
willet								x		
spotted sandpiper							x	x	x	
upland sandpiper										
whimbrel										
hudsonian godwit										
marbled godwit							x		x	
ruddy turnstone										
sanderling										
semipalmated sandpiper										
western sandpiper										
least sandpiper							x		x	
white-rumped sandpiper										
Baird's sandpiper										
pectoral sandpiper										
dunlin										
stilt sandpiper										
buff-breasted sandpiper										
short-billed dowitcher									x	
long-billed dowitcher										
common snipe			x	x	x	x		x	y	x
Wilson's phalarope	x					x	x	x	x	
red-necked phalarope	x					x		x		
red phalarope	x					x		x		
Franklin's gull	x					x	x	x	x	
Bonaparte's gull	x					x	x	x	x	
mew gull	x						x	x		
ring-billed gull	x						x	x		
California gull	x						x	x		
herring gull	x						x	x		
Iceland gull	x							x		
glaucous gull	x							x		
Caspian tern	x									
common tern	x					x	x	x	x	
arctic tern	x							x		
black tern	x					x	x	x	x	
rock dove										
mourning dove		x								
great-horned owl		x	x	x	x		x		x	x
snowy owl		x								
northern hawk owl		x	x			x			x	
barred owl										
great gray owl		x	x	x	x	x	x		x	x
long-eared owl										
short-eared owl						x		x		
boreal owl			x	x					x	
common nighthawk										
belted kingfisher						x	x	x	x	
yellow-bellied sapsucker			x	x	x					x
downy woodpecker			x		x					x
hairy woodpecker		x	x	x	x					x
three-toed woodpecker		x	x	x					x	

Table 1. Potential Use of Vegetation Communities by Bird Species

Common Name	open water	jack pine forest	mixed wood forest	black and white spruce forest	aspen (poplar) forest	graminoid fen/shrubby	riparian	marsh	wooded fens or bogs	aspen-paper birch forest
black-backed woodpecker		x	x	x					x	
northern flicker		x	x	x	x					x
pileated woodpecker			x	x	x					x
olive-sided flycatcher		x	x			x	x		x	
great-crested flycatcher			x		x					x
western wood-pewee		x	x	x	x	x	x	x	x	x
yellow-bellied flycatcher		x	x	x	x				x	x
alder flycatcher			x	x	x		x		x	x
least flycatcher			x	x	x				x	x
eastern phoebe			x		x	x	x		x	x
Say's phoebe							x			
eastern kingbird			x		x	x	x		x	x
horned lark					x					x
tree swallow			x		x	x	x	x	x	x
bank swallow							x	x		
cliff swallow							x	x		
barn swallow							x	x		
gray jay		x	x	x	x				x	x
blue jay			x		x					x
black-billed magpie		x	x		x		x			x
American crow		x	x	x	x				x	x
common raven		x	x	x	x		x		x	x
black-capped chickadee			x		x					x
boreal chickadee		x	x	x			x		x	
red-breasted nuthatch		x	x	x					x	
brown creeper		x	x	x						
house wren		x								
winter wren		x	x	x					x	
marsh wren						x	x	x	x	
golden-crowned kinglet		x	x	x						
ruby-crowned kinglet		x	x	x	x				x	x
mountain bluebird			x		x				x	x
veery										
gray-cheeked thrush										
Swainson's thrush			x	x	x		x		x	x
hermit thrush		x	x	x	x				x	x
American robin			x	x			x			
northern mockingbird		x								
brown thrasher		x								
American pipit									x	
Bohemian waxwing		x	x	x			x			
cedar waxwing			x	x	x		x		x	x
northern shrike										
European starling			x		x					x
solitary vireo			x						x	
warbling vireo			x		x					x
Philadelphia vireo			x		x				x	x
red-eyed vireo			x	x	x		x			x
Tennessee warbler			x	x	x	x	x	x	x	x
orange-crowned warbler			x		x		x		x	x
yellow warbler						x	x		x	
magnolia warbler		x	x	x	x		x		y	x
Cape May warbler			x	x						
yellow-rumped warbler		x	x	x	x				y	x
warbler		x	x	x						
palm warbler			x	x	x	x			x	x
bay-breasted warbler				x	x				x	x
blackpoll warbler			x	x					x	
black-and-white warbler			x	x	x		x		x	x
American redstart			x	x	x		x		x	x
ovenbird			x	x	x				x	x
northern waterthrush			x	x		x	x	x	X	
Connecticut warbler			x	x	x				x	x
mourning warbler			x		x					x

Table 1. Potential Use of Vegetation Communities by Bird Species

Common Name	open water	jack pine forest	mixed wood forest	black and white spruce forest	aspen (poplar) forest	graminoid fen/shrubby	riparian	marsh	wooded fens or bogs	aspen-paper birch forest
common yellowthroat			x	x		x	x	x	x	
Wilson's warbler			x				x		x	
Canada warbler			x		x		x		x	x
western tanager			x		x				x	x
rose-breasted grosbeak			x	x	x					x
indigo bunting		x								
American tree sparrow							x		x	
chipping sparrow			x	x	x				x	x
clay-colored sparrow						x	x		x	
vesper sparrow									x	
savannah sparrow						x		x	x	
LeConte's sparrow			x			x		x	x	
sharp-tailed sparrow						x	x	x	x	
fox sparrow							x		x	
song sparrow						x	x	x	x	
Lincoln's sparrow						x	x	x	x	
swamp sparrow						x	x	x	x	
white-throated sparrow		x	x	x	x		x		x	x
white-crowned sparrow							x		x	
Harris' sparrow		x								
dark-eyed junco		x	x	x					x	
Lapland longspur		x								
Smith's longspur		x								
snow bunting		x								
bobolink		x								
red-winged blackbird					x	x	x	x	x	x
western meadowlark		x								
yellow-headed blackbird						x	x	x	x	
rusty blackbird						x	x		x	
Brewer's blackbird					x	x	x		x	x
common grackle						x	x		x	
brown-headed cowbird						x				
northern oriole										
pine grosbeak										
purple finch			x	x	x					x
red crossbill		x	x	x	x					x
white-winged crossbill			x	x	x				x	x
common redpoll			x	x	x				x	x
hoary redpoll		x								
pine siskin		x	x	x	x				x	x
American goldfinch										
evening grosbeak			x	x	x				x	x
house sparrow										
Species Richness	63	48	81	57	67	70	97	78	112	67
Richness Index	0.23	0.00	0.52	0.14	0.30	0.34	0.77	0.47	1.00	0.30

Table 2 Potential Use of Vegetation Communities by Mammal Species

common name	open water	jack pine	mixedwood forest	black and white spruce	aspen and poplar forest	graminoid fen/shrubby fen	riparian	marsh	wooded fen/bog	aspen-paper birch forest
masked shrew		x	x	x	x				x	x
dusky shrew				x			x		x	
water shrew						x	x	x		
arctic shrew			x		x				x	x
pygmy shrew		x	x	x	x				x	x
little brown bat	x					x	x	x		
northern long-eared bat	x	x	x	x	x	x	x	x	x	x
silver-haired bat	x		x		x	x	x	x		x
big brown bat	x					x	x	x		
hoary bat	x	x	x	x	x	x	x	x	x	x
snowshoe hare		x	x	x	x				x	x
least chipmunk		x	x	x	x					x
woodchuck			x							
red squirrel		x	x	x					x	
northern flying squirrel		x	x	x					x	
beaver	x					x	x	x		
deer mouse		x	x	x	x					x
red-backed vole		x	x	x	x				x	x
heather vole		x					x		x	
meadow vole			x		x	x	x		x	
muskrat	x					x	x	x	x	
northern bog lemming				x		x	x		x	
meadow jumping mouse						x	x		x	
porcupine			x		x					x
coyote		x	x	x	x		x		x	x
gray wolf		x	x	x	x				x	x
red fox		x	x	x	x		x		x	x
black bear		x	x	x	x				x	x
marten		x		x		x			x	
fisher		x		x		x			x	
ermine		x	x	x					x	
least weasel		x	x	x					x	
mink				x		x	x	x	x	
wolverine		x	x	x					x	
striped skunk			x	x	x					x
river otter	x					x	x	x	x	
Canada lynx		x	x	x					x	
mule deer			x		x					x
white-tailed deer			x		x					x
moose			x	x	x	x	x		x	x
Species Richness	*8*	*21*	*27*	*25*	*20*	*16*	*18*	*10*	*28*	*19*
Richness Index	0.00	0.65	0.95	0.85	0.60	0.40	0.50	0.10	1.00	0.55

Table 3 Potential Use of Vegetation Communities by Amphibian and Reptile Species

Common Name	open water	jack pine forest	mixedwood forest	black and white spruce forest	aspen (poplar) forest	fen	riparian	marsh	treed bog (black spruce)	aspen-paper birch forest
Canadian toad		x	x	x	x	x	x	x	x	x
striped chorus frog						x	x	x	x	
wood frog						x	x	x	x	
red-sided garter snake		x	x	x	x	x	x	x	x	x
Species Richness	0	2	2	2	2	4	4	4	4	2
Richness Index	0.00	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.00	0.50