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REPORT ON

WILDLIFE HABITAT

SUITABILITY INDEX (HSI) MODELLING

FOR

PROJECT MILLENNIUM

Submitted to:

Suncor Energy Inc.

Fort McMurray, AB

April 1998 **972-2205**

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April 29, 1998

Proj. No. 972-2205

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RE: Final Report on Wildlife Habitat Suitability Index (HSI) Modelling for Project Millennium

Dear Martin:

Attached are fifty copies of the Wildlife Habitat Suitability Index (HSI) Modelling for Project Millennium. This report documents HSI analyses of wildlife habitat for key indicator resources (KIRs) within Project Millennium Local Study Area (LSA) and Regional Study Area (RSA).

If you have any additional questions about the report, please contact either Michael Raine at 299-4642 or me at 299-5640.

Yours very truly,

GOLDER ASSOCIATES LTD.

Shawn McKeon

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

attachments (50)

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

Models for some species were adapted from models prepared by Golder Associates (1998), Axys Environmental Consulting Ltd., and Westworth, Brusnyk and Associates Ltd. Habitat variable data were obtained from Golder Associates, Conor Pacific Environmental and published accounts. Modelling was conducted by Wayne Bessie, GIS analyses by Jill Hebb and The Forestry Corp. Report writing was conducted by Wayne Bessie, Marilyn Collard, Michael Raine, and Shira Mulloy. Appendix II data were tabulated by Tony Calverley, analyzed by John Virgl, and written by Derek Melton. Additional model development assistance was provided by Calvin Clark and Greg Wagner (Conor Pacific Environmental). Technical assistance with tables and figures was provided by Carrie Anderson, Karen Quine, Raeleen Serrie, and Kelly Gurski. Initial peer review was performed by John Gulley. The report was edited for technical content by Michael Raine and Derek Melton. Formatting was conducted by Maureen Myers.

EXECUTIVE SUMMARY

This document reports on the analysis of Key Indicator Resource (KIR) wildlife habitat within Suncor Energy Inc.'s (Suncor) Project Millennium (the Project) Local Study Area (LSA) and Regional Study Area (RSA). Analysis of habitat capability was accomplished through Habitat Suitability Index (HSI) modelling. The goals of this study were to establish baseline habitat capability values for the two study areas, and then assess potential changes to these habitat values as a result of mine developments and other industrial or infrastructure developments. A further goal for the LSA was to determine the long-term changes to wildlife habitat after mine closure and completion of vegetation community reclamation and regrowth.

HSI models were adapted from existing models which were used in a previous oil sands EIA. The species modelled included: beavers, black bears, cape may warblers, dabbling ducks species group, fishers, great gray owls, moose, pileated woodpeckers, red-backed voles, ruffed grouse, snowshoe hares and western tanagers. In addition, an analysis of wildlife species biodiversity at the community level was conducted as was an analysis of moose linkage and fracture areas within the RSA based on human developments which hinder or allow unrestricted access to useable habitat.

HSI models allow assessment of the capability of habitats to support any of the ecological requirements of a species. They do this by rating a vegetation community's compositional and structural components (e.g., downed wood cover) on a scale ranging from 0 - 1. These ratings are then combined in an overall index that ranges from 0 - 1, where 0 indicates the habitat does not meet the species' critical needs, and 1 indicates all of the species' needs can be found in that area. These index values are then multiplied by the area of each vegetation community and the products are summed to determine Habitat Units (HUs). HUs quantify the total habitat of a species throughout a study area. HUs were compared in this study to demonstrate impacts of development and reclamation on the habitat of each KIR. Likewise, species richness HUs were defined and compared to assess changes in wildlife species diversity, while changes to moose linkage habitat areas were used to assess potential fragmentation of useable moose habitat.

In the LSA, beavers were predicted to have 1,273 HUs at pre-development conditions. This value was reduced by 33% to 859 HUs due to mine development (Steepbank and Project Millennium). On closure, when all habitats were reclaimed, beaver habitat was predicted to return to 1,191 HUs, which represented a long-term decrease of 6% from pre-development conditions. In the RSA, beavers were predicted to have 192,045 HUs at baseline. The cumulative effects of the Project on beaver habitat was a reduction of 0.1% of the HUs from baseline, and the impact of all planned projects was a 1% reduction. In all, the Project only contributed 6% to the total reduction in HUs at the regional level. Note that the losses due to the project in the RSA only relate to losses as part of the Project outside of the

Steepbank Mine area since the Steepbank area is already considered part of the approved baseline.

Black bears were predicted to have 6,869 HUs at pre-development conditions in the LSA. This was predicted to be reduced by 57% by the Project to 2,925 HUs. Upon closure, black bear habitat was predicted to increase to 8,726 HUs, a long-term increase of 27% from pre-development conditions. In the RSA, black bears were predicted to have 1,247,278 HUs at baseline. The cumulative effects of the Project on black bear habitat was a reduction of 0.2% of the HUs from baseline, and the impact of all planned projects was a 1% reduction. In all, the Project contributed 18% to the total reduction in HUs at the regional level.

Cape May warblers were predicted to have 4,556 HUs at pre-development conditions in the LSA. This was reduced by 58% by the Project to 1,915 HUs, but on closure, warbler habitat was predicted to increase to 3,717 HUs, which represented a long-term decrease of 18% from pre-development conditions. In the RSA, Cape May warblers were predicted to have 903,110 HUs at baseline. The cumulative effects of the Project on Cape May warbler habitat was a reduction of 0.2% of the HUs from baseline, and the impact of all planned projects was a 1% reduction. In all, the Project contributed 13% to the total reduction in HUs at the regional level.

Dabbling ducks were predicted to have 1,552 HUs at pre-development conditions in the LSA. This was reduced by 28% by the Project to 1,114 HUs. On closure, dabbling duck habitat was predicted to increase to 2,516 HUs, a long-term increase of 62% from pre-development conditions. This large increase was largely related to the creation of several end-pit lakes. In the RSA, dabbling ducks were predicted to have 243,130 HUs at baseline. The cumulative effects of the Project on dabbling duck habitat was a reduction of <1% of the HUs from baseline, and the impact of all planned projects was a 0.6% reduction. In all, the Project only contributed 6% to the total reduction in HUs at the regional level.

Fishers were predicted to have 10,807 HUs at pre-development conditions in the LSA. This was predicted to be reduced by 61% by the Project to 4,225 HUs. On closure, fisher habitat was predicted to increase to 9,983 HUs, which represented a long-term decrease of 8% from pre-development conditions. In the RSA, fishers were predicted to have 1,508,485 HUs at baseline. The cumulative effects of the Project on fisher habitat was a reduction of 0.3% of the HUs from baseline, and the impact of all planned projects was a 1% reduction. Thus, the Project contributed 19% to the total reduction in HUs at the regional level.

Great gray owls were predicted to have 6,965 HUs at pre-development conditions in the LSA. This was predicted to be reduced by 59% by the

Project to 2,863 HUs, but post-closure great gray owl habitat was predicted to increase back to 6,514 HUs, which represented a long-term decrease of 7% from pre-development conditions. In the RSA, great gray owls were predicted to have 1,510,550 HUs at baseline. The cumulative effects of the Project on great gray owl habitat was a reduction of 0.1% of the HUs from baseline, and the impact of all planned projects was a 2% reduction. In all, the Project only contributed 7% to the total reduction in HUs at the regional level.

Moose were predicted to have 9,614 HUs at pre-development conditions in the LSA. This was reduced by 59% by the Project to 3943 HUs. On closure, moose habitat was predicted to increase to 10,826 HUs, which represents a long-term increase of 13% from pre-development conditions. In the RSA, moose were predicted to have 1,535,910 HUs at baseline. The cumulative effects of the Project on moose habitat was a reduction of 0.2% of the HUs from baseline, and the impact of all planned projects was a 1% reduction. In all, the Project contributed 17% to the total reduction in HUs at the regional level.

Total moose fracture zone area in the RSA (at baseline) was 6% of the RSA or 132,564 ha. This increased to 6% of the RSA due to the Project, and then to 7% when all planned developments were included. Within the East-West travel corridor which encompasses the Project (one-sixth of the RSA), the project resulted in an increase in fracture zone percentage from 10% to 12%, and was the only project that resulted in an increase in fracture zone in that corridor in the CEA. Fracture areas represent habitats unusable to moose due to human caused disturbances, whether or not the habitat was suitable. The linkage and fracture zone analysis also indicated the presence of several linkage areas surrounded by development activities. These areas will likely require the maintenance of several access corridors to ensure moose continue to use these during the time span of the Project and other cumulative developments.

Pileated woodpeckers were predicted to have 6,274 HUs at pre-development conditions in the LSA. This was reduced by 53% by the Project to 2,975 HUs. On closure pileated woodpecker habitat was predicted to increase to 8,624 HUs, which represents a long-term increase of 38% from pre-development conditions. In the RSA, pileated woodpeckers were predicted to have 782,295 HUs at baseline. The cumulative effects of the Project on pileated woodpecker habitat was a reduction of 0.2% of the HUs from baseline, and the impact of all planned projects was a 1% reduction. In total, the Project contributed 27% to the total reduction in HUs at the regional level.

Red-backed voles were predicted to have 11,310 HUs at pre-development conditions in the LSA. This was reduced by 56% by the Project to 4,943 HUs. On closure, vole habitat was predicted to increase back to 12,173 HUs, which represents a long-term increase of 8% from pre-development conditions. In the RSA, red-backed voles were predicted to have 1,679,543 HUs at baseline. The cumulative effects of the Project on red-backed vole habitat was a reduction of 0.2% of the HUs from baseline, and the impact of all planned projects was a 1% reduction. In total, the Project contributed 18% to the total reduction in HUs at the regional level.

Ruffed grouse were predicted to have 6,685 HUs at pre-development conditions in the LSA. This was predicted to be reduced by 54% by the Project to 3080 HUs. On closure, ruffed grouse habitat was predicted to increase back to 8,904 HUs, which represents a long-term increase of 33% from pre-development conditions. In the RSA, ruffed grouse were predicted to have 765,545 HUs at baseline. The cumulative effects of the Project on ruffed grouse habitat was a reduction of 0.3% of the HUs from baseline, and the impact of all planned projects was a 1% reduction. In all, the Project contributed 27% to the total reduction in HUs at the regional level.

Snowshoe hares were predicted to have 14,426 HUs at pre-development conditions in the LSA. This was reduced by 59% by the Project to 5,930 HUs. On closure, snowshoe hare habitat was predicted to increase back to 13,208 HUs, which represents a long-term decrease of 8% from pre-development conditions. In the RSA, snowshoe hares were predicted to have 1,638,593 HUs at baseline. The cumulative effects of the Project on snowshoe hare habitat was a reduction of 0.3% of the HUs from baseline, and the impact of all planned projects was a 2% reduction. In total, the Project contributed 20% to the total reduction in HUs at the regional level.

The final individual species modelled was the western tanager. This species was predicted to have 2,929 HUs at pre-development conditions in the LSA. This was reduced by 45% by the Project to 1,625 HUs. On closure, western tanager habitat was predicted to increase to 6,099 HUs, an increase of 108% from pre-development conditions. This large increase was predicted due to the loss of low suitability wetlands and their replacement with high suitability uplands. In the RSA, western tanagers were predicted to have 662,250 HUs at baseline. The cumulative effects of the Project on western tanager habitat was a reduction of 0.1% of the HUs from baseline, and the impact of all planned projects was a 1% reduction. In all, the Project only contributed 7% to the total reduction in HUs at the regional level.

In the LSA, Relative Species Richness Modelling was predicted to have:

- 13,441 HUs at pre-development conditions for mammals
- 12,996 HUs for birds
- 12,971 HUs for reptiles and amphibians

The Project reduced richness HUs by 59% (mammals), 60% (birds) and 61% (reptiles and amphibians). On closure, mammal richness showed a long-term decrease from pre-development conditions of 7%, bird richness decreased by 13% and reptiles/amphibian richness decreased by 24%. These large decreases were related to the loss of the relatively rich peatlands and replacement with slightly lower richness upland communities. In the RSA, biodiversity habitat was initially 1,851,217 HUs for mammals, 1,686,496 HUs for birds, and 1,826,347 HUs for reptiles and amphibians. The mammals, birds, and amphibians/reptiles were all decreased by 0.3% due to the Project, and 1.3 to 1.4 % of all planned developments. Thus, the Project only contributed 18.7% (mammals) 20.9% (birds) and 21.1% (reptiles and amphibians) to the total reduction in HUs at the regional level.

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1 INTRODUCTION

Suncor Energy Inc. (Suncor) is planning an expansion of their Steepbank Mine and the upgrading of their processing facilities to produce 210 000 bbl/cd. This development is known as Project Millennium (the Project). The area is located approximately 30-35 km north of Fort McMurray and on the east side of the Athabasca River. As part of an Environmental Impact Assessment (EIA) for the project, Suncor is required to assess the potential impacts of 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.

In this report, Habitat Suitability Index (HSI) modelling (US Fish and Wildlife Service 1981) is used to assess impacts to wildlife habitat for the Local and Regional Study Areas (LSA and RSA) of the Project. Baseline habitat, impacts due to the Project alone, and regional Cumulative Effects Analyses (CEA) are presented. The regional analysis includes analyses of: 1) baseline conditions (existing and approved developments), 2) impacts of the Project alone (termed Scenario 1 or the Project Specific Impact Assessment); and 3) impacts of the Project and planned projects (Scenario 2 or the cumulative effects assessment). In addition, models of wildlife biodiversity and linkage zones for moose are presented in this report.

Pertinent companion documents to this report include:

- Baseline Wildlife Report (Golder 1998n);
- Wildlife EIA (Suncor Energy Inc. 1998); and
- Wildlife CEA (Suncor Energy Inc. 1998).

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. Today, HSI modelling is used in EIAs to determine potential impacts of project activities on wildlife resources.

The report is organized into the following sections:

Theory and Use of HSI Models

In Section 2, a background to the HSI process is provided, including objectives and steps in the modelling process.

Spatial and Temporal Boundaries

The study areas and time frames for the assessments are defined in Section 3.

Key Indicator Resources

In Section 4, the Key Indicator Resource species (KIRs) selected for the Project are presented and a rationale for their selection is provided.

Methods

In Section 5, sources for the models and input data are described, as are methods for the impact analyses.

Results and Discussion

Results of the HSI analyses are presented and discussed for each KIR in Section 6, for the LSA and in Section 7 for the RSA.

Summary

Finally, in Section 8, the main findings are presented in a series of summary tables and are discussed.

2 THEORY AND USE OF HSI MODELS

HSI models are analytical tools for determining the relative potential of an area to act as habitat for a wildlife species. Habitat is defined in the models according to physical structures within areas and arrangements of physical properties among areas. An implicit assumption is that the total amount of habitat is related to the potential to support individuals or populations of a wildlife species. An explicit assumption is that habitat areas may be summed within an area of interest to determine the total area of habitat available to a species. These sums are then used to quantify habitat losses and gains as a result of changes in land use.

2.1 BACKGROUND

HSI models 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 capability to support a species' biological needs. These relationships are then combined mathematically in 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 it is of optimum suitability. HSI values for each habitat type are then multiplied by the area (ha) of the habitat type to determine the number of habitat units (HUs) 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 as many other factors, such as hunting and poaching, predation, disease and parasites play a role in determining populations. They are, however, appropriate for:

1. Determining a ranking of the capability of a single habitat area to support various wildlife species, so management plans can reflect the needs of wildlife in the area or so a baseline status of wildlife habitat is known before habitat modifications.

2. 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.

3. Comparing the same area at different times by predicting changes to the habitat structure as a result of industrial activity and/or natural succession.

Long experience with HSI models in the United States has led to the development of standard protocols for HSI development and use (U.S. Fish and Wildlife Service 1981). Over the last decade, large forestry companies throughout North America have begun developing habitat models that can be linked to forest harvesting scenarios to assess changes over hundreds of years of management (e.g., Beck and Beck 1995). Mining project EIAs are also using HSI modelling to assess habitat baseline conditions and potential changes associated with mine development or reclamation activities (e.g., Golder 1998p).

2.2 OBJECTIVES

Objectives for HSI mapping are normally to determine project-related impacts. In this report, HSI models are used to determine habitat conditions at pre-development, impact, and fully reclaimed scenarios in the Project LSA. In the RSA, a progression of developments are assessed: baseline, baseline with Project (Scenario 1), and baseline with Project and all other planned developments (Scenario 2 or CEA). In this manner the cumulative impacts of the Project and other developments on the wildlife habitat resource are assessed.

2.3 STEPS INVOLVED IN HSI MODELLING

The steps in HSI modelling are:

- development of HSI models for wildlife Key Indicator Resources;
- verification of model relationships;
- testing model performance; and
- verification of the model's predictions.

These steps are discussed in more detail in the following sections.

2.3.1 Development of HSI Models

The development of habitat models requires an understanding of the ecology and habitat requirements of the wildlife species to be assessed. It usually involves a thorough literature review to identify all the known requirements and habitat relationships, followed by the development of model relationships that determine the species' biological needs. Previously developed HSI models may also be adapted for use in the area of interest. However, models from another area may require significant modifications for local conditions or may not be appropriate given differences in the habitat types, the data used to run the model or the scale of model application. Even models used previously in the same area are subject to these considerations.

Selection of habitat variables is done by assessing each species' needs for living space, nesting/breeding shelter, food/foraging cover, water/minerals, thermal cover, concealment cover and escape terrain. These needs can then be used to determine the attributes that are most required to determine species habitat use. Attributes may include elements of habitat structure such as: height, density, cover or size of living or dead trees or shrubs; species composition of trees, shrubs or other vegetation, presence of dead wood, rocky terrain, or open ground; and availability or distance to food, water or mineral resources, or other resources. Alternatively, the habitat type itself may be used directly in the models.

In developing habitat relationships, it is important to consider that the habitat attributes in the models must be available to perform model predictions. If an identified attribute is not in an existing data-set, it will be necessary to measure this variable in a new inventory (an expensive alternative) or it may be possible to predict the variable from related attributes (for example, tree diameter can be used to predict height). A third option is to make use of existing variables rather than new ones. This option is only valid if the exchange can be made without loss of model performance. The level of precision of the variables used for modelling is important too, since estimated attributes will pass on errors in each stage of the modelling and a well-defined model may be unable to provide precise estimates regardless of the strength of the relationship.

Once variables are selected, a relationship between each variable and habitat suitability is determined. This relationship must reflect real variation in the species biology. For example, if the opportunity for nest construction increases as trees get larger, a linear increase over a range of tree diameters may be appropriate. Two main relationship forms are: 1) continuous curves that show increasing, decreasing, or unchanging suitability over various ranges of the attribute, and 2) histograms that show specific values relative to categorical attributes or over set ranges of a given value. Each individual variable thus defines a suitability index that varies between 1 and 0, where 1 represents the optimum conditions and 0 represents an unsuitable condition. Over the range of some variables, there may never be a condition in which the habitat is unsuitable, in which case, the index should always be greater than 0. For example, if food increases with shrub cover but is still available at approximately 50% of the maximum when there are no shrubs, the index would range from 0.5 to 1.

Finally, the individual variable suitability index values are combined in an equation that reflects the manner in which all the variables interact to determine habitat use. Interactive components are generally multiplied whereas independently acting components are generally summed. In either case, a constraint is placed on the model to limit the overall suitability index to range between 0 and 1. This may involve constraining a sum to a maximum of selecting the highest of several index values or determining the mean (or weighted mean) by either the common arithmetic mean or the geometric mean. The choice of equation types can have significant effects on a model's outcome, so it is important that the method of combination is driven by knowledge about the manner in which the combination of variables influences species habitat use.

2.3.2 Verification of Model Relationships

An important step in HSI modelling is verification of the relationships determined in the above steps. This involves field testing within the range of habitats in which the animals occur. The field testing program must determine:

- whether the habitat variables in the models are the same as the ones present in the habitats the species selects;
- whether the change in habitat performance predicted over the range of each variable holds true;
- whether the combination of variables acts in the manner described in the equation relationships; and
- whether the use of different habitat types is related to the prediction of overall suitability in the model.

The outcome of this process may be a verified model, an amended model or a rejected model (in which case an entirely new model must be developed).

2.3.3 Testing Model Performance

The performance of HSI models is tested by examining outputs in a trial run with existing data and models. This testing step is independent of the verification of the model relationships, and is used mainly to ensure that the model is providing the range of values expected, and is showing as highly suitable areas that the modeller or biologist believes to be the best habitat, and shows as low those areas known not to support the species. This test is not just a test of the models, but also of the GIS software running the models, the geographic database and other habitat data driving the predictions. This step may illustrate model shortcomings, which need to be corrected, or may indicate that the habitat data or geographic data need to be updated or modified before final use.

2.3.4 Verification of Model Predictions

Unlike the previous verification steps that involve examination of parts of the model or of its performance relative to local data, this step involves examination of the predicted HSI values for different areas relative to an independent set of wildlife habitat use or population measurements over a much larger area. This step may require several years of data, collected throughout several seasons, since some species are highly variable in their habitat use among seasons and years. A continuous monitoring program may be required for some species. For other species, a data-set compiled by another source, such as a game management agency, may also be available for testing. It is important, though, that data used to build and test the model earlier are not used to verify it, since that would not be an independent test.

3 SPATIAL AND TEMPORAL BOUNDARIES

3.1 SPATIAL BOUNDARIES

The Local Study Area (LSA) was determined by a 500 m buffer around the combined footprints of the Steepbank Mine and the new mine. The 500 m buffer rule was ignored in cases where the Athabasca or Steepbank rivers were within 500 m of the combined footprint. In these cases, the LSA boundary followed the eastern edge of the Athabasca River and the southern edge of the Steepbank River. The LSA encompassed a total of 16,181 ha.

A Regional Study Area (RSA) for wildlife was selected to correspond with the RSA for vegetation and ELCs (see Golder 1998l). The boundaries for the RSA were developed in consultation with Syncrude and other industries in the oil sands area. Boundaries were set with consideration of air emission and deposition data. A total of 2,428,750 ha[1] was encompassed by the RSA.

3.2 TEMPORAL BOUNDARIES

The temporal boundaries for the EIA were defined as follows:

- Pre-Development Conditions (1997)
- Construction and Operation Phase (1997-2043)
- Closure (after 2043)

These periods were selected because the characteristics of the Project's impacts are quite different between the construction and operational phases, and a long-term view of the Project at closure is required to assess the likely success of proposed reclamation/mitigation measures. Two main phases of the development were selected for detailed analysis: the Construction and Operation phase and the Closure phase. For this analysis and report, all vegetation communities were assumed to be regrown to maturity at closure.

1 This area was determined from a rastor image of the RSA with 50 m pixels and differs slightly from areas presented in previous reports, which used a true vector-area calculation.

For the CEA scenario, it was assumed that all developments would be built and operating at their maximum extents simultaneously. As this is unlikely to occur, due to the phased nature of the developments, the CEA scenario tends to overestimate impacts.

4 KEY INDICATOR RESOURCES (KIRs)

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 manner are known as Management Indicator Species (MIS) (Salwasser and Unkel 1981), Valued Ecosystem Components (VECs) (Sadar 1994), key species and other terms. They will be termed Key Indicator Resources (KIRs) for the purposes of this report, following the terminology of the Aurora EIA (BOVAR 1996). Species chosen as KIRs for the Aurora Mine EIA were selected based on a scoring of species' political importance (endangered status), commercial and subsistence economic importance, non-consumptive importance and ecological importance (BOVAR 1996). Rather than repeat this process, the study team reviewed the selection process and adopted the KIRs of the Aurora Mine EIA for the Millennium Mine EIA. Following review of this list by Alberta Environmental Protection (AEP) personnel, two additional KIRs were selected: the western tanager and the pileated woodpecker. In addition to representing their respective species groups, KIRs were chosen for the reasons listed in Table 1.

Table 1 Wildlife Key Indicator Resources and Selection Rationale

Species or Group	Ecological or Economic Reasons
Beaver	Economic importance, semi-aquatic habits
Black Bear	Economic importance, carnivore
Cape May Warbler	Use of white spruce forests, neotropical migrant
Dabbling Ducks	Importance in food chain, economic and recreational importance
Fisher	Use of late seral stages, economic importance, carnivore
Great Gray Owl	Raptor, use of wetlands
Moose	Economic importance, early successional species, large ranging species with requirement for landscape-level movement corridors
Pileated Woodpecker	Use of late seral stages, large diameter trees and snags
Red-Backed Vole	Importance in food chain
Ruffed Grouse	Economic and recreational importance
Snowshoe Hare	Importance in food chain
Western Tanager	Use of open forest mixedwood, neotropical migrant
Mammal Species Richness	Important indicator of biodiversity, cosmopolitan distribution
Bird Species Richness	Important indicator of biodiversity, emphasis on forests, marshes and shrublands
Reptile and Amphibian Species Richness	Important indicator of biodiversity, emphasis on wetlands

5 METHODS

5.1 MODEL SOURCES

HSI models were adapted from models previously used for other oil sands projects (Golder 1998). Models for the 12 KIRs, biodiversity and linkage zones are presented in Appendix I.

5.2 INPUT DATA

5.2.1 Data Layers

5.2.1.1 Local Study Area

The LSA consists of 16,181 ha. Four important digital habitat features were incorporated to perform HSI modelling and conduct the impact assessment: a hydrology layer, a pre-development conditions vegetation layer, a project components layer and a post-reclamation vegetation layer.

Pre-Development Conditions Vegetation Layer

In this project, all modelling was based on vegetation community classifications. Therefore, all data and habitat areas were calculated based on the digital vegetation maps developed for the vegetation component of the pre-development conditions (Golder 1998l). The pre-development conditions vegetation layer consists of mapped polygons classified by a combination of ecological phase or AVI Code (Table 2) and Alberta Wetlands Inventory (AWI) classes (Table 3; Figure 1).

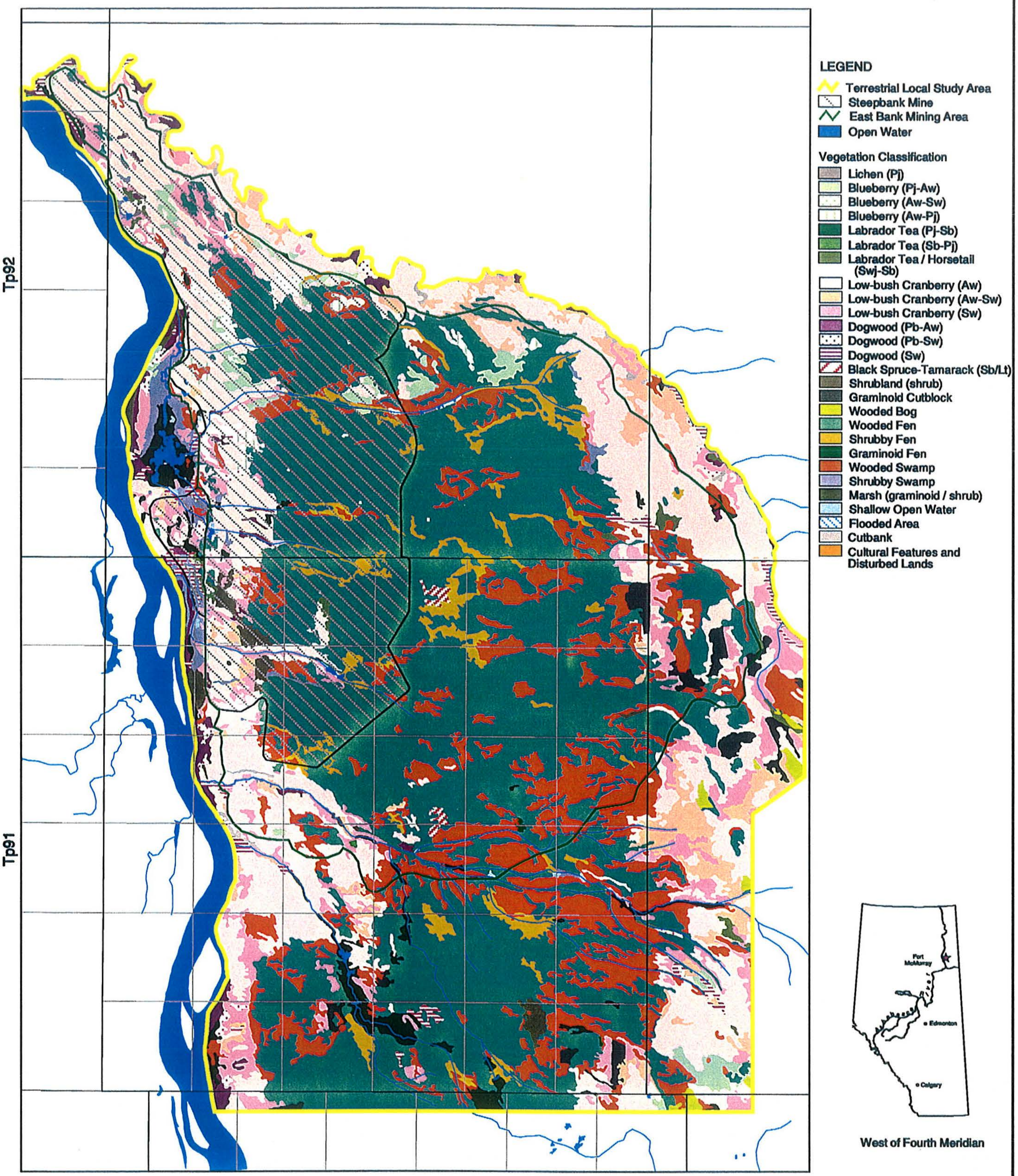
Hydrology Layer

The hydrology layer included all the streams, rivers, ponds, and lakes within the LSA. It was used in conjunction with water polygon data that existed in the vegetation layer. Incorporating the hydrology layer with vegetation was accomplished by splitting the vegetation polygons that were bisected by stream and rivers. This was required so that the distance from water buffers applied in the beaver and dabbling duck models could be accomplished from the vegetation layer edge. Additional hydrological features were incorporated into the closure reclamation map (reclaimed ponds and wetlands) and were also used for the modelling. Using these combined layers, at pre-development conditions, 114 hectares of open water occur in the LSA (Table 4). This changes to 101 hectares at the full mine impact Table 6), and is reclaimed to 1,019 hectares at closure (Table 8). The high closure number is the result of the construction of reclaimed tailings ponds.

Table 2 Vegetation Classification Types in the Local Study Area

General Vegetation Types	Ecological Phase or AVI Code	Description
Forests	a1	Lichen - Jack Pine
	b1	Blueberry Jack Pine - Aspen
	b2	Blueberry Aspen(Paper Birch)
	b3	Blueberry Aspen-White Spruce
	b4	Blueberry White Spruce-Jack Pine
	c1	Labrador Tea - mesic Jack Pine-Black Spruce
	d1	Low-bush Cranberry Aspen
	d2	Low-bush Cranberry Aspen-White Spruce
	d3	Low-bush Cranberry White Spruce
	e1	Dogwood Balsam Poplar-Aspen
	e2	Dogwood Balsam Poplar-White Spruce
	e3	Dogwood White Spruce
	g1	Labrador Tea - subhygric Black Spruce-Jack Pine
	h1	Labrador Tea/Horsetail White Spruce-Black Spruce
	Sb/Lt	Black Spruce - Larch Complexes
Shrublands	Shrub	Shrubland
Meadows	HG/CC	Herbaceous Graminoid Meadows or Cutblocks
	CIP	Revegetated Industrial Lands
	CIW	Well Sites - vegetated
Disturbed / Sparsely Vegetated	NMC	Cutbanks
	NMR	Rock
	NMS	Sand
	AIG	Gravel Pits
	AIH	Roads and Rights of Ways

Each polygon is described by a set of selected attributes that were used for modelling purposes (Appendix II). Areas of each vegetation type were summed for comparison with changes in wildlife HSI results (Table 4).



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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

SUNCOR ENERGY

Project Millennium

LOCAL STUDY AREA
VEGETATION CLASSIFICATION

14 Apr. 1998 | Figure 1 | PRODUCED BY: JS REVIEWED BY:

Table 3 Wetland and Open Water Classification for the Local Study Area

General Wetland Types	AWI or AVI Code	Description
Bogs	BFNN	Wooded bog (tree cover >70%)
	BTNN	Wooded bog (tree cover >10% and ≤70%)
Fens	FFNN	Wooded Fen (tree cover >70%)
	FONG	Graminoid Fen
	FONS	Shrubby Fen
	FTNN	Wooded Fen (tree cover >10% and ≤70%)
Marshes	MONG	Graminoid Marsh
	MONS	Shrubby Marsh
Swamps	SFNN	Swamp (tree cover >70%)
	SONS	Swamp (deciduous shrub)
	STNN	Swamp (tree cover >10% and ≤70%)
Flood Zones	NWF	Periodically Flooded Areas
Open Water	NWL	Lake
	NWR	River
	WONN	Shallow open water

Table 4 Pre-Development Areas of Terrestrial Vegetation and Wetland Classes in the Local Study Area

Phase	Description	Pre-development Area (ha)	Percent
a1	Lichen Pj	1	<0.1
AIG	Gravel Pits	<1	<0.1
AIH	Roads and Rights of Ways	5	<0.1
b1	Blueberry Pj-Aw	226	1.4
b2	Blueberry Aw(Bw)	28	0.2
b3	Blueberry Aw-Sw	60	0.4
b4	Blueberry Sw-Pj	50	0.3
BFNN	Wooded bog (tree cover >70%)	26	0.2
BTNN	Wooded bog (tree cover >10% and <=70%)	20	0.1
c1	Labrador Tea - mesic Pj-Sb	1	<0.1
CIP	Revegetated Industrial Lands	12	0.1
CIW	Well Sites - vegetated	5	<0.1
d1	Low-bush Cranberry Aw	3,348	20.7
d2	Low-bush Cranberry Aw-Sw	588	3.6
d3	Low-bush Cranberry Sw	941	5.8
e1	Dogwood Pb-Aw	212	1.3
e2	Dogwood Pb-Sw	63	0.4
e3	Dogwood Sw	127	0.8
FFNN	Wooded Fen (tree cover >70%)	966	6.0
FONG	Graminoid Fen	4	<0.1
FONS	Shrubby Fen	426	2.6
FTNN	Wooded Fen (tree cover >10% and <=70%)	6,010	37.1
g1	Labrador Tea - subhygric Sb-Pj	1	<0.1
h1	Labrador Tea/Horsetail Sw-Sb	59	0.4
HG/CC	Herbaceous Graminoid Cutblock	170	1.1
MONG	Graminoid Marsh	107	0.7
MONS	Shrubby Marsh	211	1.3
NMC	Cutbanks	33	0.2
NMR	Rock	<1	<0.1
NMS	Sand	1	<0.1
NWF	Flooded Area	6	<0.1
NWL	Lake	20	0.1
NWR	River	79	0.5
Sb/Lt	Black Spruce - Larch Complexes	20	0.1
SFNN	Swamp (tree cover >70%)	687	4.2
Shrub	Shrubland	131	0.8
SONS	Swamp (deciduous shrub)	161	1.0
STNN	Swamp (tree cover >10% and <=70%)	1,359	8.4
WONN	Shallow open water	15	0.1
Total		**16,181**	**100.0**

Project Components Layer

The project footprint (Figure 2) was used to overlay on the baseline maps to determine impacts for each KIR. The approved Steepbank Mine area encompasses some 3,776 ha while a total of 5,644 ha of land is expected to be disturbed with the Project Millennium (Table 5).

Table 5 Areas of Project Millennium Developments in the Local Study Area Used Throughout the HSI Report

Development or Feature	Area (ha) and Precision[a]
Terrestrial Local Study Area (TLSA)	16181 ± 1
Approved Steepbank Mine Area	3776 ± 1
East bank mining area	9281 ± 1
Undeveloped Area outside East bank mining area	6900 ± 1
Project Millennium Area	5644 ± 1
Project Millennium Area Used in Regional Study Area Analyses[b]	5505 ± 1

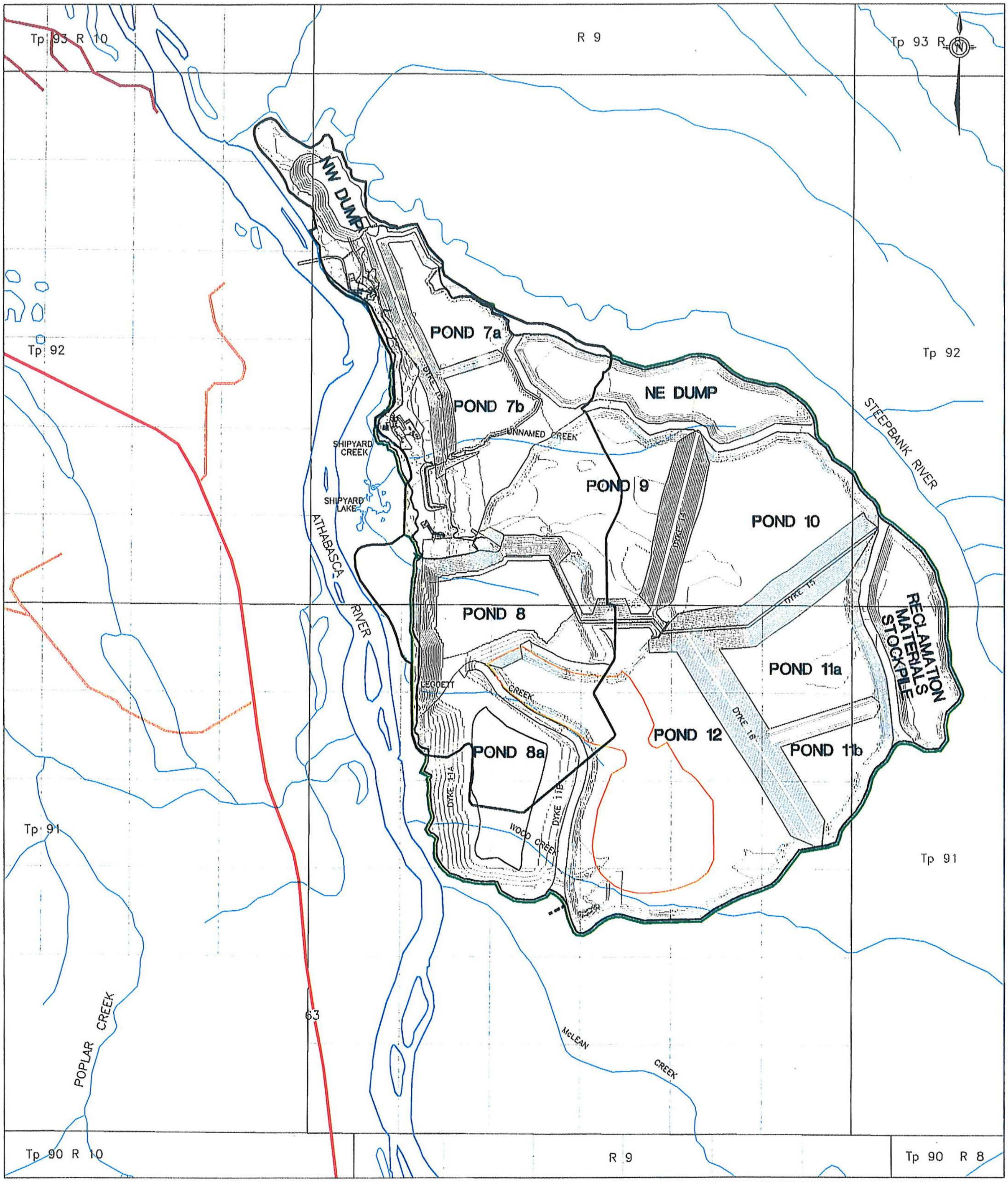
[a] Summed areas vary due to rounding error
[b] Calculated as East bank mining area minus Steepbank Mine

Impacts of the footprint on the vegetation resources of the LSA (Table 6) were used in the modelling process. Table 6 indicates that some vegetation phases will not be affected at all by the Project, while others will be totally lost. These losses will be important when discussing habitat changes for individual KIRs, especially for vegetation types with large area reductions. On average, some 57% of the LSA will be impacted by the Project.

Table 6 Vegetation Area Impacts and Remaining Vegetation Areas in the Local Study Area

Phase	Pre-development Area (ha)	Steepbank Mine Impact (ha)	Steepbank Mine Impact (%)	East Bank Mining Area Impact (ha)	East Bank Mining Area Impact (%)	Areas Remaining After Development	Remainder as Percent of Pre-development
a1	1	1	100.0	1	100.0	0	0.0
AIG	0	0	100.0	0	100.0	0	0.0
AIH	5	0	0.0	0	0.0	5	100.0
b1	226	98	43.1	145	63.9	82	36.1
b2	28	26	94.1	27	99.6	0	0.4
b3	60	57	95.1	57	95.1	3	4.9
b4	50	37	72.9	50	99.0	0	1.0
BFNN	26	0	0.0	0	0.0	26	100.0
BTNN	20	0	0.0	0	0.0	20	100.0
c1	1	1	100.0	1	100.0	0	0.0
CIP	12	11	88.5	11	88.5	1	11.5
CIW	5	3	59.9	4	85.0	1	15.0
d1	3,348	923	27.6	1,780	53.2	1,568	46.8
d2	588	60	10.2	135	23.0	453	77.0
d3	941	212	22.6	315	33.5	626	66.5
e1	212	28	13.3	35	16.4	177	83.6
e2	63	16	24.8	14	23.0	48	77.0
e3	127	25	19.5	14	10.9	113	89.1
FFNN	966	262	27.2	547	56.6	419	43.4
FONG	4	0	0.0	3	76.2	1	23.8
FONS	426	110	25.8	325	76.2	101	23.8
FTNN	6,010	1,528	25.4	4,396	73.1	1,614	26.9
g1	1	0	0.0	1	100.0	0	0.0
h1	59	21	36.2	32	53.4	28	46.6
HG/CC	170	0	0.0	69	40.7	101	59.3
MONG	107	12	11.3	14	12.8	93	87.2
MONS	211	22	10.4	18	8.3	193	91.7
NMC	33	2	6.9	6	19.2	27	80.8
NMR	0	2	584.8	0	0.0	0	100.0
NMS	1	0	0.0	0	0.0	1	100.0
NWF	6	0	0.0	0	1.0	6	99.0
NWL	20	0	0.0	3	14.9	17	85.1
NWR	79	0	0.0	2	2.6	77	97.4
Sb/Lt	20	0	0.0	20	100.0	0	0.0
SFNN	687	51	7.5	378	55.1	309	44.9
Shrub	131	51	38.9	57	43.7	74	56.3
SONS	161	47	29.4	43	26.6	118	73.4
STNN	1,359	162	11.9	769	56.6	590	43.4
WONN	15	6	41.6	8	55.4	7	44.6
Total	**16,181**	**3,776**	**23.3**	**9,281**	**57.4**	**6,901**	**42.6**

J:\1997\2205\7730\EASTBANK.dwg



LEGEND

EAST BANK MINING AREA

SUNCOR STEEPBANK MINE

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 3km

SCALE 1:100,000

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PROJECT MILLENNIUM LOCAL STUDY AREA
EAST BANK MINING AREA COMPONENTS

14 Apr. 1998	Figure 2	DRAWN BY: RFM

Reclaimed Vegetation Layer

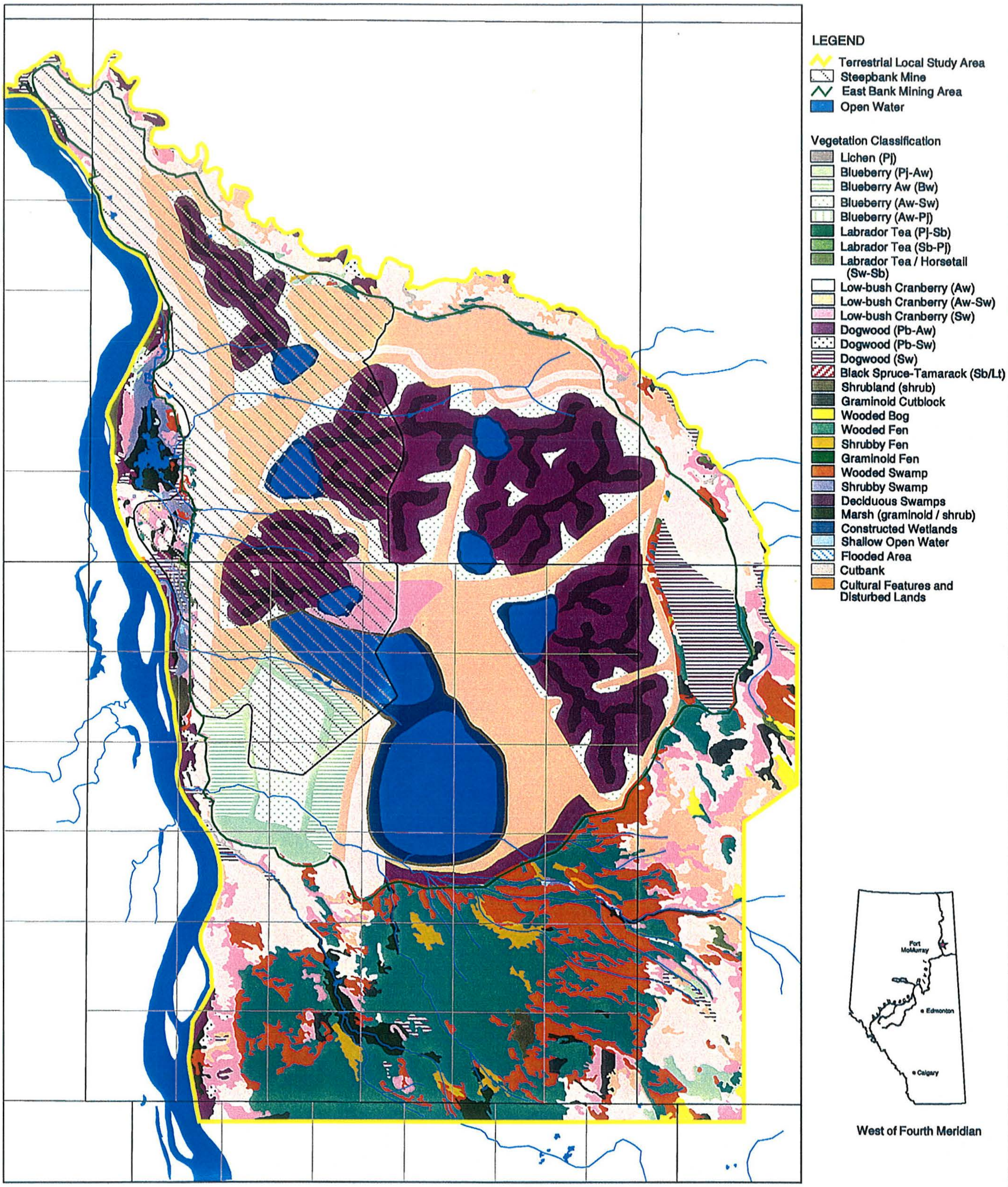
The post-closure vegetation base layer (Figure 3) demonstrates the changes that would occur many years in the future after the mine is closed. The reclaimed vegetation layers are based on presumed soil and terrain attributes which will exist once pits are no longer operational. Thus, although the vegetation that will occur cannot be specifically verified, a foundation of expertise exists on which to base generalized reclamation types. This point is important because the reclaimed landscape can have many effects on wildlife habitat and tends, in this plan, to create more uniform large forest patches, which will also result in large patches of uniformly suitable wildlife habitat.

The Project closure plan discusses these issues much more fully, but some of the important points, as they could affect wildlife habitat, are summarized below. First, there will be some new vegetation types that will be added to the LSA. These include constructed wetlands, end-pit lakes and wet shrublands (Table 7). For purposes of HSI modelling, these areas were assumed to correspond directly to natural vegetation types at closure (Table 7).

Table 7 Additional Reclamation Vegetation and Wetland Classes for Project Millennium Closure Scenario

Closure Class	Description	Equivalent Pre-Development Code	Description
c-wet	Constructed Wetlands	MONG	Graminoid Marsh
water	End-Pit Lake	NWL	Lake
Sh-SONS	Wet Shrublands	SONS	Shrubby Deciduous Swamp

The vegetation at reclamation will be substantially different from the pre-development conditions according to the current plan, and in large part this relates to a loss of peatlands (swamps and fens) and replacement of those areas with open water/wetlands and upland forests (Table 8). These changes may have large impacts on wildlife, especially species that make use of the much more productive and diverse upland forest habitats.



SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

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LOCAL STUDY AREA
CLOSURE VEGETATION CLASSIFICATION

14 Apr. 1998	Figure 3	PRODUCED BY: JS REVIEWED BY:

/data14/suncor/local/97009701/arcview/lsa_vegetation.apr

Table 8 Far-Future Closure Areas of Terrestrial Vegetation and Wetland Classes in the Local Study Area

Phase	Pre-Development Area (ha)	Closure Area (ha)	Closure Area as Percent of Pre-Development	Closure Change from Pre-Development (ha)	Closure Change from Pre-Development (%)
a1	1	0	0.0	-1	-100.0
AIG	0	0	0.0	0	-100.0
AIH	5	5	100.0	0	0.0
b1	226	262	115.5	35	15.5
b2	28	306	1111.1	279	1011.1
b3	60	873	1466.8	814	1366.8
b4	50	2	4.1	-48	-95.9
BFNN	26	26	100.0	0	0.0
BTNN	20	20	100.0	0	0.0
c1	1	0	0.0	-1	-100.0
CIP	12	3	21.0	-9	-79.0
CIW	5	1	19.1	-4	-80.9
d1	3,348	2,776	82.9	-572	-17.1
d2	588	2,723	463.3	2,136	363.3
d3	941	777	82.5	-164	-17.5
e1	212	2,062	973.5	1,851	873.5
e2	63	52	82.6	-11	-17.4
e3	127	391	306.6	263	206.6
FFNN	966	430	44.5	-537	-55.5
FONG	4	1	23.8	-3	-76.2
FONS	426	106	24.9	-320	-75.1
FTNN	6,010	1,657	27.6	-4,353	-72.4
g1	1	0	0.0	-1	-100.0
h1	59	32	53.6	-28	-46.4
HG/CC	170	109	63.8	-62	-36.2
MONG	107	370	346.4	263	246.4
MONS	211	194	92.1	-17	-7.9
NMC	33	27	81.8	-6	-18.2
NMR	0	0	100.0	0	0.0
NMS	1	1	100.0	0	0.0
NWF	6	6	100.0	0	0.0
NWL	20	935	4728.1	915	4628.1
NWR	79	77	97.4	-2	-2.6
Sb/Lt	20	0	0.0	-20	-100.0
SFNN	687	322	46.9	-365	-53.1
Shrub	131	155	118.8	25	18.8
SONS	161	839	521.1	678	421.1
STNN	1,359	634	46.7	-725	-53.3
WONN	15	7	46.2	-8	-53.8
Total	**16,181**	**16,182**	**100.0**	**0**	**0.0**

5.2.1.2 Regional Study Area

Three digital data layers were used in the geographic analyses of habitat suitability in the RSA analysis. These were a hydrology layer, a baseline vegetation layer, and a human disturbances layer where each individual development area could be added separately. Roads and other cultural disturbances were also indicated on the disturbance layer. The RSA data was converted to a rastor (pixel based) image for all analyses, due to the large size of the data set and the increased modelling efficiency.

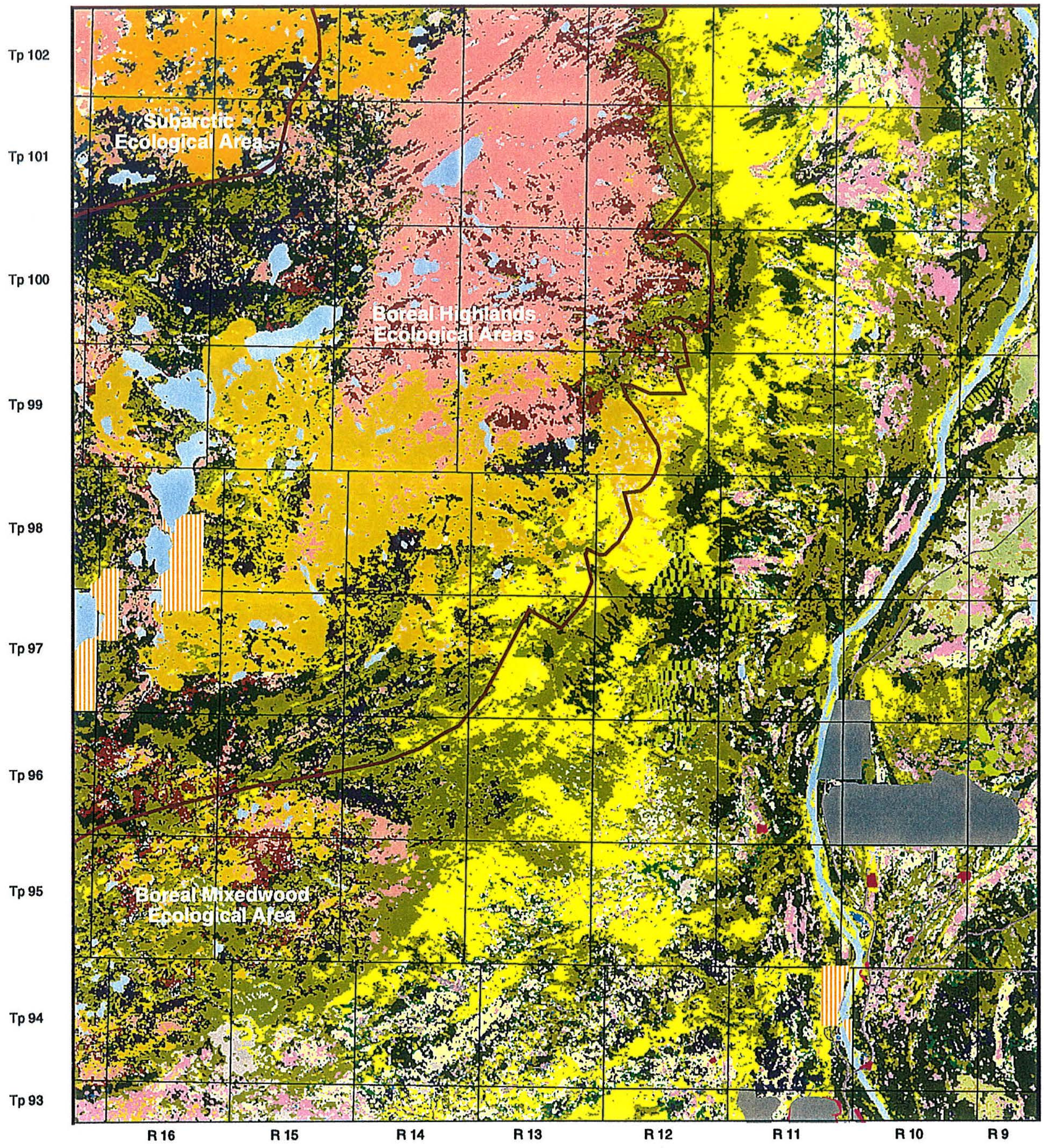
Baseline Vegetation Layer

The vegetation layer for the RSA was determined from interpretation of landsat imagery at a 30 m resolution (Figures 4a-4d). The remote sensing technique used similar reflectance spectra to train the GIS software to pick out similar vegetation types (Table 9) throughout the region. This process also picked up some of the larger rivers and linear disturbances, which were used in development of the hydrology and impact layers. A comparison of the LSA and RSA vegetation classes is provided in Table 10. The 38 LSA classes were coalesced into 19 RSA classes. In addition, 2 classes (municipalities and low shrub wetland) not represented in the LSA were mapped for the region.

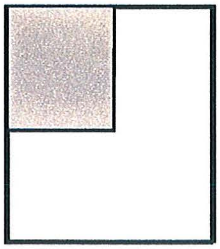
The baseline areas of vegetation and wetland classes in the RSA are provided in Table 11.

Hydrology Layer

The hydrology layer, which was used to obtain all rivers, creeks, ponds and lakes in the RSA was derived from NTS topographic maps and from the regional orthophoto. All water resources which were available from the existing satellite imagery were assumed to act as lakes or ponds. In addition, all linear water features (streams and rivers) were overlaid as vectors onto the existing vegetation layer. Because a rastor image was used, there was no need to bisect vegetation types where streams crossed as in the LSA.



West of Fourth Meridian



SOURCES: Suncor, Syncrude, Petro-Canada, Golder, Landsat TM Satellite Image Classification, Larkspur Biological, Conor Pacific

Scale 1:500,000

5 0 5 10 15 20

Kilometres

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Forestry
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

VEGETATION CLASSIFICATION

- Open Pine Lichen
- Mixed Deciduous (Aw Dom.)
- Mixedwood (Sw-Aw Dom.)
- Mixed Coniferous (Sw Dom.)
- Mixed Coniferous (Sw-Pj/Pl Dom.)
- Mixed Coniferous (Pj/Pl Dom.)
- Mixed Coniferous (Sb-Lt Dom.)
- Wet Closed Coniferous (Sb Dom.)
- Wet Open Coniferous (Sb Dom.)
- Pine Regeneration (Pine<2m)
- Shrubland
- Bog (Sphagnum Dom.)
- Bog (Shrub Dom.)
- Shrubby Fen
- Graminoid Fen
- Marsh Emergents
- Barren Ground / Bedrock Exposure
- Unclassified

N

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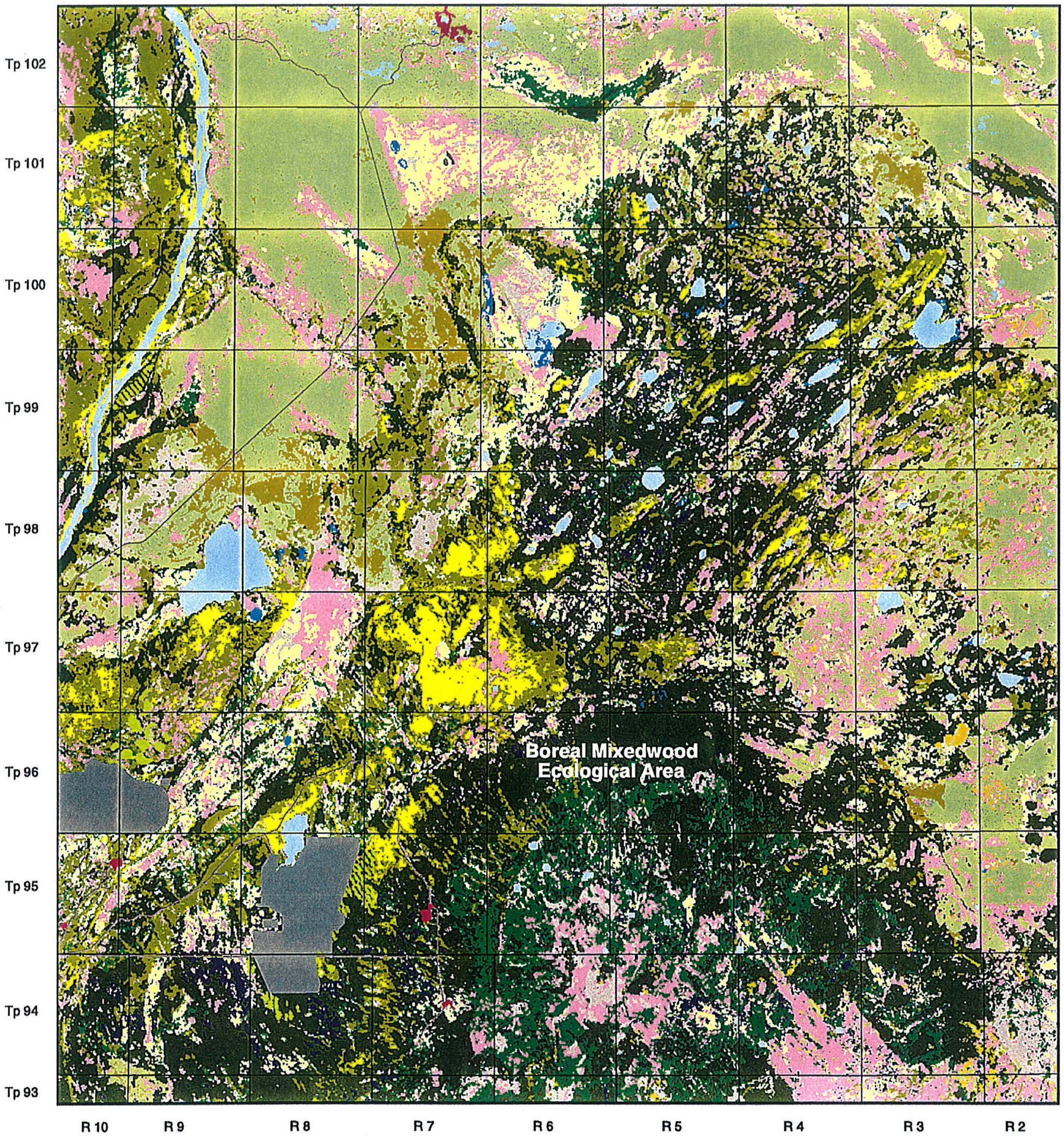
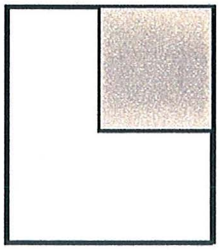
REGIONAL STUDY AREA VEGETATION CLASSIFICATION IMPACT ASSESSMENT BASELINE

14 Apr. 1998	Figure 4a	PRODUCED BY: K.K.O. REVIEWED BY:



West of Fourth Meridian



SOURCES: Suncor, Syncrude, Petro-Canada, Golder, Landsat TM Satellite Image Classification, Larkspur Biological, Conor Pacific

Scale 1:500,000

5 0 5 10 15 20

Kilometres

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Forestry
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

VEGETATION CLASSIFICATION

- Open Pine Lichen
- Mixed Deciduous (Aw Dom.)
- Mixedwood (Sw-Aw Dom.)
- Mixed Coniferous (Sw Dom.)
- Mixed Coniferous (Sw-Pj/Pl Dom.)
- Mixed Coniferous (Pj/Pl Dom.)
- Mixed Coniferous (Sb-Lt Dom.)
- Wet Closed Coniferous (Sb Dom.)
- Wet Open Coniferous (Sb Dom.)
- Pine Regeneration (Pine<2m)
- Shrubland
- Bog (Sphagnum Dom.)
- Bog (Shrub Dom.)
- Shrubby Fen
- Graminoid Fen
- Marsh Emergents
- Barren Ground / Bedrock Exposure
- Unclassified

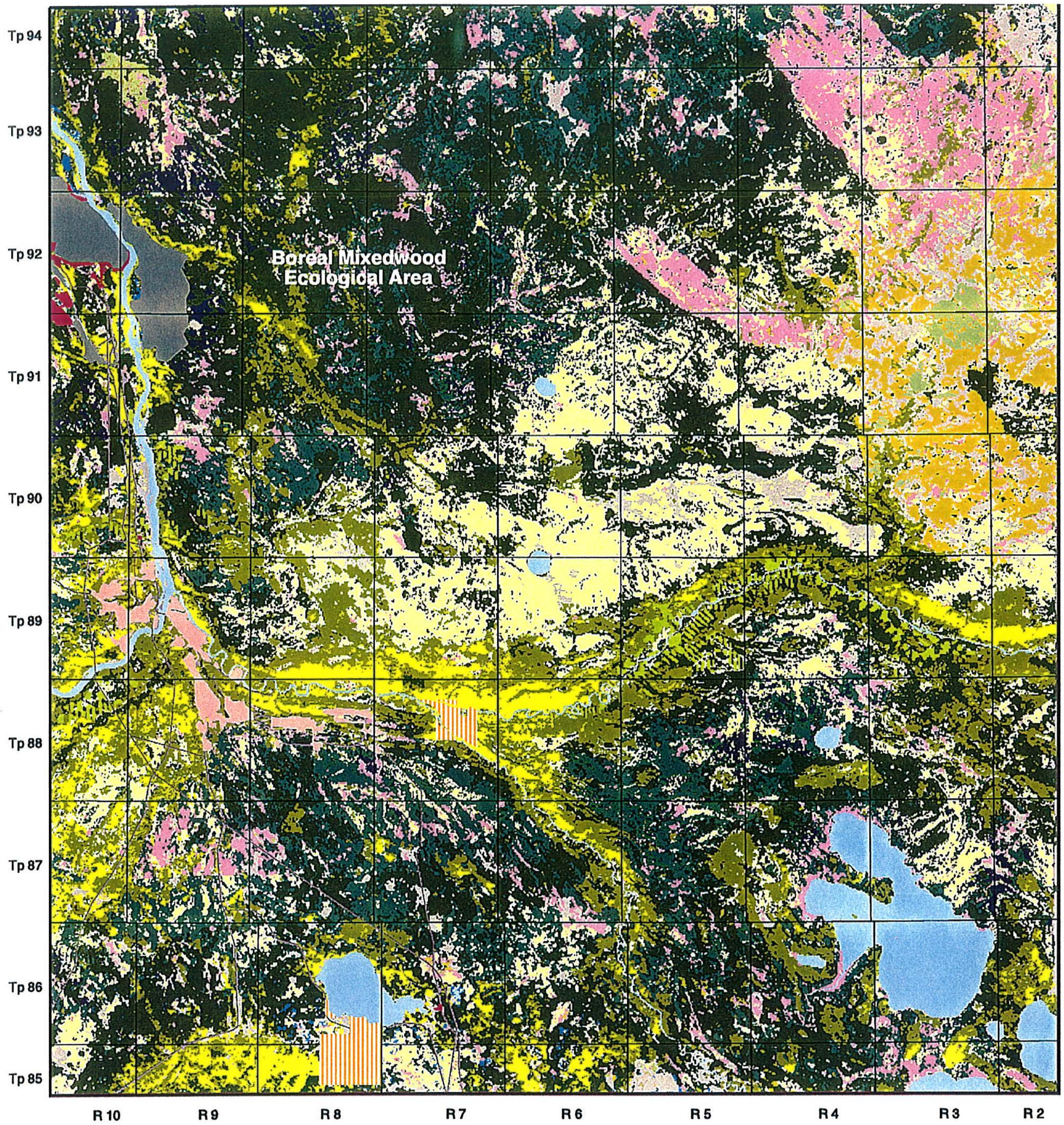
N

SUNCOR ENERGY

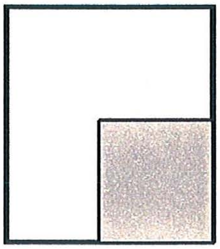
Project Millennium

REGIONAL STUDY AREA VEGETATION CLASSIFICATION IMPACT ASSESSMENT BASELINE

14 Apr. 1998	Figure 4b	PRODUCED BY: K.K.O. REVIEWED BY: MB



West of Fourth Meridian



SOURCES: Suncor, Syncrude, Petro-Canada, Golder, Landsat TM Satellite Image Classification, Larkspur Biological, Conor Pacific

Scale 1:500,000

5 0 5 10 15 20

Kilometres

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Forestry
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

VEGETATION CLASSIFICATION

- Open Pine Lichen
- Mixed Deciduous (Aw Dom.)
- Mixedwood (Sw-Aw Dom.)
- Mixed Coniferous (Sw Dom.)
- Mixed Coniferous (Sw-Pj/Pl Dom.)
- Mixed Coniferous (Pj/Pl Dom.)
- Mixed Coniferous (Sb-Lt Dom.)
- Wet Closed Coniferous (Sb Dom.)
- Wet Open Coniferous (Sb Dom.)
- Pine Regeneration (Pine<2m)
- Shrubland
- Bog (Sphagnum Dom.)
- Bog (Shrub Dom.)
- Shrubby Fen
- Graminoid Fen
- Marsh Emergents
- Barren Ground / Bedrock Exposure
- Unclassified

N

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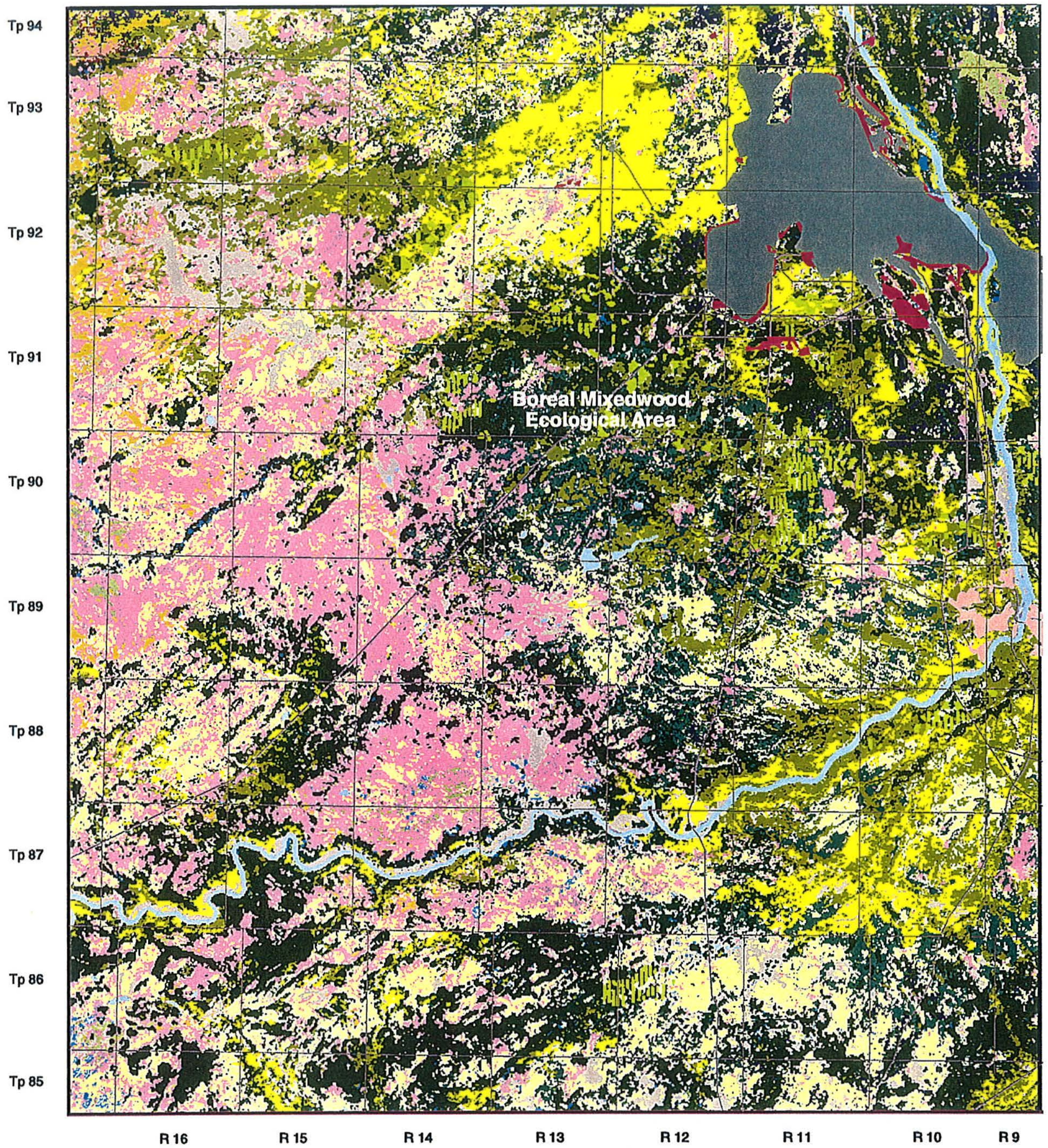
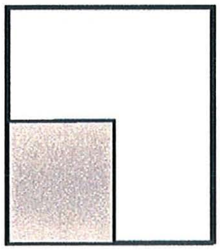
REGIONAL STUDY AREA
VEGETATION CLASSIFICATION
IMPACT ASSESSMENT BASELINE

14 Apr. 1998	Figure 4c	PRODUCED BY: K.K.G. REVIEWED BY:



West of Fourth Meridian



SOURCES: Suncor, Syncrude, Petro-Canada, Golder, Landsat TM Satellite Image Classification, Larkspur Biological, Conor Pacific

Scale 1:500,000

5 0 5 10 15 20

Kilometres

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Forestry
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

VEGETATION CLASSIFICATION

- Open Pine Lichen
- Mixed Deciduous (Aw Dom.)
- Mixedwood (Sw-Aw Dom.)
- Mixed Coniferous (Sw Dom.)
- Mixed Coniferous (Sw-Pj/Pl Dom.)
- Mixed Coniferous (Pj/Pl Dom.)
- Mixed Coniferous (Sb-Lt Dom.)
- Wet Closed Coniferous (Sb Dom.)
- Wet Open Coniferous (Sb Dom.)
- Pine Regeneration (Pine<2m)
- Shrubland
- Bog (Sphagnum Dom.)
- Bog (Shrub Dom.)
- Shrubby Fen
- Graminoid Fen
- Marsh Emergents
- Barren Ground / Bedrock Exposure
- Unclassified

N

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REGIONAL STUDY AREA
VEGETATION CLASSIFICATION
IMPACT ASSESSMENT BASELINE

14 Apr. 1998	Figure 4d	PRODUCED BY: K.K.O. REVIEWED BY:

Table 9 Vegetation and Wetland Classification for the Regional Study Area by Ecoregion

RSA Vegetation Classes	Ecoregion		
	Boreal Mixedwood	**Subarctic**	**Boreal Highlands**
Water	x	x	x
Open Pine	x		x
Mixed Coniferous (White Spruce dominant)	x	x	x
Marsh	x	x	x
Pine Regeneration	x	x	x
Mixed Deciduous (Aspen dominant)	x	x	x
Mixedwood (White Spruce - Aspen dominant)	x	x	x
Mixed Coniferous (Pine dominant)	x		
Wet Closed Coniferous (Black Spruce)	x		x
Wet Open Coniferous (Black Spruce - Tamarack)	x		x
Mixed Coniferous (Black Spruce - Tamarack)	x	x	x
Shrubby Fen	x	x	x
Graminoid Fen	x		x
Barren Ground/Exposed Bedrock	x	x	x
Bog (Sphagnum around edges of graminoid fens)	x	x	x
Mixed Coniferous (White Spruce - Pine dominant)	x	x	x
Low Shrub Wetland (bog)	x	x	x
Shrubland (low shrub recolonization, no pine)		x	x
Forestry Cutblocks	x		
Municipalities	x		
Disturbed and Developed Lands	x		
Area (ha)	2,163,950	25,558	239,242
Total Area		**2,428,750**	

Presence of each vegetation type noted with an "x"

Table 10 Comparison Matrix Between Local and Regional Vegetation Classifications

RSA Vegetation Classes	LSA Vegetation Classes
Water	WONN - Shallow Open Water NWL - Lakes NWR - Rivers and Creeks NWF - Flooded Areas
Open Pine	a1 - Lichen Jack Pine
Mixed Coniferous (White Spruce dominant)	d3 - Low-bush cranberry White Spruce e3 - Dogwood White Spruce h1 - Labrador Tea - Horsetail White Spruce - Black Spruce
Marsh	MONG - Graminoid Marsh MONS - Shrubby Marsh
Pine Regeneration	Not Represented in LSA
Mixed Deciduous (Aspen dominant)	b2 - Blueberry Aspen - Paper Birch d1 - Low-bush cranberry Aspen e1 - Dogwood Balsam Poplar - Aspen
Mixedwood (White Spruce - Aspen dominant)	b3 - Blueberry Aspen - White Spruce d2 - Low-bush cranberry Aspen - White Spruce e2 - Dogwood Balsam Poplar - White Spruce
Mixed Coniferous (Pine dominant)	b4 - Blueberry - White Spruce - Jack Pine[a]
Wet Closed Coniferous (Black Spruce)	FFNN - Wooded Fen SFNN - Wooded Swamp
Wet Open Coniferous (Black Spruce - Tamarack)	FTNN - Treed Fen STNN - Treed Swamp
Mixed Coniferous (Black Spruce - Tamarack)	Sb - Lt - Black Spruce - Larch Complexes g1 - Labrador Tea subhygric - Black Spruce - Jack Pine
Shrubby Fen	FONS - Shrubby Fen SONS - Shrubby Swamp
Graminoid Fen	FONG - Graminoid Fen
Barren Ground/Exposed Bedrock	NMC - Cutbanks NMR - Barren Rock NMS - Sand
Bog (Sphagnum around edges of graminoid fens)	BTNN - Treed Bog BFNN - Wooded Bog
Mixed Coniferous (White Spruce - Pine dominant)	b4 - Blueberry - White Spruce - Jack Pine[a]
Low Shrub Wetland (bog)	Not Represented in LSA
Shrubland (low shrub recolonization, no pine)	Shrub - Upland Shrubland
Forestry Cutblocks	HG/CC - Herbaceous Graminoid Meadow and Clearcuts
Municipalities	Not Represented in LSA
Disturbed and Developed Lands	AIG - Gravel Pits AIH - Roads and Rights of Way CIP - Revegetated Industrial Lands CIW - Well Sites - Vegetated

[a] This type has been split, depending on the dominance of pine and spruce, into 2 regional classes.

Table 11 Baseline Areas of Vegetation and Wetland Classes in the Regional Study Area, Used in HSI Analyses

Vegetation Type	Area (ha) [(a)]	Percent
Bog	3,335	0.1
Coniferous-Pj/Sw/Sb	15,075	0.6
Coniferous-Sw	112,226	4.6
Coniferous-Sw/Pj	18,834	0.8
Graminoid Fen	224,675	9.3
Human disturbance	3,180	0.1
Low Shrub Wetland	64,798	2.7
Marsh	5,668	0.2
Mixed Deciduous	177,737	7.3
Mixedwood-Sw/Aw	318,875	13.1
Municipalities	4,085	0.2
Natural disturbance	17,338	0.7
Old Cutblocks	2,512	0.1
Open Pine	130,783	5.4
Open pit mines	41,946	1.7
Pine Regen	87,476	3.6
Recent Cutblocks	11,592	0.5
Shrubby Fen	290,096	11.9
Unclassified	75,835	3.1
Upland Sb-Lt	93,399	3.8
Upland Shrub	16,648	0.7
Water	64,475	2.7
Wet Closed Coniferous Sb	512,274	21.1
Wet Open Coniferous Sb-Lt	135,892	5.6
Total	**2,428,750**	**100.0**

(a) These areas are slightly modified from those reported in other reports. This occurred because the Digital Map of the Regional Study Area was converted to a rastor image with 50 m pixels for the HSI analysis, with resulting squaring of vegetation type edges.

Human Disturbances Layer

The disturbance layer was developed from a variety of sources, including the RSA orthophoto, the vegetation map, and information from approved or planned developments (Figure 5). These were used in conjunction with the other layers to define a baseline condition (all completed and approved developments up to 1998), an impact condition (baseline plus Project) and the CEA condition (baseline, Project and new Approved Projects) (Table 12).

Table 12 Regional Developments Included in Baseline, Project Millennium, and Cumulative Effects Assessment (CEA) Scenarios Which Affect HSI Modelling and Analyses

Development Scenario	Development	Area[(a)]
Baseline - Existing and Approved	Suncor Lease 86/17	2,877
	Syncrude Mildred Lake	18,782
	Suncor Steepbank	3,776
	Suncor Fee Lot 2	522
	Northstar Energy	22
	SOLV-EX	2,088
	Municipalities	4,022
	Pipelines, Roadways, Other Disturbances	2,904
	Syncrude Aurora Mine	15,171
Total Baseline Developments		50,164
Project Millennium		5,644
Baseline + Millennium Total		55,808
CEA - Planned Projects	Millennium Mine Project	4,343
	Shell Lease 13 East	7,215
	Mobil Kearl Oil Sands Mine	5,350
	Petro Canada MacKay River	33
	Fort McMurray Expansion	5,902
Total CEA Developments		22,843
CEA + Millennium		28,487
Total - All Developments		**78,651**

(a) These areas are official published values which may differ from totals used in the HSI analysis due to the use of a digital 50 metre pixel rastor image for all analyses.

The vegetation areas expected to be lost due to the Project and CEA Scenario are provided in Table 13.

Table 13 Development Areas and Vegetation Areas Remaining After Development of Project Millennium and CEA Scenario

Vegetation Type	Baseline	Millennium[a] Losses or Gains	Areas At Millennium[a]	CEA Losses or Gains	Areas At CEA[b]
Bog	3,335	0	3,335	0	3,335
Coniferous-Pj/Sw/Sb	15,075	-1	15,074	0	15,075
Coniferous-Sw	112,226	-151	112,075	-772	111,455
Coniferous-Sw/Pj	18,834	-13	18,820	0	18,834
Graminoid Fen	224,675	-3	224,672	-1,437	223,238
Low Shrub Wetland	64,798	-30	64,768	0	64,798
Marsh	5,668	-7	5,661	-3	5,665
Mixed Deciduous	177,737	-889	176,849	-2,585	175,152
Mixedwood-Sw/Aw	318,875	-85	318,790	-7,057	311,818
Natural disturbance	17,338	0	17,338	-757	16,581
Old Cutblocks[c]	2,512	-69	2,443	11,592	14,105
Open Pine	130,783	-48	130,734	-79	130,704
Pine Regen	87,476	0	87,476	-2	87,474
Recent Cutblocks[c]	11,592	0	11,592	-11,592	0
Shrubby Fen	290,096	-215	289,882	-4,094	286,003
Unclassified	75,835	0	75,835	-187	75,648
Upland Sb-Lt	93,399	-20	93,378	-1,205	92,194
Upland Shrub	16,648	-6	16,641	0	16,648
Wet Closed Coniferous Sb	512,274	-896	511,378	-9,325	502,949
Wet Open Coniferous Sb-Lt	135,892	-3,200	132,691	-2,237	133,655
Water	64,475	-5	64,469	-127	64,348
Total Vegetation/Water	2,379,540	-5,639	2,373,901	-29,865	2,349,675
Other Human Disturbances	3,180	-1	3,179	1,162	4,342
Municipalities	4,085	0	4,085	5,858	9,943
Industrial Developments	41,946	5,640	47,586	22,845	64,791
Total Developments	49,210	5,640	54,849	29,865	79,075
Total	**2,428,750**	**0**	**2,428,750**	**0**	**2,428,750**

(a) Project Millennium areas were determined from LSA Analyses as east bank mining area minus Steepbank Mine area.
(b) For this table and all HSI/Richness Index Analyses, the CEA scenario includes the project Millennium areas.
(c) Between baseline and CEA scenarios, all existing cutblocks are changed from recent to old categories.

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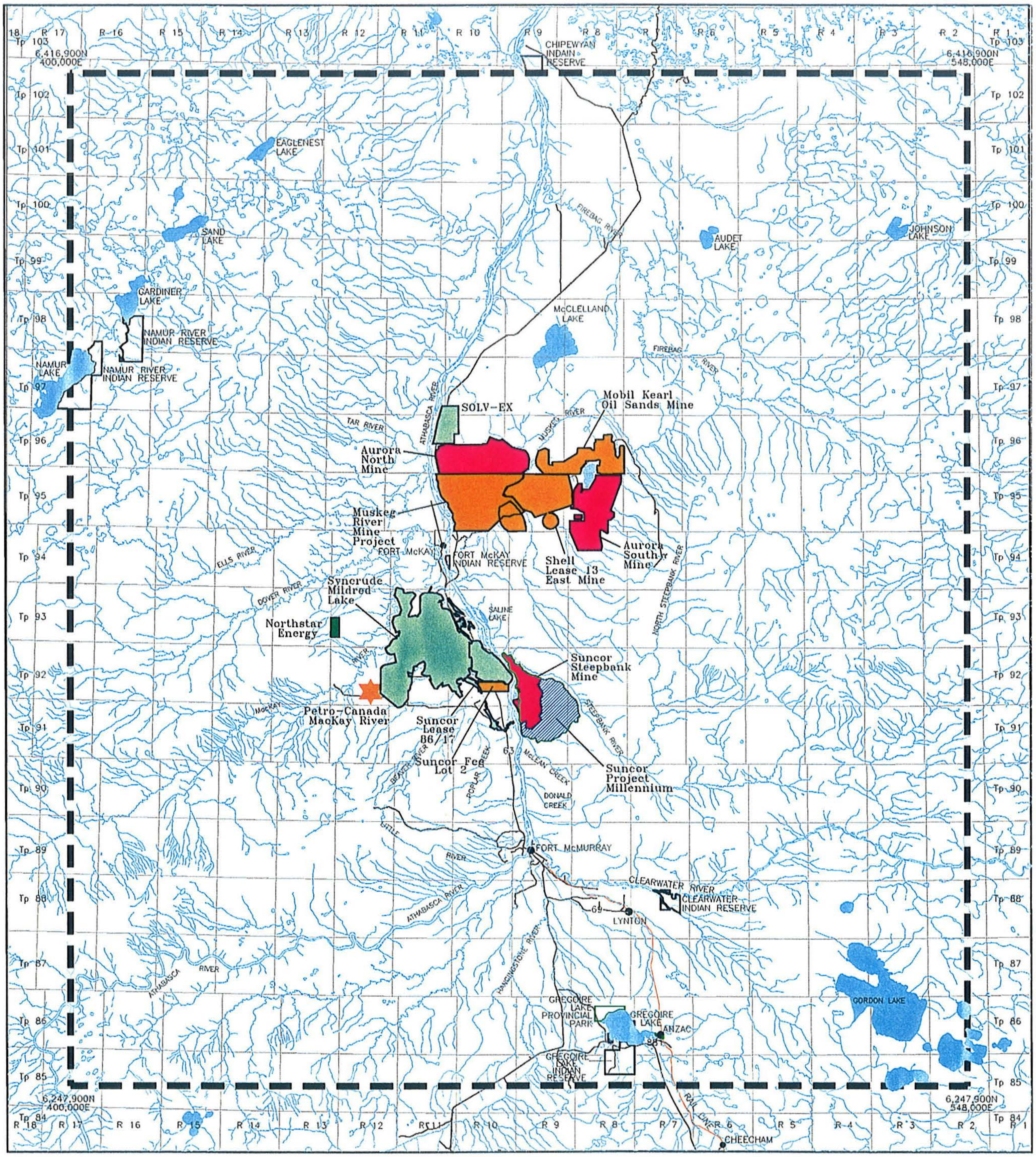

LEGEND

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

0 10 20 30 40 50km

SCALE 1:1,000,000

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REGIONAL STUDY AREA CUMULATIVE EFFECTS ASSESSMENT OIL SANDS DEVELOPMENTS

16 Apr. 1998	Figure 5	DRAWN BY: RFM/CG

REFERENCE

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

5.2.2 Habitat Variables

Habitat variables for the models included those for tree and shrub cover, downed wood density, ground cover and tree attribute data. These variables are defined below and are presented in Appendix II for the LSA and Appendix III for the RSA. Attributes were derived from AVI mapping, vegetation plot data and published values.

5.2.2.1 Tree and Shrub Cover, Ground Cover of Herbs, Mosses and Lichens

Tree and shrub cover means and ground cover means were derived from published values in Beckingham and Archibald's (1995) Field Guide to Ecosites of Northern Alberta, and from oil sands region vegetation plot data obtained from Conor Pacific Environmental and Golder Associates. All data was analysed at the ecophase level of vegetation community organization, or at the wetlands community level for peatlands, marshes and swamps. Data was first analysed from all sample plots to obtain means by vegetation class. Then, owing to low sample sizes for many vegetation classes, the results were averaged with values obtained from Beckingham and Archibald (1996). This achieved a balance between inclusion of local data and incorporation of published values. At the end of this process, some vegetation types still had few data available, and were assigned appropriate habitat attributes based on professional judgement. Note that local data was available only for the Boreal Mixedwood ecoregion, and values for the Boreal Highlands and Subarctic Ecoregion vegetation classes in the RSA came entirely from published values.

Table 14 Attributes Used in Habitat Data Development Derived From Vegetation Plot Data and Published Values

Attribute Code	Description
Pj	Jack + Lodgepole Pine Tree Cover
Sw	White Spruce Tree Cover
Sb	Black Spruce Tree Cover
Fb	Balsam Fir Tree Cover
Lt	Tamarack Tree Cover
Aw	Aspen Tree Cover
Pb	Balsam Poplar Tree Cover
Bw	Paper Birch Tree Cover
Conifer	Conifer Tree Cover (excluding Tamarack)
Deciduous	Deciduous Tree Cover
Tree	Total Tree Cover (Including Tamarack)
pine	Jack + Lodgepole Pine Shrub Cover
wspruce	White Spruce Shrub Cover
bspruce	Black Spruce Shrub Cover
fir	Balsam Fir Shrub Cover
tamarack	Tamarack Shrub Cover
aspen	Aspen Shrub Cover
bpoplar	Balsam Poplar Shrub Cover
pbirch	Paper Birch Shrub Cover
alder	Green + River Alder Cover
sask	Saskatoon Cover
dbirch	Dwarf + Bog Birch Cover
lleaf	Leatherleaf Cover
dogwood	Red-osier Dogwood Cover
hazel	Hazelnut Cover
ltea	Northern + Labrador Tea Cover
hsuckle	Bracted + Twining Honeysuckle Cover
cherry	Pin + Chokecherry Cover
currant	Currant + Gooseberry Cover
rose	Prickly + Wild Rose Cover
rberry	Raspberry Cover
willow	Willow Cover
bfberry	Buffaloberry Cover
sberry	Snowberry Cover
blberry	Blueberry Cover
lbcberry	Low Bush Cranberry Cover
buckthorn	Buckthorn Cover
cinquefoil	Shrubby Cinquefoil Cover
gale	Gale Cover
laurel	Laurel Cover
rosemary	Rosemary Cover
sage	Sagebrush Cover
sconif	Conifer Shrub Cover
sdecid	Deciduous Shrub Cover
shrub	Total Shrub Cover
dwshrub	Dwarf Shrub Cover
forb	Broadleaf Herb Cover
gram	Graminoid Cover
moss	Moss Cover
lich	Lichen Cover
wood	Down Logs > 10 cm diameter per hectare
litter	Litter Cover

5.2.2.2 Tree Composition, Stand Height, Mean Diameter at Breast Height (DBH), Age, Canopy Closure, and Moisture

Tree composition, stand height, mean DBH, age, canopy closure and moisture attributes were determined from the Alberta Vegetation Inventory (AVI) database for the LSA (Table 15). Each AVI class was assigned an ecological phase/wetland class. Thus, the above attributes were simply sorted among the phase/wetland classes and means were determined. Note that in the LSA baseline analysis, the actual values for these attributes on a polygon by polygon basis were used, rather than the means. The means were used in the Closure vegetation layer and in the regional analysis, after averaging among vegetation classes that made up the regional classes. Tree height was provided directly in the AVI dataset, as was canopy closure class, age and moisture class. Tree composition and DBH were first calculated for each stand in the AVI, and then averaged. Calculation techniques are described below.

Table 15 Attributes Used in Habitat Data Development Derived From Alberta Vegetation Inventory

Attribute Code	Description
Height	Mean Canopy Tree Height in metres
Age	Stand Age in years
DBH	Diameter at Breast Height in centimetres
PJP	Jack Pine Percent Composition
SWP	White Spruce Percent Composition
SBP	Black Spruce Percent Composition
FBP	Balsam Fir Percent Composition
LTP	Tamarack Percent Composition
AWP	Aspen Percent Composition
PBP	Balsam Poplar Percent Composition
BWP	Paper Birch Percent Composition
CONP	Conifer Tree Percent Composition
DECP	Deciduous Tree Percent Composition
TOTP	Total Tree Percent Composition
Moisture	Moisture Modifier Code
CanClos	Canopy Closure Class Code
DomTree	Dominant Tree Species Code

* In the LSA, only the Project Millennium AVI was used. For the RSA, the weighted mean (by area) of the Project Millennium AVI, Muskeg River Mine AVI, and Syncrude Aurora Mine AVI was used.

5.2.2.3 Tree Composition

Tree 1/10th proportions were provided in the AVI dataset. These were multiplied by 10 to give percents. These were summed by tree groups: deciduous, coniferous and total trees. Note that tamarack was not added into either deciduous or coniferous categories, but was included in the total tree group. This was done since the value of conifers in most of the HSI models is the shelter effect they provide in winter, which would not be provided by the needleless tamarack trees.

5.2.2.4 Diameter at Breast Height

DBH was predicted from stand height using the equations below. The dominant tree species was the one listed in the species #1 category within the AVI. Height is in metres for all equations. Stands where there were no trees were assigned a DBH of 0 (Table 16).

Table 16 Equations Used to Calculate Diameter at Breast Height (DBH) From Mean Tree Height in AVI Datasets

Dominant Tree:	Equation
White Spruce	DBH (cm) = 10^(0.15+0.95*log10(height))
Jack Pine or any Deciduous	DBH (cm) = 10^(0.15+0.90*log10(height))
Black Spruce	DBH (cm) = 10^(0.15+0.85*log10(height))
Tamarack	DBH (cm) = 10^(0.15+0.75*log10(height))

^ = raised to power of

* = multiplied (Equations courtesy W. Bessie, Unpublished Research)

5.2.2.5 Downed Wood Density and Litter Cover

Downed wood density and litter cover were determined from field plot data collected by Golder Associates in 1997 combined with data collected by BOVAR in 1996. Each data point was assigned an ecophase class based on existing vegetation information collected at each point. The litter and density values were sorted by ecological phase and means were determined. Data gaps were filled in based on professional judgment.

5.2.2.6 Regional Study Area Habitat Variables

The same ecological data were combined from several classes to determine the RSA values (Appendix III). All combinations were determined by the mean among the LSA classes which were included in the much broader regional study classes (Table 10). For example, the deciduous forest RSA vegetation type was made up of b2 - blueberry aspen paper birch, d1 - low bush cranberry aspen, and e1 - dogwood balsam poplar-aspen types from the LSA. For tree attributes, AVI data was obtained from three studies:

- Muskeg River Mine (Golder, 1998)
- Syncrude Aurora Mine (BOVAR 1996)
- Project Millennium (Suncor Energy Inc. 1998)

The RSA vegetation was split among 3 ecoregions, each with its own combination of vegetation types (see Vegetation Baseline Report) and, thus, the percentages for habitat attributes are averaged slightly differently for each vegetation type, resulting in different means for each vegetation type in each ecoregion (Appendix III). The assumption was made that the proportion of each stand type which made up each class was the same as the proportions present in the LSA. Thus, the mean for the regional area was weighted based on the actual number of polygons of a each type in the LSA. This same averaging technique was applied to all ecological attributes.

5.3 MODEL ANALYSES

Impact analyses for the LSA included assessment of habitat losses and/or gains, due to site clearing and loss of effective habitat due to disturbance.

5.3.1 Site Clearing

Changes associated with the Project (Figure 2) were overlain on the HSI map for each KIR to determine the impacts of site clearing. HSI analyses for the EIA included mapping of baseline habitat conditions, determining habitat losses due to project construction, and then determining habitat gains due to reclamation post closure. Losses due to construction were determined by overlaying the maximum extent of the project footprint over baseline habitat maps for each KIR. Losses calculated in this manner represent a conservative approach to impact assessment in that the entire footprint will not be in a disturbed state at any one time. Due to the phased nature of the development, and to progressive reclamation of mined-out areas, the actual amount of habitat at any given time will not be reduced as much as analysis in this report indicates.

5.3.2 Disturbance

Wildlife species may avoid or reduce their use of habitat adjacent to areas of human activity. Impacts are greater if the adjacent habitat is of high quality and if the total supply of habitat in the area is limiting. One way to estimate the amount of habitat affected by disturbance (i.e., habitat effectiveness) is to assume disturbance Zones of Influence (ZI) and Disturbance Coefficients (DC) for each KIR and each activity type. A ZI is the maximum distance to which a disturbance (e.g., traffic noise) is felt, and a DC is the effectiveness of the habitat within the ZI in fulfilling the requirements of the species (e.g., a DC of 0.9 represents 90% habitat effectiveness). ZIs and DCs can be used with HSI mapping within a Geographic Information System (GIS) to estimate the quantity and quality of habitat (expressed in HUs) that could be affected by a development.

Different species react differently to developments. Most work on this subject has been done for grizzly bears. Numerous studies (e.g., Mattson et al. 1987 McClellan and Shackleton 1988, 1989a, 1989b, Purves et al. 1992, Mace et al. 1996) have measured the displacement of grizzly bears by different levels of human activities.

Horejsi (1979) found that moose were disturbed by active seismic line work to within 1 km, while other researchers have found that moose avoid areas of human activity but did not determine a zone of influence (e.g., Hancock 1976, Rolley and Keith 1980). Still others have found that moose can habituate to human disturbance (e.g., Pauls 1987).

Unfortunately, results of such studies are often highly variable due to the difficulties associated with studying wide-ranging and reclusive species, and most study designs are based on rather arbitrary buffer distances around disturbance features (e.g., analyze locations less than and greater than 500 m from roads: Mace et al. 1996). Therefore, most displacement models have relied on professional judgement, using empirical data as a guide only.

BOVAR (1996) used a ZI of 500 m for moose and 100 m for snowshoe hares for the Aurora Mine EIA. They made a conservative assumption that displacement was complete within the ZI for these species (i.e., DC was zero for all activity types). In contrast, they assumed that all other KIRs were not displaced by the Aurora Mine development.

Westworth (1996) used a ZI of 250 m and a DC of zero for all KIRs for the Suncor EIA, due to sensory disturbance, reduced hiding and thermal cover, reduced forage palatability due to the accumulation of dust, and, for breeding birds, increased risk of nest predation from edge-adapted species.

The ZIs and DCs used for the Project EIA are shown in Table 17. These variables were determined through professional judgement, based on a literature review and other oil sands EIAs. Habitat alienation from disturbance was not considered to be a factor for red-backed voles.

Table 17 Wildlife Zones of Influence and Disturbance Coefficients for Human Developments and Linear Access Hunting and Trapping Corridors

Species	Roads/River Access Routes		Active Mine Sites, Industrial Facilities		Municipalities		Other Linear Disturbances	
	DC	ZI (m)	DC	ZI (m)	DC	ZI (m)	DC	ZI (m)
Beaver	0.5	500	0.0	0	0.5	500	0.5	500
Black Bear[a]	0.5	1000	0.75	100	0.5	500	0.75	500
Cape May Warbler	0.75	100	0.75	100	0.75	100	0.0	0
Dabbling Ducks	0.5	250	0.75	100	0.75	100	0.75	100
Fisher[a]	0.5	500	0.75	100	0.5	500	0.5	500
Great Gray Owl	0.75	100	0.75	100	0.75	100	0.0	0
Moose[a]	0.5	1000	0.75	100	0.5	500	0.5	500
Pileated Woodpecker	0.75	100	0.75	100	0.75	100	0.0	0
Red-backed Vole	Disturbance Coefficients Not Applied							
Ruffed Grouse	0.5	250	0.75	100	0.5	100	0.5	100
Snowshoe Hare	0.5	500	0.75	100	0.75	500	0.75	500
Western Tanager	0.75	100	0.75	100	0.75	100	0.0	0

[a] Roads include the Athabasca River Channel, Steepbank River, and Clearwater River for these species, since these are extensively traveled and used for hunting/trapping corridors during the fall and winter.

6 LOCAL STUDY AREA

6.1 WILDLIFE RICHNESS

The expected number of mammal, bird and reptile and amphibian species which could occur within each vegetation class in the LSA is presented in Table 19. This table was adapted from Appendix IV, which was developed from an expected association of species plus any observations within generalized vegetation types for the Shell Muskeg River Mine EIA (Golder 1998p).

The vegetation type with the most mammal species (n=28) was the wooded peatland type, which included wooded bog (BFNN, BTNN) and wooded fen (FFNN, FTNN) vegetation types. This was followed by mixedwoods (27), and spruce-dominated coniferous stands (25). Moderate numbers (16) occur in open peatlands and graminoid fens and 8 species are found in open water. Revegetated disturbed lands are expected to support 7 species, whereas natural disturbances with sparse vegetative cover (open sand, rock, cutbanks and flooded areas) are expected to have no associated mammal species. These habitat types were mapped using relative richness index scores, which are the species per habitat type divided by total maximum species in any one type (Figure 6).

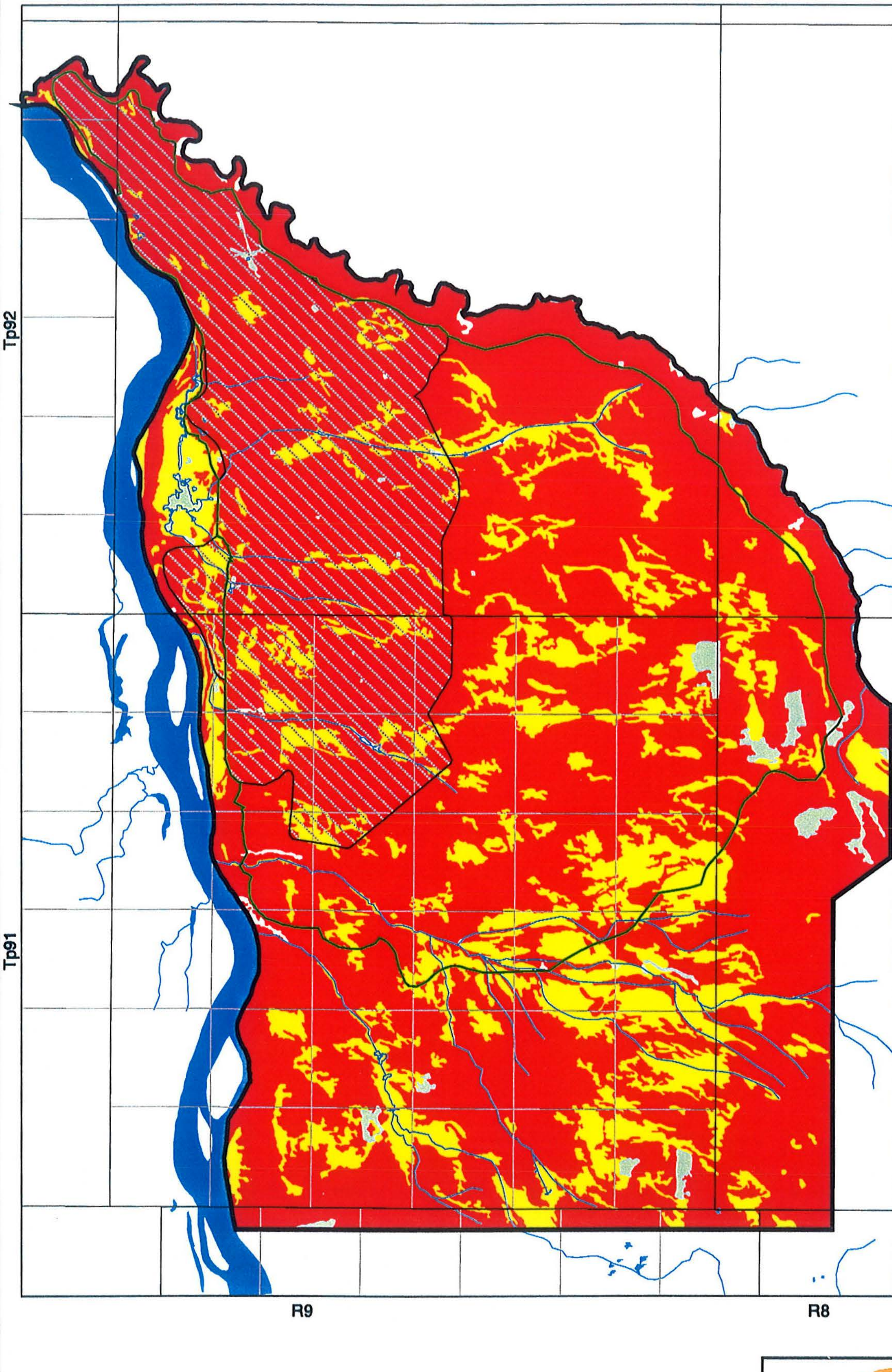
Analysis for bird species indicated that the wooded peatland types support the most species (n=112). Other types with a high richness included the swamp types (97), mixedwood types (81), open peatlands (71), deciduous forests (67) and open water (63). Types with less species included open pine, spruce dominated coniferous types and revegetated disturbed zones. Natural disturbances had no associated species. These habitat types were mapped using relative richness index scores (Figure 7).

Reptile and amphibian species were highest with 4 species in wooded peatlands and swamps, followed by 2 species in most upland types, and no species in disturbed, revegetated, or open water types. Note that the lack of species in open water indicates that only adult amphibians were included in this list. These areas were mapped using relative richness index scores (Figure 8).

Table 19 Expected Number Of Species of Mammals, Birds, Reptiles and Amphibians per LSA Vegetation Phase

Phase	Description	Mammals	Birds	Reptiles and Amphibians[a]
a1	Lichen Pj	21	48	2
AIG	Gravel Pits	0	0	0
AIH	Roads and Rights of Ways	7	28	0
b1	Blueberry Pj-Aw	21	48	2
b2	Blueberry Aw(Bw)	20	67	2
b3	Blueberry Aw-Sw	27	81	2
b4	Blueberry Sw-Pj	25	57	2
BFNN	Wooded bog (tree cover >70%)	28	112	4
BTNN	Wooded bog (tree cover >10% and <=70%)	28	112	4
c1	Labrador Tea - mesic Pj-Sb	21	48	2
CIP	Revegetated Industrial Lands	7	28	0
CIW	Well Sites - vegetated	7	0	0
d1	Low-bush Cranberry Aw	20	67	2
d2	Low-bush Cranberry Aw-Sw	27	81	2
d3	Low-bush Cranberry Sw	25	57	2
e1	Dogwood Pb-Aw	20	67	2
e2	Dogwood Pb-Sw	27	81	2
e3	Dogwood Sw	25	57	2
FFNN	Wooded Fen (tree cover >70%)	28	112	4
FONG	Graminoid Fen	16	71	4
FONS	Shrubby Fen	16	71	4
FTNN	Wooded Fen (tree cover >10% and <=70%)	28	112	4
g1	Labrador Tea - subhygric Sb-Pj	25	57	2
h1	Labrador Tea/Horsetail Sw-Sb	25	57	2
HG/CC	Herbacious Graminoid Cutblock	7	28	0
MONG	Graminoid Marsh	16	71	4
MONS	Shrubby Marsh	10	78	4
NMC	Cutbanks	0	0	0
NMR	Rock	0	0	0
NMS	Sand	0	0	0
NWF	Flooded Area	8	63	0
NWL	Lake	8	63	0
NWR	River	8	63	0
Sb/Lt	Black Spruce - Larch Complexes	25	57	2
SFNN	Swamp (tree cover >70%)	18	97	4
Shrub	Shrubland	16	71	4
SONS	Swamp (deciduous shrub)	18	97	4
STNN	Swamp (tree cover >10% and <=70%)	18	97	4
WONN	Shallow open water	8	63	0

[a] Adult Individuals



LEGEND
Terrestrial Local Study Area
East Bank Mining Area
Steepbank Mine
Open Water

HABITAT RICHNESS RATING
Nil
Low
Moderate
High

West of Fourth Meridian

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LOCAL STUDY AREA
MAMMAL HABITAT RICHNESS
BASELINE SCENARIO

08 Apr. 1998 | Figure 6 | PRODUCED BY: CGA REVIEWED BY: WB

SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

N

1000 0 1000 2000 3000
Metres
Scale 1:100,000

Map Projection: UTM 12
Datum: NAD 83

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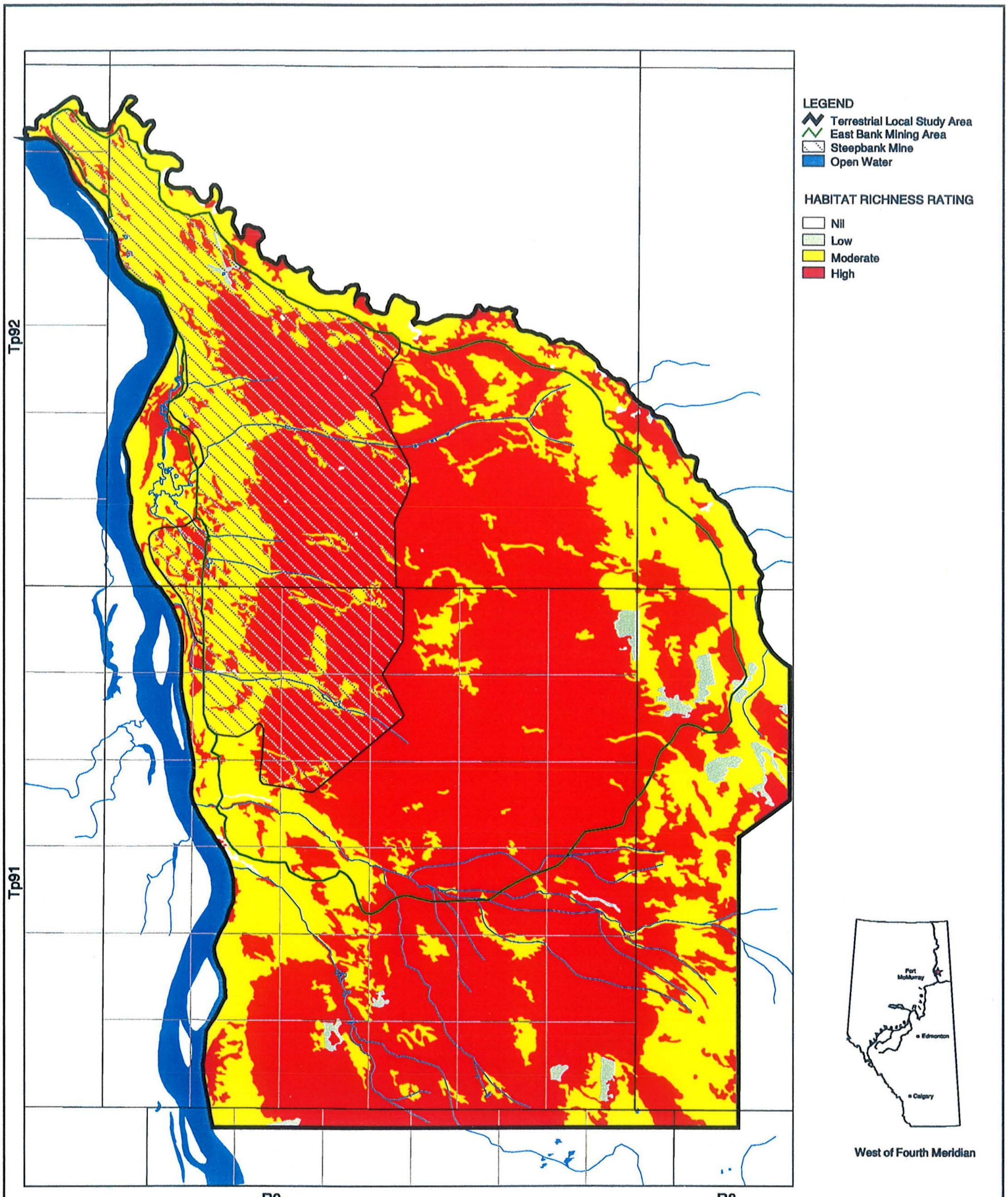

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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

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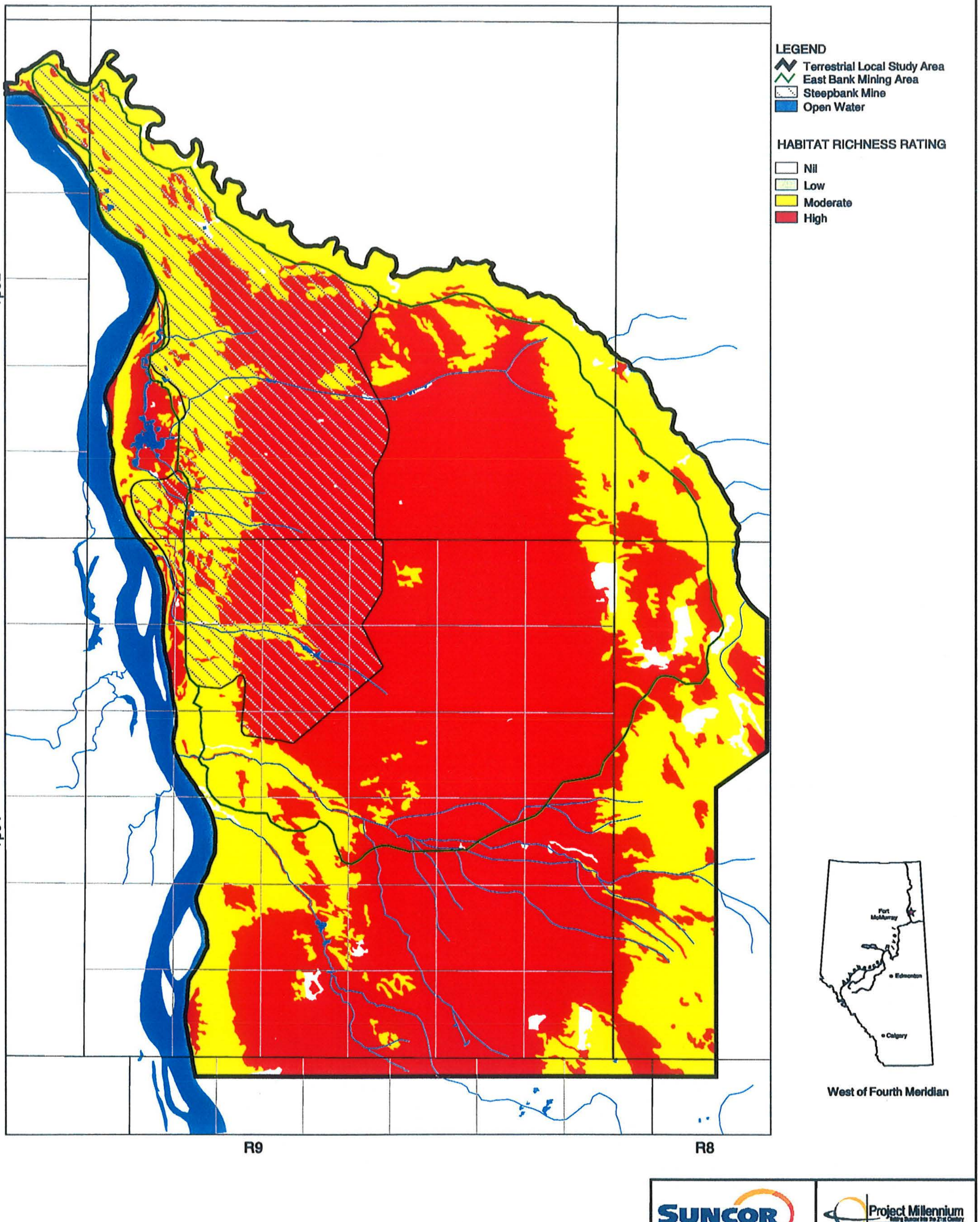
LOCAL STUDY AREA
BIRD HABITAT RICHNESS
BASELINE SCENARIO

08 Apr. 1998

Figure 7

PRODUCED BY: CGA
REVIEWED BY: WB



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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

SUNCOR ENERGY

Project Millennium

LOCAL STUDY AREA
REPTILE AND AMPHIBIAN HABITAT RICHNESS
BASELINE SCENARIO

07 Apr. 1998 | Figure 8 | PRODUCED BY: CGA REVIEWED BY: WB

6.1.1 Mammal Habitat Richness

6.1.1.1 Baseline Conditions

The richness index (RI) values of the various ecosite phases within the LSA for mammals is presented in Table 20. Nineteen phases were considered to have a high RI, eight were considered to have a medium RI, seven were considered low and four had a RI of 0.

Table 20 LSA Mammal Richness Index Vegetation Class Ratings

Habitat Richness Class	Phase	Description	Richness Index
High Richness (0.67 - 1.00)	BFNN	Wooded bog (tree cover >70%)	1.00
	BTNN	Wooded bog (tree cover >10% and ≤70%)	1.00
	FFNN	Wooded Fen (tree cover >70%)	1.00
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	1.00
	b3	Blueberry Aw-Sw	0.96
	d2	Low-bush Cranberry Aw-Sw	0.96
	e2	Dogwood Pb-Sw	0.96
	b4	Blueberry Sw-Pj	0.89
	d3	Low-bush Cranberry Sw	0.89
	e3	Dogwood Sw	0.89
	g1	Labrador Tea - subhygric Sb-Pj	0.89
	h1	Labrador Tea/Horsetail Sw-Sb	0.89
	Sb/Lt	Black Spruce - Larch Complexes	0.89
	a1	Lichen Pj	0.75
	b1	Blueberry Pj-Aw	0.75
	c1	Labrador Tea - mesic Pj-Sb	0.75
	b2	Blueberry Aw(Bw)	0.71
	d1	Low-bush Cranberry Aw	0.71
	e1	Dogwood Pb-Aw	0.71
Medium Richness (0.34 - 0.66)	SFNN	Swamp (tree cover >70%)	0.64
	SONS	Swamp (deciduous shrub)	0.64
	STNN	Swamp (tree cover >10% and ≤70%)	0.64
	FONG	Graminoid Fen	0.57
	FONS	Shrubby Fen	0.57
	MONG	Graminoid Marsh	0.57
	Shrub	Shrubland	0.57
	MONS	Shrubby Marsh	0.36
Low Richness (0.01 - 0.33)	NWL	Lake	0.29
	NWR	River	0.29
	WONN	Shallow open water	0.29
	AIH	Roads and Rights of Ways	0.25
	CIP	Revegetated Industrial Lands	0.25
	CIW	Well Sites - vegetated	0.25
	HG/CC	Herbacious Graminoid Cutblock	0.25
No Richness (0.00)	AIG	Gravel Pits	0.00
	NMC	Cutbanks	0.00
	NMS	Sand	0.00
	NWF	Flooded Area	0.00

Mammal richness HUs by vegetation types are provided in Table 21. At predevelopment conditions, the highest HU scores were determined for treed fens (FTNN) with 6,010 HUs, low bush cranberry - aspen (d1) with 2,377 HUs, wooded fens (FFNN) with 966 HUs, treed swamps (STNN) with 870 HUs and low bush cranberry - white spruce (d3) with 837 HUs.

These results indicate the combined importance of the areas of each of the habitat types (see Table 4) and the RI of each of these types (Table 20).

Table 21 LSA Mammal Richness Habitat Units: Predevelopment, Impact and Closure

Pre-Development Vegetation Type	Pre-Development (HU)	Steepbank Mine Impact (HU)	Steepbank Mine Impact (%)	East Bank Mining Area Impact (HU)	East Bank Mining Area Impact (%)	Closure (HU)	Closure Change From Pre-Development (HU)	Closure Change From Pre-Development (%)
a1	1	-1	-100.0	-1	-100.0	0	-1	-100.0
AIG	0	0	0.0	0	0.0	0	0	0.0
AIH	1	0	0.0	0	0.0	1	0	0.0
b1	170	-73	-43.1	-109	-63.9	196	+26	+15.5
b2	20	-18	-94.2	-19	-99.5	217	+198	+1,010.9
b3	57	-54	-95.1	-54	-95.1	838	+781	+1,366.7
b4	45	-33	-72.9	-44	-99.0	2	-43	-95.8
BFNN	26	0	0.0	0	0.0	26	0	0.0
BTNN	20	0	0.0	0	0.0	20	0	0.0
c1	1	-1	-100.0	-1	-100.0	0	-1	-100.0
CIP	3	-3	-88.7	-3	-88.7	1	-2	-79.0
CIW	1	-1	-60.2	-1	-85.4	0	-1	-81.3
d1	2,377	-656	-27.6	-1,264	-53.2	1971	-406	-17.1
d2	564	-57	-10.2	-130	-23.0	2614	+2,050	+363.3
d3	837	-189	-22.6	-280	-33.5	691	-146	-17.4
e1	150	-20	-13.3	-25	-16.4	1464	+1,314	+873.7
e2	60	-15	-24.8	-14	-23.0	50	-11	-17.4
e3	113	-22	-19.5	-12	-10.9	348	+234	+206.6
FFNN	966	-262	-27.2	-547	-56.6	430	-537	-55.5
FONG	2	0	0.0	-2	-76.3	1	-2	-76.3
FONS	243	-63	-25.8	-185	-76.2	60	-182	-75.1
FTNN	6,010	-1,528	-25.4	-4,396	-73.1	1657	-4,353	-72.4
g1	1	0	0.0	-1	-100.0	0	-1	-100.0
h1	53	-19	-36.2	-28	-53.4	28	-25	-46.4
HG/CC	43	0	0.0	-17	-40.7	27	-15	-36.2
MONG	61	-7	-11.3	-8	-12.8	211	+150	+246.5
MONS	76	-8	-10.4	-6	-8.3	70	-6	-7.9
NMC	0	0	0.0	0	0.0	0	0	0.0
NMR	0	0	0.0	0	0.0	0	0	0.0
NMS	0	0	0.0	0	0.0	0	0	0.0
NWF	0	0	0.0	0	0.0	0	0	0.0
NWL	6	0	0.0	-1	-14.8	271	+265	+4,632.1
NWR	23	-1	-2.6	-1	-2.6	22	-1	-2.6
Sb/Lt	18	0	0.0	-18	-100.0	0	-18	-100.0
SFNN	440	-33	-7.5	-242	-55.1	206	-234	-53.1
Shrub	75	-29	-38.9	-33	-43.7	89	+14	+18.8
SONS	103	-30	-29.4	-27	-26.6	537	+434	+421.0
STNN	870	-104	-11.9	-492	-56.6	406	-464	-53.3
WONN	4	-2	-41.8	-2	-55.5	2	-2	-54.1
Total	**13,441**	**-3,228**	**-24.0**	**-7,963**	**-59.2**	**12,458**	**-983**	**-7.3**

The percent of the LSA which had suitable habitat (sum of low, medium and high habitat areas divided by the total number of hectares) for mammal richness was 99.7% and consisted of 13,441 HUs (Table 22). None of the unsuitable habitat consisted of water, since this type had a low RI. The mean RI of the LSA (total HUS/total area) was 0.83 which indicated that the LSA consists of relatively rich habitat for mammals. This occurs due to the high proportion of fens and swamps in the LSA which have high richness indices.

Table 22 LSA Mammal Richness Indices and Habitat Units Summary

		Percent of Area by Suitability Class								Percent of Habitat Units by Suitability Class		
	Area	Unsuitable Habitat			Suitable Habitat				Habitat			
Scenario	(ha)	Water	Other	Total	Low	Med	High	Total	Units	Low	Med.	High
Predevelopment	16,181	0.0	0.3	0.3	1.9	19.1	78.8	99.7	13,441	0.6	13.9	85.5
Steepbank	3,776	0.0	0.1	0.1	0.6	12.1	87.3	99.9	3,228	0.2	8.5	91.4
East Bank Mine Impact	9,281	0.0	0.1	0.1	1.1	17.3	81.6	99.9	7,963	0.3	12.5	87.2
Remaining at Full Impact	6,901	0.0	0.5	0.5	3.0	21.4	75.1	99.5	5,477	1.0	15.9	83.0
Closure	16,181	0.0	0.2	0.2	7.0	16.2	76.6	99.8	12,458	2.6	12.7	84.7

Of the 13,441 HUs of mammal richness habitat, the LSA is currently composed of 81 HUs (1%) of low quality habitat, 1,869 HUs (14%) of medium quality habitat and 11,491 HUs (85%) of high quality habitat (Table 23). The distribution of HUs for the Steepbank Mine and the mine impact area were similar to that seen in the LSA. Mammal richness habitat within the Steepbank mining area was composed of 6 HUs (<1%) of low quality habitat, 273 HUs (9%) of medium quality habitat, and 2,949 HUs (91%) of high quality habitat. The mean richness of the Steepbank mine was 0.85 (3,328 HUs) and the mine impact area was 0.86 (7,963 HU). Mammal richness habitat within the mine impact area was composed of 25 HUs (<1%) of low quality habitat, 995 HUs (13%) of medium quality habitat and 6,943 HUs (87%) of high quality habitat.

Table 23 LSA Mammal Richness Habitat Units: Changes per Habitat Class for Impact and Closure Scenarios

	Predevelopment		Steepbank (HUs Lost)		East Bank Mine Impact (HUs Lost)		Remaining at Impact		Closure	
Habitat Class	HU	%	HU	%	HU	%	HU	%	HU	%
Low	81	0.6	6	0.2	25	0.3	56	1.0	325	2.6
Med	1,869	13.9	273	8.5	995	12.5	874	16.0	1,580	12.7
High	11,491	85.5	2,949	91.4	6,943	87.2	4,548	83.0	10,554	84.7
Total HUs	13,441	100.0	3,228	100.0	7,963	100.0	5,478	100.0	12,458	100.0
Total Area (ha)	16,181		3,776		9,281		6,900		16,181	
Mean Suitability	0.83		0.85		0.86		0.79		0.77	

The mapped distribution of mammal habitat richness at predevelopment conditions (Figure 6) demonstrates that the majority of the LSA is high in mammal richness, with a few scattered areas of medium and low suitability. Compared to the vegetation map of the LSA (Figure 1), the moderate areas are seen to be mainly wooded swamps and shrubby fens in the central regions of the LSA, and shrubby swamps and graminoid fens near the open water habitat in the northwest corner.

The mammal habitat richness model has not been tested for verification of habitat predictions, due to too few data. Instead, the predictions are based partly on oil sands area observations and represent a reasonable approach to the quantitative calculation of biodiversity at the habitat level.

6.1.1.2 Construction Impacts

Direct habitat loss due to the mine is projected to affect mammal richness habitat by removing 59% of the HUs present (Table 24). Most losses are seen in treed fens (FTNN), low bush cranberry - aspen, wooded fens (FFNN), and treed swamps (STNN) (Table 21). Thirty-one percent of low, 53% of medium and 60% of high quality habitat will be lost due to site clearing, for a total loss of 59%. Comparatively, the Steepbank Mine would have reduced total HUs within the LSA by 24%.

Since the mean suitability of the mine impact area prior to development was slightly greater than the entire LSA, the mean richness of areas remaining at impact decreases from 0.83 to 0.79 at full impact (Table 23).

Table 24 LSA Mammal Habitat Richness: Change from Predevelopment Under Impact and Closure Scenarios

Habitat Class	Pre-development (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	Mine Impact (Loss of HU)	Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	81	-6	-7.2	-25	-30.8	+244	+300.8
Med	1,869	-273	-14.6	-995	-53.3	-289	-15.5
High	11,491	-2,949	-25.7	-6,943	-60.4	-937	-8.2
Total	**13,441**	**-3,228**	**-24.0**	**-7,963**	**-59.2**	**-983**	**-7.3**

6.1.1.3 Closure Impacts

During closure, the mine footprint will be reclaimed to the following vegetation types (Table 8, Figure 3):

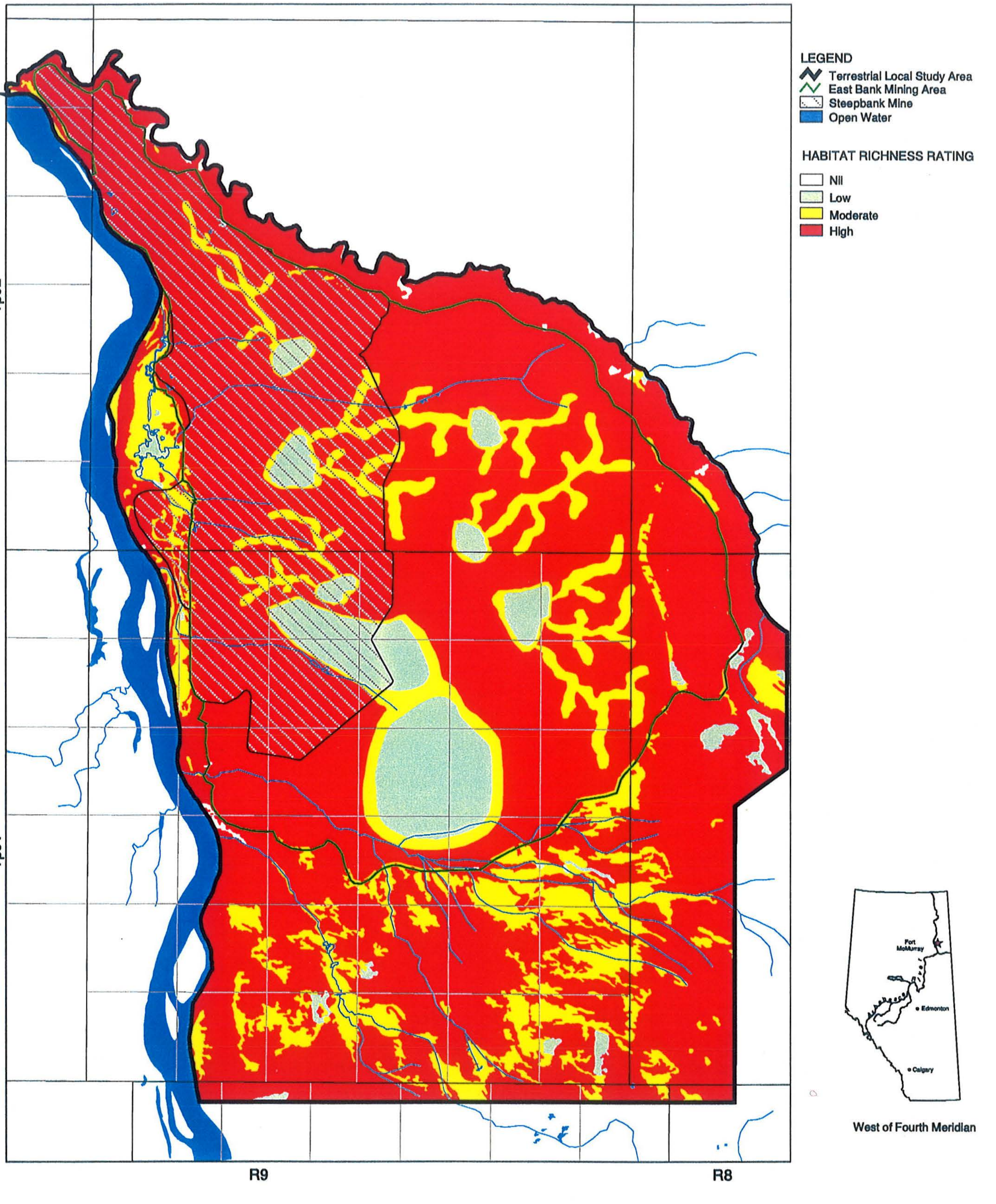
- low bush cranberry-trembling aspen-white spruce (d2);
- dogwood-balsam poplar-trembling aspen (e1);
- lakes (NWL);
- blueberry-trembling aspen-white spruce (b3);

- shrubby deciduous swamp (SONS);
- blueberry-trembling aspen (paper birch) (b2);
- graminoid marsh (MONG);
- dogwood-white spruce (e3);
- blueberry-jack pine-trembling aspen (b1); and
- shrubland (Shrub).

All of these vegetation types represent moderate to high suitability habitat for mammal richness, except for lakes (NWL). Even though a variety of moderate to high suitability habitats for mammal richness will be reclaimed, the reclamation of lakes leads to an overall decrease in mammal richness potential from baseline conditions following closure (Figure 9).

Mammal richness is expected to return to 12,458 HUs after reclamation and vegetation succession is complete (Table 23). Compared to pre-development conditions, this represents a long-term loss of 983 HUs (7%) relative to baseline conditions following closure (Table 24). This primarily results from an increase of 915 ha of low richness end pit lakes.

Potential modifications to improve the closure habitat value for mammal richness would include the redevelopment of wooded peatlands in place of end pit lakes and shrublands.



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SOURCES: Suncor
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Map Projection: UTM 12
Datum: NAD 83

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LOCAL STUDY AREA
MAMMAL HABITAT RICHNESS
CLOSURE SCENARIO

08 Apr. 1998

Figure 9

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REVIEWED BY: WB

6.1.2 Bird Richness

6.1.2.1 Baseline Conditions

High richness habitat for birds within the LSA included the following ecosite phases (Table 25):

- wooded bogs and fens (BFNN, BTNN, FFNN, FTNN);
- swamps (SFNN, SONS, STNN);
- blueberry-trembling aspen-white spruce (b3);
- low-bush cranberry-trembling aspen-white spruce (d2);
- dogwood-balsam poplar-white spruce (e2); and
- shrubby marsh (MONS).

Habitat for birds with no richness included gravel pits (AIG), vegetated well sites (CIW), cutbanks (NMC), sand (NMS), and flooded areas (NWF).

Table 25 LSA Bird Richness Index Vegetation Class Ratings

Habitat Richness Class	Phase	Description	Richness Index
High Richness (0.67 - 1.00)	BFNN	Wooded bog (tree cover >70%)	1.00
	BTNN	Wooded bog (tree cover >10% and ≤70%)	1.00
	FFNN	Wooded Fen (tree cover >70%)	1.00
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	1.00
	SFNN	Swamp (tree cover >70%)	0.87
	SONS	Swamp (deciduous shrub)	0.87
	STNN	Swamp (tree cover >10% and ≤70%)	0.87
	b3	Blueberry Aw-Sw	0.72
	d2	Low-bush Cranberry Aw-Sw	0.72
	e2	Dogwood Pb-Sw	0.72
	MONS	Shrubby Marsh	0.70
Medium Richness (0.34 - 0.66)	FONG	Graminoid Fen	0.63
	FONS	Shrubby Fen	0.63
	MONG	Graminoid Marsh	0.63
	Shrub	Shrubland	0.63
	b2	Blueberry Aw(Bw)	0.60
	d1	Low-bush Cranberry Aw	0.60
	e1	Dogwood Pb-Aw	0.60
	NWL	Lake	0.56
	NWR	River	0.56
	WONN	Shallow OpenWwater	0.56
	b4	Blueberry Sw-Pj	0.51
	d3	Low-bush Cranberry Sw	0.51
	e3	Dogwood Sw	0.51
	g1	Labrador Tea - Subhygric Sb-Pj	0.51
	h1	Labrador Tea/Horsetail Sw-Sb	0.51
	Sb/Lt	Black Spruce - Larch Complexes	0.51
	a1	Lichen Pj	0.43
	b1	Blueberry Pj-Aw	0.43
	c1	Labrador Tea - Mesic Pj-Sb	0.43
Low Richness (0.01 - 0.33)	AIH	Roads and Rights of Ways	0.25
	CIP	Revegetated Industrial Lands	0.25
	HG/CC	Herbacious Graminoid Cutblock	0.25
No Richness (0.00)	AIG	Gravel Pits	0.00
	CIW	Well Sites - Vegetated	0.00
	NMC	Cutbanks	0.00
	NMS	Sand	0.00
	NWF	Flooded Area	0.00

At predevelopment conditions the vegetation phases contributing to the most richness HUs within the LSA included the FTNN, d1 and STNN types (Table 26). Losses in richness HUs due to the mine are predicted to range from 0 to 100% for any particular vegetation phase.

Table 26 LSA Bird Richness Habitat Units: Predevelopment, Impact and Closure

Phase	Pre-Develop-ment (HU)	Steepbank Mine Impact (HU)	Steepbank Mine Impact (%)	East Bank Mining Area Impact (HU)	East Bank Mining Area Impact (%)	Closure (HU)	Closure Change from Pre-Development (HU)	Closure Change from Pre-Development (%)
a1	1	-1	-100.0	-1	-100.0	0	-1	-100.0
AIG	0	0	0.0	0	0.0	0	0	0.0
AIH	1	0	0.0	0	0.0	1	0	0.0
b1	97	-42	-43.1	-62	-63.9	113	+15	+15.5
b2	17	-16	-94.1	-16	-99.5	184	+167	+1,010.9
b3	43	-41	-95.1	-41	-95.1	629	+586	+1,366.5
b4	26	-19	-72.9	-25	-99.0	1	-24	-95.9
BFNN	26	0	0.0	0	0.0	26	0	0.0
BTNN	20	0	0.0	0	0.0	20	0	0.0
c1	1	-1	-100.0	-1	-100.0	0	-1	-100.0
CIP	3	-3	-88.7	-3	-88.7	1	-2	-79.0
CIW	0	0	0.0	0	0.0	0	0	0.0
d1	2,009	-554	-27.6	-1,068	-53.2	1,665	-343	-17.1
d2	423	-43	-10.2	-97	-23.0	1,961	+1,538	+363.3
d3	480	-108	-22.6	-161	-33.5	396	-84	-17.5
e1	127	-17	-13.2	-21	-16.4	1,237	+1,110	+873.9
e2	45	-11	-24.8	-10	-23.0	37	-8	-17.4
e3	65	-13	-19.5	-7	-10.9	199	+134	+206.5
FFNN	966	-262	-27.2	-547	-56.6	430	-537	-55.5
FONG	2	0	0.0	-2	-76.4	1	-2	-76.4
FONS	268	-69	-25.8	-205	-76.2	67	-201	-75.1
FTNN	6,010	-1,528	-25.4	-4,396	-73.1	1,657	-4,353	-72.4
g1	1	0	0.0	-1	-100.0	0	-1	-100.0
h1	30	-11	-36.2	-16	-53.4	16	-14	-46.4
HG/CC	43	0	0.0	-17	-40.7	27	-15	-36.2
MONG	67	-8	-11.3	-9	-12.8	233	+166	+246.5
MONS	148	-15	-10.4	-12	-8.3	136	-12	-7.9
NMC	0	0	0.0	0	0.0	0	0	0.0
NMR	0	0	0.0	0	0.0	0	0	0.0
NMS	0	0	0.0	0	0.0	0	0	0.0
NWF	0	0	0.0	0	0.0	0	0	0.0
NWL	11	0	0.0	-2	-14.9	524	+512	+4,629.4
NWR	44	-1	-2.6	-1	-2.6	43	-1	-2.6
Sb/Lt	10	0	0.0	-10	-100.0	0	-10	-100.0
SFNN	598	-45	-7.5	-329	-55.1	280	-317	-53.1
Shrub	82	-32	-38.9	-36	-43.7	98	+15	+18.8
SONS	140	-41	-29.4	-37	-26.6	730	+590	+421.1
STNN	1,182	-141	-11.9	-669	-56.6	552	-630	-53.3
WONN	9	-4	-41.6	-5	-55.4	4	-5	-53.8
Total	**12,996**	**-3,024**	**-23.3**	**-7,807**	**-60.1**	**11,268**	**-1,728**	**-13.3**

The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha in the LSA) for bird richness is 99.7% (12,996 HUs). None of the unsuitable habitat consisted of water (Table 27).

Table 27 LSA Bird Richness Indices and Habitat Units Summary

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med.	High
Predevelopment	16,181	0.0	0.3	0.3	1.2	35.8	62.7	99.7	12,996	0.4	25.8	73.9
Steepbank	3,776	0.0	0.1	0.1	0.3	41.2	58.4	99.9	3,024	0.1	29.5	70.4
East Bank Mine Impact	9,281	0.0	0.1	0.1	0.9	30.5	68.5	99.9	7,807	0.3	21.1	78.6
Remaining at Full Impact	6,901	0.0	0.5	0.5	1.6	43.0	55.0	99.5	5,189	0.5	32.8	66.7
Closure	16,181	0.0	0.2	0.2	0.7	51.0	48.0	99.8	11,268	0.3	42.4	57.3

Of the 12,996 HUs of bird richness habitat, the LSA is currently composed of 47 HUs (<1%) of low quality habitat, 3,347 HUs (26%) of medium quality habitat, and 9,602 HUs (74%) of high quality habitat (Table 28). This means richness at predevelopment was 0.80 (high) (Table 28). The distribution of HUs for the Steepbank and the mine impact areas were similar to that seen in the LSA. Bird richness habitat within the Steepbank mining area was composed of 3 HUs (<1%) of low quality habitat, 894 HUs (30%) of medium quality habitat, and 2,128 HUs (70%) of high quality habitat. The mean richness for the Steepbank mine was also 0.80, same as the entire predevelopment area (Table 28).

Table 28 LSA Bird Richness Habitat Units: Changes per Habitat Class for Impact and Closure Scenarios

Habitat Class	Predevelop-ment HU	%	Steepbank HU	%	East Bank Mine Impact HU	%	Remaining at Impact HU	%	Closure HU	%
Low	47	0.4	3	0	20	0.3	27	0.5	29	0.3
Med	3,347	25.8	894	30	1,313	17	1,699	32.8	4,780	42.4
High	9,602	73.9	2,128	70	6,459	83	3,463	66.7	6,459	57.3
Total HUs	12,996	100.0	3,024	100	7,863	100	5,189	100.0	11,268	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.80		0.80		0.84		0.75		0.70	

Bird richness habitat within the mine impact area was composed of 20 HUs (<1%) of low quality habitat, 1,313 HUs (17%) of medium quality habitat, and 6,549 HUs (83%) of high quality habitat (Table 28).

The majority of the LSA is rated as high suitability habitat for bird richness, with areas of medium suitability associated with the perimeters of the LSA (Figure 7).

The bird habitat richness model has not been tested for verification of habitat predictions, due to too few data. Instead, the predictions are based partly on oil sands area observations and represent a reasonable approach to the quantitative calculation of biodiversity at the habitat level.

6.1.2.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect bird richness habitat by removing 60% of the HUs present (Table 29). Forty-three percent of low, 49% of medium, and 64% of high quality habitat will be lost due to site clearing. The mean richness of the east bank mining area prior to development was 0.84, slightly higher than the mean for the TLSA. Thus, once removed the mean richness decreases to 0.75 within the remaining areas (and is zero within the mine area).

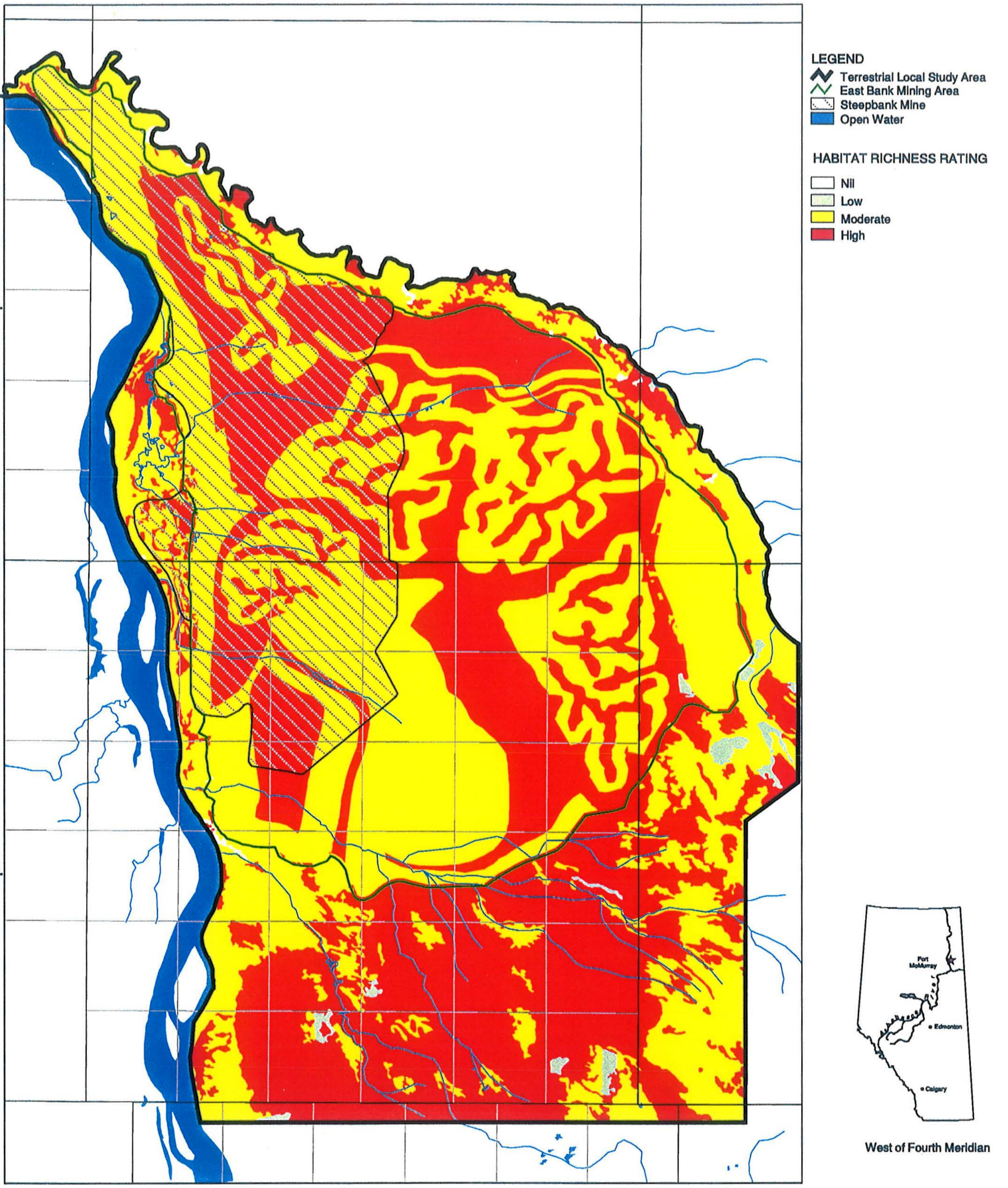
Table 29 LSA Bird Habitat Richness: Change From Predevelopment Under Impact and Closure Scenarios

Habitat Class	Predevelop-ment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	47	-3	-5.7	-20	-42.8	-18	-38.0
Med	3,347	-894	-26.7	-1,647	-49.2	+1,434	+42.8
High	9,602	-2,128	-22.2	-6,140	-63.9	-3,144	-32.7
Total	12,996	-3,024	-23.3	-7,807	-60.1	-1,728	-13.3

6.1.2.3 Closure Impacts

Bird richness habitat is expected to increase during reclamation, resulting in 1,728 HUs (13%) less than baseline conditions following closure. This is due to an overall loss of 38% (18 HUs) of low suitability habitat, a gain of 43% (1,434 HUs) of moderate suitability habitat, and a loss of 33% of high suitability habitat (3,144 HUs), relative to baseline conditions.

All of the vegetation types that will be reclaimed (Table 8) represent moderate to high suitability richness habitat for birds (Table 25). Although a variety of medium to high suitability habitats for bird richness will be reclaimed, bird richness habitat is expected decrease over baseline conditions following closure due to the loss of the relatively rich wooded bog and fen vegetation types (Table 29, Figure 10).



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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

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LOCAL STUDY AREA
BIRD HABITAT RICHNESS
CLOSURE SCENARIO

08 Apr. 1998

Figure 10

PRODUCED BY: CGA
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6.1.3 Reptile And Amphibian Richness

6.1.3.1 Baseline Conditions

The richness indices of the various ecosite phases within the LSA for reptile and amphibians is presented in Table 30 . High suitability habitat for reptile and amphibian richness within the LSA included the following ecosite phases:

- wooded bogs (BFNN, BTNN);
- wooded fens (FFNN, FTNN);
- graminoid fens (FONG);
- shrubby fens (FONS):
- swamps (SFNN, SONS, STNN); and
- shrubland (Shrub).

Habitat for reptiles and amphibians with no richness included gravel pits (AIG), roads (AIH), revegetated industrial lands (CIP), cutbanks (NMC), sand (NMS), lakes (NWL), and rivers (NWR).

Table 30 LSA Reptile and Amphibian Richness Index Vegetation Class Ratings

Habitat Richness Class	Phase	Description	Richness Index
High Richness (0.67 - 1.00)	BFNN	Wooded Bog (tree cover >70%)	1.00
	BTNN	Wooded Bog (tree cover >10% and ≤70%)	1.00
	FFNN	Wooded Fen (tree cover >70%)	1.00
	FONG	Graminoid Fen	1.00
	FONS	Shrubby Fen	1.00
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	1.00
	MONG	Graminoid Marsh	1.00
	MONS	Shrubby Marsh	1.00
	SFNN	Swamp (tree cover >70%)	1.00
	Shrub	Shrubland	1.00
	SONS	Swamp (deciduous shrub)	1.00
	STNN	Swamp (tree cover >10% and ≤70%)	1.00
Medium Richness (0.34 - 0.66)	a1	Lichen Pj	0.50
	b1	Blueberry Pj-Aw	0.50
	b2	Blueberry Aw(Bw)	0.50
	b3	Blueberry Aw-Sw	0.50
	b4	Blueberry Sw-Pj	0.50
	c1	Labrador Tea - Mesic Pj-Sb	0.50
	d1	Low-bush Cranberry Aw	0.50
	d2	Low-bush Cranberry Aw-Sw	0.50
	d3	Low-bush Cranberry Sw	0.50
	e1	Dogwood Pb-Aw	0.50
	e2	Dogwood Pb-Sw	0.50
	e3	Dogwood Sw	0.50
	g1	Labrador Tea - Subhygric Sb-Pj	0.50
	h1	Labrador Tea/Horsetail Sw-Sb	0.50
	Sb/Lt	Black Spruce - Larch Complexes	0.50
No Richness (0.00)	AIG	Gravel Pits	0.00
	AIH	Roads and Rights of Ways	0.00
	CIP	Revegetated Industrial Lands	0.00
	CIW	Well Sites - Vegetated	0.00
	HG/CC	Herbacious Graminoid Cutblock	0.00
	NMC	Cutbanks	0.00
	NMS	Sand	0.00
	NWF	Flooded Area	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow Open Water	0.00

Reptile and amphibian richness HUs by vegetation types are demonstrated in Table 31. At predevelopment conditions the vegetation types that contributed the most to reptile and amphibian richness included the FTNN, d1 and STNN types.

Table 31 LSA Reptile and Amphibian Richness Habitat Units: Predevelopment, Impact and Closure

Phase	Predevelopment (HU)	Steepbank Mine Impact (HU)	Steepbank Mine Impact (%)	East Bank Mining Area Impact (HU)	East Bank Mining Area Impact (%)	Closure (HU)	Closure Change From Predevelopment (HU)	Closure Change From Predevelopment (%)
a1	1	-1	-100.0	-1	-100.0	0	-1	-100.0
AIG	0	0	0.0	0	0.0	0	0	0.0
AIH	0	0	0.0	0	0.0	0	0	0.0
b1	113	-49	-43.1	-72	-63.9	131	+18	+15.5
b2	14	-13	-94.1	-14	-99.6	153	+139	+1,011.3
b3	30	-28	-95.1	-28	-95.1	437	+407	+1,367.0
b4	25	-18	-72.9	-25	-99.0	1	-24	-95.9
BFNN	26	0	0.0	0	0.0	26	0	0.0
BTNN	20	0	0.0	0	0.0	20	0	0.0
c1	1	-1	-100.0	-1	-100.0	0	-1	-100.0
CIP	0	0	0.0	0	0.0	0	0	0.0
CIW	0	0	0.0	0	0.0	0	0	0.0
d1	1,674	-462	-27.6	-890	-53.2	1,388	-286	-17.1
d2	294	-30	-10.2	-68	-23.0	1,362	+1,068	+363.3
d3	470	-106	-22.5	-157	-33.5	388	-82	-17.4
e1	106	-14	-13.3	-17	-16.4	1,031	+925	+873.6
e2	31	-8	-24.8	-7	-23.0	26	-5	-17.4
e3	64	-12	-19.5	-7	-10.9	195	+132	+206.6
FFNN	966	-262	-27.2	-547	-56.6	430	-537	-55.5
FONG	4	0	0.0	-3	-76.3	1	-3	-76.3
FONS	426	-110	-25.8	-325	-76.2	106	-320	-75.1
FTNN	6,010	-1,528	-25.4	-4,396	-73.1	1,657	-4,353	-72.4
g1	1	0	0.0	-1	-100.0	0	-1	-100.0
h1	30	-11	-36.2	-16	-53.4	16	-14	-46.4
HG/CC	0	0	0.0	0	0.0	0	0	0.0
MONG	107	-12	-11.3	-14	-12.8	370	+263	+246.4
MONS	211	-22	-10.4	-17	-8.3	194	-17	-7.9
NMC	0	0	0.0	0	0.0	0	0	0.0
NMR	0	0	0.0	0	0.0	0	0	0.0
NMS	0	0	0.0	0	0.0	0	0	0.0
NWF	0	0	0.0	0	0.0	0	0	0.0
NWL	0	0	0.0	0	0.0	0	0	0.0
NWR	0	0	0.0	0	0.0	0	0	0.0
Sb/Lt	10	0	0.0	-10	-100.0	0	-10	-100.0
SFNN	687	-51	-7.5	-378	-55.1	322	-365	-53.1
Shrub	131	-51	-38.9	-57	-43.7	155	+25	+18.8
SONS	161	-47	-29.4	-43	-26.6	839	+678	+421.1
STNN	1,359	-162	-11.9	-769	-56.6	634	-724	-53.3
WONN	0	0	0.0	0	0.0	0	0	0.0
Total	**12,971**	**-2,998**	**-23.1**	**-7,863**	**-60.6**	**9,884**	**-3,088**	**-23.8**

The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha within the LSA) for reptile and amphibian richness is 98% (12,971 HUs). Less than 1% of the unsuitable habitat consisted of water, while the remainder was composed of the other unsuitable types (Table 30).

Table 32 LSA Reptile and Amphibian Richness Indices and Habitat Units Summary

Scenario	Area (ha)	Percent of Area by Suitability Class							Habitat Units	Percent of Habitat Units by Suitability Class		
		Unsuitable Habitat			Suitable Habitat							
		Water	Other	Total	Low	Med	High	Total		Low	Med.	High
Predevelopment	16,181	0.7	1.4	2.1	0.0	35.4	62.5	97.9	12,971	0.0	22.1	77.9
Steepbank	3,776	0.2	0.4	0.7	0.0	39.8	59.5	99.3	2,998	0.0	25.1	74.9
East Bank Mine Impact	9,281	0.1	1.0	1.1	0.0	28.3	70.6	98.9	7,863	0.0	16.7	83.3
Remaining at Full Impact	6,901	1.5	2.1	3.6	0.0	45.6	52.3	97.9	5,108	0.0	30.3	69.7
Closure	16,181	6.3	0.9	7.2	0.0	63.4	29.4	92.8	9,884	0.0	51.9	48.1

Of the 12,971 HUs of reptile and amphibian richness habitat, the LSA is currently composed of no HUs (0%) of low quality habitat, 2,863 HUs (22%) of medium quality habitat, and 10,108 HUs (78%) of high quality habitat (Table 33). The mean suitability at predevelopment was 0.80. The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Reptile and amphibian richness habitat within the Steepbank mining area was composed of no HUs (0%) of low quality habitat, 752 HUs (25%) of medium quality habitat and 2,998 HUs (75%) of high quality habitat. The mean richness for the Steepbank mine was 0.79 or high prior to development.

Table 33 LSA Reptile and Amphibian Richness Habitat Units: Changes per Habitat Class for Impact and Closure Scenarios

Habitat Class	Predevelopment HU	Predevelopment %	Steepbank HU	Steepbank %	East Bank Mine Impact HU	East Bank Mine Impact %	Remaining at Impact HU	Remaining at Impact %	Closure HU	Closure %
Low	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Med	2,863	22.1	752	25.1	1,313	16.7	1,550	30.3	5,128	51.9
High	10,108	77.9	2,246	74.9	6,549	83.3	3,559	69.7	4,756	48.1
Total	12,971	100.0	2,998	100	7,863	100.0	5,108	100.0	9,884	100.0
Total Area	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.80		0.79		0.85		0.74		0.61	

Reptile and amphibian richness habitat within the mine impact area was composed of no HUs (0%) of low quality habitat, 1,313 HUs (17%) of medium quality habitat, and 6,549 HUs (83%) of high quality habitat (Table 33).

The majority of the LSA is rated as high suitability habitat for reptile and amphibian richness, with medium suitability habitat scattered around the perimeter (Figure 8).

The reptile and amphibian habitat richness model has not been tested for verification of habitat predictions, due to too few data. Instead, the predictions are based partly on oil sands area observations and represent a reasonable approach to the quantitative calculation of biodiversity at the habitat level.

6.1.3.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect reptile and amphibian richness habitat by removing 61% of the HUs present (Table 34). Zero percent of low, 46% of medium and 65% of high quality habitat will be lost due to site clearing. The mean richness of the east bank mining area prior to development was 0.85 (high). After mining, the areas outside of the mine have a mean richness of 0.74 and areas within the mine are 0.0.

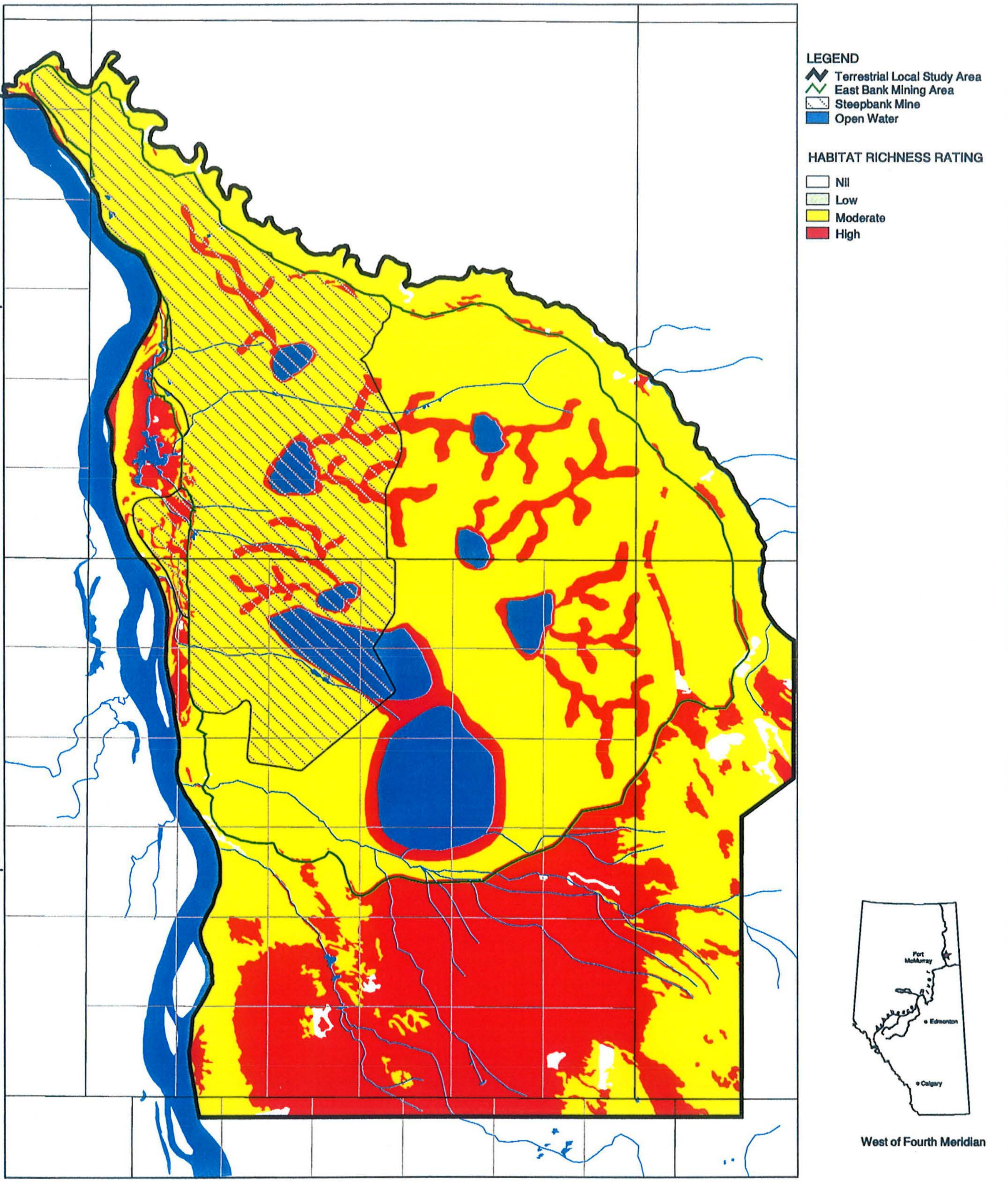
Table 34 LSA Reptile and Amphibian Habitat Richness: Change From Predevelopment Under Impact and Closure Scenarios

Habitat Class	Predevelop-ment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	0	0	0.0	0	0.0	0	0.0
Med	2,863	-752	-26.3	-1,313	-45.9	+2,265	+79.1
High	10,108	-2,246	-22.2	-6,549	-64.8	-5,352	-52.9
Total	12,971	-2,998	-23.1	-7,863	-60.6	-3,088	-23.8

6.1.3.3 Closure Impacts

Reptile and amphibian richness habitat is expected to increase by 37% during reclamation, resulting in 3,088 HUs (24%) less than baseline conditions following closure (Table 34).

All of these vegetation types that are projected to be reclaimed represent moderate to high suitability habitat, except for lakes (NWL) (Table 30). Although a variety of moderate to high suitability habitats for reptile and amphibian richness will be reclaimed, reptile and amphibian richness is expected to decrease as most wooded bogs and fens, with their high richness values, will not be reclaimed (Table 34, Figure 11).



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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

LOCAL STUDY AREA
REPTILE AND AMPHIBIAN HABITAT RICHNESS
CLOSURE SCENARIO

08 Apr. 1998

Figure 11

PRODUCED BY: CGA
REVIEWED BY:

6.2 BEAVER

6.2.1 Baseline Conditions

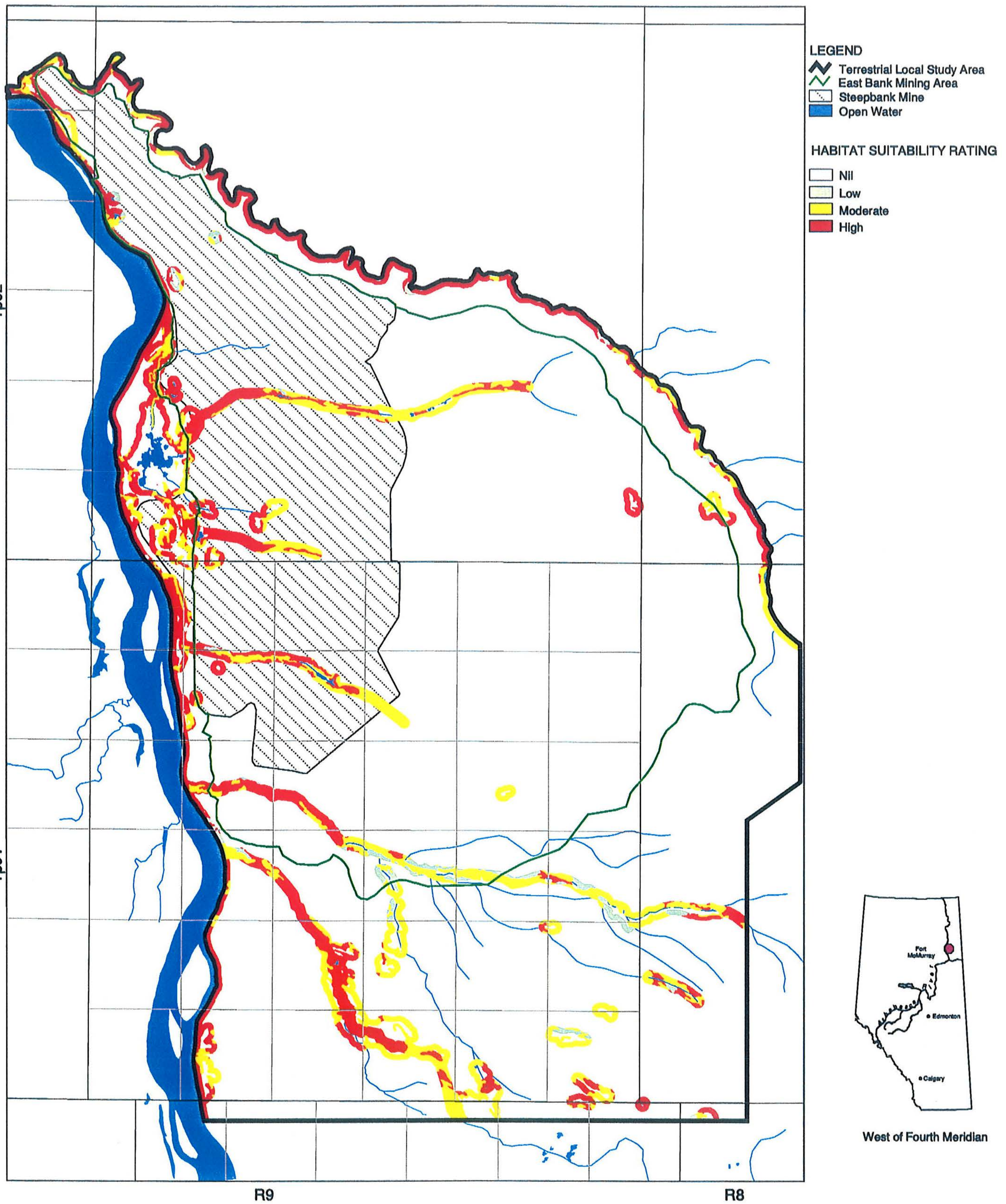
The suitability of the various vegetation phases within the LSA for beaver habitat is presented in Table 35 and the baseline habitat map is provided in Figure 12. High suitability habitat for beavers within the LSA included the following ecosite phases when close to water (i.e., <100 m):

- blueberry-trembling aspen (paper birch) (b2);
- low-bush cranberry-trembling aspen (d1);
- dogwood-balsam poplar-trembling aspen (e1);
- dogwood-balsam poplar-white spruce (e2);
- shrubby fen (FONS);
- shrubby marsh (MONS);
- shrubland (Shrub); and
- shrubby deciduous swamp (SONS).

Unsuitable habitat for beavers included graminoid marshes (MONG), lakes (NWL), rivers (NWR) and shallow open water (WONN). The water classes received low suitability scores as the beaver model was based on beaver food and cover supply, and not reproductive habitat.

Table 35 Beaver HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	b2	Blueberry Aw(Bw)	1.00
	d1	Low-bush Cranberry Aw	1.00
	e1	Dogwood Pb-Aw	1.00
	e2	Dogwood Pb-Sw	1.00
	FONS	Shrubby Fen	1.00
	MONS	Shrubby Marsh	1.00
	Shrub	Shrubland	1.00
	SONS	Swamp (deciduous shrub)	1.00
	d2	Low-bush Cranberry Aw-Sw	0.98
	b1	Blueberry Pj-Aw	0.85
Medium Suitability (0.34 - 0.66)	BFNN	Wooded bog (tree cover >70%)	0.63
	CC-OLD	Regrown Cutblocks at Closure	0.63
	HG/CC	Herbacious Graminoid Cutblock	0.60
	b3	Blueberry Aw-Sw	0.60
	NWF	Flooded Area	0.53
	FTNN	Wooded Fen (tree cover >10% and <=70%)	0.45
	e3	Dogwood Sw	0.43
	FFNN	Wooded Fen (tree cover >70%)	0.41
	Sb/Lt	Black Spruce - Larch Complexes	0.40
	d3	Low-bush Cranberry Sw	0.37
	STNN	Swamp (tree cover >10% and <=70%)	0.36
Low Suitability (0.01 - 0.33)	b4	Blueberry Sw-Pj	0.29
	SFNN	Swamp (tree cover >70%)	0.28
	AIH	Roads and Rights of Ways	0.27
	a1	Lichen Pj	0.19
	BTNN	Wooded bog (tree cover >10% and <=70%)	0.18
	h1	Labrador Tea/Horsetail Sw-Sb	0.17
	NMC	Cutbanks	0.13
	NMS	Sand	0.13
	AIG	Gravel Pits	0.11
	g1	Labrador Tea - subhygric Sb-Pj	0.10
	CIP	Revegetated Industrial Lands	0.07
	CIW	Well Sites - vegetated	0.07
	c1	Labrador Tea - mesic Pj-Sb	0.06
	FONG	Graminoid Fen	0.05
Unsuitable (0.00)	MONG	Graminoid Marsh	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow open water	0.00



SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

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Project Millennium
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LOCAL STUDY AREA
BEAVER HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998	Figure 12	PRODUCED BY: CGA REVIEWED BY: WB

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The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for beavers is 11% (1,273 HUs). Of the 89% which was considered unsuitable habitat, only 1% consisted of water (Table 36). Other habitat areas classified as unsuitable was distant from a water source (i.e., >100m).

Table 36 Percent of Area and Habitat Units by Suitability Class for Beaver Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class							Habitat Units	Percent of Habitat Units by Suitability Class		
		Unsuitable Habitat			Suitable Habitat							
		Water	Other	Total	Low	Med	High	Total		Low	Med.	High
Predevelopment	16,181	0.7	88.5	89.2	0.5	4.2	6.0	10.8	1,273	1.6	22.2	76.2
Steepbank	3,776	0.2	89.3	89.5	0.4	3.9	6.2	10.5	296	0.7	20.3	79.0
East Bank Mine Impact	9,281	0.1	93.8	93.9	0.1	2.8	3.2	6.1	414	0.0	25.9	74.1
Remaining at Full Impact	6,901	1.5	81.3	82.8	1.2	6.2	9.8	17.2	859	2.3	20.4	77.3
Closure	16,181	6.3	84.1	90.4	0.3	3.4	5.8	9.6	1,191	1.0	20.3	78.7

Of the 1,273 HUs of beaver habitat, the LSA is currently composed of 20 HUs (2%) of low quality habitat, 282 HUs (22%) of medium quality habitat, and 970 HUs (76%) of high quality habitat (Table 37). The mean suitability of the predevelopment TLSA (total HUs/total area) was 0.08 or low (Table 37). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Beaver habitat within the Steepbank mine area was composed of 2 HUs (1%) of low quality habitat, 60 HUs (20%) of medium quality habitat and 234 HUs (79%) of high quality habitat. The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for beavers is 11% (296 HUs). Of the 90% which was considered unsuitable habitat, 0% consisted of water (Table 36)

Table 37 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Beaver Habitat in the LSA

Habitat Class	Predevelopment HU	Predevelopment %	Steepbank HU	Steepbank %	East Bank Mine Impact HU	East Bank Mine Impact %	Remaining at Impact HU	Remaining at Impact %	Closure HU	Closure %
Low	20	1.6	2	0.7	0	0.0	20	2.3	12	1.0
Med	282	22.2	60	20.3	107	25.9	175	20.4	242	20.3
High	970	76.2	234	79.0	307	74.1	664	77.3	937	78.7
Total HUs	1,273	100.0	296	100.0	414	100.0	859	100.0	1,191	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.08		0.08		0.04		0.12		0.07	

Beaver habitat within the mine impact area was composed of 0 HUs (0%) of low quality habitat, 107 HUs (26%) of medium quality habitat, and 307

HUs (74%) of high quality habitat (Table 37). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for beavers is 6% (396 HUs). Of the 94% which was considered unsuitable habitat, <1% consisted of water (Table 36).

High suitability habitat for beavers was mainly seen along the various creeks and rivers along the perimeter of the LSA (Figure 12). These areas were associated with water and contained habitats comprised of aspen poplar and balsam poplar or shrubby fens, marshes or shrubland, preferred by beavers. Lower suitability or unsuitable habitat was seen in the middle of the LSA due to distance from water and the occurrence of graminoid fens and wooded swamps in this area (Figure 1).

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that beavers prefer relatively deep waterbodies near stands of early deciduous vegetation. As the LSA is dominated by coniferous bogs and fens, it was expected to provide generally poor habitat for beavers. Golder (1998n) did report that there were active beaver lodges on Shipyard Lake and along Unnamed Creek within the LSA. The habitat modelling supported these findings in that both Shipyard Lake and various creeks near the perimeter of the LSA contained high suitability habitat for beavers, while the majority of the LSA contained low or unsuitable habitat for beavers. Thus, the beaver model appears to performing as required.

6.2.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect beaver habitat by removing 33% of the HUs present (Table 38). Approximately 38% of moderate and 32% of high quality habitat will be lost due to site clearing.

Table 38 Summary of Changes in Beaver Habitat Units From Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	20	-2	-11.0	+0	+0.2	-8	-39.2
Med	282	-60	-21.3	-107	-37.9	-41	-14.3
High	970	-234	-24.1	-307	-31.6	-33	-3.4
Total	1,273	-296	-23.3	-414	-32.5	-81	-6.4

While beavers are somewhat resilient to human activities, they are limited by the distribution of aspen and willow for food and suitable aquatic habitat for protection and parts of their life cycle (Section D5.2 in Suncor 1998). Habitat loss, alteration and fragmentation from site clearing are expected to have a negative effect on beavers. Mitigation measures to reduce the effects of site clearing on habitat loss were discussed in Section D5.2 in Suncor (1998). Progressive reclamation and the phased nature of development will ensure that the actual mine impact will never fully disturb the entire mining area at any one time.

6.2.3 Closure Impacts

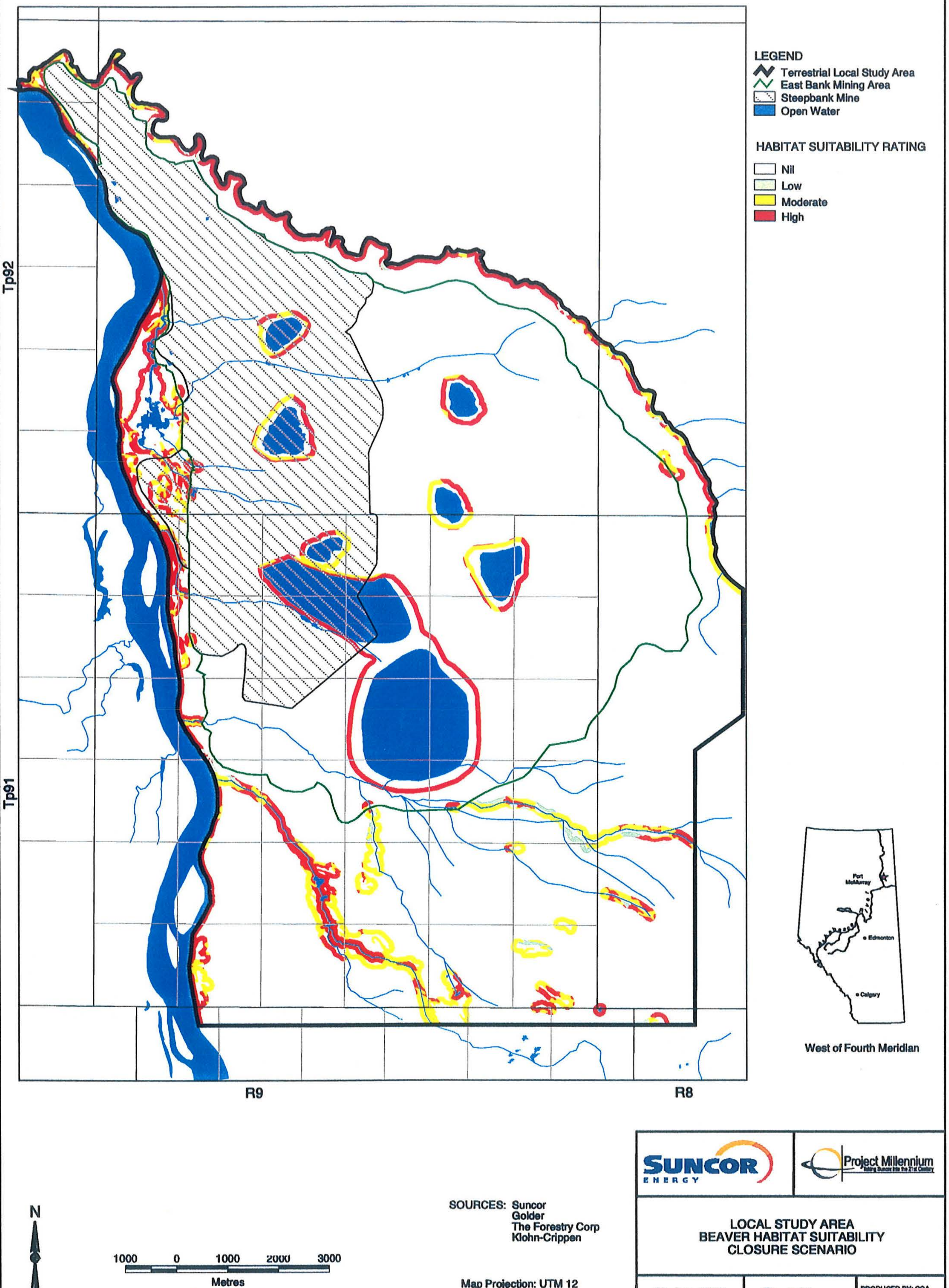
Beaver habitat is expected to increase by 26% during reclamation but still be 6% less than baseline conditions following closure. This is due to an overall loss of 8 HUs (39%) of low suitability habitat, 41 HUs (14%) of medium suitability habitat and 33 HUs (3%) of high suitability habitat (Table 38).

During closure, the mine footprint will be reclaimed to the following vegetation types (Table 8, Figure 3):

- low bush cranberry-trembling aspen-white spruce (d2);
- dogwood-balsam poplar-trembling aspen (e1);
- lake (NWL);
- blueberry-trembling aspen-white spruce (b3);
- shrubby deciduous swamp (SONS);
- blueberry-trembling aspen (paper birch) (b2);
- graminoid marsh (MONG);
- dogwood-white spruce (e3);
- blueberry-jack pine-trembling aspen (b1); and
- shrubland (Shrub).

With regard to beavers, all of these habitat types represent medium to high suitability except for graminoid marshes and lakes (Table 35). This was due to the fact that in the model, lakes and marshes are unsuitable for food habitat. Few of the above vegetation types actually occur in proximity to water. Thus, beaver habitat is expected to decrease over baseline conditions following closure. The constructed wetlands and areas of deciduous forest surrounding areas of open water were determined to provide the most suitable habitat for beaver (Figures 3 and 13).

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for beavers would include reclaiming deciduous vegetation in proximity to waterbodies.



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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

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Project Millennium

LOCAL STUDY AREA
BEAVER HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998

Figure 13

PRODUCED BY: CGA
REVIEWED BY: WB

6.3 BLACK BEAR

6.3.1 Baseline Conditions

The suitability of the various ecosite phases within the LSA for black bear habitat is presented in Table 39 and the baseline habitat map is shown in Figure 14. High suitability habitat for black bears within the LSA included the following ecosite phases:

- low-bush cranberry-trembling aspen (d1);
- low-bush cranberry-trembling aspen-white spruce (d2);
- blueberry-jack pine-trembling aspen (b1);
- shrubland (Shrub);
- blueberry-white spruce-jack pine (b4);
- lichen jack pine (a1);
- blueberry-trembling aspen-white spruce (b3);
- dogwood balsam poplar-trembling aspen (e1);
- low-bush cranberry white spruce (d3);
- Labrador tea-mesic jack pine-black spruce (c1); and
- Labrador tea-subhygric black spruce-jack pine (g1).

Unsuitable habitat for black bears included graminoid marshes (MONG), lakes (NWL), rivers (NWR), and shallow open water (WONN).

Table 39 Black Bear HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	d1	Low-bush Cranberry Aw	0.92
	d2	Low-bush Cranberry Aw-Sw	0.89
	b1	Blueberry Pj-Aw	0.85
	Shrub	Shrubland	0.85
	b4	Blueberry Sw-Pj	0.83
	a1	Lichen Pj	0.82
	b3	Blueberry Aw-Sw	0.80
	e1	Dogwood Pb-Aw	0.79
	d3	Low-bush Cranberry Sw	0.78
	c1	Labrador Tea - mesic Pj-Sb	0.78
	g1	Labrador Tea - subhygric Sb-Pj	0.78
	e2	Dogwood Pb-Sw	0.77
	b2	Blueberry Aw(Bw)	0.71
Medium Suitability (0.34 - 0.66)	Sb/Lt	Black Spruce - Larch Complexes	0.64
	e3	Dogwood Sw	0.62
	SONS	Swamp (deciduous shrub)	0.57
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.54
	FFNN	Wooded Fen (tree cover >70%)	0.53
	h1	Labrador Tea/Horsetail Sw-Sb	0.49
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.47
	BFNN	Wooded bog (tree cover >70%)	0.45
	FONS	Shrubby Fen	0.40
	CC-OLD	Regrown Cutblocks at Closure	0.35
Low Suitability (0.01 - 0.33)	STNN	Swamp (tree cover >10% and ≤70%)	0.32
	SFNN	Swamp (tree cover >70%)	0.31
	MONS	Shrubby Marsh	0.19
	NWF	Flooded Area	0.18
	AIH	Roads and Rights of Ways	0.11
	HG/CC	Herbacious Graminoid Cutblock	0.10
	AIG	Gravel Pits	0.09
	NMC	Cutbanks	0.02
	NMS	Sand	0.02
	FONG	Graminoid Fen	0.01
	CIP	Revegetated Industrial Lands	0.01
	CIW	Well Sites - vegetated	0.01
Unsuitable (0.00)	MONG	Graminoid Marsh	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow open water	0.00

The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for black bears is 99% (6,869 HUs). Of the 1% which was considered unsuitable habitat, half consisted of water (Table 40). Other habitat classified as unsuitable was the graminoid marsh type. The mean suitability of the LSA (total HUS/total area) was 0.42 (medium).

Table 40 Percent of Area and Habitat Units by Suitability Class for Black Bear Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med.	High
Predevelopment	16,181	0.7	0.7	1.4	26.9	59.1	12.6	98.6	6,869	16.1	57.0	26.9
Steepbank	3,776	0.2	0.4	0.6	19.6	68.5	11.3	99.4	1,644	11.2	65.1	23.7
East Bank Mine Impact	9,281	0.1	0.1	0.3	21.6	67.3	10.9	99.7	3,944	13.1	63.5	23.4
Remaining at Full Impact	6,901	1.5	1.4	2.8	34.0	48.1	15.0	97.2	2,925	20.2	48.2	31.6
Closure	16,181	6.3	2.3	8.6	15.4	36.4	39.6	91.4	8,726	7.3	30.7	62.1

Of the 6,869 HUs of black bear habitat, the LSA is currently composed of 1,107 HUs (16%) of low quality habitat, 3,915 HUs (57%) of medium quality habitat, and 1,847 HUs (27%) of high quality habitat (Table 41). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Black bear habitat within the Steepbank mining area was composed of 184 HUs (11%) of low quality habitat, 1,070 HUs (65%) of medium quality habitat, and 390 HUs (24%) of high quality habitat (Table 41). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for black bears is 99% (1,644 HUs). Of the 1% which was considered unsuitable habitat, <1% consisted of water.

Table 41 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Black Bear Habitat in the LSA

Habitat Class	Predevelopment HU	Predevelopment %	Steepbank HU	Steepbank %	East Bank Mine Impact HU	East Bank Mine Impact %	Remaining at Impact HU	Remaining at Impact %	Closure HU	Closure %
Low	1,107	16.1	184	11.2	517	13.1	590	20.2	635	7.3
Med	3,915	57.0	1,070	65.1	2,504	63.5	1,410	48.2	2,675	30.7
High	1,847	26.9	390	23.7	923	23.4	925	31.6	5,416	62.1
Total HUs	6,869	100.0	1,644	100.0	3,944	100.0	2,925	100.0	8,726	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.42		0.44		0.42		0.42		0.54	

Black bear habitat within the mine impact area was composed of 517 HUs (13%) of low quality habitat, 2,504 HUs (64%) of medium quality habitat, and 923 HUs (23%) of high quality habitat (Table 41). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for black bears is 100% (3,919 HUs). Of the <1% which was considered unsuitable habitat, approximately half consisted of water (Table 40).

High suitability habitat for black bears was mainly seen along the outer perimeters of the LSA (Figure 14). These areas were associated with the low-bush cranberry deciduous and mixedwood forests, preferred by black bears. Lower suitability or unsuitable habitat was seen in the middle of the LSA due to the occurrence of graminoid fens and wooded swamps in this area.

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that black bears prefer deciduous stands due to the higher diversity of food shrub species. As the LSA is dominated by coniferous bogs and fens, it was expected to provide generally poor habitat for black bears.

6.3.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect black bear habitat by removing 57% of the HUs present (Table 42). Forty-seven percent of low, 64% of medium, and 50% of high quality habitat will be lost due to site clearing.

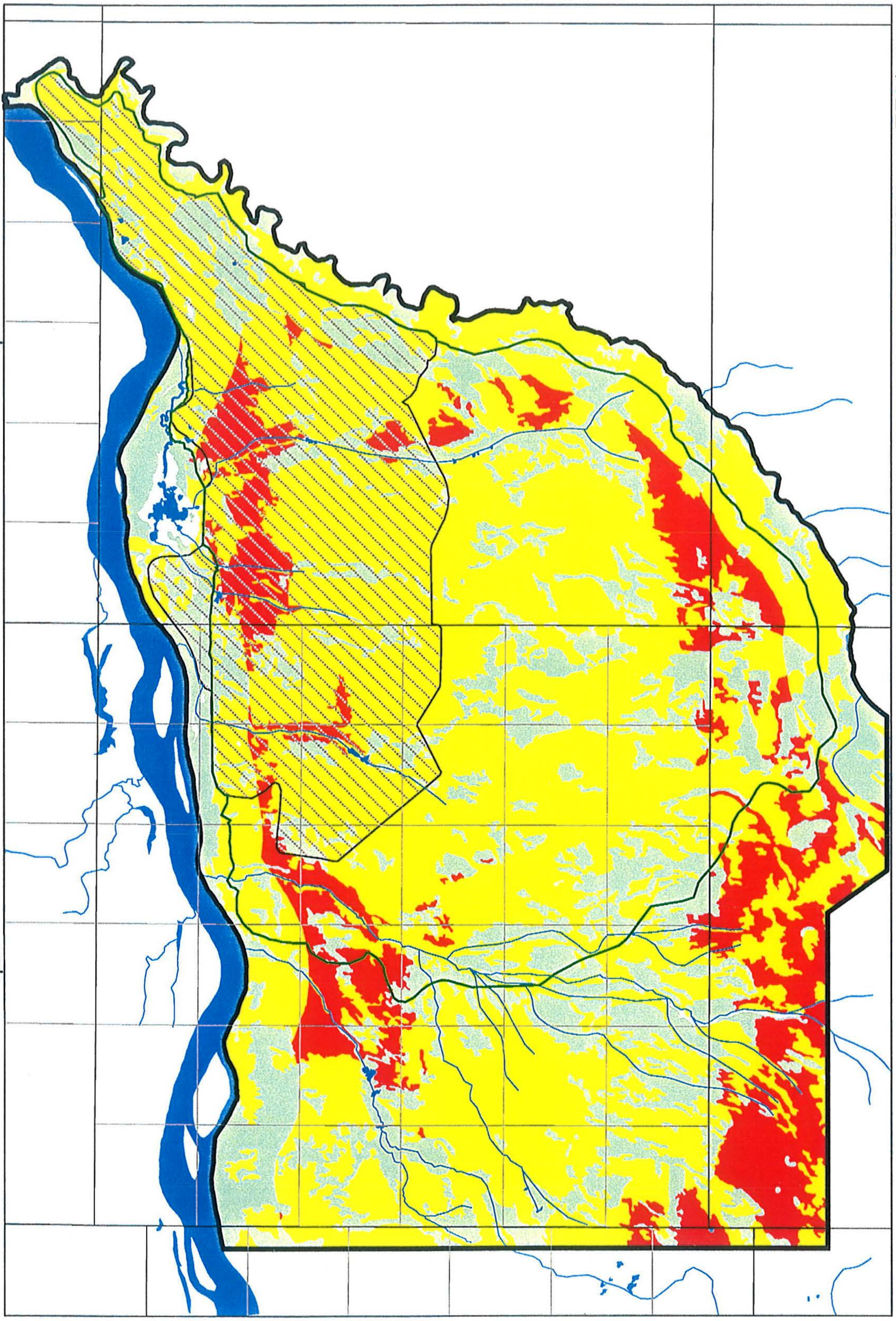
Table 42 Summary of Changes in Black Bear Habitat Units from Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	1,107	-184	-16.6	-517	-46.7	-472	-42.6
Med	3,915	-1,070	-27.3	-2,504	-64.0	-1,240	-31.7
High	1,847	-390	-21.1	-923	-49.9	+3,569	+193.2
Total	6,869	-1,644	-23.9	-3,944	-57.4	+1,857	+27.0

The effects of habitat loss, alteration and fragmentation can be expected to displace bears from otherwise suitable habitat (Section D5.2 in Suncor 1998). The displacement of bears from preferred habitat may have negative consequences on their long-term survival due to loss of familiar home ranges, displacement from preferred denning sites, and reduced reproductive success to due to nutritional stress. Mitigation measures to reduce the effects of site clearing on habitat loss were discussed in Section D5.2 in Suncor (1998). Progressive reclamation and the phased nature of development will ensure that the actual mine impact will never fully disturb the entire mining area at any one time.

6.3.3 Closure

Black bear habitat is expected to increase by 84% during reclamation, resulting in 1,857 HUs (27%) over baseline conditions following closure



LEGEND

- Terrestrial Local Study Area
- East Bank Mining Area
- Steepbank Mine
- Open Water

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

West of Fourth Meridian

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SOURCES: Suncor
Golder
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Map Projection: UTM 12
Datum: NAD 83

LOCAL STUDY AREA
BLACK BEAR HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998	Figure 14	PRODUCED BY: CGA REVIEWED BY: WB

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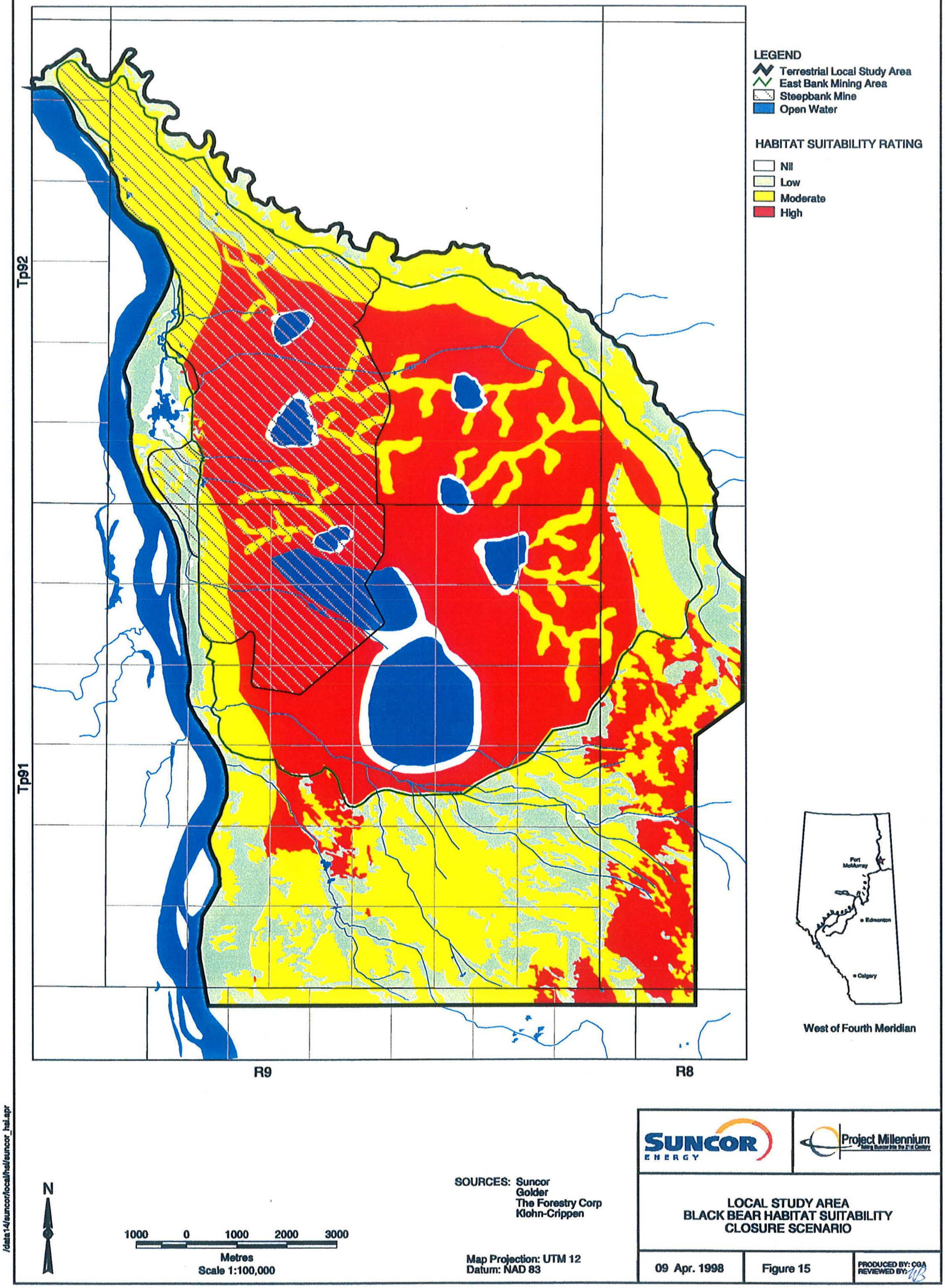
(Figure 15). This is due to an overall gain of 3,569 HUs (193%) of high suitability habitat (Table 42).

During closure, the mine footprint will be reclaimed to the following vegetation types (Table 8, Figure 3):

- low bush cranberry-trembling aspen-white spruce (d2);
- dogwood-balsam poplar-trembling aspen (e1);
- lakes (NWL);
- blueberry-trembling aspen-white spruce (b3);
- shrubby deciduous swamp (SONS);
- blueberry-trembling aspen (paper birch) (b2);
- graminoid marsh (MONG);
- dogwood-white spruce (e3);
- blueberry-jack pine-trembling aspen (b1); and
- shrubland (Shrub).

With regard to black bears, all of these habitat types represent medium to high suitability except for graminoid marshes and lakes (Table 39). Thus, black bear habitat is expected to increase over baseline conditions following closure. The low-bush cranberry mixedwood (d2), the blueberry-jack pine-trembling aspen (b1), and the shrubland (shrub) were determined to provide the most suitable habitat for black bears (Figures 3, 15).

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). No further modifications are required to improve the habitat value for black bears.



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SOURCES: Suncor
Golder
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Map Projection: UTM 12
Datum: NAD 83

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LOCAL STUDY AREA
BLACK BEAR HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998

Figure 15

PRODUCED BY: CGA
REVIEWED BY:

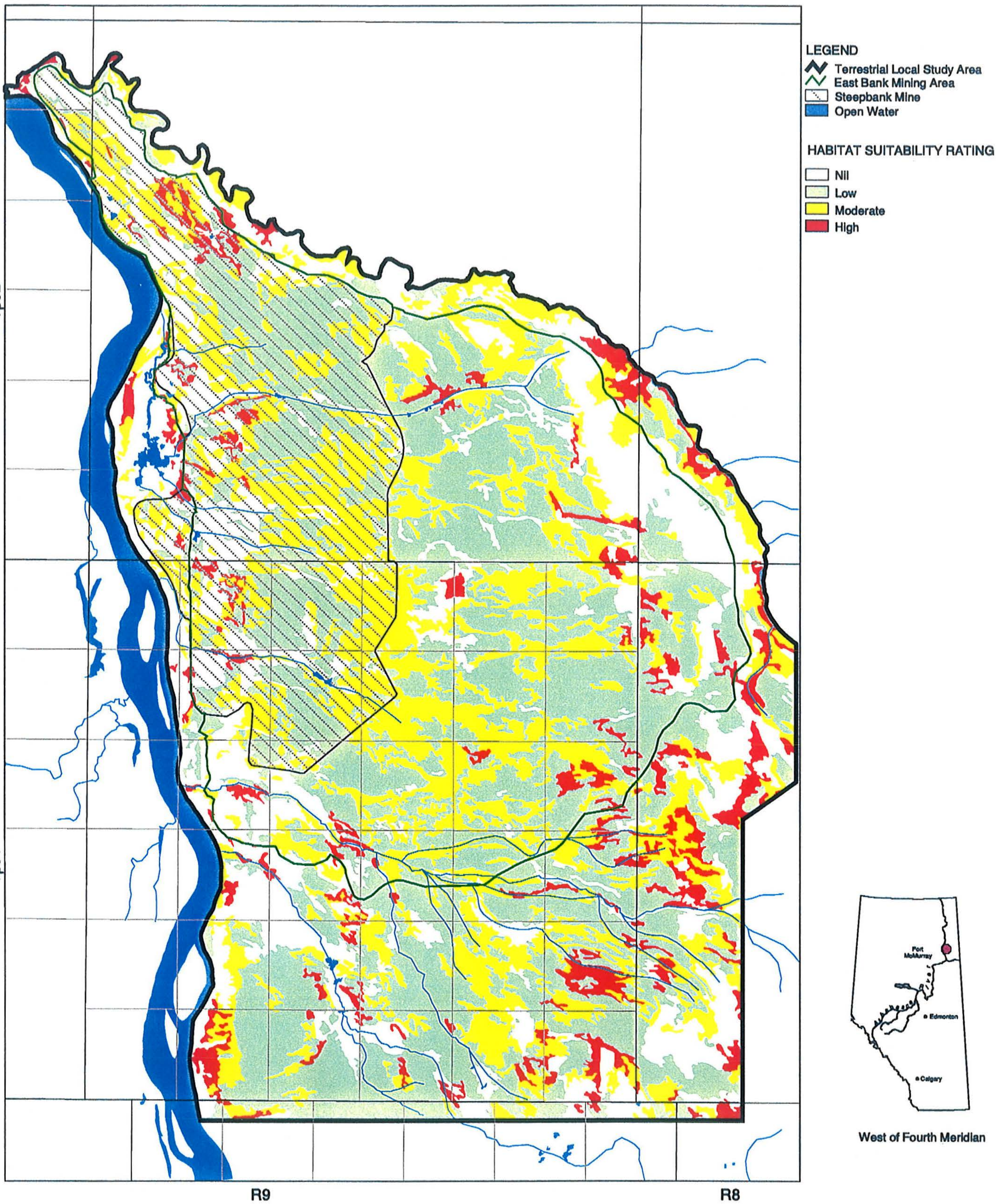
6.4 CAPE MAY WARBLER

6.4.1 Baseline Conditions

The suitability of the various ecosite phases within the LSA for Cape May warbler habitat is presented in Table 43 and the habitat map is shown in Figure 16. High suitability habitat for Cape May warblers within the LSA included the following ecosite phases:

- low-bush cranberry-white spruce (d3);
- dogwood-white spruce (e3); and
- blueberry-trembling aspen-white spruce (b3).

Unsuitable habitat for Cape May warblers included a range of vegetation types from graminoid marshes (MONG), lakes (NWL), rivers (NWR), and shallow open water (WONN) to well sites (CIW), gravel pits (AIG), and dogwood-balsam poplar-trembling aspen (e1).



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Metres
Scale 1:100,000

SOURCES: Suncor
Golder
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Map Projection: UTM 12
Datum: NAD 83

LOCAL STUDY AREA
CAPE MAY WARBLER HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998

Figure 16

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REVIEWED BY: WB

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Table 43 Cape May Warbler HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	d3	Low-bush Cranberry Sw	0.85
	e3	Dogwood Sw	0.85
	b3	Blueberry Aw-Sw	0.82
Medium Suitability (0.34 - 0.66)	c1	Labrador Tea - mesic Pj-Sb	0.64
	b4	Blueberry Sw-Pj	0.52
	a1	Lichen Pj	0.51
	h1	Labrador Tea/Horsetail Sw-Sb	0.50
	g1	Labrador Tea - subhygric Sb-Pj	0.48
	STNN	Swamp (tree cover >10% and ≤70%)	0.48
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.46
	Sb/Lt	Black Spruce - Larch Complexes	0.45
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.40
Low Suitability (0.01 - 0.33)	CC-OLD	Regrown Cutblocks at Closure	0.30
	b1	Blueberry Pj-Aw	0.27
	d2	Low-bush Cranberry Aw-Sw	0.26
	e2	Dogwood Pb-Sw	0.26
	SFNN	Swamp (tree cover >70%)	0.24
	BFNN	Wooded bog (tree cover >70%)	0.21
	FFNN	Wooded Fen (tree cover >70%)	0.20
	FONS	Shrubby Fen	0.03
	d1	Low-bush Cranberry Aw	0.01
Unsuitable (0.00)	e1	Dogwood Pb-Aw	0.00
	b2	Blueberry Aw(Bw)	0.00
	AIG	Gravel Pits	0.00
	AIH	Roads and Rights of Ways	0.00
	CIP	Revegetated Industrial Lands	0.00
	CIW	Well Sites - vegetated	0.00
	FONG	Graminoid Fen	0.00
	HG/CC	Herbacious Graminoid Cutblock	0.00
	MONG	Graminoid Marsh	0.00
	MONS	Shrubby Marsh	0.00
	NMC	Cutbanks	0.00
	NMS	Sand	0.00
	NWF	Flooded Area	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	Shrub	Shrubland	0.00
	SONS	Swamp (deciduous shrub)	0.00
	WONN	Shallow open water	0.00

The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for Cape May warblers is 75% (4,556 HUs). The mean suitability of the LSA (total HUs/total area).

Table 44 Percent of Area and Habitat Units by Suitability Class for Beaver Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med.	High
Predevelopment	16,181	0.7	23.9	24.6	41.8	26.8	6.8	75.4	4,556	27.8	51.0	21.1
Steepbank	3,776	0.2	24.1	24.3	37.4	34.1	4.2	75.7	1,096	24.9	62.1	13.0
East Bank Mine Impact	9,281	0.1	20.5	20.7	44.7	30.5	4.2	79.3	2,641	30.9	56.6	12.4
Remaining at Full Impact	6,901	1.5	28.5	29.9	37.9	21.9	10.2	70.1	1,915	23.6	43.2	33.2
Closure	16,181	6.3	32.4	38.7	38.8	10.0	12.5	61.3	3,717	29.8	23.7	46.5

Of the 4,556 HUs of Cape May warbler habitat, the LSA is currently composed of 1,269 HUs (28%) of low quality habitat, 2,234 HUs (51%) of medium quality habitat and 963 HUs (21%) of high quality habitat (Table 45). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Cape May warbler habitat within the Steepbank mining area was composed of 272 HUs (25%) of low quality habitat, 681 HUs (62%) of medium quality habitat, and 142 HUs (13%) of high quality habitat (Table 45). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for Cape May warblers is 76% (1,096 HUs).

Table 45 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Cape May Warbler Habitat in the LSA

Habitat Class	Predevelopment HU	%	Steepbank HU	%	East Bank Mine Impact HU	%	Remaining at Impact HU	%	Closure HU	%
Low	1,269	27.8	272	24.9	817	30.9	452	23.6	1,107	29.8
Med	2,324	51.0	681	62.1	1,496	56.6	828	43.2	881	23.7
High	963	21.1	142	13.0	328	12.4	635	33.2	1,729	46.5
Tota HUsl	4,556	100.0	1,096	100.0	2,641	100.0	1,915	100.0	3,717	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.28		0.29		0.28		0.28		0.23	

Cape May warbler habitat within the mine impact area was composed of 817 HUs (31%) of low quality habitat, 1,496 HUs (57%) of medium quality habitat, and 328 HUs (12%) of high quality habitat (Table 45). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for Cape May warblers is 79% (2,641 HUs). Of the 21% which was considered unsuitable habitat, <1% consisted of water (Table 44).

High suitability habitat for Cape May warblers was scattered in various pockets around the perimeter of the LSA (Figure 16). These areas were associated the white spruce forests, preferred by Cape May warblers. Lower suitability or unsuitable habitat was seen in the middle of the LSA due to the occurrence of graminoid fens and wooded swamps in this area.

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that Cape May warblers prefer late stage coniferous stands, consisting mainly of white spruce with good canopy closure. As the LSA is dominated by coniferous bogs and fens, it was expected to provide generally poor habitat for Cape May warblers.

A comparison of the HIS model predictions with field data (Appendix V) was limited due to the small number of Cape May warblers observed (n=5).

6.4.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect Cape May warbler habitat by removing 58% of the HUs present (Table 46). Sixty-four percent of low, 64% of medium, and 34% of high quality habitat will be lost due to site clearing.

Table 46 Summary of Changes in Cape May Warbler Habitat Units From Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	1,269	-272	-21.5	-817	-64.4	-162	-12.8
Med	2,324	-681	-29.3	-1,496	-64.4	-1,443	-62.1
High	963	-142	-14.8	-328	-34.1	+766	+79.5
Total	4,556	-1,096	-24.0	-2,641	-58.0	-839	-18.4

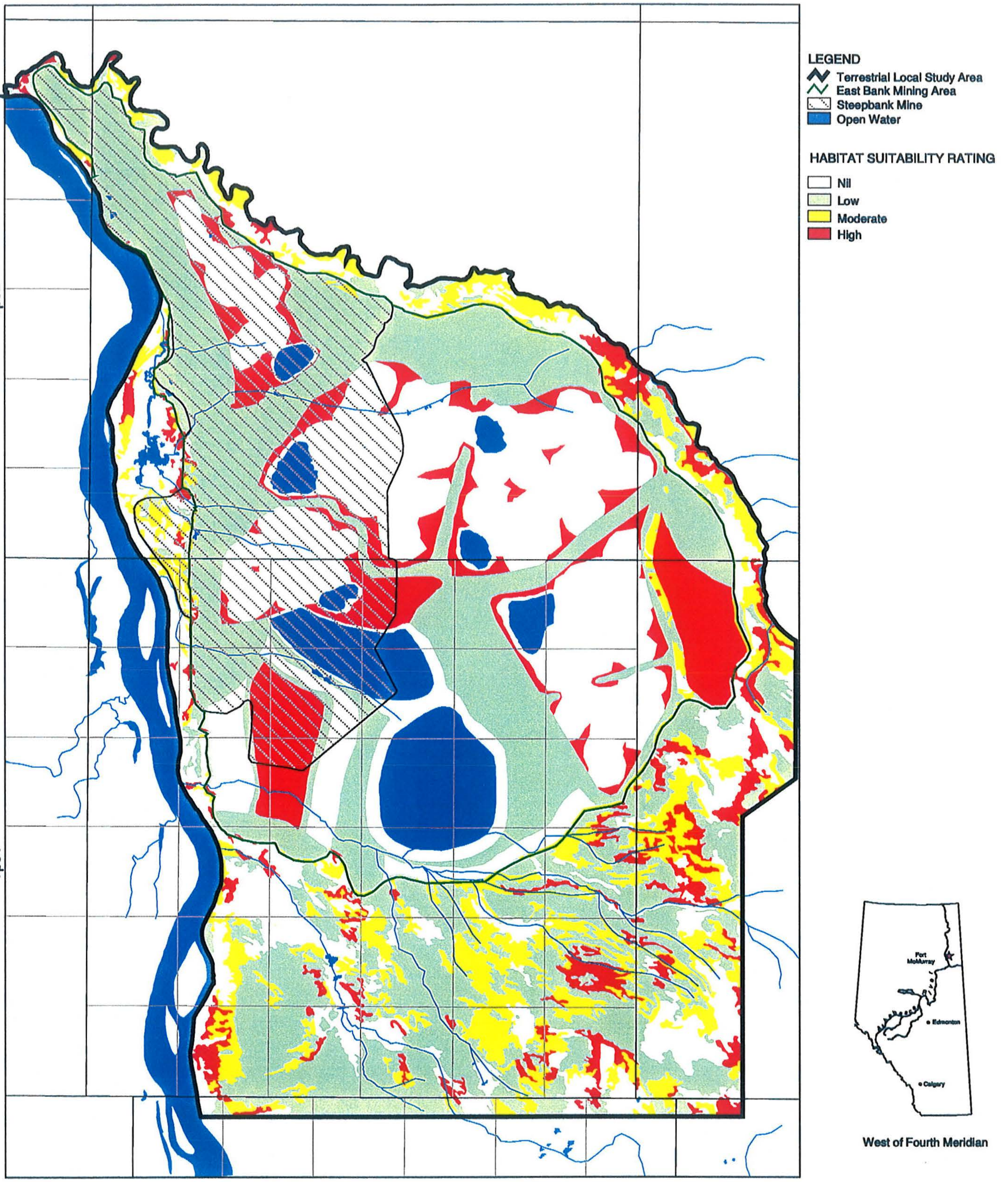
Since old growth white spruce forest is limited within the LSA, any loss of habitat will affect Cape May warblers. The effects of habitat loss, alteration and fragmentation can be expected to displace Cape May warblers from otherwise suitable habitat (Section D5.2 in Suncor 1998). In particular, habitat loss and fragmentation expose migratory birds to a number of impacts, including increased competition for nest sites, predators, and cowbird parasitism.

6.4.3 Closure

Cape May warbler habitat is expected to increase by 40% during reclamation, but still be less than 839 HUs (18%) over baseline conditions following closure (Table 46, Figure 17). This is due to an overall loss of 1,443 HUs (62%) of medium suitability habitat and gains of 766 HUs (80%) of high suitability habitat.

Vegetation types that will be reclaimed on the mine site (Figure 3) represent low to unsuitable habitat except for dogwood-white spruce (e3) and blueberry-trembling aspen-white spruce (b3) (Table 43). These areas of high suitability will mainly occur in thin bands around the dogwood-balsam poplar-trembling aspen vegetation types (Figure 3, 17). A fairly large patch of suitable habitat will also occur in the southwest corner of the reclaimed area. However, overall, Cape May warbler habitat is expected to decrease over baseline conditions following closure.

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for Cape May warblers would include reclaiming additional areas of white spruce habitat.



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SOURCES: Suncor
Golder
The Forestry Corp
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Map Projection: UTM 12
Datum: NAD 83

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LOCAL STUDY AREA
CAPE MAY WARBLER HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998

Figure 17

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6.5 DABBLING DUCKS

6.5.1 Baseline Conditions

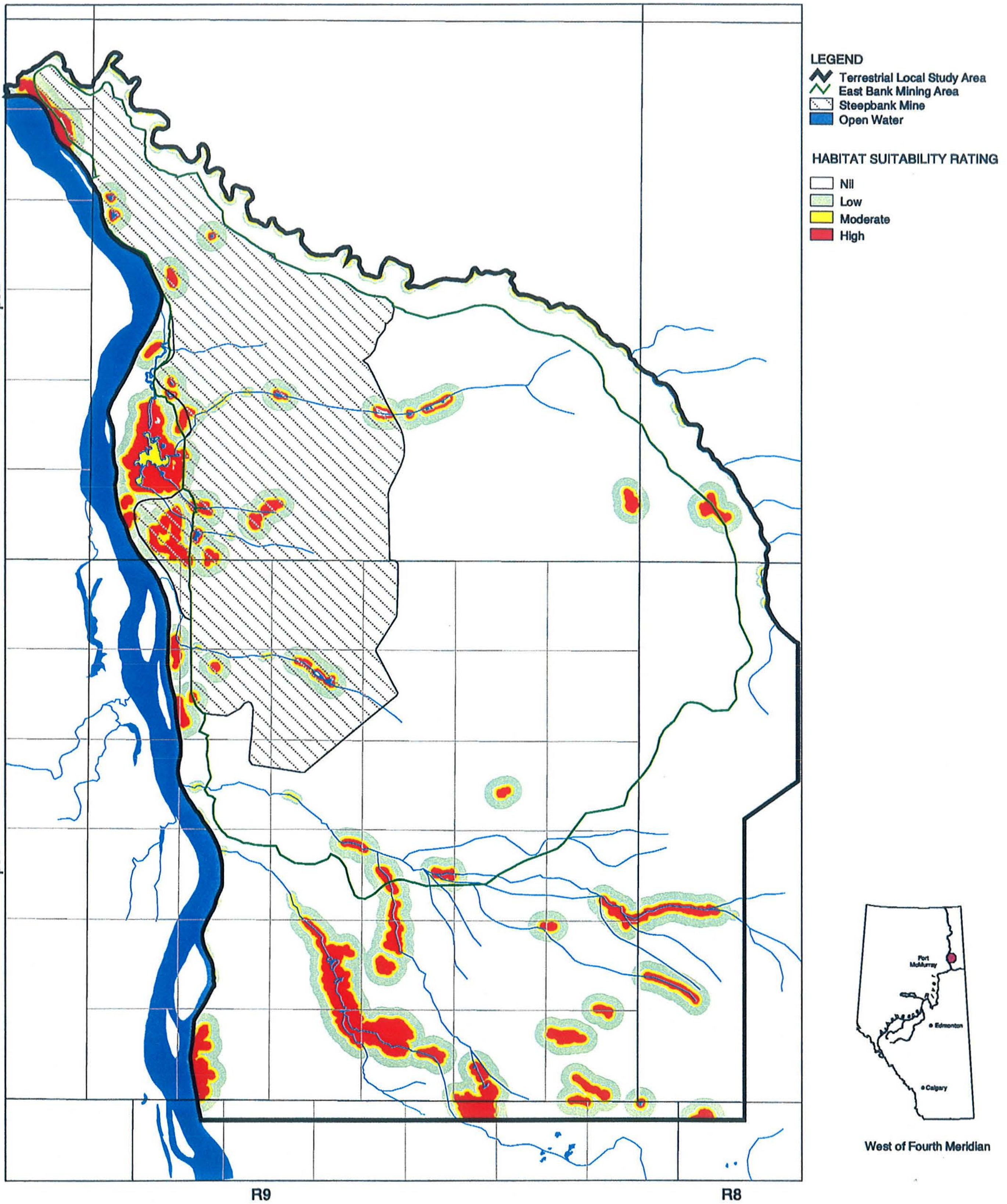
The suitability of the various ecosite phases within the LSA for dabbling duck habitat is presented in Table 47 and Figure 18. High suitability habitat for dabbling ducks within the LSA included the following ecosite phases:

- marshes; and
- vegetated areas adjacent to ponds, lakes, and marshes;

Unsuitable habitat for dabbling ducks included a range of vegetation types from upland vegetation types to disturbed areas to other vegetated areas which were not in proximity to water. As well, rivers and creeks with a high degree of stream gradient were not considered to be suitable habitat.

Table 47 Dabbling Ducks HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Habitat Type	Distance From Habitat Type	HSI
High Suitability	Marshes	Within Type	1.00
(0.67 - 1.00)	Vegetated Areas Adjacent to Ponds, Lakes, Marshes	0 - 50 m	1.00
Medium Suitability	Lakes and Ponds	Within Type	0.66
(0.34 - 0.66)	Vegetated Areas Adjacent to Ponds, Lakes, Marshes	50 - 100 m	0.66
	Vegetated Areas Adjacent to Rivers and Streams < 5 degree gradient	0 - 50 m	0.66
Low Suitability	Rivers and Creeks < 5 degree stream gradient	Within Type	0.33
(0.01 - 0.33)	Vegetated Areas Adjacent to Ponds, Lakes, Marshes	100 - 250 m	0.33
	Vegetated Areas Adjacent to Rivers and Streams < 5 degree gradient	50 - 100 m	0.33
Unsuitable	Upland Forests, Shrublands and Meadows	Within Type	0.00
(0.00)	Disturbed Areas	Within Type	0.00
	Bogs, Swamps and Fens	Within Type	0.00
	Rivers and Creeks > 5 degree stream gradient	Within Type	0.00
	Vegetated Areas Adjacent to Ponds, Lakes, Marshes	> 250 m	0.00
	Vegetated Areas Adjacent to Rivers and Streams < 5 degree gradient	> 100 m	0.00
	Vegetated Areas Adjacent to Rivers and Stream > 5 degree gradient	All distances	0.00



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SOURCES: Suncor
Golder
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Map Projection: UTM 12
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LOCAL STUDY AREA
DABBLING DUCKS HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998

Figure 18

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The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for dabbling ducks is 17% (1,552 HUs). Of the 83% all was habitat too far from open water to be available for use (Table 48).

Table 48 Percent of Area and Habitat Units by Suitability Class for Dabbling Duck Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med.	High
Predevelopment	16,181	0.0	82.9	82.9	9.5	3.2	4.4	17.1	1,552	32.8	21.8	45.4
Steepbank	3,776	0.0	82.6	82.6	10.9	3.2	3.3	17.4	339	40.0	23.6	36.4
East Bank Mine Impact	9,281	0.0	90.8	90.8	6.1	1.7	1.4	9.2	438	43.5	24.0	32.6
Remaining at Full Impact	6,901	0.0	72.3	72.3	14.2	5.2	8.3	27.7	1,114	28.6	20.9	50.5
Closure	16,181	0.0	74.5	74.5	10.3	9.0	6.2	25.5	2,516	21.7	38.1	40.1

Of the 1,552 HUs of dabbling duck habitat, the LSA is currently composed of 509 HUs (33%) of low quality habitat, 338 HUs (22%) of medium quality habitat, and 705 HUs (45%) of high quality habitat (Table 49). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Dabbling duck habitat within the Steepbank mining area was composed of 136 HUs (40%) of low quality habitat, 80 HUs (24%) of medium quality habitat, and 123 HUs (36%) of high quality habitat (Table 49). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for dabbling ducks is 17% (339 HUs). Of the 83% which was considered unsuitable habitat, none (0%) consisted of water (Table 48).

Table 49 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Dabbling Duck Habitat in the LSA

Habitat Class	Predevelopment HU	%	Steepbank HU	%	East Bank Mine Impact HU	%	Remaining at Impact HU	%	Closure HU	%
Low	509	32.8	136	40.0	190	43.5	319	28.6	547	21.7
Med	338	21.8	80	23.6	105	24.0	233	20.9	959	38.1
High	705	45.4	123	36.4	142	32.6	563	50.5	1,010	40.1
Total HUs	1,552	100.0	339	100.0	438	100.0	1,114	100.0	2,516	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.10		0.09		0.05		0.16		0.16	

Dabbling duck habitat within the mine impact area was composed of 190 HUs (44%) of low quality habitat, 105 HUs (24%) of medium quality habitat and 142 HUs (33%) of high quality habitat (Table 49). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for dabbling ducks is 9% (438 HUs). Of the 91% which was considered unsuitable habitat, none(0%) consisted of water (Table 48).

High suitability habitat for dabbling ducks was scattered in various pockets around the lakes and creeks of the LSA (Figure 18). Lower suitability or unsuitable habitat was seen in the middle of the LSA due to the occurrence of graminoid fens and wooded swamps in this area (Figure 1).

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that dabbling ducks prefer emergent vegetation edge combined with shrub habitat in the vicinity of water edge. As the LSA is dominated by coniferous bogs and fens, with few suitable waterbodies, it was expected to provide generally poor habitat for dabbling ducks.

6.5.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect dabbling duck habitat by removing 28% of the HUs present (Table 50). Thirty-seven percent of low, 31% of medium, and 20% of high quality habitat will be lost due to site clearing.

Table 50 Summary of Changes in Dabbling Duck Habitat Units from Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	509	-136	-26.6	-190	-37.4	+38	+7.4
Med	338	-80	-23.7	-105	-31.1	+622	+184.1
High	705	-123	-17.5	-142	-20.2	+304	+43.2
Total	1,552	-339	-21.8	-438	-28.2	+964	+62.1

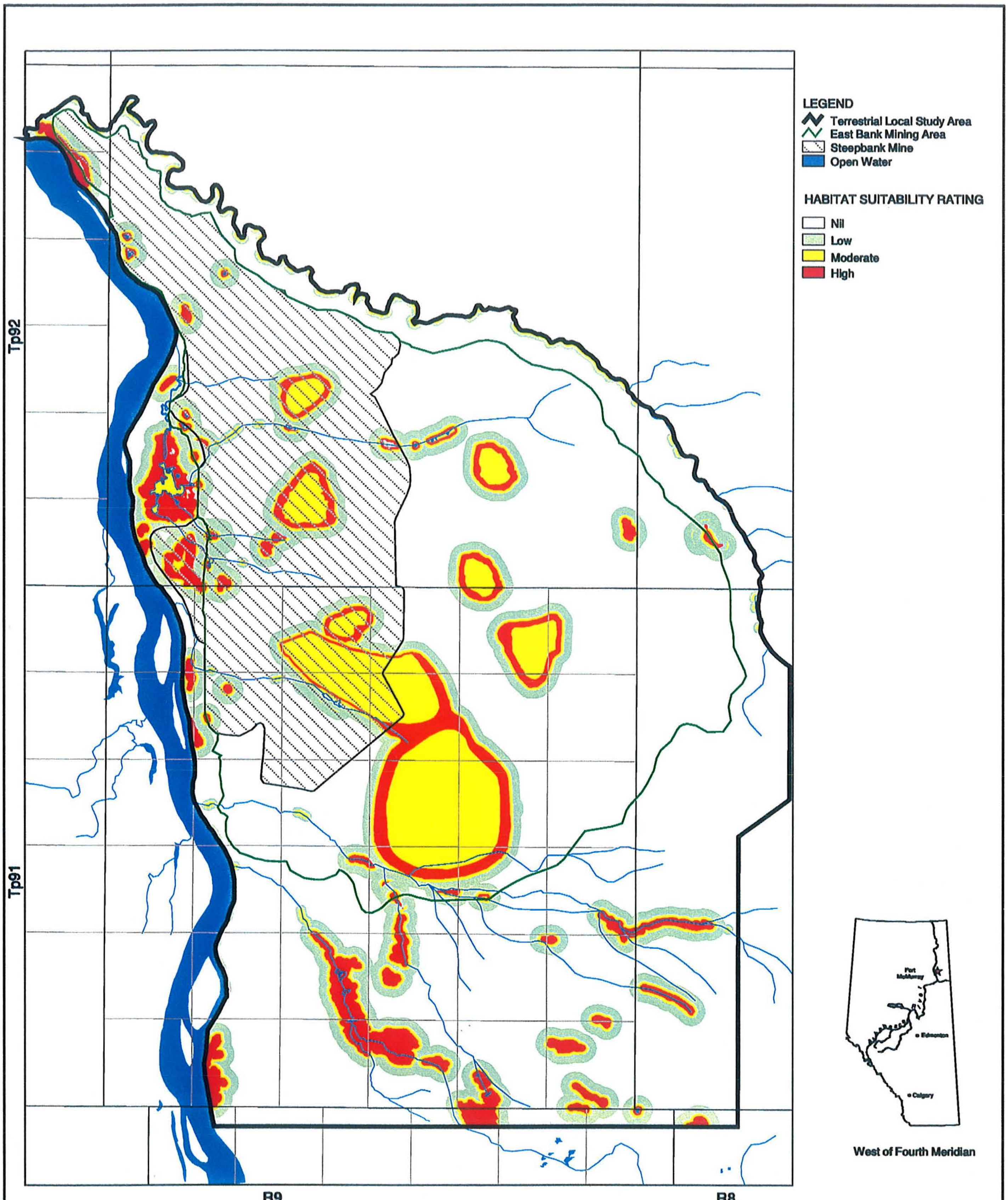
Optimal habitat for dabbling ducks is represented by the interspersion of land with aquatic habitats (e.g., shallow marshes, open-water marshes, and potholes). Limiting factors for dabbling ducks include lack of permanent and semi-permanent water, extensive water fluctuations, and lack of nesting cover. Loss of habitat due to site clearing is expected to affect dabbling ducks.

6.5.3 Closure

Dabbling duck habitat is expected to increase by 90% during reclamation, resulting in 964 HUs (62%) over baseline conditions following closure (Figure 19) This is due to overall gains of 622 HUs (184%) of medium suitability habitat and 304 HUs (43%) of high suitability habitat (Table 50).

During closure, portions of the mine footprint will be reclaimed to lakes and graminoid marshes which represent high suitability habitat (Table 47). In particular, the areas of constructed wetlands around the lakes will be important for dabbling ducks (Figure 3, 19). Thus, overall, dabbling duck habitat is expected to increase over baseline conditions following closure.

Potential modifications to improve the habitat value for dabbling ducks are not required.



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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

SUNCOR ENERGY

Project Millennium

LOCAL STUDY AREA
DABBLING DUCKS HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998

Figure 19

PRODUCED BY: CGA
REVIEWED BY:

6.6 FISHER

6.6.1 Baseline Conditions

The suitability of the various ecosite phases within the LSA for fisher habitat is presented in Table 51 and a habitat map for baseline conditions is shown in Figure 20. High suitability habitat for fishers within the LSA included the following ecosite phases:

- swamps with tree cover > 70% (SFNN);
- blueberry-white spruce-jack pine (b4);
- low-bush cranberry white spruce (d3);
- dogwood white spruce (e3);
- wooded bogs with tree cover >70% (BFNN);
- wooded fens with tree cover >70% (FFNN);
- blueberry-jack pine-trembling aspen (b1);
- swamps with tree cover between 10% and 70% (STNN);
- low-bush cranberry-trembling aspen-white spruce (d2);
- dogwood-balsam poplar-white spruce (e2);
- lichen jack pine (a1); and
- wooded bogs with tree cover between 10 and 70%.

Unsuitable habitat for fishers included lakes (NWL), rivers (NWR), and shallow, open water (WONN).

Table 51 Fisher HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	SFNN	Swamp (tree cover >70%)	0.88
	b4	Blueberry Sw-Pj	0.88
	d3	Low-bush Cranberry Sw	0.88
	e3	Dogwood Sw	0.88
	BFNN	Wooded bog (tree cover >70%)	0.84
	FFNN	Wooded Fen (tree cover >70%)	0.84
	b1	Blueberry Pj-Aw	0.83
	STNN	Swamp (tree cover >10% and ≤70%)	0.83
	d2	Low-bush Cranberry Aw-Sw	0.83
	e2	Dogwood Pb-Sw	0.83
	a1	Lichen Pj	0.82
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.81
	h1	Labrador Tea/Horsetail Sw-Sb	0.80
	g1	Labrador Tea - subhygric Sb-Pj	0.80
	Sb/Lt	Black Spruce - Larch Complexes	0.80
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.76
	e1	Dogwood Pb-Aw	0.75
	CC-OLD	Regrown Cutblocks at Closure	0.71
	d1	Low-bush Cranberry Aw	0.69
Medium Suitability (0.34 - 0.66)	b3	Blueberry Aw-Sw	0.60
	c1	Labrador Tea - mesic Pj-Sb	0.57
	b2	Blueberry Aw(Bw)	0.57
	FONS	Shrubby Fen	0.51
	MONS	Shrubby Marsh	0.50
	Shrub	Shrubland	0.50
	SONS	Swamp (deciduous shrub)	0.50
	HG/CC	Herbacious Graminoid Cutblock	0.46
	NWF	Flooded Area	0.36
Low Suitability (0.01 - 0.33)	AIH	Roads and Rights of Ways	0.23
	NMC	Cutbanks	0.17
	NMS	Sand	0.17
	AIG	Gravel Pits	0.16
	CIP	Revegetated Industrial Lands	0.15
	CIW	Well Sites - vegetated	0.15
	FONG	Graminoid Fen	0.14
	MONG	Graminoid Marsh	0.13
Unsuitable (0.00)	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow open water	0.00

The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for fishers is 99% (10,807 HUs). Water made up the remaining 1% (Table 52). The mean suitability of the LSA (total HUs/total area) is 0.67 (high) (Table 53).

Table 52 Percent of Area and Habitat Units by Suitability Class for Fisher Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class							Habitat Units	Percent of Habitat Units by Suitability Class		
		Unsuitable Habitat			Suitable Habitat							
		Water	Other	Total	Low	Med	High	Total		Low	Med.	High
Predevelopment	16,181	0.7	0.0	0.7	4.3	42.3	52.6	99.3	10,807	1.5	33.2	65.4
Steepbank	3,776	0.2	0.0	0.2	4.0	42.0	53.9	99.8	2,538	1.4	33.0	65.6
East Bank Mine Impact	9,281	0.1	0.0	0.1	1.6	37.4	60.8	99.9	6,582	0.6	28.8	70.7
Remaining at Full Impact	6,901	1.5	0.0	1.5	8.0	48.9	41.7	98.5	4,225	2.9	40.0	57.1
Closure	16,181	6.3	0.0	6.3	5.2	35.4	53.1	93.7	9,983	1.7	29.2	69.2

Of the 10,807 HUs of fisher habitat, the LSA is currently composed of 161 HUs (2%) of low quality habitat, 3,583 HUs (33%) of medium quality habitat, and 7,063 HUs (65%) of high quality habitat (Table 53). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Fisher habitat within the Steepbank mining area was composed of 36 HUs (1%) of low quality habitat, 836 HUs (33%) of medium quality habitat, and 1,665 HUs (66%) of high quality habitat (Table 53). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for fishers is 100% (2,538 HUs). Of the <1% which was considered unsuitable habitat, all of it consisted of water (Table 52).

Table 53 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Fisher Habitat in the LSA

Habitat Class	Predevelop-ment		Steepbank		East Bank Mine Impact		Remaining at Impact		Closure	
	HU	%	HU	%	HU	%	HU	%	HU	%
Low	161	1.5	36	1.4	36	0.6	125	2.9	165	1.7
Med	3,583	33.2	836	33.0	1,894	28.8	1,689	40.0	2,914	29.2
High	7,063	65.4	1,665	65.6	4,652	70.7	2,411	57.1	6,905	69.2
Total HUs	10,807	100.0	2,538	100.0	6,582	100.0	4,225	100.0	9,983	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.67		0.67		0.71		0.61		0.62	

Fisher habitat within the mine impact area was composed of 36 HUs (1%) of low quality habitat, 1,894 HUs (29%) of medium quality habitat, and 4,652 HUs (71%) of high quality habitat (Table 53). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for fishers is 100% (6,544 HUs). Of the <1% which was considered unsuitable habitat, all of it consisted of water (Table 52).

High suitability habitat for fishers was found throughout the LSA (Figure 20). Lower suitability was seen along the perimeter of the LSA, along the

Steepbank and Athabasca Rivers and around Shipyard Lake, due to the lack of suitable cover near waterbodies.

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that fishers prefer mid to late stage coniferous forests. As the LSA is dominated by coniferous bogs and fens, with few waterbodies, it was expected to provide quality habitat for fishers (Table 51).

No relationship was found between fisher habitat use within the LSA and the HSI ratings for the model (Appendix V). However, low sample sizes limited the test.

6.6.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect fisher habitat by removing 61% of the HUs present (Table 54). Twenty-three percent of low, 53% of medium, and 66% of high quality habitat will be lost due to site clearing.

Table 54 Summary of Changes in Fisher Habitat Units from Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelop-ment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	161	-36	-22.6	-36	-22.6	+4	+2.8
Med	3,583	-836	-23.3	-1,894	-52.9	-670	-18.7
High	7,063	-1,665	-23.6	-4,652	-65.9	-158	-2.2
Total	10,807	-2,538	-23.5	-6,582	-60.9	-824	-7.6

Fishers prefer high canopy closure (e.g., 80 to 100% closure) of late successional conifer-dominated forests. They use open areas selectively, mostly in proximity to forest cover. Habitat selection is somewhat dependent on the habitat selection of preferred prey items such as snowshoe hares. Fishers are sensitive to habitat loss, alteration and fragmentation, and the Project will have a negative impact on fishers.

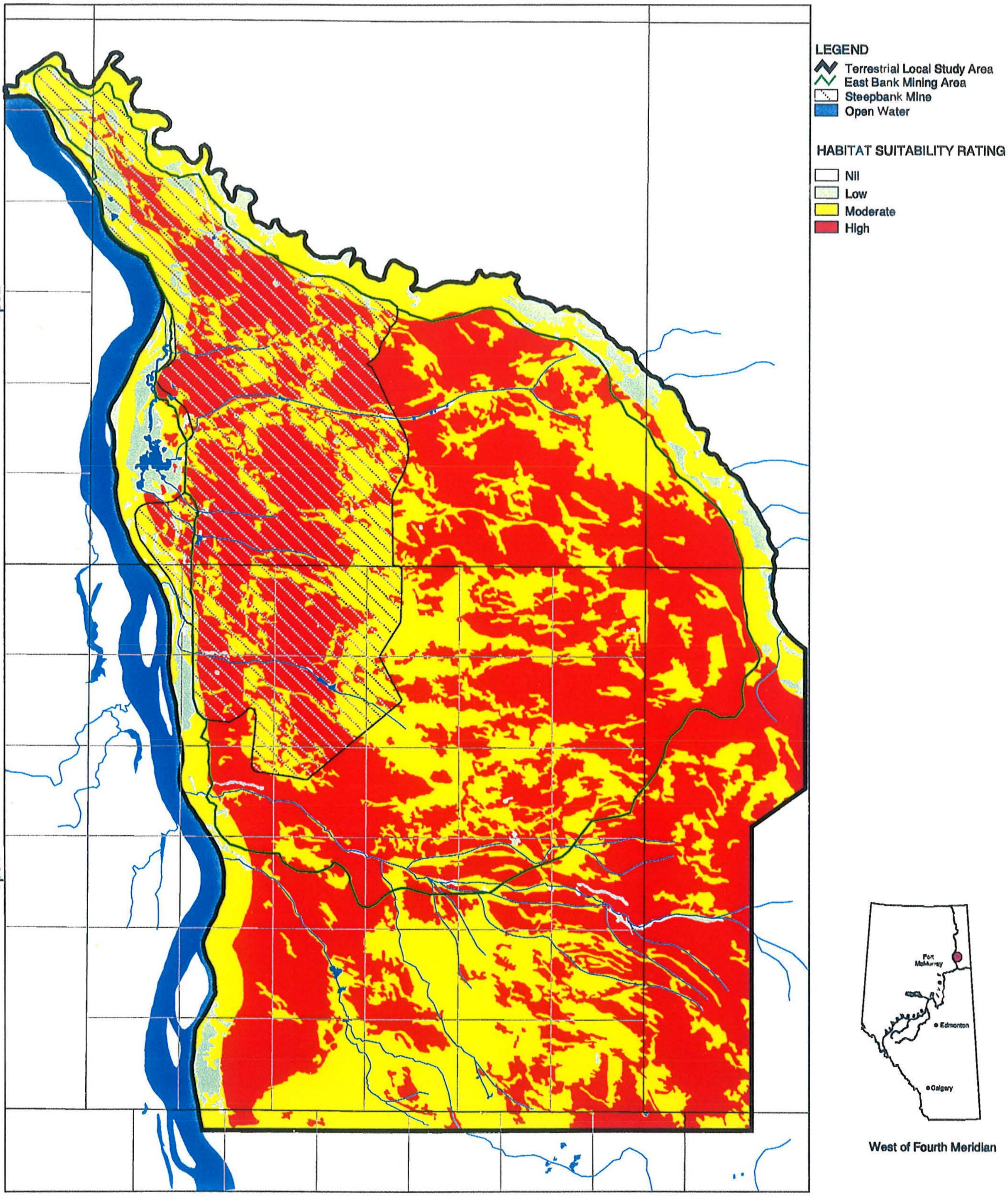
6.6.3 Closure

Fisher habitat is expected to increase by 53% during reclamation, resulting in a net loss of 824 HUs (7.6%) over baseline conditions following closure (Table 54, Figure 21).

With regard to fishers, all of these habitats projected to be reclaimed represent moderate to high suitability habitats, except for lakes and graminoid marshes (Table 51). These areas of high and moderate suitability habitat will be found throughout the LSA following closure

(Figure 21). Thus, overall, fisher habitat is expected to decrease over baseline conditions following closure.

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for fishers are not required.



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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

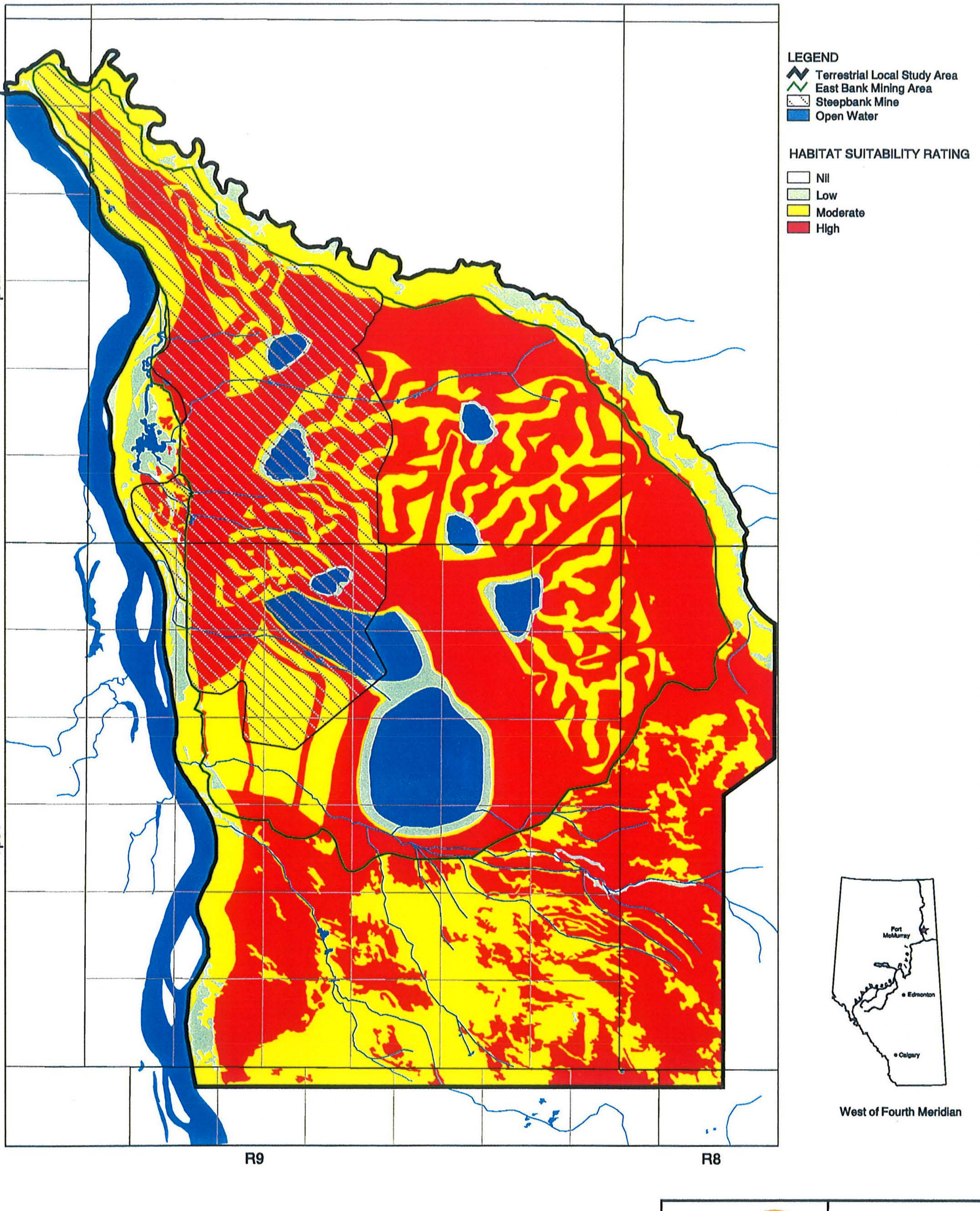
Map Projection: UTM 12
Datum: NAD 83

SUNCOR ENERGY

Project Millennium
Taking Suncor into the 21st Century

LOCAL STUDY AREA
FISHER HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998	Figure 20	PRODUCED BY: CGA REVIEWED BY: MS



SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

SUNCOR ENERGY

Project Millennium
Taking Suncor into the 21st Century

LOCAL STUDY AREA
FISHER HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998	Figure 21	PRODUCED BY: CGA REVIEWED BY: WG

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6.7 GREAT GRAY OWL

6.7.1 Baseline Conditions

The suitability of the various ecosite phases within the LSA for great gray owl food and cover habitat is presented in Tables 55 and 56, respectively. The baseline habitat map for the species is presented in Figure 22.

High suitability foraging habitat (Table 55) for great gray owls within the LSA included the following ecosite phases revegetated industrial lands (CIP);

- vegetated well sites (CIW);
- graminoid fens (FONG); and
- roads and right-of-ways (AIH).

Unsuitable foraging habitat for great gray owls included lakes (NWL), rivers (NWR) and shallow, open water (WONN).

High suitability cover habitat (Table 56) for great gray owls within the LSA included the following ecosite phases:

- dogwood-balsam poplar-trembling aspen (e1);
- dogwood-balsam poplar-white spruce (e2);
- blueberry-trembling aspen-paper birch (b2);
- low-bush cranberry-trembling aspen (d1);
- low-bush cranberry-trembling aspen-white spruce (d2);
- low-bush cranberry-white spruce (d3); and
- dogwood-white spruce (e3).

Unsuitable cover habitat for great gray owls included roads and right-of-ways (AIH); revegetated industrial lands (AIH); graminoid fens (FONG), lakes (NWL), and shrubland (Shrub). These areas were unsuitable for cover as they did not contain nesting trees or protective cover.

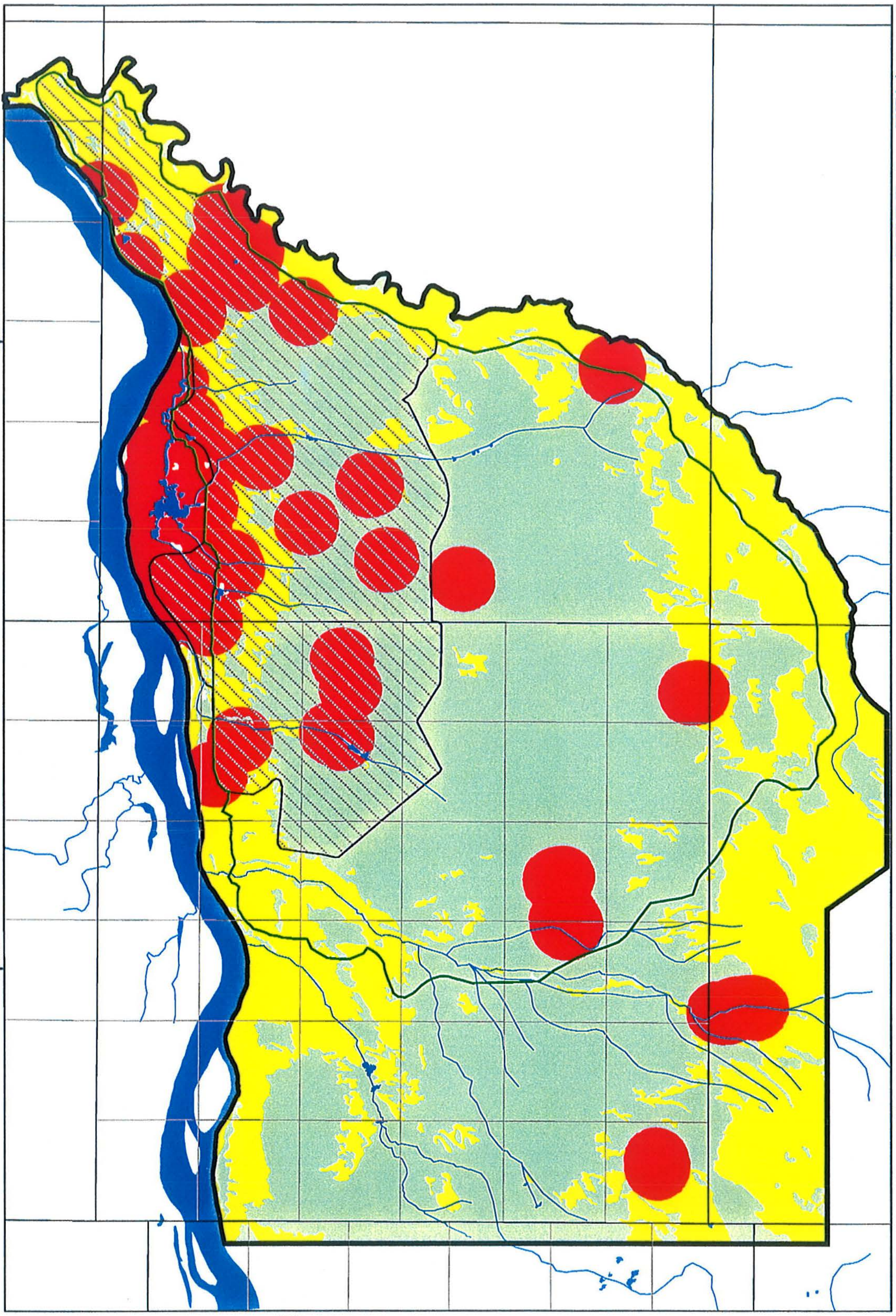
Table 55 Great Gray Owl Food HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	CIP	Revegetated Industrial Lands	1.00
	CIW	Well Sites - vegetated	1.00
	FONG	Graminoid Fen	1.00
	AIH	Roads and Rights of Ways	0.75
Medium Suitability (0.34 - 0.66)	HG/CC	Herbacious Graminoid Cutblock	0.63
	h1	Labrador Tea/Horsetail Sw-Sb	0.54
	AIG	Gravel Pits	0.53
	e3	Dogwood Sw	0.52
	b2	Blueberry Aw(Bw)	0.52
	a1	Lichen Pj	0.51
	NMC	Cutbanks	0.51
	NMS	Sand	0.51
	MONG	Graminoid Marsh	0.50
	FONS	Shrubby Fen	0.42
	e2	Dogwood Pb-Sw	0.40
	SONS	Swamp (deciduous shrub)	0.40
	d3	Low-bush Cranberry Sw	0.37
Low Suitability (0.01 - 0.33)	CC-OLD	Regrown Cutblocks at Closure	0.30
	BFNN	Wooded bog (tree cover >70%)	0.27
	b1	Blueberry Pj-Aw	0.27
	c1	Labrador Tea - mesic Pj-Sb	0.26
	Sb/Lt	Black Spruce - Larch Complexes	0.26
	FFNN	Wooded Fen (tree cover >70%)	0.25
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.25
	d2	Low-bush Cranberry Aw-Sw	0.23
	d1	Low-bush Cranberry Aw	0.23
	MONS	Shrubby Marsh	0.22
	SFNN	Swamp (tree cover >70%)	0.22
	STNN	Swamp (tree cover >10% and ≤70%)	0.22
	NWF	Flooded Area	0.17
	b4	Blueberry Sw-Pj	0.16
	e1	Dogwood Pb-Aw	0.15
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.15
	b3	Blueberry Aw-Sw	0.13
	Shrub	Shrubland	0.13
	g1	Labrador Tea - subhygric Sb-Pj	0.11
Unsuitable (0.00)	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow open water	0.00

Table 56 Great Gray Owl HSI Cover Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	e1	Dogwood Pb-Aw	1.00
	e2	Dogwood Pb-Sw	0.93
	b2	Blueberry Aw(Bw)	0.90
	d1	Low-bush Cranberry Aw	0.90
	d2	Low-bush Cranberry Aw-Sw	0.89
	d3	Low-bush Cranberry Sw	0.82
	e3	Dogwood Sw	0.81
	b1	Blueberry Pj-Aw	0.79
	b4	Blueberry Sw-Pj	0.73
	b3	Blueberry Aw-Sw	0.68
	a1	Lichen Pj	0.68
Medium Suitability (0.34 - 0.66)	h1	Labrador Tea/Horsetail Sw-Sb	0.64
	STNN	Swamp (tree cover >10% and ≤70%)	0.54
	g1	Labrador Tea - subhygric Sb-Pj	0.53
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.51
	BFNN	Wooded bog (tree cover >70%)	0.50
	FFNN	Wooded Fen (tree cover >70%)	0.50
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.50
	Sb/Lt	Black Spruce - Larch Complexes	0.50
	SFNN	Swamp (tree cover >70%)	0.50
	CC-OLD	Regrown Cutblocks at Closure	0.50
	c1	Labrador Tea - mesic Pj-Sb	0.37
Unsuitable (0.00)	AIG	Gravel Pits	0.00
	AIH	Roads and Rights of Ways	0.00
	CIP	Revegetated Industrial Lands	0.00
	CIW	Well Sites - vegetated	0.00
	FONG	Graminoid Fen	0.00
	FONS	Shrubby Fen	0.00
	HG/CC	Herbacious Graminoid Cutblock	0.00
	MONG	Graminoid Marsh	0.00
	MONS	Shrubby Marsh	0.00
	NMC	Cutbanks	0.00
	NMS	Sand	0.00
	NWF	Flooded Area	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	Shrub	Shrubland	0.00
	SONS	Swamp (deciduous shrub)	0.00
	WONN	Shallow open water	0.00

The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for great gray owls is 99% (6,695 HUs). Of the 1% which was considered unsuitable habitat, all of it consisted of water (Table 57). The mean suitability of the LSA (total HUs/total area) was 0.43 or medium (Table 58).



LEGEND

- Terrestrial Local Study Area
- East Bank Mining Area
- Steepbank Mine
- Open Water

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

West of Fourth Meridian

SUNCOR ENERGY

Project Millennium

SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

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1000 0 1000 2000 3000
Metres
Scale 1:100,000

Map Projection: UTM 12
Datum: NAD 83

LOCAL STUDY AREA
GREAT GRAY OWL HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998

Figure 22

PRODUCED BY: CGA
REVIEWED BY:

/data14/suncor/local/hsl/suncor_hsl.apr

Table 57 Percent of Area and Habitat Units by Suitability Class for Great Gray Owl Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class							Habitat Units	Percent of Habitat Units by Suitability Class		
		Unsuitable Habitat			Suitable Habitat							
		Water	Other	Total	Low	Med	High	Total		Low	Med.	High
Predevelopment	16,181	0.7	0.0	0.7	54.2	28.7	16.4	99.3	6,965	37.4	28.9	33.7
Steepbank	3,776	0.2	0.0	0.2	44.0	16.4	39.4	99.8	2,082	23.5	12.8	63.7
East Bank Mine Impact	9,281	0.1	0.0	0.1	60.2	19.6	20.0	99.9	4,120	41.2	18.8	39.9
Remaining at Full Impact	6,901	1.5	0.0	1.5	46.1	40.9	11.6	98.5	2,846	32.0	43.5	24.5
Closure	16,181	6.3	0.0	6.3	29.8	56.1	7.8	93.7	6,514	21.2	61.2	17.6

Of the 6,965 HUs of great gray owl habitat, the LSA is currently composed of 2,608 HUs (37%) of low quality habitat, 2,013 HUs (29%) of medium quality habitat and 2,344 HUs (34%) of high quality habitat (Table 58). Great gray owl habitat within the Steepbank mining area was composed of no HUs (0%) of low quality habitat, 489 HUs (23%) of medium quality habitat and 267 HUs (13%) of high quality habitat (Table 58). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for great gray owls is 100% (2,082 HUs). Of the <1% which was considered unsuitable habitat, all of it consisted of water (Table 57).

Table 58 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Great Gray Owl Habitat in the LSA

Habitat Class	Predevelop-ment		Steepbank		East Bank Mine Impact		Remaining at Impact		Closure	
	HU	%	HU	%	HU	%	HU	%	HU	%
Low	2,608	37.4	0	0	1,699	41.4	909	31.8	1,381	21.2
Med	2,013	28.9	489	23	775	18.9	1,238	43.2	3,989	61.2
High	2,344	33.7	267	13	1,629	39.7	716	25.0	1,144	17.6
Total HUs	6,965	100.0	1,327	64	4,102	100	2,863	100.0	6,514	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.43		0.35		0.44		0.41		0.40	

Great gray owl habitat within the mine impact area composed of 1,699 HUs (41%) of low quality habitat, 775 HUs (19%) of medium quality habitat, and 1,629 HUs (40%) of high quality habitat (Table 58). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for great gray owls is 100% (4,071 HUs). Of the <1% which was considered unsuitable habitat, all of it consisted of water (Table 57).

High suitability habitat for great gray owls was mainly concentrated in the northwest corner of the LSA (Figure 22). A few scattered pockets of high suitability habitat were seen throughout the LSA. The majority of the LSA consisted of lower suitability habitat, possibly due to the lack of suitable cover in the fens.

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that great gray owls hunt in open coniferous, deciduous and mixedwood forests, interspersed with muskegs, marshes and wet meadows. As the LSA is dominated by coniferous bogs and fens, with limited cover, it was expected to provide generally poor habitat for great gray owls.

Only 2 incidental observations were made on great gray owls during field surveys, therefore, verification of the great gray owl model was not possible (Appendix V).

6.7.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect great gray owl habitat by removing 60% of the HUs present (Table 59). Sixty-five percent of low, 39% of medium and 70% of high quality habitat will be lost due to site clearing.

Table 59 Summary of Changes in Great Gray Owl Habitat Units From Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	2,608	0	0.0	-1,699	-65.1	-1,228	-47.1
Med	2,013	-489	-24.3	-775	-38.5	+1,976	+98.2
High	2,344	-267	-11.4	-1,629	-69.5	-1,200	-51.2
Total	6,965	-1,327	-19.0	-4,102	-58.9	-451	-6.5

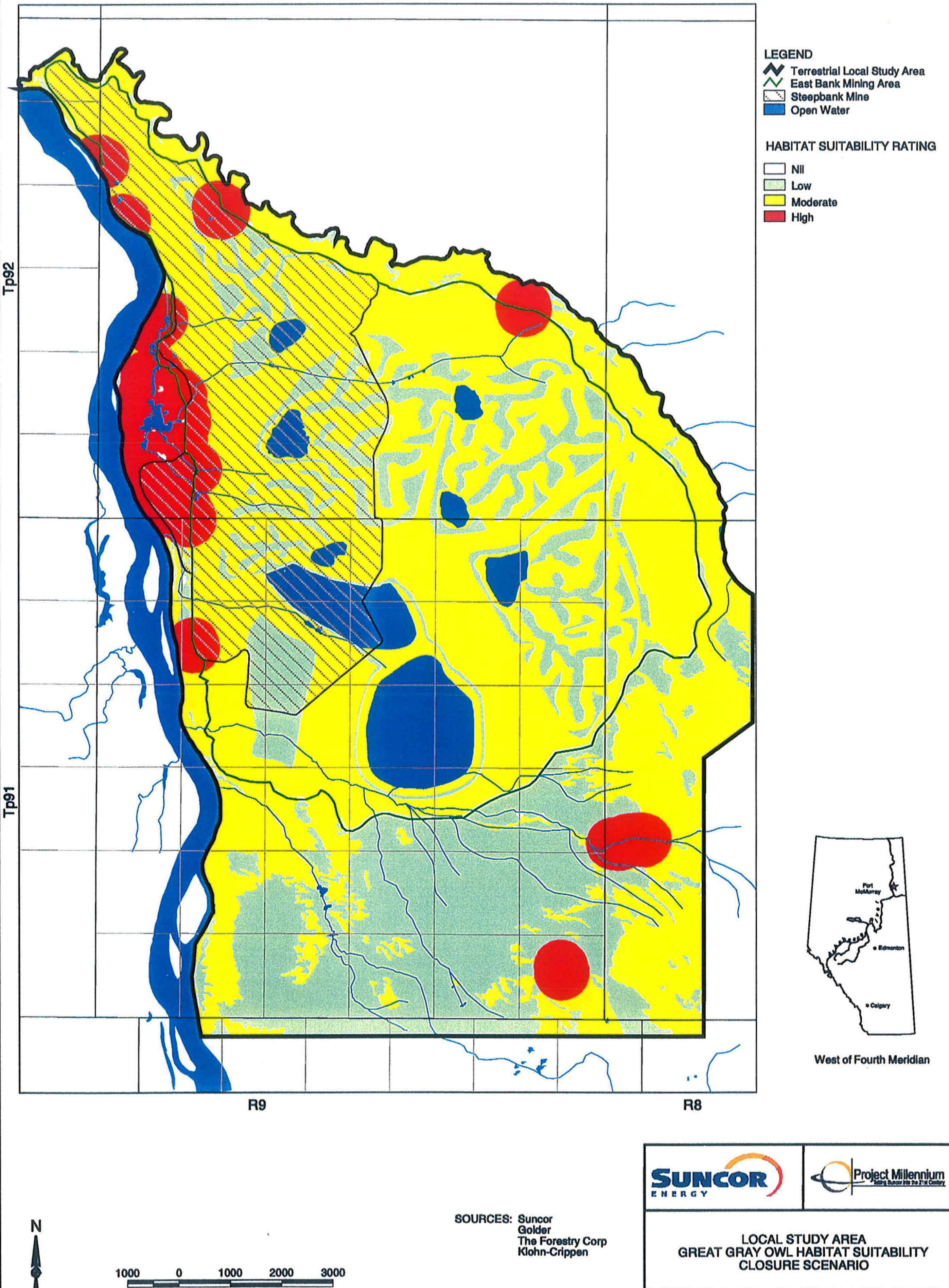
Forest cover is important for nesting great gray owls, and nesting occurs in mature poplar stands, often mixed with spruce, jack pine, and tamarack. Great gray owls hunt in fairly open areas, including graminoid fens and revegetated industrial areas. Human activities, such as site clearing, that remove nesting and foraging habitat will have an effect on great gray owls.

6.7.3 Closure

Great gray owl habitat is expected to increase by 52% during reclamation, but still be less than 451 HUs (7%) over baseline conditions following closure (Figure 23). This is due to overall losses of 1,228 HUs (47%) of low suitability habitat and 1,200 HUs (51%) of high suitability habitat (Table 59).

Some of the vegetation types that will be reclaimed on the mine site represent moderate to high suitability for cover and some represent moderate to high suitable for foraging (Figure 23). Only the blueberry-trembling aspen-paper birch (b2) and the dogwood-white spruce (e3) represent high to medium suitability for both cover and food for great gray owls. While lakes (NWL) and shrubland (shrub) represent low to unsuitable habitat for both cover and food for great gray owls. As few habitats that provide both cover and food for great gray owls will be reclaimed, great gray owl habitat is expected to decrease over baseline conditions following closure.

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for great gray owls include reclaiming vegetation types that provide cover and food in proximity to each other. This would include deciduous, mixedwood, and coniferous stands in proximity to graminoid fens and other open areas.



SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

SUNCOR ENERGY

Project Millennium

LOCAL STUDY AREA
GREAT GRAY OWL HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998	Figure 23	PRODUCED BY: CGA REVIEWED BY:

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6.8 MOOSE

6.8.1 Baseline Conditions

The suitability of the various ecosite phases within the LSA for moose food and cover habitat is presented in Tables 60 and 61 and the baseline habitat map is shown in Figure 24.

High suitability cover habitat (Table 61) for moose within the LSA included the following ecosite phases:

- blueberry-white spruce-jack pine (b4);
- low-bush cranberry-white spruce (d3);
- dogwood-white spruce (e3);
- lichen jack pine (a1);
- Labrador tea/horsetail-white spruce-black spruce (h1);
- blueberry-jack pine-trembling aspen (b1);
- low-bush cranberry-trembling aspen-white spruce (d2);
- dogwood-balsam poplar-white spruce (e2);
- Labrador tea-subhygric-black spruce-jack pine (g1); and
- swamps with tree cover between 10 and 70%.

Unsuitable cover habitat for moose included roads and right-of-ways (AIH); revegetated industrial lands (AIH); graminoid fens (FONG): lakes (NWL) and shrubland (Shrub).

High suitability foraging habitat (Table 60) for moose within the LSA included the following ecosite phases:

- shrubby marshes (MONS);
- shrubland (Shrub);
- shrubby deciduous swamps (SONS);
- shrubby fens (FONS);
- low-bush cranberry-trembling aspen (d1); and
- dogwood-balsam poplar-trembling aspen (e1).

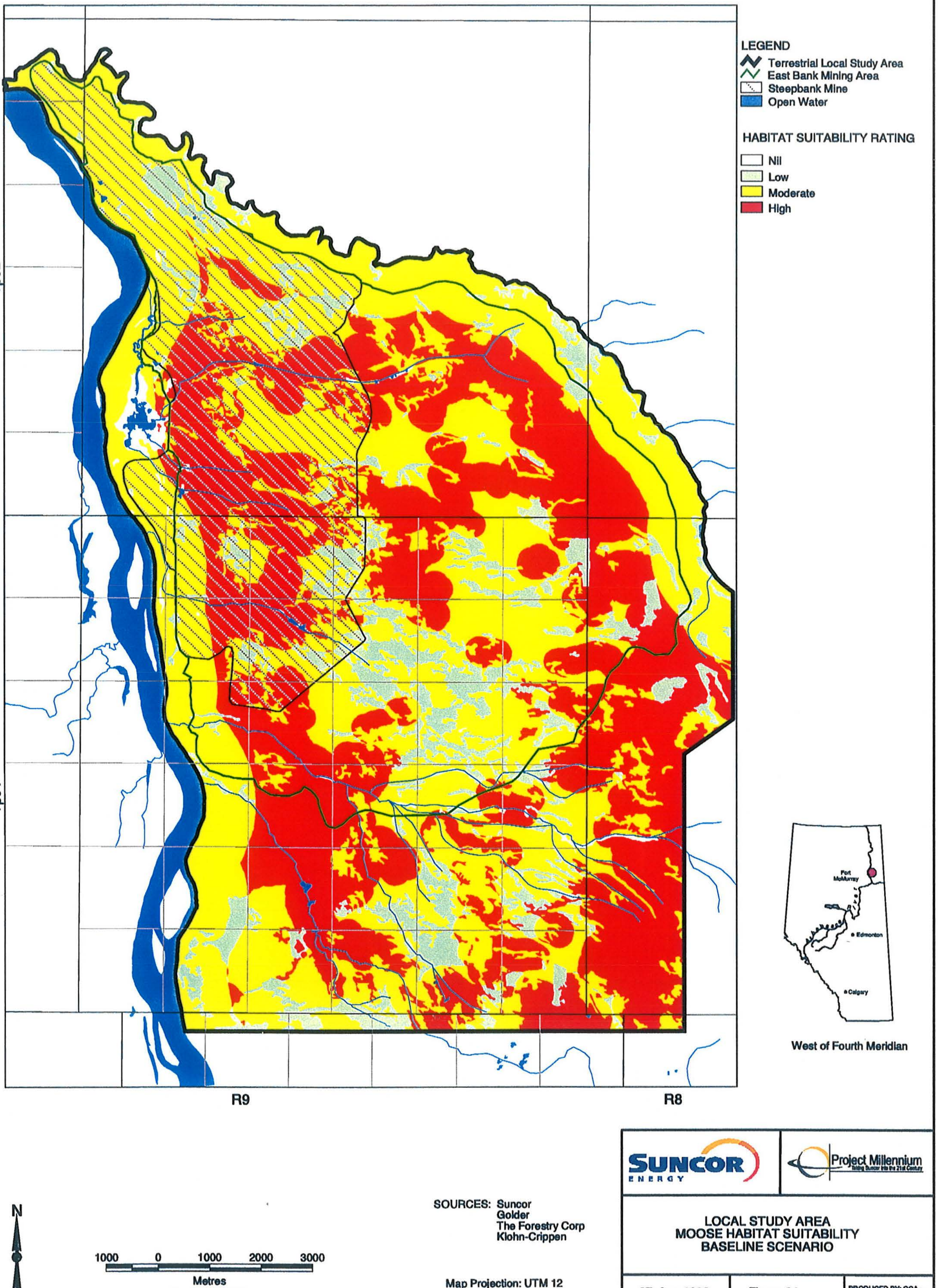
Unsuitable foraging habitat for moose included graminoid marshes (MONG), lakes (NWL), rivers (NWR), shallow open water (WONN).

Table 60 Moose Food HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	MONS	Shrubby Marsh	1.00
	Shrub	Shrubland	1.00
	SONS	Swamp (deciduous shrub)	1.00
	FONS	Shrubby Fen	0.92
	d1	Low-bush Cranberry Aw	0.79
	e1	Dogwood Pb-Aw	0.74
Medium Suitability (0.34 - 0.66)	e2	Dogwood Pb-Sw	0.53
	BFNN	Wooded bog (tree cover >70%)	0.52
	NWF	Flooded Area	0.51
	d2	Low-bush Cranberry Aw-Sw	0.48
	HG/CC	Herbacious Graminoid Cutblock	0.48
	FFNN	Wooded Fen (tree cover >70%)	0.46
	Sb/Lt	Black Spruce - Larch Complexes	0.42
	CC-OLD	Regrown Cutblocks at Closure	0.42
	SFNN	Swamp (tree cover >70%)	0.41
	STNN	Swamp (tree cover >10% and ≤70%)	0.41
	e3	Dogwood Sw	0.40
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.38
	b4	Blueberry Sw-Pj	0.38
	b1	Blueberry Pj-Aw	0.37
Low Suitability (0.01 - 0.33)	b3	Blueberry Aw-Sw	0.30
	d3	Low-bush Cranberry Sw	0.27
	AIH	Roads and Rights of Ways	0.21
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.20
	g1	Labrador Tea - subhygric Sb-Pj	0.20
	a1	Lichen Pj	0.17
	h1	Labrador Tea/Horsetail Sw-Sb	0.16
	NMC	Cutbanks	0.14
	NMS	Sand	0.14
	b2	Blueberry Aw(Bw)	0.12
	AIG	Gravel Pits	0.12
	CIP	Revegetated Industrial Lands	0.09
	CIW	Well Sites - vegetated	0.09
	c1	Labrador Tea - mesic Pj-Sb	0.07
	FONG	Graminoid Fen	0.03
Unsuitable (0.00)	MONG	Graminoid Marsh	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow open water	0.00

Table 61 Moose Cover HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	b4	Blueberry Sw-Pj	1.00
	d3	Low-bush Cranberry Sw	1.00
	e3	Dogwood Sw	1.00
	a1	Lichen Pj	0.98
	h1	Labrador Tea/Horsetail Sw-Sb	0.94
	b1	Blueberry Pj-Aw	0.94
	d2	Low-bush Cranberry Aw-Sw	0.93
	e2	Dogwood Pb-Sw	0.92
	g1	Labrador Tea - subhygric Sb-Pj	0.85
	STNN	Swamp (tree cover >10% and <=70%)	0.85
	Sb/Lt	Black Spruce - Larch Complexes	0.79
	BTNN	Wooded bog (tree cover >10% and <=70%)	0.76
	BFNN	Wooded bog (tree cover >70%)	0.75
	FTNN	Wooded Fen (tree cover >10% and <=70%)	0.75
	SFNN	Swamp (tree cover >70%)	0.75
	FFNN	Wooded Fen (tree cover >70%)	0.74
	b2	Blueberry Aw(Bw)	0.70
	d1	Low-bush Cranberry Aw	0.70
	e1	Dogwood Pb-Aw	0.70
Medium Suitability	CC-OLD	Regrown Cutblocks at Closure	0.60
Low Suitability (0.01 - 0.33)	b3	Blueberry Aw-Sw	0.23
	c1	Labrador Tea - mesic Pj-Sb	0.23
Unsuitable (0.00)	AIG	Gravel Pits	0.00
	AIH	Roads and Rights of Ways	0.00
	CIP	Revegetated Industrial Lands	0.00
	CIW	Well Sites - vegetated	0.00
	FONG	Graminoid Fen	0.00
	FONS	Shrubby Fen	0.00
	HG/CC	Herbacious Graminoid Cutblock	0.00
	MONG	Graminoid Marsh	0.00
	MONS	Shrubby Marsh	0.00
	NMC	Cutbanks	0.00
	NMS	Sand	0.00
	NWF	Flooded Area	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	Shrub	Shrubland	0.00
	SONS	Swamp (deciduous shrub)	0.00



SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

SUNCOR ENERGY

Project Millennium
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LOCAL STUDY AREA
MOOSE HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998	Figure 24	PRODUCED BY: CGA REVIEWED BY:

/data14/suncor/local/hsi/suncor_hsi.spr

The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for moose is 99% (9,614 HUs). Of the 1% which was considered unsuitable habitat, half of it consisted of water (Table 62).

Table 62 Percent of Area and Habitat Units by Suitability Class for Moose Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med.	High
Predevelopment	16,181	0.7	0.7	1.4	11.2	49.0	38.5	98.6	9,614	5.1	40.9	54.0
Steepbank	3,776	0.2	0.3	0.5	9.1	53.0	37.4	99.5	2,238	4.2	43.3	52.5
East Bank Mine Impact	9,281	0.1	0.1	0.3	11.1	47.4	41.2	99.7	5,671	5.0	39.2	55.8
Remaining at Full Impact	6,901	1.5	1.4	2.8	11.2	51.1	34.9	97.2	3,943	5.2	43.4	51.5
Closure	16,181	6.3	0.4	6.7	6.8	34.2	52.3	93.3	10,826	2.7	25.5	71.7

Of the 9,614 HUs of moose habitat, the LSA is currently composed of 489 HUs (5%) of low quality habitat, 3,933 HUs (41%) of medium quality habitat, and 5,193 HUs (54%) of high quality habitat (Table 63). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Moose habitat within the Steepbank mining area was composed of 94 HUs (4%) of low quality habitat, 970 HUs (43%) of medium quality habitat, and 1,174 HUs (53%) of high quality habitat (Table 63). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for moose is 100% (2,238 HUs). Of the <1% which was considered unsuitable habitat, just less than half is water (Table 62).

Table 63 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Moose Habitat in the LSA

Habitat Class	Predevelopment HU	%	Steepbank HU	%	East Bank Mine Impact HU	%	Remaining at Impact HU	%	Closure HU	%
Low	489	5.1	94	4.2	285	5.0	204	5.2	296	2.7
Med	3,933	40.9	970	43.3	2,223	39.2	1,710	43.4	2,764	25.5
High	5,193	54.0	1,174	52.5	3,164	55.8	2,030	51.5	7,766	71.7
Total HUs	9,614	100.0	2,238	100.0	5,671	100.0	3,943	100.0	10,826	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.59		0.59		0.61		0.57		0.67	

Moose habitat within the mine impact area was composed of 285 HUs (5%) of low quality habitat, 2,223 HUs (39%) of medium quality habitat, and 3,164 HUs (56%) of high quality habitat (Table 63). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for moose is 100% (5,671 HUs). Of the <1% which was considered unsuitable habitat, half of it is water (Table 62).

High suitability habitat for moose was found throughout the LSA (Figure 24). Less suitable habitat was seen along the perimeter and in the center of the LSA. The majority of the LSA consisted of moderate to high suitability habitat, possibly due to the predominance of fens and swamps providing both food and cover.

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that moose are generalist species with broad habitat requirements. In particular, early seral stage forest in juxtaposition with mature forest and waterbodies provides a diverse mix of ideal habitat. The majority of moose foraging occurs within 100 m of suitable cover.

Most observations of moose sign were made in deciduous habitats, which were modelled as having high food values. However, inadequate sample sized prevented a detailed analysis (Appendix V).

6.8.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect moose habitat by removing 59% of the HUs present (Table 64). Fifty-eight percent of low, 57% of medium and 61% of high quality habitat will be lost due to site clearing.

Table 64 Summary of Changes in Moose Habitat Units From Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	489	-94	-19.2	-285	-58.3	-192	-39.4
Med	3,933	-970	-24.7	-2,223	-56.5	-1,168	-29.7
High	5,193	-1,174	-22.6	-3,164	-60.9	+2,572	+49.5
Total	9,614	-2,238	-23.3	-5,671	-59.0	+1,211	+12.6

Development of the Project is expected to affect moose directly through loss of suitable aspen-dominated habitat, key areas of browse availability, and wintering range. Loss of habitat will not result in direct mortality as both moose and calves are fairly mobile. However, loss of habitat will affect moose as moose tend to be highly traditional in their use of seasonal ranges, particularly in boreal habitats. As well, displaced moose may be exposed to increased hunting pressure.

6.8.3 Closure

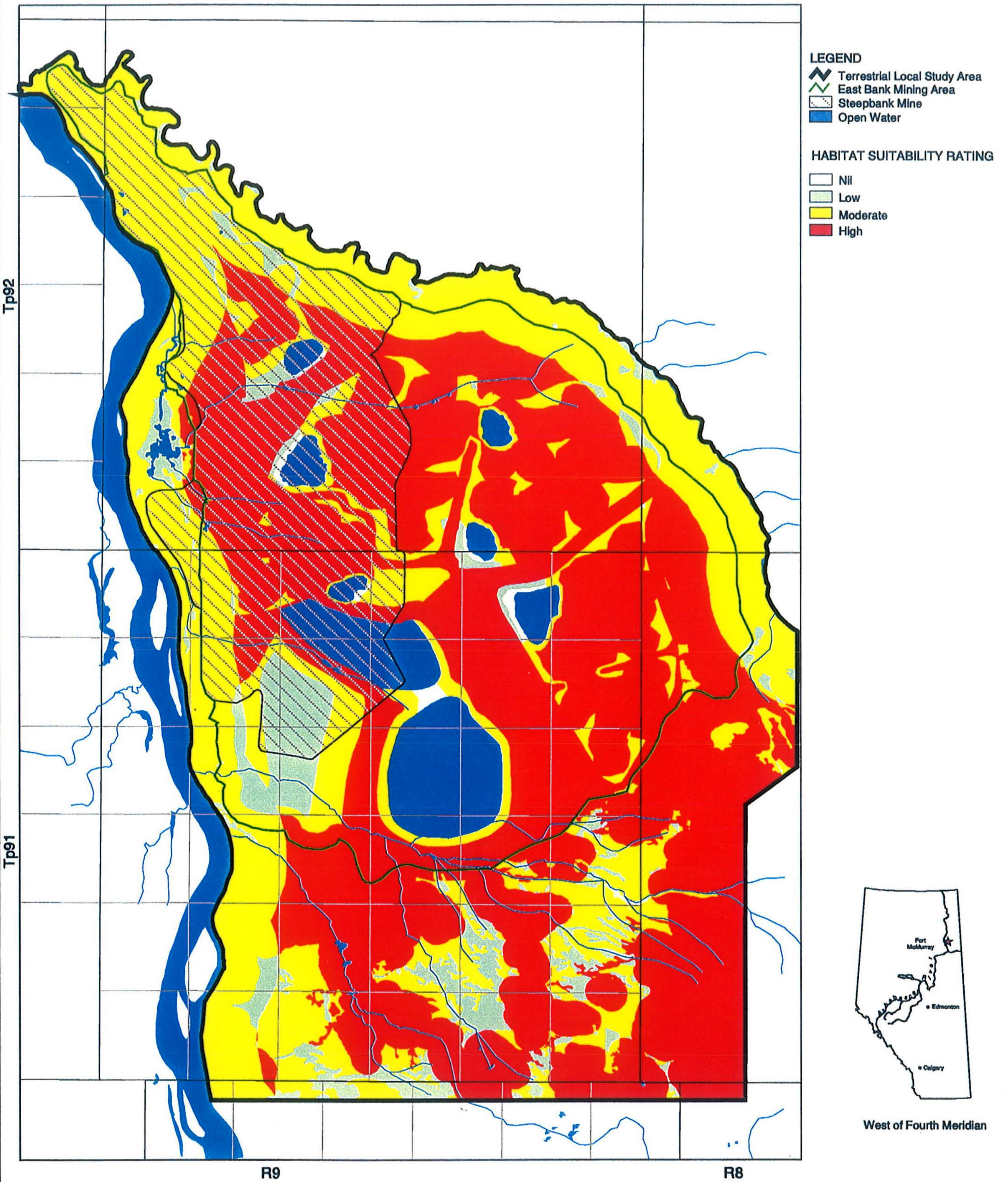
Moose habitat is expected to increase by 72% during reclamation, resulting in 1,211 HUs (13%) over baseline conditions following closure. This is due to an overall gain of 2,572 HUs (50%) of high suitability habitat (Table 64).

During closure, the mine footprint will be reclaimed to the following vegetation types (Table 8, Figure 3):

- low bush cranberry-trembling aspen-white spruce (d2);
- dogwood-balsam poplar-trembling aspen (e1);
- lakes (NWL);
- blueberry-trembling aspen-white spruce (b3);
- shrubby deciduous swamp (SONS);
- blueberry-trembling aspen (paper birch) (b2);
- graminoid marsh (MONG);
- dogwood-white spruce (e3);
- blueberry-jack pine-trembling aspen (b1); and
- shrubland (Shrub).

With regard to moose, some of these vegetation types represent moderate to high suitability for cover and some represent moderate to high suitable for foraging (Table 60, 61). Only the dogwood-white spruce (e3); blueberry-jack pine-trembling aspen (b1); low-bush cranberry-trembling aspen-white spruce (d2); and dogwood-balsam poplar-trembling aspen (e1) represent high to medium suitability for both cover and food for moose. While lakes (NWL); graminoid marshes (MONG); and blueberry-trembling aspen-white spruce (b3) represent low to unsuitable habitat for both cover and food for moose. As a variety of suitable habitats for moose will be reclaimed, moose habitat is expected to increase over baseline conditions following closure (Figure 25).

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for moose are not required.



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Project Millennium

SOURCES: Suncor
Golder
The Forestry Corp
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Metres
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Map Projection: UTM 12
Datum: NAD 83

LOCAL STUDY AREA
MOOSE HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998

Figure 25

PRODUCED BY: CGA
REVIEWED BY:

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6.9 PILEATED WOODPECKER

6.9.1 Baseline Conditions

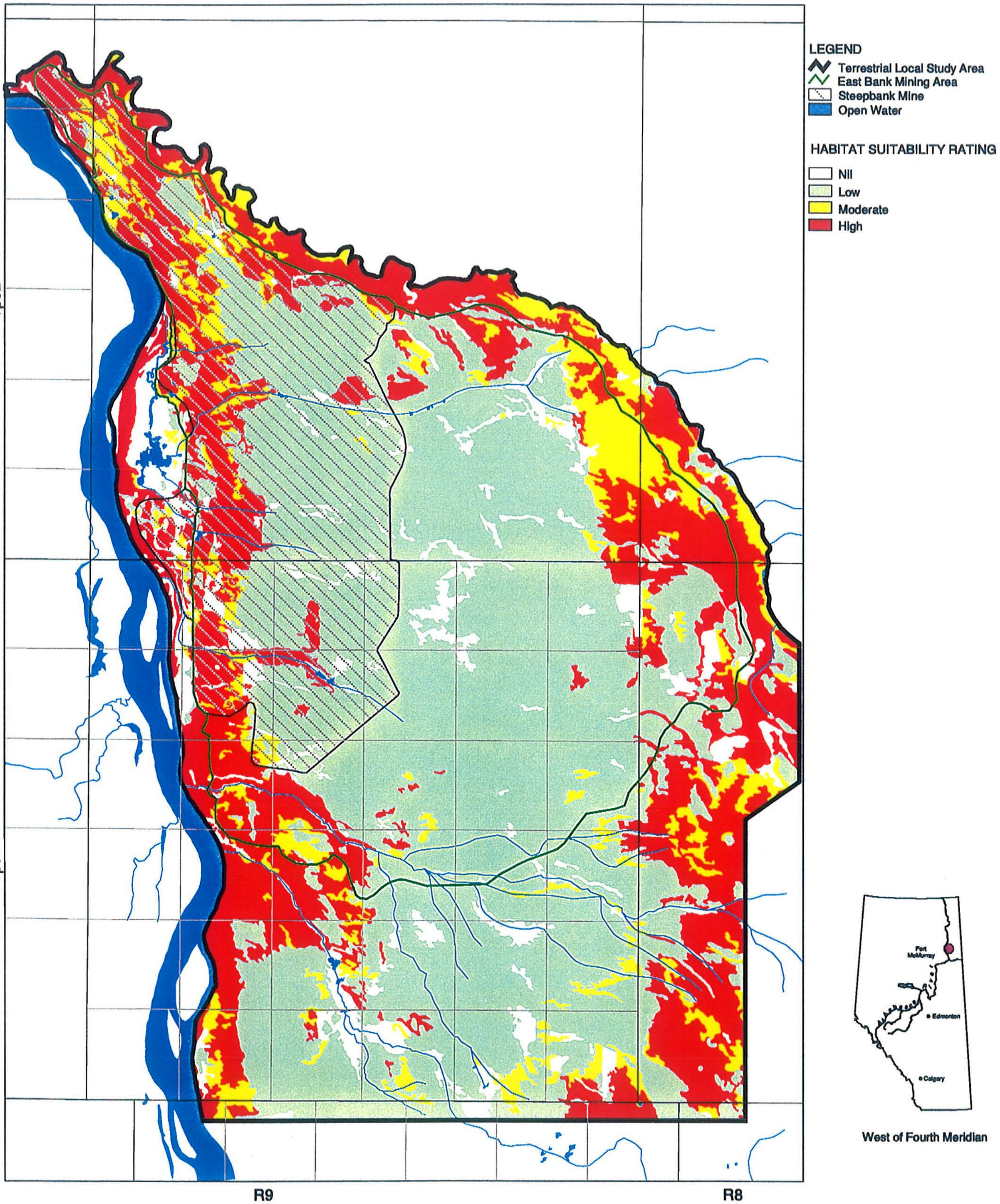
The suitability of the various ecosite phases within the LSA for pileated woodpecker habitat is presented in Table 65 and shown in Figure 26. High suitability habitat for pileated woodpeckers within the LSA included the following ecosite phases:

- dogwood-balsam poplar-trembling aspen (e1);
- blueberry-trembling aspen-paper birch (b2);
- dogwood-balsam poplar-white spruce (e2);
- low-bush cranberry-trembling aspen-white spruce (d2);
- low-bush cranberry-trembling aspen (d1);
- blueberry-jack pine-trembling aspen (b1); and
- blueberry-white spruce-jack pine (b4).

Unsuitable habitat for pileated woodpeckers included roads and right-of-ways (AIH); revegetated industrial lands (AIH); graminoid fens (FONG); graminoid marshes (MONG); lakes (NWL) and shrubland (Shrub).

Table 65 Pileated Woodpecker HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	e1	Dogwood Pb-Aw	1.00
	b2	Blueberry Aw(Bw)	0.88
	e2	Dogwood Pb-Sw	0.78
	d2	Low-bush Cranberry Aw-Sw	0.75
	d1	Low-bush Cranberry Aw	0.74
	b1	Blueberry Pj-Aw	0.71
	b4	Blueberry Sw-Pj	0.69
Medium Suitability (0.34 - 0.66)	d3	Low-bush Cranberry Sw	0.62
	e3	Dogwood Sw	0.61
	b3	Blueberry Aw-Sw	0.47
	CC-OLD	Regrown Cutblocks at Closure	0.45
	a1	Lichen Pj	0.37
	h1	Labrador Tea/Horsetail Sw-Sb	0.36
Low Suitability (0.01 - 0.33)	Sb/Lt	Black Spruce - Larch Complexes	0.31
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.31
	SFNN	Swamp (tree cover >70%)	0.29
	FFNN	Wooded Fen (tree cover >70%)	0.29
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.28
	STNN	Swamp (tree cover >10% and ≤70%)	0.27
	g1	Labrador Tea - subhygric Sb-Pj	0.24
	BFNN	Wooded bog (tree cover >70%)	0.23
	c1	Labrador Tea - mesic Pj-Sb	0.16
Unsuitable (0.00)	AIG	Gravel Pits	0.00
	AIH	Roads and Rights of Ways	0.00
	CIP	Revegetated Industrial Lands	0.00
	CIW	Well Sites - vegetated	0.00
	FONG	Graminoid Fen	0.00
	FONS	Shrubby Fen	0.00
	HG/CC	Herbacious Graminoid Cutblock	0.00
	MONG	Graminoid Marsh	0.00
	MONS	Shrubby Marsh	0.00
	NMC	Cutbanks	0.00
	NMS	Sand	0.00
	NWF	Flooded Area	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	Shrub	Shrubland	0.00
	SONS	Swamp (deciduous shrub)	0.00
	WONN	Shallow open water	0.00



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Metres
Scale 1:100,000

SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

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LOCAL STUDY AREA
PILEATED WOODPECKER HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998 | Figure 26 | PRODUCED BY: CGA
REVIEWED BY: WS

The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for pileated woodpeckers is 91% (6,274 HUs). Of the 9% which was considered unsuitable habitat, 1% consisted of water (Table 66). The mean suitability of the LSA (total HUs/total area) was 0.39 or medium (Table 67).

Table 66 Percent of Area and Habitat Units by Suitability Class for Pileated Woodpecker Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class							Habitat Units	Percent of Habitat Units by Suitability Class		
		Unsuitable Habitat			Suitable Habitat							
		Water	Other	Total	Low	Med	High	Total		Low	Med.	High
Predevelopment	16,181	0.7	7.8	8.5	55.1	9.4	27.0	91.5	6,274	28.1	11.0	60.9
Steepbank	3,776	0.2	6.8	7.0	53.9	9.8	29.2	93.0	1,541	26.4	11.4	62.2
East Bank Mine Impact	9,281	0.1	5.9	6.0	64.1	7.5	22.4	94.0	3,299	35.9	9.1	55.0
Remaining at Full Impact	6,901	1.5	10.4	11.8	42.9	11.9	33.3	88.2	2,976	19.4	13.2	67.4
Closure	16,181	6.3	11.2	17.5	18.8	12.6	51.1	82.5	8,624	7.0	11.7	81.3

Of the 6,274 HUs of pileated woodpecker habitat, the LSA is currently composed of 1,761 HUs (28%) of low quality habitat, 693 HUs (11%) of medium quality habitat, and 3,820 HUs (61%) of high quality habitat (Table 67). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Pileated woodpecker habitat within the Steepbank mining area was composed of 406 HUs (26%) of low quality habitat, 176 HUs (11%) of medium quality habitat, and 959 HUs (62%) of high quality habitat (Table 67). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for pileated woodpeckers is 93% (1,541 HUs). Of the 7% which was considered unsuitable habitat, <1% consisted of water (Table 66).

Table 67 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Pileated Woodpecker Habitat in the LSA

	Predevelop-ment		Steepbank		Mine Impact		Remaining at Impact		Closure	
Habitat Class	HU	%	HU	%	HU	%	HU	%	HU	%
Low	1,761	28.1	406	26.4	1,185	35.9	576	19.4	603	7.0
Med	693	11.0	176	11.4	300	9.1	394	13.2	1,013	11.7
High	3,820	60.9	959	62.2	1,814	55.0	2,006	67.4	7,008	81.3
Total HUs	6,274	100.0	1,541	100.0	3,299	100.0	2,976	100.0	8,624	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.39		0.41		0.36		0.43		0.53	

Pileated woodpecker habitat within the mine impact area was composed of 1,185 HUs (36%) of low quality habitat, 300 HUs (9%) of medium quality habitat, and 1,814 HUs (55%) of high quality habitat (Table 67). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for pileated woodpeckers is 94% (3,299 HUs). Of the 6% which was considered unsuitable habitat, <1% consisted of water (Table 66).

High suitability habitat for pileated woodpeckers was mainly concentrated around the perimeter of the LSA (Figure 26). A few scattered pockets of high suitability habitat were also seen within the LSA. The majority of the LSA consisted of lower suitability habitat, possibly due to the lack of suitable forage and nesting trees in the fens.

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that pileated woodpeckers require mature to old growth, dense-canopied forests, particularly mixed and deciduous woods, for nesting, roosting, and foraging. Due to their large body size and since they are primary cavity nesters, they require large-diameter snags to construct nesting and roosting cavities. As the LSA is dominated by coniferous bogs and fens, with limited large snags, it was expected to provide generally poor habitat for pileated woodpeckers.

6.9.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect pileated woodpecker habitat by removing 53% of the HUs present (Table 68). Sixty-seven percent of low, 43% of medium and 47% of high quality habitat will be lost due to site clearing.

Table 68 Summary of Changes in Pileated Woodpecker Habitat Units From Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	1,761	-406	-23.1	-1,185	-67.3	-1,158	-65.8
Med	693	-176	-25.3	-300	-43.2	+320	+46.1
High	3,820	-959	-25.1	-1,814	-47.5	+3,188	+83.5
Total	6,274	-1,541	-24.6	-3,299	-52.6	+2,350	+37.5

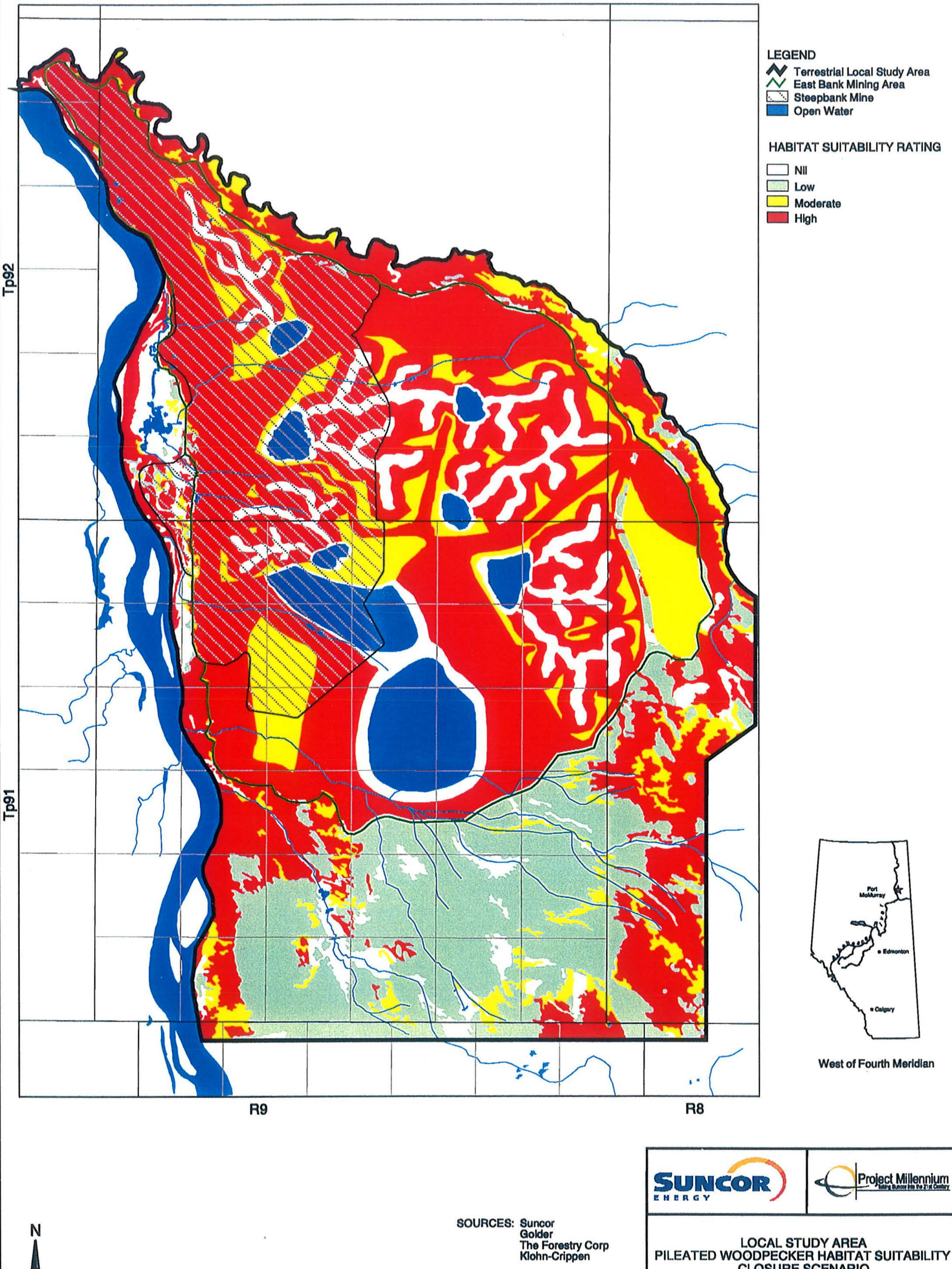
Pileated woodpeckers excavate nests in large dead trees, and feed on insects in large-diameter live, standing dead, or downed trees. The best habitat consists of mature mixed coniferous forest with >2 canopy layers, large live trees and dead and downed woody debris. It is expected that site clearing will remove large blocks of habitat, including large-diameter nest and roost trees.

6.9.3 Closure

Pileated woodpecker habitat is expected to increase by 90% during reclamation, resulting in 2,350 HUs (38%) over baseline conditions following closure (Table 68). This is due to overall gains of 320 HUs (46%) of medium suitability habitat and 3,188 HUs (84%) of high suitability habitat.

The vegetation types projected to be reclaimed represent medium to high suitability habitat, except for graminoid marshes (MONG); lakes (NWL); shrubland (shrub); and shrubby deciduous swamps (SONS). As a variety of moderate to high suitability habitats for pileated woodpeckers will be reclaimed, pileated woodpecker habitat is expected to increase over baseline conditions following closure (Figure 27).

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for pileated woodpeckers are not required.



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SOURCES: Suncor
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Map Projection: UTM 12
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SUNCOR ENERGY

Project Millennium — Taking Suncor into the 21st Century

LOCAL STUDY AREA
PILEATED WOODPECKER HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998	Figure 27	PRODUCED BY: CGA REVIEWED BY:

6.10 RED-BACKED VOLE

6.10.1 Baseline Conditions

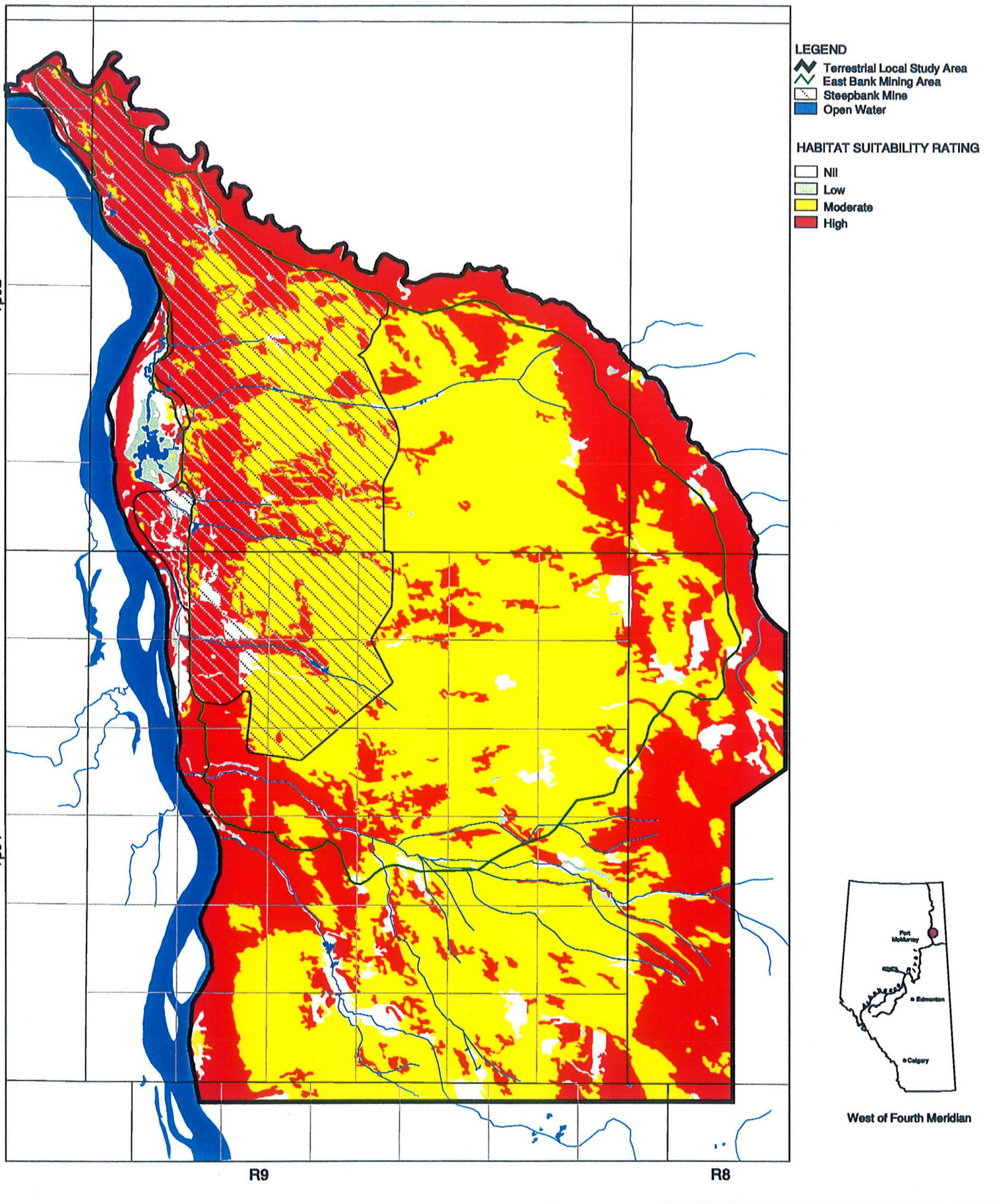
The suitability of the various ecosite phases within the LSA for red-backed vole habitat is presented in Table 69. Figure 28 depicts baseline habitat conditions for this KIR. High suitability habitat for red-backed voles within the LSA included the following ecosite phases:

- blueberry-white spruce-jack pine (b4);
- low-bush cranberry-trembling aspen (d1);
- dogwood-balsam poplar-trembling aspen (e1);
- low-bush cranberry-trembling aspen-white spruce (d2);
- blueberry-jack pine-trembling aspen (b1);
- dogwood-balsam poplar-white spruce (e2);
- low-bush cranberry-white spruce (d3);
- dogwood-white spruce (e3);
- blueberry-trembling aspen-white spruce (b3);
- wooded bogs (BTNN and BFNN);
- black spruce-larch complexes (Sb/Lt);
- wooded fens (FTNN and FFNN);
- Labrador tea - Subhygric - black spruce - jack pine (g1);
- regrown cutblocks at closure;
- Labrador tea - Mesic - jack pine - black spruce (c1);
- lichen - jack pine (a1);
- Labrador tea - horsetail - white spruce - black spruce (h1); and
- shurbby fens (FONS).

Unsuitable habitat for red-backed voles included graminoid marshes (MONG), lakes (NWL); shallow open water (WONN) and shrubby marshes (MONS).

Table 69 Red-backed Vole HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	b4	Blueberry Sw-Pj	1.00
	d1	Low-bush Cranberry Aw	1.00
	e1	Dogwood Pb-Aw	1.00
	d2	Low-bush Cranberry Aw-Sw	0.99
	b1	Blueberry Pj-Aw	0.95
	e2	Dogwood Pb-Sw	0.93
	d3	Low-bush Cranberry Sw	0.91
	e3	Dogwood Sw	0.87
	b3	Blueberry Aw-Sw	0.87
	BFNN	Wooded bog (tree cover >70%)	0.86
	Sb/Lt	Black Spruce - Larch Complexes	0.86
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.84
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.80
	g1	Labrador Tea - subhygric Sb-Pj	0.74
	CC-OLD	Regrown Cutblocks at Closure	0.72
	c1	Labrador Tea - mesic Pj-Sb	0.72
	a1	Lichen Pj	0.71
	h1	Labrador Tea/Horsetail Sw-Sb	0.69
	FFNN	Wooded Fen (tree cover >70%)	0.68
	FONS	Shrubby Fen	0.67
Medium Suitability (0.34 - 0.66)	SFNN	Swamp (tree cover >70%)	0.66
	STNN	Swamp (tree cover >10% and ≤70%)	0.66
	b2	Blueberry Aw(Bw)	0.50
	SONS	Swamp (deciduous shrub)	0.42
	HG/CC	Herbacious Graminoid Cutblock	0.40
	Shrub	Shrubland	0.38
Low Suitability (0.01 - 0.33)	AIH	Roads and Rights of Ways	0.12
	AIG	Gravel Pits	0.06
	CIP	Revegetated Industrial Lands	0.06
	CIW	Well Sites - vegetated	0.06
	FONG	Graminoid Fen	0.06
	NMC	Cutbanks	0.06
	NMS	Sand	0.06
Unsuitable (0.00)	MONG	Graminoid Marsh	0.00
	MONS	Shrubby Marsh	0.00
	NWF	Flooded Area	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow open water	0.00



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SOURCES: Suncor
Golder
The Forestry Corp
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Map Projection: UTM 12
Datum: NAD 83

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LOCAL STUDY AREA
RED-BACKED VOLE HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998 | Figure 28 | PRODUCED BY: CGA
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The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for red-backed voles is 99% (11,310 HUs). Of the 1% which was considered unsuitable habitat, all of it consisted of water (Table 70). The mean suitability of the LSA (total HUs/total area) was 0.70 or high (Table 71).

Table 70 Percent of Area and Habitat Units by Suitability Class for Red-backed Vole Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class – Unsuitable Habitat – Water	Other	Total	Suitable Habitat – Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class – Low	Med.	High
Predevelopment	16,181	0.7	0.0	0.7	1.1	57.7	40.5	99.3	11,310	0.1	46.4	53.5
Steepbank	3,776	0.2	0.0	0.2	0.7	52.7	46.4	99.8	2,745	0.1	41.4	58.5
East Bank Mine Impact	9,281	0.1	0.0	0.1	0.4	64.9	34.6	99.9	6,367	0.0	54.1	45.8
Remaining at Full Impact	6,901	1.5	0.0	1.5	2.0	48.1	48.5	98.5	4,943	0.2	36.4	63.5
Closure	16,181	9.9	2.7	12.6	0.8	27.8	63.4	92.0	12,173	0.1	19.1	80.8

Of the 11,310 HUs of red-backed vole habitat, the LSA is currently composed of 12 HUs (<1%) of low quality habitat, 5,243 HUs (46%) of medium quality habitat, and 6,055 HUs (54%) of high quality habitat (Table 71). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Red-backed vole habitat within the Steepbank mining area was composed of 2 HUs (<1%) of low quality habitat, 1,136 HUs (41%) of medium quality habitat, and 1,607 HUs (59%) of high quality habitat (Table 71). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for red-backed voles is 100% (2,745 HUs). Of the <1% which was considered unsuitable habitat, all of it consisted of water.

Table 71 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Red-backed Vole Habitat in the LSA

Habitat Class	Predevelop-ment HU	%	Steepbank HU	%	East Bank Mine Impact HU	%	Remaining at Impact HU	%	Closure HU	%
Low	12	0	2	0	2	0.0	9	0.2	10	0.1
Med	5,243	46	1,136	41	3,446	54.1	1,797	36.4	2,325	19.1
High	6,055	54	1,607	59	2,919	45.8	3,137	63.5	9,838	80.8
Tota HUsl	11,310	100	2,745	100	6,367	100.0	4,943	100.0	12,173	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.70		0.73		0.69		0.72		0.75	

Red-backed vole habitat within the mine impact area was composed of 2 HUs (0%) of low quality habitat, 3,446 HUs (54%) of moderate quality habitat, and 2,919 HUs (46%) of high quality habitat (Table 71). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for red-backed voles is 100% (6,367 HUs). Of the <1% which was considered unsuitable habitat, all of it consisted of water.

High suitability habitat for red-backed voles was mainly concentrated around the perimeter of the LSA (Figure 28). A few scattered pockets of high suitability habitat were also seen within the LSA. The majority of the LSA consisted of moderate suitability habitat. Very few pockets of low or unsuitable habitat were observed.

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that aspen and mixed white spruce-jack pine communities provide prime habitat for red-backed voles. Red-backed voles have also been recorded in a variety of wetland, riparian, and coniferous habitats. In northern Alberta, red-backed voles occupy a variety of boreal habitats, using both ground and shrub layers for food and cover. Thus, the LSA was expected to provide an abundance of suitable habitat for red-backed voles.

6.10.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect red-backed vole habitat by removing 56% of the HUs present (Table 72). Nineteen percent of low, 66% of medium and 48% of high quality habitat will be lost due to site clearing.

Table 72 Summary of Changes in Red-backed Vole Habitat Units From Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	12	-2	-14.6	-2	-19.7	-2	-18.9
Med	5,243	-1,136	-21.7	-3,446	-65.7	-2,918	-55.6
High	6,055	-1,607	-26.5	-2,919	-48.2	+3,783	+62.5
Total	11,310	-2,745	-24.3	-6,367	-56.3	+863	+7.6

As red-backed voles are habitat generalists, inhabiting mesic habitats within mature coniferous, deciduous and mixed forests with abundant downed woody debris and dense vegetation. Site clearing is projected to remove an abundance of potential red-backed vole habitat.

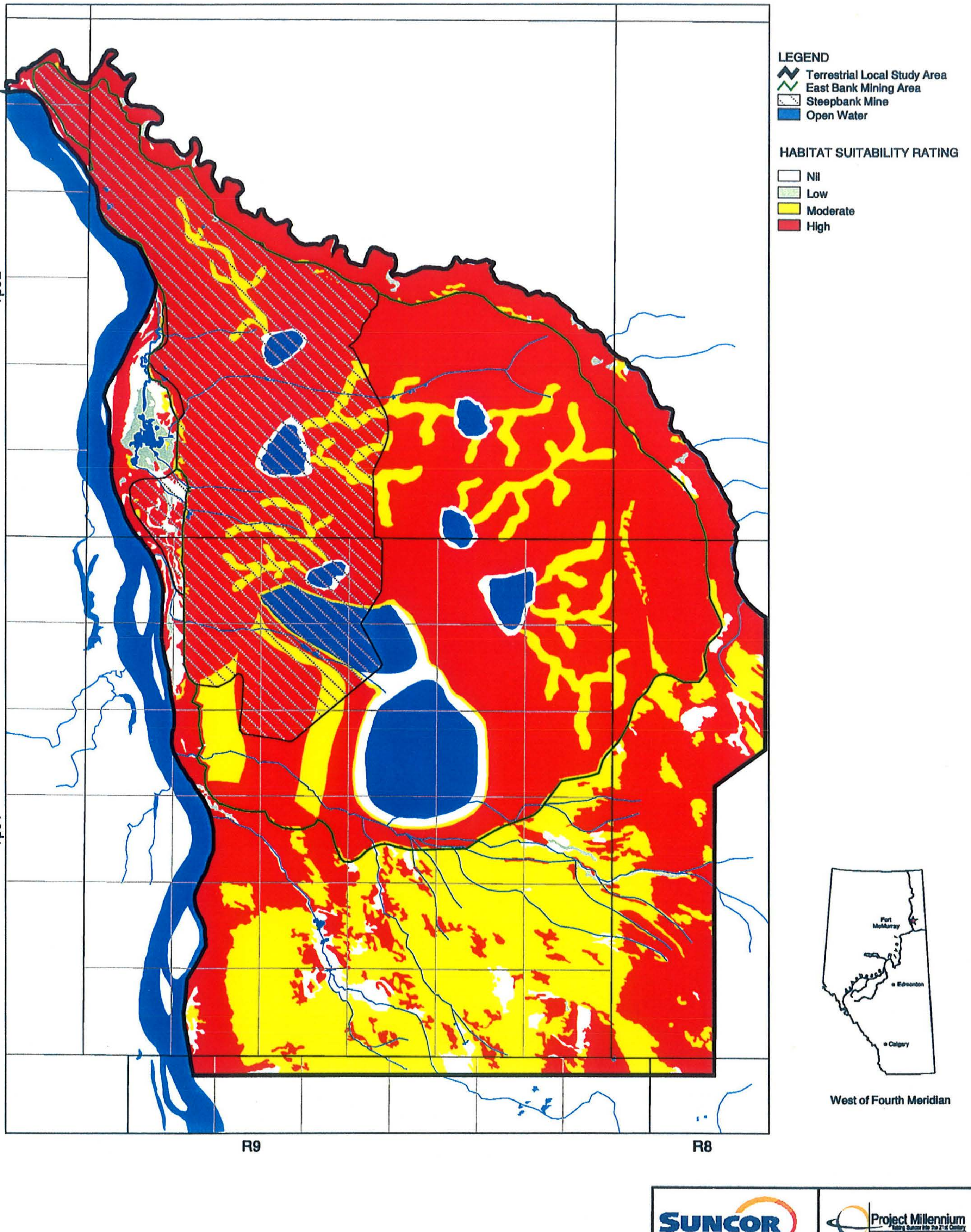
6.10.3 Closure

Red-backed vole habitat is expected to increase by 64% during reclamation, resulting in 863 HUs (8%) over baseline conditions following closure

(Table 72). This is due to an overall gain of 3,783 HUs (63%) of high suitability habitat.

During closure, the mine footprint will be reclaimed with moderate to high suitability habitat types (Figure 29), except for graminoid marshes (MONG) and lakes (NWL). As a variety of moderate to high suitability habitats for red-backed voles will be reclaimed, red-backed vole habitat is expected to increase over baseline conditions following closure.

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for red-backed voles are not required.



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Map Projection: UTM 12
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Project Millennium

LOCAL STUDY AREA
RED-BACKED VOLE HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998

Figure 29

PRODUCED BY: CGA
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6.11 RUFFED GROUSE

6.11.1 Baseline Conditions

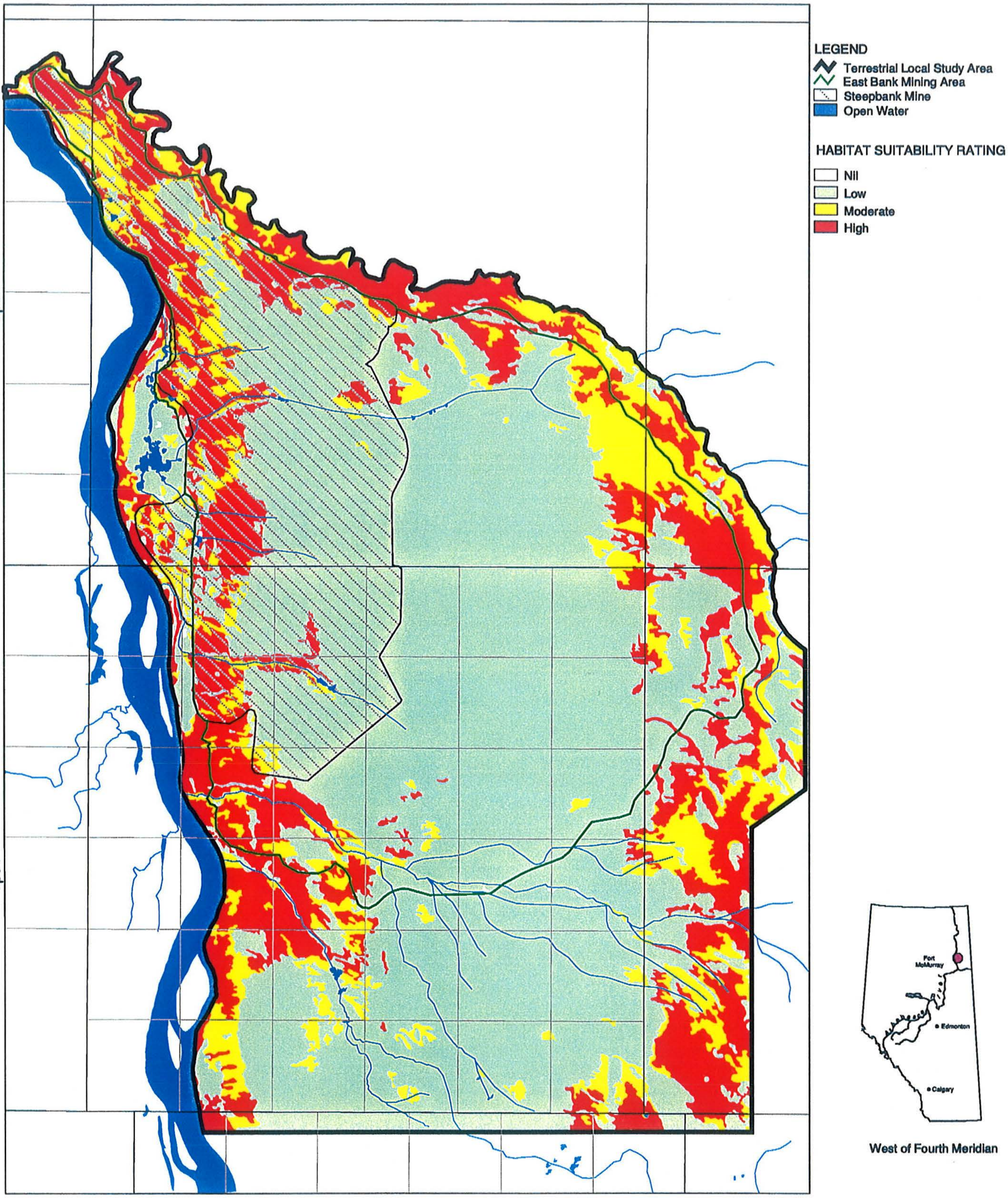
The suitability of the various ecosite phases within the LSA for ruffed grouse habitat is presented in Table 73 and baseline conditions are shown in Figure 30. High suitability habitat for ruffed grouse within the LSA included the following ecosite phases:

- dogwood-balsam poplar-trembling aspen (e1);
- low-bush cranberry-trembling aspen (d1);
- low-bush cranberry-trembling aspen-white spruce (d2);
- blueberry-trembling aspen-paper birch (b2);
- dogwood-balsam poplar-white spruce (e2); and
- blueberry-jack pine-trembling aspen (b1).

Unsuitable habitat for ruffed grouse included lakes (NWL), rivers (NWR), and shallow open water (WONN).

Table 73 Ruffed Grouse HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	e1	Dogwood Pb-Aw	0.95
	d1	Low-bush Cranberry Aw	0.83
	d2	Low-bush Cranberry Aw-Sw	0.74
	b2	Blueberry Aw(Bw)	0.73
	e2	Dogwood Pb-Sw	0.69
	b1	Blueberry Pj-Aw	0.68
Medium Suitability (0.34 - 0.66)	b3	Blueberry Aw-Sw	0.55
	CC-OLD	Regrown Cutblocks at Closure	0.43
	b4	Blueberry Sw-Pj	0.42
	d3	Low-bush Cranberry Sw	0.36
	SONS	Swamp (deciduous shrub)	0.35
	MONS	Shrubby Marsh	0.34
Low Suitability (0.01 - 0.33)	e3	Dogwood Sw	0.33
	FONS	Shrubby Fen	0.30
	BFNN	Wooded bog (tree cover >70%)	0.29
	a1	Lichen Pj	0.29
	Shrub	Shrubland	0.28
	h1	Labrador Tea/Horsetail Sw-Sb	0.27
	STNN	Swamp (tree cover >10% and <=70%)	0.26
	g1	Labrador Tea - subhygric Sb-Pj	0.26
	c1	Labrador Tea - mesic Pj-Sb	0.25
	SFNN	Swamp (tree cover >70%)	0.24
	Sb/Lt	Black Spruce - Larch Complexes	0.23
	BTNN	Wooded bog (tree cover >10% and <=70%)	0.23
	FFNN	Wooded Fen (tree cover >70%)	0.20
	FTNN	Wooded Fen (tree cover >10% and <=70%)	0.20
	HG/CC	Herbacious Graminoid Cutblock	0.15
	NWF	Flooded Area	0.14
	AIH	Roads and Rights of Ways	0.04
	NMC	Cutbanks	0.02
	NMS	Sand	0.02
	AIG	Gravel Pits	0.02
	CIP	Revegetated Industrial Lands	0.02
	CIW	Well Sites - vegetated	0.02
	FONG	Graminoid Fen	0.02
	MONG	Graminoid Marsh	0.02
Unsuitable (0.00)	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow open water	0.00



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LOCAL STUDY AREA
RUFFED GROUSE HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998

Figure 30

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The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for ruffed grouse is 99% (6,685 HUs). Of the 1% which was considered unsuitable habitat, all of it consisted of water (Table 74). The mean suitability of the LSA (total HUs/total area) was 0.41 or medium (Table 75).

Table 74 Percent of Area and Habitat Units by Suitability Class for Ruffed Grouse Habitat in the LSA

		Percent of Area by Suitability Class								Percent of Habitat Units by Suitability Class		
	Area	Unsuitable Habitat			Suitable Habitat				Habitat			
Scenario	(ha)	Water	Other	Total	Low	Med	High	Total	Units	Low	Med.	High
Predevelopment	16,181	0.7	0.0	0.7	65.0	13.0	21.2	99.3	6,685	35.3	16.0	48.7
Steepbank	3,776	0.2	0.0	0.2	61.4	13.3	25.1	99.8	1,667	31.0	15.1	54.0
East Bank Mine Impact	9,281	0.1	0.0	0.1	71.9	10.1	17.8	99.9	3,605	41.6	13.7	44.7
Remaining at Full Impact	6,901	1.5	0.0	1.5	55.7	17.0	25.8	98.5	3,081	27.8	18.7	53.5
Closure	16,181	6.3	0.0	6.3	28.3	18.0	47.4	93.7	8,904	11.3	15.2	73.4

Of the 6,685 HUs of ruffed grouse habitat, the LSA is currently composed of 2,357 HUs (35%) of low quality habitat, 1,070 HUs (16%) of medium quality habitat and 3,258 HUs (49%) of high quality habitat (Table 75). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Ruffed grouse habitat within the Steepbank mining area was composed of 516 HUs (31%) of low quality habitat, 251 HUs (15%) of medium quality habitat, and 899 HUs (54%) of high quality habitat (Table 75). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for ruffed grouse is 100% (2,745 HUs). Of the <1% which was considered unsuitable habitat all of it consisted of water.

Table 75 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Ruffed Grouse Habitat in the LSA

	Predevelop-ment		Steepbank		East Bank Mine Impact		Remaining at Impact		Closure	
Habitat Class	HU	%	HU	%	HU	%	HU	%	HU	%
Low	2,357	35	516	31	1,501	41.6	856	27.8	1,008	11.3
Med	1,070	16	251	15	494	13.7	576	18.7	1,357	15.2
High	3,258	49	899	54	1,610	44.7	1,648	53.5	6,539	73.4
Total HUs	6,685	100	1,667	100	3,605	100.0	3,081	100.0	8,904	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.41		0.44		0.39		0.45		0.55	

Ruffed grouse habitat within the mine impact area was composed of 1,501 HUs (42%) of low quality habitat, 494 HUs (14%) of medium quality habitat, and 1,610 HUs (45%) of high quality habitat (Table 75). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for ruffed grouse is 100% (3,538 HUs). All of the <1% which was considered unsuitable habitat consisted of water.

High and medium suitability habitat for ruffed grouse was mainly concentrated around the perimeter of the LSA (Figure 30). A few scattered pockets of high and moderate suitability habitat were also seen within the LSA. The majority of the LSA consisted of low suitability habitat.

In the wildlife baseline report for Project Millennium, Golder (1998n) reported that ruffed grouse distribution is tied to deciduous and mixedwood forest, particularly those seral stages that possess a well-developed shrub component. Thus, the LSA was expected to provide a moderate amount of suitable habitat for ruffed grouse.

Winter track counts of grouse could not differentiate between grouse species and sample sizes were low (Appendix V). Thus, verification of the model using field data was not possible.

6.11.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect ruffed grouse habitat by removing 54% of the HUs present (Table 76). Sixty-three percent of low, 46% of medium and 49% of high quality habitat will be lost due to site clearing.

Table 76 Summary of Changes in Ruffed Grouse Habitat Units From Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	2,357	-516	-21.9	-1,501	-63.7	-1,349	-57.2
Med	1,070	-251	-23.5	-494	-46.1	+286	+26.8
High	3,258	-899	-27.6	-1,610	-49.4	+3,281	+100.7
Total	6,685	-1,667	-24.9	-3,605	-53.9	+2,219	+33.2

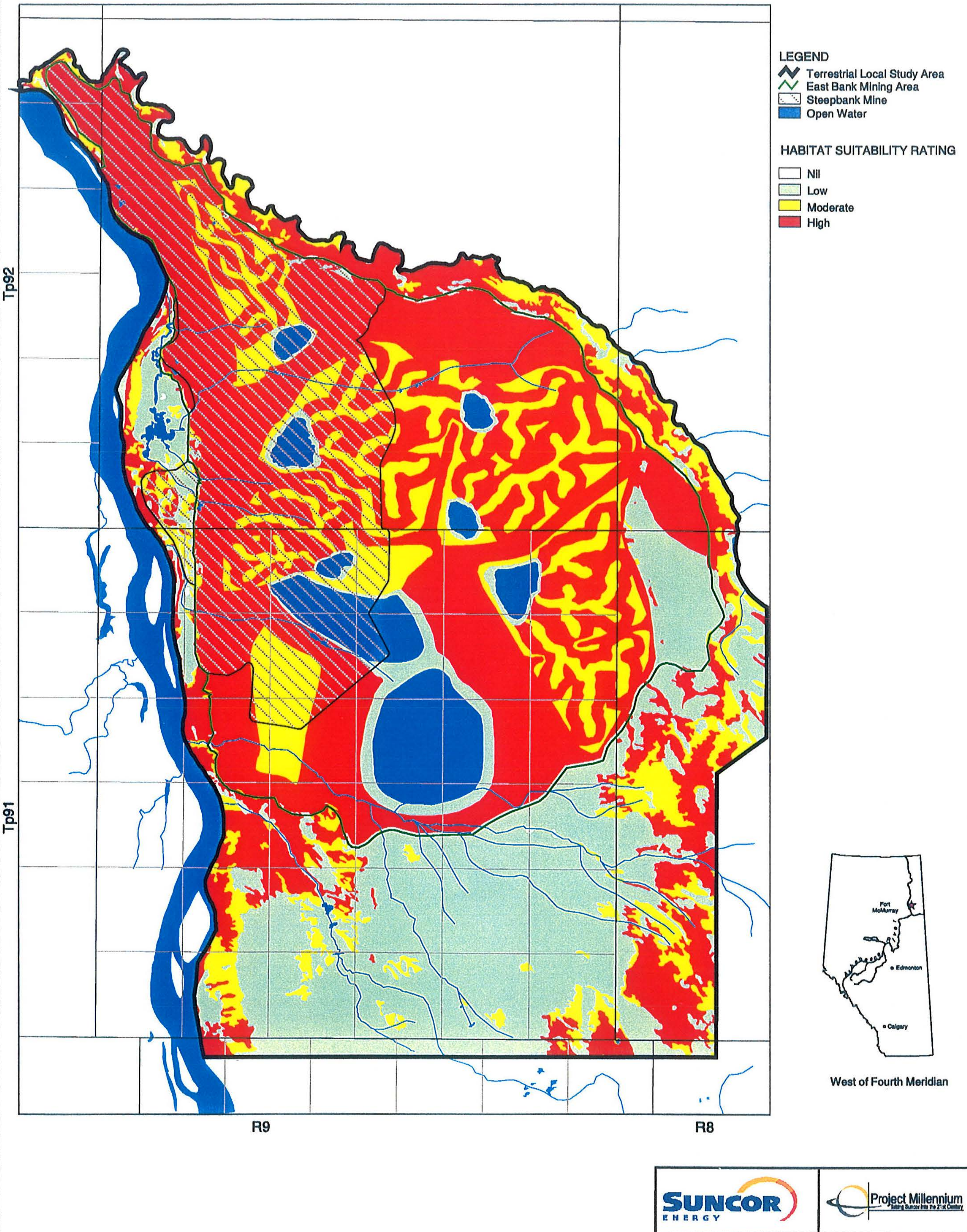
The effects of habitat loss, alteration and fragmentation on ruffed grouse are difficult to predict, however, some displacement to adjacent, suitable habitat is likely to occur.

6.11.3 Closure

Ruffed grouse habitat is expected to increase by 87% during reclamation, resulting in 2,219 HUs (33%) over baseline conditions following closure (Table 76). This is due to an overall gain of 27% moderate suitability habitat (286 HUs) and 101% of high suitability habitat (3,281 HUs), relative to baseline conditions.

With regard to ruffed grouse, all of the vegetation types that will be reclaimed represent moderate to high suitability habitat, except for dogwood-white spruce (e3), shrubland (shrub), graminoid marshes (MONG) and lakes (NWL) (Figure 31). As a variety of moderate to high suitability habitats for ruffed grouse will be reclaimed, ruffed grouse habitat is expected to increase over baseline conditions following closure.

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for ruffed grouse are not required.



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LOCAL STUDY AREA
RUFFED GROUSE HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998	Figure 31	PRODUCED BY: CGA REVIEWED BY:

6.12 SNOWSHOE HARE

6.12.1 Baseline Conditions

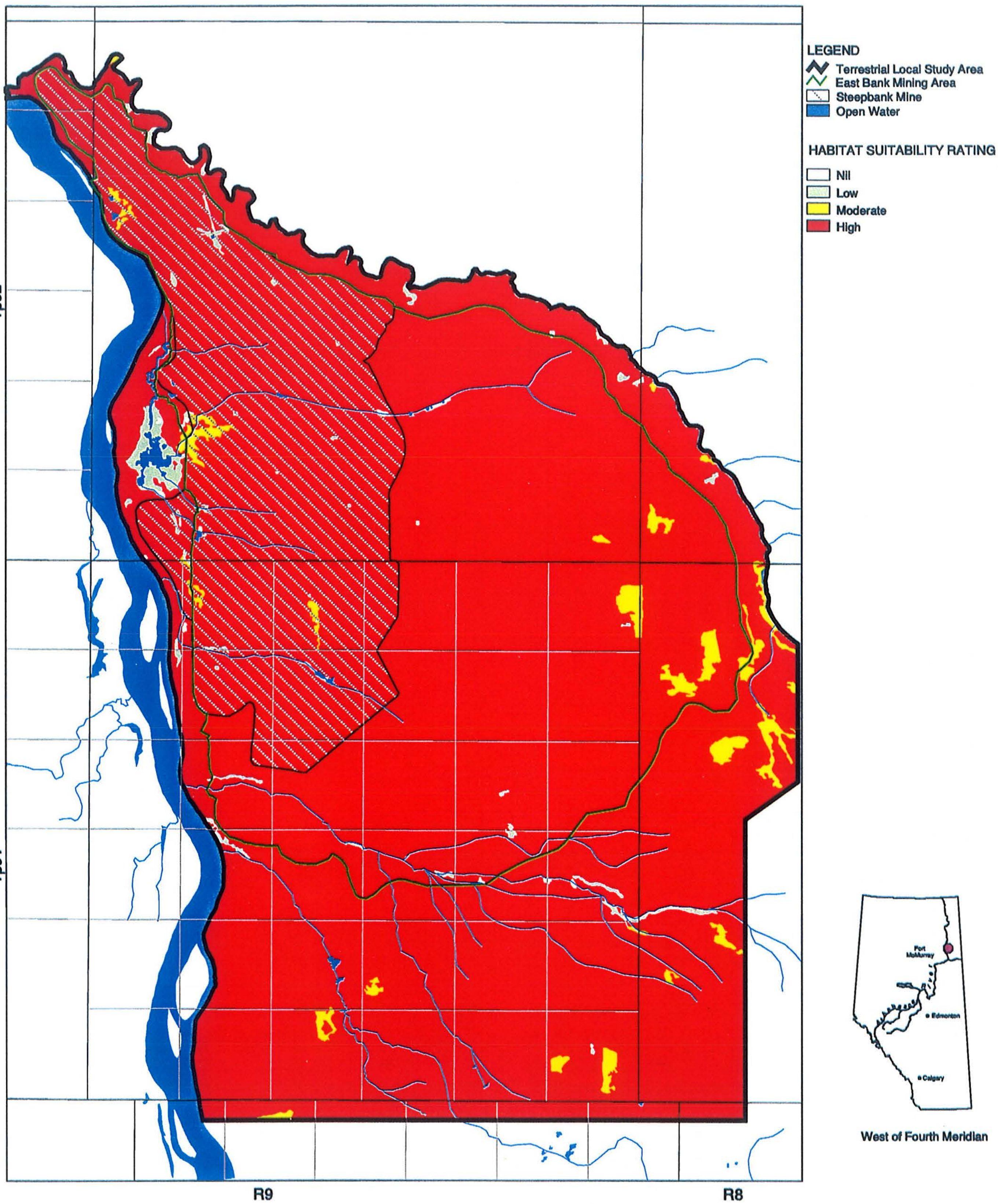
The suitability of the various ecosite phases within the LSA for snowshoe hare habitat is presented in Table 77. Baseline conditions are mapped in Figure 32. High suitability habitat for snowshoe hares within the LSA included the following ecosite phases:

- low-bush cranberry-trembling aspen (d1);
- wooded fens (FTNN and FFNN);
- shrubby fen (FONS);
- shrubby marsh (MONS);
- treed or shurbby swamps (SONS, SFNN and STNN);
- shrubland (Shrub);
- dogwood-balsam poplar-trembling aspen (e1);
- low-bush cranberry-trembling aspen-white spruce (d2);
- wooded bogs (BTNN and BFNN);
- black spruce - larch complexes (Sb-Lt);
- blueberry - white spruce - jack pine (b4);
- blueberry - aspen - white spruce (b3);
- dogwood - balsam poplar - white spruce (e2);
- regrown cutblocks at closure;
- Labrador tea Subhygric - black spruce - jack pine (g1);
- low-bush cranberry - white spruce (d3);
- blueberry - jack pine - aspen (b1);
- herbaceous/graminoid cutblocks (h6/cc); and
- dogwood - white spruce (e3).

Unsuitable habitat for snowshoe hares included lakes (NWL), rivers (NWR) and shallow open water (WONN).

Table 77 Snowshoe Hare HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	d1	Low-bush Cranberry Aw	0.95
	FFNN	Wooded Fen (tree cover >70%)	0.95
	FONS	Shrubby Fen	0.95
	MONS	Shrubby Marsh	0.95
	SFNN	Swamp (tree cover >70%)	0.95
	Shrub	Shrubland	0.95
	SONS	Swamp (deciduous shrub)	0.95
	e1	Dogwood Pb-Aw	0.93
	d2	Low-bush Cranberry Aw-Sw	0.92
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.88
	STNN	Swamp (tree cover >10% and ≤70%)	0.88
	Sb/Lt	Black Spruce - Larch Complexes	0.87
	BFNN	Wooded bog (tree cover >70%)	0.86
	b4	Blueberry Sw-Pj	0.83
	b3	Blueberry Aw-Sw	0.79
	e2	Dogwood Pb-Sw	0.79
	CC-OLD	Regrown Cutblocks at Closure	0.78
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.76
	g1	Labrador Tea - subhygric Sb-Pj	0.75
	d3	Low-bush Cranberry Sw	0.74
	b1	Blueberry Pj-Aw	0.74
	HG/CC	Herbacious Graminoid Cutblock	0.73
	e3	Dogwood Sw	0.70
Medium Suitability (0.34 - 0.66)	c1	Labrador Tea - mesic Pj-Sb	0.65
	NWF	Flooded Area	0.57
	h1	Labrador Tea/Horsetail Sw-Sb	0.47
	a1	Lichen Pj	0.46
	b2	Blueberry Aw(Bw)	0.41
	AIH	Roads and Rights of Ways	0.37
Low Suitability (0.01 - 0.33)	NMC	Cutbanks	0.27
	NMS	Sand	0.27
	AIG	Gravel Pits	0.26
	CIP	Revegetated Industrial Lands	0.25
	CIW	Well Sites - vegetated	0.25
	FONG	Graminoid Fen	0.23
	MONG	Graminoid Marsh	0.20
Unsuitable (0.00)	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow open water	0.00



SUNCOR ENERGY

Project Millennium

SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

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Metres
Scale 1:100,000

Map Projection: UTM 12
Datum: NAD 83

LOCAL STUDY AREA
SNOWSHOE HARE HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998

Figure 32

PRODUCED BY: CGA
REVIEWED BY:

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The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for snowshoe hares is 99% (14,426 HUs). All of the 1% considered unsuitable habitat consisted of water (Table 78). The mean suitability of the LSA (total HUs/total area) was 0.89 or high (Table 79).

Table 78 Percent of Area and Habitat Units by Suitability Class for Snowshoe Hare Habitat in the LSA

		Percent of Area by Suitability Class								Percent of Habitat Units by Suitability Class		
	Area	Unsuitable Habitat			Suitable Habitat				Habitat			
Scenario	(ha)	Water	Other	Total	Low	Med	High	Total	Units	Low	Med.	High
LSA	16,181	0.7	0.0	0.7	1.0	1.8	96.5	99.3	14,426	0.1	1.2	98.7
Steepbank	3,776	0.2	0.0	0.2	0.7	1.3	97.7	99.8	3,381	0.1	0.7	99.2
Full Mine Impact	9,281	0.1	0.0	0.1	0.4	0.1	99.4	99.9	8,496	0.1	0.0	99.9
Remaining at Full Impact	6,901	1.5	0.0	1.5	1.9	4.1	92.6	98.5	5,930	0.3	2.9	96.9
Closure	16,181	6.3	0.0	6.3	2.5	2.9	88.3	93.7	13,208	0.5	1.7	97.8

Of the 14,426 HUs of snowshoe hare habitat, the LSA is currently composed of 2 HUs (<1%) of low quality habitat, 171 HUs (1%) of medium quality habitat, and 14,234 HUs (99%) of high quality habitat (Table 79). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Snowshoe hare habitat within the Steepbank mining area was composed of 4 HUs (<1%) of low quality habitat, 24 HUs (1%) of medium quality habitat, and 3,353 HUs (99%) of high quality habitat (Table 79). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for snowshoe hares is 100% (3,381 HUs). All of the <1% considered unsuitable habitat consisted of water.

Table 79 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Snowshoe Hare Habitat in the LSA

	Predevelopmen t		Steepbank		Mine Impact		Remaining at Impact		Closure	
Habitat Class	HU	%	HU	%	HU	%	HU	%	HU	%
Low	21	0	4	0	6	0.1	16	0.3	72	0.5
Med	171	1	24	1	0	0.0	171	2.9	224	1.7
High	14,234	99	3,353	99	8,490	99.9	5,744	96.9	12,912	97.8
TotalHUs	14,426	100	3,381	100	8,496	100.0	5,930	100.0	13,208	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.89		0.90		0.92		0.86		0.82	

Snowshoe hare habitat within the mine impact area was composed of 6 HUs (<1%) of low quality habitat, no HUs (0%) of medium quality habitat, and 8490 HUs (100%) of high quality habitat (Table 79). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for snowshoe hares is 100% (8,496 HUs). All of the <1% considered unsuitable habitat consisted of water.

The majority of the LSA is rated as high suitability habitat for snowshoe hares, with a few scattered areas of medium habitat occurring near the perimeter (Figure 32).

The wildlife baseline report for Project Millennium, Golder (1998n) reported that 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. Thus, the LSA was expected to provide a medium amount of suitable habitat for snowshoe hares.

Winter track count data was not positively correlated with HSI values (Appendix V). However, caution must be exercised in interpreting this result due to a small sample size.

6.12.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect snowshoe hare habitat by removing 59% of the HUs present (Table 80). Twenty-six percent of low, <1% of medium and 60% of high quality habitat will be lost due to site clearing.

Table 80 Summary of Changes in Snowshoe Hare Habitat Units From Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	21	-4	-17.4	-6	-26.1	+51	+238.1
Med	171	-24	-14.2	-0	-0.2	+53	+31.1
High	14,234	-3,353	-23.6	-8,490	-59.6	-1,322	-9.3
Total	14,426	-3,381	-23.4	-8,496	-58.9	-1,218	-8.4

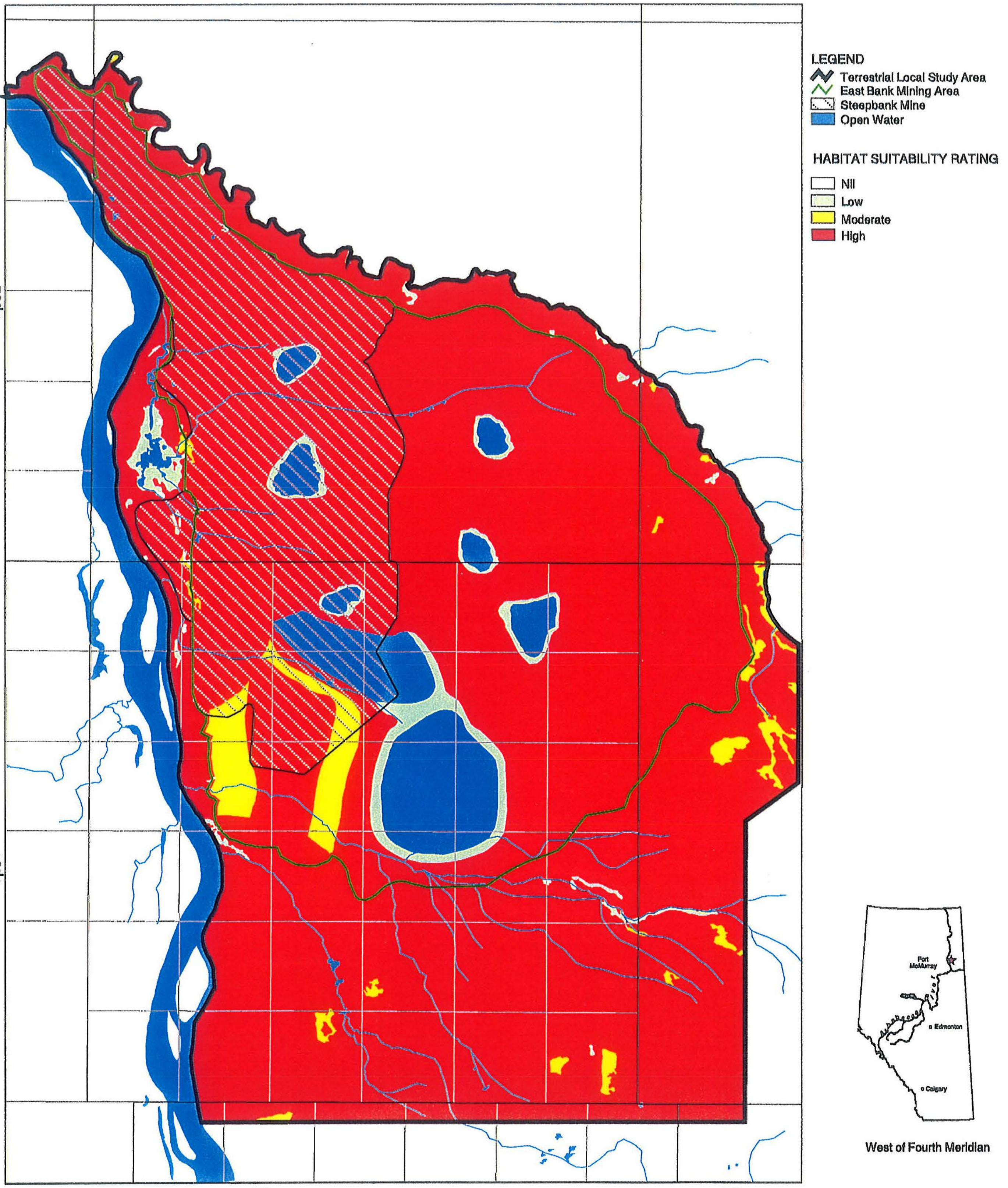
Snowshoe hares are relatively sedentary animals that live within a limited home range (typically <10 ha). The average home range in Alberta is 200 m diameter. Studies suggest habitat alteration, such as forest cutting, eliminates hares if suitable habitat with forest cover is not provided within 200 to 400 m. However, in the longer term, habitat alterations such as forest removal can rejuvenate understory vegetation with the potential of improving habitat for snowshoe hares.

6.12.3 Closure

Snowshoe hare habitat is expected to increase by 51% during reclamation, resulting in 1,218 HUs (8%) less than baseline conditions following closure (Table 80). This is due to an overall loss of 9% of high suitability habitat (1,322 HUs), relative to baseline conditions.

All of the vegetation types that are projected to be reclaimed following closure represent moderate to high suitability habitat, except for graminoid marshes (MONG) and lakes (NWL). Although a variety of moderate to high suitability habitats for snowshoe hares will be reclaimed, snowshoe hare habitat is expected decrease below baseline conditions following closure due to the difficulties in reclaiming bogs and fens (Figure 33).

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for snowshoe hares are not required.



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Metres
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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

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Project Millennium

LOCAL STUDY AREA
SNOWSHOE HARE HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998

Figure 33

PRODUCED BY: CGA
REVIEWED BY:

6.13 WESTERN TANAGER

6.13.1 Baseline Conditions

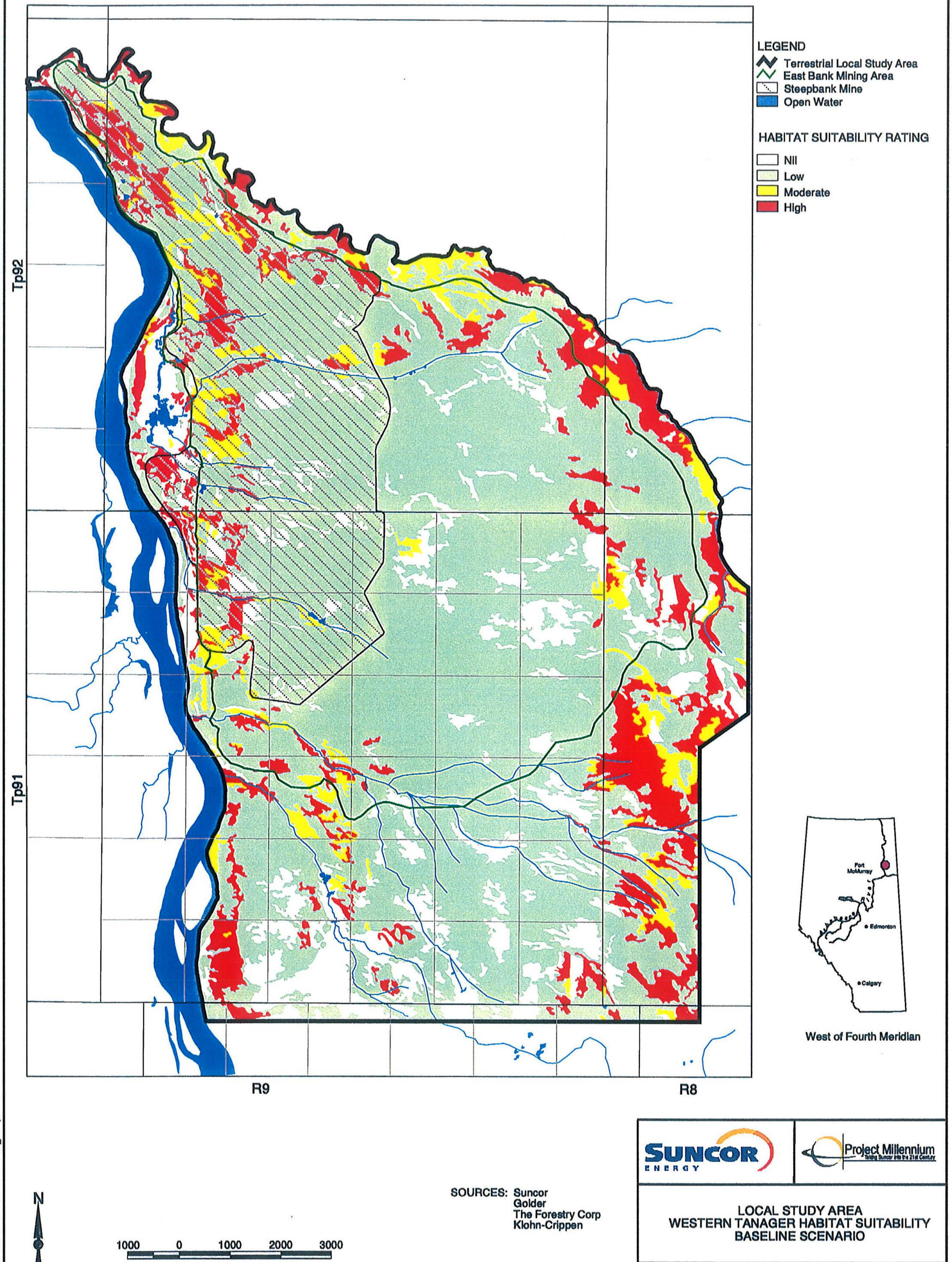
The suitability of the various ecosite phases within the LSA for western tanager habitat is presented in Table 81 and shown in Figure 34. High suitability habitat for western tanagers within the LSA included the following ecosite phases:

- blueberry trembling aspen-white spruce(b3);
- blueberry jack pine-trembling aspen (b1);
- blueberry white spruce-jack pine (b4);
- low bush cranberry trembling aspen-white spruce (d2);
- low bush cranberry trembling aspen-white spruce (d2);
- low-bush cranberry-white spruce (d3);
- dogwood-balsam poplar-white spruce (e2);
- dogwood-white spruce (e3);
- lichen-jack pine (a1);
- Labrador tea - Mesic - jack pine- black spruce (c1); and
- Labrador tea - horsetail - white spruce - black spruce (h1).

Unsuitable habitat for western tanagers included shrubby fen (FONS), swamp (SONS), shrubland (shrub), herbaceous graminoid cutblock (HG/CC) and graminoid fen (FONG).

Table 81 Western Tanager HSI Vegetation Class Ratings in the LSA

Habitat Suitability Class	Phase	Description	HSI
High Suitability (0.67 - 1.00)	b3	Blueberry Aw-Sw	1.00
	b1	Blueberry Pj-Aw	0.90
	b4	Blueberry Sw-Pj	0.90
	d2	Low-bush Cranberry Aw-Sw	0.90
	d3	Low-bush Cranberry Sw	0.90
	e2	Dogwood Pb-Sw	0.90
	e3	Dogwood Sw	0.90
	a1	Lichen Pj	0.85
	c1	Labrador Tea - mesic Pj-Sb	0.69
	h1	Labrador Tea/Horsetail Sw-Sb	0.67
Medium Suitability	d1	Low-bush Cranberry Aw	0.41
Low Suitability (0.01 - 0.33)	Sb/Lt	Black Spruce - Larch Complexes	0.30
	e1	Dogwood Pb-Aw	0.22
	b2	Blueberry Aw(Bw)	0.21
	g1	Labrador Tea - subhygric Sb-Pj	0.09
	STNN	Swamp (tree cover >10% and ≤70%)	0.09
	BTNN	Wooded bog (tree cover >10% and ≤70%)	0.04
	CC-OLD	Regrown Cutblocks at Closure	0.04
	FTNN	Wooded Fen (tree cover >10% and ≤70%)	0.03
	BFNN	Wooded bog (tree cover >70%)	0.02
	SFNN	Swamp (tree cover >70%)	0.01
	FFNN	Wooded Fen (tree cover >70%)	0.01
Unsuitable (0.00)	FONS	Shrubby Fen	0.00
	SONS	Swamp (deciduous shrub)	0.00
	Shrub	Shrubland	0.00
	HG/CC	Herbacious Graminoid Cutblock	0.00
	FONG	Graminoid Fen	0.00
	AIG	Gravel Pits	0.00
	AIH	Roads and Rights of Ways	0.00
	CIP	Revegetated Industrial Lands	0.00
	CIW	Well Sites - vegetated	0.00
	MONG	Graminoid Marsh	0.00
	MONS	Shrubby Marsh	0.00
	NMC	Cutbanks	0.00
	NMS	Sand	0.00
	NWF	Flooded Area	0.00
	NWL	Lake	0.00
	NWR	River	0.00
	WONN	Shallow open water	0.00



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LOCAL STUDY AREA
WESTERN TANAGER HABITAT SUITABILITY
BASELINE SCENARIO

07 Apr. 1998 | Figure 34 | PRODUCED BY: CGA REVIEWED BY: WB

The overall suitability of the LSA (sum of low, medium and high habitat areas divided by the total number of ha) for western tanagers is 85% (2,929 HUs). Of the 15% which was considered unsuitable habitat, 1% consisted of water (Table 82). The mean suitability of the LSA (total HUs/total area) was 0.18 or low (Table 83).

Table 82 Percent of Area and Habitat Units by Suitability Class for Western Tanager Habitat in the LSA

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med.	High
Predevelopment	16,181	0.7	14.1	14.8	67.4	5.4	12.4	85.2	2,929	24.4	14.8	60.7
Steepbank	3,776	0.2	9.5	9.7	69.6	6.9	13.7	90.3	749	21.4	17.8	60.9
East Mine Impact	9,281	0.1	9.3	9.4	78.0	4.4	8.2	90.6	1,304	31.5	15.7	52.8
Remaining at Full Impact	6,901	1.5	20.6	22.0	53.1	6.7	18.1	78.0	1,625	18.7	14.2	67.1
Closure	16,181	6.3	15.5	21.8	36.8	10.3	31.1	78.2	6,099	13.0	11.8	75.2

Of the 2,929 HUs of western tanager habitat, the LSA is currently composed of 715 HUs (24%) of low quality habitat, 435 HUs (15%) of medium quality habitat, and 1,779 HUs (61%) of high quality habitat (Table 83). The distribution of HUs for the Steepbank and the mine impact area were similar to that seen in the LSA. Western tanager habitat within the Steepbank mining area was composed of 160 HUs (22%) of low quality habitat, 133 HUs (18%) of medium quality habitat, and 456 HUs (61%) of high quality habitat (Table 83). The overall suitability of the Steepbank mining area (sum of low, medium and high habitat areas divided by the total number of ha) for western tanagers is 90% (749 HUs). Of the 10% which was considered unsuitable habitat <1% consisted of water.

Table 83 Changes per Habitat Suitability Class for Impact and Closure Scenarios for Western Tanager Habitat in the LSA

Habitat Class	Predevelopment HU	%	Steepbank HU	%	East Bank Mine Impact HU	%	Remaining at Impact HU	%	Closure HU	%
Low	715	24.4	160	21.4	411	31.5	304	18.7	791	13.0
Med	435	14.8	133	17.8	204	15.7	230	14.2	722	11.8
High	1,779	60.7	456	60.9	688	52.8	1,091	67.1	4,587	75.2
Tota HUsl	2,929	100.0	749	100.0	1,304	100.0	1,625	100.0	6,099	100.0
Total Area (ha)	16,181		3,776		9,281		6,901		16,181	
Mean Suitability	0.18		0.20		0.14		0.24		0.38	

Western tanager habitat within the mine impact area was composed of 411 HUs (32%) of low quality habitat, 204 HUs (16%) of medium quality habitat, and 688 HUs (52%) of high quality habitat (Table 83). The overall suitability of the mine impact area (sum of low, medium and high habitat areas divided by the total number of ha) for western tanagers is 91% (1,277 HUs). Of the 9% which was considered unsuitable habitat, <1% consisted of water.

The majority of the LSA is rated as low suitability habitat for western tanagers, with a few scattered areas of medium and high suitability habitat occurring near the perimeter (Figure 34).

The wildlife baseline report for Project Millennium, Golder (1998n) reported that suitable foraging and nesting habitat for western tanagers consists of open coniferous and mixedwood forests. They are occasionally found in pure deciduous stands. Thus, the LSA was expected to provide a low amounts of suitable habitat for western tanager.

Verification of the HSI model using point count data indicated a significant, positive trend between tanager observations and HSI values (Appendix V). Thus, existing data suggests that the model is a reasonable one for the species.

6.13.2 Construction Impacts

Direct habitat loss due to mine development is projected to affect western tanager habitat by removing 45% of the HUs present (Table 84). Fifty-eight percent of low, 47% of medium and 39% of high quality habitat will be lost due to site clearing.

Table 84 Summary of Changes in Western Tanager Habitat Units From Predevelopment to Impact and Closure Scenarios

Habitat Class	Predevelopment (HU)	Steepbank Mine Impact (Loss of HU)	Steepbank Mine Impact (% Change)	East Bank Mine Impact (Loss of HU)	East Bank Mine Impact (% Change)	Closure (HU)	Closure (% Change)
Low	715	-160	-22.4	-411	-57.5	+76	+10.6
Med	435	-133	-30.6	-204	-47.0	+287	+66.1
High	1,779	-456	-25.6	-688	-38.7	+2,808	+157.8
Total	2,929	-749	-25.6	-1,304	-44.5	+3,170	+108.3

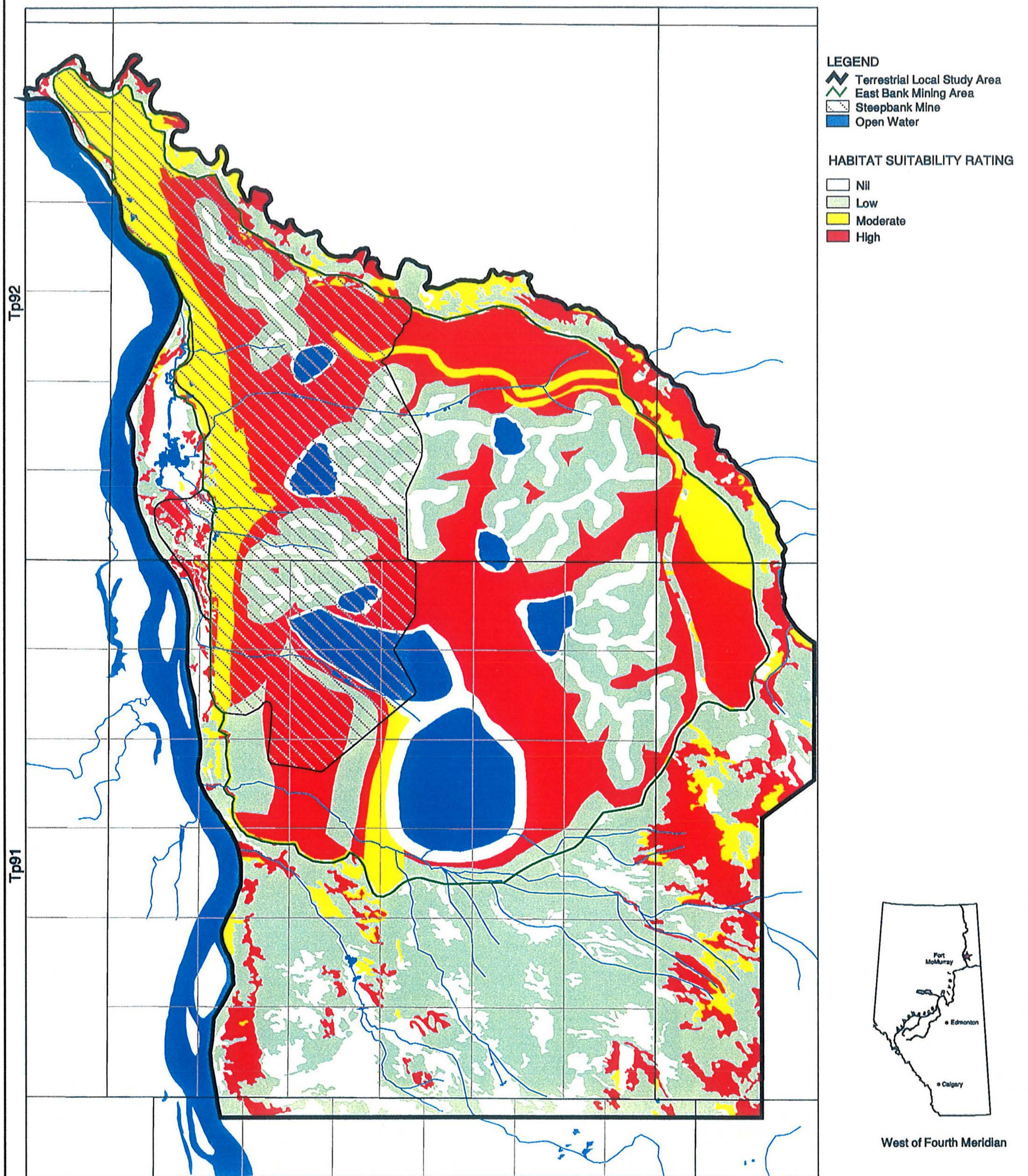
Habitat loss and fragmentation effects expose migratory songbirds to a number of impacts, including increased competition for nest sites, predators, and cowbird parasitism. Thus, habitat loss resulting from site clearing is expected to affect western tanagers.

6.13.3 Closure

Western tanager habitat is expected to increase by 153% during reclamation, resulting in 3,170 HUs (108%) over baseline conditions following closure (Table 84). This is due to an overall gain of 11% (76 HUs) of low suitability habitat, 66% (287 HUs) of medium suitability habitat, and 158% of high suitability habitat (2,808 HUs), relative to baseline conditions.

During closure, the mine footprint will be reclaimed with vegetation types that represent moderate to high suitability habitat, except for deciduous, shrubby swamps (SONS), shrubland (shrub), graminoid marshes (MONG) and lakes (NWL) (Figure 35). As a result, western tanager habitat is expected increase over baseline conditions following closure.

Proper reclamation planning allows for the optimization of habitat for selected species (e.g., moose). Potential modifications to improve the habitat value for western tanager are not required.



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Metres
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SOURCES: Suncor
Golder
The Forestry Corp
Klohn-Crippen

Map Projection: UTM 12
Datum: NAD 83

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LOCAL STUDY AREA
WESTERN TANAGER HABITAT SUITABILITY
CLOSURE SCENARIO

09 Apr. 1998

Figure 35

PRODUCED BY: CGA
REVIEWED BY:

7 REGIONAL STUDY AREA

The results for the Regional Study Area (RSA) are presented in this section. The impact analysis for the RSA presents a worst-case scenario, in which all areas proposed or approved for development are regarded as fully impacted and unsuitable for wildlife habitat requirements. Thus, reclamation activities and the progressive nature of developments over time are not modelled. In this way, the RSA impact assessment provides a direct comparison to the LSA impact assessment results, where project development components were also modelled as fully impacted.

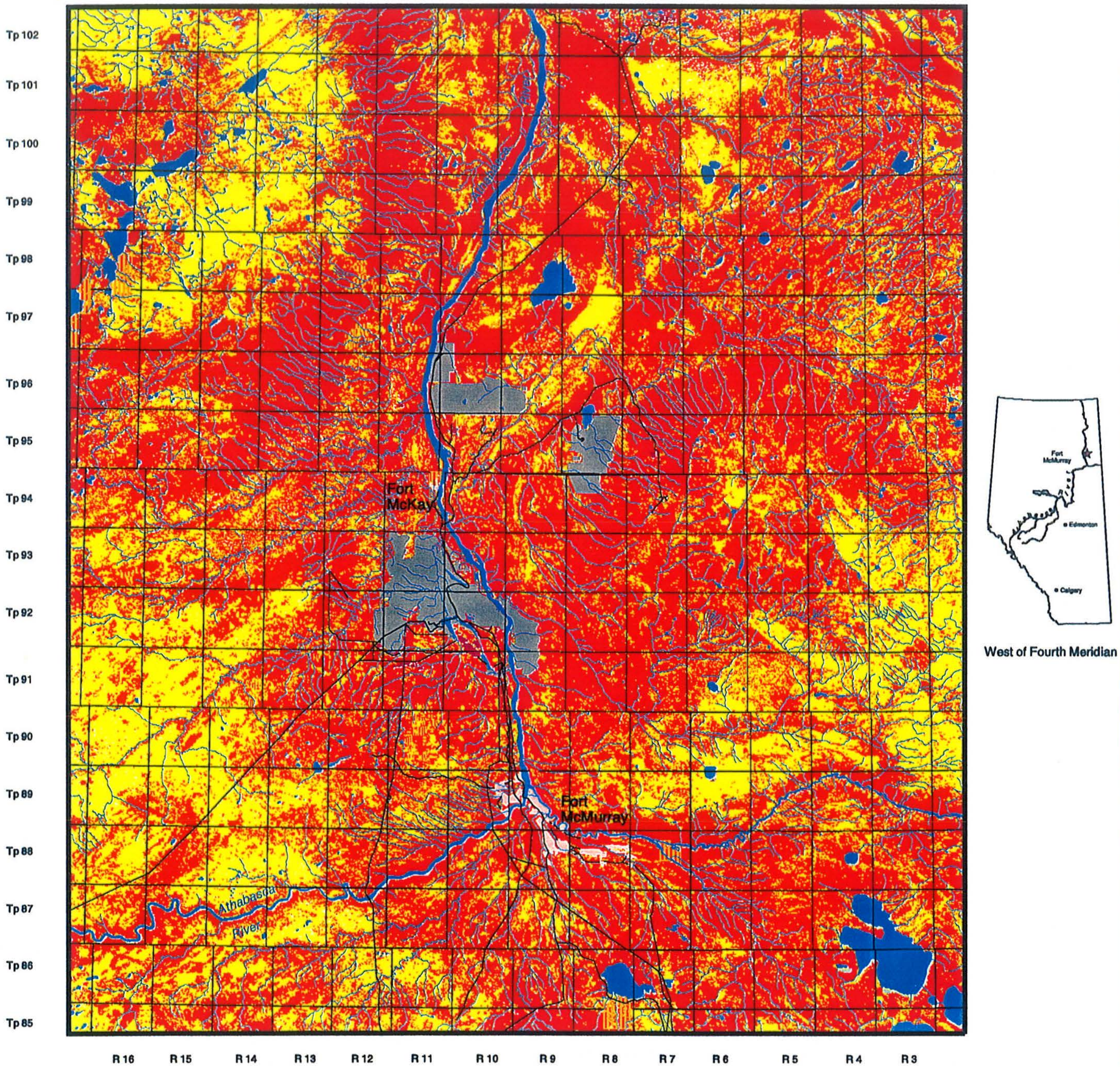
7.1 WILDLIFE RICHNESS

The expected number of mammal, bird and reptile and amphibian species which could occur within each vegetation class in the RSA is presented in Table 85. Maps of baseline conditions for these groups are provided in Figures 36 - 38. Table 85 was adapted from Appendix IV, which was developed from an expected association of species plus any observations within generalized vegetation types for the Shell Muskeg River Mine EIA (Golder 1998p). Richness values for the Millennium area were not included as they were not measured for this purpose.

The regional vegetation types with the most expected mammal species (n=28) were the wet closed coniferous types. This was followed by mixedwood Sw/Aw (27) and spruce-dominated coniferous stands (25). Moderate numbers (18) were expected to occur in the upland shrub type and in regenerating pine stands (16) and fens (16). Revegetated disturbed lands were expected to support 7 species, whereas natural disturbances with sparse vegetative cover (open sand, rock, cutbanks and flooded areas) were expected to have no associated mammal species. These habitat types were mapped using relative richness index scores, which are the species per habitat type divided by total maximum species in any one type (Figures 36-38).

Table 85 Expected Number of Mammals, Birds, Reptiles and Amphibians per RSA Vegetation Type

Vegetation Class	Mammal	Bird	Reptiles and Amphibian
Mixed Deciduous	20	67	2
Mixedwood-Sw/Aw	27	81	2
Coniferous-Sw	25	57	2
Coniferous-Sw/Pj	25	57	2
Coniferous-Pj/Sw/Sb	25	57	2
Open Pine	21	48	2
Pine Regen	16	71	4
Upland Sb-Lt	25	57	2
Wet Closed Coniferous Sb	28	112	4
Wet Closed Coniferous Sb-Lt	28	112	4
Shrubby Fen	16	71	4
Graminoid Fen	16	71	4
Low Shrub Wetland	16	71	4
Bog	16	71	4
Marsh	10	78	4
Upland Shrub	18	97	4
Recent Cutblocks	16	71	4
Old Cutblocks	16	71	4
Natural Disturbances	0	0	0
Water	8	63	0



SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

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Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

HABITAT RICHNESS RANKING

- Nil
- Low
- Moderate
- High

N

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**REGIONAL STUDY AREA
MAMMAL HABITAT RICHNESS
BASELINE SCENARIO**

28 Apr. 1998 | Figure 36 | PRODUCED BY: MK REVIEWED BY:

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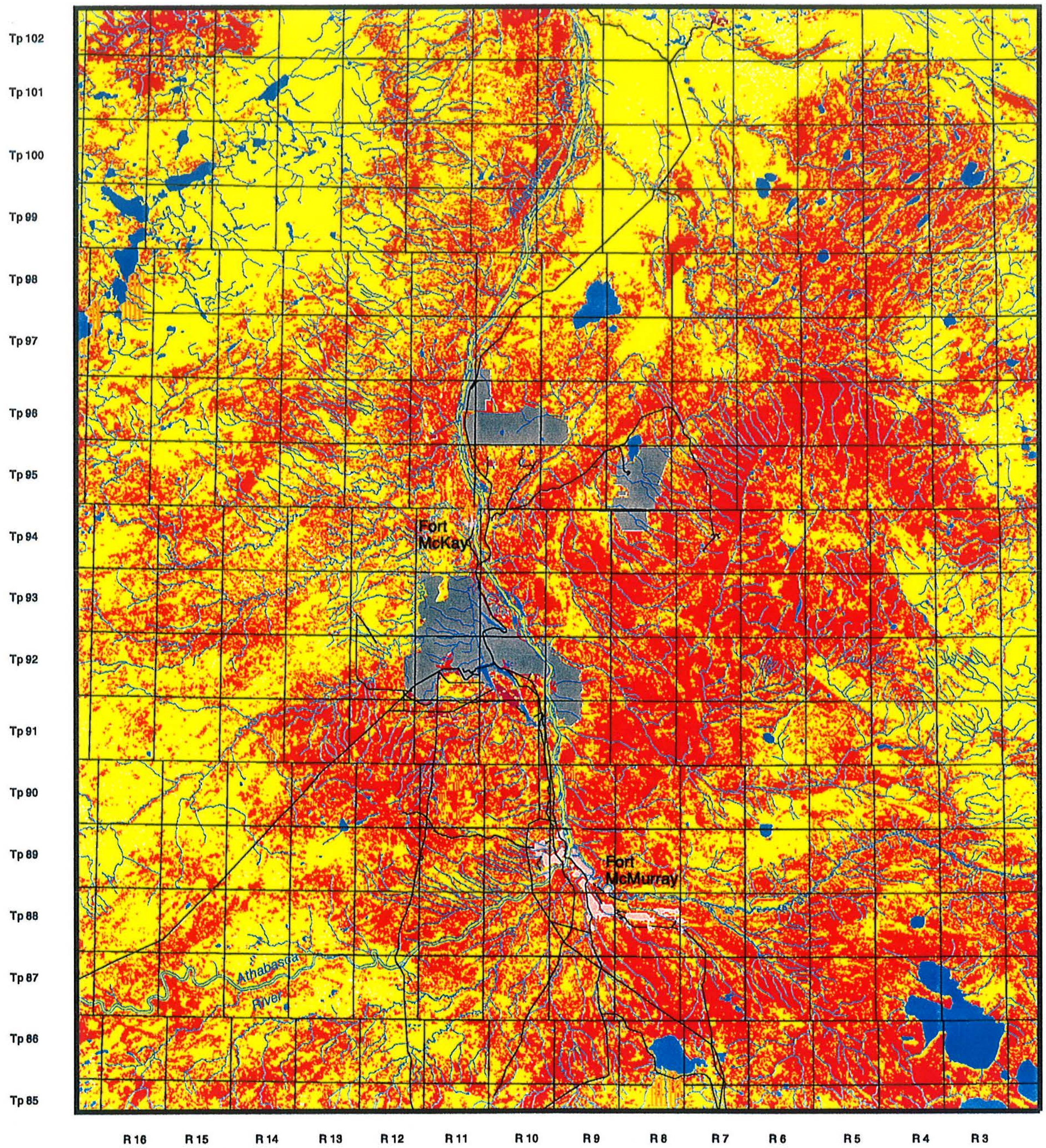

West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

HABITAT RICHNESS RANKING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA BIRD HABITAT RICHNESS BASELINE SCENARIO

16 Apr. 1998	Figure 37	PRODUCED BY: MK REVIEWED BY:

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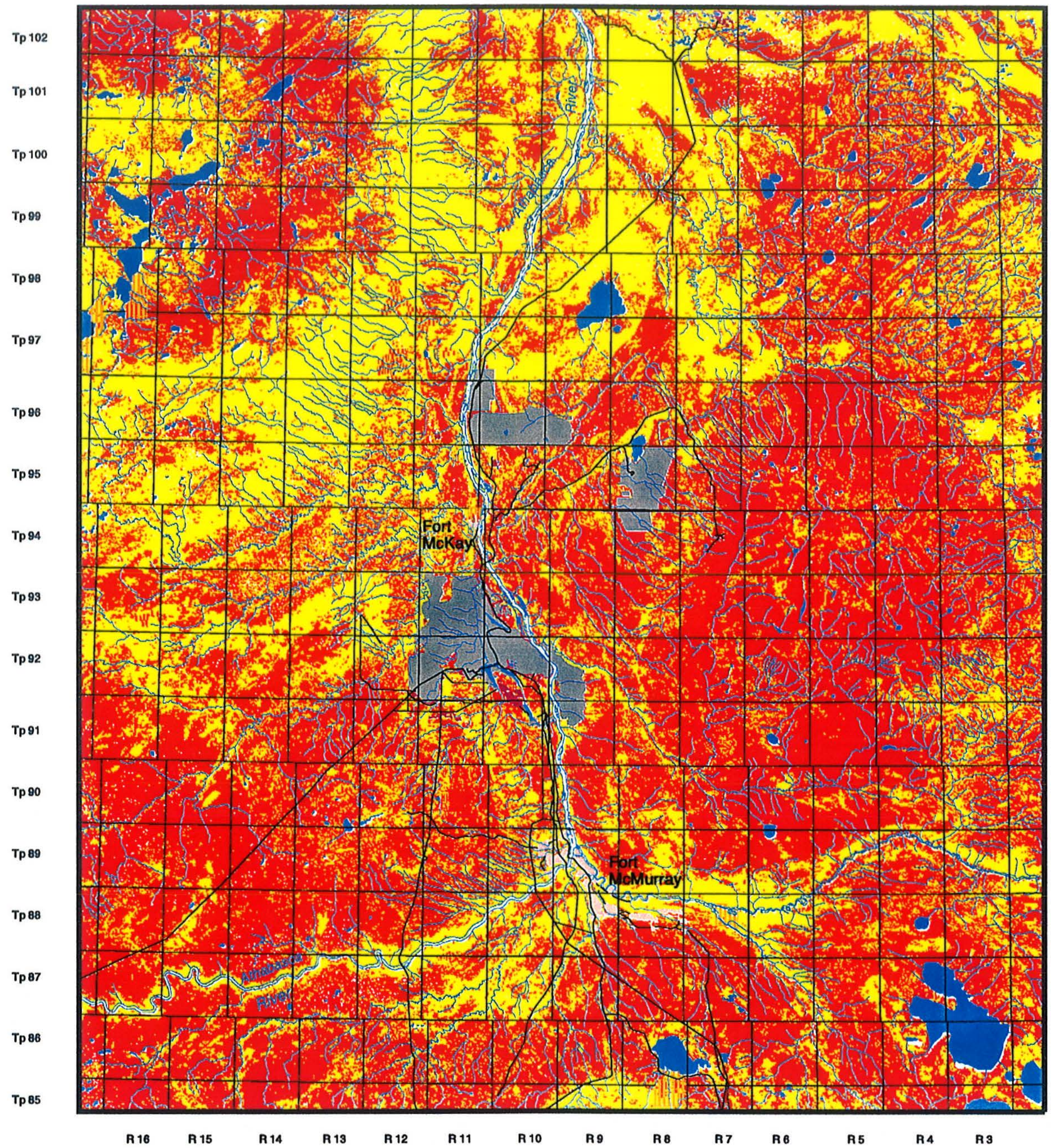

West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

HABITAT RICHNESS RANKING

- Nil
- Low
- Moderate
- High

N

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Project Millennium

REGIONAL STUDY AREA
REPTILE AND AMPHIBIAN
HABITAT RICHNESS
BASELINE SCENARIO

16 Apr. 1998	Figure 38	PRODUCED BY: MK REVIEWED BY:

/data15/oilsands/hsl/arcview/reptile.apr

7.1.1 Mammals

7.1.1.1 Baseline Conditions

The mammal richness index values of the various vegetation types within the RSA are presented in Table 86. Baseline conditions for mammal richness are mapped in Figure 36. High richness habitat for mammals within the RSA included the following vegetation types:

- wet closed coniferous black spruce;
- wet open coniferous black spruce-larch;
- mixedwood-white spruce-trembling aspen;
- coniferous white spruce;
- coniferous white spruce-jack pine;
- coniferous-jack pine-white spruce-black spruce;
- upland black spruce-larch;
- open pine; and
- mixed deciduous.

Unsuitable habitat for mammal richness included natural disturbances, municipalities, open pit mines and human disturbances.

Table 86 Mammal Habitat Richness Index Vegetation Class Ratings in the RSA

Richness Index Rating	Regional Vegetation Class	HSI
High Richness (0.67 - 1.00)	Wet Closed Coniferous Sb	1.00
	Wet Open Coniferous Sb-Lt	1.00
	Mixedwood-Sw/Aw	0.96
	Coniferous-Sw	0.89
	Coniferous-Sw/Pj	0.89
	Coniferous-Pj/Sw/Sb	0.89
	Upland Sb-Lt	0.89
	Open Pine	0.75
	Mixed Deciduous	0.71
Medium Richness (0.34 - 0.66)	Upland Shrub	0.64
	Pine Regen	0.57
	Shrubby Fen	0.57
	Graminoid Fen	0.57
	Low Shrub Wetland	0.57
	Bog	0.57
	Recent Cutblocks	0.57
	Old Cutblocks	0.57
Low Richness (0.01 - 0.33)	Marsh	0.36
	Water	0.29
No Richness (0.00)	Natural Disturbances	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

Changes to mammal richness by RSA vegetation type (Table 87) resulting from Project Millennium shows that it will have an overall impact of -0.3% of the RSA types, with losses for individual types ranging from 0.0 to 2.3%. Under the CEA scenario, losses will average 1.4% (range of 0.0 to 2.2). Positive changes occur in old cutblocks which regrow from the initial recent clearcut (herb/grass) stage to the older (shrub/sapling) stage. This is seen in the CEA impact column where all the recent cutblock area at baseline is "aged" to the old cutblock status at the CEA scenario.

Table 87 Baseline, Project Millennium and CEA Mammal Richness Habitat Units per RSA Vegetation Type

Vegetation. Type	Baseline	Millennium Losses or Gains	Millennium % Impact	CEA Losses or Gains	CEA % Impact
Bog	1,901	0	0.0	+0	+0.0
Coniferous-Pj/Sw/Sb	13,417	-1	-0.0	+0	+0.0
Coniferous-Sw	99,881	-135	-0.1	-686	-0.7
Coniferous-Sw/Pj	16,762	-12	-0.1	+0	+0.0
Graminoid Fen	128,065	-2	-0.0	-820	-0.6
Human disturbance	0	0	0.0	0	0.0
Low Shrub Wetland	36,935	-17	-0.0	+0	+0.0
Marsh	2,040	-4	-0.2	-1	-0.1
Mixed Deciduous	126,193	-631	-0.5	-1,835	-1.5
Mixedwood-Sw/Aw	306,120	-81	-0.0	-6,774	-2.2
Municipalities	0	0	0.0	0	0.0
Natural disturbance	0	-4	0.0	0	0.0
Old Cutblocks	1,432	-17	-1.2	+6,608	+461.5
Open Pine	98,087	-36	-0.0	-59	-0.1
Open pit mines	0	0	0.0	0	0.0
Pine Regen	49,862	0	0.0	-2	-0.0
Recent Cutblocks	6,608	0	0.0	-6,608	-100.0
Shrubby Fen	165,355	-122	-0.1	-2,333	-1.4
Unclassified	37,918	0	0.0	-94	-0.2
Upland Sb-Lt	83,125	-18	-0.0	-1,072	-1.3
Upland Shrub	10,655	-4	-0.0	0	0.0
Water	18,698	-1	-0.0	-37	-0.2
Wet Closed Coniferous Sb	512,274	-676	-0.1	-9,325	-1.8
Wet Open Coniferous Sb-Lt	135,892	-3,082	-2.3	-2,237	-1.6
Total	**1,851,217**	**-4,844**	**-0.3**	**-25,272**	**-1.4**

Note: Some losses seen at Project Millennium are not seen again at CEA. This occurred because the Millennium results were from the more specific LSA analysis, which was classified separately from the RSA. LSA types were reclassified to RSA types by use of Table 10.

The percent of the RSA which consisted of habitat expected to support mammal species (sum of low, medium and high habitat areas divided by total area) was 97% at baseline (Table 88), None of the area with no richness consisted of water which was ranked as low richness habitat due to use by aquatic mammals. Thus the 3% which was unsuitable related entirely to the area of existing baseline developments and disturbances.

Table 88 Mammal Richness Percent of Area and Habitat Units by Suitability Class in the RSA

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Unsuitable Habitat: Other	Unsuitable Habitat: Total	Suitable Habitat: Low	Suitable Habitat: Med	Suitable Habitat: High	Suitable Habitat: Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med	High
Baseline	2,428,750	0.0	2.7	2.7	2.7	32.2	62.4	97.3	1,851,217	1.0	23.8	75.2
Project Millennium (Development Area)	5,506	0.0	0.1	0.1	1.4	20.9	77.6	99.9	4,735	0.4	15.2	84.4
Remaining After Millennium	2,423,244	0.0	2.7	2.7	2.7	32.2	62.3	97.3	1,846,482	1.0	23.8	75.2
CEA (Development Area)	29,865	0.0	2.5	2.5	0.4	19.2	77.9	97.5	25,275	0.1	12.9	87.0
CEA (Undeveloped Area)	2,398,885	0.0	2.7	2.7	2.7	32.4	62.2	97.3	1,825,942	1.0	24.0	75.0

High richness habitat for mammals within the RSA is shown by HUs in Table 89 and Figure 36. Of the 1,851,217 HUs of mammal richness habitat, the RSA is currently composed of 18,698 HUs (1%) of low quality habitat, 440,769 HUs (24%) of moderate quality habitat and 1,391,750 HUs (75%) of high quality habitat. The habitat distribution within the LSA was similar with even more emphasis on high habitat. High suitability habitat was seen throughout the RSA (Figure 36). The mean richness of the RSA was 0.76 (high) (Table 89).

Table 89 Mammal Habitat Richness: Habitat Units per Habitat Class for Project Millennium and CEA Impact Scenarios for the RSA

Habitat Class	RSA Baseline (Habitat Units) HU	%	Project Millennium (Units Lost) HU	%	RSA CEA (Units Lost) HU	%	RSA CEA (Habitat Units) HU	%
Low	18,698	1.0	19	0.4	37	0.1	18,661	1.0
Medium	440,769	23.8	722	15.2	3,249	12.9	437,520	24.0
High	1,391,750	75.2	3,994	84.4	21,989	87.0	1,369,761	75.0
Total HUs	1,851,217	100.0	4,735	100.0	25,275	100.0	1,825,942	100.0
Total Area (ha)	2,428,750		5,640		29,865		2,428,750	
Mean Richness	0.76		0.84		0.84		0.75	

7.1.1.2 Impact of Project Millennium

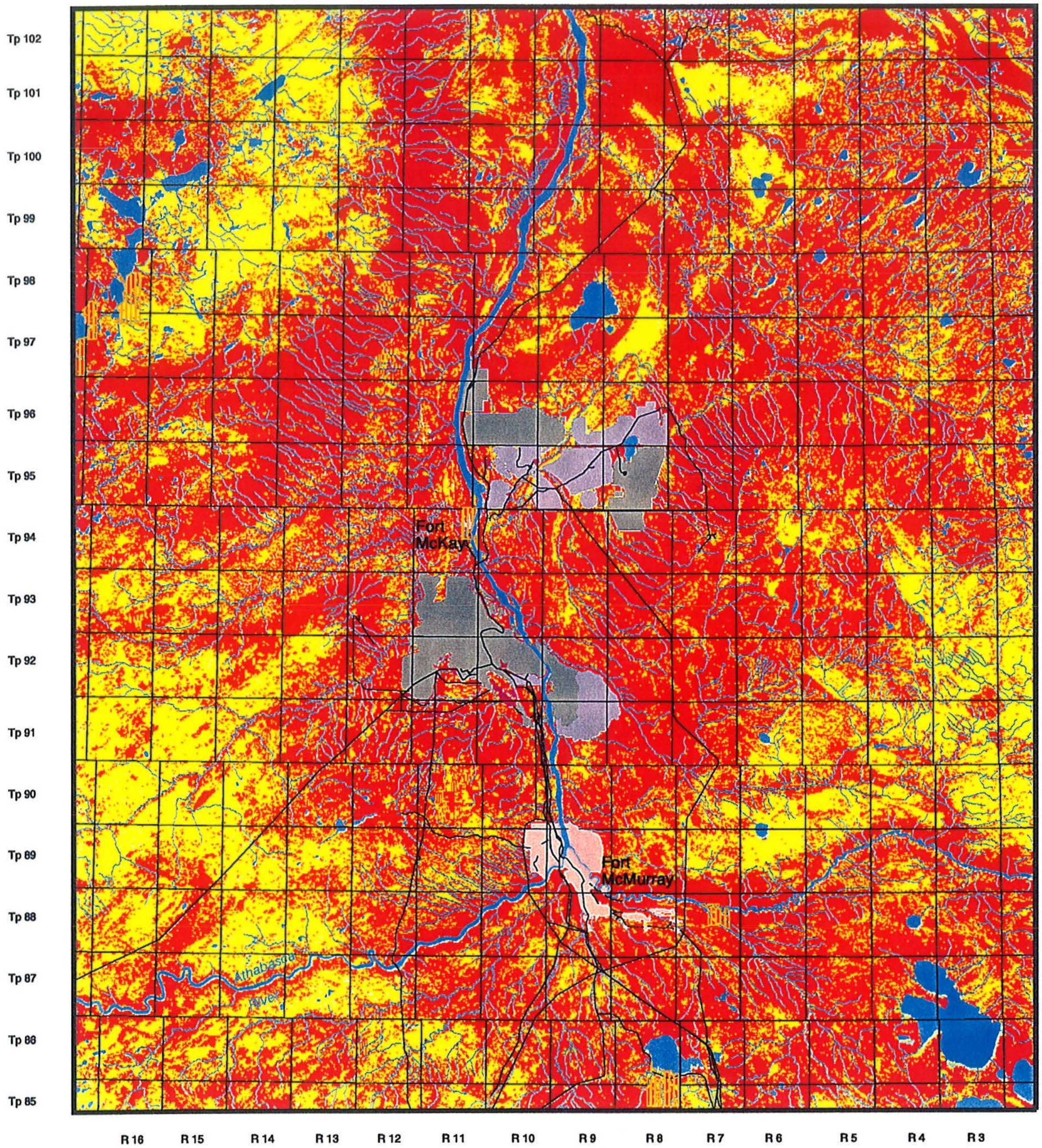
Direct habitat loss due to mine development is projected to affect mammal richness by removing 0.3%, or 4,735 HUs within the RSA (Table 90, Figure 39). Less than one percent of low , 0.2% of moderate and 0.3% of high richness habitat will be lost due to Project Millennium.

Table 90 Mammal Habitat Richness: Change From Pre-Development Under Project Millennium and CEA Impact Scenarios for the RSA

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	18,698	-19	-0.1	-37	-0.2	51.6
Med	440,769	-722	-0.2	-3,249	-0.7	22.2
High	1,391,750	-3,994	-0.3	-21,989	-1.6	18.2
Total	**1,851,217**	**-4,735**	**-0.3**	**-25,275**	**-1.4**	**18.7**

7.1.1.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1.4%, or 25,275 mammal richness HUs within the RSA (Table 90 and Figure 39). Of this loss, 19% is due to the effects of Project Millennium. In total, 0.2% of low suitability habitat, 0.7% of moderate and 1.6% of high suitability habitat for mammal richness will be lost.



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT RICHNESS RATING

- Nil
- Low
- Moderate
- High

N

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Project Millennium

REGIONAL STUDY AREA MAMMAL HABITAT RICHNESS CUMULATIVE EFFECTS ASSESSMENT SCENARIO

16 Apr. 1998	Figure 39	PRODUCED BY: MK REVIEWED BY: MB

7.1.2 Birds

7.1.2.1 Baseline Conditions

The suitabilities of the various vegetation types within the RSA for bird richness are presented in Table 91. High richness habitat for bird richness within the RSA included the following vegetation types:

- wet closed coniferous black spruce;
- wet open coniferous black spruce-larch;
- upland shrubland;
- mixedwood-white spruce-trembling aspen; and
- marsh.

Unsuitable habitat for bird richness included natural disturbances, municipalities, open pit mines and human disturbances. There were no vegetation types which represented low richness for birds.

Table 91 Bird Habitat Richness Index Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Richness (0.67 - 1.00)	Wet Closed Coniferous Sb	1.00
	Wet Open Coniferous Sb-Lt	1.00
	Upland Shrub	0.87
	Mixedwood-Sw/Aw	0.72
	Marsh	0.70
Medium Richness (0.34 - 0.66)	Pine Regen	0.63
	Shrubby Fen	0.63
	Graminoid Fen	0.63
	Low Shrub Wetland	0.63
	Bog	0.63
	Recent Cutblocks	0.63
	Old Cutblocks	0.63
	Mixed Deciduous	0.60
	Water	0.56
	Coniferous-Sw	0.51
	Coniferous-Sw/Pj	0.51
	Coniferous-Pj/Sw/Sb	0.51
	Upland Sb-Lt	0.51
	Open Pine	0.43
No Richness (0.00)	Natural Disturbances	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

Changes to bird richness by RSA vegetation type (Table 92) resulting from Project Millennium shows that it will have an overall impact of -0.3% of the RSA types, with losses for individual types ranging from 0.0 to 2.3%. Under the CEA scenario, losses will average 1.4% (range of -2.2 to +461%). Positive changes to vegetation types are predicted to occur as a result of regrowth of cutblocks, as was discussed for mammal richness.

Table 92 Baseline, Project Millennium and CEA Bird Richness Habitat Units per RSA Vegetation Type

Vegetation Type	Baseline	Millennium Losses or Gains	Millennium % Impact	CEA Losses or Gains	CEA % Impact
Bog	2,101	0	0.0	-0	-0.0
Coniferous-Pj/Sw/Sb	7,688	-1	-0.0	0	0.0
Coniferous-Sw	57,235	-77	-0.1	-393	-0.7
Coniferous-Sw/Pj	9,605	-7	-0.1	+0	+0.0
Graminoid Fen	141,545	-2	-0.0	-905	-0.6
Human disturbance	0	0	0.0	0	0.0
Low Shrub Wetland	40,823	-25	-0.1	0	0.0
Marsh	3,967	-5	-0.1	-2	-0.1
Mixed Deciduous	106,642	-533	-0.5	-1,551	-1.5
Mixedwood-Sw/Aw	229,590	-61	-0.0	-5,081	-2.2
Municipalities	0	0	0.0	0	0.0
Natural disturbance	0	0	0.0	0	0.0
Old Cutblocks	1,583	-17	-1.1	+7,303	+461.4
Open Pine	56,237	-21	-0.0	-34	-0.1
Open pit mines	0	0	0.0	0	0.0
Pine Regen	55,110	0	0.0	-1	-0.0
Recent Cutblocks	7,303	0	0.0	-7,303	-100.0
Shrubby Fen	182,761	-135	-0.1	-2,579	-1.4
Unclassified	37,918	0	0.0	-94	-0.2
Upland Sb-Lt	47,633	-10	-0.0	-614	-1.3
Upland Shrub	14,484	-4	-0.0	-0	-0.0
Water	36,106	-3	-0.0	-71	-0.2
Wet Closed Coniferous Sb	512,274	-816	-0.2	-9,325	-1.8
Wet Open Coniferous Sb-Lt	135,892	-3,158	-2.3	-2,237	-1.6
Total	**1,686,496**	**-4,874**	**-0.3**	**-22,887**	**-1.4**

Note: Some losses seen at Project Millennium are not seen again at CEA. This occurred because the Millennium results were from the more specific LSA analysis, which was classified separately from the RSA. LSA types were reclassified to RSA types by use of Table 10.

The overall suitability of the RSA (total area of low, medium and high areas divided by the total number of ha) for bird richness at baseline is 97.3%, or 1,686,496 HUs. None of the unsuitable habitat consisted of water (Table 93). All currently developed areas were considered unsuitable habitat.

Table 93 Bird Richness Percent of Area and Habitat Units by Suitability Class in the RSA

Scenario	Area (ha)	Percent of Area by Suitability Class							Habitat Units	Percent of Habitat Units by Suitability Class		
		Unsuitable Habitat			Suitable Habitat					Low	Med	High
		Water	Other	Total	Low	Med	High	Total				
Baseline	2,428,750	0.0	2.7	2.7	0.0	56.5	40.7	97.3	1,686,496	0.0	46.9	53.1
Project Millennium (Development Area)	5,506	0.0	0.1	0.1	0.0	23.5	76.4	99.9	4,783	0.0	16.1	83.9
Remaining After Millennium	2,423,244	0.0	2.7	2.7	0.0	56.6	40.7	97.3	1,681,713	0.0	46.9	53.1
CEA (Development Area)	29,865	0.0	2.5	2.5	0.0	35.1	62.4	97.5	22,888	0.0	27.3	72.7
CEA (Undeveloped Area)	2,398,885	0.0	2.7	2.7	0.0	56.8	40.5	97.3	1,663,608	0.0	47.1	52.9

High richness habitat for bird richness within the RSA is shown by HUs in Table 94 and Figure 37. Of the 1,686,496 HUs of bird richness habitat, the RSA is currently composed of 0 HUs (0%) of low quality habitat, 790,290 HUs (47%) of moderate suitability habitat and 896,206 HUs (53%) of high suitability habitat. The habitat distribution within the LSA was similar, although less moderate and more high suitability habitat were observed. High suitability habitat was distributed throughout the RSA (Figure 37). The mean richness of the RSA was 0.69 or high (Table 94).

Table 94 Bird Habitat Richness: Habitat Units per Habitat Class for Project Millennium and CEA Impact Scenarios for the RSA

Habitat Class	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
	HU	%	HU	%	HU	%	HU	%
Low	0	0.0	0	0.0	0	0.0	0	0.0
Medium	790,290	46.9	771	16.1	6,243	27.3	784,047	47.1
High	896,206	53.1	4,012	83.9	16,645	72.7	879,561	52.9
Total HUs	1,686,496	100.0	4,783	100.0	22,888	100.0	1,663,608	100.0
Total Area (ha)	2,428,750		5,640		29,865		2,428,750	
Mean Richness	0.69		0.85		0.77		0.68	

7.1.2.2 Impact of Project Millennium

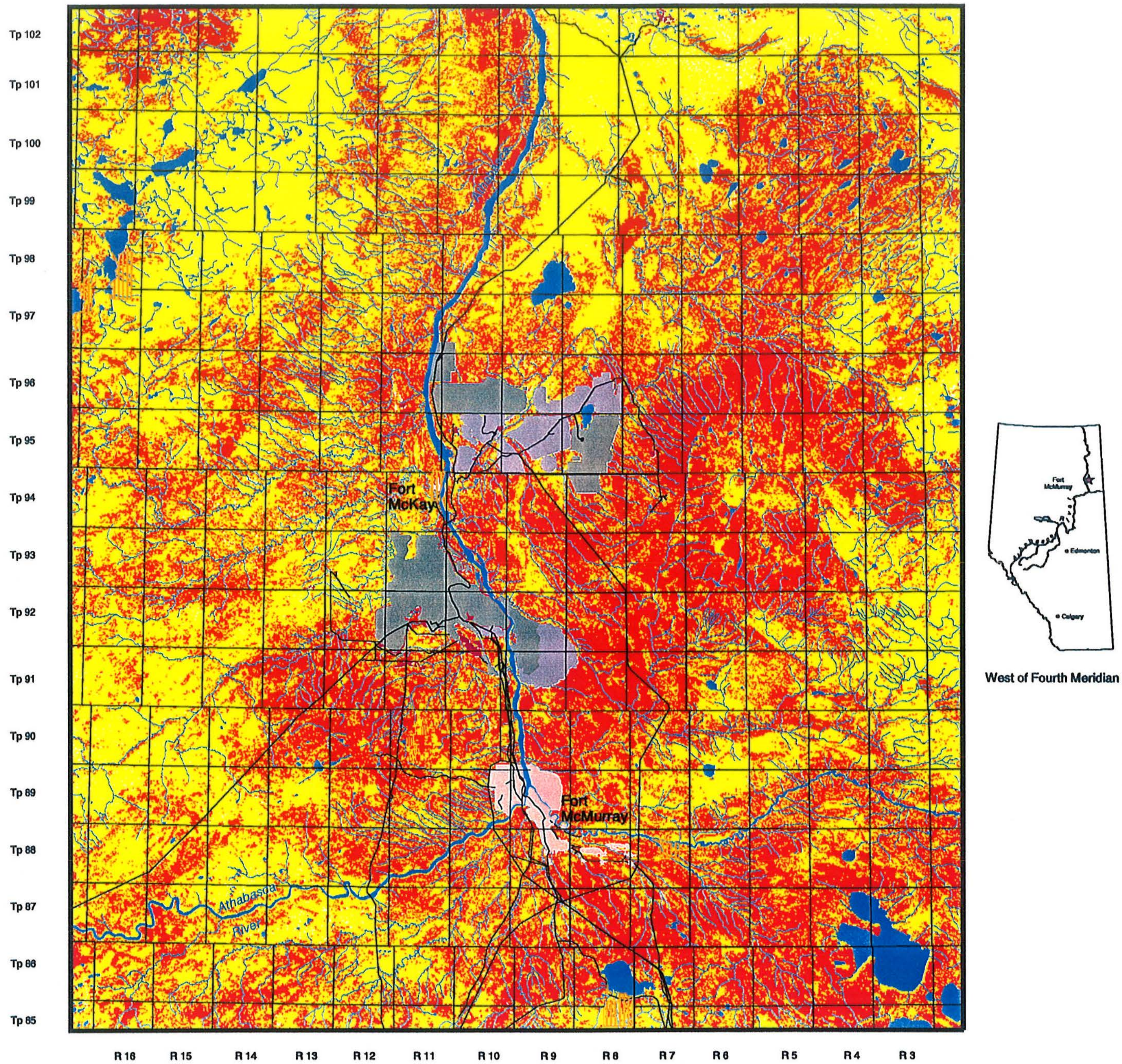
Direct habitat loss due to mine development is projected to affect bird richness by removing 0.3%, or 4,783 HUs within the RSA (Table 95, Figure 40). No low, 0.1% of moderate and 0.4% of high richness habitat will be lost due to Project Millennium.

Table 95 Bird Habitat Richness: Change From Pre-Development Under Project Millennium and CEA Impact Scenarios for the RSA

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	0	+0	+0.0	+0	+0.0	0.0
Med	790,290	-771	-0.1	-6,243	-0.8	12.3
High	896,206	-4,012	-0.4	-16,645	-1.9	24.1
Total	**1,686,496**	**-4,783**	**-0.3**	**-22,888**	**-1.4**	**20.9**

7.1.2.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1.4%, or 22,888 Bird Richness HUs within the RSA (Table 95 and Figure 40). Of this loss, 21% is due to the effects of Project Millennium. In total, no low suitability habitat, 0.8% of moderate and 1.9% of high suitability habitat for bird richness will be lost.



SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT RICHNESS RATING

- Nil
- Low
- Moderate
- High

N

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Project Millennium

REGIONAL STUDY AREA
BIRD HABITAT RICHNESS
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO

16 Apr. 1998

Figure 40

PRODUCED BY: MK
REVIEWED BY:

/data15/oilsands/hsl/arcview/bird.apr

7.1.3 Reptiles and Amphibians

7.1.3.1 Baseline Conditions

The suitability of the various vegetation types within the RSA for reptile and amphibian richness is presented in Table 96. High suitability habitat for reptile and amphibian richness within the RSA included the following vegetation types:

- pine regeneration;
- wet closed coniferous-black spruce;
- wet open coniferous-black spruce-larch;
- shrubby fen;
- graminoid fen;
- low shrub wetland;
- bog;
- marsh;
- upland shrub;
- recent cutblocks; and
- old cutblocks.

Unsuitable habitat for reptile and amphibian richness included natural disturbances, open water, municipalities, open pit mines and human disturbances. There were no vegetation types which represented low richness for reptiles and amphibians.

Table 96 Reptile and Amphibian Habitat Richness Index Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Richness (0.67 - 1.00)	Pine Regen	1.00
	Wet Closed Coniferous Sb	1.00
	Wet Open Coniferous Sb-Lt	1.00
	Shrubby Fen	1.00
	Graminoid Fen	1.00
	Low Shrub Wetland	1.00
	Bog	1.00
	Marsh	1.00
	Upland Shrub	1.00
	Recent Cutblocks	1.00
	Old Cutblocks	1.00
Medium Richness (0.34 - 0.66)	Mixed Deciduous	0.50
	Mixedwood-Sw/Aw	0.50
	Coniferous-Sw	0.50
	Coniferous-Sw/Pj	0.50
	Coniferous-Pj/Sw/Sb	0.50
	Open Pine	0.50
	Upland Sb-Lt	0.50
No Richness (0.00)	Natural Disturbances	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

Changes to reptile and amphibian richness by RSA vegetation type (Table 97) resulting from Project Millennium shows that it will have an overall impact of -0.3% of the RSA types, with losses for individual types ranging from 0.0 to 2.4%. Under the CEA scenario, losses will average 1.3% (range of -2.2 to +461%). Positive changes to vegetation types are predicted to occur as a result of regrowth of cutblocks, as was discussed for mammal richness.

Table 97 Baseline, Project Millennium and CEA Bird Richness Habitat Units per RSA Vegetation Type

Vegetation Type	Baseline	Millennium Losses or Gains	Millennium % Impact	CEA Losses or Gains	CEA % Impact
Bog	3,335	0	0.0	0	0.0
Coniferous-Pj/Sw/Sb	7,538	-1	-0.0	0	0.0
Coniferous-Sw	56,113	-76	-0.1	-386	-0.7
Coniferous-Sw/Pj	9,417	-7	-0.1	0	0.0
Graminoid Fen	224,675	-3	-0.0	-1,437	-0.6
Human disturbance	0	0	0.0	0	0.0
Low Shrub Wetland	64,798	-30	-0.0	0	0.0
Marsh	5,668	-7	-0.1	-3	-0.1
Mixed Deciduous	88,869	-444	-0.5	-1,293	-1.5
Mixedwood-Sw/Aw	159,437	-42	-0.0	-3,528	-2.2
Municipalities	0	0	0.0	0	0.0
Natural disturbance	0	0	0.0	0	0.0
Old Cutblocks	2,512	0	0.0	+11,592	+461.4
Open Pine	65,391	-24	-0.0	-39	-0.1
Open pit mines	0	0	0.0	0	0.0
Pine Regen	87,476	0	0.0	-2	-0.0
Recent Cutblocks	11,592	0	0.0	-11,592	-100.0
Shrubby Fen	290,096	-215	-0.1	-4,093	-1.4
Unclassified	37,918	0	0.0	-94	-0.2
Upland Sb-Lt	46,699	-10	-0.0	-602	-1.3
Upland Shrub	16,648	-6	-0.0	0	0.0
Water	0	0	0.0	0	0.0
Wet Closed Coniferous Sb	512,274	-896	-0.2	-9,325	-1.8
Wet Open Coniferous Sb-Lt	135,892	-3,200	-2.4	-2,237	-1.6
Total	**1,826,347**	**-4,961**	**-0.3**	**-23,039**	**-1.3**

Note: Some losses seen at Project Millennium are not seen again at CEA. This occurred because the Millennium results were from the more specific LSA analysis, which was classified separately from the RSA. LSA types were reclassified to RSA types by use of Table 10.

The overall suitability of the RSA (total area of low, medium and high habitat divided by the total number of ha) for reptile and amphibian richness at baseline is 95%, or 1,826,347 HUs (Table 98). All currently developed areas and open water were considered unsuitable habitat.

Table 98 Reptile and Amphibian Richness Percent of Area and Habitat Units by Suitability Class in the RSA

Scenario	Area (ha)	Percent of Area by Suitability Class							Habitat Units	Percent of Habitat Units by Suitability Class		
		Unsuitable Habitat			Suitable Habitat							
		Water	Other	Total	Low	Med	High	Total		Low	Med	High
Baseline	2,428,750	2.7	2.7	5.4	0.0	38.8	55.8	94.6	1,826,347	0.0	25.8	74.2
Project Millennium (Development Area)	5,506	0.1	1.4	1.5	0.0	20.4	78.2	98.5	4,864	0.0	11.5	88.5
Remaining After Millennium	2,423,244	2.7	2.7	5.4	0.0	38.9	55.7	94.6	1,821,483	0.0	25.8	74.2
CEA (Development Area)	29,865	0.4	2.5	3.0	0.0	39.8	57.3	97.0	23,040	0.0	25.8	74.2
CEA (Undeveloped Area)	2,398,885	2.7	2.7	5.4	0.0	38.8	55.8	94.6	1,803,307	0.0	25.8	74.2

High richness habitat for reptile and amphibian richness within the RSA is shown by HUs in Table 99 and Figure 38. Of the 1,826,347 HUs of reptile and amphibian richness habitat, the RSA is currently composed of 0 HUs (0%) of low quality habitat, 471,382 HUs (26%) of moderate suitability habitat and 1,354,965 HUs (74%) of high suitability habitat. The habitat distribution within the LSA was similar. High suitability habitat was seen throughout the RSA (Figure 38). The mean richness of the RSA was 0.75 (high) (Table 99).

Table 99 Reptile and Amphibian Habitat Richness: Habitat Units per Habitat Class for Project Millennium and CEA Impact Scenarios for the RSA

	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
Habitat Class	HU	%	HU	%	HU	%	HU	%
Low	0	0.0	0	0.0	0	0.0	0	0.0
Medium	471,382	25.8	561	11.5	5,942	25.8	465,440	25.8
High	1,354,965	74.2	4,303	88.5	17,098	74.2	1,337,867	74.2
Total	1,826,347	100.0	4,864	100.0	23,040	100.0	1,803,307	100.0
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Richness	0.75		0.86		0.77		0.74	

7.1.3.2 Impact of Project Millennium

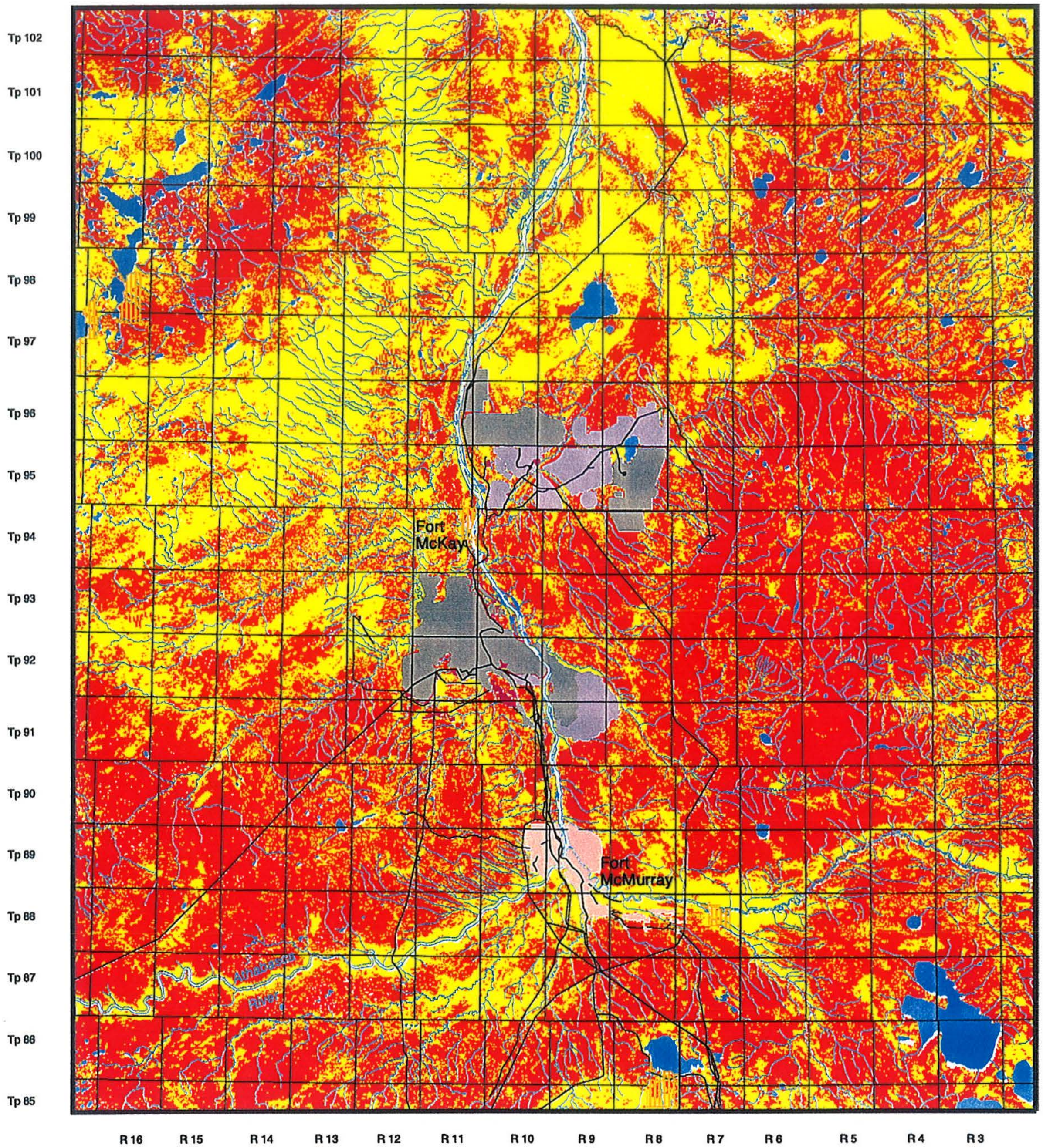
Direct habitat loss due to mine development is projected to affect reptile and amphibian richness by removing 0.3%, or 4,864 HUs within the RSA (Table 100, Figure 41). No low, 0.1% of moderate and 0.3% of high richness habitat will be lost due to Project Millennium.

Table 100 Reptile and Amphibian Habitat Richness: Change From Pre-Development Under Project Millennium and CEA Impact Scenarios for the RSA

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	0	0	0.0	0	0.0	0.0
Med	471,382	-561	-0.1	-5,942	-1.3	9.4
High	1,354,965	-4,303	-0.3	-17,098	-1.3	25.2
Total	**1,826,347**	**-4,864**	**-0.3**	**-23,040**	**-1.3**	**21.1**

7.1.3.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1.3%, or 23,040 reptile and amphibian richness HUs within the RSA (Table 100 and Figure 41). Of this loss, 21% is due to the effects of Project Millennium. In total, no low suitability habitat, 1.3% of moderate and 1.3% of high suitability habitat for reptile and amphibian richness will be lost.



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT RICHNESS RATING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA REPTILE AND AMPHIBIAN HABITAT RICHNESS CUMULATIVE EFFECTS ASSESSMENT SCENARIO

16 Apr. 1998	Figure 41	PRODUCED BY: MK REVIEWED BY:

7.2 BEAVER

7.2.1 Baseline Conditions

The suitability of the various vegetation types within the RSA for beaver habitat is presented in Table 101[2] and baseline conditions are mapped in Figure 42. High suitability habitat for beavers within the RSA included the following vegetation types if they were within 100 m from open water of marsh habitats:

- mixed deciduous;
- pine regeneration;
- shrubby fen;
- upland shrub;
- mixedwood-white spruce-trembling aspen; and
- old cutblocks.

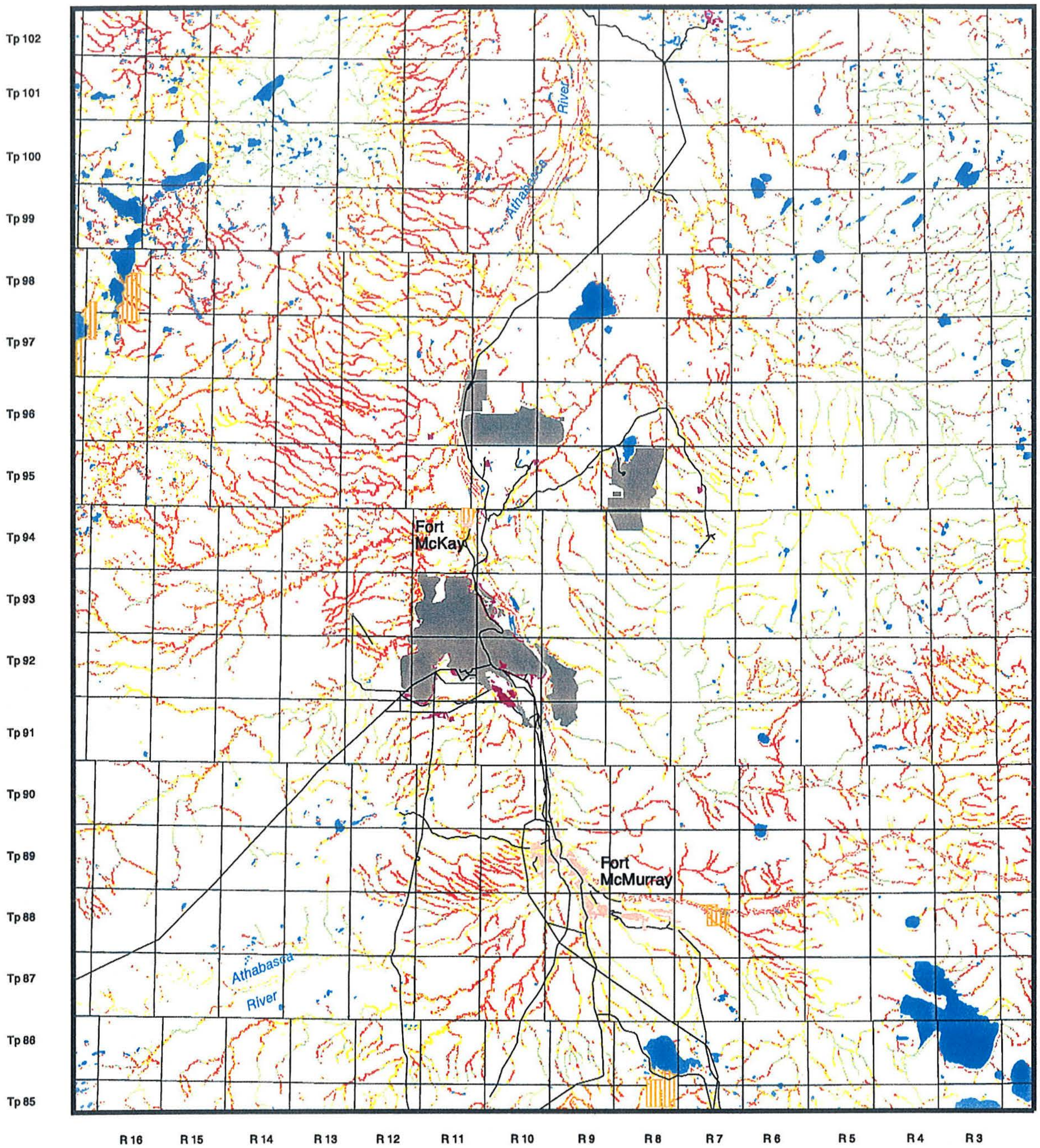
Unsuitable habitat for beavers included the areas within marshes and open water, municipalities, open pit mines and human disturbances, plus all areas greater than 100 m from an open water source.

[2] For beaver and all other KIRs, only values for the Boreal Mixedwood Ecoregion are shown, since this represents the majority of the area of the RSA. Slight variations in suitability by vegetation types occurred in the other ecoregions but did not generally affect suitability rankings among high, medium and low.

Table 101 Beaver HSI Vegetation Class Ratings in the RSA (for Food Areas Within 100 m of Open Water)

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Mixed Deciduous	1.00
	Pine Regen	1.00
	Shrubby Fen	1.00
	Upland Shrub	1.00
	Mixedwood-Sw/Aw	0.86
	Old Cutblocks	0.70
Medium Suitability (0.34 - 0.66)	Wet Open Coniferous Sb-Lt	0.61
	Recent Cutblocks	0.58
	Upland Sb-Lt	0.48
	Coniferous-Sw	0.38
	Low Shrub Wetland	0.34
Low Suitability (0.01 - 0.33)	Bog	0.33
	Coniferous-Sw/Pj	0.31
	Wet Closed Coniferous Sb	0.26
	Open Pine	0.19
	Coniferous-Pj/Sw/Sb	0.17
	Natural Disturbances	0.13
	Graminoid Fen	0.05
Unsuitable (0.00)	Marsh	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

The overall suitability of the RSA (total area of low, medium and high habitat divided by the total number of ha) for beavers at baseline is 15%, or 192,045 HUs. Of the unsuitable habitat, only 3% consisted of water (Table 102). Most of the unsuitable habitat was made up of habitat areas greater than 100 metres from the nearest open water source. The mean suitability of the RSA was 0.08 (low). However, the areas in which habitat existed were mainly high (Table 103).



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND
- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

BIODIVERSITY RANKING
- Nil
- Low
- Moderate
- High

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REGIONAL STUDY AREA
BEAVER HABITAT SUITABILITY
BASELINE SCENARIO

28 Apr. 1998	Figure 42	PRODUCED BY: M.D.W. REVIEWED BY:

Table 102 Beaver HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat			Suitable Habitat				Habitat Units	Percent of Habitat Units by Suitability Class		
		Water	Other	Total	Low	Med	High	Total		Low	Med	High
Baseline	2,428,750	2.7	82.7	85.3	5.8	3.4	5.5	14.7	192,045	13.7	20.3	66.1
Project Millennium (Development Area)	5,506	0.1	96.7	96.8	0.0	2.1	1.1	3.2	117	0.0	39.2	60.8
Remaining After Millennium	2,423,244	2.7	82.7	85.3	5.8	3.4	5.5	14.7	191,928	13.7	20.3	66.1
CEA (Development Area)	29,865	0.4	89.2	89.7	3.6	5.6	1.1	10.3	1,896	13.7	52.3	34.0
CEA (Undeveloped Area)	2,398,885	2.7	82.6	85.3	5.8	3.3	5.5	14.7	190,149	13.7	20.0	66.4

Suitable habitat for beavers within the RSA is shown in Table 103 and Figure 42. Of the 192,045 HUs of beaver habitat, the RSA is currently composed of 26,239 HUs (14%) of low quality habitat, 38,927 HUs (20%) of moderate quality habitat and 126,879 HUs (66%) of high quality habitat. This is similar to the habitat distribution within the LSA. High suitability habitat was mainly seen along the various creeks and rivers.

Table 103 Beaver HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

Habitat Class	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
	HU	%	HU	%	HU	%	HU	%
Low	26,239	13.7	0	0.0	260	13.7	25,979	13.7
Medium	38,927	20.3	47	39.2	992	52.3	37,935	20.0
High	126,879	66.1	73	60.8	644	34.0	126,235	66.4
Total	192,045	100.0	120	100.0	1,896	100.0	190,149	100.0
Low Units Gained[a]			2					
Net Total Loss			117					
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.08		0.02		0.06		0.08	

[a] Habitat units in the high or medium categories may be converted to medium or low habitat units in some cases, due to a reduction in habitat quality rather than strictly a loss in quantity. However, for percentages shown on this table, only the net loss is shown to a minimum of zero then habitat gains at low or medium are tabulated separately to result in the Net Habitat Loss.

7.2.2 Impact Assessment

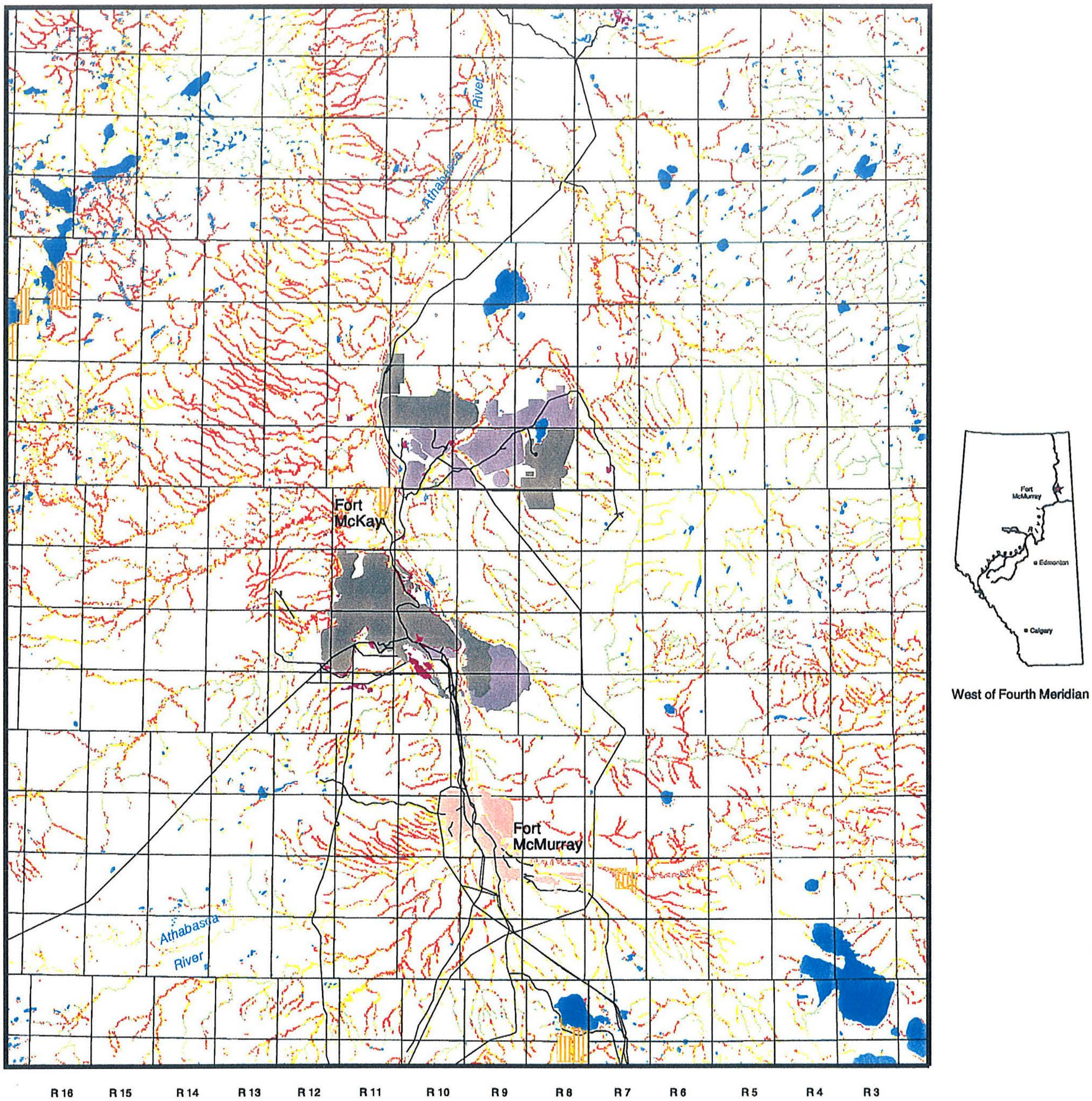
Direct habitat loss due to mine development is projected to affect beaver habitat by removing 0.1%, or 117 HUs within the RSA (Table 104, Figure 43). Zero percent of low, 0.1% of moderate and 0.1% of high quality habitat will be lost due to Project Millennium.

Table 104 Beaver HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	26,239	+2	+0.0	-260	-1.0	-0.9
Med	38,927	-47	-0.1	-992	-2.5	4.7
High	126,879	-73	-0.1	-644	-0.5	11.3
Total	**192,045**	**-117**	**-0.1**	**-1,896**	**-1.0**	**6.2**

7.2.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1%, or 1,896 HUs within the RSA (Table 104 and Figure 43). Of this loss, 6% is due to the effects of Project Millennium. In total, 1% of low, 3% of moderate and 1% of high suitability habitat for beavers will be lost.



SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA
BEAVER HABITAT SUITABILITY
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO

13 Apr. 1998 | Figure 43 | PRODUCED BY: K.K.Q. REVIEWED BY:

/data15/oilsands/nsl/arcview/beaver.apr

7.3 BLACK BEAR

7.3.1 Baseline Conditions

The suitability of the various vegetation types within the RSA for black bear habitat is presented in Table 105. High suitability habitat for black bears within the RSA included the following vegetation types:

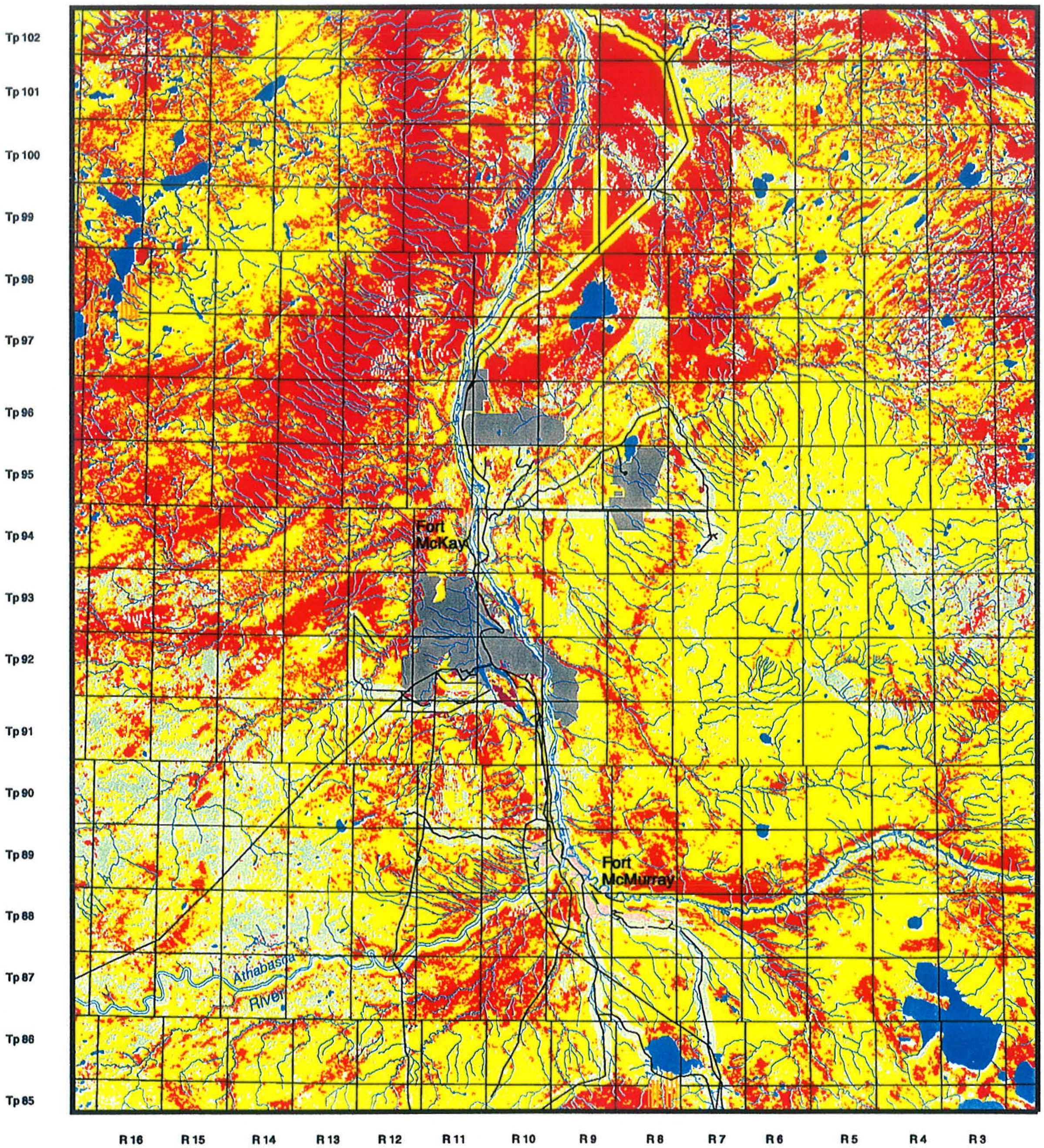
- mixed deciduous;
- mixedwood-white spruce-trembling aspen;
- coniferous-white spruce-jack pine;
- coniferous-jack pine-white spruce-black spruce;
- upland shrub;
- open pine; and
- coniferous-white spruce.

Unsuitable habitat for black bears included marshes, water, municipalities, open pit mines and human disturbances.

Table 105 Black Bear HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Mixed Deciduous	0.91
	Mixedwood-Sw/Aw	0.86
	Coniferous-Sw/Pj	0.86
	Coniferous-Pj/Sw/Sb	0.85
	Upland Shrub	0.85
	Open Pine	0.82
	Coniferous-Sw	0.74
Medium Suitability (0.34 - 0.66)	Upland Sb-Lt	0.64
	Wet Closed Coniferous Sb	0.55
	Pine Regen	0.50
	Wet Open Coniferous Sb-Lt	0.49
	Bog	0.46
	Low Shrub Wetland	0.44
	Old Cutblocks	0.35
	Shrubby Fen	0.35
Low Suitability (0.01 - 0.33)	Recent Cutblocks	0.10
	Natural Disturbances	0.02
	Graminoid Fen	0.01
Unsuitable (0.00)	Marsh	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

The overall suitability of the RSA (total number of HUs divided by the total number of ha) for black bears at baseline is 95%, or 1,247,278 HUs (Table 106). Of the unsuitable habitat, 3% consisted of water. All currently developed areas were considered unsuitable habitat as were marshes. The mean suitability for the RSA was 0.51 (medium). However, there was approximately an even split between medium and high habitat units (Table 107).



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

BIODIVERSITY RANKING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA
BLACK BEAR HABITAT SUITABILITY
BASELINE SCENARIO

28 Apr. 1998	Figure 44	PRODUCED BY: M.D.W. REVIEWED BY:

/data15/oilsands/nsl/arcview/bbear.apr

Table 106 Black Bear HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med	High
Baseline	2,428,750	2.7	2.3	4.9	12.8	53.5	28.8	95.1	1,247,278	1.5	51.6	47.0
Project Millennium (Development Area)	5,506	0.1	0.0	0.1	22.9	66.4	10.5	99.9	2,300	14.5	62.4	23.1
Remaining After Millennium	2,423,244	2.7	2.3	4.9	12.8	53.4	28.9	95.1	1,244,978	1.4	51.5	47.0
CEA (Development Area)	29,865	0.4	0.0	0.4	44.6	34.4	20.5	99.6	13,150	8.2	51.5	40.3
CEA (Undeveloped Area)	2,398,885	2.7	2.3	5.0	12.4	53.7	28.9	95.0	1,234,128	1.4	51.6	47.1

Suitable habitat for black bears within the RSA is shown in Table 107 and Figure 44. Of the 1,247,278 HUs of black bear habitat, the RSA is currently composed of 18,198 HUs (2%) of low quality habitat, 643,101 HUs (52%) of moderate quality habitat and 585,979 HUs (47%) of high quality habitat. This is similar to the habitat distribution within the LSA, although there were more areas of low suitability habitat and fewer areas of high suitability habitat in the LSA. High suitability habitat was mainly seen in the northern portions of the RSA, in the mixedwood habitats along the various draws.

Table 107 Black Bear HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

Habitat Class	RSA Baseline (Habitat Units) HU	%	Project Millennium (Units Lost) HU	%	RSA CEA (Units Lost) HU	%	RSA CEA (Habitat Units) HU	%
Low	18,198	1.5	333	14.5	1,082	8.2	17,116	1.4
Medium	643,101	51.6	1,435	62.4	6,766	51.5	636,335	51.6
High	585,979	47.0	532	23.1	5,302	40.3	580,677	47.1
Total	1,247,278	100.0	2,300	100.0	13,150	100.0	1,234,128	100.0
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.51		0.41		0.44		0.51	

7.3.2 Impact Assessment

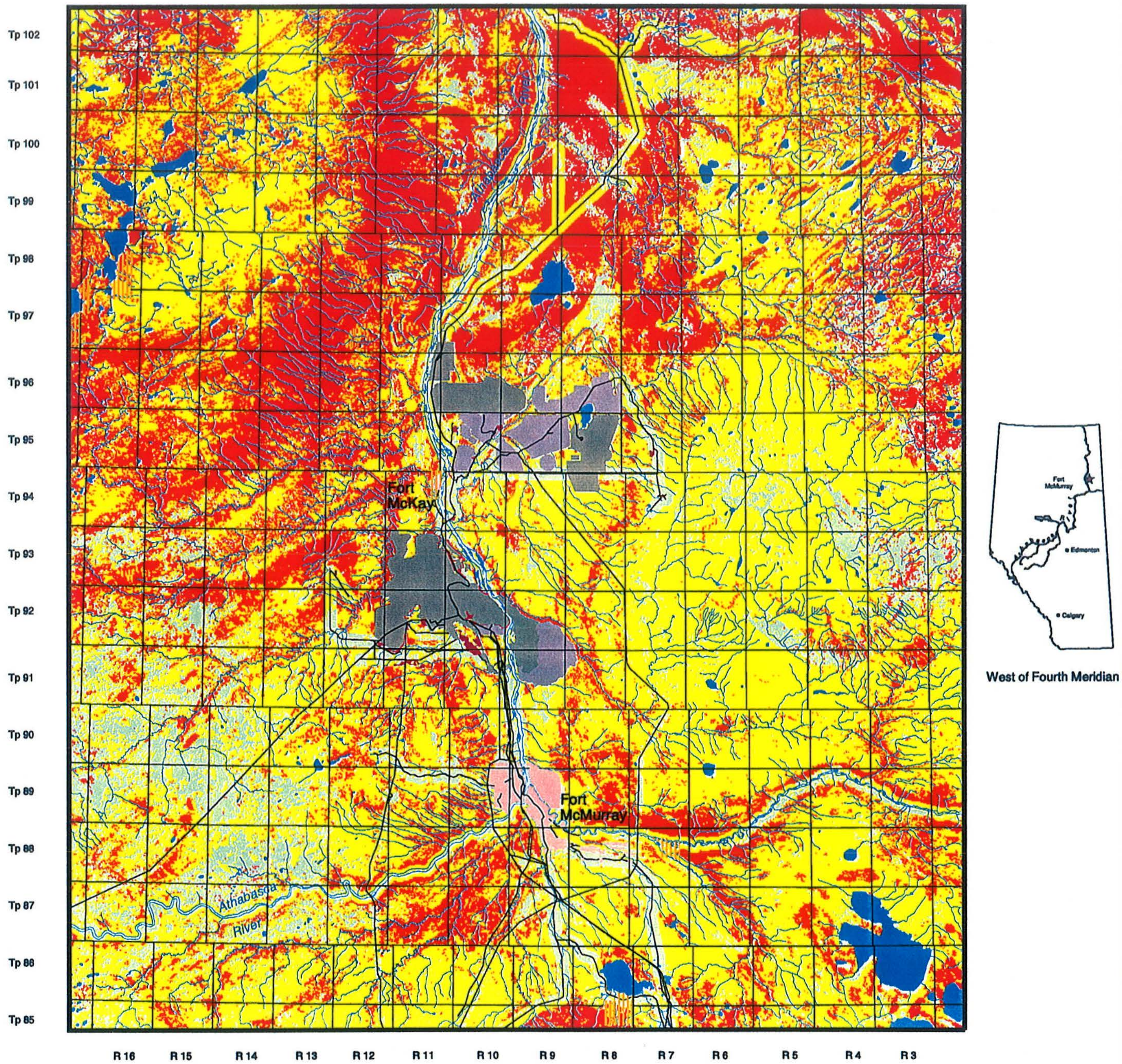
Direct habitat loss due to mine development is projected to affect black bear habitat by removing 0.2%, or 2,300 HUs within the RSA (Table 108). Two percent of low, 0.2% of moderate and 0.1% of high quality habitat will be lost due to Project Millennium.

Table 108 Black Bear HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	18,198	-333	-1.8	-1,082	-5.9	30.8
Med	643,101	-1,435	-0.2	-6,766	-1.1	21.2
High	585,979	-532	-0.1	-5,302	-0.9	10.0
Total	**1,247,278**	**-2,300**	**-0.2**	**-13,150**	**-1.1**	**17.5**

7.3.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1%, or 13,150 HUs within the RSA (Table 108 and Figure 45). Of this loss, 18% is due to the effects of Project Millennium. In total, 31% of low, 21% of moderate and 10% of high suitability habitat for black bears will be lost.



SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA BLACK BEAR HABITAT SUITABILITY CUMULATIVE EFFECTS ASSESSMENT SCENARIO

14 Apr. 1998 | Figure 45 | PRODUCED BY: K.K.O. REVIEWED BY: [signature]

/data15/oilsands/hsi/arcview/bbear_cea.apr

7.4 CAPE MAY WARBLER

7.4.1 Baseline Conditions

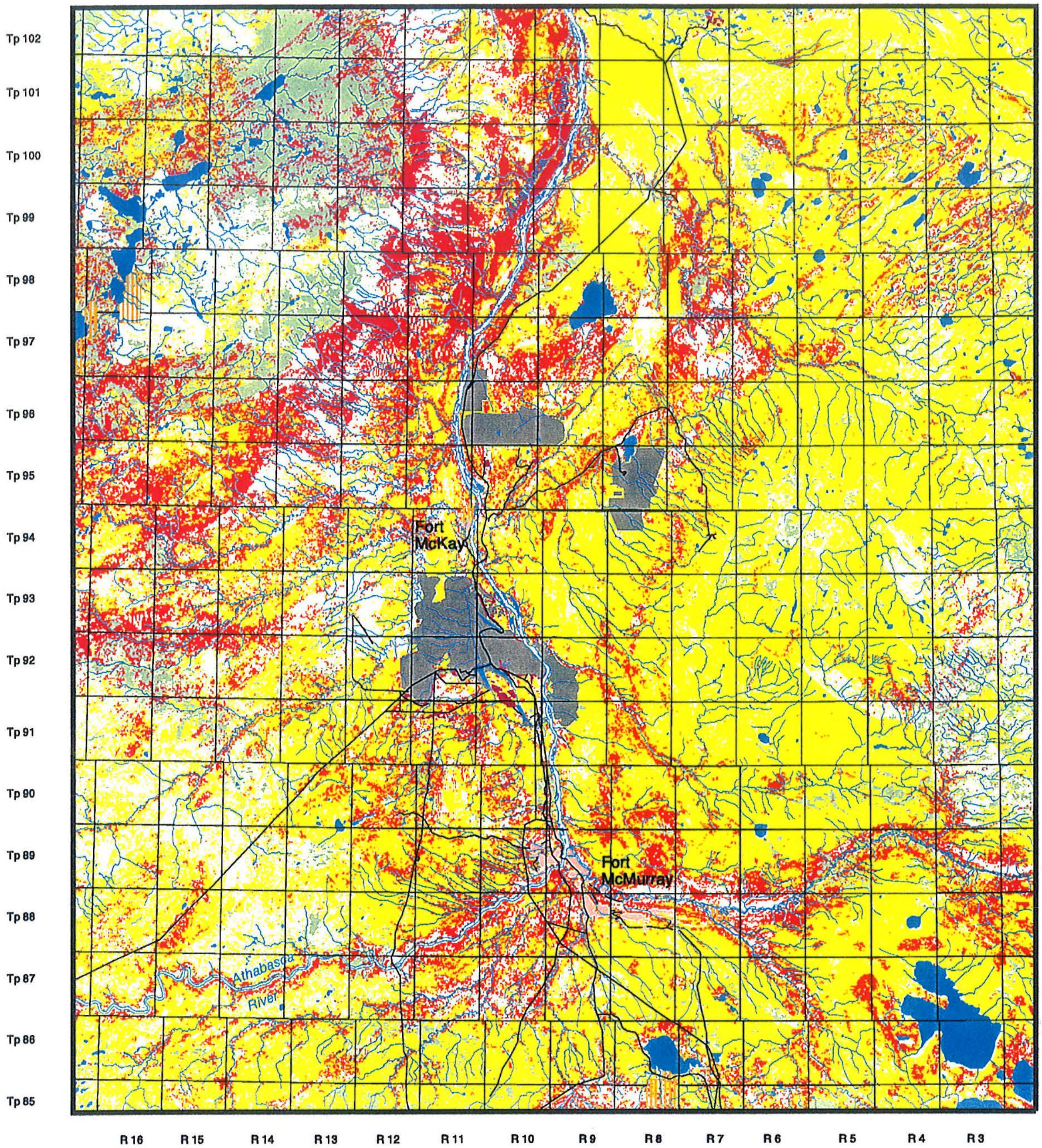
The suitability of the various vegetation types within the RSA for Cape May warbler habitat is presented in Table 109. A map of baseline conditions for this species is provided in Figure 46. High suitability habitat for Cape May warblers within the RSA included the following vegetation types:

- coniferous-white spruce; and
- mixedwood-white spruce-trembling aspen.

Unsuitable habitat for Cape May warblers included mixed deciduous, pine regeneration, graminoid fens, upland shrubland, marshes, water, municipalities, open pit mines and human disturbances. Most of the remaining vegetation classes were medium.

Table 109 Cape May Warbler HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Coniferous-Sw	0.85
	Mixedwood-Sw/Aw	0.73
Medium Suitability (0.34 - 0.66)	Low Shrub Wetland	0.57
	Bog	0.57
	Shrubby Fen	0.53
	Coniferous-Sw/Pj	0.52
	Open Pine	0.51
	Coniferous-Pj/Sw/Sb	0.50
	Wet Closed Coniferous Sb	0.46
	Upland Sb-Lt	0.38
	Wet Open Coniferous Sb-Lt	0.34
Low Suitability (0.01 - 0.33)	Old Cutblocks	0.17
Unsuitable (0.00)	Mixed Deciduous	0.00
	Pine Regen	0.00
	Graminoid Fen	0.00
	Marsh	0.00
	Upland Shrub	0.00
	Recent Cutblocks	0.00
	Natural Disturbances	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

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N

REGIONAL STUDY AREA
CAPE MAY WARBLER HABITAT SUITABILITY
BASELINE SCENARIO

09 Apr. 1998	Figure 46	PRODUCED BY: MK REVIEWED BY:

The overall suitability of the RSA (total area of low, medium and high habitat divided by the total number of ha) for Cape May warblers at baseline is 73%, or 903,110 HUs (Table 110). Of the unsuitable habitat, 3% consisted of water, with the rest mainly being deciduous forests and disturbed lands. The mean suitability for the RSA was 0.37 (medium) (Table 111).

Table 110 Cape May Warbler HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class							Habitat Units	Percent of Habitat Units by Suitability Class		
		Unsuitable Habitat			Suitable Habitat							
		Water	Other	Total	Low	Med	High	Total		Low	Med	High
Baseline	2,428,750	2.7	23.9	26.6	7.3	49.0	17.1	73.4	903,110	3.7	61.1	35.2
Project Millennium (Development Area)	5,506	0.1	18.1	18.2	49.6	28.0	4.1	81.8	1,545	35.2	52.7	12.0
Remaining After Millennium	2,423,244	2.7	23.9	26.6	7.2	49.1	17.1	73.4	901,565	3.6	61.1	35.2
CEA (Development Area)	29,865	0.3	39.6	39.9	0.0	41.3	18.8	60.1	11,682	0.0	57.6	42.4
CEA (Undeveloped Area)	2,398,885	2.7	23.5	26.2	7.9	48.9	17.0	73.8	891,428	3.9	61.0	35.0

Suitable habitat for Cape May warblers within the RSA is shown in Table 111 and Figure 46. Of the 903,110 HUs of Cape May warbler habitat, the RSA is currently composed of 33,231 HUs (4%) of low quality habitat, 551,920 HUs (61%) of moderate quality habitat and 317,959 HUs (35%) of high quality habitat. This is similar to the habitat distribution within the LSA, although there were more areas of low suitability habitat and fewer areas of moderate and high suitability habitat in the LSA. High suitability habitat was mainly seen in the northern portions of the RSA, in the old growth white spruce forests near the various draws.

Table 111 Cape May Warbler HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
Habitat Class	**HU**	**%**	**HU**	**%**	**HU**	**%**	**HU**	**%**
Low	33,231	3.7	544	35.2	0	0.0	35,156	3.9
Medium	551,920	61.1	815	52.7	7,838	57.6	544,082	61.0
High	317,959	35.2	186	12.0	5,769	42.4	312,190	35.0
Total	903,110	100.0	1,545	100.0	13,607	100.0	891,428	100.0
Low Units Gained[a]					1,925			
Net Total Loss					11,682			
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.37		0.27		0.39		0.37	

[a] Habitat units in the high or medium categories may be converted to medium or low habitat units in some cases, due to a reduction in habitat quality rather than strictly a loss in quantity. However, for percentages shown on this table, only the net loss is shown to a minimum of zero then habitat gains at low or medium are tabulated separately to result in the Net Habitat Loss.

7.4.2 Impact Assessment

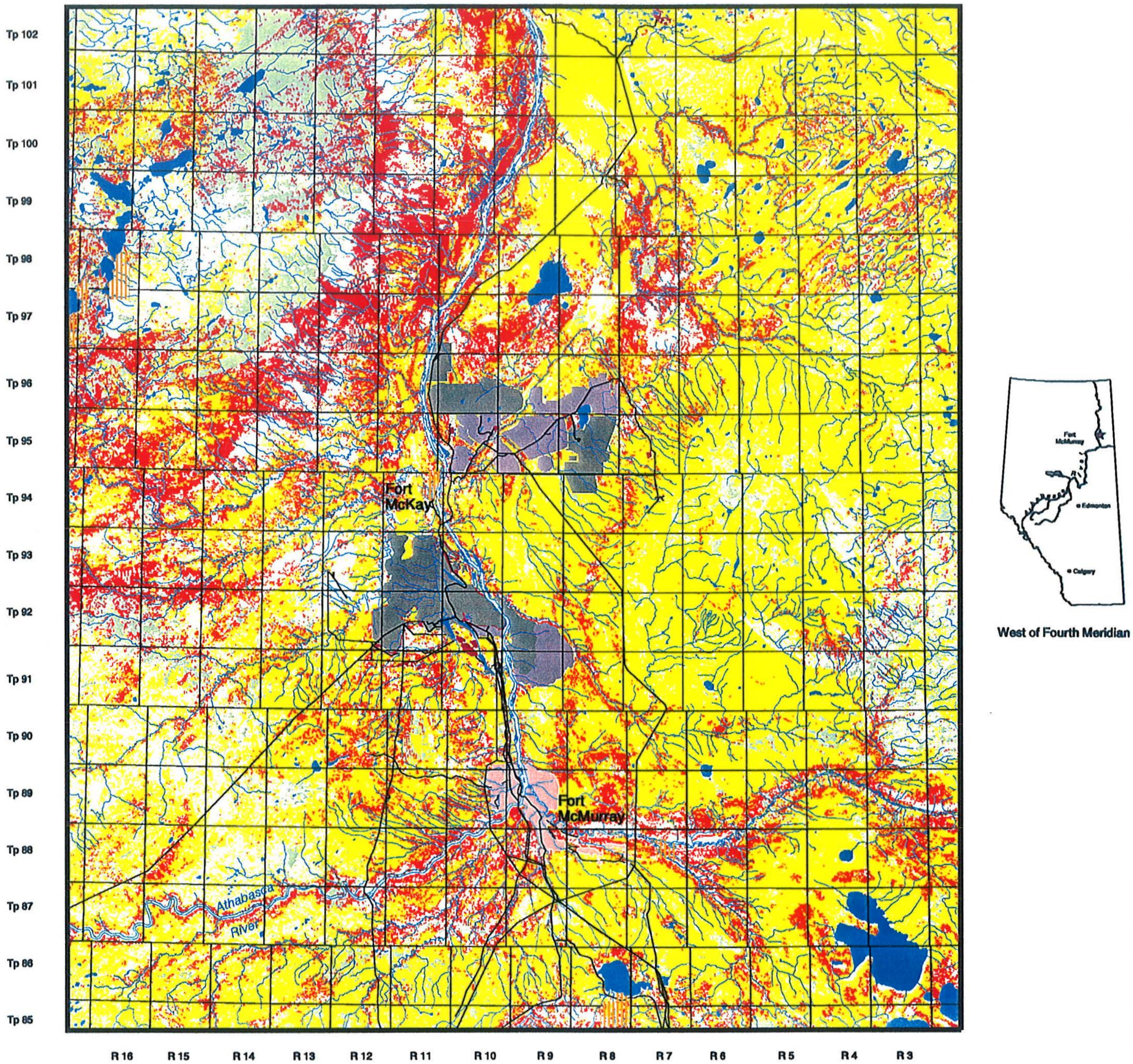
Direct habitat loss due to mine development is projected to affect Cape May warbler habitat by removing 0.2%, or 1,545 HUs within the RSA (Table 112). Two percent of low, 0.1% of moderate and 0.1% of high quality habitat will be lost due to Project Millennium.

Table 112 Cape May Warbler HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	33,231	-544	-1.6	+1,925	+5.8	-28.3
Med	551,920	-815	-0.1	-7,838	-1.4	10.4
High	317,959	-186	-0.1	-5,769	-1.8	3.2
Total	**903,110**	**-1,545**	**-0.2**	**-11,682**	**-1.3**	**13.2**

7.4.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1%, or 11,682 HUs within the RSA (Table 112 and Figure 47). Of this loss, 13% is due to the effects of Project Millennium. In total, 28% of low, 10% of moderate and 3% of high suitability habitat for Cape May warblers will be lost.



SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

SUNCOR ENERGY

Project Millennium

**REGIONAL STUDY AREA
CAPE MAY WARBLER
HABITAT SUITABILITY
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO**

14 Apr. 1998	Figure 47	PRODUCED BY: K.K.O. REVIEWED BY:

/data15/oilsands/hsi/arcview/warbler_cea.apr

7.5 DABBLING DUCKS

7.5.1 Baseline Conditions

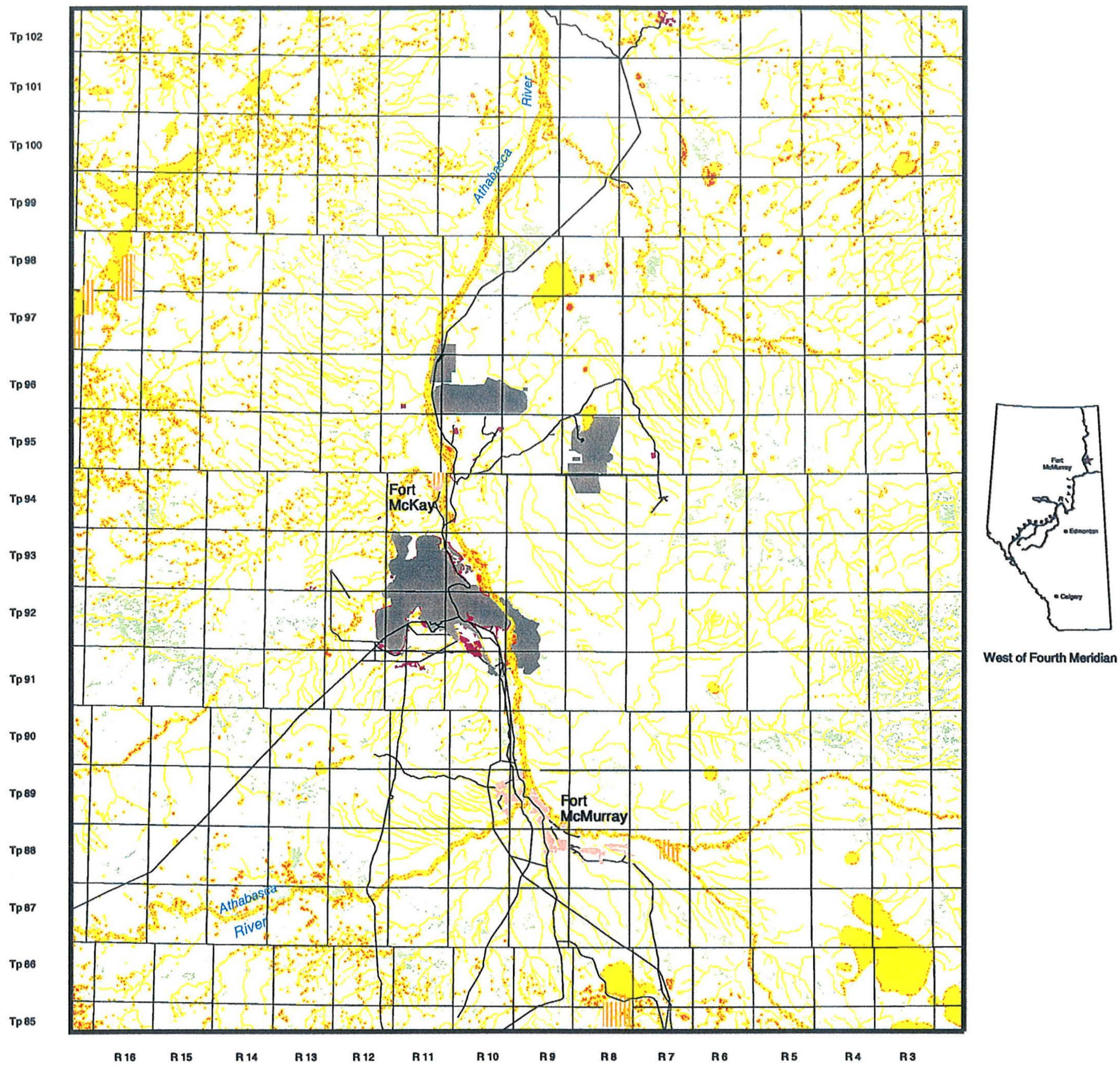
The suitability of the various vegetation types within the RSA for dabbling duck habitat is presented in Table 113 and Figure 48. High suitability habitat for dabbling ducks within the RSA included the following vegetation types:

- marshes; and
- vegetated areas adjacent to ponds, lakes and marshes

Lakes and ponds were considered to be medium habitat. Unsuitable habitat for dabbling ducks included upland forests, shrublands and meadows; disturbed areas; bogs, swamps and fens; rivers and creeks with fast stream gradients and vegetated areas >250m from ponds, lakes and marshes.

Table 113 Dabbling Ducks HSI Vegetation Class Ratings in the RSA

Habitat Suitability Class	Habitat Type	Distance From Habitat Type	HSI
High Suitability (0.67 - 1.00)	Marshes	Within Type	1.00
	Vegetated Areas Adjacent to Ponds, Lakes, Marshes	0 - 50 m	1.00
Medium Suitability (0.34 - 0.66)	Lakes and Ponds	Within Type	0.66
	Vegetated Areas Adjacent to Ponds, Lakes, Marshes	50 - 100 m	0.66
	Vegetated Areas Adjacent to Rivers and Streams < 5 degree gradient	0 - 50 m	0.66
Low Suitability (0.01 - 0.33)	Rivers and Creeks < 5 degree stream gradient	Within Type	0.33
	Vegetated Areas Adjacent to Ponds, Lakes, Marshes	100 - 250 m	0.33
	Vegetated Areas Adjacent to Rivers and Streams < 5 degree gradient	50 - 100 m	0.33
Unsuitable (0.00)	Upland Forests, Shrublands and Meadows	Within Type	0.00
	Disturbed Areas	Within Type	0.00
	Bogs, Swamps and Fens	Within Type	0.00
	Rivers and Creeks > 5 degree stream gradient	Within Type	0.00
	Vegetated Areas Adjacent to Ponds, Lakes, Marshes	> 250 m	0.00
	Vegetated Areas Adjacent to Rivers and Streams < 5 degree gradient	> 100 m	0.00
	Vegetated Areas Adjacent to Rivers and Stream > 5 degree gradient	All distances	0.00



SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

BIODIVERSITY RANKING

- Nil
- Low
- Moderate
- High

N

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Project Millennium

**REGIONAL STUDY AREA
DABBLING DUCKS HABITAT SUITABILITY
BASELINE SCENARIO**

20 Apr. 1998	Figure 48	PRODUCED BY: K.K.O. REVIEWED BY:

The overall suitability of the RSA (total area of low, medium and high areas divided by the total number of ha) for dabbling ducks at baseline is 21%, or 243,120 HUs (Table 114). Of the unsuitable habitat, the majority consisted of vegetated areas greater than the required distances from lakes, ponds or rivers. The mean suitability for the RSA (HU/Area) was 0.10 (low); however, by habitat units the suitability of most areas which were >0 was medium.

Table 114 Dabbling Ducks HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat			Suitable Habitat				Habitat Units	Percent of Habitat Units by Suitability Class		
		Water	Other	Total	Low	Med	High	Total		Low	Med	High
Baseline	2,428,750	0.0	79.5	79.5	9.9	9.4	1.2	20.5	243,130	26.5	62.0	11.5
Project Millennium (Development Area)	5,506	0.0	96.5	96.5	2.7	0.6	0.2	3.5	99	55.5	25.2	19.3
Remaining After Millennium	2,423,244	0.0	79.4	79.4	10.0	9.4	1.2	20.6	243,031	26.5	62.0	11.5
CEA (Development Area)	29,865	0.0	89.8	89.8	5.2	4.7	0.2	10.2	1,564	29.7	62.3	8.1
CEA (Undeveloped Area)	2,398,885	0.0	79.4	79.4	10.0	9.5	1.2	20.6	241,565	26.5	62.0	11.5

Suitable habitat for dabbling ducks within the RSA is shown in Table 115 and Figure 48. Of the 243,130 HUs of dabbling duck habitat, the RSA is currently composed of 64,410 HUs (27%) of low quality habitat, 150,800 HUs (62%) of moderate quality habitat and 27,920 HUs (12%) of high quality habitat. The habitat distribution within the LSA consisted of fewer areas of medium suitability habitat and more areas of high suitability habitat. High suitability habitat within the RSA was mainly seen in the vicinity of various lakes and creeks.

Table 115 Dabbling Ducks HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

Habitat Class	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
	HU	%	HU	%	HU	%	HU	%
Low	64,410	26.5	55	55.5	464	29.7	63,946	26.5
Medium	150,800	62.0	25	25.2	974	62.3	149,825	62.0
High	27,920	11.5	19	19.3	126	8.1	27,794	11.5
Total	243,130	100.0	99	100.0	1,564	100.0	241,565	100.0
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.10		0.02		0.05		0.10	

7.5.2 Impact Assessment

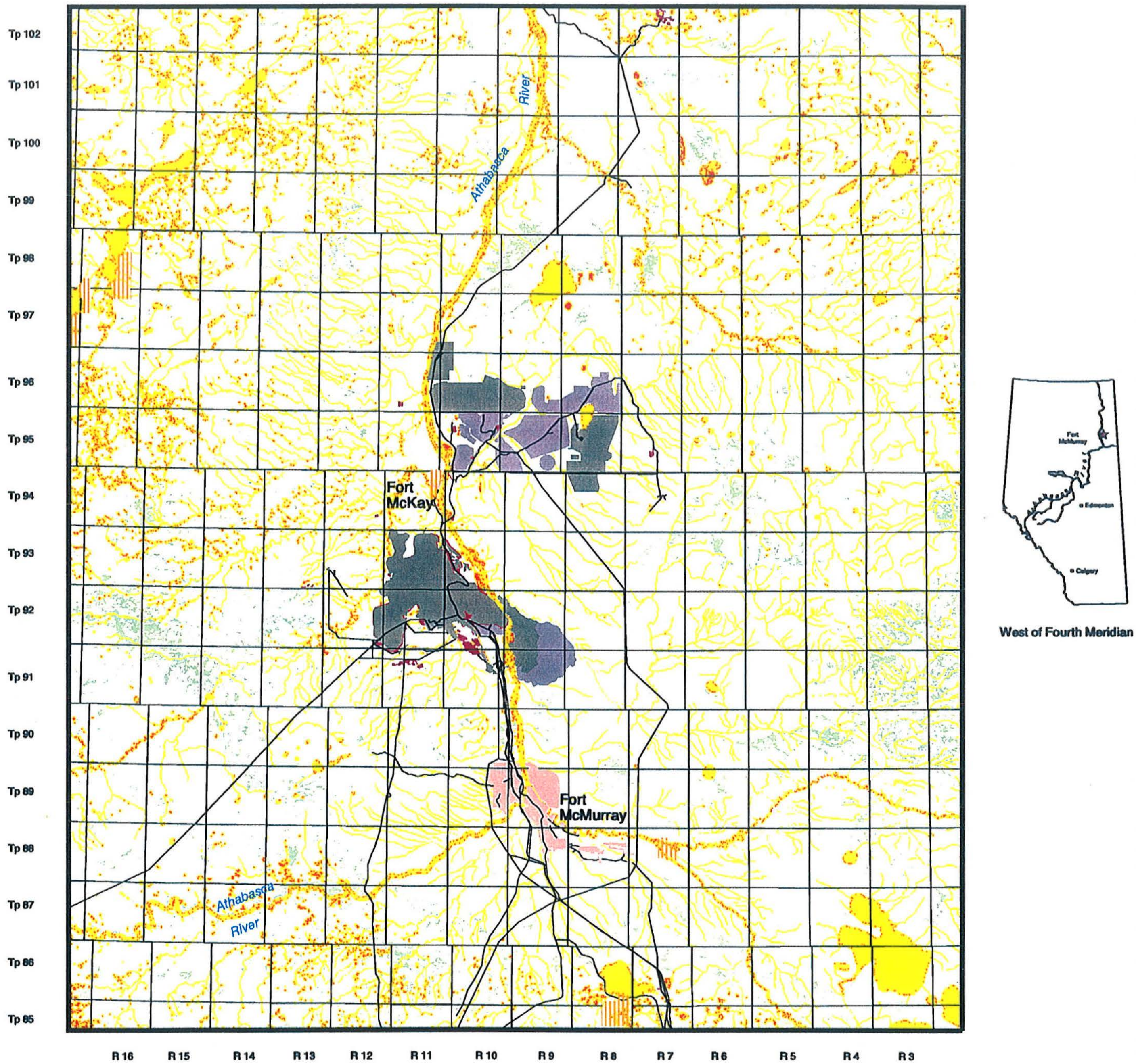
Direct habitat loss due to mine development is projected to affect dabbling duck habitat by removing <0.1%, or 99 HUs within the RSA (Table 116). Zero percent of low, <0.1% of moderate and 0.1% of high quality habitat will be lost due to Project Millennium.

Table 116 Dabbling Ducks HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	64,410	-55	-0.1	-464	-0.7	11.8
Med	150,800	-25	-0.0	-974	-0.6	2.6
High	27,920	-19	-0.1	-126	-0.5	15.2
Total	**243,130**	**-99**	**-0.0**	**-1,564**	**-0.6**	**6.3**

7.5.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 0.6%, or 1,564 HUs within the RSA (Table 116 and Figure 49). Of this loss, 6% is due to the effects of Project Millennium. In total, 12% of low, 3% of moderate and 15% of high suitability habitat for dabbling ducks will be lost.



SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA DABBLING DUCKS HABITAT SUITABILITY CUMULATIVE EFFECTS ASSESSMENT SCENARIO

14 Apr. 1998	Figure 49	PRODUCED BY: K.K.O. REVIEWED BY:

/data15/oilsands/hsi/arcview/ducks_cea.apr

7.6 FISHER

7.6.1 Baseline Conditions

The suitability of the various vegetation types within the RSA for fisher habitat is presented in Table 117 and Figure 50. High suitability habitat for fishers within the RSA included the following vegetation types:

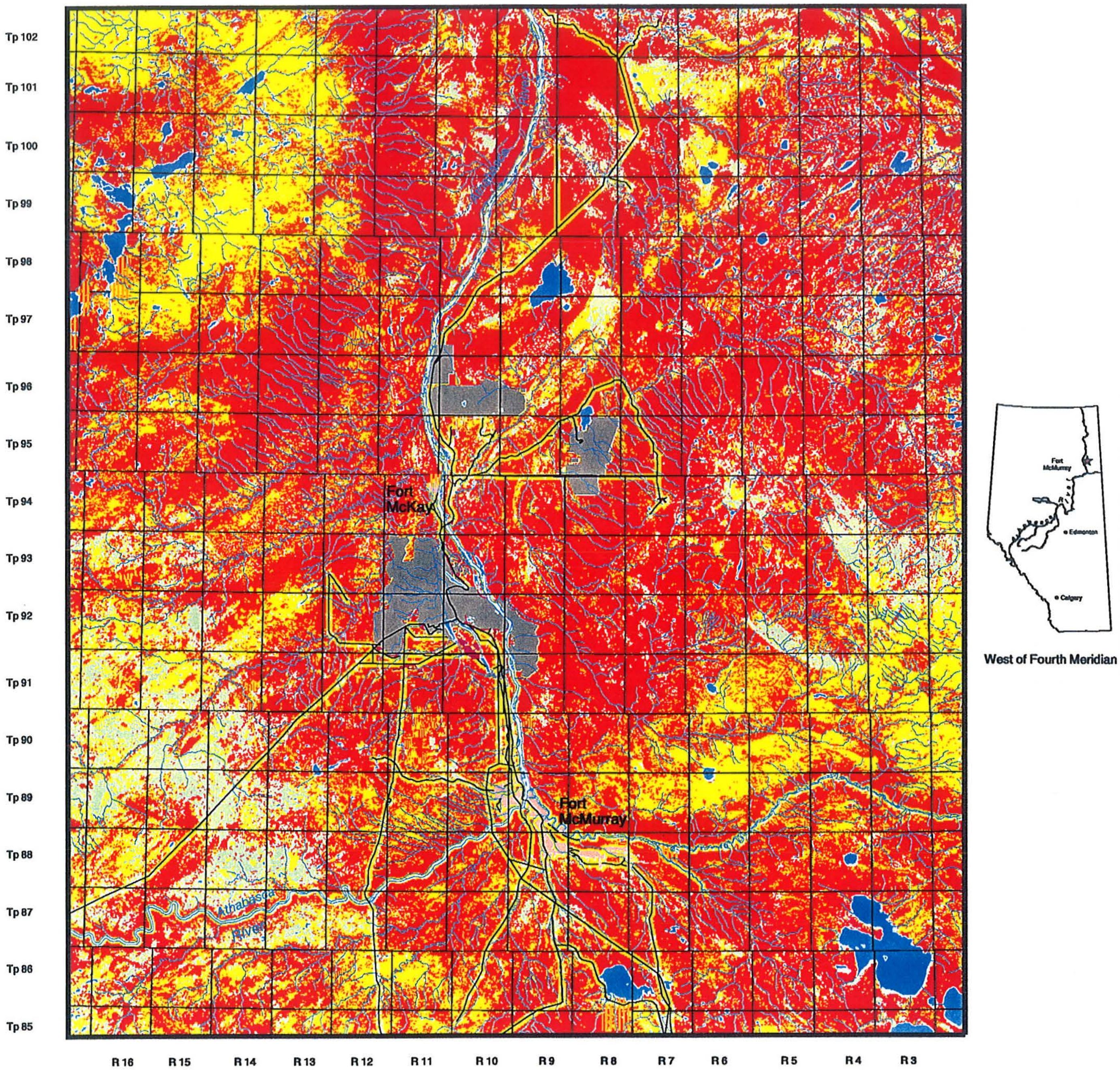
- coniferous-white spruce;
- coniferous-white spruce-jack pine;
- coniferous-jack pine-white spruce-black spruce;
- wet closed coniferous black spruce;
- mixedwood-white spruce-trembling aspen;
- open pine;
- upland black spruce-tamarack;
- mixed deciduous; and
- wet open coniferous black spruce-tamarack.

Unsuitable habitat for fishers included marshes, water, municipalities, open pit mines and human disturbances.

Table 117 Fisher HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Coniferous-Sw	0.88
	Coniferous-Sw/Pj	0.88
	Coniferous-Pj/Sw/Sb	0.86
	Wet Closed Coniferous Sb	0.81
	Mixedwood-Sw/Aw	0.81
	Open Pine	0.81
	Upland Sb-Lt	0.76
	Mixed Deciduous	0.76
	Wet Open Coniferous Sb-Lt	0.73
Medium Suitability (0.34 - 0.66)	Shrubby Fen	0.57
	Bog	0.55
	Old Cutblocks	0.55
	Low Shrub Wetland	0.53
	Pine Regen	0.51
	Upland Shrub	0.50
	Recent Cutblocks	0.38
Low Suitability (0.01 - 0.33)	Natural Disturbances	0.17
	Graminoid Fen	0.14
Unsuitable (0.00)	Marsh	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

The overall suitability of the RSA (total area of low, medium and high habitat divided by the total number of ha) for fishers at baseline is 95%, or 1,508,485 HUs (Table 118). All currently developed areas and open water were considered unsuitable habitat. The mean suitability of the RSA (HU/area) was 0.62 (medium) (Table 119). However, for areas with habitat units, the majority was high habitat.



SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

BIODIVERSITY RANKING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA
FISHER HABITAT SUITABILITY
BASELINE SCENARIO

27 Apr. 1998	Figure 50	PRODUCED BY: M.D.W. REVIEWED BY:

/data15/oilsands/rsa/arcview/fisher.apr

Table 118 Fisher HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med	High
Baseline	2,428,750	2.7	2.0	4.7	10.8	25.1	59.4	95.3	1,508,485	2.5	21.2	76.3
Project Millennium (Development Area)	5,506	0.1	0.0	0.1	0.0	34.4	65.5	99.9	4,045	0.0	26.1	73.9
Remaining After Millennium	2,423,244	2.7	2.0	4.7	10.8	25.1	59.4	95.3	1,504,440	2.5	21.2	76.3
CEA (Development Area)	29,865	0.4	0.0	0.4	1.2	4.8	93.5	99.6	21,591	0.0	0.0	100.0
CEA (Undeveloped Area)	2,398,885	2.7	2.1	4.7	10.9	25.4	59.0	95.3	1,486,894	2.6	21.5	75.9

Suitable habitat for fishers within the RSA is shown in Table 119 and Figure 50. Of the 1,508,485 HUs of fisher habitat, the RSA is currently composed of 33,312 HUs (3%) of low quality habitat, 319,519 HUs (21%) of moderate quality habitat and 1,150,654 HUs (76%) of high quality habitat. The habitat distribution within the LSA was similar. High suitability habitat was seen throughout the RSA.

Table 119 Fisher HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

Habitat Class	RSA Baseline (Habitat Units) HU	%	Project Millennium (Units Lost) HU	%	RSA CEA (Units Lost) HU	%	RSA CEA (Habitat Units) HU	%
Low	38,312	2.5	0	0.0	0	0.0	38,596	2.6
Medium	319,519	21.2	1,058	26.1	0	0.0	319,843	21.5
High	1,150,654	76.3	2,987	73.9	22,199	100.0	1,128,455	75.9
Total	1,508,485	100.0	4,045	100.0	22,199	100.0	1,486,894	100.0
Low Units Gained[(a)]					284			
Medium Units Gained[(a)]					324			
Net Total Loss					21,591			
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.62		0.72		0.72		0.61	

(a) Habitat units in the high or medium categories may be converted to medium or low habitat units in some cases, due to a reduction in habitat quality rather than strictly a loss in quantity. However, for percentages shown on this table, only the net loss is shown to a minimum of zero then habitat gains at low or medium are tabulated separately to result in the Net Habitat Loss.

7.6.2 Impact Assessment

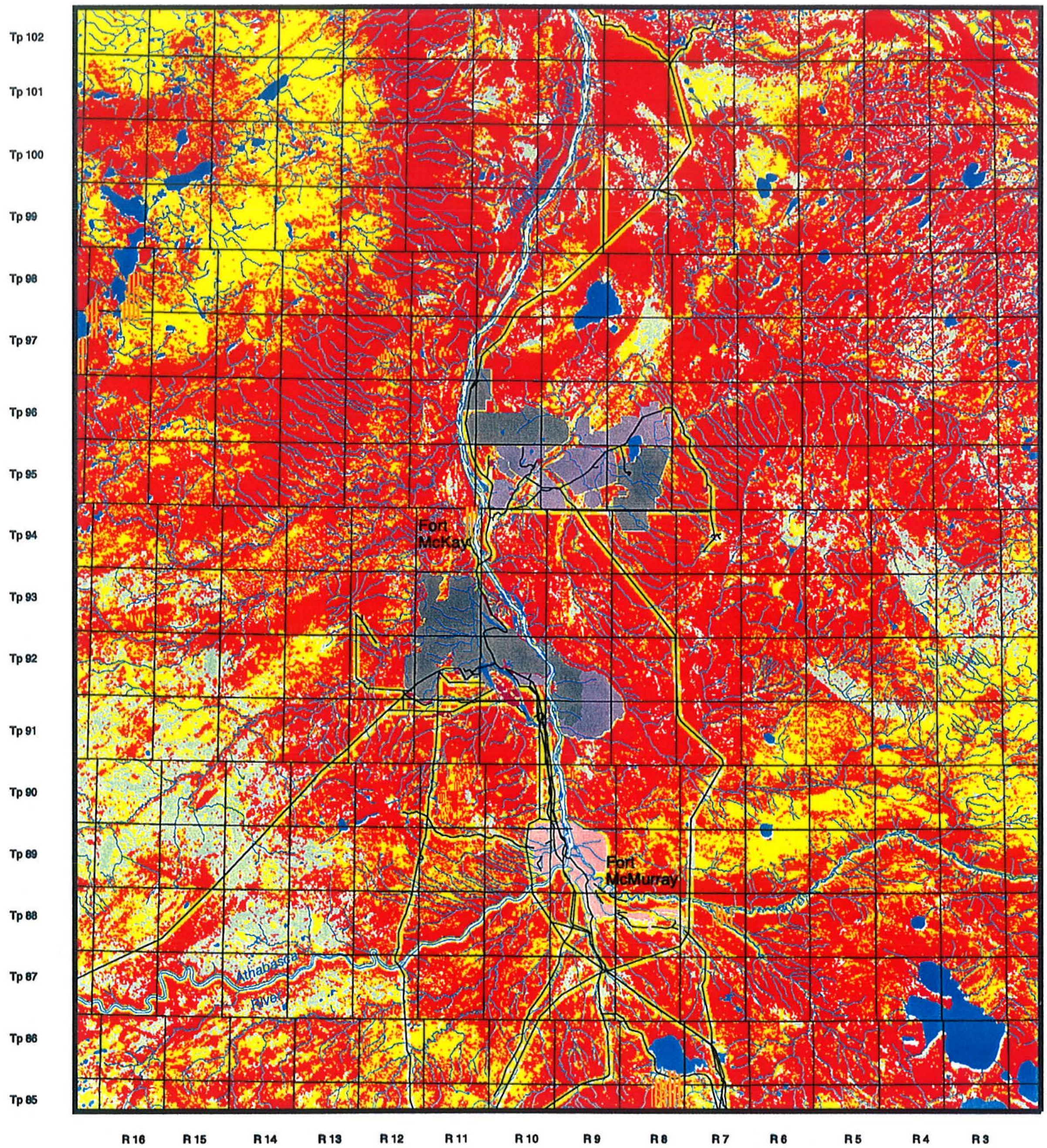
Direct habitat loss due to mine development is projected to affect fisher habitat by removing 0.3%, or 4,045 HUs within the RSA (Table 120). Zero percent of low, 0.3% of moderate and 0.3% of high quality habitat will be lost due to Project Millennium.

Table 120 Fisher HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	38,312	-0	-0.0	+284	+0.7	0.0
Med	319,519	-1,058	-0.3	+324	+0.1	-326.4
High	1,150,654	-2,987	-0.3	-22,199	-1.9	13.5
Total	**1,508,485**	**-4,045**	**-0.3**	**-21,591**	**-1.4**	**18.7**

7.6.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1.4%, or 21,591 HUs within the RSA (Table 120 and Figure 51). Of this loss, 1.9% is due to the effects of Project Millennium. In total, 1.9% of high suitability habitat for fishers will be lost, but will be offset slightly by gains to low and medium habitat.



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA FISHER HABITAT SUITABILITY CUMULATIVE EFFECTS ASSESSMENT SCENARIO

14 Apr. 1998

Figure 51

PRODUCED BY: K.K.O.
REVIEWED BY: MB

/data15/oilsands/nsl/arcview/fisher_cea.apr

7.7 GREAT GRAY OWL

7.7.1 Baseline Conditions

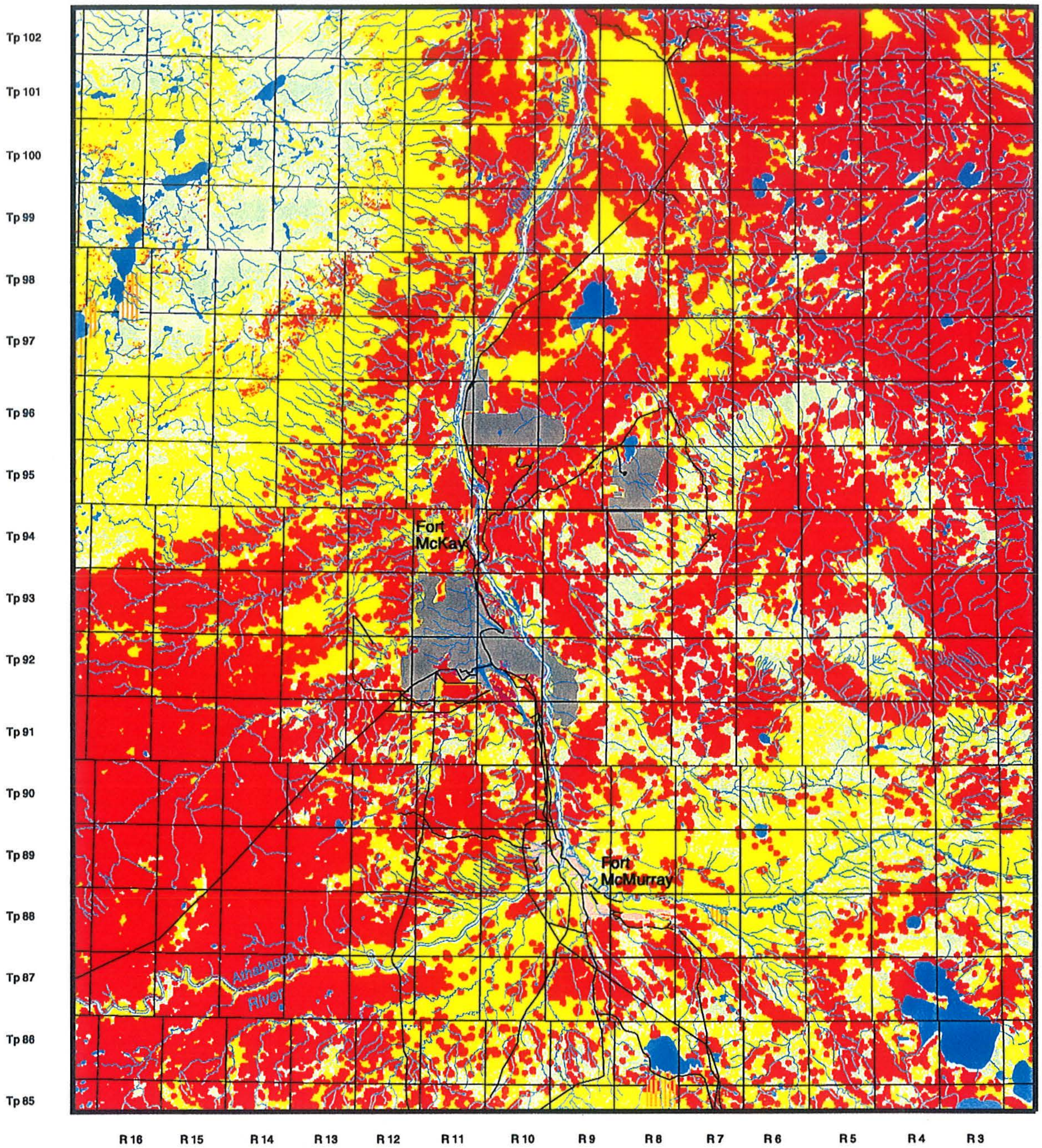
The suitability of the various vegetation types within the RSA for great gray owl habitat food and cover is presented in Tables 121 and 122, respectively. Food and cover areas were combined using spatial rules and cannot be shown as HSI values here. A baseline map of habitat conditions for the species is provided in Figure 52. High suitability foraging habitat for great gray owls within the RSA included the following vegetation types:

- graminoid fens; and
- recent cutblocks.

Unsuitable foraging habitat for great gray owls included water, municipalities, open pit mines and human disturbances.

Table 121 Great Gray Owl Food HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	Food HSI
High Suitability (0.67 - 1.00)	Graminoid Fen	1.00
	Recent Cutblocks	0.90
Medium Suitability (0.34 - 0.66)	Old Cutblocks	0.65
	Coniferous-Sw	0.52
	Open Pine	0.51
	Natural Disturbances	0.51
	Marsh	0.50
	Shrubby Fen	0.38
	Mixed Deciduous	0.34
Low Suitability (0.01 - 0.33)	Pine Regen	0.30
	Mixedwood-Sw/Aw	0.28
	Wet Open Coniferous Sb-Lt	0.28
	Upland Sb-Lt	0.26
	Low Shrub Wetland	0.24
	Bog	0.24
	Wet Closed Coniferous Sb	0.17
	Coniferous-Sw/Pj	0.16
	Upland Shrub	0.13
	Coniferous-Pj/Sw/Sb	0.12
Unsuitable (0.00)	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

BIODIVERSITY RANKING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA
GREAT GRAY OWL HABITAT SUITABILITY
BASELINE SCENARIO

28 Apr. 1998	Figure 52	PRODUCED BY: M.D.W. REVIEWED BY:

/data15/oilsands/hsl/arcview/ggowl.apr

High suitability cover habitat for great gray owls within the RSA included the following vegetation types:

- mixed deciduous;
- mixedwood-white spruce-trembling aspen;
- coniferous-white spruce;
- coniferous-white spruce-jack pine; and
- open pine.

Unsuitable cover habitat for great gray owls included graminoid fens, marshes, upland shrubland, recent cutblocks, natural disturbances, water, municipalities, open pit mines and human disturbances.

Table 122 Great Gray Owl Cover HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	Cover HSI
High Suitability (0.67 - 1.00)	Mixed Deciduous	0.92
	Mixedwood-Sw/Aw	0.92
	Coniferous-Sw	0.82
	Coniferous-Sw/Pj	0.73
	Open Pine	0.68
Medium Suitability (0.34 - 0.66)	Coniferous-Pj/Sw/Sb	0.63
	Wet Closed Coniferous Sb	0.50
	Upland Sb-Lt	0.50
	Wet Open Coniferous Sb-Lt	0.50
	Old Cutblocks	0.50
Low Suitability (0.01 - 0.33)	Pine Regen	0.25
	Shrubby Fen	0.25
	Low Shrub Wetland	0.25
	Bog	0.25
Unsuitable (0.00)	Graminoid Fen	0.00
	Marsh	0.00
	Upland Shrub	0.00
	Recent Cutblocks	0.00
	Natural Disturbances	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

The overall suitability of the RSA (sum of low, medium, and high areas divided by the total number of ha) for great gray owls at baseline is 95%, or 1,510,550 HUs (Table 123). The mean suitability (HU/area) was 0.62

(medium) (Table 124). However, most habitat units were found in the high HSI class.

Table 123 Great Gray Owl HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med	High
Baseline	2,428,750	2.7	2.0	4.7	18.0	24.9	52.4	95.3	1,510,550	7.4	19.2	73.3
Project Millennium (Development Area)	5,506	0.1	0.0	0.1	71.4	21.8	6.8	99.9	2,037	59.4	25.0	15.7
Remaining After Millennium	2,423,244	2.7	2.0	4.7	17.9	24.9	52.5	95.3	1,508,513	7.4	19.2	73.4
CEA (Development Area)	29,865	0.3	0.0	0.3	0.0	0.0	99.7	99.7	31,076	0.0	0.0	100.0
CEA (Undeveloped Area)	2,398,885	2.7	2.1	4.7	18.3	25.7	51.3	95.3	1,479,474	7.6	20.1	72.3

Suitable habitat for great gray owls within the RSA is shown in Table 124 and Figure 52. Of the 1,508,485 HUs of great gray owl habitat, the RSA is currently composed of 112,509 HUs (7%) of low quality habitat, 290,562 HUs (19%) of moderate quality habitat and 1,107,479 HUs (73%) of high quality habitat. The habitat distribution within the LSA consisted of more low suitability habitat and less high suitability habitat. High suitability habitat was seen throughout the RSA, except in the northwest corner.

Table 124 Great Gray Owl HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

Habitat Class	RSA Baseline (Habitat Units) HU	%	Project Millennium (Units Lost) HU	%	RSA CEA (Units Lost) HU	%	RSA CEA (Habitat Units) HU	%
Low	112,509	7.4	1,209	59.4	0	0.0	112,695	7.6
Medium	290,562	19.2	509	25.0	0	0.0	297,768	20.1
High	1,107,479	73.3	319	15.7	38,468	100.0	1,069,011	72.3
Total	1,510,550	100.0	2,037	100.0	38,468	100.0	1,479,474	100.0
Low Units Gained[(a)]					186			
Medium Units Gained[(a)]					7,206			
Net Total Loss					31,076			
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.62		0.36		1.04		0.61	

(a) Habitat units in the high or medium categories may be converted to medium or low habitat units in some cases, due to a reduction in habitat quality rather than strictly a loss in quantity. However, for percentages shown on this table, only the net loss is shown to a minimum of zero then habitat gains at low or medium are tabulated separately to result in the Net Habitat Loss.

7.7.2 Impact Assessment

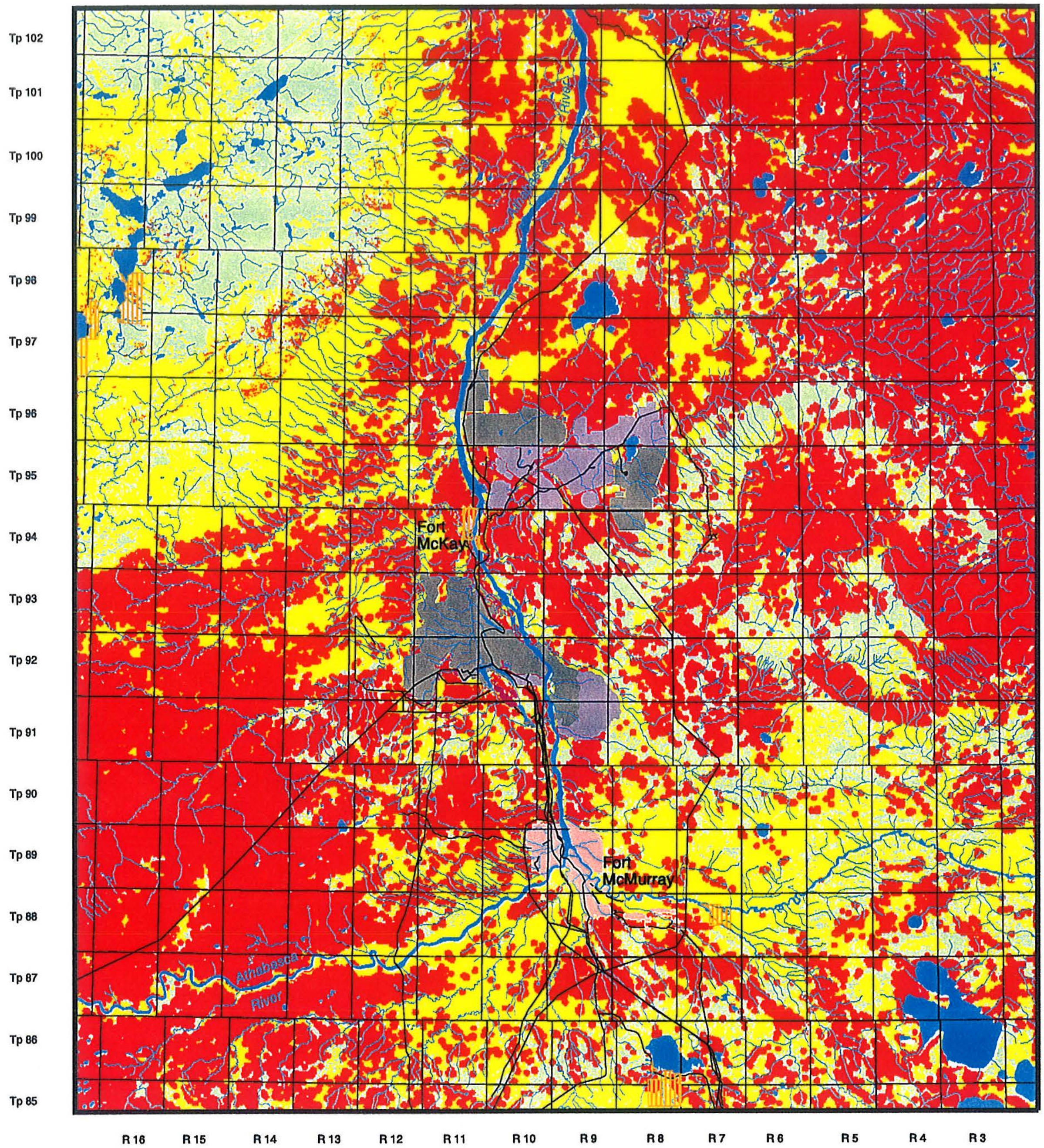
Direct habitat loss due to mine development is projected to affect great gray owl habitat by removing 0.1%, or 2,037 HUs within the RSA (Table 125). One percent of low, 0.2% of moderate and <0.1% of high quality habitat will be lost due to Project Millennium.

Table 125 Great Gray Owl HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	112,509	-1,209	-1.1	+186	+0.2	-650.2
Med	290,562	-509	-0.2	+7,206	+2.5	-7.1
High	1,107,479	-319	-0.0	-38,468	-3.5	0.8
Total	**1,510,550**	**-2,037**	**-0.1**	**-31,076**	**-2.1**	**6.6**

7.7.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 2.1%, or 31,076 HUs within the RSA (Table 125 and Figure 53). Of this loss, 7% is due to the effects of Project Millennium. In total, 3.5% of high suitability habitat for great gray owls will be lost.



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000
10 0 10 20 30 40
Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND
- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RANKING
- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA
GREAT GRAY OWL HABITAT SUITABILITY
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO

13 Apr. 1998	Figure 53	PRODUCED BY: MK REVIEWED BY:

/data15/oilsands/hsi/arcview/ggowl.apr

7.8 MOOSE

7.8.1 Baseline Conditions

The suitability of the various vegetation types within the RSA for moose winter food and cover is presented in Tables 126 and 127, respectively. Food and cover areas were then combined spatially to determine habitat units. Figure 54 provides a map of baseline conditions for moose.

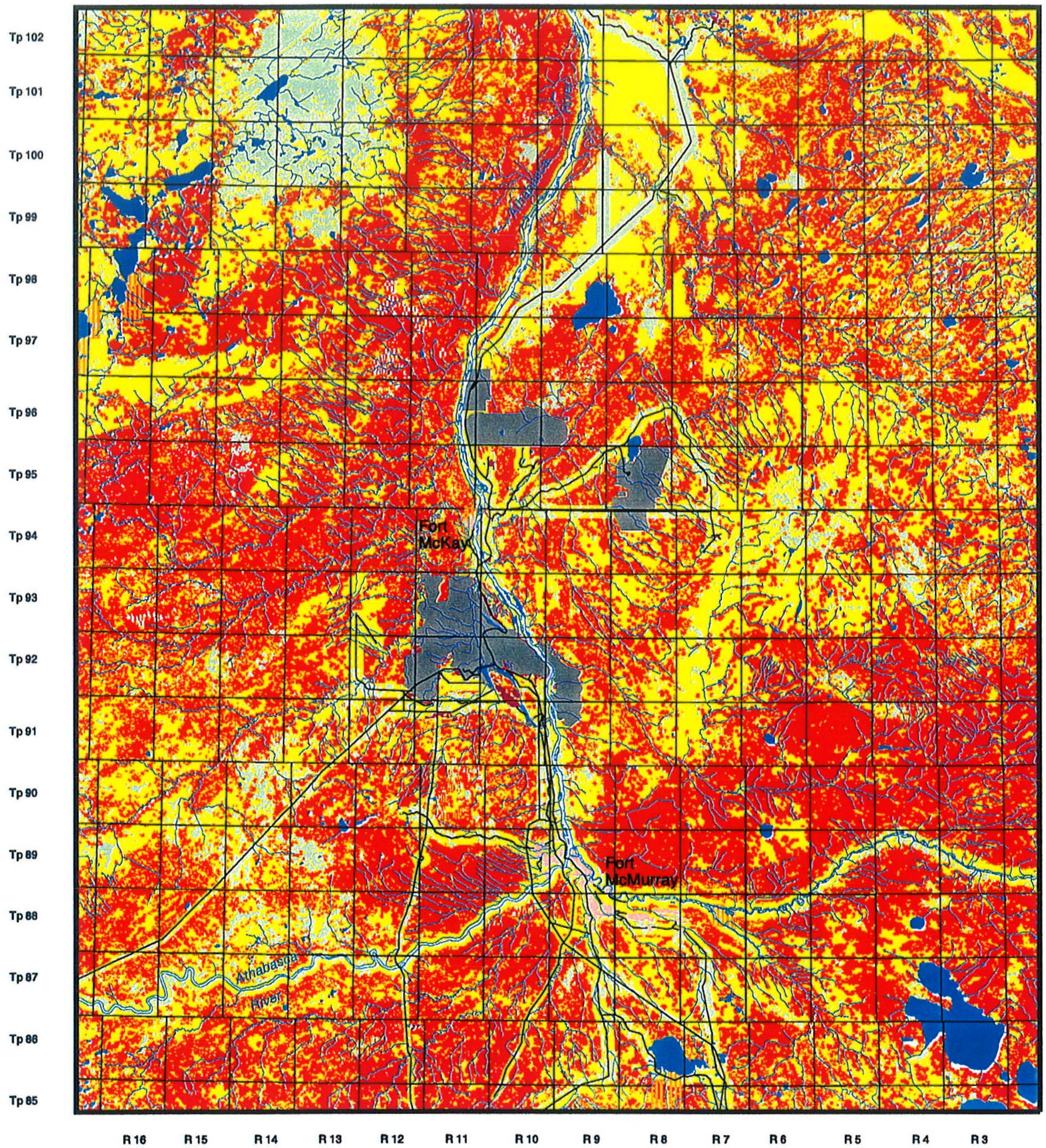
High suitability winter foraging habitat for moose within the RSA included the following vegetation types:

- pine regeneration;
- upland shrubland; and
- shrubby fen.

Unsuitable foraging habitat for moose included human disturbances, marshes, municipalities, open pit mines and water.

Table 126 Moose Food HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	Winter Food HSI
High Suitability (0.67 - 1.00)	Pine Regen	1.00
	Upland Shrub	1.00
	Shrubby Fen	0.97
Medium Suitability (0.34 - 0.66)	Mixed Deciduous	0.62
	Recent Cutblocks	0.59
	Upland Sb-Lt	0.52
	Old Cutblocks	0.52
	Wet Open Coniferous Sb-Lt	0.50
	Mixedwood-Sw/Aw	0.49
	Coniferous-Sw/Pj	0.48
	Coniferous-Sw	0.34
Low Suitability (0.01 - 0.33)	Bog	0.32
	Wet Closed Coniferous Sb	0.29
	Coniferous-Pj/Sw/Sb	0.27
	Low Shrub Wetland	0.24
	Open Pine	0.17
	Natural Disturbances	0.17
	Graminoid Fen	0.04
Unsuitable (0.00)	Human Disturbances	0.00
	Marsh	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Water	0.00



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

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Project Millennium

REGIONAL STUDY AREA MOOSE HABITAT SUITABILITY BASELINE SCENARIO

28 Apr. 1998	Figure 54	PRODUCED BY: MK REVIEWED BY:

/data15/oilsands/hsi/arcview/moosenew.apr

High suitability cover habitat for moose within the RSA included the following vegetation types:

- coniferous-white spruce;
- coniferous-white spruce-jack pine;
- open pine;
- coniferous-jack pine-white spruce-black spruce;
- mixedwood white spruce-trembling aspen;
- wet closed coniferous black spruce;
- upland black spruce-tamarack;
- mixed deciduous; and
- wet open coniferous black spruce-tamarack.

Unsuitable cover habitat for moose included graminoid fens, human disturbances, marshes, municipalities, natural disturbances, open pit mines, recent cutblocks, upland shrubland and water.

Table 127 Moose Cover HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Coniferous-Sw	1.00
	Coniferous-Sw/Pj	1.00
	Open Pine	0.98
	Coniferous-Pj/Sw/Sb	0.92
	Mixedwood-Sw/Aw	0.91
	Wet Closed Coniferous Sb	0.77
	Upland Sb-Lt	0.72
	Mixed Deciduous	0.70
	Wet Open Coniferous Sb-Lt	0.67
Medium Suitability (0.34 - 0.66)	Old Cutblocks	0.49
Low Suitability (0.01 - 0.33)	Bog	0.19
	Low Shrub Wetland	0.19
	Shrubby Fen	0.17
	Pine Regen	0.06
Unsuitable (0.00)	Graminoid Fen	0.00
	Human Disturbances	0.00
	Marsh	0.00
	Municipalities	0.00
	Natural Disturbances	0.00
	Open Pit Mines	0.00
	Recent Cutblocks	0.00
	Upland Shrub	0.00
	Water	0.00

The overall suitability of the RSA (sum of low, medium and high habitat areas divided by the total number of ha) for moose at baseline is 95%, or 1,535,910 HUs (Table 128). The mean suitability of the RSA (total HUs/total area) was 0.63 (moderate) (Table 129). However, most areas with habitat were rated as high.

Table 128 Moose HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat: Water	Other	Total	Suitable Habitat: Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class: Low	Med	High
Baseline	2,428,750	2.7	2.3	4.9	8.2	40.8	46.1	95.1	1,535,910	2.1	35.2	62.6
Project Millennium (Development Area)	5,506	0.1	0.0	0.1	12.5	43.6	43.7	99.9	3,433	5.6	36.5	58.0
Remaining After Millennium	2,423,244	2.7	2.3	4.9	8.2	40.8	46.1	95.1	1,532,477	2.1	35.2	62.7
CEA (Development Area)	29,865	0.4	0.0	0.4	22.1	22.3	55.2	99.6	20,205	8.7	18.1	73.2
CEA (Undeveloped Area)	2,398,885	2.7	2.3	5.0	8.0	41.0	46.0	95.0	1,515,705	2.0	35.5	62.5

Suitable habitat for moose within the RSA is shown in Table 129 and Figure 54. Of the 1,535,910 HUs of moose habitat, the RSA is currently composed of 32,693 HUs (2%) of low quality habitat, 541,119 HUs (35%) of moderate quality habitat and 962,098 HUs (63%) of high quality habitat. The habitat distribution within the LSA was similar. High suitability habitat was seen throughout the RSA, except for a small area in the northwest corner.

Table 129 Moose HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
Habitat Class	HU	%	HU	%	HU	%	HU	%
Low	32,693	2.1	191	5.6	1,756	8.7	30,937	2.0
Medium	541,119	35.2	1,253	36.5	3,665	18.1	537,454	35.5
High	962,098	62.6	1,990	58.0	14,784	73.2	947,314	62.5
Total	1,535,910	100.0	3,433	100.0	20,205	100.0	1,515,705	100.0
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.63		0.61		0.68		0.62	

7.8.2 Impact Assessment

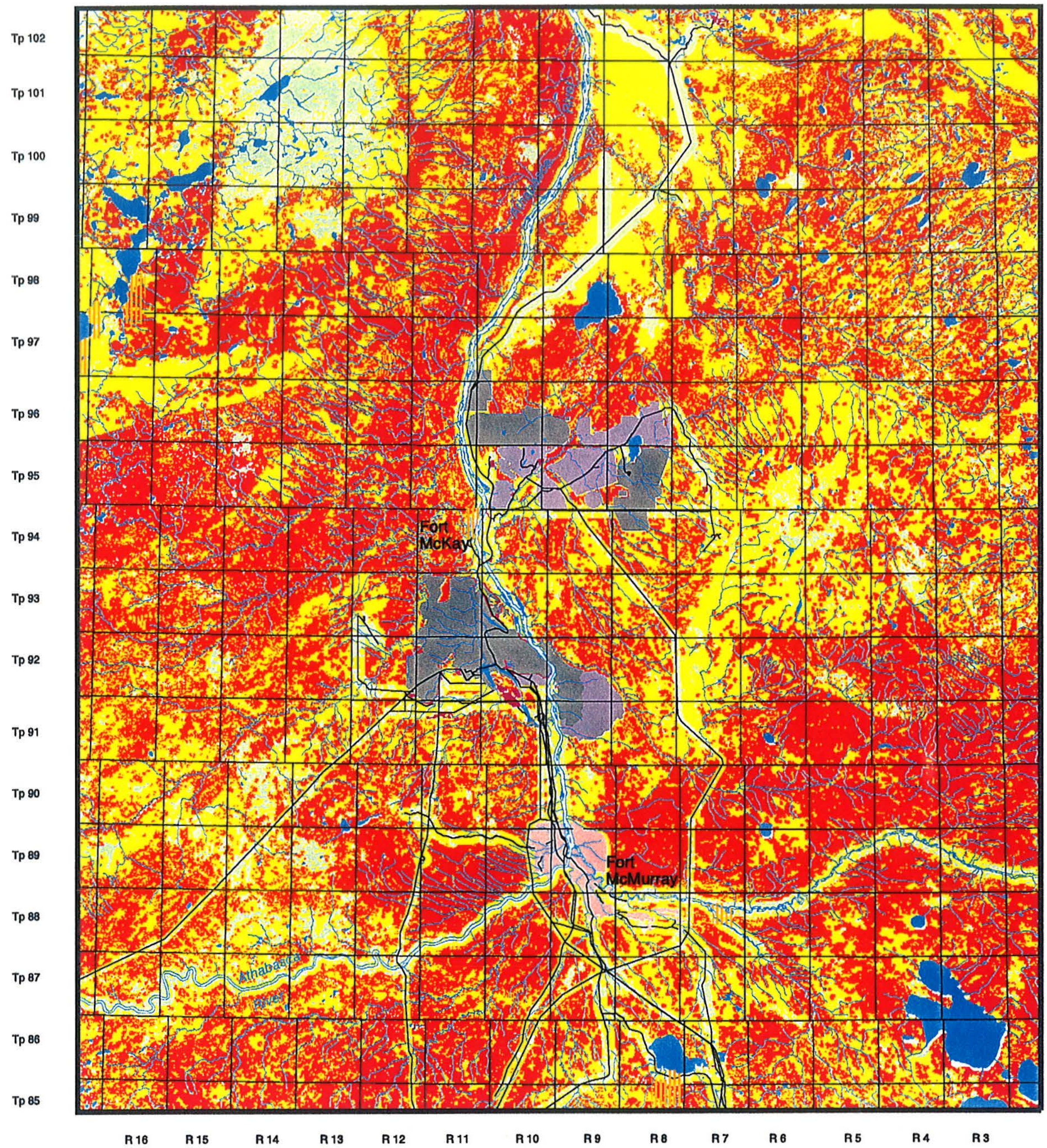
Direct habitat loss due to mine development is projected to affect moose habitat by removing 0.2%, or 3,433 HUs within the RSA (Table 130). One percent of low, 0.2% of moderate and 0.2% of high quality habitat will be lost due to Project Millennium.

Table 130 Moose HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	32,693	-191	-0.6	-1,756	-5.4	10.9
Med	541,119	-1,253	-0.2	-3,665	-0.7	34.2
High	962,098	-1,990	-0.2	-14,784	-1.5	13.5
Total	**1,535,910**	**-3,433**	**-0.2**	**-20,205**	**-1.3**	**17.0**

7.8.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1.3%, or 20,205 HUs within the RSA (Table 130 and Figure 55). Of this loss, 17% is due to the effects of Project Millennium. In total, 5% of low suitability habitat, 1% of moderate suitability habitat and 2% of high suitability habitat for moose will be lost.



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA
MOOSE HABITAT SUITABILITY
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO

14 Apr. 1998	Figure 55	PRODUCED BY: K.K.Q. REVIEWED BY:

/data15/oilsands/hsi/arcview/moose_cea.apr

7.9 PILEATED WOODPECKER

7.9.1 Baseline Conditions

The suitability of the various vegetation types within the RSA for pileated woodpecker habitat is presented in Table 131 and Figure 56. High suitability habitat for pileated woodpeckers within the RSA included the following vegetation types:

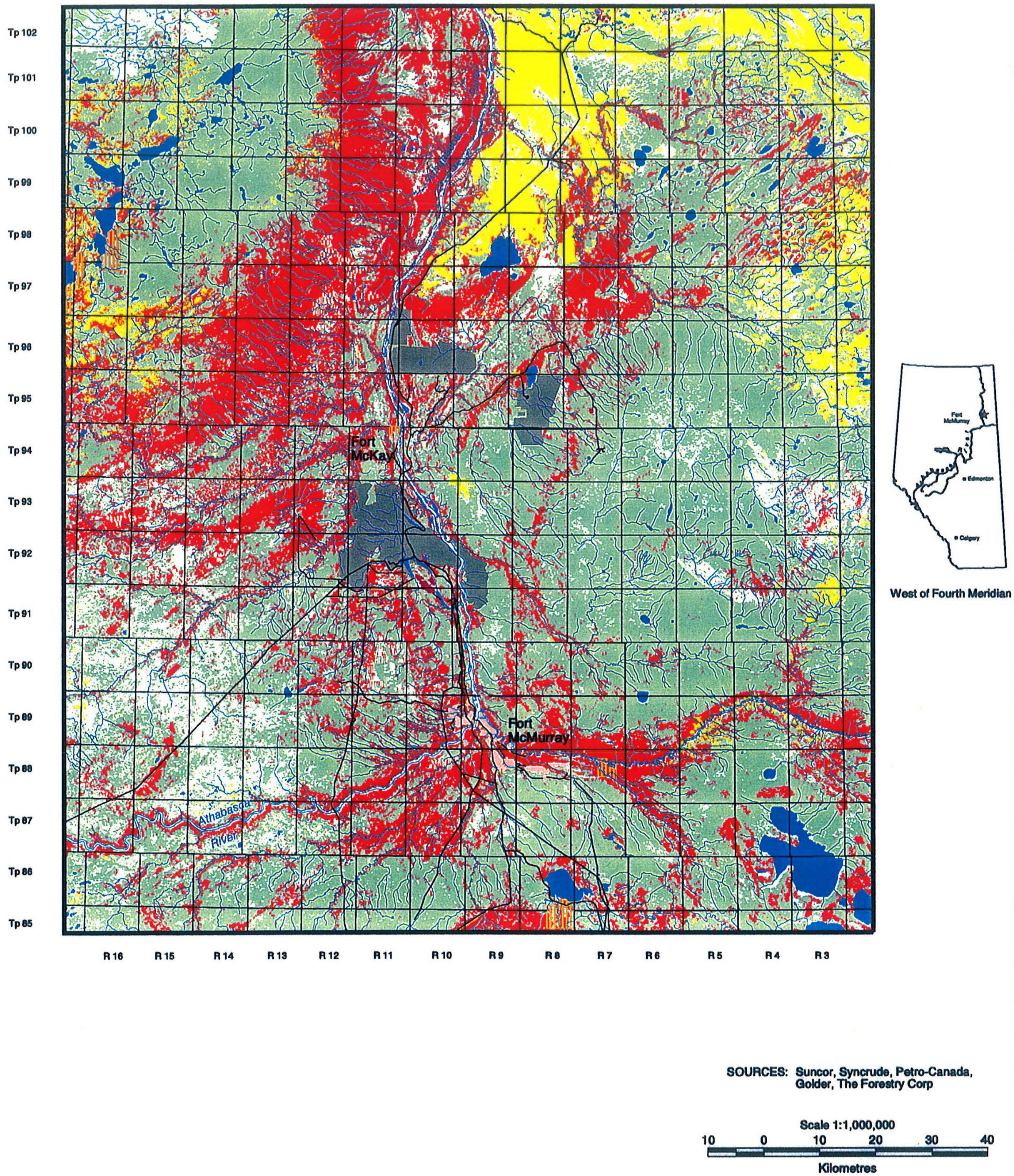
- mixed deciduous;
- mixedwood-white spruce-trembling aspen; and
- coniferous-white spruce.

Unsuitable habitat for pileated woodpeckers included graminoid fens, marshes, upland shrubland, recent cutblocks, natural disturbances, water, municipalities, open pit mines and human disturbances. These areas are unsuitable due to lack of nesting trees and deadwood for foraging.

Table 131 Pileated Woodpecker HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Mixed Deciduous	0.93
	Mixedwood-Sw/Aw	0.75
	Coniferous-Sw	0.69
Medium Suitability (0.34 - 0.66)	Coniferous-Sw/Pj	0.61
	Old Cutblocks	0.45
	Open Pine	0.43
	Coniferous-Pj/Sw/Sb	0.42
Low Suitability (0.01 - 0.33)	Upland Sb-Lt	0.24
	Wet Closed Coniferous Sb	0.21
	Wet Open Coniferous Sb-Lt	0.20
	Shrubby Fen	0.16
	Low Shrub Wetland	0.14
	Bog	0.14
	Pine Regen	0.02
Unsuitable (0.00)	Graminoid Fen	0.00
	Marsh	0.00
	Upland Shrub	0.00
	Recent Cutblocks	0.00
	Natural Disturbances	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

The overall suitability of the RSA (sum of low, medium, and high habitat areas divided by the total number of ha) for pileated woodpeckers at baseline is 84%, or 782,295 HUs (Table 132). Of the unsuitable habitat, most was located in developed areas, open water and graminoid fens. The mean suitability of the RSA (total HUs/total area) was 0.32 (low) (Table 133). However, of areas that had habitat units, the majority was found within the high class.



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Project Millennium

REGIONAL STUDY AREA
PILEATED WOODPECKER HABITAT SUITABILITY
BASELINE SCENARIO

09 Apr. 1998	Figure 56	PRODUCED BY: MK REVIEWED BY:

/data15/oilsands/hsi/arcview/beaver.apr

Table 132 Pileated Woodpecker HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat			Suitable Habitat				Habitat Units	Percent of Habitat Units by Suitability Class		
		Water	Other	Total	Low	Med	High	Total		Low	Med	High
Baseline	2,428,750	2.7	13.4	16.0	52.7	7.3	23.9	84.0	782,295	30.6	10.4	59.0
Project Millennium (Development Area)	5,506	0.1	5.3	5.4	71.1	5.9	17.7	94.6	1,758	44.3	7.0	48.6
Remaining After Millennium	2,423,244	2.7	13.4	16.1	52.7	7.4	23.9	83.9	780,537	30.5	10.4	59.0
CEA (Development Area)	29,865	0.3	33.4	33.7	41.3	0.0	25.1	66.3	6,469	29.6	0.0	70.4
CEA (Undeveloped Area)	2,398,885	2.7	13.0	15.7	52.6	7.9	23.8	84.3	775,826	30.4	11.2	58.5

Suitable habitat for pileated woodpeckers within the RSA is shown in Table 133 and Figure 56. Of the 782,295 HUs of woodpecker habitat, the RSA is currently composed of 239,171 HUs (31%) of low quality habitat, 81,405 HUs (10%) of moderate quality habitat and 461,719 HUs (59%) of high quality habitat. The habitat distribution within the LSA was similar. High suitability habitat was seen along the various draws in the northwest and southern portions of the RSA.

Table 133 Pileated Woodpecker HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

Habitat Class	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
	HU	%	HU	%	HU	%	HU	%
Low	239,171	30.6	779	44.3	3,427	29.6	235,744	30.4
Medium	81,405	10.4	124	7.0	0	0.0	86,532	11.2
High	461,719	59.0	855	48.6	8,169	70.4	453,550	58.5
Total	782,295	100.0	1,758	100.0	11,596	100.0	775,826	100.0
Medium Units Gained[(a)]					5,127			
Net Total Loss					6,469			
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.32		0.31		0.22		0.32	

[(a)] Habitat units in the high or medium categories may be converted to medium or low habitat units in some cases, due to a reduction in habitat quality rather than strictly a loss in quantity. However, for percentages shown on this table, only the net loss is shown to a minimum of zero then habitat gains at low or medium are tabulated separately to result in the Net Habitat Loss.

7.9.2 Impact Assessment

Direct habitat loss due to mine development is projected to affect pileated woodpecker habitat by removing 0.2%, or 1,758 HUs within the RSA

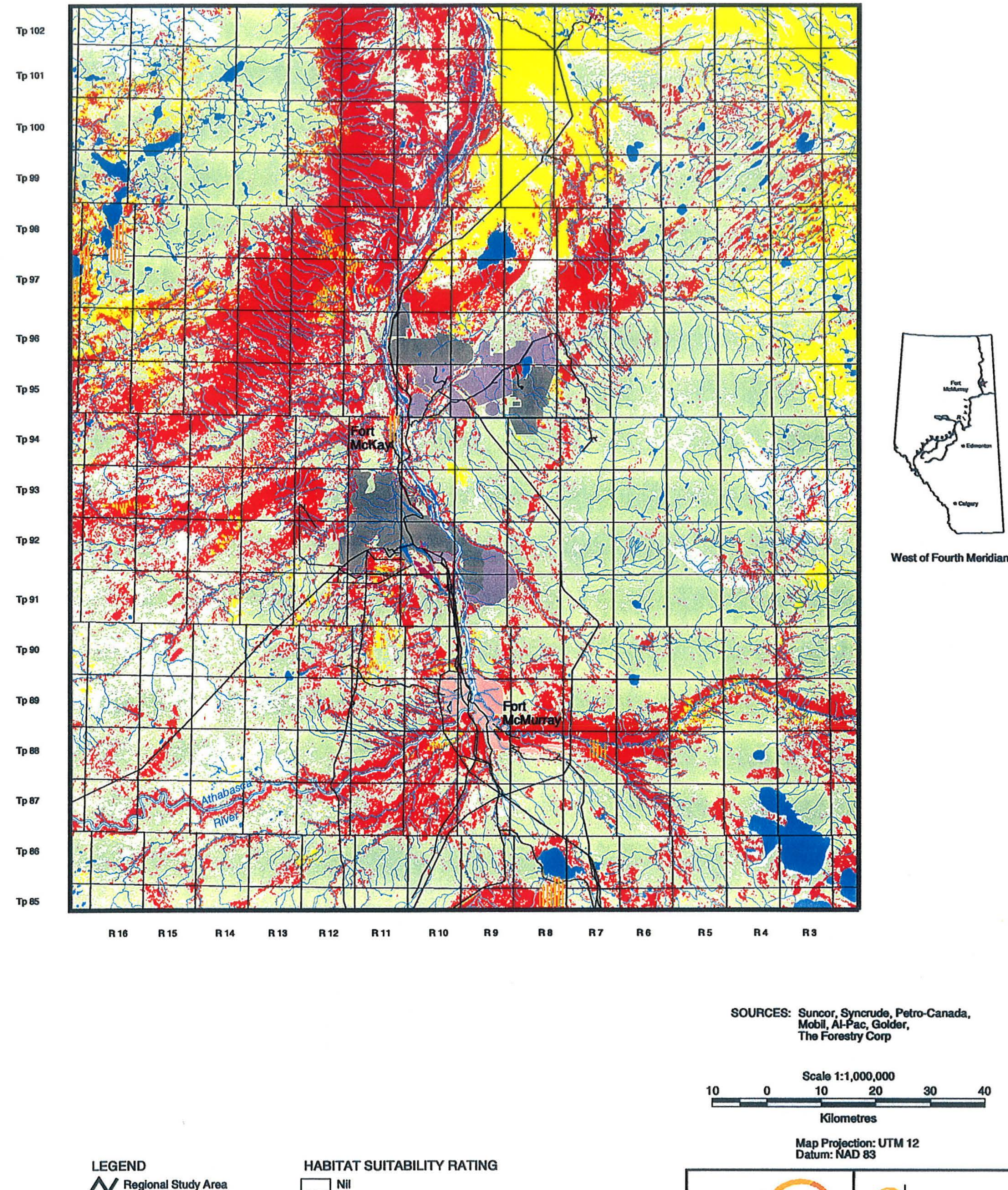
(Table 134). Less than one percent of low, 0.2% of moderate and 0.2% of high quality habitat will be lost due to Project Millennium.

Table 134 Pileated Woodpecker HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	239,171	-779	-0.3	-3,427	-1.4	22.7
Med	81,405	-124	-0.2	+5,127	+6.3	-2.4
High	461,719	-855	-0.2	-8,169	-1.8	10.5
Total	782,295	-1,758	-0.2	-6,469	-0.8	27.2

7.9.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 0.8%, or 6,469 HUs within the RSA (Table 133 and Figure 57). Of this loss, 27% is due to the effects of Project Millennium. In total, 2% of low suitability habitat and 2% of high suitability habitat for pileated woodpeckers will be lost.



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Project Millennium

REGIONAL STUDY AREA
PILEATED WOODPECKER
HABITAT SUITABILITY
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO

14 Apr. 1998 | Figure 57 | PRODUCED BY: K.K.O. REVIEWED BY:

7.10 RED-BACKED VOLE

7.10.1 Baseline Conditions

The suitability of the various vegetation types within the RSA for red-backed vole habitat is presented in Table 135 and Figure 58. High suitability habitat for red-backed voles within the RSA included the following vegetation types:

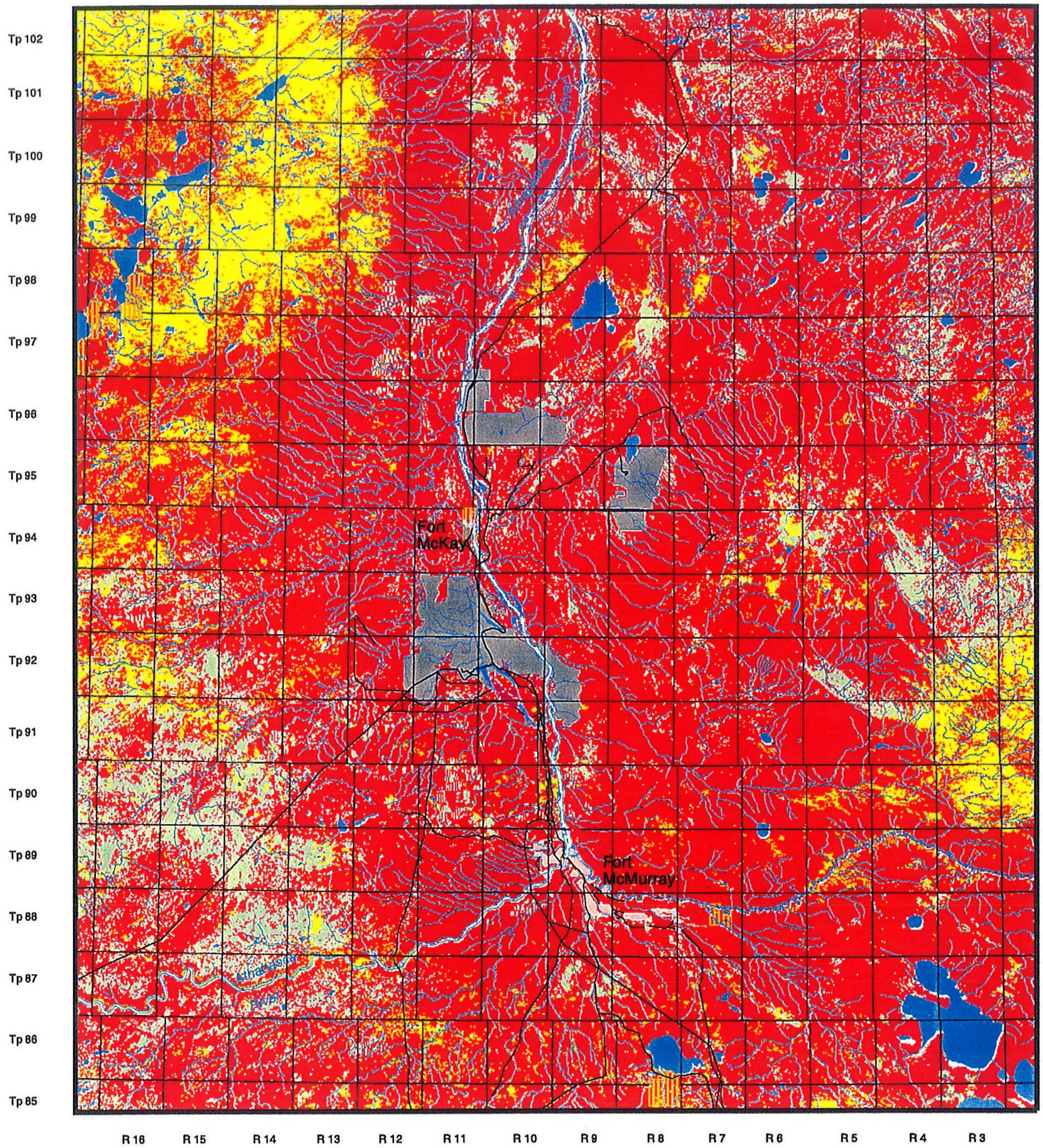
- coniferous-white spruce-jack pine;
- mixedwood-white spruce-trembling aspen;
- coniferous jack pine-white spruce-black spruce;
- mixed deciduous;
- upland black spruce-tamarack;
- wet open coniferous-black spruce-tamarack;
- coniferous white spruce;
- wet closed coniferous black spruce;
- shrubby fens; and
- open pine.

Unsuitable habitat for red-backed voles included marshes, water, municipalities, open pit mines and human disturbances.

Table 135 Red-backed Vole HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Coniferous-Sw/Pj	1.00
	Mixedwood-Sw/Aw	0.96
	Coniferous-Pj/Sw/Sb	0.95
	Mixed Deciduous	0.94
	Upland Sb-Lt	0.93
	Wet Open Coniferous Sb-Lt	0.91
	Coniferous-Sw	0.86
	Wet Closed Coniferous Sb	0.83
	Shrubby Fen	0.70
	Open Pine	0.69
Medium Suitability (0.34 - 0.66)	Low Shrub Wetland	0.66
	Bog	0.66
	Old Cutblocks	0.60
	Pine Regen	0.55
	Upland Shrub	0.41
Low Suitability (0.01 - 0.33)	Recent Cutblocks	0.31
	Graminoid Fen	0.06
	Natural Disturbances	0.06
Unsuitable (0.00)	Marsh	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

The overall suitability of the RSA (sum of low, medium and high habitat areas divided by the total number of ha) for red-backed voles at baseline is 95%, or 1,679,543 HUs (Table 136). Most of the unsuitable habitat consisted of water and developed areas. The mean suitability for the RSA (total HUs/total area) was 0.69 (high) and this is also seen in the percent by habitat units breakdown (Table 137).



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA
RED-BACKED VOLE HABITAT SUITABILITY
BASELINE SCENARIO

27 Apr. 1998	Figure 58	PRODUCED BY: MK REVIEWED BY:

/data15/oilsands/hsl/arcview/beaver.apr

Table 136 Red-Backed Vole HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat Water	Other	Total	Suitable Habitat Low	Med	High	Total	Habitat Units	Percent of Habitat Units by Suitability Class Low	Med	High
Baseline	2,428,750	2.7	2.3	4.9	10.4	10.3	74.3	95.1	1,679,543	1.1	8.7	90.3
Project Millennium (Development Area)	5,506	0.1	0.0	0.1	0.2	73.3	26.5	99.9	3,623	0.0	63.8	36.2
Remaining After Millennium	2,423,244	2.7	2.3	4.9	10.5	10.2	74.4	95.1	1,675,920	1.1	8.5	90.4
CEA (Development Area)	29,865	0.1	0.0	0.1	8.0	0.0	91.9	99.9	20,566	3.2	0.0	96.8
CEA (Undeveloped Area)	2,398,885	2.7	2.3	5.0	10.0	16.4	68.6	95.0	1,658,977	0.9	14.6	84.5

Suitable habitat for red-backed voles within the RSA is shown in Table 137 and Figure 58. Of the 1,679,543 HUs of red-backed vole habitat, the RSA is currently composed of 18,114 HUs (1%) of low quality habitat, 145,293 HUs (9%) of moderate quality habitat and 1,516,136 HUs (90%) of high quality habitat. The habitat distribution within the LSA was similar, however more moderate suitability and less high suitability habitat was observed. High suitability habitat was seen throughout the RSA.

Table 137 Red-backed Vole HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

Habitat Class	RSA Baseline (Habitat Units) HU	%	Project Millennium (Units Lost) HU	%	RSA CEA (Units Lost) HU	%	RSA CEA (Habitat Units) HU	%
Low	18,114	1.1	1	0.0	3,725	3.2	14,389	0.9
Medium	145,293	8.7	2,310	63.8	0	0.0	242,321	14.6
High	1,516,136	90.3	1,312	36.2	113,869	96.8	1,402,267	84.5
Total	1,679,543	100.0	3,622	100.0	117,594	100.0	1,658,977	100.0
Medium Units Gained[a]					97,028			
Net Total Loss					20,566			
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.69		0.64		0.69		0.68	

[a] Habitat units in the high or medium categories may be converted to medium or low habitat units in some cases, due to a reduction in habitat quality rather than strictly a loss in quantity. However, for percentages shown on this table, only the net loss is shown to a minimum of zero then habitat gains at low or medium are tabulated separately to result in the Net Habitat Loss.

7.10.2 Impact Assessment

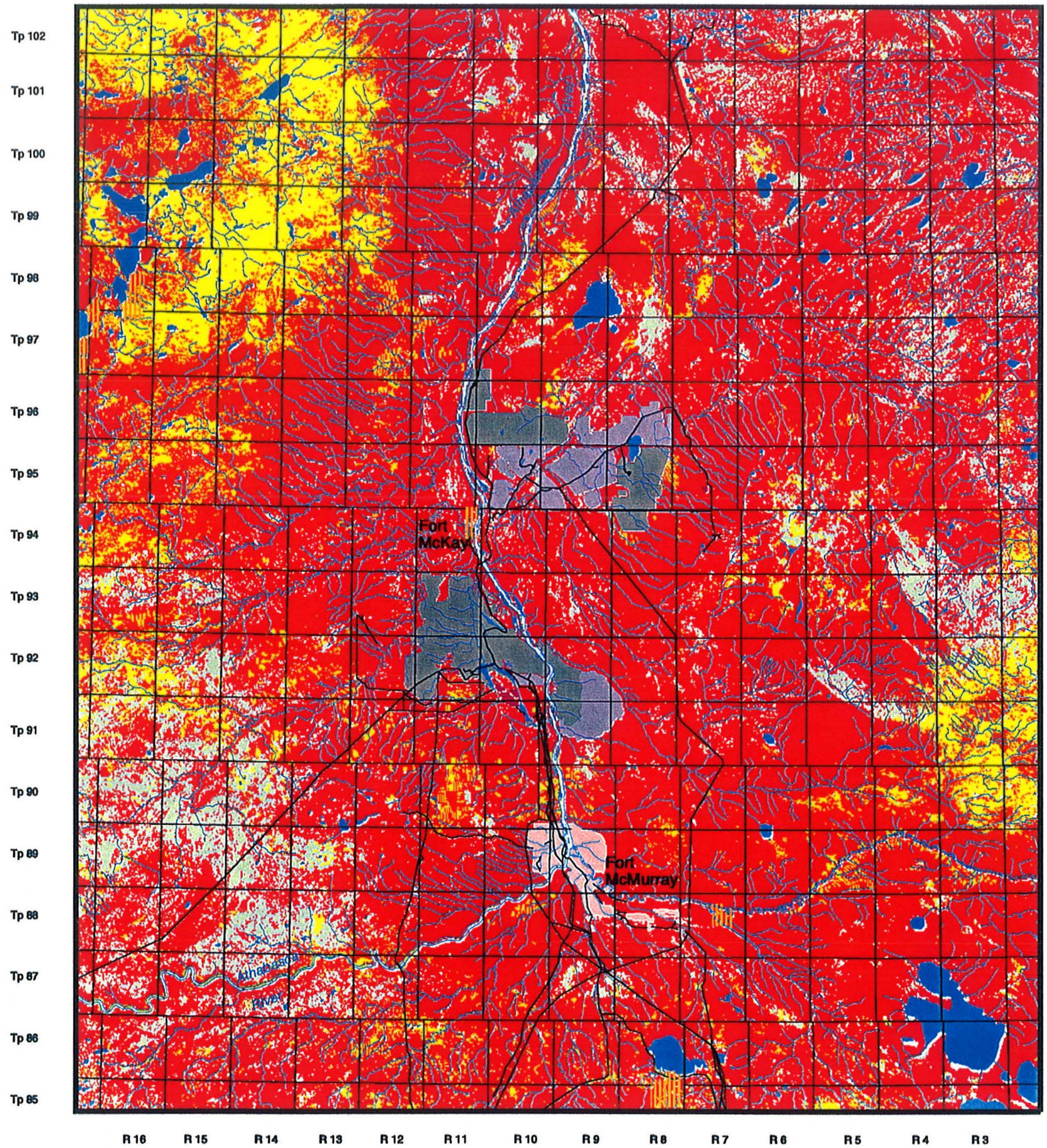
Direct habitat loss due to mine development is projected to affect vole habitat by removing 0.2%, or 3,623 HUs within the RSA (Table 138). Less than one percent of low, 1.6% of moderate and 0.1% of high quality habitat will be lost due to Project Millennium.

Table 138 Red-backed Vole HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	18,114	-1	-0.0	-3,725	-20.6	0.0
Med	145,293	-2,310	-1.6	+97,028	+66.8	-2.4
High	1,516,136	-1,312	-0.1	-113,869	-7.5	1.2
Total	**1,679,543**	**-3,623**	**-0.2**	**-20,566**	**-1.2**	**17.6**

7.10.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1.2%, or 20,566 HUs within the RSA (Table 138 and Figure 59). Of this loss, 18% is due to the effects of Project Millennium. In total, 21% of low suitability habitat and 8% of high suitability habitat for red-backed voles will be lost.



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

SUNCOR ENERGY

Project Millennium

**REGIONAL STUDY AREA
RED-BACKED VOLE HABITAT SUITABILITY
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO**

14 Apr. 1998	Figure 59	PRODUCED BY: K.K.O. REVIEWED BY:

/data15/oilsands/hsi/arcview/vole_ces.apr

7.11 RUFFED GROUSE

7.11.1 Baseline Conditions

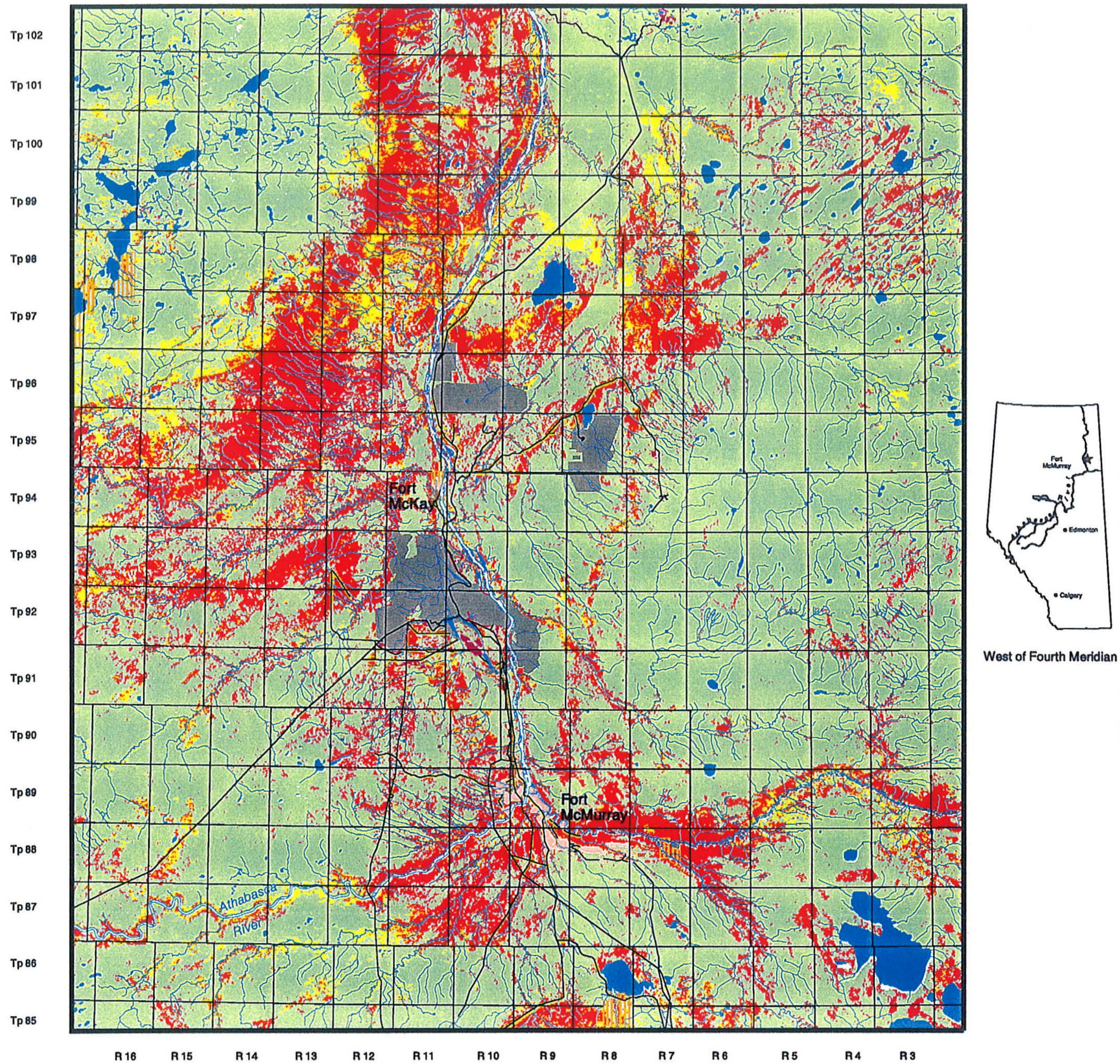
The suitability of the various vegetation types within the RSA for ruffed grouse habitat is presented in Table 139 and Figure 60. High suitability habitat for ruffed grouse within the RSA included the following vegetation types:

- mixed deciduous; and
- mixedwood-white spruce-trembling aspen.

Unsuitable habitat for ruffed grouse included marshes, water, municipalities, open pit mines and human disturbances. Natural disturbances and graminoid fens were also very low (0.02).

Table 139 Ruffed Grouse HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Mixed Deciduous	0.88
	Mixedwood-Sw/Aw	0.71
Medium Suitability (0.34 - 0.66)	Old Cutblocks	0.49
	Coniferous-Sw/Pj	0.42
	Coniferous-Pj/Sw/Sb	0.36
Low Suitability (0.01 - 0.33)	Coniferous-Sw	0.33
	Pine Regen	0.31
	Upland Shrub	0.30
	Open Pine	0.28
	Upland Sb-Lt	0.25
	Shrubby Fen	0.24
	Wet Closed Coniferous Sb	0.23
	Wet Open Coniferous Sb-Lt	0.23
	Bog	0.14
	Low Shrub Wetland	0.13
	Recent Cutblocks	0.11
	Natural Disturbances	0.02
	Graminoid Fen	0.02
Unsuitable (0.00)	Marsh	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00



SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND
- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING
- Nil
- Low
- Moderate
- High

N

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Project Millennium
Taking Suncor into the 21st Century

REGIONAL STUDY AREA
RUFFED GROUSE HABITAT SUITABILITY
BASELINE SCENARIO

09 Apr. 1998 | Figure 60 | PRODUCED BY: MK REVIEWED BY:

/data15/oilsands/nsl/arcview/beaver.apr

The overall suitability of the RSA (sum of low, medium and high habitat areas divided by the total number of ha) for ruffed grouse at baseline is 95%, or 765,545 HUs (Table 140). Of the unsuitable habitat, most was water and developed areas. The mean suitability of the RSA (total HUs/total area) was 0.32 (low). This is reflected in the percent by area values but by HUs, the high habitat had the most habitat.

Table 140 Ruffed Grouse HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat			Suitable Habitat				Habitat Units	Percent of Habitat Units by Suitability Class		
		Water	Other	Total	Low	Med	High	Total		Low	Med	High
Baseline	2,428,750	2.7	2.0	4.7	74.0	2.5	18.8	95.3	765,545	50.1	3.7	46.2
Project Millennium (Development Area)	5,506	0.1	0.0	0.1	79.2	7.9	12.9	99.9	1,938	50.8	12.5	36.7
Remaining After Millennium	2,423,244	2.7	2.0	4.7	74.0	2.4	18.9	95.3	763,607	50.1	3.7	46.2
CEA (Development Area)	29,865	0.3	0.0	0.3	77.6	0.0	22.1	99.7	7,133	45.8	0.0	54.2
CEA (Undeveloped Area)	2,398,885	2.7	2.1	4.7	73.6	2.9	18.7	95.3	758,412	49.8	4.5	45.7

Suitable habitat for ruffed grouse within the RSA is shown in Table 141 and Figure 60. Of the 765,545 HUs of red-backed vole habitat, the RSA is currently composed of 282,674 HUs (50%) of low quality habitat, 28,436 HUs (4%) of moderate quality habitat and 353,435 HUs (46%) of high quality habitat. The habitat distribution within the LSA was similar. High suitability habitat was seen in the various draws in the northwest and southern portions of the RSA.

Table 141 Ruffed Grouse HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
Habitat Class	HU	%	HU	%	HU	%	HU	%
Low	383,674	50.1	985	50.8	5,719	45.8	377,955	49.8
Medium	28,436	3.7	243	12.5	0	0.0	33,799	4.5
High	353,435	46.2	711	36.7	6,777	54.2	346,658	45.7
Total	765,545	100.0	1,938	100.0	12,496	100.0	758,412	100.0
Medium Units Gained[(a)]					5,363			
Net Total Loss					7,133			
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.32		0.34		0.24		0.31	

(a) Habitat units in the high or medium categories may be converted to medium or low habitat units in some cases, due to a reduction in habitat quality rather than strictly a loss in quantity. However, for percentages shown on this table, only the net loss is shown to a minimum of zero then habitat gains at low or medium are tabulated separately to result in the Net Habitat Loss.

7.11.2 Impact Assessment

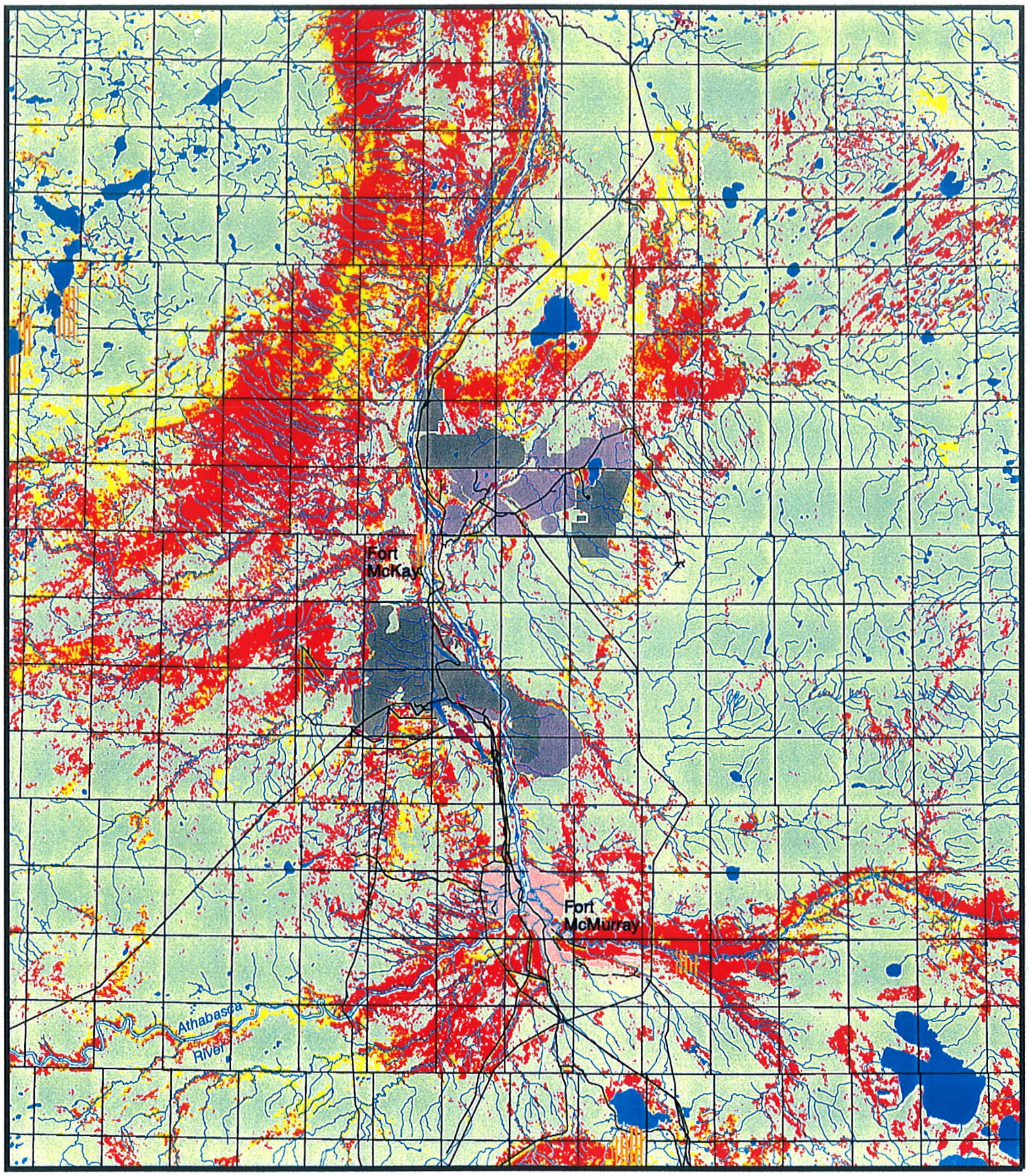
Direct habitat loss due to mine development is projected to affect grouse habitat by removing 0.3%, or 1,938 HUs within the RSA (Table 142). Less than one percent of low, 0.9% of moderate and 0.2% of high quality habitat will be lost due to Project Millennium.

Table 142 Ruffed Grouse HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	383,674	-985	-0.3	-5,719	-1.5	17.2
Med	28,436	-243	-0.9	+5,363	+18.9	-4.5
High	353,435	-711	-0.2	-6,777	-1.9	10.5
Total	**765,545**	**-1,938**	**-0.3**	**-7,133**	**-0.9**	**27.2**

7.11.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 0.9%, or 7,133 HUs within the RSA (Table 142 and Figure 61). Of this loss, 27% is due to the effects of Project Millennium. In total, 2% of low suitability habitat and 2% of high suitability habitat for ruffed grouse will be lost.



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA
RUFFED GROUSE HABITAT SUITABILITY
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO

14 Apr. 1998	Figure 61	PRODUCED BY: K.K.G. REVIEWED BY: MB

/data15/oilsands/hsi/arcview/grouse_cea.apr

7.12 SNOWSHOE HARE

7.12.1 Baseline Conditions

The suitability of the various vegetation types within the RSA for snowshoe hare habitat is presented in Table 143 and Figure 62. High suitability habitat for snowshoe hares within the RSA included the following vegetation types:

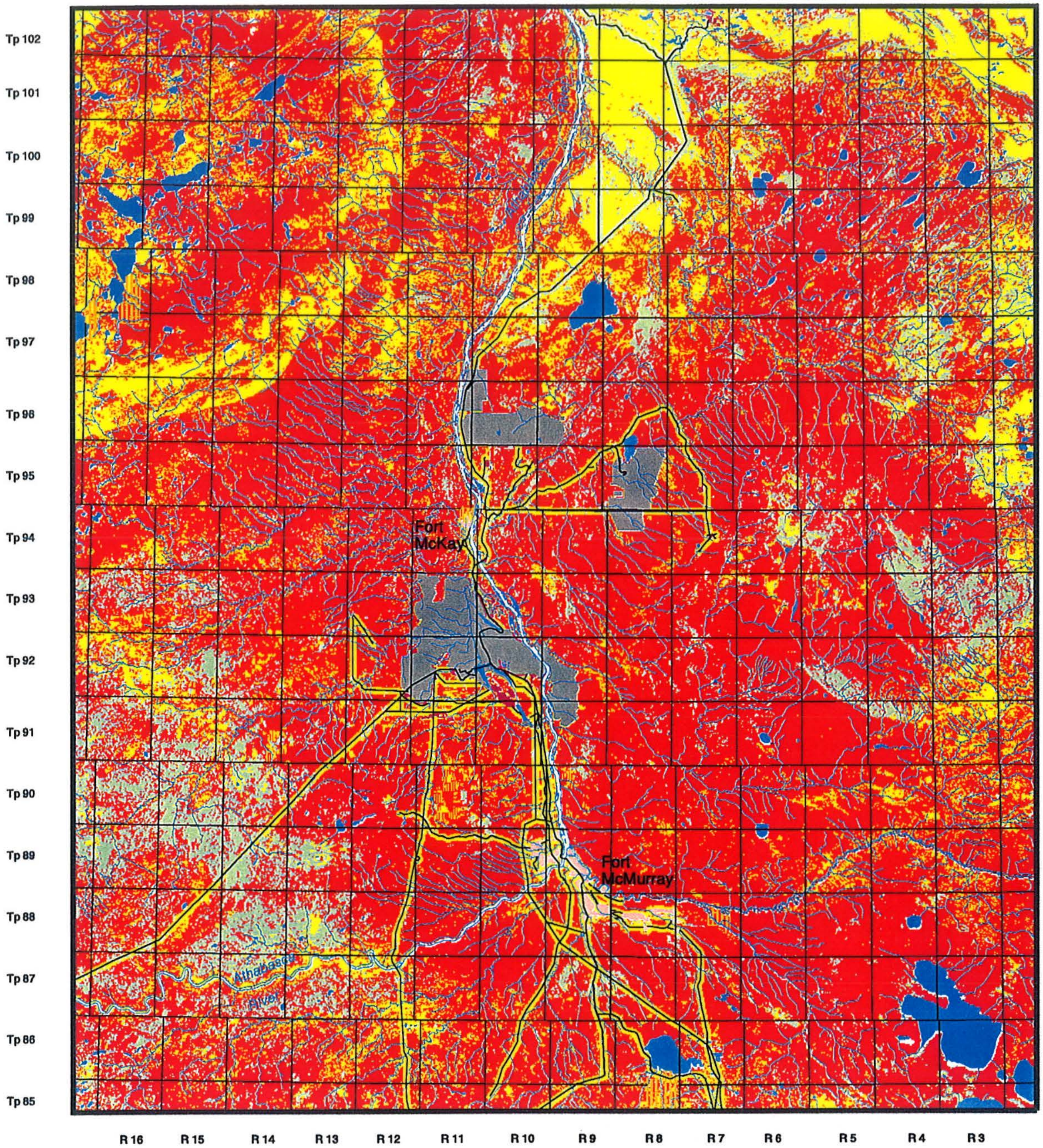
- shrubby fens;
- upland shrubland;
- pine regeneration;
- wet open coniferous black spruce-tamarack;
- upland black spruce-tamarack;
- coniferous-white spruce-jack pine;
- mixedwood-white spruce- trembling aspen;
- mixed deciduous;
- wet closed coniferous black spruce;
- coniferous-jack pine-white spruce-black spruce;
- bog; and
- low, shrubby wetlands.

Unsuitable habitat for snowshoe hares included marshes, water, municipalities, open pit mines and human disturbances.

Table 143 Snowshoe Hare HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Shrubby Fen	0.95
	Upland Shrub	0.95
	Pine Regen	0.93
	Wet Open Coniferous Sb-Lt	0.88
	Upland Sb-Lt	0.87
	Coniferous-Sw/Pj	0.83
	Mixedwood-Sw/Aw	0.81
	Mixed Deciduous	0.78
	Wet Closed Coniferous Sb	0.78
	Coniferous-Pj/Sw/Sb	0.76
	Bog	0.73
	Low Shrub Wetland	0.71
Medium Suitability (0.34 - 0.66)	Coniferous-Sw	0.66
	Old Cutblocks	0.63
	Recent Cutblocks	0.61
	Open Pine	0.44
Low Suitability (0.01 - 0.33)	Natural Disturbances	0.27
	Graminoid Fen	0.23
Unsuitable (0.00)	Marsh	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

The overall suitability of the RSA (sum of low, medium, and high habitat areas divided by the total number of ha) for snowshoe hares at baseline is 95%, or 1,638,593 HUs (Table 144). Of the unsuitable habitat, most consisted of water and developed areas. The mean suitability of the RSA (total HUs/total area) was 0.67 (high) (Table 145).



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

N

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REGIONAL STUDY AREA
SNOWSHOE HARE HABITAT SUITABILITY
BASELINE SCENARIO

09 Apr. 1998	Figure 62	PRODUCED BY: MK REVIEWED BY:

/data15/oilsands/hsi/arcview/beaver.apr

Table 144 Snowshoe Hare HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat			Suitable Habitat				Habitat Units	Percent of Habitat Units by Suitability Class		
		Water	Other	Total	Low	Med	High	Total		Low	Med	High
Baseline	2,428,750	2.7	2.0	4.7	10.7	20.3	64.3	95.3	1,638,593	3.6	16.4	80.0
Project Millennium (Development Area)	5,506	0.1	0.0	0.1	0.2	0.0	99.7	99.9	5,115	0.0	0.0	100.0
Remaining After Millennium	2,423,244	2.7	2.0	4.7	10.8	20.3	64.2	95.3	1,633,478	3.6	16.4	79.9
CEA (Development Area)	29,865	0.4	0.0	0.4	5.9	0.0	93.7	99.6	25,705	1.7	0.0	98.3
CEA (Undeveloped Area)	2,398,885	2.7	2.1	4.7	10.8	20.8	63.7	95.3	1,612,888	3.7	16.8	79.6

Suitable habitat for snowshoe hares within the RSA is shown in Table 145 and Figure 62. Of the 1,638,593 HUs of snowshoe hare habitat, the RSA is currently composed of 59,535 HUs (4%) of low quality habitat, 267,972 HUs (16%) of moderate quality habitat and 1,311,086 HUs (80%) of high quality habitat. The habitat distribution within the LSA was similar but had a higher proportion of high habitat. High suitability habitat was seen throughout the RSA.

Table 145 Snowshoe Hare HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

Habitat Class	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
	HU	%	HU	%	HU	%	HU	%
Low	59,535	3.6	2	0.0	480	1.7	59,055	3.7
Medium	267,972	16.4	0	0.0	0	0.0	270,430	16.8
High	1,311,086	80.0	5,137	100.0	27,683	98.3	1,283,403	79.6
Total	1,638,593	100.0	5,139	100.0	28,163	100.0	1,612,888	100.0
Medium Units Gained[a]			24		2,458			
Net Total Loss			5,115		25,705			
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.67		0.91		0.86		0.66	

[a] Habitat units in the high or medium categories may be converted to medium or low habitat units in some cases, due to a reduction in habitat quality rather than strictly a loss in quantity. However, for percentages shown on this table, only the net loss is shown to a minimum of zero then habitat gains at low or medium are tabulated separately to result in the Net Habitat Loss.

7.12.2 Impact Assessment

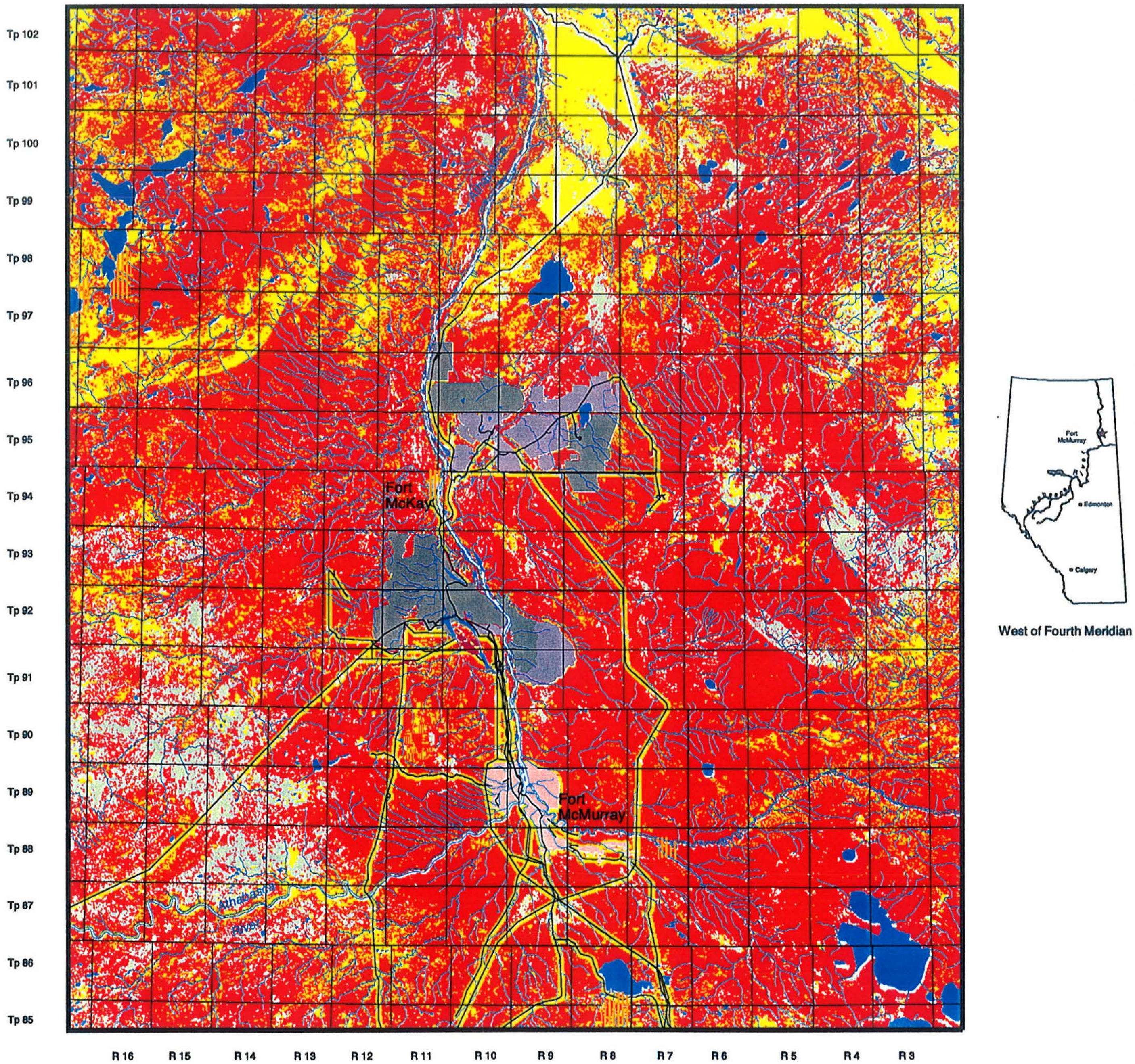
Direct habitat loss due to mine development is projected to affect hare habitat by removing 0.3%, or 5,115 HUs within the RSA (Table 146). Less than one percent of low and 0.4% of high quality habitat will be lost due to Project Millennium.

Table 146 Snowshoe Hare HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	59,535	-2	-0.0	-480	-0.8	0.4
Med	267,972	+24	+0.0	+2,458	+0.9	1.0
High	1,311,086	-5,137	-0.4	-27,683	-2.1	18.6
Total	**1,638,593**	**-5,115**	**-0.3**	**-25,705**	**-1.6**	**19.9**

7.12.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 0.9%, or 7,133 HUs within the RSA (Table 146 and Figure 63). Of this loss, 27% is due to the effects of Project Millennium. In total, 2% of low suitability habitat and 2% of high suitability habitat for snowshoe hares will be lost.



SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

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N

REGIONAL STUDY AREA
SNOWSHOE HARE HABITAT SUITABILITY
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO

14 Apr. 1998	Figure 63	PRODUCED BY: K.K.O. REVIEWED BY:

/data15/oilsands/hsi/arcview/share_ces.apr

7.13 WESTERN TANAGER

7.13.1 Baseline Conditions

The suitability of the various vegetation types within the RSA for western tanager habitat is presented in Table 147 and Figure 64. High suitability habitat for western tanagers within the RSA included the following vegetation types:

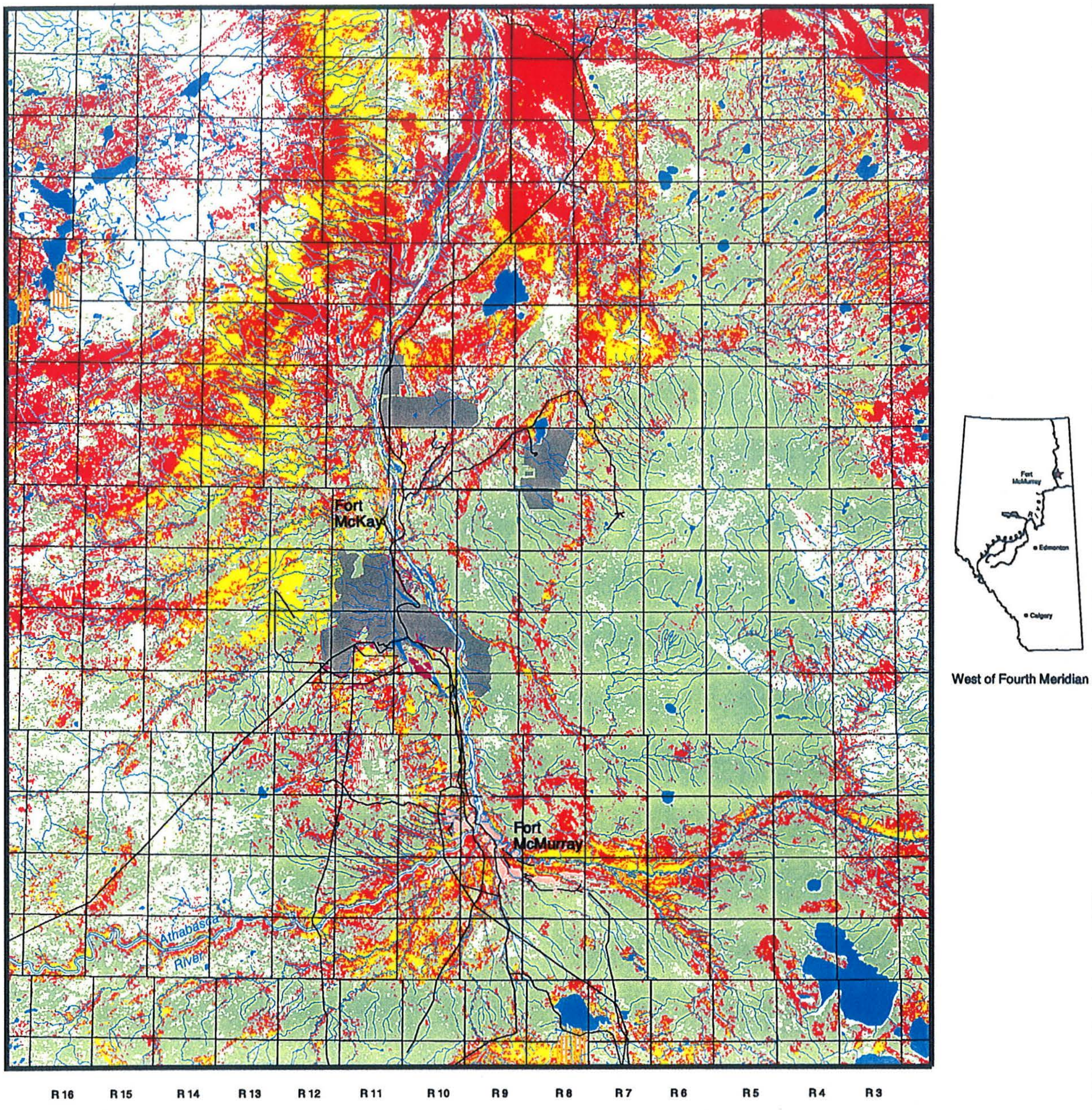
- mixedwood-white spruce-trembling aspen;
- coniferous-white spruce;
- coniferous-white spruce-jack pine; and
- open pine.

Unsuitable habitat for western tanagers included pine regeneration, upland shrubland, recent cutblocks, graminoid fens, marshes, water, municipalities, open pit mines and human disturbances.

Table 147 Western Tanager HSI Vegetation Class Ratings in the RSA

Habitat Suitability Rating	Regional Vegetation Class	HSI
High Suitability (0.67 - 1.00)	Mixedwood-Sw/Aw	0.90
	Coniferous-Sw	0.90
	Coniferous-Sw/Pj	0.90
	Open Pine	0.85
Medium Suitability (0.34 - 0.66)	Coniferous-Pj/Sw/Sb	0.66
	Mixed Deciduous	0.35
Low Suitability (0.01 - 0.33)	Upland Sb-Lt	0.30
	Wet Closed Coniferous Sb	0.04
	Old Cutblocks	0.04
	Wet Open Coniferous Sb-Lt	0.03
	Bog	0.02
	Low Shrub Wetland	0.02
	Shrubby Fen	0.01
Unsuitable (0.00)	Pine Regen	0.00
	Upland Shrub	0.00
	Recent Cutblocks	0.00
	Graminoid Fen	0.00
	Marsh	0.00
	Natural Disturbances	0.00
	Water	0.00
	Municipalities	0.00
	Open Pit Mines	0.00
	Human Disturbances	0.00

The overall suitability of the RSA (total number of HUs divided by the total number of ha) for western tanagers at baseline is 78%, or 662,250 HUs (Table 148). Of the unsuitable habitat, most was unsuitable vegetated areas. The mean suitability of the RSA (total HUs/total areas) was 0.27 (low). This is reflected in the areas of habitat rankings but not in the habitat units which are mainly in high habitats.



SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

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Project Millennium

REGIONAL STUDY AREA
WESTERN TANAGER HABITAT SUITABILITY
BASELINE SCENARIO

09 Apr. 1998	Figure 64	PRODUCED BY: MK REVIEWED BY:

/data15/oilsands/hsi/arcview/beaver.apr

Table 148 Western Tanager HSI: Percentage Distribution of Areas and Habitat Units in the RSA for Baseline, Project Millennium and CEA Scenarios

Scenario	Area (ha)	Percent of Area by Suitability Class: Unsuitable Habitat			Suitable Habitat				Habitat Units	Percent of Habitat Units by Suitability Class		
		Water	Other	Total	Low	Med	High	Total		Low	Med	High
Baseline	2,428,750	2.7	19.5	22.2	46.1	8.0	23.7	77.8	662,250	11.3	11.3	77.3
Project Millennium (Development Area)	5,506	0.1	9.1	9.2	83.7	2.7	4.4	90.8	554	45.3	12.8	41.9
Remaining After Millennium	2,423,244	2.7	19.5	22.2	46.0	8.1	23.8	77.8	661,696	11.3	11.3	77.3
CEA (Development Area)	29,865	0.4	46.2	46.6	18.4	8.7	26.3	53.4	8,430	5.2	11.0	83.8
CEA (Undeveloped Area)	2,398,885	2.7	19.2	21.9	46.4	8.0	23.7	78.1	653,820	11.4	11.3	77.2

Suitable habitat for western tanagers within the RSA is shown in Table 149 and Figure 64. Of the 662,250 HUs of western tanager habitat, the RSA is currently composed of 75,118 HUs (11%) of low quality habitat, 75,083 HUs (11%) of moderate quality habitat and 512,049 HUs (77%) of high quality habitat. The habitat distribution within the LSA differed in having greater habitat units in low and less in high. High suitability habitat was seen along the various draws in the northern portions of the RSA.

Table 149 Western Tanager HSI: Habitat Units and Percent Distribution in the RSA for Baseline, Project Millennium and CEA Scenarios

Habitat Class	RSA Baseline (Habitat Units)		Project Millennium (Units Lost)		RSA CEA (Units Lost)		RSA CEA (Habitat Units)	
	HU	%	HU	%	HU	%	HU	%
Low	75,118	11.3	251	45.3	438	5.2	74,680	11.4
Medium	75,083	11.3	71	12.8	931	11.0	74,152	11.3
High	512,049	77.3	232	41.9	7,061	83.8	504,988	77.2
Total	662,250	100.0	554	100.0	8,430	100.0	653,820	100.0
Total Area	2,428,750		5,640		29,865		2,428,750	
Mean Suitability	0.27		0.10		0.28		0.27	

7.13.2 Impact Assessment

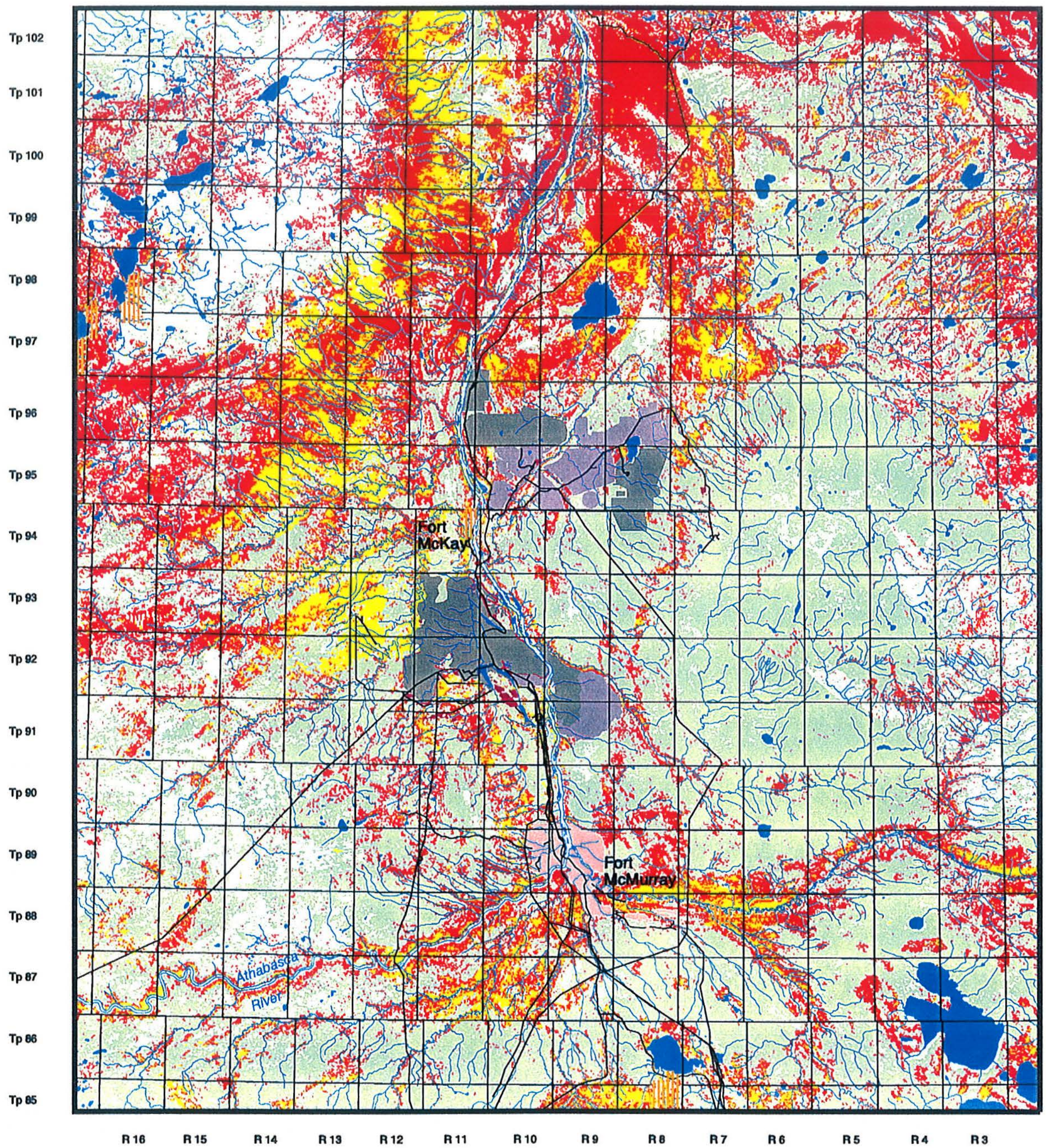
Direct habitat loss due to mine development is projected to affect tanager habitat by removing 0.1%, or 554 HUs within the RSA (Table 150). Less than one percent of low and 0.1% of moderate quality habitat will be lost due to Project Millennium.

Table 150 Western Tanager HSI: Percentage Change From RSA Baseline due to the Project Millennium and CEA Developments

Habitat Class	RSA Baseline (HU)	Project Millennium (HU Loss or Gain)	Project Millennium (% Loss or Gain)	RSA CEA (HU Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millennium/CEA)
Low	75,118	-251	-0.3	-438	-0.6	57.3
Med	75,083	-71	-0.1	-931	-1.2	7.6
High	512,049	-232	-0.0	-7,061	-1.4	3.3
Total	**662,250**	**-554**	**-0.1**	**-8,430**	**-1.3**	**6.6**

7.13.3 Cumulative Effects Assessment

The combined effects of existing, approved and planned developments, including Project Millennium, will account for a loss of 1.3%, or 8,430 HUs within the RSA (Table 150 and Figure 65). Of this loss, 7% is due to the effects of Project Millennium. In total, 0.6% of low suitability habitat, 1.2% of moderate and 1.4% of high suitability habitat for western tanagers will be lost.



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Linear Disturbances
- Open Water
- Existing Open Pit Mines
- Other Disturbances
- Proposed Open Pit Mines
- In-Situ
- Municipalities
- Indian Reserves

HABITAT SUITABILITY RATING

- Nil
- Low
- Moderate
- High

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N

REGIONAL STUDY AREA WESTERN TANAGER HABITAT SUITABILITY CUMULATIVE EFFECTS ASSESSMENT SCENARIO

14 Apr. 1998	Figure 65	PRODUCED BY: K.K.O. REVIEWED BY:

/data15/oilsands/nsl/arcview/tanager_cea.apr

7.14 MOOSE LINKAGE ZONES

Results of the Linkage Zone Analysis for moose will be expressed in terms of percentage of areas that are effectively restricting moose (fracture zones) movement. The model is described in Appendix I.

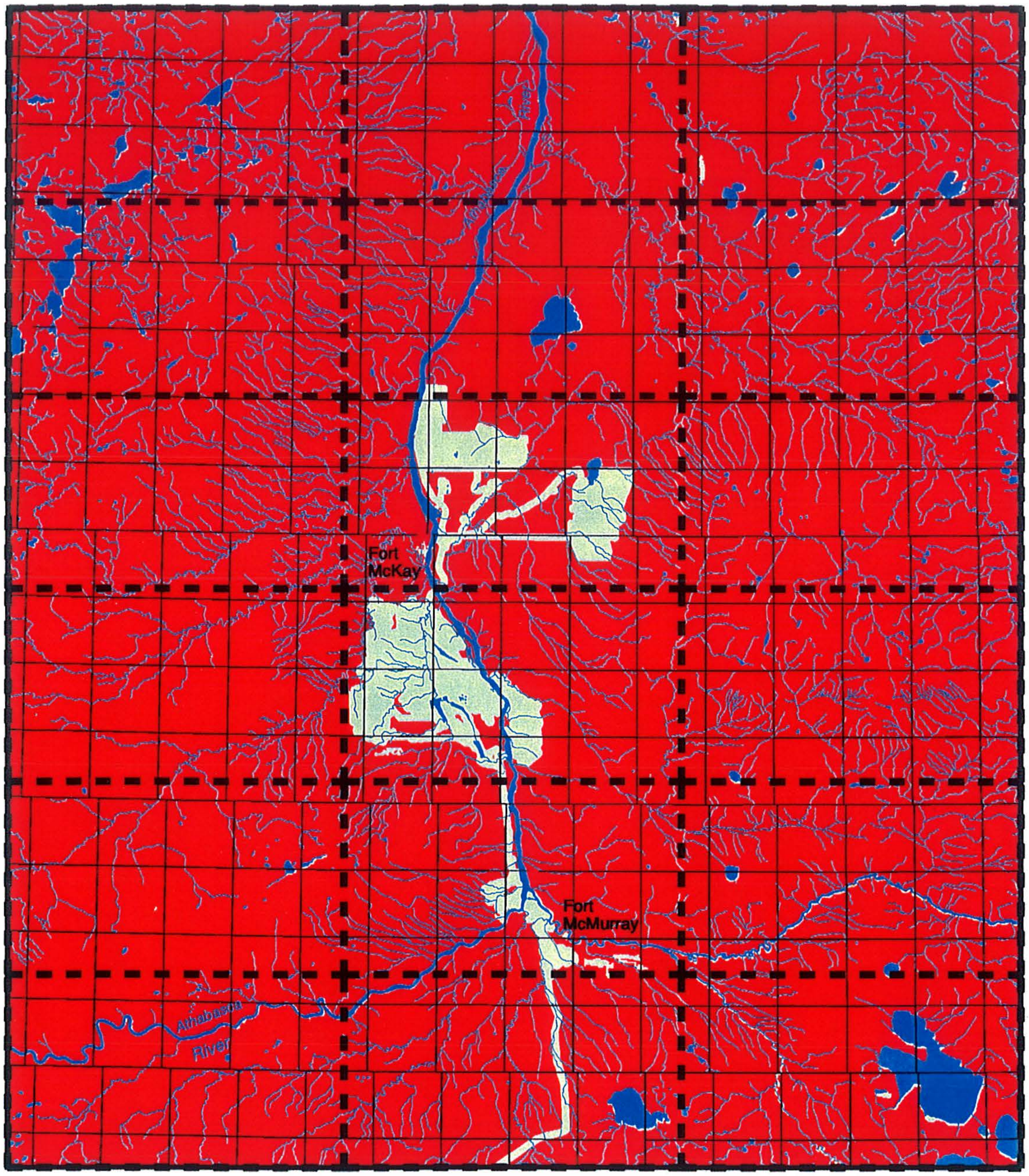
7.14.1 Baseline Conditions

Baseline conditions (Figure 66) show that current fracture zones are concentrated in the Fort McMurray and Syncrude/Suncor areas, and the recently approved Aurora North and South mines. In total, 5.5% of the RSA was considered to be fracture zone for moose (Table 151). The highway was modelled as a fracture zone for moose, although this should not be regarded as an impermeable barrier. Fracture percentages of east-west movement rectangles (see Figure 66) ranged from 2.2 to 10.1%. The highest amounts of fractured habitat were found in east-west rectangles 3 (7.8%) and 4 (10.1%), which correspond to the Suncor/Syncrude area. North-south movement rectangles ranged in percent fracture from 1.6 to 12.2%, with most of the fractured habitat being in rectangle 2.

Table 151 Baseline, Project Millennium, and CEA Moose Linkage and Fracture Zone Analysis Results

Scenario	Area Sampled[a]	Linkage Zone (ha)	Fracture Zone (ha)	% Linkage	% Fracture
Baseline	Entire RSA	2,296,230	132,564	94.5	5.5
	East-West 1	395,911	8,874	97.8	2.2
	East-West 2	391,736	13,062	96.8	3.2
	East-West 3	373,331	31,466	92.2	7.8
	East-West 4	364,023	40,776	89.9	10.1
	East-West 5	391,500	13,298	96.7	3.3
	East-West 6	379,747	25,044	93.8	6.2
	North-South 1	796,635	12,960	98.4	1.6
	North-South 2	711,134	98,463	87.8	12.2
	North-South 3	788,479	21,097	97.4	2.6
Project Millennium	Entire RSA	2,289,995	138,799	94.3	5.7
	East-West 1	395,911	8,874	97.8	2.2
	East-West 2	391,736	13,062	96.8	3.2
	East-West 3	373,331	31,466	92.2	7.8
	East-West 4	357,797	47,003	88.4	11.6
	East-West 5	391,492	13,307	96.7	3.3
	East-West 6	379,747	25,044	93.8	6.2
	North-South 1	796,635	12,960	98.4	1.6
	North-South 2	704,899	104,698	87.1	12.9
	North-South 3	788,479	21,079	97.4	2.6
CEA	Entire RSA	2,266,111	162,684	93.3	6.7
	East-West 1	395,911	8,874	97.8	2.2
	East-West 2	391,736	13,062	96.8	3.2
	East-West 3	355,061	49,737	87.7	12.3
	East-West 4	357,710	47,089	88.4	11.6
	East-West 5	385,985	18,813	95.4	4.6
	East-West 6	379,726	25,064	93.8	6.2
	North-South 1	796,635	12,960	98.4	1.6
	North-South 2	681,014	128,583	84.1	15.9
	North-South 3	788,479	21,079	97.4	2.6

[a] See Figures 66 and 67 for demonstration of sample areas



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND
- Regional Study Area
- Sample Corridor Rectangle
- Open Water

HABITAT ZONE
- Fracture Zone
- Linkage Zone

N

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Project Millennium

REGIONAL STUDY AREA
MOOSE LINKAGE MODEL RESULTS
BASELINE SCENARIO

27 Apr. 1998	Figure 66	PRODUCED BY: K.K.O. REVIEWED BY:

/data15/oilsands/hal/arcview/mooselink.apr

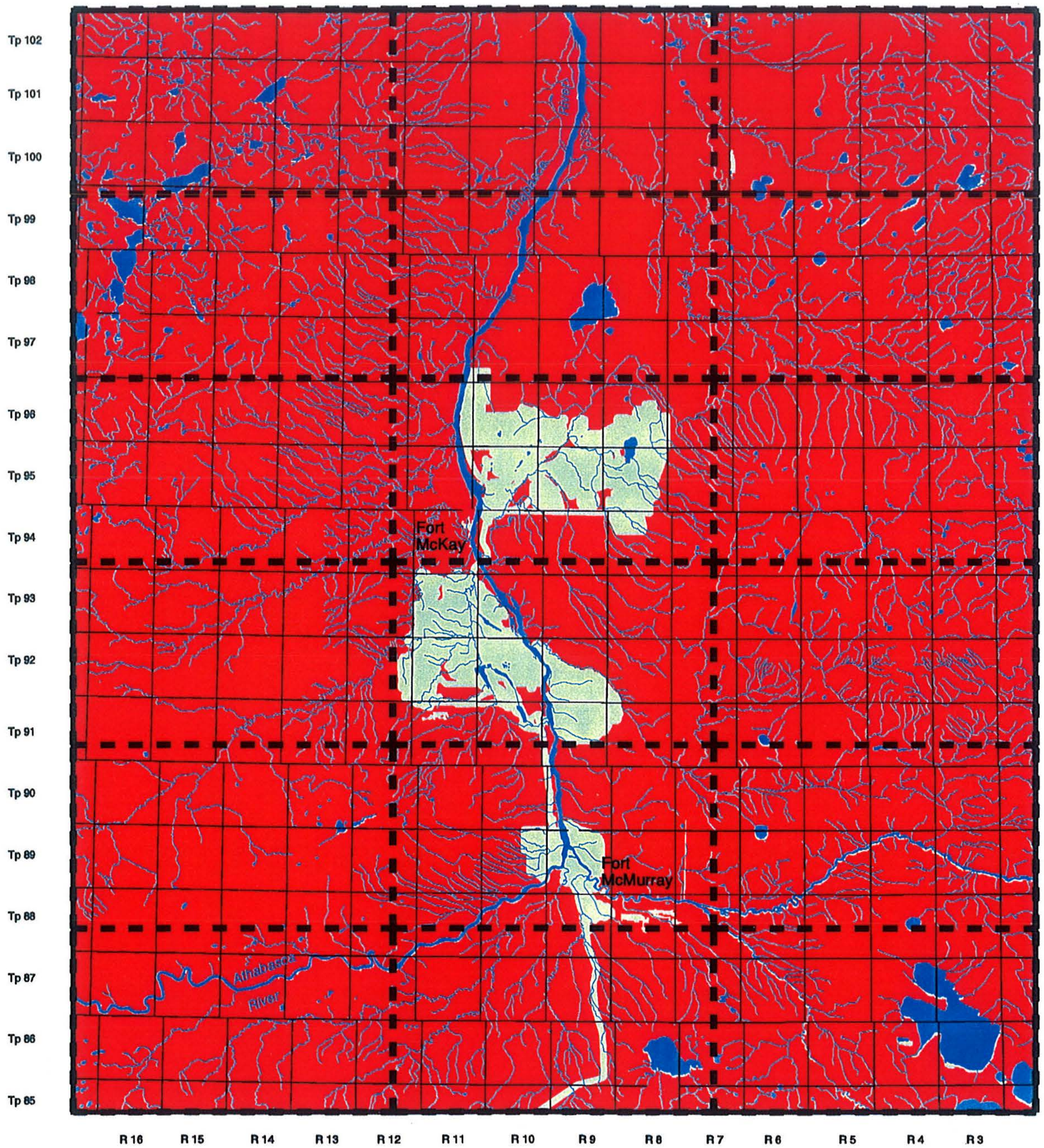
7.14.2 Impact Assessment

Inclusion of Project Millennium in the Linkage Zone Model (Figure 67, Table 152) results in an increase in fractured habitat from 5.5 to 5.7%, an increase of 0.2% over baseline. Nearly all of the east-west effects are within east-west rectangle 4, where the fractured habitat increases from 10.1 to 11.6%. Similarly, all of the north-south increases in fractured habitat occurred within north-south rectangle 2, where the increase was from 12.2 to 12.9%.

It should be noted that the Linkage Zone Model as constructed for this assessment was conservative in its assumptions. It is very likely, and in fact anticipated, that moose will be able to utilize local movement corridors designed as mitigation within the individual mine developments. These corridors were designed to have a minimum average width of 1 km (Shell Canada Limited 1997), a width considered in the Linkage Zone Model to be inadequate for moose, as it was designed to assess larger, inter-regional movements by moose. Preservation of local corridors that connect larger, more regional corridors may be critical to the success of the larger corridors. The Linkage Zone Model shows a number of linkage areas within the development zones which are conditional dates for corridors of connections (Figure 66).

Table 152 Incremental Increase in Moose Fracture Zone Percentages From Baseline to CEA Scenarios

Area Sampled	Baseline	Project Millennium	CEA
Entire RSA	5.5	5.7	6.7
East-West 1	2.2	2.2	2.2
East-West 2	3.2	3.2	3.2
East-West 3	7.8	7.8	12.3
East-West 4	10.1	11.6	11.6
East-West 5	3.3	3.3	4.6
East-West 6	6.2	6.2	6.2
North-South 1	1.6	1.6	1.6
North-South 2	12.2	12.9	15.9
North-South 3	2.6	2.6	2.6



West of Fourth Meridian

SOURCES: Suncor, Syncrude, Petro-Canada, Mobil, Al-Pac, Golder, The Forestry Corp

Scale 1:1,000,000

10 0 10 20 30 40

Kilometres

Map Projection: UTM 12
Datum: NAD 83

LEGEND

- Regional Study Area
- Sample Corridor Rectangles
- Open Water

HABITAT ZONE

- Fracture Zone
- Linkage Zone

N

SUNCOR ENERGY

Project Millennium

**REGIONAL STUDY AREA
MOOSE LINKAGE MODEL RESULTS
CUMULATIVE EFFECTS
ASSESSMENT SCENARIO**

27 Apr. 1998	Figure 67	PRODUCED BY: K.K.O. REVIEWED BY:

/data15/oilsands/hsi/arcview/mooselink.apr

7.14.3 Cumulative Effects Assessment

Analysis of the effects of approved projects in addition to the Project in the Linkage Zone Model (Figure 67) shows an increase in fractured habitat from 5.5% of the RSA at baseline to 6.7%, an increase of 1.2% (Table 152). While the largest effects are within east-west rectangle 3, where the fractured habitat increases from 7.8 to 12.3%, increases are also noted for east-west rectangles 4 (10.1 to 11.6%) and 5 (3.3 to 4.6%). Increases in fractured habitat for north-south rectangles occurred only in rectangle 2 (12.2 to 15.9%).

While these changes within the RSA may be looked upon as small, they may result in important changes to the regional and local wildlife populations. Unfortunately, our current knowledge on wildlife movements and populations within the region preclude any definitive statements being made regarding the potential magnitude of these impacts. It is recommended that corridors be designed at the local level, within and between the various developments, to lessen the potential impacts of an increase in fracture zones. These corridors should be monitored during development construction and operation phases to determine their efficacy as travel corridors. Also, if development beyond the CEA scenario is contemplated, planners should ensure that east-west linkages between the northern oil sands developments near Fort McKay are maintained. To this end, the effect of the highway on moose movements should be investigated to determine if it acts as a barrier.

8 SUMMARY

A summary of the HSI results is provided in this Section. Summaries of the LSA and RSA data are provided in 8.1 and 8.2, respectively.

8.1 LOCAL STUDY AREA

8.1.1 Baseline Conditions

A rank order of wildlife KIR HUs shows that the LSA has the most potential habitat for snowshoe hares, with a total of 14,426 HUs (Table 153). Other species with large amounts of habitat included the red-backed vole (11,310 HUs) and the fisher (10,807 HUs). KIRs that depend upon mature white spruce forests had lesser amounts of habitat available to them (e.g., Cape May warbler: 4,556 HUs; western tanager: 2,929 HUs), and KIRs that require water for their habitat needs had the least amount of available habitat (dabbling ducks: 1,552 HUs; beavers: 1,273 HUs).

Table 153 Rank Order and Percent of Potential Habitat Units of Wildlife KIRs in the LSA

Rank	Species	LSA-Pre-Development (HUs)	Percent of Potential HUs
1	Snowshoe Hare	14,426	89.2
2	Mammal Richness	13,441	83.1
3	Bird Richness	12,996	80.3
4	Reptile and Amphibian Richness	12,971	80.2
5	Red-backed Vole	11,310	69.9
6	Fisher	10,807	66.8
7	Moose	9,614	59.4
8	Great Gray Owl	6,965	43.0
9	Black Bear	6,869	42.5
10	Ruffed Grouse	6,685	41.3
11	Pileated Woodpecker	6,274	38.8
12	Cape May Warbler	4,556	28.2
13	Western Tanager	2,929	18.1
14	Dabbling Ducks	1,552	9.6
15	Beaver	1,273	7.9
	Potential HUs	**16,181**	

8.1.2 Impact Assessment

Impacts related to site clearing for the Project were estimated to range from 32.5% to 60.9% of any KIRs habitat supply (Tables 154 - 155). Impacts were predicted to have the greatest relative impact on habitat for the fisher

(60.9%), moose (59.0%), the great gray owl (58.9%), the snowshoe hare (58.9%) and the Cape May warbler (58.0%).

Reclamation of the Project site was predicted to have minor negative to major positive long-term impacts on KIR habitat relative to baseline conditions. Most predicted changes were due to greater amounts of upland habitats being planned under the closure scenario. Thus wetlands species, such as beavers, were predicted to lose 6.4% of their habitat, while upland species were predicted to have minor to major habitat gains. Peatland species were predicted to decrease.

Other species that were predicted to have an overall decrease in habitat included the fisher (-7.6%), the snowshoe hare (-8.4%) and the Cape May warbler (-18.4%). Species richness was also expected to decrease, from 7.3 to 23.8% (Table 155). The decrease in hare and fishers can be partly attributed to the percent increase in open water which directly removes habitat for these species.

In total, the goal of achieving an equivalent or greater habitat capability for KIRs following reclamation was met, given that the average relative change in habitat for all KIRs was positive.

Table 154 Summary of LSA HSI and Richness Index Total Habitat Units at Pre-Development, Steepbank Mine, East Bank Mining Area, and Closure Scenarios

Species or Group	LSA Pre-Development	Steepbank	Mine Impact	Closure
Beaver	1,273	296	414	1,191
Black Bear	6,869	1,644	3,944	8,726
Cape May Warbler	4,556	1,096	2,641	3,717
Dabbling Ducks	1,552	339	438	2,516
Fisher	10,807	2,538	6,582	9,983
Great Gray Owl	6,965	1,327	4,102	6,514
Moose	9,614	2,238	5,671	10,826
Pileated Woodpecker	6,274	1,541	3,299	8,624
Red-backed Vole	11,310	2,745	6,367	12,173
Ruffed Grouse	6,685	1,667	3,605	8,904
Snowshoe Hare	14,426	3,381	8,496	13,208
Western Tanager	2,929	749	1,304	6,099
Mammal Richness	13,441	3,228	7,963	12,458
Bird Richness	12,996	3,024	7,807	11,268
Reptile and Amphibian Richness	12,971	2,998	7,863	9,884

Table 155 Summary of Percent Impacts to HSI and Richness Index Habitat Units at Steepbank Mine, East Bank Mining Area and Closure Scenarios, Compared To LSA Pre-Development Values

Species	LSA Pre-Development (HUs)	Steepbank Mine Impact (% Change From Pre-Development)	East Bank Mining Area Impact (% Change From Pre-Development))	LSA-Closure (% Change From Pre-Development))
Beaver	1,273	-23.3	-32.5	-6.4
Black Bear	6,869	-23.9	-57.4	+27.0
Cape May Warbler	4,556	-24.0	-58.0	-18.4
Dabbling Ducks	1,552	-21.8	-28.2	+62.1
Fisher	10,807	-23.5	-60.9	-7.6
Great Gray Owl	6,965	-19.0	-58.9	-6.5
Moose	9,614	-23.3	-59.0	+12.6
Pileated Woodpecker	6,274	-24.6	-52.6	+37.5
Red-backed Vole	11,310	-24.3	-56.3	+7.6
Ruffed Grouse	6,685	-24.9	-53.9	+33.2
Snowshoe Hare	14,426	-23.4	-58.9	-8.4
Western Tanager	2,929	-25.6	-44.5	+108.3
Mammal Richness	13,441	-24.0	-59.2	-7.3
Bird Richness	12,996	-23.3	-60.1	-13.3
Reptile and Amphibian Richness	12,971	-23.1	-60.6	-23.8

8.2 REGIONAL STUDY AREA

8.2.1 Baseline Condition

Similar to the results for the LSA, the red-backed vole (1,679,543 or 69.2% of the possible 2,428,750 HUs) and the snowshoe hare (1,638,593 or 67.5%) had the highest baseline HUs of all the KIRs for the RSA (Table 156). Other species with high HU values included the moose, the great gray owl and the fisher. The species with the least regional habitat was the beaver with 192,045 (7.9 %), and dabbling ducks with 243,130 (10.0%) HUs. These results are not surprising, considering that these two species must be located in or adjacent to open water resources.

Table 156 Rank Order and Percent of Potential Habitat Units of Wildlife KIRs in the RSA

Rank	Species	LSA-Pre-Development (HUs)	Percent of Potential HUs
1	Mammal Richness	1,851,217	76.2
2	Reptile and Amphibian Richness	1,826,347	75.2
3	Bird Richness	1,686,496	69.4
4	Red-backed Vole	1,679,543	69.2
5	Snowshoe Hare	1,638,593	67.5
6	Moose	1,535,910	63.2
7	Great Gray Owl	1,510,550	62.2
8	Fisher	1,508,485	62.1
9	Black Bear	1,247,278	51.4
10	Cape May Warbler	903,110	37.2
11	Pileated Woodpecker	782,295	32.2
12	Ruffed Grouse	765,545	31.5
13	Western Tanager	662,250	27.3
14	Dabbling Ducks	243,130	10.0
15	Beaver	192,045	7.9
	Potential HUs	**2,428,750**	

8.2.2 Impact Assessment

Changes to wildlife KIRs related to the Project were assessed in terms of the changes to total HUs in relation to the currently approved projects (Table 157). The Project in the RSA resulted in losses of HUs ranging from 0.0% (dabbling ducks) to 0.3% (fisher; Table 158). Richness values for mammals, birds and reptiles and amphibians were all predicted to decline by 0.3%.

Table 157 Summary of RSA HSI and Richness Index Total Habitat Units at Baseline, Project Millennium, and CEA Scenarios

Species or Group	RSA Baseline	Project Millennium Development Area	Remaining at Millennium	RSA CEA Development Areas	Remaining at CEA
Beaver	192,045	117	191,928	1,896	190,149
Black Bear	1,247,278	2,300	1,244,978	13,150	1,234,128
Cape May Warbler	903,110	1,545	901,565	11,682	891,428
Dabbling Ducks	243,130	99	243,031	1,564	241,565
Fisher	1,508,485	4,045	1,504,440	21,591	1,486,894
Great Gray Owl	1,510,550	2,037	1,508,513	31,076	1,479,474
Moose	1,535,910	3,433	1,532,477	20,205	1,515,705
Pileated Woodpecker	782,295	1,758	780,537	6,469	775,826
Red-backed Vole	1,679,543	3,623	1,675,920	20,566	1,658,977
Ruffed Grouse	765,545	1,938	763,607	7,133	758,412
Snowshoe Hare	1,638,593	5,115	1,633,478	25,705	1,612,888
Western Tanager	662,250	554	661,696	8,430	653,820
Mammal Richness	1,851,217	4,735	1,846,482	25,275	1,825,942
Bird Richness	1,686,496	4,783	1,681,713	22,888	1,663,608
Reptile and Amphibian Richness	1,826,347	4,864	1,821,483	23,040	1,803,307

8.2.3 Cumulative Effects Assessment

Changes to wildlife habitat related to the cumulative effects scenario predicted that from -0.6 to -2.1% of the HUs for any KIR would be lost (Table 158). The greatest change was predicted for the great gray owl (-2.1%) while the least change was predicted for dabbling ducks (-0.6%).

The CEA did not take reclamation into account, therefore, impacts are likely to be less in the long-term.

Richness values for mammals, birds and reptiles and amphibians were all predicted to decline by 1.3 - 1.4%.

Table 158 Summary of Percent Impacts to HSI and Richness Index Habitat Units at Baseline, Project Millennium, and CEA Scenarios, Compared To RSA Baseline Values

Species	RSA Baseline (HU)	Project Millennium (% Loss or Gain)	RSA CEA (% Loss or Gain)	Percent Disturbance Ratio (Millen/CEAx100)
Beaver	192,045	-0.1	-1.0	6.2
Black Bear	1,247,278	-0.2	-1.1	17.5
Cape May Warbler	903,110	-0.2	-1.3	13.2
Dabbling Ducks	243,130	-0.0	-0.6	6.3
Fisher	1,508,485	-0.3	-1.4	18.7
Great Gray Owl	1,510,550	-0.1	-2.1	6.6
Moose	1,535,910	-0.2	-1.3	17.0
Pileated Woodpecker	782,295	-0.2	-0.8	27.2
Red-backed Vole	1,679,543	-0.2	-1.2	17.6
Ruffed Grouse	765,545	-0.3	-0.9	27.2
Snowshoe Hare	1,638,593	-0.3	-1.6	19.9
Western Tanager	662,250	-0.1	-1.3	6.6
Mammal Richness	1,851,217	-0.3	-1.4	18.7
Bird Richness	1,686,496	-0.3	-1.4	20.9
Reptile and Amphibian Richness	1,826,347	-0.3	-1.3	21.1

9 CLOSURE

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

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APPENDIX I

HSI, BIODIVERSITY AND LINKAGE ZONE MODELS

I1 HSI MODELS

I1.1 OVERVIEW

HSI models were adapted from previous reports for 12 wildlife species:

1. Beaver
2. Black Bear
3. Cape May Warbler
4. Dabbling Ducks
5. Fisher
6. Great Gray Owl
7. Moose
8. Pileated Woodpecker.
9. Red-Backed Vole
10. Ruffed Grouse
11. Snowshoe Hare
12. Western Tanager

In addition, relative species richness models were developed to assess biodiversity at the community level for three wildlife groups:

1. Mammals
2. Birds
3. Reptiles and Amphibians

Finally, a model was developed to assess moose linkage and fracture zones in and around large industrial developments, roads and other infrastructure.

I1.2 BEAVER

I1.2.1 Introduction

The beaver model was adapted from one developed by Westworth (1996) for the Suncor Steepbank Mine study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses beaver habitat by first determining the proximity of land to suitable open water (low gradient rivers, creeks, ponds or marshes). Then it examines if food and cover of the appropriate types exist in those zones. Although water and marsh areas are used as living habitat, this model assesses only the land areas which provide food resources of the proper quality adjacent to water and marsh areas. This approach also avoids categorizing the entire open water zone of large lakes and rivers as appropriate habitat.

I1.2.2 Habitat Requirements

I1.2.2.1 Food

Beaver food is determined by the relative proportion of deciduous shrubs and trees in the habitat adjacent to open water. Deciduous trees and shrubs, particularly willows, aspen and balsam poplar, are preferred food sources, although all deciduous trees and shrubs are ranked equally in this model based on their cover.

I1.2.2.2 Cover

Cover for beavers is provided by the canopy closure of large trees and of shrubs, regardless of species. Additional cover also results in additional food resources (quantity), whereas the species composition deals with the quality.

I1.2.3 Model Development

I1.2.3.1 Woody Vegetation Cover

This is the total canopy cover of trees and shrubs, determined using the cover values for each species. The cover of trees and shrubs is required to be greater than 0, and reaches optimum suitability at mid-cover ranges. Over the range 0 to 60% cover, the value increases from 0.0 to 1.0. The suitability remains optimum for values greater than 60% (Figure I-1).

I1.2.3.2 Deciduous Tree + Shrub Composition

This variable is the relative proportion of deciduous trees and shrubs which make up the woody vegetation cover. It is determined as the sum of the deciduous tree cover and selected species of the deciduous shrub cover divided by the total woody cover[1]. As the proportion of deciduous trees and shrubs increases the suitability also increases, until the optimum is reached

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1 100 x (Aspen Trees + Aspen Shrubs + Balsam Poplar Trees + Balsam Poplar Shrubs + Paper Birch Trees + Paper Birch Shrubs + Alder + Saskatoon + Dwarf Birch + Dogwood + Hazelnut + Cherry + Willow + Low-bush Cranberry) / (Total Tree + Shrub Cover)

at 50% or higher. Thus over the range 0 to 50%, SI(2) = composition/50, whereas at all higher values SI(2) = 1 (Figure I-1).

I1.2.3.3 Distance to Water

A distance to water buffer of 100 m is applied from the edge of every creek, river, or pond or marsh in the study area. Within 100 m the habitat may be considered suitable if food and cover are available. Areas >100 m from water are considered unsuitable (Figure I-1).

I1.2.3.4 Stream Gradient

The gradient of a river or creek determines whether the water velocity is slow and gentle enough to allow for dam construction and beaver use. Based on Westworth (1996), a gradient > 15 degrees is considered unsuitable, whereas 0 - 5 degrees is optimum. Between those two values, the suitability is set at 0.5 (Figure I-1).

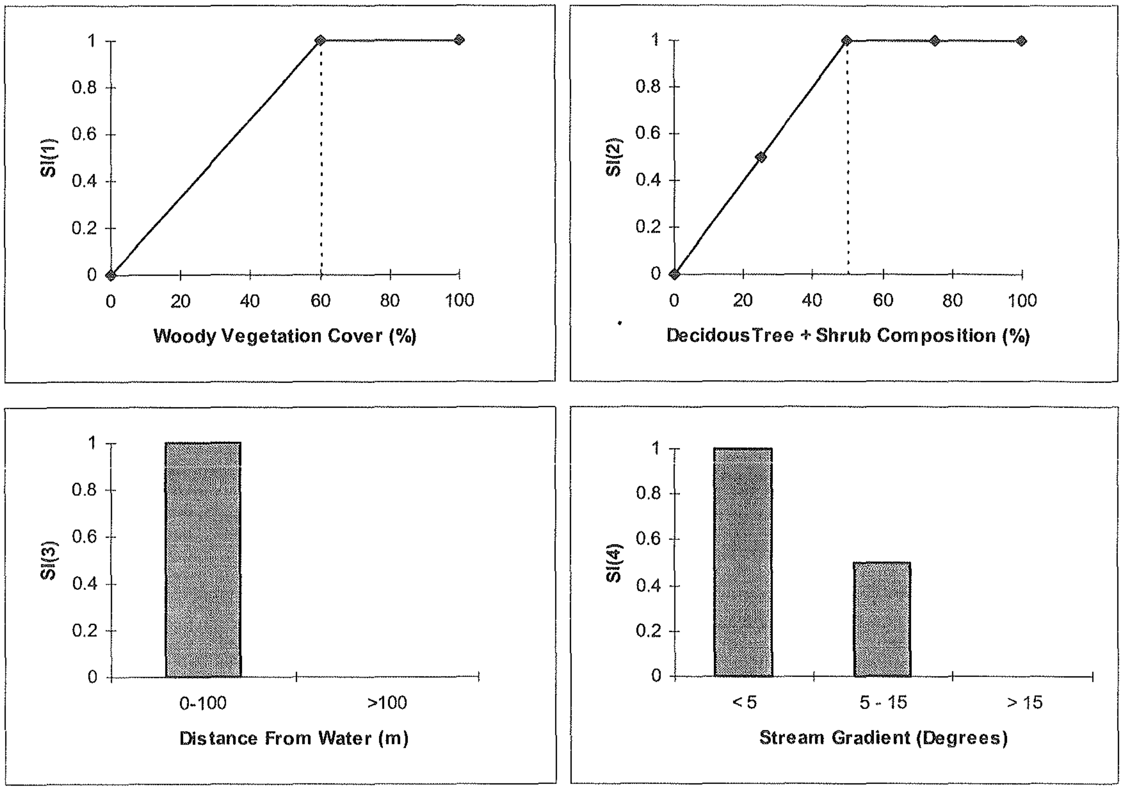
I1.2.3.5 Disturbance Coefficients

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for beavers are listed in Table I-1. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table I-1 Zones of Influence and Disturbance Coefficients for Beavers

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads	500 m	0.5
Active Mine sites, gravel pits, dumps, plant facilities	0 m	N/A
Plant and Camp Sites, Towns	500 m	0.5
Utility Corridors	500 m	0.5

Figure I-1 Suitability Index Values in Relation to Habitat Variables in the Beaver HSI Model



I1.2.3.6 Equation

The HSI model for beavers assumes that all four suitability index components define required habitat for beavers, thus high values for one index cannot compensate for low values of any other. The model is calculated as the product of the four indices and the disturbance coefficient.

$$HSI = SI(1) \times SI(2) \times SI(3) \times SI(4) \times DC$$

I1.2.4 Current Status on Model Validation

The beaver model was developed based on literature reviews and has not been tested with independent data. A modified version of this model was previously used in the Muskeg River Mine EIA (Golder 1998). Although data were not available for quantitative testing, Golder Associates wildlife biologist reported that the many of the areas found by the model to be high habitat in the Suncor Project Millenium Local Study Area also supported beaver populations (Marilyn Collard, Golder Associates, personal communication).

I1.3 BLACK BEAR

I1.3.1 Introduction

The black bear model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses black bear habitat by determining food and cover requirements. The food and cover needs are then combined in an overall suitability equation.

I1.3.2 Habitat Requirements

I1.3.2.1 Food

Black bear food is determined by the cover of berry producing shrubs within a habitat area. This variable is used because bears require large numbers of berries to store energy for over-winter survival, and this period of time is critical for year-round survival. In this model, the total cover of the main berry producing shrubs in the diet of the black bear was used to quantify this variable.

I1.3.2.2 Cover

Black bears require escape cover from predators and intraspecific competitors, especially when immature. In this model, the cover of shrubs, tree canopy closure and the tree maturity all relate to increased black bear cover. The tree maturity is represented by the mean tree diameter at breast height (DBH) in centimetres, and relates to the ability of a bear to climb a tree for protection.

I1.3.3 Model Development

I1.3.3.1 Shrub Cover

This variable is the cover of all tall erect shrub species[2] determined by summing individual species coverages. A stand with no shrub cover is unsuitable. Over the range of 0 to 50% cover, the suitability increases to fully optimum. From 50 to 80% the suitability remains optimum, then decreases to 0.8 over the range 80 to 100% (Figure I-2).

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[2] shrub percent cover of pine, white spruce, black spruce, fir, tamarack, aspen, balsam poplar, paper birch, alders, saskatoon, dwarf birch, dogwood, hazelnut, cherries, willow and low-bush cranberry

I1.3.3.2 Tree Canopy Closure Class

Tree canopy closure is measured by classes in the inventory data which were used in model assessments. Closed canopied stands provide the greatest cover but overly dense stands are believed to hinder movement and thus the suitability is reduced slightly. Open (O) class is unsuitable (0.0). 'A' crown closure is rated 0.25. 'B' crown closure is rated 0.75. 'C' crown closure is rated 1.0 and 'D' crown closure decreases to 0.9 (Figure I-2).

I1.3.3.3 Mean Tree DBH

As tree DBH increases the suitability for escape cover increases from 0.1 where DBH = 0 to 1.0 at DBH = 15 cm. For all trees > 15 cm, the suitability is optimum (Figure I-2).

I1.3.3.4 Total Berry Shrub Cover

This variable was determined from the sum of percent cover of the following shrub species:

buffaloberry, blueberry, saskatoon, low-bush cranberry, pin / choke cherry, currant / gooseberry, raspberry, and dwarf shrubs which include: bearberry, bog cranberry, crowberry, bilberry, twinflower and creeping juniper.

There is no suitability where there were no berry shrubs (SI(4) = 0.0). This increases to optimum over the range 0 to 20% and remains optimum at all higher values (Figure I-2).

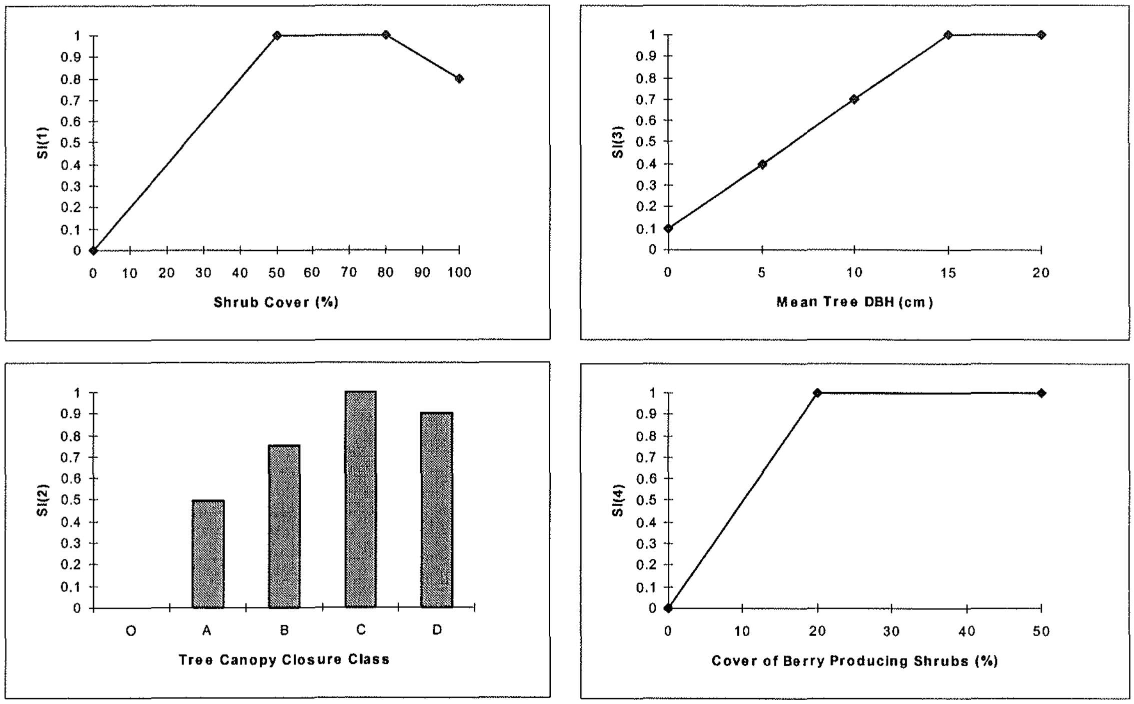
I1.3.3.5 Disturbance Coefficients

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for black bears are listed in Table I-2. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table I-2 Zones of Influence and Disturbance Coefficients for Black Bears

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads, Major Rivers	1000 m	0.5
Active Mine sites, gravel pits, dumps, plant facilities	100 m	0.75
Plant and Camp Sites, Towns	500 m	0.5
Utility Corridors	500 m	0.75

Figure I-2 Suitability Index Values in Relation to Habitat Variables in the Black Bear HSI Model



I1.3.3.6 Equations

The cover HSI equation considers that 60% of the cover is determined by shrub cover and 40% is determined from tree cover. Thus the following weighted average was used:

HSI Cover = [0.6 x SI(1)] + [(0.4 x SI(2)) x SI(3)]

The food cover was directly related to SI(4).

HSI Food = SI(4)

The overall HSI for bear habitat was determined by weighting the value of food at 70% and cover at 30% in a weighted average. Thus a site with no cover could have a suitability value if it had food and vice versa, but it cannot have optimum conditions unless both food and cover are high. This average is then reduced by the disturbance coefficient (DC).

HSI Overall = {[0.7 x HSI Food] + [0.3 x HSI Cover]} x DC

I1.3.4 Current Status on Model Validation

The black bear model has been developed based on literature reviews and has not been tested with independent data. It was used in the Shell Muskeg River Mine Environmental Impact Assessment (EIA) by Golder Associates (Golder 1998). An earlier version of the model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data. However, the model was reviewed by Alberta Fish and Wildlife and was thought to be acceptable (Axys 1996). Too few data were available to perform a model verification, but black bear sign recorded by Golder Associates Wildlife Biologists were located within medium and high habitat types in the Suncor Project Millenium local study area (see Appendix V).

I1.4 CAPE MAY WARBLER

I1.4.1 Introduction

The Cape May warbler model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses Cape May warbler habitat by use of variables which relate to both food and cover requirements. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equation.

I1.4.2 Habitat Requirements

I1.4.2.1 Food

Cape May warbler food and cover are determined from the same habitat variables. These include tree canopy closure, percentage conifer composition, mean tree height, and dominant tree species. The insectivorous Cape May warbler mainly feeds within the branches of tall conifers (Axys 1996).

I1.4.2.2 Cover

Cover requirements include open canopied forests comprised mainly of tall conifers in which white spruce is the most suitable species.

I1.4.3 Model Development

I1.4.3.1 Tree Canopy Closure

The Cape May warbler prefers open-canopied forest stands. Untreed open habitats (meadows and shrublands) are unsuitable (SI(1) = 0.0). 'A' canopy closure stands (6 to 30%) are rated as optimum (1.0), 'B' (31 to 50%) are rated at 0.7, and higher crown closure classes (C and D: 51 to 100%) are rated at 0.3 (Figure I-3).

I1.4.3.2 Conifer Tree Percent Composition

Conifer tree percent composition is related to Cape May warbler suitability through a series of linear relationships over different ranges of the composition. From 0 to 40%, SI(2) increases from 0.0 to 0.2. Then from 40 to 50% conifers the suitability increases from 0.2 to 0.75. It then increases to full suitability at 75% and remains optimum (1.0) at all percentages greater than 75. Note that tamarack is not included in the conifer percentage (Figure I-3).

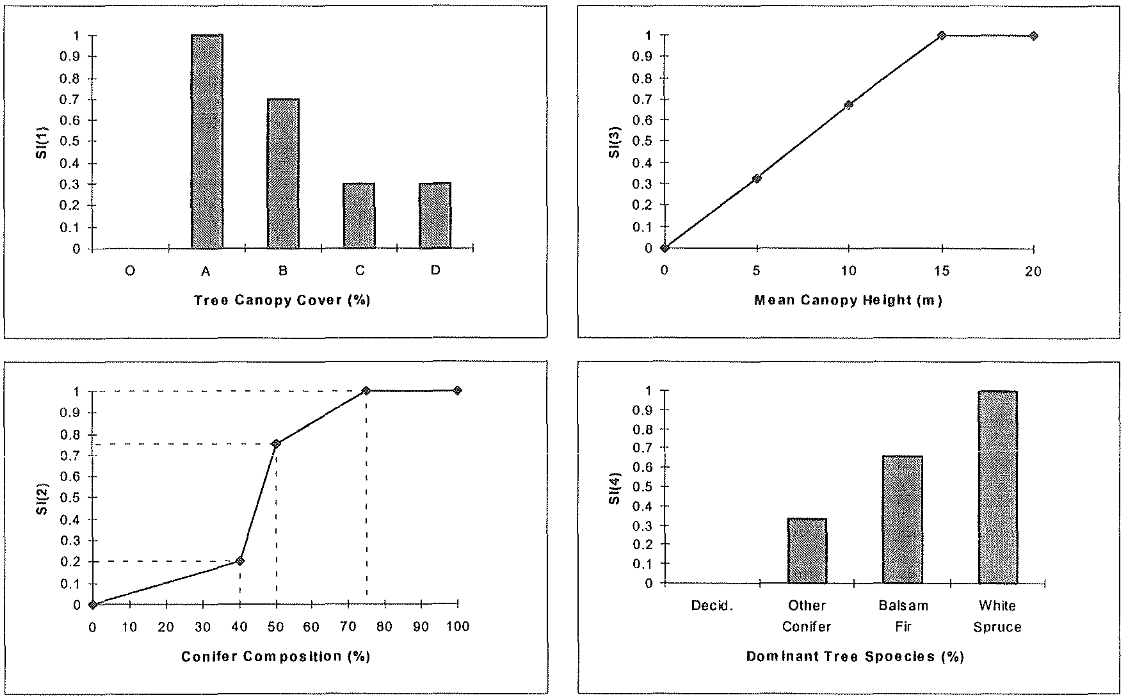
I1.4.3.3 Mean Canopy Tree Height

Canopy tree height is directly related to suitability over the range 0 to 15 m height. At all taller heights the stand height is optimum (1.0) (Figure I-3).

I1.4.3.4 Dominant Tree Species

The dominant tree species determines the availability of singing sites for reproductive behaviour. Dominant tree species is based on the percentage composition of each tree species. Where two species are tied for cover, the highest ranking species is listed as the dominant species. White spruce is the highest ranked species and receives a rating of 1.0. Balsam fir is second most preferred and is rated at 0.67. Other conifers are rated at 0.33, and deciduous trees are unsuitable (0.0) (Figure I-3).

Figure I-3 Suitability Index Values in Relation to Habitat Variables in the Cape May Warbler HSI Model



I1.4.3.5 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for Cape May warblers are listed in Table I-3. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table I-3 Zones of Influence and Disturbance Coefficients for Cape May Warblers

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads	100 m	0.75
Active Mine sites, gravel pits, dumps, plant facilities	100 m	0.75
Plant and Camp Site, Towns	100 m	0.75
Utility Corridors	0 m	N/A

I1.4.3.6 Equation

The Cape May warbler equation is the average of the product of the first two indices and the last two indices. This average is multiplied by the disturbance coefficient (DC).

$$HSI = \{ [0.5 \times SI(1) \times SI(2)] + [0.5 \times SI(3) \times SI(4)] \} \times DC$$

I1.4.4 Current Status on Model Validation

The Cape May warbler model was developed for the Alberta oil sands region based on literature reviews. This model was used to determine Cape May warbler habitat associations in the Shell Muskeg River Mine EIA (Golder 1998). An earlier version of the model was used in the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data, nor was it reviewed by outside experts. This model produced values for generalized vegetation types which were positively (although not significantly) correlated to Cape May warbler point counts conducted as part of the baseline wildlife survey of the Suncor Project Millenium EIA (see Appendix V).

I1.5 DABBLING DUCKS

I1.5.1 Introduction

This model was based on a model developed for dabbling ducks for the Suncor Steepbank Mine study area (Westworth and Associates 1996), which lists Sousa (1985) as the author of a model for blue-winged teals in the prairie pothole region of the United States, as the primary model source. However, the model was changed significantly for adaptation to the wetland types present in the oil sands region of Alberta.

I1.5.2 Habitat Requirements

I1.5.2.1 Food and Cover

Dabbling ducks primarily feed and seek cover in the same habitat types: namely in the vegetated shoreline on the edges of ponds, marshes and rivers. Ducks also feed throughout open water areas, and may use those habitats as safe sites away from land-dwelling predators, and use large ponds and lakes as "staging areas" during migration. Cover is very important at early stages of a dabbling ducks life, and this usually occurs at the edges of ponds, marshes or rivers.

I1.5.2.2 Distance to Water

The distance inland that a duck will make use of vegetation was assumed to be 250 m in the Westworth (1996) model. However, ephemeral wetlands were thought to only be used up to a maximum of 100 m distance. Although the Westworth (1996) model did not consider rivers and creeks as habitat for evaluation, the large size and slow moving nature of many of the edge habitats of rivers in the Alberta oil sands region suggested that they would be worthy for inclusion. A second variable, stream gradient, was used to determine which creeks and rivers were worthy of consideration. Duck surveys in this area have confirmed that ducks are present along creeks, mainly in relation to beaver activity. It was considered that the distance from a river in which a duck would use habitat would be lower than the distance from ponds and marshes. This would tend to weight the importance of ponds much higher than rivers and creeks.

I1.5.3 Model Development

I1.5.3.1 Habitat Type

The first suitability index was determined from the type of habitat in the study areas (Table I-4). Upland forests, disturbed areas and peatlands were not considered to be suitable habitat (0.0), unless it was near a water body as described in the next index. Open water areas of lakes and ponds were rated as medium habitat (0.66). This was chosen since the ducks may use open areas for feeding and escape, but they still require vegetation in order to nest. Low gradient rivers and creeks were assigned as low suitability habitat (0.33). The highest rating (1.00) was assigned to marshes since there is abundant food and cover in these habitats.

Table I-4 Suitability of Habitat Types, Independent of Distance From the Nearest Water Body

Habitat Type	SI(1)
Upland Forests, Shrublands and Meadows	0.00
Disturbed Areas	0.00
Bogs, Swamps, and Fens	0.00
Lakes and Ponds - open water zone	0.66
Rivers and Creeks ≤ 5 degree stream gradient	0.33
Rivers and Creeks > 5 degree stream gradient	0.00
Marshes	1.00

I1.5.3.2 Distance to Open Water

The second suitability index is determined from the distance to the nearest pond, lake, marsh, creek or river. Any (undisturbed) habitat which falls within the distances from the edge of these habitats as shown in Table I-5 is rated as either high (1.00), moderate (0.66) or low (0.33). Any area greater than 250 m from ponds or marshes, or greater than 100 m from a river or creek is unsuitable (0.0). All areas adjacent to streams with a gradient > 5 degrees are also unsuitable (0.0).

Table I-5 Suitability Index for Various Distances From Open Water Habitats

Wetland Type	Buffer Distance	SI(2)
Pond, Lake, Marsh, Open Water, Natural or Reclaimed	0 - 50 m	1.00
	50 - 100 m	0.66
	100 - 250 m	0.33
	> 250 m	0.00
Rivers and Streams ≤ 5 degree gradient	0 - 50 m	0.66
	50 - 100 m	0.33
	> 100 m	0.00
Rivers and Stream > 5 degree gradient	All distances	0.00

I1.5.3.3 Disturbance Coefficients

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. Human disturbances are particularly important along roads and utility corridors which are accessible to hunters. Zones of influence and the disturbance coefficients for dabbling ducks are listed in Table I-6. Where > 1 zone of influence overlaps, the lowest disturbance coefficient is applied.

Table I-6 Zones of Influence and Disturbance Coefficients for Dabbling Ducks

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads	250 m	0.5
Active Mine Sites, Gravel Pits, Dumps and Plant Facilities	100 m	0.75
Plant and Camp Site, Towns	100 m	0.75
Utility Corridors	100 m	0.75

I1.5.3.4 Equation

Habitat for dabbling ducks is related either to the first or second suitability index, whichever is highest. The suitability is then reduced by the disturbance coefficient (DC).

$$HSI = \text{Maximum (Habitat Rating, Distance Rating)} \times DC$$

Note that additional ponds, lakes and river habitat within the distance to water buffer are not rated higher than the values given in Table I-5. Also disturbed and developed habitat is unsuitable even when it is near a water source.

I1.5.4 Current Status on Model Validation

The dabbling duck model was developed based on literature reviews and has not been tested with independent data. The model was first used in the Muskeg River Mine EIA (Golder 1998). Too few data were collected in the Suncor Project Millenium local study area to test the validity of the model (see Appendix V).

I1.6 FISHER

I1.6.1 Introduction

The fisher model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses fisher habitat by use of variables which relate to both food and cover requirements. Food habitat relates to predictions from the snowshoe hare and red-backed vole HSI models, which are also discussed in Appendix I).

I1.6.2 Habitat Requirements

I1.6.2.1 Food

Fishers make use of many species of prey, ranging from insects to carrion, but the most important food sources are snowshoe hare and other small mammals (Axys 1996). Food habitat is therefore closely associated with the cover habitats of the dominant prey. In this model, the habitat suitability index output from the snowshoe hare and red-backed vole models have been incorporated to determine the habitat areas which will provide the most food.

I1.6.2.2 Cover

Fishers make use of dense canopy cover, especially of coniferous forests or mixedwoods. Fishers tend to avoid open stands. Optimum fisher cover is related to stand maturity (Axys 1996).

I1.6.3 Model Development

I1.6.3.1 Tree Canopy Closure Class

Fishers prefer stands with high canopy closure, although they will occasionally use open stands for feeding if it is near concealment cover. Open stands (0 to 5% closure) result in a suitability index of 0.1. 'A' canopy closure stands (6 to 30%) have SI(1) = 0.25, and 'B' canopy closure (31 to 50%) is set at 0.75. 'C' (51 to 70%) and 'D' (71 to 100) are set at 1.0 (Figure I-4).

I1.6.3.2 Conifer Percent in Canopy

Conifer tree percent composition is related to fisher suitability through a series of linear relationships over various ranges of the composition. From 0 to 40%, SI(2) increases from 0.0 to 0.2. Then from 40 to 50 % conifers the suitability increases from 0.2 to 0.75. It then increases to full suitability at 75% and remains optimum (1.0) at all higher values. Note that tamarack is not included in the conifer percentage (Figure I-4).

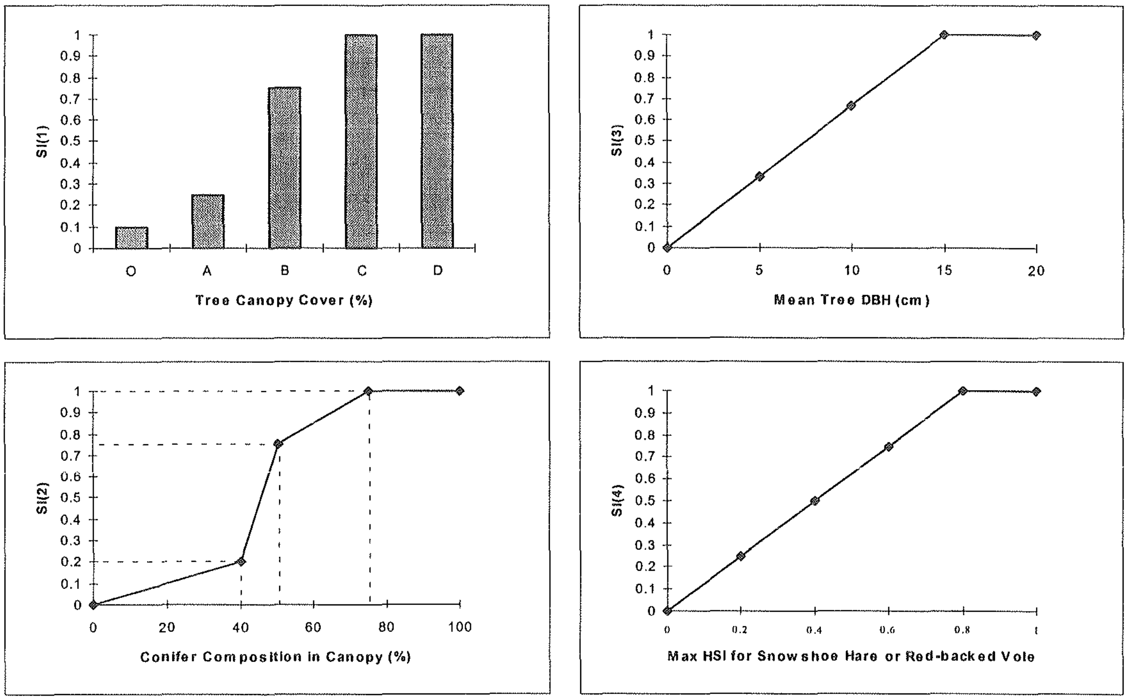
I1.6.3.3 Mean Tree DBH

Diameter at breast height is used to determine an index of stand maturity (SI(3)). Over the diameter range 0 to 15 cm, the suitability increases from 0 to 1. At all higher values, SI(3) remains optimum (Figure I-4).

I1.6.3.4 Prey HSI

The suitability index values of snowshoe hares and red backed voles are examined to determine this next variable. First, the highest of the two values is chosen. Then the suitability for fisher food (SI(4)) is set to increase from 0 at unsuitable prey HSI to optimum at all values greater than or equal to 0.8 (Figure I-4).

Figure I-4 Suitability index Values in Relation to Habitat Variables in the Fisher HSI Model



I1.6.3.5 Disturbance Coefficients

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. Major rivers are also included since winter traplines are often accessed via rivers. The zones of influence and the disturbance coefficients for fisher are listed in Table I-7. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table I-7 Zones of Influence and Disturbance Coefficients for Fishers

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads and Major Rivers[a]	500 m	0.5
Active Mine sites, gravel pits, dumps and plant facilities	100 m	0.75
Plant and Camp Site, Towns	500 m	0.5
Utility Corridors	500 m	0.5

(a) For this study, the Athabasca, Clearwater and Steepbank Rivers were included

I1.6.3.6 Equations

The fisher equation is split into a food and cover index. The food index is based simply on the Prey HSI component. The cover index is determined as the average of the conifer percentage index and the stand maturity index, multiplied by the canopy closure index. The food and cover indices are then averaged, and this is multiplied by the disturbance coefficient (DC).

$$\text{HSI Cover} = \text{SI}(1) \times [0.5 \times \text{SI}(2) + 0.5 \times \text{SI}(3)]$$

$$\text{HSI Food} = \text{SI}(4)$$

$$\text{HSI} = (0.5 \times \text{HSI Cover} + 0.5 \times \text{HSI Food}) \times \text{DC}$$

I1.6.4 Current Status on Model Validation

The fisher model was developed for the Alberta oil sands region based on literature reviews. The model was used to determine habitat association for fishers in the Shell Muskeg River Mine EIA (Golder 1998). An earlier version of the model was used in the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data. It was, however, reviewed by from Alberta Fish and Wildlife and thought to be an acceptable model. Winter track survey data collected in the Suncor Project Millenium local study area was positively (although not significantly) correlated to HSI values for the generalized vegetation types in which the tracks were located (see Appendix V). More data will be required to verify this model.

I1.7 GREAT GRAY OWL

I1.7.1 Introduction

The great gray owl model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. An interim version was used by Golder as part of the Shell Muskeg River Mine EIA (Golder 1998). Following that study, the spatial analysis of food and cover was refined to better select and weight the importance of high food habitat areas in determining the overall HSI. This model assesses great gray owl habitat by use of variables which relate to both food and cover requirements.

I1.7.2 Habitat Requirements

I1.7.2.1 Food

Great gray owls prey primarily on small rodents which inhabit forest clearings, grassy areas, open fens or other vegetation types with open canopies and few shrubs. They also hunt in wet peatlands (fens and bogs) where shrub cover is minimal. Favourite prey include red-backed voles, mice and lemmings, although prey use varies with abundance.

I1.7.2.2 Cover

Great gray owls prefer a diverse mix of peatland and mixedwood forest types near open feeding areas. They hunt from a perch, so trees must be present in the open area or on the edge. For nesting, great gray owls prefer high canopy closure near the nest site, but they will nest in areas with as little as 10 to 30 % closure in some cases.

I1.7.2.3 Nest Trees

These owls utilize pre-existing stick nests or broken topped trees. Stick nests are most often found high in the canopy in the crotch of a mature aspen or balsam poplar tree. Thus, great gray owls tend to nest in mature forests. Foraging habitat must be near the nest site to ensure food for owlets. The distance is usually within the range of 250 - 500 m from a forest clearing edge.

I1.7.3 Model Development

I1.7.3.1 Tree Canopy Closure Class

Tree canopy closure class has been set high to match the cover needs for nesting habitat. Open stands receive no suitability (SI(1)=0.0), 'A' crown closure stands (6 to 30 %) receive a 0.5 value, and all other stands (31 to 100 %) are rated as fully optimum (Figure I-5).

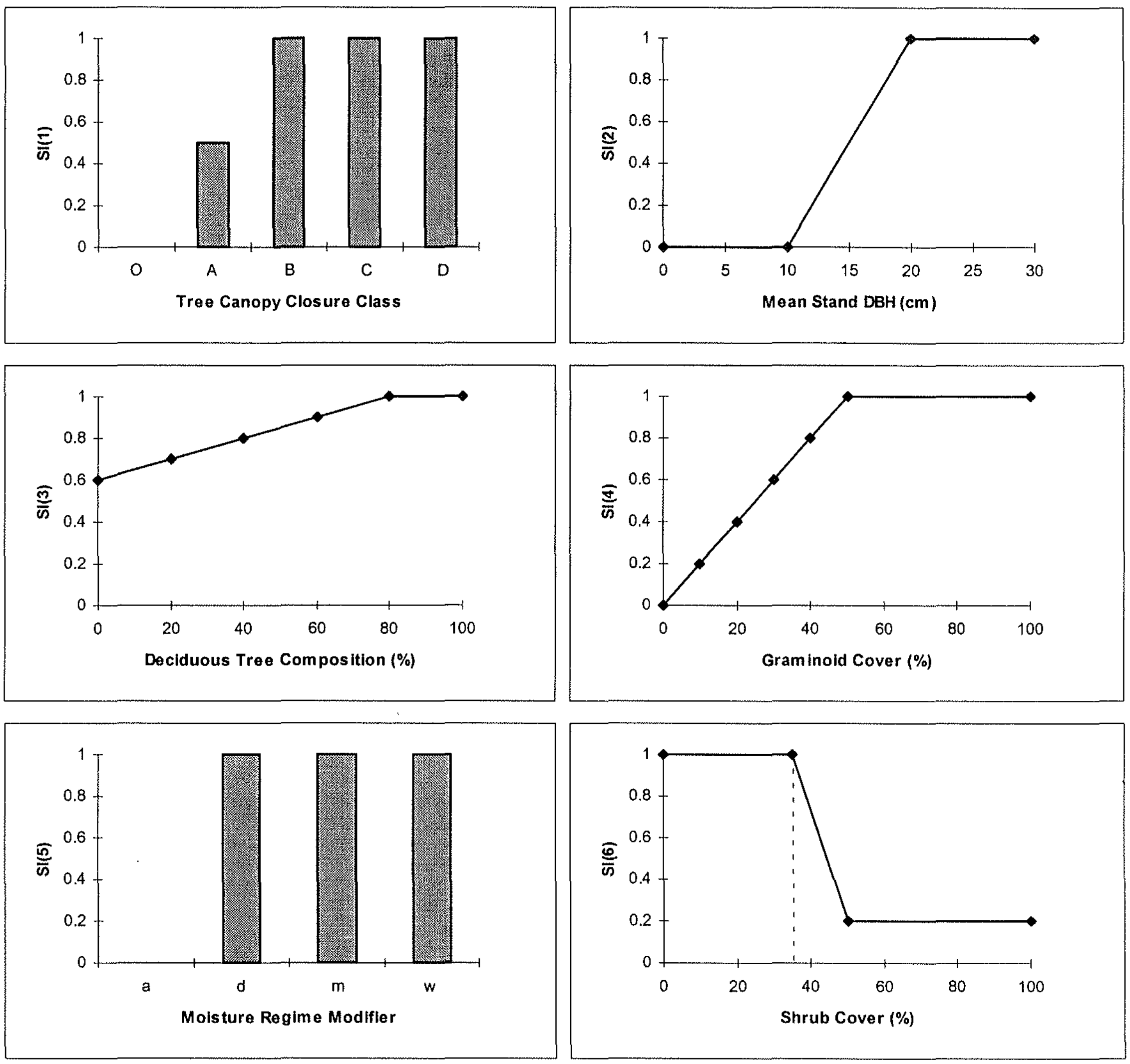
I1.7.3.2 Mean Stand DBH

Tree DBH is used as an index of stand maturity. Stands where the average DBH is < 10 cm are unsuitable (SI(2) = 0.0). Over the range 10 to 20 cm SI(2) increases from 0.0 to 1.0, and SI(2) remains optimum for all greater mean diameters (Figure I-5). This has been decreased from the original range of 15 - 25 cm, since the vegetation types in the RSA are determined by averaging stands, which results in no stand types being ≥ 25 cm.

I1.7.3.3 Percent Deciduous Trees

Deciduous tree composition is included to restrict high suitability great gray owl cover to pure deciduous or mixedwood forests. Suitability increases from 0.6 at 0% cover to 1.0 at 80 % cover. At greater than 80% deciduous the suitability index is optimum. (Figure I-5).

Figure I-5 Suitability Index Values in Relation to Habitat Variables in the Great Gray Owl HSI Model



I1.7.3.4 Graminoid Cover

Graminoid cover (that is grass, sedge, and rush cover) is used to determine foraging habitat, since this determines the amount of habitat which has no tree or shrub cover. Graminoid cover is also positively related to prey numbers. Where graminoid cover is greater than or equal to 50%, SI(4) = 1. At lower covers the value decreases until it is 0.0 at no cover (Figure I-5).

I1.7.3.5 Soil Moisture Class

Soil moisture class has been included in this model to indicate areas which are most likely to be used as foraging cover. Aquatic sites (a) are unsuitable since the water is standing at the surface and rodents will not be inhabiting these sites. These sites include most lakes, ponds and marshes. All other types, {wet (w), mesic (m) and dry (d)}are rated as fully optimum (Figure I-5).

I1.7.3.6 Shrub Cover

Shrub cover has been include to determine foraging habitat. Sites with up to 35% shrub cover are considered optimum, since ample sites exist for capture of prey. This index decreases to 0.2 over the range 30 to 50 % cover. Then, the suitability remains at 0.2 for all greater cover values (Figure I-5).

I1.7.3.7 Disturbance Coefficients

The disturbance coefficient (DC) is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The reductions in habitat suitability result from noise avoidance and increased mortality (vehicle collisions, power line electrocutions). However, great gray owls often benefit from human disturbances, due to increased feeding opportunity in cleared areas. The zones of influence and DC values for great gray owls reflect these competing effects (Table I-8).

Table I-8 Zones of Influence and Disturbance Coefficients for Great Gray Owls

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads	100 m	0.75
Active Mine sites, gravel pits, dumps and plant facilities	100 m	0.75
Plant and Camp Site, Towns	100 m	0.75
Utility Corridors	0 m	NA

I1.7.3.8 Cover and Food HSI Equations

The great gray owl model first determines independent cover and food HSI values. These are then combined in a spatial adjacency analysis between high food habitat and cover habitat. The cover index is determined as the mean of SI(1) and the-product of SI(2) and SI(3). The food habitat is determined similarly using the mean of SI(4) and the product of SI(5) and SI(6).

HSI Cover = 0.5 x SI(1) + 0.5 x SI(2) x SI(3)

HSI Food = 0.5 x SI(4) + 0.5 x SI(5) x SI(6)

I1.7.3.9 Spatial Analysis

All high food habitat areas (HSI Food ≥ 0.67) are selected for a spatial analysis. All habitat within 500 m of the initial high food areas have their food value increased to the high food value to reflect the availability of nearby food anywhere within a short flight for an owl. Likewise, the highest cover HSI value within 500 m of the high food area is assigned to the high food habitat.

I1.7.3.10 Overall HSI Equation

The great gray owl HSI is calculated using the weighted average of food and cover HSI. Food is the more important requirement for determining owl habitat, so this index is weighted at 0.7 and cover HSI is rated at 0.3. The disturbance coefficient is then multiplied by the weighted mean.

HSI Overall = {0.7 x HSI Food + 0.3 x HSI Cover} x DC

I1.7.4 Current Status on Model Validation

The great gray owl model was developed for the Alberta oil sands region based on literature reviews and has not been tested with independent data. Previous versions of the model applied as part of the Syncrude Aurora Mine EIA (Axys 1996) and the Muskeg River Mine EIA (Golder 1998) were not validated by population or habitat use data. It was, however, reviewed by Alberta Fish and Wildlife as part of the Syncrude Aurora Mine EIA and was thought to be an acceptable model. Too few great gray owl sightings were made during field work in the Suncor Project Millenium local study area, so the model could not be quantitatively tested with independent data. These sitings were within an area with moderate food and high cover ratings.

I1.8 MOOSE

I1.8.1 Introduction

This model is a primarily winter model of moose habitat and assesses only woody browse food sources, and winter cover habitat. The moose model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The model was first adapted for use in the Shell

Muskeg River Mine EIA, but did not perform as expected in the Regional Study Area (RSA). For this project, the RSA vegetation classification was more refined and the model was reworked to better reflect the available spatial and vegetation type specific data. The spatial analysis of adjacency between food and cover was also further developed to better match the relationship between good habitat and the required balance of food and cover.

I1.8.2 Habitat Requirements

I1.8.2.1 Food

Moose generally consume woody browse during the fall and winter seasons. Preferred browse include all willow species, red osier dogwood, several other deciduous species and subalpine/balsam fir (Axys 1996). Aspen, birch and balsam poplar are also highly utilized species. In spring and summer herbaceous plants, aquatic plants and browse (complete with leaves) are consumed, although browse still makes up the bulk of the diet.

I1.8.2.2 Cover

Cover provides protection from predators, insects and extreme weather, and is used during feeding, resting and movement activities. Often the same areas provide food and cover habitat. However, areas with high shrub cover and thus high food are often lacking in thermal and protective cover. Open areas with no shrubs or trees are generally avoided. In general an interspersion of cover types is considered the best moose habitat, since these areas provide food and cover areas that moose can easily travel between. Dense forest stands are preferred for winter cover as they provide ample shelter from wind-chill and tend to accumulate less snow.

I1.8.3 Model Development

I1.8.3.1 Cover of Preferred Browse Species

Preferred browse species were weighted and summed from shrub cover values in the habitat dataset. Species weighted by 1.0 include willow, aspen, balsam poplar, red osier dogwood and beaked hazelnut. Species weighted by 0.75 include saskatoon, pin and choke cherry, prickly rose, gooseberry and currant, and raspberry. Species weighted by 0.5 include buffaloberry, balsam fir, green and river alder, bracted honeysuckle, paper birch, jack pine, and dwarf and bog birch. White spruce and black spruce are weighted by 0.25. A sensitivity analysis conducted as part of the model evaluation was conducted to select a better value at which food habitat would become optimum, since the previous version used 50% and almost all habitats in the regional study area were too generalized to become anything but moderate at that percentage. This analysis showed that the amount of high habitat increased to expected values at around 40%, but that at lower values, the amount of high habitat increased beyond expectations. Thus, SI(1) was adapted to increase from 0.0 when there is no browse cover, to 1.0 at 40% or higher values (Figure I-6).

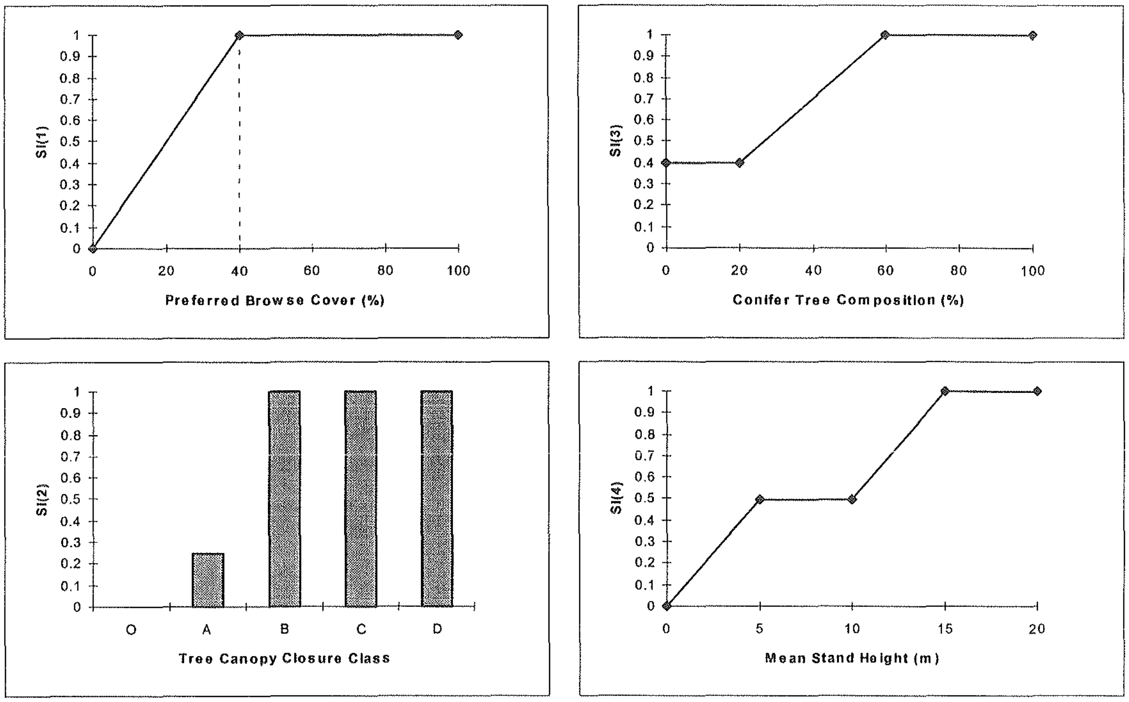
I1.8.3.2 Tree Canopy Closure Class

Tree canopy closure class was used to predict the availability of thermal and escape cover. Open stands (0 to 5%) are unsuitable, 'A' canopy closure stands (6 to 30%) are rated at 0.25, and 'B', 'C' and 'D' stands (31 to 100%) are rated 1.0 (Figure I-6).

I1.8.3.3 Percent Conifer Composition

Conifer trees provide superior protection against wind and provide greater visual cover than deciduous trees. However, pure deciduous stands will still be utilized by moose to a lesser degree. Thus, no conifer percentage up to 20% conifers results in SI(3) = 0.4. This increases to 1.0 at 60% conifers or higher (Figure I-6).

Figure I-6 Suitability Index Values in Relation to Habitat Variables inthe Moose HSI Model



I1.8.3.4 Mean Canopy Tree Height

Canopy height has been added as a variable to reduce cover suitability in regenerating forest stands and shrublands. From 0 to 5 m, SI(4) increases from 0.0 to 0.5. The suitability then remains at 0.5 until 10 m is reached. Then between 10 and 15 m the suitability increase to 1.0.

I1.8.3.5 Disturbance Coefficients

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipelines, utility corridors, and industrial developments. Major rivers are also included since these are used as hunting travel routes. The zones of influence and the disturbance coefficients for moose are listed in Table I-9, and were based on the reductions to habitat associated with noise, collisions, and hunting mortality.

Table I-9 Zones of Influence and Disturbance Coefficients for Moose

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads and Major Rivers[a]	1000 m	0.5
Active Mine sites, gravel pits, dumps and plant facilities	100 m	0.75
Plant and Camp Sites, Towns	500 m	0.5
Utility Corridors	500 m	0.5

[a] Major rivers for this study included the Athabasca, Steepbank, and Clearwater Rivers

I1.8.3.6 Food and Cover HSI Equations

The moose habitat model first determines cover and food HSI values. The food index is determined from SI(1):

HSI Food = SI(1);

whereas, the cover index is determined from the product of SI(2) and the mean of SI(3) and SI(4):

HSI Cover = SI(2) x [0.5 x SI(3) + 0.5 x SI(4)]

I1.8.3.7 Spatial Analysis of Food and Cover

All high food habitat areas (HSI Food = 0.67) are selected for a spatial analysis. All habitat within 250 m of the initial high food areas have their food value increased to the high food value. Likewise, the highest cover HSI value within 250 m of the high food area is assigned to the area initially with the high food habitat.

I1.8.3.8 Overall HSI Equation

The overall HSI equation is the mean of the food and cover after the spatial analysis is completed. This mean is then multiplied by the disturbance coefficient.

HSI = 0.5 x highest HSI Food + 0.5 x highest HSI Cover x DC

This was altered from a previous version in which the food habitat was weighted at 0.7 and cover at 0.3. This change was made since a number of habitat types had HSI food = 1, which would result in the habitat near those high food types being rated high (> 0.67) regardless of the cover habitat.

I1.8.3.9 Current Status on Model Validation

The moose model was developed for the Alberta oil sands region based on literature reviews and has been compared to moose habitat use within the Syncrude local study area and throughout the regional area (Axys 1996). The moose model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996) and was reviewed by Alberta Fish and Wildlife and was thought to be an acceptable model. The results for this model were at least partially empirically validated by Axys (1996). The model version used in the Shell Muskeg River Mine EIA was not independently tested or verified. For this study the moose model was not verified due to too few sightings in the Suncor Project Millenium Local Study Area. Those sightings which were made were located mainly in deciduous forests which have high food and moderate cover (see Appendix V).

I1.9 PILEATED WOODPECKER

I1.9.1 Introduction

The pileated woodpecker model was developed using two recently developed models as a basic guideline for development. The first was developed by Golder Associates (1997) for use in Central Saskatchewan. The second was developed by the Foothills Model Forest (1996) for west-central Alberta.

The pileated woodpecker is the largest North American woodpecker and is widely distributed across the boreal forest and other forest zones in North America. These year-round residents are notable for being tree cavity excavators and for their use of bark/wood dwelling insects as their primary food source. They are generally associated with mature forest types with high densities of large diameter snags and downed wood.

I1.9.2 Habitat Requirements

I1.9.2.1 Nesting and Roosting

Pileated woodpeckers require large diameter trees for nesting. In the boreal forest they prefer aspen or balsam poplar live trees, but are also known to excavate nests in dead snags and paper birch. Aspens appear to be preferred since these trees are susceptible to heartwood rot which is easier to excavate than solid wood. Nests are usually excavated high in the canopy on the main trunk of the tree. As well as nesting, several other large trees are utilized for roosting cavities which are used as rest stops during long foraging activities, as an alternative location for the mate not incubating the eggs or chicks, or during inclement weather. Roost trees are often previous years nests but also include large diameter snags of conifers or deciduous trees.

I1.9.2.2 Food

Pileated woodpeckers forage primarily on carpenter ants and wood boring beetle larvae, but will feed on nuts, berries and other insect prey opportunistically. Foraging substrate consists of large diameter downed logs, snags and insect infested live trees. During the winter, downed logs are usually unavailable for foraging due to snow and freezing temperatures. Usually mature forests are used for foraging since these have the highest number of large snags and logs, but older harvested forest areas may also be used due to the presence of rotten stumps and slash.

I1.9.2.3 Cover and Habitat Area

Cover resources are associated with both foraging and predator avoidance. Pileated woodpeckers usually prefer areas with high canopy closure or other concealment to protect them from their main predator: the goshawk. Closed canopied forests also tend to accumulate less snow and are thus more able to provide food in the winter. Pileated Woodpeckers are territorial and defend a year-round range with ample food, cover and nesting resources. Home range sizes vary among studies but are usually on the order of 250 to 500 hectares in the boreal forest.

I1.9.3 Model Development

I1.9.3.1 Tree Canopy Closure Class

Only forested habitats are suitable for pileated woodpecker year-round habitat. Thus, non-forested stands (class O: 0 to 5% canopy closure) are unsuitable. 'A' canopy closure stands (6 to 30%) are rated at 0.5, 'B' stands (31 to 50%) are rated at 0.8, and higher canopy closure stands (C and D: 51 to 100%) are fully optimum (SI(1) = 1.0); Figure I-7). This reflects the needs for high cover for food and concealment.

I1.9.3.2 Deciduous Tree Composition

Deciduous tree composition has been included to ensure that aspen or other preferred tree species are present in at least minimal amount to provide the nest tree. The optimum condition has been set to occur at 10% deciduous trees which is the minimum value for deciduous tree composition which appears in the Alberta Vegetation Inventory of forest areas (Figure I-7).

I1.9.3.3 Mean Stand Height

Mean stand height has been used in this model to determine conditions in which trees are tall enough for nesting and in which trees are of large enough size for providing roosting and nesting opportunities. Over the range 0 to 10 m height, SI(3) is 0.0. SI(3) increases from unsuitable (0.0) to optimum suitability (1.0) between 10 and 20 m height. The suitability remains at 1.0 for all higher heights (Figure I-7).

I1.9.3.4 Stand Age

Stand age is used as an indirect measure of snag and downed wood density. This was done since there were insufficient data on snag abundance in our inventories. Snag abundance and sufficient downed wood density is assumed to be unsuitable at 0 years post disturbance, and increase to optimum at 80 years post disturbance. Some concern has been expressed regarding the large influx of snags and downed wood immediately following disturbance by fire. However, this wood tends to remain hard and charcoal coated for many years and should not be available as insect substrate until the new forest reaches advanced ages. Note that this variable only applies to forested stands; for all other stands SI(4) = 0.

I1.9.3.5 Disturbance Coefficients

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for pileated woodpeckers are listed in Table I-10. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Figure I-7 Suitability Index Values in Relation to Habitat Variables in the Pileated Woodpecker HSI Model

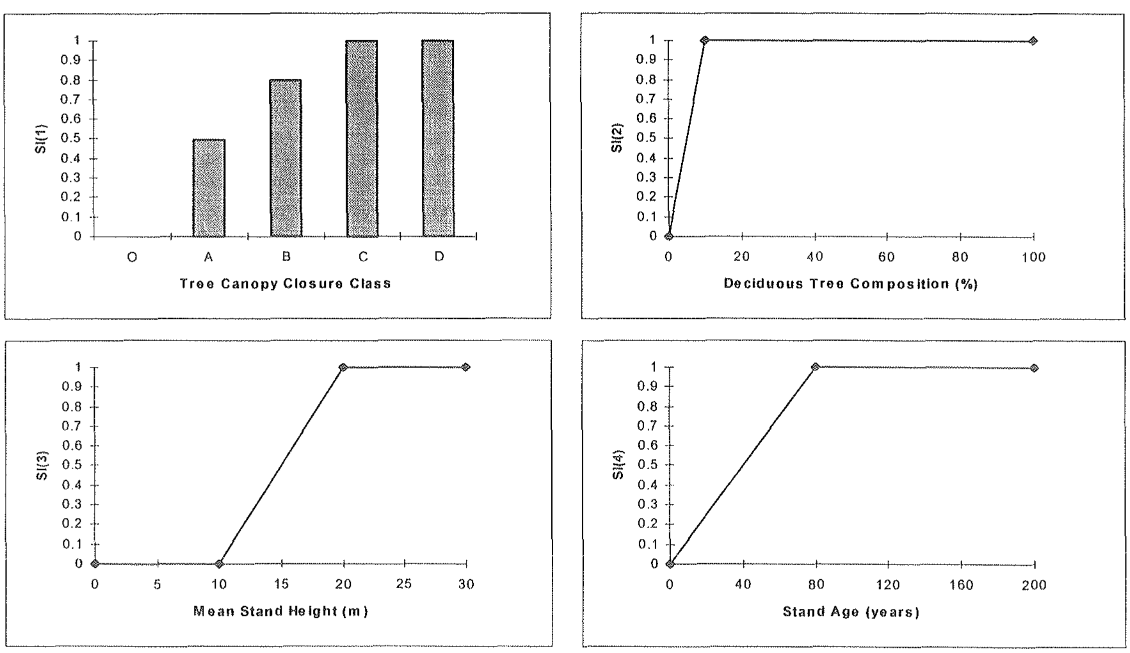


Table I-10 Zones of Influence and Disturbance Coefficients for Pileated Woodpeckers

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads	100 m	0.75
Active Mine sites, gravel pits, dumps and plant facilities	100 m	0.75
Plant and Camp Site, Towns	100 m	0.75
Utility Corridors	0 m	N/A

I1.9.3.6 Equation

The pileated woodpecker HSI considers that the canopy closure variable and the disturbance coefficient has the most influence on habitat utilization, so SI(1) and the coefficient is multiplied directly to the weighted mean of the other three indices. The weighting used rates SI(2) as twice as important as SI(3) and SI(4).

$$HSI = SI(1) \times [(SI(2) \times 0.5) + (SI(3) \times 0.25) + (SI(4) \times 0.25)] \times DC$$

I1.9.4 Current Status on Model Validation

The pileated woodpecker model has only been developed based on literature reviews and has not been tested with independent data. The model was previously used but not verified in the Muskeg River Mine EIA (Golder 1998). Pileated woodpecker location data, obtained during baseline wildlife studies for the Suncor Project Millenium EIA were used to test the performance of the model to predict habitat suitability. The results showed that the location of pileated woodpeckers were positively although not significantly correlated to the HSI value for general vegetation types (see Appendix V). Thus, there is a suggestion that the model is performing as expected, although more data will be required to make a conclusive statement.

I1.10 RED-BACKED VOLE

I1.10.1 Introduction

The red-backed vole model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses red-backed vole habitat by use of variables which relate to both food and cover requirements.

I1.10.2 Habitat Requirements

I1.10.2.1 Food

Red-backed voles are omnivorous and feed on herbaceous plants, twigs, berries, fungi, arthropods and other foods which are available in abundance. The relative use of herbaceous plants and fungi increases in summer. In winter, fruits, twigs and leaf litter may be consumed via subnivean access.

I1.10.2.2 Cover

In winter, cover is provided by snow, but the presence of downed wood or shrubs aids in maintaining subnivean corridors. In summer, downed wood, leaf litter and mature forest tree and shrub canopy closure provide protective cover.

I1.10.3 Model Development

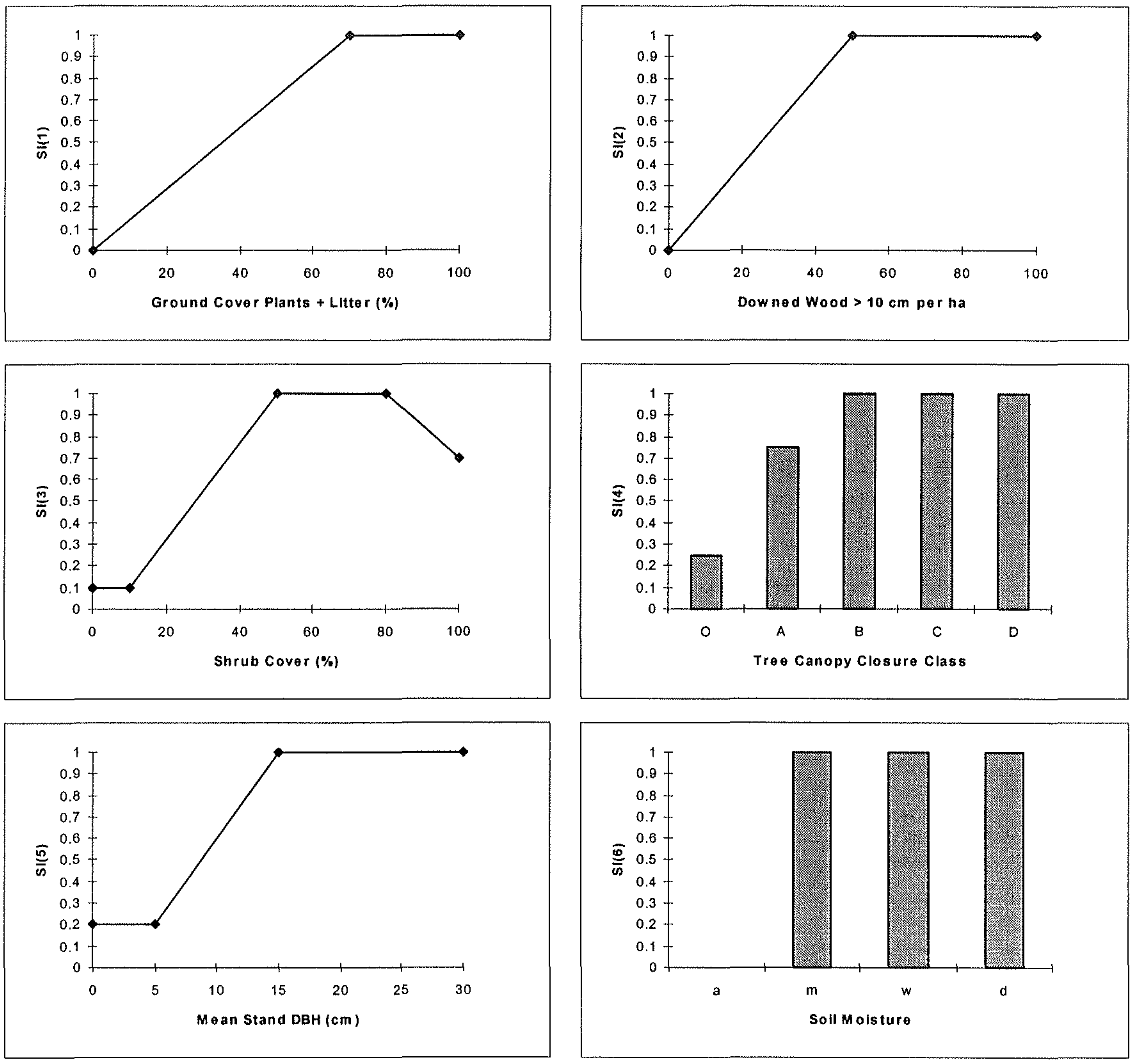
I1.10.3.1 Cover of Herbaceous Plants and Litter (%)

This variable is the sum of dwarf or prostrate shrubs, forbs, graminoids, and open leaf or needle litter. From 0 to 70% cover SI(1) increases from 0 to 1 and remains at 1 for higher covers (Figure I-8).

I1.10.3.2 Downed Wood Density (per ha)

Downed wood density refers to logs greater than 10 cm diameter. Over the range 0 to 50 logs per hectare, suitability increases from 0.0 to 1.0, and remains optimum at all higher densities (Figure I-8). This variable was decreased from 250 logs per ha owing to the low average downed log number available in the data.

Figure I-8 Suitability Index Values in Relation to Habitat Variables in the Red-backed Vole HSI Model



I1.10.3.3 Shrub Cover (%)

SI(3) is 0.1 between 0 and 10% shrub cover. This reflects the preference for shrubby areas, but the knowledge that red-backed voles occasionally inhabit open areas. It then increases to 1.0 at 50 % cover and remains optimum until 80%. Above 80% the shrub cover will inhibit herbaceous growth and thus reduce food suitability. Thus, SI(3) decreases slightly from 1.0 to 0.7 at 100% or higher cover (Figure I-8).

I1.10.3.4 Tree Canopy Closure Class

High tree canopy closures provide more optimal cover for red-backed voles. Thus, open stands are rated at 0.25, 'A' closure stands are rated 0.75, and B - D stands are rated 1.0. (Figure I-8).

I1.10.3.5 Mean Stand DBH

The final variable influencing habitat suitability for red-backed voles is mean DBH which is used as an indicator of stand maturity. Stands up to 5 cm of DBH receive an index value of 0.2. Over the range 5 to 15 cm DBH the suitability increases to 1.0, and this remains at 1.0 for all greater DBH values (Figure I-8).

I1.10.3.6 Soil Moisture

As a simple filter to limit ponds and marshes from being rated as suitable habitat, the model includes the soil moisture modifier, and sets dry, mesic and wetland stand types to 1.0 and aquatic types to 0.0. (Figure I-8).

I1.10.3.7 Equation

The red backed vole model does not include a disturbance coefficient. First the product of SI(1) and SI(2) is found, as is the produce of SI(4) and SI(5). The two products and SI(3) are then used in a weighted mean to determine the vole's HSI:

$$HSI = [0.3 \times SI(1) \times SI(2)] + [0.4 \times SI(3)] + [0.3 \times SI(4) \times SI(5)]$$

I1.10.4 Current Status on Model Validation

The red-backed vole model was developed for the Alberta oil sands region based on literature reviews and has not been tested with independent data. A previous version of the model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data. It was also not verified in the Muskeg River Mine EIA (Golder 1998). It was, however, reviewed by Alberta Fish and Wildlife as apart of the Aurora EIA (Axys 1996) and thought to be an acceptable model. The model was not verified in this study due to lack of data (see Appendix V).

I1.11 RUFFED GROUSE

I1.11.1 Introduction

The ruffed grouse model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses grouse habitat by use of variables which relate to both food and cover requirements. The main modification to the Axys (1996) model was the conversion of relationships from histograms to continuous curves over the range of the habitat variables. This resulted in a few changes to the values of the suitability indices over the ranges of the variables, but did not result in structural changes to the model or the equations.

I1.11.2 Habitat Requirements

I1.11.2.1 Food

Ruffed grouse are omnivores and feed on twigs, buds, herbaceous plants, berries, seeds and insects. Insects are especially important in the first two months of life. Fall foods consist of shrubs with berry fruit, twigs and buds. In winter, the buds of trembling aspen (and to a lesser extent, willow) are the main foods.

I1.11.2.2 Cover

Mixedwood and pure deciduous forest types are the most common habitats. Shrub densities are also influential on habitat cover, such that moderately dense stands are rated high, whereas overly dense stands are less suitable. Mature stands are preferred but not essential.

I1.11.3 Model Development

I1.11.3.1 Tree Canopy Closure Class

Open canopied stands receive a rating of only 0.1. This increases to 0.5 for 'A' closure stands, then 0.75, for 'B', and 1.0 for C and D stands (Figure I-9).

I1.11.3.2 Deciduous Composition (%)

Stands with 0 to 20% deciduous trees are rated at 0.2. This increases over the range 20 to 50% to 1.0. At higher cover the value remains at 1.0 (Figure I-9)

I1.11.3.3 Mean Stand DBH (cm)

DBH is used as an index of forest maturity. Stands with < 7.5 cm mean diameter are rated at 0.2. SI(3) increases to 1.0 at 15 cm DBH and remains at 1 for all greater values (Figure I-9).

I1.11.3.4 Shrub Cover (%)

Shrub cover generally increases habitat suitability, but at extremely high values, the stand becomes a dense thicket which is not preferred. Thus SI(4) increases from 0.1 at 0 to 10%, to 1.0 at 50%. It then remains at 1.0 until 80%, after which it decreases to 0.7 at 100% or higher (Figure I-9).

I1.11.3.5 Cover of Food Shrubs

Food shrubs include the sum of aspen (saplings), willow, raspberry, pin and choke cherry, saskatoon, blueberry, low bush cranberry, prickly rose, red osier dogwood, beaked hazelnut and buffaloberry. (SI(5) is never less than 0.2. Between 0 and 50 % cover SI(5) increases to 1. Then at all coverages greater than 50% the index value is 1.0 (Figure I-9).

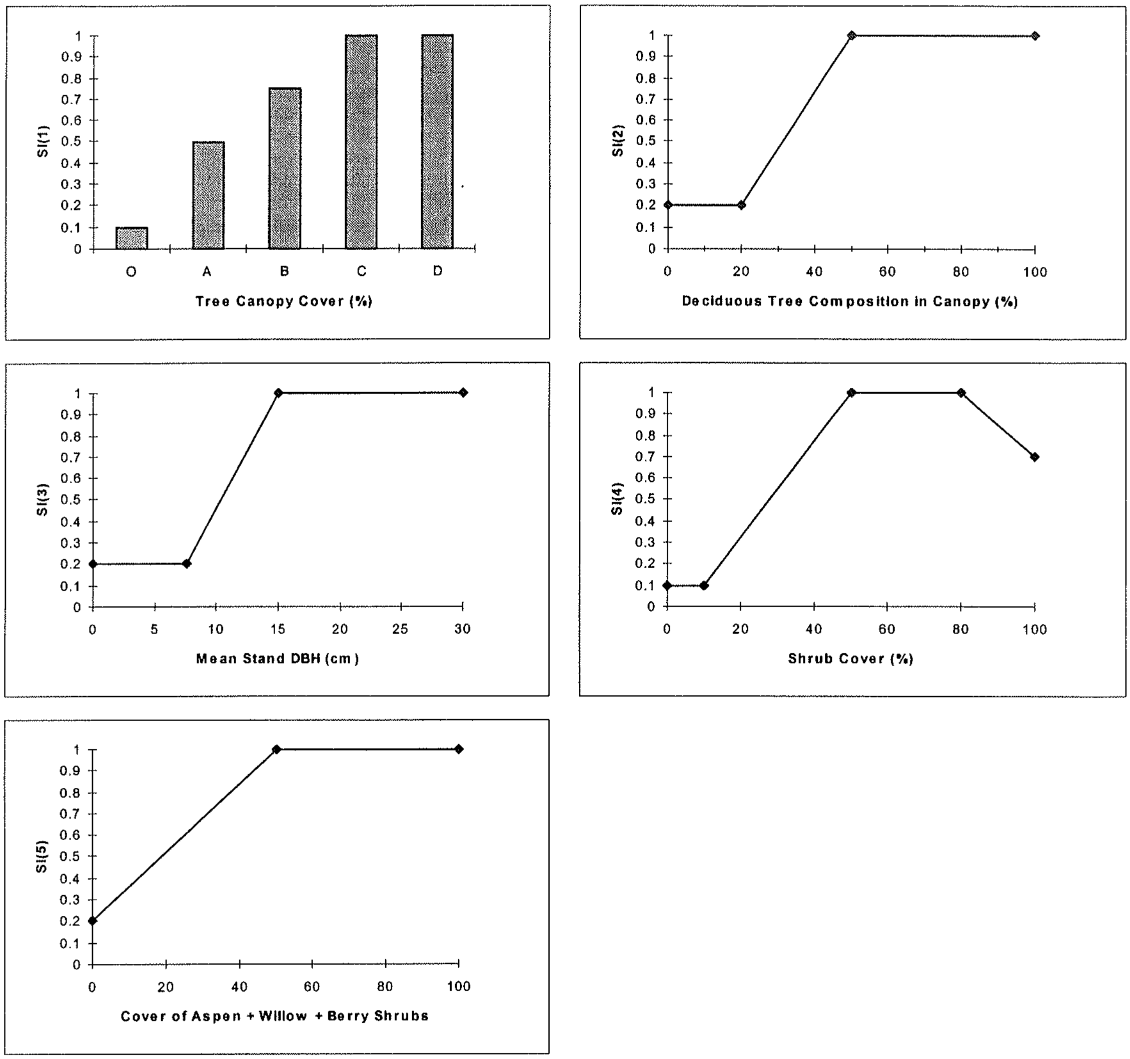
I1.11.3.6 Disturbance Coefficient

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for ruffed grouse are listed in Table I-11. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table I-11 Zones of Influence and Disturbance Coefficients for Ruffed Grouse

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads	250 m	0.5
Active Mine sites, gravel pits, dumps, plant facilities	100 m	0.75
Plant and Camp Site	100 m	0.5
Utility Corridors	100 m	0.5

Figure I-9 Suitability Index Values in Relation to Habitat Variables in the Ruffed Grouse HSI Model



I1.11.3.7 Equations

HSI Cover = SI(1) x {0.7 x SI(2) + 0.3 x SI(3)}

HSI Food = SI(4) x SI(5)

HSI Overall = (0.3 x HSI Food + 0.7 x HSI Cover) x DC

I1.11.4 Current Status on Model Validation

The ruffed grouse model was developed for the Alberta oil sands region based on literature reviews. A previous version of the model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996), but was not validated by population or habitat use data. It was, however, reviewed by Alberta Fish and Wildlife and is thought to be an acceptable model. This model has been applied in both the Shell Muskeg River Mine EIA and now the Suncor Project Millenium EIA. Baseline grouse locations were used in an attempt to verify the models performance in relation to predicted habitat associations. The testing indicated a positive but insignificant correlation between the two (see Appendix V). More data will be required to conclusively demonstrate model performance.

I1.12 SNOWSHOE HARE

I1.12.1 Introduction

The snowshoe hare model was adapted from one developed by Axys (1996) for the Syncrude/Suncor regional study area. The rationale for variable selection and model form will not be discussed except for changes to the model. This model assesses hare habitat by use of variables which relate to both food and cover requirements.

I1.12.2 Habitat Requirements

I1.12.2.1 Food

In winter, hares feed on woody plant buds and twigs, evergreen leaves and the bark of trees. Although many species will be eaten if necessary, they are generally considered survival foods for years with high snowfall. Survival foods include black spruce, Labrador tea and snowberry. Preferred species include willow, birch, alder, raspberry, blueberry and rose. Many other species will also be consumed. In summer, diet shifts to mainly forbs.

I1.12.2.2 Cover

Snowshoe hares are habitat generalists and make use of high cover forests and shrublands.

I1.12.3 Model Development

I1.12.3.1 Shrub Cover

Shrub cover from 0 to 50% increases habitat suitability from unsuitable (0.0) to optimum (1.0; Figure I-10).

I1.12.3.2 Tree Canopy Closure Class

Tree canopy closure also increases suitability, but the lack of trees is not considered unsuitable. Open stands (0 to 5% closure) are rated 0.4. 'A' closure stands (6 to 30%) are rated 0.6. B stands (31 to 50%) are rated 0.8, and C - D stands (51 to 100%) are fully optimum (Figure I-10).

I1.12.3.3 Food Cover (%)

Food cover is related to winter food species and is determined by summing species with the following weightings of shrub or tree sapling species (and trees combined):

Food Cover = beaked hazelnut + willow + aspen + balsam poplar + red-osier dogwood + paper birch + dwarf/bog birch + low bush cranberry + 0.75 x (prickly rose + raspberry + alder + saskatoon + buffaloberry + tamarack + pine + fir) + 0.25 x (white spruce + black spruce) + 0.1 x (tree cover).

Over the range 0 to 50% SI(3) increases from 0.4 to 1.0. Food is never rated less than 0.4 (Figure I-10).

I1.12.3.4 Disturbance Coefficients

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for snowshoe hare are listed in Table I-12. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Figure I-10 Suitability Index Values in Relation to Habitat Variables in the Snowshoe Hare HSI Model

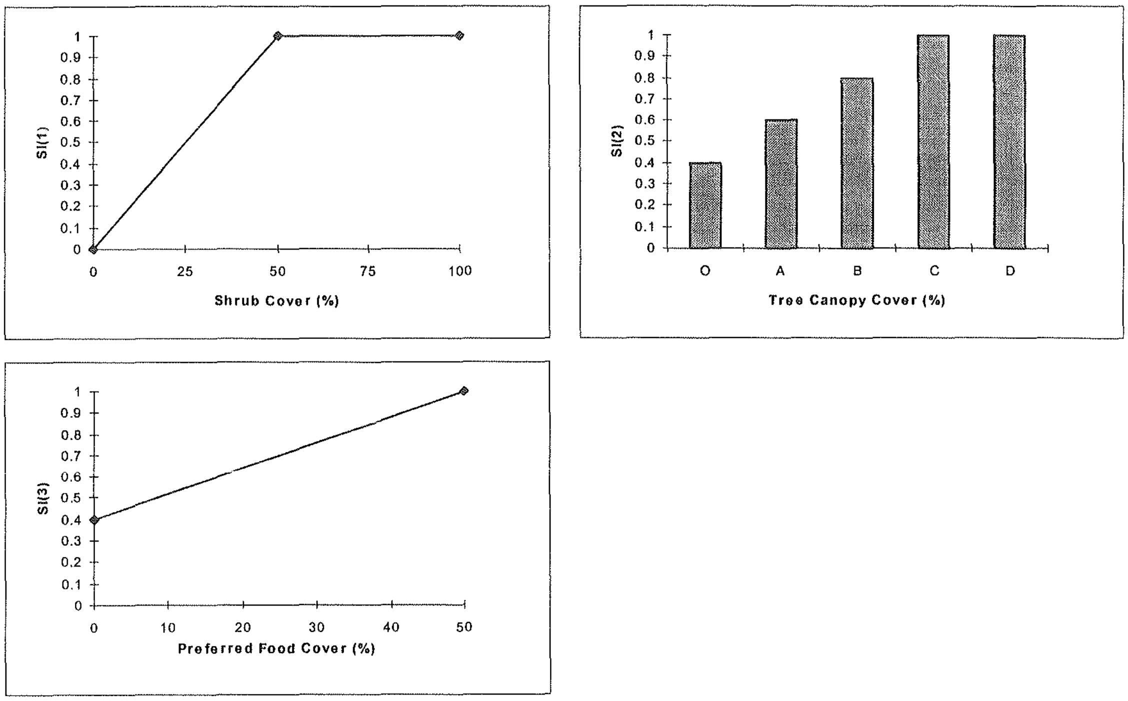


Table I-12 Zones of Influence and Disturbance Coefficients for Snowshoe Hare HSI

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads	500 m	0.5
Active Mine sites, gravel pits, dumps and plant facilities	100 m	0.75
Plant and Camp Site, Towns	500 m	0.75
Utility Corridors	500 m	0.75

I1.12.3.5 Equations

The snowshoe hare suitability indices are first combined to determine food and cover HSI. These are then averaged and multiplied by the disturbance coefficient to determine the overall HSI.

$$\text{HSI Cover} = 0.5 \times SI(1) + 0.5 \times SI(2)$$

$$\text{HSI Food} = SI(1) \times SI(3)$$

$$\text{HSI Overall} = (0.5 \times \text{HSI Cover} + 0.5 \times \text{HSI Food}) \times DC$$

I1.12.4 Current Status on Model Validation

The snowshoe hare model was developed for the Alberta oil sands region based on literature reviews and has been compared to snowshoe hare habitat use within the Syncrude local study area and throughout the regional area (Axys 1996). The snowshoe hare model was applied as part of the Syncrude Aurora Mine EIA (Axys 1996) and was reviewed by from Alberta Fish and Wildlife and thought to be an acceptable model. The results for this model were at least partially empirically validated as noted above, although no correlation was found between vegetation rating and observations made during this study (see Appendix V). This was not surprising, considering that the model predicts that most habitat types are high.

I1.13 WESTERN TANAGER

I1.13.1 Introduction

This model was first developed by Golder Associates for use in the Shell Muskeg River Mine EIA (Golder 1998). The western tanager is widely distributed but uncommon throughout most of northern Alberta. The western tanager prefers open forest mixedwood or pure conifer boreal forests (Peterson 1961), but is occasionally found in pure deciduous stands in Alberta (Semenchuk 1992). In the western National Parks western tanagers are generally found in montane pine or aspen forests (Holroyd and Van Tighem 1983). They nest high in the canopy of trees with near-horizontal branches, up to 15 m (Semenchuk 1992). They prefer upland rather than lowland habitat types.

I1.13.2 Habitat Requirements

I1.13.2.1 Food

The western tanager consumes both insects and berries (Peterson 1961, Semenchuk 1992). They usually feed in the higher portions of trees or among bushes, but will also catch insects aerially. Feeding opportunities are dependent on the number of fine branches available for insect habitat. Thus, shrubs and coniferous tree branches are preferred feeding sources and deciduous branches are less preferred. Berries are also a preferred food but are highly seasonal. However, habitats with high berry species cover may be important in habitat selection, since berries are a highly energetic food resource.

I1.13.2.2 Cover

Cover requirements include an open canopied forest area with tall trees for nesting and a high percentage of conifers for cover. However, tanagers will still occur in pure deciduous stands in low abundance, and only a few conifers are required in a stand to provide the needed thermal and concealment cover.

I1.13.3 Model Development

I1.13.3.1 Tree Canopy Closure

The tanager will most likely be found in open (A and B crown closure) stands of pure conifers or mixedwoods. Thus, we have rated A canopy closure stands (6 to 30%) as optimum (SI(1) = 1.0), B stands (31 to 50%) are rated at 0.9, C (51 to 85%) are set at 0.8, and D (86 to 100%) are set at 0.3 suitability. Open stands are also rated very low (0.1) due to lack of cover requirements (Figure I-11).

I1.13.3.2 Coniferous Tree Percentage in Canopy

Tanagers will occur in pure deciduous forests, so the minimum value of SI(2) has been set at 0.2, and this increases to 1 at 20% conifers (Figure I-11). At all higher values, SI(2) remains optimum (Figure I-11).

I1.13.3.3 Mean Canopy Tree Height

The tree height value has been used to allow for proper nesting height. Although 15 m is not required for nesting, at this tree height, nests at 10 or more metres will be possible, since the branch they use must also be large and stable (Figure I-11). Up to 10 metres in height, nesting opportunities are limited, and SI(3) increases slowly from unsuitable at 0 m height to 0.2 at 10 m height. Between 10 and 15 metres, the suitability increases to optimum, and remains at 1.0 for all taller heights (Figure I-11).

I1.13.3.4 Weighted Woody Cover

Insect food is generally abundant in most forest stands so SI(4) has been rated at a minimum of 0.5. As woody cover increases, the foraging opportunities also increases, since the tanager has more small branches available for concealment and insect capture. We have weighted cover by shrub, conifer and deciduous tree types at 1, 0.5 and 0.25 respectively. This was done because the architecture of shrubs generally provides the most feeding cover and also locations for insects to be found, this is followed by the multi-branched conifers and finally the sparsely branched deciduous trees. Thus:

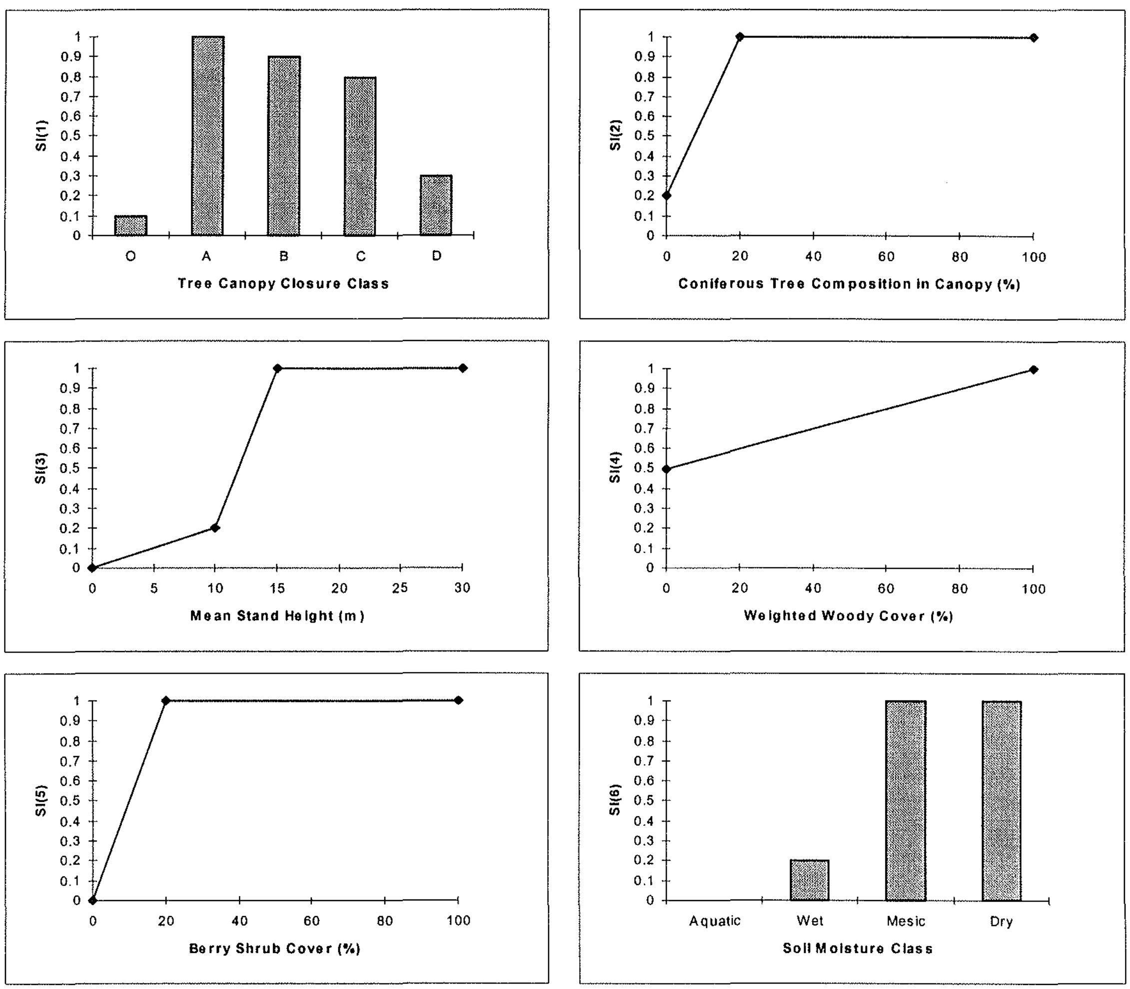
Weighted Woody Cover (%) = Shrub Cover + 0.25 x Deciduous Tree Cover + 0.5 x Coniferous Tree Cover

Between 0 and 100% weighted cover, the suitability increases from 0.5 to 1.0 (Figure I-11).

I1.13.3.5 Berry Shrub Cover

As berry shrub cover increases from 0 to 20%, the suitability increases from 0.0 to 1.0. Suitability remains at 1.0 for all higher values. Berry shrubs are determined by adding together the individual coverages of Saskatoon, pin and choke cherry, currant, gooseberry, rose, raspberry, buffaloberry, blueberry and low-bush cranberry (Figure I-11).

Figure I-11 Suitability Index Values in Relation to Habitat Variables in the Western Tanager HSI Model



I1.13.3.6 Soil Moisture Class

Finally the soil moisture class was included simply to restrict the best results to dry and mesic forest types rather than fens, bogs and treed swamps.

Aquatic sites (ponds, marshes) are set at 0.0. Peatland sites are set at 0.2. All other stand types are set at 1.0 (Figure I-11).

I1.13.3.7 Disturbance Coefficients

The disturbance coefficient is used to reduce habitat suitability in areas adjacent to human disturbances (within a zone of influence) including roads, towns, pipeline and utility corridors, and industrial developments. The zones of influence and the disturbance coefficients for western tanagers are listed in Table I-13. Where more than one zone of influence overlaps, the lowest disturbance coefficient will be applied.

Table I-13 Zones of Influence and Disturbance Coefficients for Western Tanagers

Disturbance Type	Zone of Influence	Disturbance Coefficient
Roads	100 m	0.75
Active Mine sites, gravel pits, dumps, plant facilities	100 m	0.75
Plant and Camp Site, Towns	100 m	0.75
Utility Corridors	0 m	N/A

I1.13.3.8 Equations

Western tanager cover HSI is determined from the product of the first three indices, since all are considered equally important in determining tanager cover habitat. The food HSI, however, is determined by an additive equation, since the two food sources are believed to be independent. Thus, the lack of insect food can be compensated by berry food and vice-versa.

$$\text{HSI Cover} = \text{SI}(1) \times \text{SI}(2) \times \text{SI}(3)$$

$$\text{HSI Food} = \min\,[1, \text{SI}(4) + \text{SI}(5)]$$

$$\text{HSI} = \text{HSI Cover} \times \text{HSI Food} \times \text{SI}(6) \times \text{DC}.$$

I1.13.4 Current Status on Model Validation

The western tanager model was developed based on literature reviews. It was first applied in the Muskeg River Mine EIA (Golder 1998) but was not independently verified. As part of this study, the HSI prediction for generalized vegetation types was compared with point count sitings (Appendix V). The results indicated that the two were positively and significantly correlated. Thus, the model passes a preliminary verification level, but caution is advised since the sample size was very low, and many more data will be required to come to a full conclusion on performance.

I2 BIODIVERSITY MODELS

I2.1 INTRODUCTION

There are four generally-accepted levels at which biodiversity may be examined: landscape, community, species and genetic. This model addresses wildlife species-level diversity and then links these values to vegetation 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.

I2.2 MODEL DEVELOPMENT

Wildlife diversity was first measured by species richness in vegetation types (Table I-14). Since not all species could be surveyed, a literature review combined with available data was used to assign species to general vegetation types in the oil sands region (Appendix IV). These values were then used to create a relative richness index which was the ratio of species richness in each vegetation type to the maximum species richness among all vegetation types. This created an index, similar to HSI values, which ranged from 0 to 1 (Table I-15).

The Richness Index (RI) values were then assigned to each vegetation type throughout the study areas, multiplied by the area in hectares and summed to determine richness habitat units. Other habitat types, such as, disturbed and reclaimed areas were assigned values based on professional judgement.

Table I-14 Number of Species per Broad Vegetation Type

Broad Vegetation Type	Mammal	Bird	Reptile and 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
Deciduous Forest	20	67	2
Graminoid/Shrubby Fen	16	70	4
Riparian	18	97	4
Marsh	10	78	4
Wooded Fen/Bog	28	112	4

Table I-15 Richness Index Values for General Vegetation Types

Broad Vegetation Type	Mammal	Bird	Reptile and Amphibian
Open Water	0.29	0.56	0.00
Jack Pine Forest	0.75	0.43	0.50
Mixedwood Forest	0.96	0.72	0.50
Black and White Spruce Forest	0.89	0.51	0.50
Deciduous Forest	0.71	0.60	0.50
Graminoid/Shrubby Fen	0.57	0.63	1.00
Riparian	0.64	0.87	1.00
Marsh	0.36	0.70	1.00
Wooded Fen/Bog	1.00	1.00	1.00

I3 LINKAGE ZONE MODEL

I3.1 INTRODUCTION

Cumulative effects of the Project on wildlife movement corridors were assessed by analyzing then potential for moose movement in relation to habitat and human disturbances. A quantitative procedure known as Linkage Zone Analysis was used for the assessment (e.g., Meitz 1994; Gibeau et al. 1996). Moose were selected for the analysis as this species is: 1) of high concern in the RSA; 2) wide-ranging and thus requires space for movements; and 3) sensitive to disturbance. It was considered that a regional corridor network designed for moose could benefit other wildlife KIRs.

Linkage zones (movement corridors) are combinations of landscape features that allow animals to move through and live in areas impacted by man (Gibeau et al. 1996). 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 a region. Soule (1991) points out that corridors must be designed on a species-specific basis. A detailed description of corridor planning is provided in Golder (1997a).

Understanding of movement corridor requirements is based on results of studies on higher profile wildlife species, such as grizzly bears. Core areas for grizzly bears were defined by Puchlerz and Servheen (1994) as areas that:

1. have no motorized use nor high intensity, non-motorized use of roads or trails during the non-denning period;
2. are a minimum of 500 m from any road or motorized trail;
3. are representative of important seasonal habitats; and
4. are in place for 10 years (the generation time of a female grizzly bear).

To our knowledge, only two CEA studies (Gibeau et al. 1996 and Apps 1997) have used these components to study grizzly bears in Canada. Recent work with linkage zone models has been done in the US by Meitz (1994) and Kehoe (1995). Methods from these sources were adapted to derive a moose linkage zone analysis for the RSA. This model was previously used in the Shell Muskeg River Mine CEA (Golder 1998).

13.2 MODEL DEVELOPMENT

This model attempts to identify those areas in which moose can freely move within the study areas. It is an additional understanding of species habitat quantity after performing HSI analysis which demonstrates habitat quality. Thus, each scenario analyzed demonstrates two areas:

1. Linkage Areas which allow free movement among habitats (which may be low, medium, or high).
2. Fracture Zones which act as barriers to moose movement due to roads, towns, or industrial developments.

The following mapped land features at different development scenarios and associated zones of influence were used within a vector-based GIS model to define areas likely to act as barriers to moose movement:

- Large Areas (> 100 contiguous hectares) of Unsuitable Habitat (determined from the Moose HSI Model)

Large areas of habitat (low, medium or high) were considered necessary for moose to inhabit an area. Areas with suitability > 0 were considered linkage zones, and areas > 100 ha in size with HSI = 0 were fracture zones. Developments included:

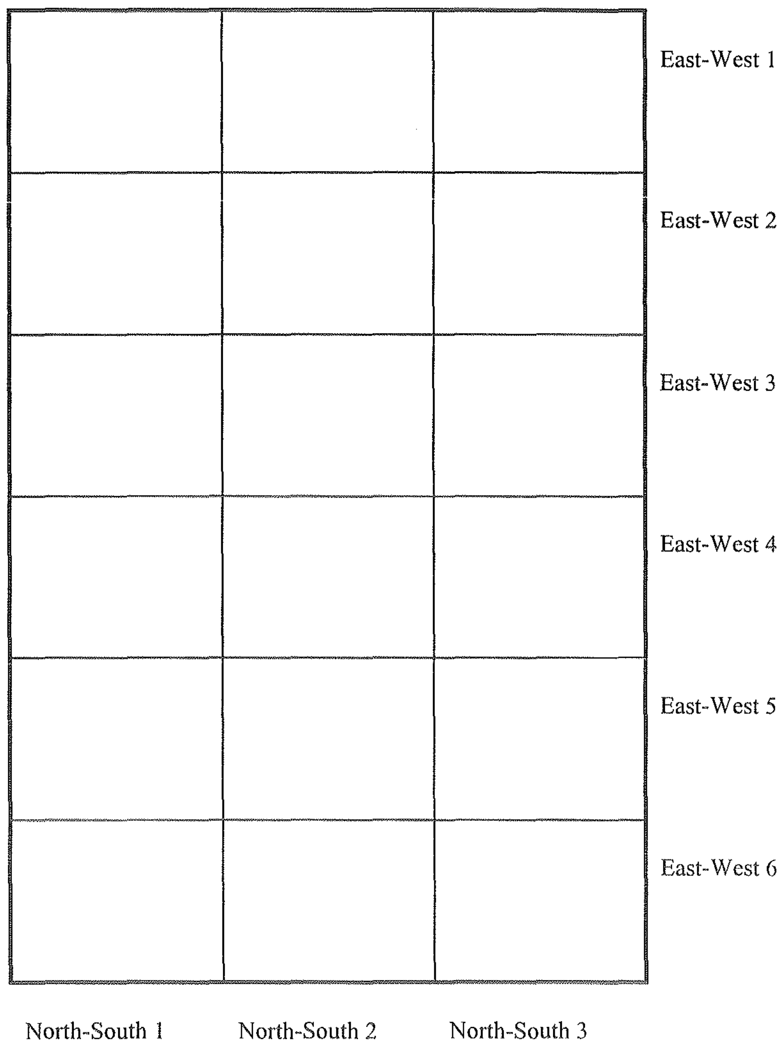
- Urban Developments
- Heavy Use Roads (highways and heavy truck roads) - for this project, this will be defined as the main highway, from furthest south extent to the furthest active northern mine.
- Industrial Development Areas

All of the above developments were assumed to have an associated disturbance zone of influence of 500 metres from their outside peripheries. All areas within the disturbance area or zone of influence were considered fracture zones. All other areas were linkage zones. Note that this method does not consider that minor linear disturbances (utility corridors and pipelines) or that minor area based disturbances (well sites, clear-cuts) are fracture areas.

Fracture zones from the two methods were then combined and the remaining area was the linkage zone.

Moose linkage and fracture zone impacts due to cumulative effects were analysed for the entire RSA by determining the percentage of the RSA fractured under each regional impact scenario. Then, the specific amounts of linkage habitat for moose within corridors in an east-west direction and a north-south direction were analysed. This was accomplished by dividing the RSA into a grid as shown in Figure I-12. The analysis was thus restricted to 6 blocks in an east-west direction and 3 blocks in a north-south direction, so that each comparison would be based on the same linear movement distance. Thus, the analysis subdivides the RSA into large potential movement corridors and details whether there are any significant concerns in those zones.

Figure I-12 Linkage Zone Model Analysis Template



APPENDIX II

LOCAL DATA

II1 HABITAT ATTIBUTES USED FOR HSI MODELLING IN THE LOCAL STUDY AREA

Attribute Code	Description
Pj	Jack Pine Tree Cover %
Sw	White Spruce Tree Cover %
Sb	Black Spruce Tree Cover %
Fb	Balsam Fir Tree Cover %
Lt	Tamarack Tree Cover %
Aw	Aspen Tree Cover %
Pb	Balsam Poplar Tree Cover %
Bw	Paper Birch Tree Cover %
Conifer	Conifer Tree Cover % (excluding Tamarack)
Deciduous	Deciduous Tree Cover %
Tree	Total Tree Cover % (Including Tamarack)
pine	Jack Pine Shrub Cover %
wspruce	White Spruce Shrub Cover %
bspruce	Black Spruce Shrub Cover %
fir	Balsam Fir Shrub Cover %
tamarack	Tamarack Shrub Cover %
aspen	Aspen Shrub Cover %
bpoplar	Balsam Poplar Shrub Cover %
pbirch	Paper Birch Shrub Cover %
alder	Green + River Alder Cover %
sask	Saskatoon Cover %
dbirch	Dwarf + Bog Birch Cover %
lleaf	Leatherleaf Cover %
dogwood	Red-osier Dogwood Cover %
hazel	Hazelnut Cover %
ltea	Northern + Labrador Tea Cover %
hsuckle	Bracted + Twining Honeysuckle Cover %
cherry	Pin + Chokecherry Cover %
currant	Currant + Gooseberry Cover %
rose	Prickly + Wild Rose Cover %
rberry	Raspberry Cover %
willow	Willow Cover %
bfberry	Buffaloberry Cover %
sberry	Snowberry Cover %
blberry	Blueberry Cover %

Attribute Code	Description
lbcberry	Low Bush Cranberry Cover %
buckthorn	Buckthorn Cover %
cinquefoil	Shrubby Cinquefoil Cover %
gale	Gale Cover %
laurel	Laurel Cover %
rosemary	Rosemary Cover %
sage	Sagebrush Cover %
sconif	Conifer Shrub Cover %
sdecid	Decidous Shrub Cover %
shrub	Total Shrub Cover %
dwshrub	Dwarf Shrub Cover %
forb	Broadleaf Herb Cover %
gram	Graminoid Cover %
moss	Moss Cover %
lich	Lichen Cover %
wood	Down Logs > 10 cm diameter (ha^{-1})
litter	Litter Cover %
Height	Mean Canopy Tree Height (m)
Age	Stand Age (y)
DBH	Diameter at Breast Height (cm)
PJP	Jack Pine Percent Composition
SWP	White Spruce Percent Composition
SBP	Black Spruce Percent Composition
FBP	Balsam Fir Percent Composition
LTP	Tamarack Percent Composition
AWP	Aspen Percent Composition
PBP	Balsam Poplar Percent Composition
BWP	Paper Birch Percent Composition
CONP	Conifer Tree Percent Composition
DECP	Deciduous Tree Percent Composition
TOTP	Total Tree Percent Composition
Moisture	Moisture Modifier Code
CanClos	Canopy Closure Class Code
DomTree	Dominant Tree Species Code

Phase	Description	Pj	Sw	Sb	Fb	Lt	Aw	Pb	Bw	Con-Ifer	Decid.	Tree	Pine	Wspr-uce
a1	Lichen Pj	27.79	0.63	0.15	0.00	0.00	0.56	0.00	0.00	28.56	0.56	29.12	1.50	0.66
AIG	Gravel Pits	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIH	Roads and Rights of Ways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
b1	Blueberry Pj-Aw	25.00	0.92	0.00	0.00	0.00	22.42	0.00	2.08	25.92	24.50	50.42	0.00	1.75
b2	Blueberry Aw(Bw)	0.00	1.00	0.00	0.00	0.00	18.50	0.00	37.00	1.00	55.50	56.50	0.00	0.00
b3	Blueberry Aw-Sw	3.50	18.33	0.42	0.00	0.00	22.83	0.00	1.17	22.25	24.00	46.25	0.00	4.92
b4	Blueberry Sw-Pj	21.38	23.13	0.00	0.00	0.00	3.50	0.00	2.13	44.50	5.63	50.13	0.00	8.16
BFNN	Wooded bog (tree Cover % >70%)	0.02	3.56	10.73	0.02	0.53	0.01	0.01	0.12	14.33	0.14	14.99	0.00	0.07
BTNN	Wooded bog (tree Cover % <70%)	0.29	5.15	16.11	0.02	1.27	0.23	0.02	0.16	21.58	0.41	23.26	0.00	0.16
c1	Labrador Tea - mesic Pj-Sb	31.00	0.00	9.75	0.00	0.00	0.00	0.00	0.00	40.75	0.00	40.75	0.00	1.25
CIP	Revegetated Industrial Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CIW	Well Sites - vegetated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
d1	Low-bush Cranberry Aw	0.27	3.11	0.13	0.00	0.09	46.06	2.96	1.76	3.51	50.79	54.39	0.08	1.00
d2	Low-bush Cranberry Aw-Sw	0.00	25.09	2.58	1.50	0.00	24.67	1.71	2.13	29.17	28.52	57.69	0.00	1.75
d3	Low-bush Cranberry Sw	2.71	39.71	0.00	3.00	0.42	1.08	0.92	1.13	45.42	3.13	48.96	0.00	0.08
e1	Dogwood Pb-Aw	0.00	1.00	0.00	0.00	0.00	30.00	22.00	2.00	1.00	54.00	55.00	0.00	0.00
e2	Dogwood Pb-Sw	0.00	26.00	0.00	2.00	0.00	15.00	8.00	5.00	28.00	28.00	56.00	0.00	0.00
e3	Dogwood Sw	0.00	48.00	0.00	6.50	0.00	1.00	1.00	1.00	54.50	3.00	57.50	0.00	0.00
FFNN	Wooded Fen (tree Cover % >70%)	5.00	0.48	62.00	0.00	12.49	0.96	0.00	0.00	67.48	0.96	80.93	0.00	0.19
FONG	Graminoid Fen	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00
FONS	Shrubby Fen	0.12	1.94	0.59	0.10	1.47	5.60	0.39	0.30	2.75	6.28	10.51	0.01	0.22
FTNN	Wooded Fen (tree Cover % <70%)	0.72	4.11	18.40	0.04	12.08	0.77	0.06	0.16	23.27	0.98	36.33	0.00	0.56
g1	Labrador Tea - subhygric Sb-Pj	7.25	0.00	20.50	0.00	1.25	0.00	0.00	0.00	27.75	0.00	29.00	0.00	0.00
h1	Labrador Tea/Horsetail Sw-Sb	0.00	34.00	13.00	0.00	0.00	0.00	0.00	1.00	47.00	1.00	48.00	0.00	0.00
HG/CC	Herbacious Graminoid Cutblock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	7.00
MONG	Graminoid Marsh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MONS	Shrubby Marsh	0.00	1.00	0.00	0.00	2.00	0.00	2.00	1.00	1.00	3.00	6.00	0.00	0.00
NMC	Cutbanks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NMS	Sand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWF	Flooded Area	0.00	0.20	0.00	0.00	0.40	0.00	0.80	0.40	0.20	1.20	1.80	0.00	0.00
NWL	Lake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWR	River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb/Lt	Black Spruce - Tamarack	2.14	0.36	18.07	0.00	8.00	0.71	0.00	0.00	20.57	0.71	29.29	0.00	1.44
SFNN	Swamp (tree Cover % >70%)	5.00	6.00	54.00	0.00	15.00	0.71	0.00	0.00	65.00	0.71	80.71	0.00	1.44
Shrub	Shrubland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00
SONS	Swamp (deciduous shrub)	0.00	0.00	0.00	0.00	0.00	0.00	2.00	1.00	0.00	3.00	3.00	0.00	0.00
STNN	Swamp (tree Cover % < 70%)	2.50	3.00	27.00	0.00	7.50	0.36	0.00	0.00	32.50	0.36	40.36	0.00	1.44
WONN	Shallow open water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC-Old	Regrown Cutblocks at Closure	3.00	5.00	1.00	0.00	0.00	5.00	1.00	0.00	9.00	6.00	15.00	1.00	10.00

Phase	Description	Bspr-uce	Fir	Tamarack	Aspen	Bpop-lar	Pbirch	Alder	Sask	Dbirch	Lleaf	Dog-Wood	Hazel
a1	Lichen Pj	0.21	0.00	0.00	0.66	0.15	0.00	2.73	0.31	0.04	0.00	0.00	0.00
AIG	Gravel Pits	0.00	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIH	Roads and Rights of Ways	1.00	0.00	0.00	1.50	0.50	0.00	2.00	0.00	0.00	0.00	0.00	0.00
b1	Blueberry Pj-Aw	0.00	0.00	0.00	1.87	0.00	0.00	8.17	3.72	0.00	0.00	0.00	0.25
b2	Blueberry Aw(Bw)	0.00	0.00	0.00	1.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00	0.00
b3	Blueberry Aw-Sw	0.00	0.00	0.00	1.50	0.17	0.00	2.84	0.00	0.33	0.46	0.75	0.00
b4	Blueberry Sw-Pj	0.00	0.00	0.00	1.50	0.00	0.25	5.75	2.50	0.25	0.00	0.00	0.00
BFNN	Wooded bog (tree Cover % >70%)	5.94	0.02	1.38	0.21	0.06	0.16	2.09	0.02	8.30	0.15	0.26	0.05
BTNN	Wooded bog (tree Cover % <70%)	10.10	0.02	1.38	0.06	0.00	0.04	2.00	0.05	2.76	0.53	0.03	0.07
c1	Labrador Tea - mesic Pj-Sb	3.00	0.00	0.00	0.25	0.00	1.00	1.50	0.00	0.00	0.00	0.00	0.00
CIP	Revegetated Industrial Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CIW	Well Sites - vegetated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
d1	Low-bush Cranberry Aw	0.07	0.00	0.20	4.11	0.51	0.96	5.18	6.15	0.18	0.00	0.40	1.59
d2	Low-bush Cranberry Aw-Sw	0.03	1.50	0.03	4.13	0.00	0.51	3.37	1.36	1.00	0.00	0.51	0.50
d3	Low-bush Cranberry Sw	0.00	3.00	0.00	0.29	0.04	0.21	3.25	0.00	0.00	0.00	1.15	0.21
e1	Dogwood Pb-Aw	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00	0.00	11.00	0.00
e2	Dogwood Pb-Sw	0.00	0.00	0.00	0.00	1.00	0.00	2.00	0.00	0.00	0.00	12.00	0.00
e3	Dogwood Sw	0.00	4.00	0.00	0.00	0.00	0.00	5.00	1.50	0.00	0.00	6.50	0.00
FFNN	Wooded Fen (tree Cover % >70%)	11.02	0.00	5.40	0.00	0.00	0.00	0.12	0.29	31.06	0.08	0.00	0.00
FONG	Graminoid Fen	0.00	0.00	0.13	0.00	0.00	0.25	0.08	0.00	1.08	0.00	0.00	0.00
FONS	Shrubby Fen	0.42	0.10	1.94	0.90	0.17	0.40	3.28	0.78	15.34	0.04	0.54	0.20
FTNN	Wooded Fen (tree Cover % <70%)	7.45	0.01	5.19	0.07	0.01	0.06	1.18	0.32	16.50	0.35	0.06	0.03
g1	Labrador Tea - subhygric Sb-Pj	15.25	0.00	2.50	0.03	0.00	0.00	0.00	0.00	1.75	0.50	0.00	0.00
h1	Labrador Tea/Horsetail Sw-Sb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HG/CC	Herbacious Graminoid Cutblock	1.00	0.00	0.00	10.00	2.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
MONG	Graminoid Marsh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MONS	Shrubby Marsh	0.00	0.00	1.00	0.00	5.00	4.00	8.00	0.00	4.00	0.00	2.00	0.00
NMC	Cutbanks	0.00	0.00	0.00	1.50	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00
NMS	Sand	0.00	0.00	0.00	1.50	0.50	0.00	0.00	0.00	0.50	0.00	0.00	0.00
NWF	Flooded Area	0.20	0.00	0.20	0.60	2.00	1.60	1.60	0.00	2.80	1.00	0.40	0.00
NWL	Lake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWR	River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb/Lt	Black Spruce - Tamarack	12.31	0.00	5.71	0.00	0.00	0.00	0.86	2.14	12.81	0.06	0.00	0.00
SFNN	Swamp (tree Cover % >70%)	12.31	0.00	5.71	0.00	0.00	0.00	0.86	2.14	12.81	0.50	0.00	0.00
Shrub	Shrubland	2.00	0.00	0.00	4.00	1.00	1.00	5.00	1.00	1.00	0.00	2.00	0.00
SONS	Swamp (deciduous shrub)	1.00	0.00	0.00	3.00	5.00	4.00	0.00	0.00	10.00	5.00	0.00	0.00
STNN	Swamp (tree Cover % < 70%)	12.31	0.00	5.71	0.00	0.00	0.00	0.86	2.14	12.81	0.50	0.00	0.00
WONN	Shallow open water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC-OLD	Regrown Cutblocks at Closure	3.00	1.00	0.00	5.00	1.00	0.00	3.00	1.00	1.00	0.00	1.00	0.00

Phase	Description	Ltea	Hsuckle	Cherry	Currant	Rose	Rberry	Willow	Bfberry	Sberry	Blberry	Lbc-Berry
a1	Lichen Pj	1.55	0.00	0.49	0.00	2.38	0.00	0.39	2.13	0.15	9.06	0.46
AIG	Gravel Pits	0.00	0.00	0.00	0.00	3.00	0.00	2.00	0.00	0.00	0.00	0.00
AIH	Roads and Rights of Ways	0.00	0.00	0.00	0.00	3.00	0.00	4.00	0.00	0.00	0.00	0.00
b1	Blueberry Pj-Aw	4.83	0.17	1.50	0.00	7.23	0.25	0.42	3.65	0.00	8.93	0.25
b2	Blueberry Aw(Bw)	4.50	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	4.50	0.00
b3	Blueberry Aw-Sw	13.09	0.00	0.00	0.00	11.12	0.00	0.82	1.08	0.00	13.42	0.00
b4	Blueberry Sw-Pj	13.18	0.00	0.00	2.50	4.61	0.00	0.88	8.75	0.00	8.89	0.00
BFNN	Wooded bog (tree Cover % >70%)	30.80	0.14	0.01	0.17	0.67	0.00	17.67	0.15	0.03	0.04	0.07
BTNN	Wooded bog (tree Cover % <70%)	48.66	0.01	0.01	0.05	0.77	0.00	4.13	0.07	0.04	0.14	0.12
c1	Labrador Tea - mesic Pj-Sb	20.73	0.00	0.00	0.00	0.00	0.00	0.00	1.75	0.00	10.50	0.00
CIP	Revegetated Industrial Lands	0.00	0.00	0.00	0.00	3.00	0.00	2.00	0.00	0.00	0.00	0.00
CIW	Well Sites - vegetated	0.00	0.00	0.00	0.00	3.00	0.00	2.00	0.00	0.00	0.00	0.00
d1	Low-bush Cranberry Aw	0.89	0.16	0.29	0.32	17.50	0.88	7.21	6.57	1.19	1.07	8.32
d2	Low-bush Cranberry Aw-Sw	2.71	0.05	0.07	0.21	11.46	0.08	3.53	3.14	0.45	0.15	8.97
d3	Low-bush Cranberry Sw	7.71	0.02	0.00	0.65	8.94	0.00	0.63	1.90	0.66	0.73	7.47
e1	Dogwood Pb-Aw	0.00	8.00	0.00	3.00	14.00	2.00	4.00	0.00	0.00	0.00	9.00
e2	Dogwood Pb-Sw	0.00	7.00	0.00	3.00	8.00	1.00	0.00	0.00	0.00	0.00	8.00
e3	Dogwood Sw	0.00	2.50	0.00	2.00	5.50	1.00	0.00	0.00	0.00	0.00	4.00
FFNN	Wooded Fen (tree Cover % >70%)	19.22	0.00	0.00	0.00	0.28	0.00	4.21	0.10	0.00	1.04	0.00
FONG	Graminoid Fen	0.13	0.00	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.00	0.00
FONS	Shrubby Fen	1.77	0.27	0.03	0.32	2.77	0.10	30.74	1.10	0.17	0.17	1.26
FTNN	Wooded Fen (tree Cover % <70%)	26.78	0.03	0.01	0.06	0.51	0.00	7.32	0.16	0.02	0.05	0.13
g1	Labrador Tea - subhygric Sb-Pj	45.00	0.00	0.00	0.00	1.00	0.00	4.43	0.00	0.00	7.73	0.00
h1	Labrador Tea/Horsetail Sw-Sb	14.00	0.00	0.00	0.00	4.00	0.00	5.00	0.00	0.00	0.00	0.00
HG/CC	Herbacious Graminoid Cutblock	2.00	0.00	0.00	0.00	5.00	0.00	3.00	0.00	0.00	0.00	0.00
MONG	Graminoid Marsh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MONS	Shrubby Marsh	0.00	0.00	0.00	0.00	0.00	0.00	45.00	0.00	0.00	0.00	0.00
NMC	Cutbanks	0.00	0.00	0.00	0.00	2.00	0.00	3.00	0.00	0.00	0.00	0.00
NMS	Sand	0.00	0.00	0.00	0.00	2.00	0.00	3.00	0.00	0.00	0.00	0.00
NWF	Flooded Area	0.00	0.00	0.00	0.20	0.20	0.00	19.00	0.00	0.00	0.00	0.00
NWL	Lake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWR	River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb/Lt	Black Spruce - Tamarack	26.81	0.00	0.00	0.00	1.07	0.00	7.86	0.71	0.03	0.01	0.00
SFNN	Swamp (tree Cover % >70%)	26.81	0.50	0.00	0.50	0.00	0.00	7.86	0.00	0.00	0.00	0.00
Shrub	Shrubland	5.00	2.00	1.00	2.00	5.00	1.00	40.00	1.00	2.00	4.00	1.00
SONS	Swamp (deciduous shrub)	0.00	0.00	0.00	1.00	1.00	0.00	50.00	0.00	0.00	0.00	0.00
STNN	Swamp (tree Cover % < 70%)	26.81	0.50	0.00	0.50	0.00	0.00	7.86	0.00	0.00	0.00	0.00
WONN	Shallow open water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC-OLD	Regrown Cutblocks at Closure	2.00	0.00	0.00	0.00	5.00	0.00	3.00	0.00	0.00	0.00	0.00

Phase	Description	Buck-thorn	Cinque-Foil	Gale	Laurel	Rose-mary	Sage	Sconif	Sdecid	Shrub	Dw-Shrub	Forb
a1	Lichen Pj	0.00	0.05	0.00	0.00	0.00	0.00	2.37	22.92	25.29	21.99	4.16
AIG	Gravel Pits	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.50	6.50	2.00	5.00
AIH	Roads and Rights of Ways	0.00	0.00	0.00	0.00	0.00	0.00	3.00	14.00	17.00	2.00	5.00
b1	Blueberry Pj-Aw	0.00	0.00	0.00	0.00	0.00	0.00	1.75	42.98	44.73	19.33	15.38
b2	Blueberry Aw(Bw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.50	19.50	11.50	16.50
b3	Blueberry Aw-Sw	0.00	0.42	0.00	0.00	0.00	0.00	4.92	50.91	55.83	22.54	13.28
b4	Blueberry Sw-Pj	0.00	0.00	0.00	0.00	0.00	0.00	8.16	57.21	65.38	22.21	8.48
BFNN	Wooded bog (tree Cover % >70%)	0.00	0.23	0.22	0.24	0.03	0.00	7.42	69.20	76.62	7.28	12.22
BTNN	Wooded bog (tree Cover % <70%)	0.00	0.18	0.05	0.35	0.01	0.00	11.66	71.78	83.43	10.94	12.61
c1	Labrador Tea - mesic Pj-Sb	0.00	0.00	0.00	0.00	0.00	0.00	4.25	39.98	44.23	10.63	5.40
CIP	Revegetated Industrial Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	0.00	8.00
CIW	Well Sites - vegetated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	0.00	8.00
d1	Low-bush Cranberry Aw	0.00	0.66	0.00	0.00	0.00	0.00	1.36	65.49	66.85	7.14	26.84
d2	Low-bush Cranberry Aw-Sw	0.04	0.00	0.00	0.00	0.00	0.00	3.31	45.52	48.83	7.79	26.53
d3	Low-bush Cranberry Sw	0.31	0.00	0.00	0.00	0.00	0.00	3.08	37.24	40.32	7.41	22.84
e1	Dogwood Pb-Aw	0.00	0.00	0.00	0.00	0.00	0.00	0.00	58.00	58.00	2.00	24.00
e2	Dogwood Pb-Sw	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.00	42.00	5.00	31.00
e3	Dogwood Sw	0.00	0.00	0.00	0.00	0.00	0.00	4.00	32.00	36.00	4.50	34.00
FFNN	Wooded Fen (tree Cover % >70%)	0.00	0.01	9.75	0.00	0.05	0.00	16.61	82.82	99.43	7.44	14.20
FONG	Graminoid Fen	0.00	0.00	0.42	0.13	0.00	0.00	0.13	2.98	3.10	0.13	4.81
FONS	Shrubby Fen	0.01	0.29	0.44	0.01	0.27	0.00	2.70	64.09	66.79	2.37	13.11
FTNN	Wooded Fen (tree Cover % <70%)	0.00	0.09	1.79	0.17	0.83	0.00	13.21	69.77	82.99	7.35	11.59
g1	Labrador Tea - subhygric Sb-Pj	0.00	0.00	1.25	0.00	0.00	0.00	17.75	79.43	97.18	10.05	7.15
h1	Labrador Tea/Horsetail Sw-Sb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.00	23.00	11.00	24.00
HG/CC	Herbacious Graminoid Cutblock	0.00	0.00	0.00	0.00	0.00	0.00	10.00	35.00	45.00	0.00	12.00
MONG	Graminoid Marsh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00
MONS	Shrubby Marsh	0.00	0.00	0.00	0.00	0.00	0.00	1.00	69.00	70.00	0.00	4.00
NMC	Cutbanks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.50	7.50	0.00	5.00
NMS	Sand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.50	7.50	0.00	5.00
NWF	Flooded Area	0.00	0.00	0.00	0.00	0.00	0.00	0.40	29.80	30.20	2.00	2.70
NWL	Lake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWR	River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb/Lt	Black Spruce - Tamarack	0.00	0.06	0.00	0.00	0.36	0.00	19.46	72.23	91.69	9.22	12.16
SFNN	Swamp (tree Cover % >70%)	0.00	0.50	0.00	0.00	0.36	0.00	19.46	72.29	91.76	0.00	2.00
Shrub	Shrubland	0.00	0.00	0.00	0.00	0.00	0.00	4.00	83.00	87.00	8.00	5.00
SONS	Swamp (deciduous shrub)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	80.00	81.00	10.00	5.00
STNN	Swamp (tree Cover % < 70%)	0.00	0.50	0.00	0.00	0.36	0.00	19.46	72.29	91.76	0.00	2.00
WONN	Shallow open water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC-OLD	Regrown Cutblocks at Closure	0.00	0.00	0.00	0.00	0.00	0.00	15.00	37.00	52.00	5.00	8.00

Phase	Description	Gram	Moss	Lich	Wood	Litter	Height	Age	Dbh	Pj	Sw	Sb	Fb
a1	Lichen Pj	1.05	25.74	25.65	174.00	28.00	14.68	89.42	15.84	95.44	2.15	0.50	0.00
AIG	Gravel Pits	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIH	Roads and Rights of Ways	25.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
b1	Blueberry Pj-Aw	2.77	28.08	5.58	56.00	38.00	15.68	79.50	16.79	49.59	1.82	0.00	0.00
b2	Blueberry Aw(Bw)	1.50	2.00	0.00	13.00	65.00	17.00	67.00	18.09	0.00	1.77	0.00	0.00
b3	Blueberry Aw-Sw	3.29	12.71	1.76	58.00	18.00	17.75	80.39	20.37	7.57	39.64	0.90	0.00
b4	Blueberry Sw-Pj	6.30	42.53	3.75	58.00	48.00	15.07	75.49	17.15	42.64	46.13	0.00	0.00
BFNN	Wooded bog (tree Cover % >70%)	17.11	47.07	6.19	27.33	32.90	5.28	59.46	5.21	0.12	23.72	71.57	0.14
BTNN	Wooded bog (tree Cover % <70%)	4.94	66.59	9.67	32.73	14.97	10.28	88.98	10.17	1.26	22.15	69.29	0.08
c1	Labrador Tea - mesic Pj-Sb	0.63	40.35	19.35	29.00	42.00	13.06	85.70	14.02	76.07	0.00	23.93	0.00
CIP	Revegetated Industrial Lands	65.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CIW	Well Sites - vegetated	65.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
d1	Low-bush Cranberry Aw	12.58	6.53	0.35	108.00	70.00	17.15	79.17	18.02	0.50	5.72	0.24	0.00
d2	Low-bush Cranberry Aw-Sw	9.63	32.46	0.05	106.00	69.00	17.27	86.92	19.25	0.00	43.49	4.48	2.60
d3	Low-bush Cranberry Sw	0.72	57.93	0.14	88.00	91.00	18.17	97.47	22.11	5.53	81.11	0.00	6.13
e1	Dogwood Pb-Aw	5.00	0.00	0.00	56.00	64.00	21.12	82.78	21.93	0.00	1.82	0.00	0.00
e2	Dogwood Pb-Sw	9.00	21.00	0.00	125.00	50.00	18.94	86.76	20.83	0.00	46.43	0.00	3.57
e3	Dogwood Sw	4.50	62.00	0.00	125.00	50.00	26.48	118.72	31.65	0.00	83.48	0.00	11.30
FFNN	Wooded Fen (tree Cover % >70%)	15.44	51.73	5.90	20.82	14.54	4.76	73.57	5.18	6.18	0.60	76.61	0.00
FONG	Graminoid Fen	63.37	17.14	0.00	0.00	27.00	0.09	0.79	0.00	0.00	0.00	0.00	0.00
FONS	Shrubby Fen	31.94	19.58	0.28	32.38	59.75	2.70	22.19	1.20	1.13	18.49	5.65	0.93
FTNN	Wooded Fen (tree Cover % <70%)	14.88	58.78	4.71	33.03	21.95	7.70	87.87	7.33	1.98	11.31	50.66	0.10
g1	Labrador Tea - subhygric Sb-Pj	0.55	51.33	29.35	61.00	15.00	11.99	95.10	11.16	25.00	0.00	70.69	0.00
h1	Labrador Tea/Horsetail Sw-Sb	4.00	79.00	0.00	60.00	15.00	13.75	89.57	14.66	0.00	70.83	27.08	0.00
HG/CC	Herbacious Graminoid Cutblock	40.00	0.00	0.00	5.00	10.00	0.50	5.00	1.00	0.00	0.00	0.00	0.00
MONG	Graminoid Marsh	62.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MONS	Shrubby Marsh	22.00	5.00	0.00	0.00	0.00	2.70	4.89	0.74	0.00	16.67	0.00	0.00
NMC	Cutbanks	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NMS	Sand	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWF	Flooded Area	16.60	3.60	0.00	0.60	0.00	1.14	0.98	0.15	0.00	11.11	0.00	0.00
NWL	Lake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NWR	River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb/Lt	Black Spruce - Tamarack	15.77	53.53	3.52	50.00	17.00	10.82	100.73	9.37	7.32	1.22	61.71	0.00
SFNN	Swamp (tree Cover % >70%)	12.00	10.00	0.00	22.00	0.00	8.07	88.92	8.04	6.19	7.43	66.90	0.00
Shrub	Shrubland	3.00	15.00	0.00	3.00	25.00	2.75	0.00	0.00	0.00	0.00	0.00	0.00
SONS	Swamp (deciduous shrub)	30.00	10.00	0.00	3.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00
STNN	Swamp (tree Cover % < 70%)	12.00	10.00	0.00	22.00	0.00	11.95	104.18	11.41	6.19	7.43	66.90	0.00
WONN	Shallow open water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CC-OLD	Regrown Cutblocks at Closure	20.00	10.00	1.00	5.00	15.00	2.00	20.00	5.00	20.00	33.33	6.67	0.00

Phase	Description	LT	AW	PB	BW	Conifer	Decid	Total Comp	Moist-ure	Can-Clos	Dom-Tree
a1	Lichen Pj	0.00	1.91	0.00	0.00	98.09	1.91	100.00	m	B	PJ
AIG	Gravel Pits	0.00	0.00	0.00	0.00	0.00	0.00	0.00	d	O	NA
AIH	Roads and Rights of Ways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	m	O	NA
b1	Blueberry Pj-Aw	0.00	44.46	0.00	4.13	51.40	48.60	100.00	m	B	AW
b2	Blueberry Aw(Bw)	0.00	32.74	0.00	65.49	1.77	98.23	100.00	m	C	AW
b3	Blueberry Aw-Sw	0.00	49.37	0.00	2.52	48.11	51.89	100.00	m	A	SW
b4	Blueberry Sw-Pj	0.00	6.98	0.00	4.24	88.78	11.22	100.00	m	B	PJ
BFNN	Wooded bog (tree Cover % >70%)	3.53	0.05	0.04	0.83	95.55	0.92	100.00	w	C	SB
BTNN	Wooded bog (tree Cover % <70%)	5.46	0.99	0.07	0.70	92.78	1.77	100.00	w	B	SB
c1	Labrador Tea - mesic Pj-Sb	0.00	0.00	0.00	0.00	100.00	0.00	100.00	m	A	PJ
CIP	Revegetated Industrial Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	m	O	NA
CIW	Well Sites - vegetated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	m	O	NA
d1	Low-bush Cranberry Aw	0.16	84.69	5.45	3.24	6.46	93.38	100.00	m	B	AW
d2	Low-bush Cranberry Aw-Sw	0.00	42.77	2.97	3.69	50.57	49.43	100.00	m	B	AW
d3	Low-bush Cranberry Sw	0.85	2.21	1.87	2.30	92.77	6.38	100.00	m	B	SW
e1	Dogwood Pb-Aw	0.00	54.55	40.00	3.64	1.82	98.18	100.00	m	C	PB
e2	Dogwood Pb-Sw	0.00	26.79	14.29	8.93	50.00	50.00	100.00	m	B	PB
e3	Dogwood Sw	0.00	1.74	1.74	1.74	94.78	5.22	100.00	m	B	SW
FFNN	Wooded Fen (tree Cover % >70%)	15.43	1.19	0.00	0.00	83.38	1.19	100.00	w	D	SB
FONG	Graminoid Fen	100.00	0.00	0.00	0.00	0.00	0.00	100.00	w	O	NA
FONS	Shrubby Fen	13.98	53.30	3.68	2.83	26.21	59.82	100.00	w	O	LT
FTNN	Wooded Fen (tree Cover % <70%)	33.24	2.11	0.15	0.44	64.05	2.71	100.00	w	B	LT
g1	Labrador Tea - subhygric Sb-Pj	4.31	0.00	0.00	0.00	95.69	0.00	100.00	w	B	SB
h1	Labrador Tea/Horsetail Sw-Sb	0.00	0.00	0.00	2.08	97.92	2.08	100.00	m	B	SB
HG/CC	Herbacious Graminoid Cutblock	0.00	0.00	0.00	0.00	0.00	0.00	0.00	m	O	NA
MONG	Graminoid Marsh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	a	O	NA
MONS	Shrubby Marsh	33.33	0.00	33.33	16.67	16.67	50.00	100.00	a	O	NA
NMC	Cutbanks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	d	O	NA
NMS	Sand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	d	O	NA
NWF	Flooded Area	22.22	0.00	44.44	22.22	11.11	66.67	100.00	a	O	NA
NWL	Lake	0.00	0.00	0.00	0.00	0.00	0.00	0.00	a	O	NA
NWR	River	0.00	0.00	0.00	0.00	0.00	0.00	0.00	a	O	NA
Sb/Lt	Black Spruce - Tamarack	27.32	2.44	0.00	0.00	70.24	2.44	100.00	m	B	SB
SFNN	Swamp (tree Cover % >70%)	18.58	0.88	0.00	0.00	80.53	0.88	100.00	w	D	SB
Shrub	Shrubland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	w	O	NA
SONS	Swamp (deciduous shrub)	0.00	0.00	66.67	33.33	0.00	100.00	100.00	w	O	NA
STNN	Swamp (tree Cover % < 70%)	18.58	0.88	0.00	0.00	80.53	0.88	100.00	w	B	SB
WONN	Shallow open water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	a	O	NA
CC-OLD	Regrown Cutblocks at Closure	0.00	33.33	6.67	0.00	60.00	40.00	100.00	m	B	AW

APPENDIX III

REGIONAL DATA

III1 HABITAT ATTIBUTES USED FOR HSI MODELLING IN THE REGIONAL STUDY AREA

Attribute Code	Description
Pj	Jack Pine Tree Cover %
Sw	White Spruce Tree Cover %
Sb	Black Spruce Tree Cover %
Fb	Balsam Fir Tree Cover %
Lt	Tamarack Tree Cover %
Aw	Aspen Tree Cover %
Pb	Balsam Poplar Tree Cover %
Bw	Paper Birch Tree Cover %
Conifer	Conifer Tree Cover % (excluding Tamarack)
Deciduous	Deciduous Tree Cover %
Tree	Total Tree Cover % (Including Tamarack)
pine	Jack Pine Shrub Cover %
wspruce	White Spruce Shrub Cover %
bspruce	Black Spruce Shrub Cover %
fir	Balsam Fir Shrub Cover %
tamarack	Tamarack Shrub Cover %
aspen	Aspen Shrub Cover %
bpoplar	Balsam Poplar Shrub Cover %
pbirch	Paper Birch Shrub Cover %
alder	Green + River Alder Cover %
sask	Saskatoon Cover %
dbirch	Dwarf + Bog Birch Cover %
lleaf	Leatherleaf Cover %
dogwood	Red-osier Dogwood Cover %
hazel	Hazelnut Cover %
ltea	Northern + Labrador Tea Cover %
hsuckle	Bracted + Twining Honeysuckle Cover %
cherry	Pin + Chokecherry Cover %
currant	Currant + Gooseberry Cover %
rose	Prickly + Wild Rose Cover %
rberry	Raspberry Cover %
willow	Willow Cover %
bfberry	Buffaloberry Cover %
sberry	Snowberry Cover %
blberry	Blueberry Cover %

Attribute Code	Description
lbcberry	Low Bush Cranberry Cover %
buckthorn	Buckthorn Cover %
cinquefoil	Shrubby Cinquefoil Cover %
gale	Gale Cover %
laurel	Laurel Cover %
rosemary	Rosemary Cover %
sage	Sagebrush Cover %
sconif	Conifer Shrub Cover % (excluding Tamarack)
sdecid	Decidous Shrub Cover %
shrub	Total Shrub Cover % (Including Tamarack)
dwshrub	Dwarf Shrub Cover %
forb	Broadleaf Herb Cover %
gram	Graminoid Cover %
moss	Moss Cover %
lich	Lichen Cover %
wood	Down Logs > 10 cm diameter (ha^{-1})
litter	Litter Cover %
Height	Mean Canopy Tree Height (m)
Age	Stand Age (y)
DBH	Diameter at Breast Height (cm)
PJP	Jack Pine Percent Composition
SWP	White Spruce Percent Composition
SBP	Black Spruce Percent Composition
FBP	Balsam Fir Percent Composition
LTP	Tamarack Percent Composition
AWP	Aspen Percent Composition
PBP	Balsam Poplar Percent Composition
BWP	Paper Birch Percent Composition
CONP	Conifer Tree Percent Composition
DECP	Deciduous Tree Percent Composition
TOTP	Total Tree Percent Composition
Moisture	Moisture Modifier Code
CanClos	Canopy Closure Class Code
DomTree	Dominant Tree Species Code

Ecoregion	Ecosite	Pj	Sw	Sb	Fb	Lt	Aw	Pb	Bw	Con-ifer	Decid-uous	Tree
Boreal Mixedwood	Mixed Deciduous	0.5	2.6	0.1	0.0	0.0	39.4	5.7	1.5	3.2	46.6	49.9
Boreal Mixedwood	Mixedwood-Sw/Aw	1.4	23.6	1.2	1.2	0.0	21.3	2.3	3.1	27.4	26.7	54.1
Boreal Mixedwood	Coniferous-Sw	2.2	41.0	0.0	3.2	0.3	1.1	0.9	1.1	46.3	3.1	49.7
Boreal Mixedwood	Coniferous-Sw/Pj	21.4	23.1	0.0	0.0	0.0	3.5	0.0	2.1	44.5	5.6	50.1
Boreal Mixedwood	Coniferous-Pj/Sw/Sb	19.9	7.7	10.1	0.0	0.4	1.2	0.0	0.7	37.6	1.9	39.9
Boreal Mixedwood	Open Pine	27.8	0.6	0.1	0.0	0.0	0.6	0.0	0.0	28.6	0.6	29.1
Boreal Mixedwood	Pine Regen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Upland Sb-Lt	2.1	0.4	18.1	0.0	8.0	0.7	0.0	0.0	20.6	0.7	29.3
Boreal Mixedwood	Wet Closed Coniferous Sb	0.4	0.2	17.2	0.0	3.8	0.1	0.0	0.0	17.8	0.1	21.7
Boreal Mixedwood	Wet Open Coniferous Sb-Lt	1.0	0.4	10.6	0.0	10.8	0.3	0.0	0.0	12.0	0.3	23.1
Boreal Mixedwood	Shrubby Fen	0.0	0.1	0.5	0.0	0.1	0.0	0.0	0.0	0.7	0.0	0.8
Boreal Mixedwood	Graminoid Fen	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Boreal Mixedwood	Low Shrub Wetland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Bog	0.0	0.0	2.0	0.0	6.3	0.0	0.0	0.0	2.0	0.0	8.3
Boreal Mixedwood	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Upland Shrub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Recent Cutblocks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Old Cutblocks	3.0	5.0	1.0	0.0	0.0	5.0	1.0	0.0	9.0	6.0	15.0
Boreal Mixedwood	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Mixed Deciduous	0.5	2.5	0.5	0.0	0.0	40.0	0.5	0.0	3.5	40.5	44.0
Boreal Highlands	Mixedwood-Sw/Aw	2.0	15.0	6.0	0.0	0.0	26.0	0.0	2.0	23.0	28.0	51.0
Boreal Highlands	Coniferous-Sw	0.0	30.0	1.0	4.0	0.0	1.0	0.0	1.0	35.0	2.0	37.0
Boreal Highlands	Coniferous-Sw/Pj	10.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0	27.0	0.0	27.0
Boreal Highlands	Coniferous-Pj/Sw/Sb	12.3	5.7	9.7	0.0	0.0	1.0	0.0	0.0	27.6	1.0	28.6
Boreal Highlands	Open Pine	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	20.0
Boreal Highlands	Pine Regen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Upland Sb-Lt	2.1	0.4	18.1	0.0	8.0	0.7	0.0	0.0	20.6	0.7	29.3
Boreal Highlands	Wet Closed Coniferous Sb	0.0	0.2	22.5	0.0	3.0	0.0	0.0	0.0	22.7	0.0	25.7
Boreal Highlands	Wet Open Coniferous Sb-Lt	0.0	0.9	37.4	0.0	13.5	0.0	0.0	0.0	38.3	0.0	51.8
Boreal Highlands	Shrubby Fen	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0
Boreal Highlands	Graminoid Fen	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Boreal Highlands	Low Shrub Wetland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Bog	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Upland Shrub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Recent Cutblocks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Old Cutblocks	3.0	5.0	1.0	0.0	0.0	5.0	1.0	0.0	9.0	6.0	15.0
Boreal Highlands	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Mixed Deciduous	0.0	3.4	0.5	0.0	0.0	22.1	1.8	5.9	3.8	29.7	33.5
Subarctic	Mixedwood-Sw/Aw	4.2	12.9	9.8	0.0	0.0	20.7	0.7	2.4	26.9	23.8	50.7
Subarctic	Coniferous-Sw	0.0	30.0	0.0	0.0	0.0	0.0	0.0	1.4	30.0	1.4	31.4
Subarctic	Coniferous-Sw/Pj	10.0	0.0	19.0	0.0	0.0	0.0	0.0	0.0	29.0	0.0	29.0
Subarctic	Coniferous-Pj/Sw/Sb	11.5	0.0	21.0	0.0	0.0	0.0	0.0	0.5	32.5	0.5	33.0
Subarctic	Open Pine	18.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	0.0	18.0
Subarctic	Pine Regen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Upland Sb-Lt	2.1	0.4	18.1	0.0	8.0	0.7	0.0	0.0	20.6	0.7	29.3
Subarctic	Wet Closed Coniferous Sb	0.0	0.1	9.0	0.0	1.8	0.0	0.0	0.0	9.1	0.0	10.9
Subarctic	Wet Open Coniferous Sb-Lt	0.0	0.2	7.3	0.0	7.6	0.0	0.0	0.0	7.5	0.0	15.1
Subarctic	Shrubby Fen	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0
Subarctic	Graminoid Fen	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Subarctic	Low Shrub Wetland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Bog	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0
Subarctic	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Upland Shrub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Recent Cutblocks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Old Cutblocks	3.0	5.0	1.0	0.0	0.0	5.0	1.0	0.0	9.0	6.0	15.0
Subarctic	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Ecoregion	Ecosite	Pine	Wspruce	Bspruce	Fir	Tamar-ack	Aspen	Bpoplar	Pbirch	Alder	Sask
Boreal Mixedwood	Mixed Deciduous	0.0	0.5	0.0	0.0	0.1	2.0	0.4	0.4	6.6	2.5
Boreal Mixedwood	Mixedwood-Sw/Aw	0.0	3.1	0.0	0.9	0.0	2.3	0.2	0.4	2.7	0.5
Boreal Mixedwood	Coniferous-Sw	0.0	0.1	0.0	2.8	0.0	0.2	0.0	0.2	3.1	0.2
Boreal Mixedwood	Coniferous-Sw/Pj	0.0	8.2	0.0	0.0	0.0	1.5	0.0	0.3	5.8	2.5
Boreal Mixedwood	Coniferous-Pj/Sw/Sb	0.0	3.1	6.1	0.0	0.8	0.6	0.0	0.4	2.4	0.8
Boreal Mixedwood	Open Pine	1.5	0.7	0.2	0.0	0.0	0.7	0.1	0.0	2.7	0.3
Boreal Mixedwood	Pine Regen	15.0	1.0	0.0	0.0	0.0	15.0	2.0	0.0	1.0	0.0
Boreal Mixedwood	Upland Sb-Lt	0.0	1.4	12.3	0.0	5.7	0.0	0.0	0.0	0.9	2.1
Boreal Mixedwood	Wet Closed Coniferous Sb	0.0	0.5	10.9	0.0	3.4	0.0	0.0	0.0	1.1	0.4
Boreal Mixedwood	Wet Open Coniferous Sb-Lt	0.0	1.1	7.3	0.0	7.6	0.0	0.0	0.1	0.5	1.0
Boreal Mixedwood	Shrubby Fen	0.0	0.0	5.1	0.0	3.6	0.3	0.1	0.2	1.7	0.0
Boreal Mixedwood	Graminoid Fen	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.1	0.0
Boreal Mixedwood	Low Shrub Wetland	0.0	0.0	13.0	0.0	0.0	0.0	0.0	0.0	11.4	0.0
Boreal Mixedwood	Bog	0.0	0.0	17.5	0.0	0.0	0.0	0.0	0.0	11.4	0.0
Boreal Mixedwood	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Upland Shrub	1.0	1.0	2.0	0.0	0.0	4.0	1.0	1.0	5.0	1.0
Boreal Mixedwood	Recent Cutblocks	2.0	7.0	1.0	0.0	0.0	10.0	2.0	0.0	1.0	0.0
Boreal Mixedwood	Old Cutblocks	1.0	10.0	3.0	1.0	0.0	5.0	1.0	0.0	3.0	1.0
Boreal Mixedwood	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	1.5	0.5	0.0	0.0	0.0
Boreal Mixedwood	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Mixed Deciduous	0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0
Boreal Highlands	Mixedwood-Sw/Aw	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0
Boreal Highlands	Coniferous-Sw	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	4.0	0.0
Boreal Highlands	Coniferous-Sw/Pj	0.0	1.0	0.0	0.0	0.0	1.0	0.0	0.0	3.0	0.0
Boreal Highlands	Coniferous-Pj/Sw/Sb	0.0	0.3	4.7	0.0	0.0	0.3	0.0	0.0	1.0	0.0
Boreal Highlands	Open Pine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Pine Regen	15.0	1.0	0.0	0.0	0.0	15.0	2.0	0.0	1.0	0.0
Boreal Highlands	Upland Sb-Lt	0.0	1.4	12.3	0.0	5.7	0.0	0.0	0.0	0.9	2.1
Boreal Highlands	Wet Closed Coniferous Sb	0.0	0.4	1.3	0.0	0.1	0.0	0.0	0.0	4.0	0.0
Boreal Highlands	Wet Open Coniferous Sb-Lt	0.0	1.8	4.1	0.0	0.5	0.0	0.0	0.0	18.0	0.0
Boreal Highlands	Shrubby Fen	0.0	0.0	24.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Graminoid Fen	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.1	0.0
Boreal Highlands	Low Shrub Wetland	0.0	0.0	35.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0
Boreal Highlands	Bog	0.0	0.0	71.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0
Boreal Highlands	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Upland Shrub	1.0	1.0	2.0	0.0	0.0	4.0	1.0	1.0	5.0	1.0
Boreal Highlands	Recent Cutblocks	2.0	7.0	1.0	0.0	0.0	10.0	2.0	0.0	1.0	0.0
Boreal Highlands	Old Cutblocks	1.0	10.0	3.0	1.0	0.0	5.0	1.0	0.0	3.0	1.0
Boreal Highlands	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	1.5	0.5	0.0	0.0	0.0
Boreal Highlands	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Mixed Deciduous	0.0	1.4	0.0	0.0	0.0	0.5	0.1	0.1	1.8	0.6
Subarctic	Mixedwood-Sw/Aw	0.0	0.3	2.8	0.0	0.0	0.0	0.0	0.0	1.4	0.0
Subarctic	Coniferous-Sw	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0
Subarctic	Coniferous-Sw/Pj	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Coniferous-Pj/Sw/Sb	0.0	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Open Pine	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Pine Regen	15.0	1.0	0.0	0.0	0.0	15.0	2.0	0.0	1.0	0.0
Subarctic	Upland Sb-Lt	0.0	1.4	12.3	0.0	5.7	0.0	0.0	0.0	0.9	2.1
Subarctic	Wet Closed Coniferous Sb	0.0	0.1	3.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0
Subarctic	Wet Open Coniferous Sb-Lt	0.0	0.5	2.6	0.0	5.3	0.0	0.0	0.0	0.0	0.0
Subarctic	Shrubby Fen	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Graminoid Fen	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.1	0.0
Subarctic	Low Shrub Wetland	0.0	0.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Bog	0.0	0.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Upland Shrub	1.0	1.0	2.0	0.0	0.0	4.0	1.0	1.0	5.0	1.0
Subarctic	Recent Cutblocks	2.0	7.0	1.0	0.0	0.0	10.0	2.0	0.0	1.0	0.0
Subarctic	Old Cutblocks	1.0	10.0	3.0	1.0	0.0	5.0	1.0	0.0	3.0	1.0
Subarctic	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	1.5	0.5	0.0	0.0	0.0
Subarctic	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Ecoregion	Ecosite	Dbirch	Lleaf	Dog-wood	Hazel	Ltea	H-suckle	Cherry	Currant	Rose	Rberry	Willow
Boreal Mixedwood	Mixed Deciduous	0.1	0.0	1.8	0.6	2.2	0.9	0.1	0.4	9.8	1.0	4.1
Boreal Mixedwood	Mixedwood-Sw/Aw	0.5	0.2	2.1	0.2	6.3	0.7	0.0	0.4	10.2	0.1	2.2
Boreal Mixedwood	Coniferous-Sw	0.0	0.0	1.6	0.2	6.2	0.3	0.0	0.9	8.2	0.1	0.5
Boreal Mixedwood	Coniferous-Sw/Pj	0.3	0.0	0.0	0.0	13.2	0.0	0.0	2.5	4.6	0.0	0.9
Boreal Mixedwood	Coniferous-Pj/Sw/Sb	0.7	0.2	0.0	0.0	26.3	0.0	0.0	0.8	1.9	0.0	1.8
Boreal Mixedwood	Open Pine	0.0	0.0	0.0	0.0	1.6	0.0	0.5	0.0	2.4	0.0	0.4
Boreal Mixedwood	Pine Regen	0.0	0.0	1.0	0.0	3.0	1.0	1.0	1.0	5.0	1.0	10.0
Boreal Mixedwood	Upland Sb-Lt	12.8	0.1	0.0	0.0	26.8	0.0	0.0	0.0	1.1	0.0	7.9
Boreal Mixedwood	Wet Closed Coniferous Sb	7.0	0.3	0.0	0.1	47.8	0.0	0.0	0.0	0.3	0.0	4.2
Boreal Mixedwood	Wet Open Coniferous Sb-Lt	18.1	0.2	0.0	0.0	20.8	0.0	0.0	0.0	0.5	0.0	7.3
Boreal Mixedwood	Shrubby Fen	28.6	0.0	0.3	0.0	6.6	0.2	0.0	0.2	0.3	0.0	21.2
Boreal Mixedwood	Graminoid Fen	1.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.8
Boreal Mixedwood	Low Shrub Wetland	1.5	4.1	0.0	0.0	45.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Bog	1.5	4.1	0.0	0.0	44.2	0.0	0.0	0.0	0.0	0.0	2.0
Boreal Mixedwood	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Upland Shrub	1.0	0.0	2.0	0.0	5.0	2.0	1.0	2.0	5.0	1.0	40.0
Boreal Mixedwood	Recent Cutblocks	1.0	0.0	1.0	0.0	2.0	0.0	0.0	0.0	5.0	0.0	3.0
Boreal Mixedwood	Old Cutblocks	1.0	0.0	1.0	0.0	2.0	0.0	0.0	0.0	5.0	0.0	3.0
Boreal Mixedwood	Natural Disturbances	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	3.0
Boreal Mixedwood	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Mixed Deciduous	0.0	0.0	0.0	0.0	6.5	0.0	0.0	0.0	2.0	0.0	4.0
Boreal Highlands	Mixedwood-Sw/Aw	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	2.0
Boreal Highlands	Coniferous-Sw	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0
Boreal Highlands	Coniferous-Sw/Pj	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	1.0	0.0	0.0
Boreal Highlands	Coniferous-Pj/Sw/Sb	0.0	0.0	0.0	0.0	15.3	0.0	0.0	0.0	0.3	0.0	0.0
Boreal Highlands	Open Pine	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	1.0	0.0	0.0
Boreal Highlands	Pine Regen	0.0	0.0	1.0	0.0	3.0	1.0	1.0	1.0	5.0	1.0	10.0
Boreal Highlands	Upland Sb-Lt	12.8	0.1	0.0	0.0	26.8	0.0	0.0	0.0	1.1	0.0	7.9
Boreal Highlands	Wet Closed Coniferous Sb	0.2	1.4	0.0	0.0	26.5	0.1	0.0	0.7	0.4	0.0	0.2
Boreal Highlands	Wet Open Coniferous Sb-Lt	0.5	0.2	0.0	0.0	17.7	0.5	0.0	2.3	0.9	0.0	0.5
Boreal Highlands	Shrubby Fen	9.0	0.0	0.0	0.0	32.0	0.0	0.0	0.0	0.5	0.0	6.5
Boreal Highlands	Graminoid Fen	1.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.8
Boreal Highlands	Low Shrub Wetland	0.0	0.0	0.0	0.0	47.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Bog	0.0	0.0	0.0	0.0	47.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Upland Shrub	1.0	0.0	2.0	0.0	5.0	2.0	1.0	2.0	5.0	1.0	40.0
Boreal Highlands	Recent Cutblocks	1.0	0.0	1.0	0.0	2.0	0.0	0.0	0.0	5.0	0.0	3.0
Boreal Highlands	Old Cutblocks	1.0	0.0	1.0	0.0	2.0	0.0	0.0	0.0	5.0	0.0	3.0
Boreal Highlands	Natural Disturbances	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	3.0
Boreal Highlands	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Mixed Deciduous	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	4.4	0.0	0.7
Subarctic	Mixedwood-Sw/Aw	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.6	5.8	0.0	2.4
Subarctic	Coniferous-Sw	0.0	0.0	0.0	0.0	2.8	0.0	0.0	2.1	2.3	0.0	1.0
Subarctic	Coniferous-Sw/Pj	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	1.0	0.0	0.0
Subarctic	Coniferous-Pj/Sw/Sb	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	0.5	0.0	0.0
Subarctic	Open Pine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Pine Regen	0.0	0.0	1.0	0.0	3.0	1.0	1.0	1.0	5.0	1.0	10.0
Subarctic	Upland Sb-Lt	12.8	0.1	0.0	0.0	26.8	0.0	0.0	0.0	1.1	0.0	7.9
Subarctic	Wet Closed Coniferous Sb	4.9	0.7	0.0	0.0	15.9	0.0	0.0	0.0	0.0	0.0	2.6
Subarctic	Wet Open Coniferous Sb-Lt	17.0	0.3	0.0	0.0	12.1	0.0	0.0	0.0	0.0	0.0	7.6
Subarctic	Shrubby Fen	7.5	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	20.0
Subarctic	Graminoid Fen	1.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.8
Subarctic	Low Shrub Wetland	0.0	0.0	0.0	0.0	45.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Bog	0.0	0.0	0.0	0.0	45.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Upland Shrub	1.0	0.0	2.0	0.0	5.0	2.0	1.0	2.0	5.0	1.0	40.0
Subarctic	Recent Cutblocks	1.0	0.0	1.0	0.0	2.0	0.0	0.0	0.0	5.0	0.0	3.0
Subarctic	Old Cutblocks	1.0	0.0	1.0	0.0	2.0	0.0	0.0	0.0	5.0	0.0	3.0
Subarctic	Natural Disturbances	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	3.0
Subarctic	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Ecoregion	Ecosite	Bfberry	Sberry	Blberry	Lbc-berry	Buck-thorn	Cinque-foil	Gale	Laurel	Rose-mary	Sage	Sconif
Boreal Mixedwood	Mixed Deciduous	2.6	0.5	2.2	4.6	0.0	0.3	0.0	0.0	0.0	0.0	0.6
Boreal Mixedwood	Mixedwood-Sw/Aw	1.7	0.2	5.4	5.1	0.0	0.2	0.0	0.0	0.0	0.0	4.0
Boreal Mixedwood	Coniferous-Sw	1.5	0.5	0.6	6.8	0.3	0.0	0.0	0.0	0.0	0.0	2.9
Boreal Mixedwood	Coniferous-Sw/Pj	8.8	0.0	8.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2
Boreal Mixedwood	Coniferous-Pj/Sw/Sb	3.5	0.0	9.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	10.0
Boreal Mixedwood	Open Pine	2.1	0.2	9.1	0.5	0.0	0.1	0.0	0.0	0.0	0.0	2.4
Boreal Mixedwood	Pine Regen	1.0	1.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0
Boreal Mixedwood	Upland Sb-Lt	0.7	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.0	19.5
Boreal Mixedwood	Wet Closed Coniferous Sb	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.4	0.4	0.0	14.9
Boreal Mixedwood	Wet Open Coniferous Sb-Lt	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.4	0.0	16.0
Boreal Mixedwood	Shrubby Fen	0.2	0.0	0.0	0.0	0.0	0.1	6.8	0.0	0.0	0.0	8.7
Boreal Mixedwood	Graminoid Fen	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.1
Boreal Mixedwood	Low Shrub Wetland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0
Boreal Mixedwood	Bog	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.5
Boreal Mixedwood	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Upland Shrub	1.0	2.0	4.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Boreal Mixedwood	Recent Cutblocks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
Boreal Mixedwood	Old Cutblocks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0
Boreal Mixedwood	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Mixed Deciduous	0.0	0.0	3.5	6.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Boreal Highlands	Mixedwood-Sw/Aw	0.0	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Boreal Highlands	Coniferous-Sw	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
Boreal Highlands	Coniferous-Sw/Pj	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Boreal Highlands	Coniferous-Pj/Sw/Sb	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
Boreal Highlands	Open Pine	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Pine Regen	1.0	1.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0
Boreal Highlands	Upland Sb-Lt	0.7	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.0	19.5
Boreal Highlands	Wet Closed Coniferous Sb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	1.8
Boreal Highlands	Wet Open Coniferous Sb-Lt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	6.3
Boreal Highlands	Shrubby Fen	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.5
Boreal Highlands	Graminoid Fen	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.1
Boreal Highlands	Low Shrub Wetland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	35.0
Boreal Highlands	Bog	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	71.0
Boreal Highlands	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Upland Shrub	1.0	2.0	4.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Boreal Highlands	Recent Cutblocks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
Boreal Highlands	Old Cutblocks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0
Boreal Highlands	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Mixed Deciduous	2.7	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.4
Subarctic	Mixedwood-Sw/Aw	4.2	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	3.1
Subarctic	Coniferous-Sw	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Subarctic	Coniferous-Sw/Pj	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0
Subarctic	Coniferous-Pj/Sw/Sb	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5
Subarctic	Open Pine	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Subarctic	Pine Regen	1.0	1.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	16.0
Subarctic	Upland Sb-Lt	0.7	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.0	19.5
Subarctic	Wet Closed Coniferous Sb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	4.4
Subarctic	Wet Open Coniferous Sb-Lt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	8.4
Subarctic	Shrubby Fen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
Subarctic	Graminoid Fen	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.1
Subarctic	Low Shrub Wetland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0
Subarctic	Bog	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.0
Subarctic	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Upland Shrub	1.0	2.0	4.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
Subarctic	Recent Cutblocks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
Subarctic	Old Cutblocks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0
Subarctic	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Ecoregion	Ecosite	Sdecid	Shrub	Dwshrub	Forb	Gram	Moss	Lich	Wood	Litter
Boreal Mixedwood	Mixed Deciduous	43.0	43.6	7.7	23.4	7.2	3.4	0.1	64.0	65.4
Boreal Mixedwood	Mixedwood-Sw/Aw	41.7	45.7	12.9	24.2	6.2	25.2	0.7	88.1	43.8
Boreal Mixedwood	Coniferous-Sw	31.2	34.1	7.0	24.6	1.8	59.4	0.1	92.9	80.8
Boreal Mixedwood	Coniferous-Sw/Pj	49.1	57.2	22.2	8.5	6.3	42.5	3.8	58.0	48.0
Boreal Mixedwood	Coniferous-Pj/Sw/Sb	48.8	58.8	14.3	7.0	2.5	44.7	17.5	49.3	35.0
Boreal Mixedwood	Open Pine	20.5	22.9	22.0	4.2	1.0	25.7	25.7	174.0	28.0
Boreal Mixedwood	Pine Regen	46.0	62.0	2.0	12.0	20.0	0.0	0.0	5.0	10.0
Boreal Mixedwood	Upland Sb-Lt	52.8	72.2	9.2	12.2	15.8	53.5	3.5	50.0	17.0
Boreal Mixedwood	Wet Closed Coniferous Sb	62.3	77.2	10.3	10.8	7.1	64.8	9.5	34.3	14.8
Boreal Mixedwood	Wet Open Coniferous Sb-Lt	50.5	66.5	6.6	10.2	17.6	59.3	2.9	43.4	22.4
Boreal Mixedwood	Shrubby Fen	66.7	75.4	3.9	13.5	28.0	32.9	1.0	12.5	37.5
Boreal Mixedwood	Graminoid Fen	2.9	3.0	0.1	4.8	63.4	17.1	0.0	0.0	27.0
Boreal Mixedwood	Low Shrub Wetland	62.0	75.0	9.1	7.5	13.7	61.2	6.0	10.0	12.0
Boreal Mixedwood	Bog	63.2	80.7	9.1	7.5	13.7	61.2	6.0	10.0	12.0
Boreal Mixedwood	Marsh	0.0	0.0	0.0	9.0	62.0	6.0	0.0	0.0	0.0
Boreal Mixedwood	Upland Shrub	79.0	83.0	8.0	5.0	3.0	15.0	0.0	3.0	25.0
Boreal Mixedwood	Recent Cutblocks	25.0	35.0	0.0	12.0	40.0	0.0	0.0	5.0	10.0
Boreal Mixedwood	Old Cutblocks	22.0	37.0	5.0	8.0	20.0	10.0	1.0	5.0	15.0
Boreal Mixedwood	Natural Disturbances	7.5	7.5	0.0	5.0	0.5	0.0	0.0	0.0	0.0
Boreal Mixedwood	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Mixed Deciduous	26.5	28.0	4.5	14.0	18.5	16.0	0.0	60.5	67.5
Boreal Highlands	Mixedwood-Sw/Aw	19.0	21.0	8.0	32.0	6.0	29.0	3.0	106.0	69.0
Boreal Highlands	Coniferous-Sw	15.0	20.0	11.0	19.0	5.0	80.0	0.0	88.0	91.0
Boreal Highlands	Coniferous-Sw/Pj	16.0	17.0	12.0	12.0	1.0	75.0	5.0	58.0	48.0
Boreal Highlands	Coniferous-Pj/Sw/Sb	23.3	28.3	11.0	10.7	0.3	63.9	10.0	49.3	35.0
Boreal Highlands	Open Pine	7.0	7.0	37.0	4.0	0.0	26.0	22.0	174.0	28.0
Boreal Highlands	Pine Regen	46.0	62.0	2.0	12.0	20.0	0.0	0.0	5.0	10.0
Boreal Highlands	Upland Sb-Lt	52.8	72.2	9.2	12.2	15.8	53.5	3.5	50.0	17.0
Boreal Highlands	Wet Closed Coniferous Sb	34.2	36.0	9.0	17.0	9.5	44.6	34.4	34.3	14.8
Boreal Highlands	Wet Open Coniferous Sb-Lt	40.5	46.8	9.1	41.0	31.1	102.1	5.4	43.4	22.4
Boreal Highlands	Shrubby Fen	50.5	75.0	31.5	10.0	9.5	102.5	3.0	12.5	37.5
Boreal Highlands	Graminoid Fen	2.9	3.0	0.1	4.8	63.4	17.1	0.0	0.0	27.0
Boreal Highlands	Low Shrub Wetland	51.0	86.0	12.0	24.0	0.0	75.0	35.0	10.0	12.0
Boreal Highlands	Bog	50.0	121.0	12.0	24.0	0.0	75.0	35.0	10.0	12.0
Boreal Highlands	Marsh	0.0	0.0	0.0	9.0	62.0	6.0	0.0	0.0	0.0
Boreal Highlands	Upland Shrub	79.0	83.0	8.0	5.0	3.0	15.0	0.0	3.0	25.0
Boreal Highlands	Recent Cutblocks	25.0	35.0	0.0	12.0	40.0	0.0	0.0	5.0	10.0
Boreal Highlands	Old Cutblocks	22.0	37.0	5.0	8.0	20.0	10.0	1.0	5.0	15.0
Boreal Highlands	Natural Disturbances	7.5	7.5	0.0	5.0	0.5	0.0	0.0	0.0	0.0
Boreal Highlands	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Mixed Deciduous	12.2	13.6	18.0	8.5	2.0	3.4	1.0	28.9	53.2
Subarctic	Mixedwood-Sw/Aw	21.0	24.1	3.4	7.5	1.4	33.2	7.0	105.6	61.0
Subarctic	Coniferous-Sw	9.1	11.1	8.9	15.4	5.6	63.8	0.7	104.2	57.3
Subarctic	Coniferous-Sw/Pj	10.0	19.0	7.0	2.0	0.0	69.0	15.0	61.0	15.0
Subarctic	Coniferous-Pj/Sw/Sb	15.5	23.0	10.0	3.0	0.0	64.5	15.0	74.5	53.0
Subarctic	Open Pine	1.0	2.0	22.0	2.0	1.0	6.0	14.0	174.0	28.0
Subarctic	Pine Regen	46.0	62.0	2.0	12.0	20.0	0.0	0.0	5.0	10.0
Subarctic	Upland Sb-Lt	52.8	72.2	9.2	12.2	15.8	53.5	3.5	50.0	17.0
Subarctic	Wet Closed Coniferous Sb	24.4	28.8	10.9	5.1	3.5	47.8	34.5	34.3	14.8
Subarctic	Wet Open Coniferous Sb-Lt	38.4	46.9	13.3	5.9	12.9	64.2	11.3	43.4	22.4
Subarctic	Shrubby Fen	52.5	62.5	12.5	3.0	18.0	14.5	47.5	12.5	37.5
Subarctic	Graminoid Fen	2.9	3.0	0.1	4.8	63.4	17.1	0.0	0.0	27.0
Subarctic	Low Shrub Wetland	45.0	58.0	10.0	10.0	5.0	54.0	8.0	10.0	12.0
Subarctic	Bog	45.0	58.0	5.0	6.0	0.0	54.0	8.0	10.0	12.0
Subarctic	Marsh	0.0	0.0	0.0	9.0	62.0	6.0	0.0	0.0	0.0
Subarctic	Upland Shrub	79.0	83.0	8.0	5.0	3.0	15.0	0.0	3.0	25.0
Subarctic	Recent Cutblocks	25.0	35.0	0.0	12.0	40.0	0.0	0.0	5.0	10.0
Subarctic	Old Cutblocks	22.0	37.0	5.0	8.0	20.0	10.0	1.0	5.0	15.0
Subarctic	Natural Disturbances	7.5	7.5	0.0	5.0	0.5	0.0	0.0	0.0	0.0
Subarctic	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Ecoregion	Ecosite	Height	Age	DBH	PJP	SWP	SBP	FBP	LTP	AWP
Boreal Mixedwood	Mixed Deciduous	17.7	75.0	18.5	4.4	1.6	0.0	0.0	0.0	76.0
Boreal Mixedwood	Mixedwood-Sw/Aw	17.6	84.3	19.7	2.0	41.8	4.6	0.0	0.5	39.6
Boreal Mixedwood	Coniferous-Sw	19.6	101.7	23.5	0.5	90.9	1.1	0.0	0.2	4.9
Boreal Mixedwood	Coniferous-Sw/Pj	15.1	75.5	17.2	51.9	36.3	2.5	0.0	1.3	8.1
Boreal Mixedwood	Coniferous-Pj/Sw/Sb	13.4	85.3	14.1	44.1	12.6	32.6	0.0	6.7	3.9
Boreal Mixedwood	Open Pine	14.7	89.4	15.8	84.5	12.0	0.0	0.0	0.0	3.5
Boreal Mixedwood	Pine Regen	1.0	10.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Upland Sb-Lt	10.8	100.7	9.4	2.3	2.5	45.3	0.0	49.2	0.6
Boreal Mixedwood	Wet Closed Coniferous Sb	10.3	93.2	10.1	0.0	0.0	86.2	0.0	13.7	0.0
Boreal Mixedwood	Wet Open Coniferous Sb-Lt	9.2	94.5	8.5	0.1	0.1	48.6	0.0	51.2	0.0
Boreal Mixedwood	Shrubby Fen	3.4	42.2	2.9	0.0	17.3	57.0	0.0	22.0	0.0
Boreal Mixedwood	Graminoid Fen	0.1	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Low Shrub Wetland	6.2	93.5	6.7	0.0	0.0	99.3	0.0	0.0	0.7
Boreal Mixedwood	Bog	6.2	93.5	6.7	0.0	0.0	99.3	0.0	0.0	0.7
Boreal Mixedwood	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Upland Shrub	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Recent Cutblocks	0.5	5.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Old Cutblocks	2.0	20.0	5.0	10.0	30.0	5.0	0.0	0.0	45.0
Boreal Mixedwood	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Mixedwood	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Mixed Deciduous	17.1	73.1	18.1	1.2	5.7	1.1	0.0	0.0	90.9
Boreal Highlands	Mixedwood-Sw/Aw	17.3	86.9	19.3	3.9	29.4	11.8	0.0	0.0	51.0
Boreal Highlands	Coniferous-Sw	18.2	97.5	22.1	0.0	81.1	2.7	10.8	0.0	2.7
Boreal Highlands	Coniferous-Sw/Pj	15.1	75.5	17.2	37.0	63.0	0.0	0.0	0.0	0.0
Boreal Highlands	Coniferous-Pj/Sw/Sb	13.4	85.3	14.1	40.1	21.0	36.6	0.0	0.0	2.3
Boreal Highlands	Open Pine	14.7	89.4	15.8	100.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Pine Regen	1.0	10.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Upland Sb-Lt	10.8	100.7	9.4	2.3	2.5	45.3	0.0	49.2	0.6
Boreal Highlands	Wet Closed Coniferous Sb	10.3	93.2	10.1	0.0	0.6	90.0	0.0	9.4	0.0
Boreal Highlands	Wet Open Coniferous Sb-Lt	9.2	94.5	8.5	0.0	2.8	55.0	0.0	42.2	0.0
Boreal Highlands	Shrubby Fen	3.4	42.2	2.9	0.0	50.0	0.0	0.0	0.0	0.0
Boreal Highlands	Graminoid Fen	0.1	0.8	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Boreal Highlands	Low Shrub Wetland	6.2	93.5	6.7	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Bog	6.2	93.5	6.7	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Upland Shrub	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Recent Cutblocks	0.5	5.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Old Cutblocks	2.0	20.0	5.0	10.0	30.0	5.0	0.0	0.0	45.0
Boreal Highlands	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boreal Highlands	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Mixed Deciduous	15.4	77.0	16.3	0.0	11.6	1.3	0.0	0.0	73.8
Subarctic	Mixedwood-Sw/Aw	17.1	81.4	17.9	7.4	27.2	17.2	0.0	0.0	40.3
Subarctic	Coniferous-Sw	19.2	96.5	21.5	0.0	95.2	0.0	0.0	0.0	0.0
Subarctic	Coniferous-Sw/Pj	12.0	95.1	11.2	34.5	0.0	65.5	0.0	0.0	0.0
Subarctic	Coniferous-Pj/Sw/Sb	15.1	96.3	16.6	34.8	0.0	63.8	0.0	0.0	0.0
Subarctic	Open Pine	14.7	89.4	15.8	100.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Pine Regen	1.0	10.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Upland Sb-Lt	10.8	100.7	9.4	2.3	2.5	45.3	0.0	49.2	0.6
Subarctic	Wet Closed Coniferous Sb	10.3	93.2	10.1	0.0	0.3	89.3	0.0	10.4	0.0
Subarctic	Wet Open Coniferous Sb-Lt	9.2	94.5	8.5	0.0	1.4	54.9	0.0	43.7	0.0
Subarctic	Shrubby Fen	3.4	42.2	2.6	0.0	0.0	50.0	0.0	0.0	0.0
Subarctic	Graminoid Fen	0.1	0.8	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Subarctic	Low Shrub Wetland	6.2	93.5	6.7	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Bog	6.2	93.5	6.7	0.0	0.0	100.0	0.0	0.0	0.0
Subarctic	Marsh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Upland Shrub	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Recent Cutblocks	0.5	5.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Old Cutblocks	2.0	20.0	5.0	10.0	30.0	5.0	0.0	0.0	45.0
Subarctic	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subarctic	Water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Ecoregion	Ecosite	PBP	BWP	CONP	DECP	TOTP	Moisture	CanClos	DomTree
Boreal Mixedwood	Mixed Deciduous	18.0	0.0	6.1	93.9	100.0	m	C	AW
Boreal Mixedwood	Mixedwood-Sw/Aw	9.8	1.8	48.3	51.2	100.0	m	B	SW
Boreal Mixedwood	Coniferous-Sw	2.4	0.0	92.5	7.3	100.0	m	B	SW
Boreal Mixedwood	Coniferous-Sw/Pj	0.0	0.0	90.6	8.1	100.0	m	B	PJ
Boreal Mixedwood	Coniferous-Pj/Sw/Sb	0.0	0.0	89.3	3.9	99.9	m	B	PJ
Boreal Mixedwood	Open Pine	0.0	0.0	96.5	3.5	100.0	m	B	PJ
Boreal Mixedwood	Pine Regen	0.0	0.0	0.0	0.0	0.0	m	A	NA
Boreal Mixedwood	Upland Sb-Lt	0.0	0.0	50.2	0.6	100.0	m	B	SB
Boreal Mixedwood	Wet Closed Coniferous Sb	0.0	0.0	86.3	0.0	100.0	w	B	SB
Boreal Mixedwood	Wet Open Coniferous Sb-Lt	0.0	0.0	48.8	0.0	100.0	w	B	SB
Boreal Mixedwood	Shrubby Fen	0.0	3.7	74.3	3.7	100.0	w	A	SB
Boreal Mixedwood	Graminoid Fen	0.0	0.0	0.0	0.0	0.0	w	O	NA
Boreal Mixedwood	Low Shrub Wetland	0.0	0.0	99.3	0.7	100.0	w	A	SB
Boreal Mixedwood	Bog	0.0	0.0	99.3	0.7	100.0	w	A	SB
Boreal Mixedwood	Marsh	0.0	0.0	0.0	0.0	0.0	a	O	NA
Boreal Mixedwood	Upland Shrub	0.0	0.0	0.0	0.0	0.0	w	O	NA
Boreal Mixedwood	Recent Cutblocks	0.0	0.0	0.0	0.0	0.0	m	O	NA
Boreal Mixedwood	Old Cutblocks	10.0	0.0	45.0	55.0	100.0	m	B	AW
Boreal Mixedwood	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	d	O	NA
Boreal Mixedwood	Water	0.0	0.0	0.0	0.0	0.0	a	O	NA
Boreal Highlands	Mixed Deciduous	1.1	0.0	8.0	92.0	100.0	m	C	AW
Boreal Highlands	Mixedwood-Sw/Aw	0.0	3.9	45.1	54.9	100.0	m	B	AW
Boreal Highlands	Coniferous-Sw	0.0	2.7	94.6	5.4	100.0	m	B	SW
Boreal Highlands	Coniferous-Sw/Pj	0.0	0.0	100.0	0.0	100.0	m	B	SW
Boreal Highlands	Coniferous-Pj/Sw/Sb	0.0	0.0	97.6	2.3	99.9	m	B	SW
Boreal Highlands	Open Pine	0.0	0.0	100.0	0.0	100.0	m	B	PJ
Boreal Highlands	Pine Regen	0.0	0.0	0.0	0.0	0.0	m	A	NA
Boreal Highlands	Upland Sb-Lt	0.0	0.0	50.2	0.6	100.0	m	B	SB
Boreal Highlands	Wet Closed Coniferous Sb	0.0	0.0	90.6	0.0	100.0	w	B	SB
Boreal Highlands	Wet Open Coniferous Sb-Lt	0.0	0.0	57.8	0.0	100.0	w	A	SB
Boreal Highlands	Shrubby Fen	0.0	0.0	50.0	0.0	50.0	w	A	SB
Boreal Highlands	Graminoid Fen	0.0	0.0	0.0	0.0	100.0	w	O	NA
Boreal Highlands	Low Shrub Wetland	0.0	0.0	0.0	0.0	0.0	w	A	SB
Boreal Highlands	Bog	0.0	0.0	0.0	0.0	0.0	w	A	SB
Boreal Highlands	Marsh	0.0	0.0	0.0	0.0	0.0	a	O	NA
Boreal Highlands	Upland Shrub	0.0	0.0	0.0	0.0	0.0	w	O	NA
Boreal Highlands	Recent Cutblocks	0.0	0.0	0.0	0.0	0.0	m	O	NA
Boreal Highlands	Old Cutblocks	10.0	0.0	45.0	55.0	100.0	m	B	AW
Boreal Highlands	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	d	O	NA
Boreal Highlands	Water	0.0	0.0	0.0	0.0	0.0	a	O	NA
Subarctic	Mixed Deciduous	2.8	10.7	12.8	87.2	100.0	m	B	AW
Subarctic	Mixedwood-Sw/Aw	1.2	6.7	51.8	48.2	100.0	m	B	AW
Subarctic	Coniferous-Sw	0.0	4.8	95.2	4.8	100.0	m	B	AW
Subarctic	Coniferous-Sw/Pj	0.0	0.0	100.0	0.0	100.0	w	B	SB
Subarctic	Coniferous-Pj/Sw/Sb	0.0	1.4	98.6	1.4	100.0	m	B	SB
Subarctic	Open Pine	0.0	0.0	100.0	0.0	100.0	m	B	PJ
Subarctic	Pine Regen	0.0	0.0	0.0	0.0	0.0	m	A	NA
Subarctic	Upland Sb-Lt	0.0	0.0	50.2	0.6	100.0	m	B	SB
Subarctic	Wet Closed Coniferous Sb	0.0	0.0	89.6	0.0	100.0	w	B	SB
Subarctic	Wet Open Coniferous Sb-Lt	0.0	0.0	56.3	0.0	100.0	w	A	SB
Subarctic	Shrubby Fen	0.0	0.0	50.0	0.0	50.0	w	A	SB
Subarctic	Graminoid Fen	0.0	0.0	0.0	0.0	100.0	w	O	NA
Subarctic	Low Shrub Wetland	0.0	0.0	0.0	0.0	0.0	w	A	SB
Subarctic	Bog	0.0	0.0	100.0	0.0	100.0	w	A	SB
Subarctic	Marsh	0.0	0.0	0.0	0.0	0.0	a	O	NA
Subarctic	Upland Shrub	0.0	0.0	0.0	0.0	0.0	w	O	NA
Subarctic	Recent Cutblocks	0.0	0.0	0.0	0.0	0.0	m	O	NA
Subarctic	Old Cutblocks	10.0	0.0	45.0	55.0	100.0	m	B	AW
Subarctic	Natural Disturbances	0.0	0.0	0.0	0.0	0.0	d	O	NA
Subarctic	Water	0.0	0.0	0.0	0.0	0.0	a	O	NA

APPENDIX IV

SPECIES OCCURRENCE BY

VEGETATION TYPE

Table 1 Potential and Observed 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	Paper Birch Forest
red-throated loon	x									
arctic loon	x									
common loon	x						P			
pied-billed grebe	x						P	x		
horned grebe	x						P	x	P	
red-necked grebe	x						P	x		
eared grebe	x							x		
western grebe	x									
American white pelican	x						P			
cormorant	x						P	x		
American bittern						x	P	x	P	
great blue heron	x		x	x	P	x	P	x		P
great egret	x					x		x		
tundra swan	x									
trumpeter swan	x									
goose	x									
snow goose	x									
Ross' goose	x									
Canada goose	x						P		P	
wood duck	x					x		x		
green-winged teal	x					x	P	x	P	
American black duck	x					x		x		
mallard	x				x	x	P	x	P	x
northern pintail	x					x	P	x	P	
blue-winged teal	x					x	P	x	P	
cinnamon teal	x					x		x		
northern shoveler	x					x	P	x	P	
gadwall	x					x	P	x	P	
Eurasian wigeon	x					x		x		
American wigeon	x					x	P	x	P	
canvasback	x					x	P	x	P	
redhead	x					x	P	x	P	
ring-necked duck	x					x	P	x	P	
greater scaup	x					x		x		
lesser scaup	x					x	P.	x	P	
harlequin duck										
oldsquaw	x									
surf scoter	x					x		x		
white-winged scoter	x					x		x		
common goldeneye	x				P	x	P	x		P
Barrow's goldeneye	x					x		x		
bufflehead	x				x	x	P	x		x
hooded merganser	x					x	P	x	P	
common merganser	x					x	P	x		
merganser	x					x	P	x		
ruddy duck	x						P	x	P	
osprey	x						P		P	
bald eagle	x				x		P			x
northern harrier						x	P	x	P	
sharp-shinned hawk		P	P	P	P				x	P
Cooper's hawk										
northern goshawk			P							
broad-winged hawk			x		P				P	P
Swainson's hawk										
red-tailed hawk		P	P	P	P					P
rough-legged hawk		M								
golden eagle									P	
American kestrel			x		P		P			P
merlin							P		P	
peregrine falcon	x						P	x	P	
gyrfalcon		G								
spruce grouse		P	P	P					P	
willow ptarmigan		M								
ruffed grouse			P		P					P
sharp-tailed grouse							P		P	

X. indicates species observed on Lease 13.
P. indicates species potentially on Lease 13.

Table 1 Potential and Observed 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	Paper Birch Forest
sora					x	x	P	x	P	x
American coot	x					x	P	x	P	
sandhill crane						x	P	x	P	
whooping crane										
black-bellied plover										
lesser golden plover										
semipalmated plover							P			
killdeer							P		P	
American avocet	x							x		
greater yellowlegs						x		x	y	
lesser yellowlegs						x		x	P	
solitary sandpiper						x	P	x	P	
willet								x		
spotted sandpiper							P	x	x	
upland sandpiper										
whimbrel										
hudsonian godwit										
marbled godwit							P		x	
ruddy turnstone										
sanderling										
sandpiper										
western sandpiper										
least sandpiper							P		P	
sandpiper										
Baird's sandpiper										
pectoral sandpiper										
dunlin										
stilt sandpiper										
sandpiper										
short-billed dowitcher									P	
long-billed dowitcher										
common snipe			x	x	x	x		x	P	x
Wilson's phalarope	x					x	P	x	P	
red-necked phalarope	x					x		x		
red phalarope	x					x		x		
Franklin's gull	x					x	P	x	P	
Bonaparte's gull	x					x	P	x	P	
mew gull	x						P	x		
ring-billed gull	x						P	x		
California gull	x						P	x		
herring gull	x						P	x		
Iceland gull	x							x		
glaucous gull	x							x		
Caspian tern	x									
common tern	x					x	P	x	P	
arctic tern	x							x		
black tern	x					x	P	x	P	
rock dove										
mourning dove		G								
great-horned owl		P	P	P	P		P		P	P
snowy owl		M								
northern hawk owl		P	P			x			P	
barred owl										
great gray owl		P	P	P	P	x	P		P	P
long-eared owl										
short-eared owl						x		x		
boreal owl			x	P					P	
common nighthawk										
belted kingfisher						x	P	x	P	
sapsucker			P	x	P					P
downy woodpecker			P		P					P
hairy woodpecker		P	P	P	P					P
three-toed woodpecker		P	P	P					x	
woodpecker		P	P	P					x	
northern flicker		P	x	x	P					P

X. indicates species observed on Lease 13.
P. indicates species potentially on Lease 13.

Table 1 Potential and Observed 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	Paper Birch Forest
pileated woodpecker			P	x	P					P
olive-sided flycatcher		P	x			x	P		P	
great-crested flycatcher			x	x	P					P
western wood-pewee		P	P	x	x	x	P	x	P	P
flycatcher		P	x	x	x				x	x
alder flycatcher			x	x	x		P		x	x
least flycatcher			x						x	x
eastern phoebe			P		P	x	P		P	P
Say's phoebe							P			
eastern kingbird			x		P	x	P		P	P
horned lark					P					P
tree swallow			x		P	x	P	x	P	P
bank swallow							P	x		
cliff swallow							P	x		
barn swallow							P	x		
gray jay		P	x	x	x				x	x
blue jay			P		P					P
black-billed magpie		P	x		P		P			P
American crow		P	x	x	P				P	P
common raven		P	x	P	x		P		P	x
chickadee			P		P					P
boreal chickadee		P	P	x			P		x	
red-breasted nuthatch		P	P	x					x	
brown creeper		P	P	P						
house wren		P								
winter wren		P	x	P					x	
marsh wren						x	P	x	P	
golden-crowned kinglet		P	x	P						
ruby-crowned kinglet		P	x	x	x				x	x
mountain bluebird			x		P				P	P
veery										
gray-cheeked thrush										
Swainson's thrush			x	x	x		P		x	x
hermit thrush		P	x	x	x				x	x
American robin			x	P			P			
northern mockingbird		P								
brown thrasher		P								
American pipit									P	
Bohemian waxwing		P	x	P			P			
cedar waxwing			x	x	P		P		x	P
northern shrike										
European starling			x		P					P
solitary vireo			x						x	
warbling vireo			P		P					P
Philadelphia vireo			x		x				x	x
red-eyed vireo			x	x	x		P			x
Tennessee warbler			x	x	x	x	P	x	x	x
warbler			x		P		P		x	P
yellow warbler						x	P		x	
magnolia warbler		P	x	x	x		P		y	x
Cape May warbler			x	P						
yellow-rumped warbler		P	x	x	x				y	x
warbler		P	x	P						
palm warbler			x	x	x	x			x	x
bay-breasted warbler				P	x				P	x
blackpoll warbler			x	P					x	
warbler			x	x	x		P		P	x
American redstart			x	x	P		P		x	P
ovenbird			x	x	x				x	x
northern waterthrush			x	x		x	P	x	x	
Connecticut warbler			x	x	x				P	x
mourning warbler			x		P					P
common yellowthroat			x	x		x	P	x	P	
Wilson's warbler			x				P		P	
Canada warbler			x		x		P		P	x

X. indicates species observed on Lease 13.
P. indicates species potentially on Lease 13.

Table 1 Potential and Observed 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	Paper Birch Forest
western tanager			x		x				x	x
grosbeak			x	x	x					x
indigo bunting		G								
American tree sparrow							P		P	
chipping sparrow			x	x	x				x	x
clay-colored sparrow						x	P		P	
vesper sparrow									P	
savannah sparrow						x		x	P	
LeConte's sparrow			x			x		x	x	
sharp-tailed sparrow						x	P	x	P	
fox sparrow							P		P	
song sparrow						x	P	x	P	
Lincoln's sparrow						x	P	x	P	
swamp sparrow						x	P	x	x	
white-throated sparrow		P	x	x	x		P		x	x
white-crowned sparrow							P		P	
Harris' sparrow		M								
dark-eyed junco		P	P	x					x	
Lapland longspur		M								
Smith's longspur		M								
snow bunting		M								
bobolink		G								
red-winged blackbird					x	x	P	x	P	x
western meadowlark		G								
blackbird						x	P	x	P	
rusty blackbird						x	P		P	
Brewer's blackbird					P	x	P		P	P
common grackle						x	P		P	
brown-headed cowbird						x				
northern oriole										
pine grosbeak										
purple finch			P	P	P					P
red crossbill		P	P	P	P					P
white-winged crossbill			P	x	x				x	x
common redpoll			x	x	P				P	P
hoary redpoll		M								
pine siskin		P	P	P	x				x	x
American goldfinch										
evening grosbeak			P	P	P				x	P
house sparrow										
Species Richness	63	48	81	57	66	70	97	78	112	67
Richness Index	0.23	0.00	0.52	0.14	0.28	0.34	0.77	0.47	1.00	0.30

X. indicates species observed on Lease 13.
P. indicates species potentially on Lease 13.

Table 2 Potential and Observed 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/ShrubbP Fen	Riparian
masked shrew		P	P	P	P		
duskP shrew				P			P
water shrew						P	P
arctic shrew			P		P		
pPgmP shrew		P	P	P	P		
little brown bat	P					P	P
northern long-eared bat	P	P	P	P	P	P	P
silver-haired bat	P		P		P	P	P
big brown bat	P					P	P
hoarP bat	P	P	P	P	P	P	P
snowshoe hare		P	P	P	x		
least chipmunk		P	P	P	x		
woodchuck			P				
red squirrel		P	P	P			
northern flPing squirrel		P	P	P			
beaver	x					x	P
deer mouse		P	P	P	P		
southern red-backed vole		P	x	P	P		
heather vole		P					P
meadow vole			P		P	P	P
muskrat	x					x	P
northern bog lemming				x		x	P
meadow jumping mouse						x	P
porcupine			P		P		
coPote		P	P	P	P		P
graP wolf		P	P	P	P		
red fox		P	P	P	P		P
black bear		P	P	P	P		
marten		P		P		x	
fisher		P		P		x	
ermine		P	P	P			
least weasel		P	P	P			
mink				x		x	P
wolverine		P	x	P			
striped skunk			P	P	P		
river otter	x					x	P
canada lPnx		P	P	P			
mule deer			P		P		
white-tailed deer			P		P		
moose			P	P	P	x	P
caribou			x	P			
Species Richness	8	21	28	26	20	16	18
Richness Index	0.00	0.62	0.95	0.86	0.57	0.38	0.48

x indicates species observed on Lease 13
P indicates species potentiallP on Lease 13

Table 3 Potential and Observed 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)	Paper Birch Forest
Canadian toad		x	x	x	x	x	P	x	P	x
stripped chorus frog						x	P	x	P	
wood frog						x	P	x	P	
red-sided garter snake		x	x	x	x	x	P	x	P	x
Species Richness	0	2	2	2	2	4	4	4	4	2
Richness Index	0.00	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	0.50

x indicates species observed on Lease 13

P indicates species potentially on Lease 13

APPENDIX V

MODEL VERIFICATION RESULTS

V MODEL VERIFICATION RESULTS

V.1 COMPARISON OF HSI MODEL PREDICTIONS WITH WILDLIFE DATA FROM THE LSA

An important step in the HSI modelling process in the verification of models with field data. While the wildlife field program was not designed to test the models, the data selected was used in this Appendix to determine if any broad relationships between HSI values and KIR observations existed. A summary of HSI ratings across 13 generalized vegetation types for the 12 KIR wildlife species is given in Table 1. These values do not incorporate spatial juxtaposition of polygons, thus should only be considered to be estimates of habitat value for those models that involve spatiality. Generalized vegetation types were used so that the data would be split into fewer categories thus maintaining appropriate sample sizes.

Table 1 Summary of HSI Values for KIRs by Vegetation Types

Vegetation Type	Beaver	Black Bear	Cape May	Ducks	Fisher	Owl	Owl	Moose	Moose	Wood-pecker	Vole	Grouse	Hare	Tananger
	HSI	HSI	HSI	HSI	HSI	HSI cover	HSI food	HSI food	HSI cover	HSI	HSI	HSI	HSI	HSI
Jack Pine	0.19	0.82	0.51	0.00	0.81	0.68	0.51	0.17	0.98	0.43	0.69	0.28	0.44	0.85
White Spruce	0.38	0.74	0.85	0.00	0.88	0.82	0.52	0.34	1.00	0.69	0.86	0.33	0.66	0.90
Mixedwood	0.86	0.86	0.73	0.00	0.81	0.92	0.28	0.49	0.91	0.75	0.96	0.71	0.81	0.90
Mixed Coniferous	0.17	0.85	0.50	0.00	0.86	0.63	0.12	0.27	0.92	0.42	0.95	0.36	0.76	0.66
Deciduous	1.00	0.91	0.00	0.00	0.76	0.92	0.34	0.62	0.70	0.93	0.94	0.88	0.78	0.35
Wet Open Coniferous - Sb/Lt	0.61	0.49	0.34	0.00	0.73	0.50	0.28	0.50	0.67	0.20	0.91	0.23	0.88	0.03
Wet Closed Coniferous - Sb	0.26	0.55	0.46	0.00	0.81	0.50	0.17	0.29	0.77	0.21	0.83	0.23	0.78	0.04
Shrubby Fen	1.00	0.35	0.53	0.00	0.57	0.25	0.38	0.97	0.17	0.16	0.70	0.24	0.95	0.01
Open Bog	0.33	0.46	0.57	0.00	0.55	0.25	0.24	0.32	0.19	0.14	0.66	0.14	0.73	0.02
Wet Shrubland	1.00	0.57	0.00	0.00	0.50	0.00	0.40	1.00	0.00	0.00	0.42	0.35	0.95	0.00
Marsh	0.00	0.00	0.00	1.00	0.13	0.00	0.50	0.00	0.00	0.00	0.00	0.02	0.20	0.00
Disturbed/Cleared	0.58	0.10	0.00	0.00	0.38	0.00	0.90	0.59	0.00	0.00	0.31	0.11	0.61	0.00
Open Water	0.00	0.00	0.00	0.66	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.20	0.00

Table 2 provides a summary of relative abundance field data collected in the LSA for the KIRs. Incidental sightings are also noted.

Spearman rank correlation analysis was used to examine the association between observed relative abundance and predicted habitat suitability ratings for the Cape May warbler, western tanager, grouse, pileated woodpecker, fisher, and snowshoe hare. An implicit assumption in this analysis is that the measures of relative abundance reflect habitat use by each species within the LSA. Although all ecosites were sampled during field surveys, effort was not proportionate to area of ecosites; also, sample sizes are small for most species. Results must therefore be considered preliminary, but they are a useful start for the model validation process using independent data for an oil sands area. A qualitative comparison of field data to HSI ratings is made for the KIRs not compared statistically, because of very small sample sizes.

Table 2 Relative Abundance Data for KIRs

		Jack Pine	White Spruce	Mixedwood	Mixed Coniferous	Deciduous	Wet Open Coniferous Sb/Lt	Wet Closed Coniferous sb	Shrubby Fen	Open Bog	Wet Shrubland	Marsh	Disturbed /Cleared	Open Water
Beaver	Incidental													
Black Bear	Track Survey (bear trees)					1								
	point counts (scat)					1		1						
Cape May Warbler	point counts		1	1		1		2						
Dabbling Ducks	aerial survey (estimated numbers)													158
Fisher	track survey (tracks/km-track day)			6.44		0.89		11.8		4.92				
Great Gray Owl	Incidental	2												
Moose	Incidental					1					1			
	point counts (pellets observed)			1		3		4						
	Browse/Pellet					4			3					
	track survey (tracks/km-track day)			7.62		14.15					0.35			
Pileated Woodpecker	point counts			1		1	3	4						
Vole	track survey (tracks/km-track day)			0.3				0.9		1.7				
Ruffed Grouse	track survey (tracks/km-track day)	0.33		0.13	4			41.9		2.22				
	Incidental			4		2							1	
Snowshoe Hare	Incidental							1			1			
	track survey (tracks/km-track day)	21.83	3.45	208.96	114.78	2.51		205.24		230.07	5.02			
Western Tanager	point counts		5	5		7		1						

Table 3 **Relationship Between Relative Abundance and HSI Ratings for Several Species Inhabiting the Millennium LSA.**

Species	Correlation Coefficient	P-Value
Cape May warbler	0.37	>0.10
Western tanager	0.62	<0.05
Grouse grouse	0.44	>0.10
Pileated woodpecker	0.47	>0.10
Fisher	0.21	>0.20
Snowshoe hare	0.04	>0.50

NOTE: A total of 13 ecosites (habitats) were evaluated.

All correlations were positive, however the only significant association was for the western tanager, where model predictions were well supported by field data. The correlation for the snowshoe hare was very low. Lack of significance for other bird species and the fisher was likely mainly due to a limited amount of observations for all habitat types.

For the Cape May warbler, records came from four ecosites, two of which had predicted high HSI ratings, one moderate and one low. The grouse HSI model concerned ruffed grouse, however grouse relative abundance track data did not distinguish between grouse species. Most grouse tracks were seen in the wet closed coniferous ecosite, which was predicted to have a low HSI rating. Incidental sightings of ruffed grouse did come from two high ranked ecosites plus one low ranked site. Pileated woodpecker records came from two high ranked ecosites and two low ranked sites, although most were in the lower ranked areas. Fisher tracks were recorded in three ecosites with high ratings and one with a moderate rating.

Although there were a large number of observations for snowshoe hares across several ecosites, there was poor correlation between area use and HSI model predictions. The model predicted most ecosites to have high suitability for hares. Although most tracks were seen in high rated ecosites, other high rated ecosites had few or no tracks. Additional sampling would be needed to see if the same trends are found, which would mean that the hare model requires modification for the oil sands area.

No beaver data were available for use in this comparison to HSI predictions. Black bear signs were seen in high and medium rated ecosites. Dabbling ducks were only recorded from open water, which had a 0.66 rating, during aerial surveys, however some of these areas would also have associated marsh habitat. Two great gray owls were seen in jack pine, which had a high rating for cover and a medium rating for food. For the moose model, the HSI rating for food is often higher when the HSI rating for cover is lower. Most moose records from all methods were from the deciduous ecosite, which was rated high for cover and moderate for food.

While the results of these verfications suggest that the HSI models may be accurate for some KIRs, a work program should be initiated to further validate the models. It is suggested that a regional, multi-industry, monitoring program be initiated to conduct this important work.