Appendix 15-A

Terrestrial Wildlife and Vegetation Baseline Report

HARPER CREEK PROJECT

Application for an Environmental Assessment Certificate / Environmental Impact Statement

Harper Creek Mine Project

Terrestrial Wildlife and Vegetation Baseline Report

Prepared for

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EXECUTIVE SUMMARY

The Harper Creek Project (the Project) is a proposed open pit copper mine located in south-central British Columbia (BC), approximately 150 km northeast by road from Kamloops. The Project has an estimated 28-year mine life based on a process plant throughput of 70,000 tonnes per day. The Proponent, Harper Creek Mining Corporation, is a wholly owned subsidiary of Yellowhead Mining Inc., which is a public BC junior mineral development company trading on the Toronto Stock Exchange.

A baseline assessment of Terrestrial Wildlife and Vegetation was conducted to describe conditions within the mine study area, in support of the Application for an Environmental Assessment (EA) Certificate under the British Columbia Environmental Assessment Act (BC EAA) and the Environmental Impact Statement (EIS) under the Canadian Environmental Assessment Act (CEAA).

Baseline studies were guided by the requirements defined in the Approved Project Application Information Requirements (AIR) issued October 21, 2011, along with input from government, First Nations, and other stakeholders. Methods focused on quantifying or qualitatively describing wildlife and vegetation resources in the Project study area.

Twenty-eight Valued Components (VCs) were identified as the focus of terrestrial baseline studies. A combination of general and species-specific field surveys, ecosystem mapping, habitat suitability mapping, literature review and discussions with experts was used to determine presence and distribution within the Project study area.

Forty rare plants were observed within the Local Study Area (LSA) during baseline studies for the Project, including nine vascular plant species, six mosses and 25 lichens. None of these species were *SARA*-listed. Two vascular plant species and one moss species were identified that are believed to be newly-described to science, while four lichens were discovered that have not been recorded in BC previously. Many of these were located at the Project site area, within wetlands and subalpine meadow habitats at higher elevations in the LSA. Calcareous cliffs in the valley bottom near Vavenby also contained many of the rare lichen and moss species.

Three Ecological Communities at Risk (ECAR) were identified within the LSA using Terrestrial Ecosystem Mapping (TEM). One of these was relatively common at lower elevations of the LSA, while the remaining two ECAR were limited in distribution and only found at higher elevations, within and adjacent to the Project site area.

Wetlands were mapped throughout the LSA using the TEM. Eight wetland site series were identified: five fens and three swamps. A total of 208.7 ha of wetlands were mapped, with the majority of wetland in the LSA being located at higher elevations near the Project site area, including within the proposed TMF footprint. Water-sedge / peat-moss wetlands (Wf03) were the most common wetland site series.

Wetland distribution was also placed within a regional context through an analysis of wetlands within Vegetation Resource Inventory (VRI) mapping for the RSA. The LSA is composed of about 1.8% wetlands when compared to 0.8% within the RSA.

Old-growth forests were mapped using the TEM. Approximately 28% of the LSA was mapped as old-growth forest, much of which is found at higher elevations. However much of the LSA is also composed of forest that was likely logged in the past 40 years. The interspersion of cutblocks with old-growth forest has left the LSA very fragmented.

Butteflies, damselflies and dragonflies were surveyed in the LSA using netting surveys. During netting surveys, 42 butterfly species, three damselfly species and nine dragonfly species were observed. No species of conservation concern were identified.

Road encounter surveys, pond surveys, larval surveys, and habitat suitability mapping were all conducted to identify western toad presence and distribution within the LSA. Western toads were found to occur throughout the LSA, and appear to be relatively common throughout. Breeding sites were confirmed during pond surveys at higher elevations, within the Project site area and in particular within the TMF. Suitable habitat was mapped at all elevations, and it is expected that breeding also takes place at lower elevations within the LSA.

Barn Swallows presence and distribution within the LSA was assessed using a combination breeding bird surveys and habitat suitability mapping. This species was concentrated at low elevations along the North Thompson River, in proximity to the town of Vavenby.

Common Nighthawks were surveyed using call-playback methods to elicit responses from territorial males. Common Nighthawks were observed during baseline surveys to occur at low elevations, mainly over farm fields along the valley bottom of the North Thompson River.

Olive-sided Flycatcher presence and distribution within the LSA was assessed using breeding bird surveys and habitat suitability mapping. Individuals and suitable habitat occur throughout the LSA, wherever forest opening edges are found.

Bald Eagles were surveyed using eagle nest surveys and habitat suitability mapping. One active eagle nest was observed on the western edge of the LSA, along the valley bottom of the North Thompson River. Additional suitable nesting habitat was identified along the valley bottom as well.

Northern Goshawks were surveyed using call-playback methods. Though none were observed during targeted surveys, two were observed incidentally during other baseline studies within the LSA. Suitable nesting habitat was identified primarily at lower elevations, but no nest sites were observed.

Five bat species were identified as VCs for the baseline assessment. Three of these were confirmed to be present within the LSA using acoustic detection and capture methods: fringed myotis, little brown myotis, and northern myotis. Fringed myotis appears to exist in low densities within the LSA, while little brown myotis and northern myotis are much more common and found throughout. The remaining two bat species, Townsend’s big-eared bat and western small-footed myotis, were not observed and may not be present.

To assess the LSA for grizzly bear, habitat suitability was mapped for the species, surveys were conducted to identify den sites in suitable habitat in the RSA, and a road density analysis was performed. One den site was located and suitable habitat was identified for spring, summer and fall. Spring habitat was found to be the most limiting foraging habitat, and the LSA does not appear to contain any suitable denning habitat. Two grizzly bear tracks were observed incidentally during other baseline surveys. Although grizzlies are present, road densities are high, which likely limit grizzly use in this area.

Moose use of the LSA was assessed using habitat suitability mapping and snow-tracking surveys. Moose distribution within the LSA appears to be seasonally-dependent. During the winter, snow conditions typically limit moose to lower-elevations. During the growing season, moose distribution is expected to be less-concentrated, spreading throughout the LSA. Security/thermal habitat is common in the LSA and likely not limiting. However moderate value growing season forage habitats, according to the habitat suitability mapping, may be more restricted.

Mountain caribou were assessed within the LSA using habitat suitability mapping, snow-tracking surveys and road density analysis. Based on historic and recent observations, mountain caribou appear to use the LSA infrequently. Although the LSA contains suitable habitat for most seasons of potential use, it has been heavily fragmented by road construction and forest harvesting for years which is likely the primary cause of infrequent use.

Mule deer use of the LSA was assessed using snow-tracking surveys. Mule deer distribution in the LSA is seasonally-dependent similar to moose. Snow depth has an even greater effect on deer distribution than moose, concentrating the majority of deer in the valley bottom. During the growing season, mule deer are expected to be well-distributed in the LSA due to their adaptability and diverse habitat preferences.

Fisher and wolverine were surveyed in the LSA using snow-tracking surveys and road density analysis. Both of these species were observed in low numbers. Road density and anthropogenic use may be affecting baseline densities of wolverine in the LSA.

Rock outcrops, Great Blue Herons, Harlequin Ducks, Western Screech-owls, and Mountain Goats were all identified as potential VCs for baseline studies, but none were identified during surveys within the LSA. These VCs may not occur, or only occur infrequently, within the LSA.

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GLOSSARY AND ABBREVIATIONS

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

Acronym	**Definition**
AIR	Application Information Requirements
ATV	All-terrain Vehicle
BC	British Columbia
BCEAA	*British Columbia Environmental Assessment Act*
BCEAO	British Columbia Enviromental Assessment Office
BCWA	*BC Wildlife Act*
BGC	Biogeoclimatic
BMP	Best Management Practice
CDC	Conservation Data Centre
CDWR	Critical Deer Winter Range (LRMP)
CEA Agency	Canadian Environmental Assessment Agency
CEAA	*Canadian Environmental Assessment Act*
CEE	Cumulative Environmental Effects
CMWR	Critical Moose Winter Range (LRMP)
COH	Columbia Highlands
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWD	Coarse Woody Debris
DBH	Diameter-at-breast-height
DWR	Deer Winter Range
EA	Environmental Assessment
ECAR	Ecological Community At Risk
EIS	Environmental Impact Statement
ESSFwc2	Northern Monashee Wet Cold Engelmann Spruce – Subalpine Fir variant
ESSFwcw	Wet Cold Engelmann Spruce – Subalpine Fir Woodland subzone
ESSFwcp	Wet Cold Engelmann Spruce – Subalpine Fir Parkland subzone
FRPA	*Forest and Range Practices Act*
FSR	Forest Service Road
GBPU	Grizzly Bear Population Unit
GIS	Geographic Information System
GPS	Global Positioning System
GWM	General Wildlife Measure
GWR	Goat Winter Range
HCMC	Harper Creek Mining Corporation
ICHdw3	North Thompson Dry Warm Interior Cedar – Hemlock variant
ICHmw3	Thompson Moist Warm Interior Cedar – Hemlock variant
ICHwk1	Wells Gray Wet Cool Interior Cedar – Hemlock variant
IDFmw2	Thompson Moist Warm Interior Douglas-Fir variant
IPCBC	Invasive Plant Council of British Columbia
IWMS	Identified Wildlife Management Strategy

kV	Kilovolt
LRMP	Land and Resource Management Plan
LSA	Local Study Area
LU	Landscape Unit
MBCA	*Migratory Birds Convention Act*
MBR	Migratory Birds Regulations
MELP	Ministry of Environment, Lands and Parks
MOE	Ministry of Environment
MOF	Ministry of Forests
MOFLNRO	Ministry of Forests, Lands and Natural Resource Operations
MOFR	Ministry of Forests and Range
MU	Management Unit
MW	Megawatt
MWLAP	Ministry of Water, Land and Air Protection
MWR	Moose Winter Range
NAD	North American Datum
OGMA	Old Growth Management Area
PAG	Potentially Acid Generating
RIC	Resources Inventory Committee
RISC	Resources Information Standards Committee (formerly RIC)
ROW	Right-of-way
RSA	Regional Study Area
SARA	*Species At Risk Act*
SFMP	Sustainable Forestry Management Plan
NSH	Northern Shuswap Highland
SIM	Southern Interior Mountains
TEM	Terrestrial Ecosystem Mapping
TMF	Tailings Management Facility
TRIM	Terrain Resource Information Mapping
TLUS	Traditional Land Use Study
TSA	Timber Supply Area
UTM	Universal Transverse Mercator
UWR	Ungulate Winter Range
VC	Valued Component
VRI	Vegetation Resource Inventory
WHA	Wildlife Habitat Area
WHR	Wildlife Habitat Ratings
WNS	White-nose Syndrome

1.0 INTRODUCTION

1.1 Project Description

Harper Creek Mining Corporation (HCMC) proposes to construct and operate the Harper Creek Project (the Project), an open pit copper mine near Vavenby, British Columbia (BC). The Project has an estimated 28-year mine life based on a process plant throughput of 70,000 tonnes per day (25 million tonnes per year). Ore will be processed on site through a conventional crushing, grinding and flotation process to produce a copper concentrate, with gold and silver by-products, which will be trucked from the Project Site along approximately 24km of existing access roads to a rail load-out facility located at Vavenby. The concentrate will be transported via the existing Canadian National Railway network to the existing Vancouver Wharves storage, handling and loading facilities located at the Port of Vancouver for shipment to overseas smelters.

The Project consists of an open pit mine, on-site processing facility, tailings management facility (TMF) (for tailings solids, subaqueous storage of PAG waste rock, and recycling of water for processing), waste rock stockpiles, low grade and overburden stockpiles, a temporary construction camp, ancillary facilities, mine haul roads, sewage and waste management facilities, a 24km access road between the Project Site and a rail load-out facility located on private land owned by HCMC in Vavenby, and a 12km power line connecting the Project Site to the BC Hydro transmission line corridor in Vavenby. The Project location and infrastructure is shown in Figure 1.

This report describes the baseline conditions of Terrestrial Wildlife and Vegetation for the purposes of the Application for an Environmental Assessment (EA) Certificate under the British Columbia Environmental Assessment Act (BC EAA) and the Environmental Impact Statement (EIS) under the Canadian Environmental Assessment Act (CEAA) in accordance with the Approved Project Application Information Requirements (AIR) issued October 21, 2011.

1.2 Project Location

The Project is located in the Thompson-Nicola area of BC, approximately 150km north-east of Kamloops along Yellowhead Highway #5, approximately 10 km southwest of the unincorporated municipality of Vavenby, BC. The Project is located within National Topographic System (NTS) map sheets 82M/5 and 82M/12, is geographically centred at 51º30'N latitude and 119º48'W longitude, and is situated at approximately 1800 Metres above sea level (masl). The mineral claims comprising the Project cover an area of 42,636.48 hectares.

1.3 Project Proponent

The Proponent of the Project is HCMC, a wholly owned subsidiary of Yellowhead Mining Inc. (YMI). YMI was formed in 2005 as a private BC company specifically to acquire, explore and, if feasible, develop the Project. YMI is now a publicly owned BC based mineral development company trading on the Toronto Stock Exchange (TSX) in Canada. HCMC's strategy is to engineer, permit, finance, construct, and operate the Project.

1.4 Project Setting

The Project is located in south-central British Columbia, west of Vavenby and east of Clearwater. It is within the Northern Shuswap Highland (NSH) ecosection of BC, encompassed by the Columbia Highlands (COH) ecoregion and Southern Interior Mountains (SIM) ecoprovince. It primarily overlaps the watersheds of Jones Creek and Baker Creek (tributaries of the North Thompson River), and Harper Creek (a tributary of the Barriere River).

Biogeoclimatic (BGC) variants are large-scale ecosystem groupings based on a combination of climate, existing organisms, topographic relief, soil and geological material present, and the history of an area. The Project area is composed of the following BGC variants: the Thompson Moist Warm Interior Douglas-Fir variant (IDFmw2), the North Thompson Dry Warm Interior Cedar – Hemlock variant (ICHdw3), the Thompson Moist Warm Interior Cedar – Hemlock variant (ICHmw3), the Wells Gray Wet Cool Interior Cedar – Hemlock variant (ICHwk1), the Northern Monashee Wet Cold Engelmann Spruce – Subalpine Fir variant (ESSFwc2), the Wet Cold Engelmann Spruce – Subalpine Fir Woodland subzone (ESSFwcw), and the Wet Cold Engelmann Spruce – Subalpine Fir Parkland subzone (ESSFwcp). Descriptions below have been summarized from Lloyd et al. (2005).

The IDFmw2 occurs from the valley bottoms (375 m) to 1,150 m elevation, and is characterized by a warm, dry climatic regime with a relatively long growing season. Mid-summer soil moisture deficits are common, particularly on south aspects, and it receives about 52 cm of precipitation annually, with snowpacks rarely exceeding 75 cm. Dominant tree species include Douglas-fir (*Pseudotsuga menziesii*), Lodgepole pine (*Pinus contorta*), paper birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*). The understory is shrubby and dominated by falsebox (*Pachistima myrsinites*), saskatoon (*Amelanchier alnifolia*), Oregon grape (*Mahonia aquifolium*), birch-leaved spirea (*Spiraea betulifolia*), baldhip rose (*Rosa gymnocarpa*) and thimbleberry (*Rubus parviflorus*). The herb and moss layers are typically sparse.

The ICHdw3 occurs from valley bottoms (450 m) to 1,200 m elevation, and is the driest variant of the ICH. Summer soil moisture deficits occur frequently, receiving 50 – 60 cm of annual precipitation; snowpacks rarely exceed 75 – 100 cm. Forest cover is dominated by a mixture of broadleaf and conifer species including western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), Lodgepole pine, Douglas-fir, paper birch, and trembling aspen, with western redcedar and western hemlock being the most common regeneration species that would dominate climax stands. The understory has a moderately well-developed shrub layer containing falsebox, birch-leaved spirea, black huckleberry (*Vaccinium membranaceum*), and thimbleberry, with a poorly developed herb layer. The moss layer is well developed and dominated by red-stemmed feathermoss (*Pleurozium schreberi*) and electrified cat's-tail moss (*Rhytidiadelphus triquestrus*).

The ICHmw3 occurs from valley bottoms (450 m) to 1,600 m elevation and is moister than the ICHdw3. Prolonged summer droughts are uncommon, with an average annual precipitation of 60 – 80 cm, and winter snow accumulations of 100 – 200 cm. Western hemlock and western redcedar dominate late successional stands with hybrid Engelmann x white spruce (*Picea engelmannii x glauca*) and subalpine fir (*Abies lasiocarpa*) occurring commonly on wetter sites subject to cold air drainage at upper elevations. Fire history coupled with human disturbance has led to the widespread development of successional stands dominated by Douglas-fir, lodgepole pine, and western white pine (*Pinus monticola*). The understory is dominated by mosses, with a sparse shrub layer containing falsebox and an equally sparse herb layer.

The ICHwk1 occurs from valley bottoms (500 m) to 1,500 m elevation, and has a relatively long growing season due to warm summers and a relatively constant supply of moisture. An average annual precipitation of 80 – 120 cm combined with an average snowpack of 150 – 200 cm results in soils rarely experiencing a moisture deficit. Late succession stands of western hemlock and western redcedar dominate the landscape, with Douglas-fir, hybrid white spruce, and subalpine fir occurring in mixed successional stands. The understory has a poorly developed shrub layer, but an extensive herb layer dominated by oak fern (*Gymnocarpium dryopteris*), bunchberry (*Cornus canadensis*), queen's cup (*Clintonia uniflora*), one-leaved foamflower (*Tiarella trifoliata* var. *unifoliata*), rosy twistedstalk (*Streptopus lanceolatus*), five-leaved bramble (*Rubus pedatus*), and wild sarsaparilla (*Aralia nudicaulis*). Mosses are also well developed, and include red-stemmed feathermoss, step moss (*Hylocomium splendens*), pipecleaner moss (*Rhytidiopsis robusta*), and knight's plume (*Ptilium crista-castrensis*).

The ESSFwc2 occurs at higher elevations, 1,300 m to 1,800 m, and is characterized by a short growing season due to long, cold winters and short, cool summers. Growing season moisture deficits are rare, as average annual precipitation of 100 – 150 cm, with maximum snow depths ranging from 200 – 300 cm. Climax stands of Engelmann spruce (*Picea engelmannii*) and subalpine fir dominate the landscape, with white-flowered rhododendron (*Rhododendron albiflorum*) dominating the understory. The rich herb layer consists of oak fern, Sitka valerian, five-leaved bramble, rosy twistedstalk, and one-leaved foamflower, with a patchy moss layer.

The ESSFwcw occurs at elevations of 1,600 m to 2,000 m. This variant is characterized by long, cold winters with a deep snowpack (300 – 400 cm), and short, cool summers. An average summer precipitation of 180 – 220 cm, combined with the late snowmelt and a very short frost-free period contribute to the short growing season. Most stands are dominated by subalpine fir, with a variably-developed shrub layer containing black huckleberry and white-flowered rhododendron. The herb layer is moderately well developed and includes Sitka valerian, mountain arnica (*Arnica latifolia*), wood-rush (*Luzula* spp.), and mountain hairgrass (*Vahlodea atropurpurea*). The moss layer is also well developed and is dominated by common leafy liverwort (*Barbilophozia lycopodioides*) and mountain leafy liverwort (*Barbilophozia floerkei*).

The ESSFwcp occurs at the highest elevations within the study area. Discontinuous forests of subalpine fir tree islands occur in this variant. Trees are stunted due to the very short growing season coupled with harsh environmental conditions. Alpine heaths of mountain-heathers (*Phyllodoce* spp.) and sparsely-vegetated rock outcrops are prevalent.

1.4.1 Regional Wildlife and Vegetation

The region provides habitat for a wide variety of wildlife and vegetation species. Both black bears (*Ursus americanus*) and grizzly bears (*Ursus arctos*) are present, as well as other large predators such as cougar (*Puma concolor*) and wolf (*Canis lupus*). Ungulates include elk (*Cervus elaphus*), moose (*Alces americanus*), mountain caribou (*Rangifer tarandus*), mountain goat (*Oreamnos americanus*), and mule deer (*Odocoileus hemionus*). Medium-sized and smaller mammals that are likely present include, but are not limited to, American beaver (*Castor canadensis*), chipmunks (*Eutamias* spp.), North American deermouse (*Peromyscus maniculatus*), fisher (*Pekania pennanti*), marmots (*Marmota* spp.), Pacific marten (*Martes caurina*), American mink (*Neovison vison*), common muskrat (*Ondatra zibethicus*), American pika (*Ochotona princeps*), raccoon (*Procyon lotor*), red squirrel (*Tamiasciurus hudsonicus*), North American river otter (*Lontra canadensis*), shrews (*Sorex* spp.), snowshoe hare (*Lepus americana*), voles (*Microtus* spp.), and wolverine (*Gulo gulo luscus*). A number of bat species are expected to occur in the area, including big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), and several smaller bat species (*Myotis* spp.). Bald Eagles (*Haliaeetus leucocephalus*), Barred Owls (*Strix varia*), Great Horned Owls (*Bubo virginianus*), and Red-tailed Hawks (*Buteo jamaicensis*) are probably the most common large raptors, with Northern Goshawks (*Accipiter gentilis*) also occurring in the area. Numerous other birds and waterfowl use the area during various seasons, though fewer species will remain year-round. Herptile species expected to be present include Columbia spotted frog (*Rana luteiventris*), long-toed salamander (*Ambystoma macrodactylum*), Northern Pacific treefrog (*Pseudacris regilla*), western toad (*Anaxyrus boreas*), and three species of gartersnake (*Thamnophis* spp.). Painted turtles (*Chrysemys picta*) are also present at nearby Clearwater.

1.5 Study Objectives

Baseline studies were conducted to support the assessment of potential effects of the Project on terrestrial wildlife and vegetation resources. These studies were guided by the requirements defined in the AIR for the Project, along with input from government, First Nations, and other stakeholders. Methods focused on quantifying or qualitatively describing wildlife and vegetation resources in the Project area.

The objectives of baseline studies were to:

- identify the presence or relative abundance (where possible) of select wildlife species, vegetation communities and sensitive habitat features within the study area;
- map the distribution of ecosystems within the study area; and
- map the distribution of habitat for select wildlife species within the study area.

1.6 Baseline Study Area

Baseline studies for wildlife and vegetation took place within spatial boundaries that were selected based on the recommended boundaries defined in the AIR, along with knowledge and experience from past projects, guidance from regulators, and professional judgement.

1.6.1 Local Study Area

A Local Study Area (LSA) was identified as the primary area for baseline studies of wildlife and vegetation for the Project – the majority of baseline studies took place within this boundary. The LSA encompassed all Project facilities and an area of 1,000 m on all sides of these facilities (Figure 1), for a total size of 11,084.5 ha. The LSA includes areas beyond Project footprints to include areas where both direct and indirect Project-specific effects are most likely to occur for wildlife and vegetation. The LSA takes into consideration available information and professional opinion on zones of influence (i.e. area of reduced use or avoidance), and prescribed or recommended setbacks (Government of Alberta 2011; BC Ministry of Environment 2012b; Environment Canada 2009).

1.6.2 Regional Study Area

A Regional Study Area (RSA) was established as a secondary area for baseline data collection in order to provide additional context on wildlife and vegetation on wider-ranging wildlife species (e.g. grizzly bear). The RSA was also used as the assessment area for cumulative effects within the Environmental Impact Statement (EIS). The RSA consisted of the Vavenby and Barriere Landscape Units (LUs), which encompassed the Project, the LSA, and a broader surrounding area where there is potential for interaction of the proposed Project with past, present and future activities that might result in cumulative adverse effects on wildlife or vegetation (Figure 1). The RSA was a total size of 150,010 ha.

1.7 Valued Components

To guide the collection of baseline information in support of the assessment of potential effects of the Project, Valued Components (VCs) were identified prior to (and updated, if necessary, during and following) baseline collection. Valued Components (VCs) are aspects of the environment considered important by the Proponent, the public, First Nations, and government agencies involved in the EA process. Importance may be determined on the basis of First Nations interests, scientific and/or regulatory concern, biodiversity concern, and sensitivity to proposed Project effects.

To identify wildlife and vegetation VCs for the Project, the BC Conservation Data Centre (CDC) was queried to identify all wildlife and vegetation taxa within the Headwaters Forest District or Kamloops Forest District that were Red-listed, Blue-listed, SARA-listed, COSEWIC-listed, or IWMS-listed, and that may potentially occur within the study area (BC Conservation Data Centre 2014a). The Headwaters Forest District and Kamloops Forest District are provincial management units for MFLNRO that overlap the LSA.

Determination of potential occurrence was supplemented by reviewing actual known location records of rare species (BC Conservation Data Centre 2014a) and through observations made during Project field studies. CDC observation records have been summarized within individual VC background summaries within Section 2.2. Field study observations are summarized in Section 4.0 No additional VCs were identified through this process.

Taxa of regional concern were identified as VCs during the development of the AIR, through discussions with MFLNRO, and through review of the Conservation Framework (BC Ministry of Environment 2012a). Several taxa of concern to First Nations were also identified as VCs following Technical Working Group (TWG) meetings, during discussions between the Proponent and First Nations, and during discussions with First Nations personnel involved in terrestrial wildlife and vegetation fieldwork.

Table 1 lists the terrestrial wildlife and vegetation VCs for the Project, and the basis for identification.

Table 1: Valued Components and Basis for Identification

Valued Component	Red-List	Blue-List	SARA	COSEWIC	IWMS	Regional Concern	First Nations
Rare Plants	✓	✓	✓	✓			
Ecological Communities at Risk	✓	✓					
Wetlands						✓	
Old-growth Forests						✓	
Rock Outcrops						✓	
Butterflies		✓	✓				
Damselflies and Dragonflies	✓	✓					
Western Toad		✓	✓	✓			
Barn Swallow		✓		✓			
Common Nighthawk			✓	✓			
Great Blue Heron		✓			✓		
Harlequin Duck						✓	✓
Olive-sided Flycatcher		✓	✓	✓			
Bald Eagle						✓	
Northern Goshawk						✓	
Western Screech-owl	✓		✓	✓	✓		
Fringed Myotis		✓			✓		
Little Brown Myotis				✓			
Northern Myotis		✓		✓			
Townsend's Big-eared Bat		✓					
Western Small-footed Myotis		✓					
Fisher		✓			✓		
Grizzly Bear		✓		✓	✓		
Moose						✓	✓
Mountain Caribou	✓		✓	✓	✓		✓
Mountain Goat						✓	
Mule Deer						✓	
Wolverine		✓		✓	✓		

2.0 BACKGROUND REVIEW

2.1 Legislation, Regulations, and Guidelines

The Project is subject to both provincial and federal EAs under the *BC Environmental Assessment Act* (2002) and *Canadian Environmental Assessment Act* 2012 (CEAA; 2012). The EA will undergo a coordinated review in accordance with the 2004 Canada-BC Agreement on Environmental Assessment Cooperation. The requirements for the EA are defined in the AIR for the Project, approved by the BC Environmental Assessment Office (EAO) on October 21, 2011. This baseline report has been prepared to support the submission of the Application/EIS.

2.1.1 Federal and Provincial Legislation

Specific federal and provincial pieces of legislation that apply to the EA are detailed below, including *SARA*, *MBCA*, the *BC Wildlife Act*, and *FRPA*.

2.1.1.1 Species at Risk Act

The *Species at Risk Act* (*SARA*) was proclaimed in June 2003 as part of a three-part strategy for the protection of wildlife species at risk in Canada. The purpose of *SARA* is "to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened" (*Species at Risk Act*, 2002, c. 29, s. 6).

The Act prohibits the killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling or trading of individuals (or its parts or derivatives) of endangered, threatened and extirpated species listed in Schedule 1 of the Act. It also prohibits the damage or destruction of the residence of one or more individuals of a listed endangered or threatened species, or a listed species if a recovery strategy has recommended its reintroduction into the wild into Canada. The Act applies to: 1) all endangered, threatened and extirpated species listed on Schedule 1 when located on federal lands and territories; 2) all endangered, threatened and extirpated species listed on Schedule 1 that are also protected by the *Migratory Birds Convention Act* (*MBCA*) when located on any land (federal, provincial or private); and 3) all endangered, threatened and extirpated aquatic species (as defined by the Act) listed on Schedule 1 when located on any land (federal, provincial or private).

The Act also applies to unlisted species on federal lands when those species have been legally classified as threatened or endangered by a provincial or territorial minister. In addition, the Act has the option to be applied to non-*MBCA*, non-aquatic Schedule 1 species on provincial or private land if appealed for under subsection 34 of the Act.

For those species listed as special concern under the Act, the federal government is required to prepare a management plan for that species and its habitat, including identifying measures for the conservation of the species.

Species may be listed on Schedules 1, 2 or 3 of the Act. Taxa designated as 'at risk' in Canada are placed on Schedule 1. Taxa that were designated as 'at risk' by COSEWIC (the Committee on the Status of Endangered Wildlife in Canada) before the creation of SARA must be reassessed according to the new criteria of the Act before they can be listed on Schedule 1. Those taxa are included on Schedules 2 and 3, and are not yet officially protected under SARA.

Residence

A residence, as defined under the Act, is "a dwelling place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating" (*Species at Risk Act*, 2002, c. 29, s. 2). The Act prohibits the damage or destruction of the residence of any threatened, endangered or extirpated species listed on Schedule 1, on lands where the Act is applicable.

Residences are not applicable to all species, and thus are not always defined under the Act, nor is there any requirement under the Act to explicitly locate individual residences. In order for a specific location to be recognized as a residence, the location must relate to a crucial function in the life cycle of an individual of the species, and the location must be essential for carrying out that function.

Critical Habitat

The Act defines critical habitat as, "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species" (*Species at Risk Act*, 2002, c. 29, s. 2). Critical habitat is a population-based concept (unlike residence) and is intended to describe habitat that is critical to the recovery and health of a species at a population level. The Act prohibits the destruction of any part of critical habitat, and requires that critical habitat located on lands applicable to the Act be protected through stewardship agreements or other means. Section 61 of the Act also allows the Governor in Council to identify and protect critical habitat on provincial or territorial land, if it is deemed to be inadequately protected by other federal or provincial legislation.

Exemptions

Exemptions may be available under the Act for some activities related to public safety, health, or national security. Permits may also be available for authorizing certain activities that would otherwise contravene the Act. These activities may include scientific research related to conservation of the species in question, enhancement or other beneficial activities for the species, or incidental effects.

2.1.1.2 Migratory Birds Convention Act

Under the *Migratory Birds Convention Act* (*MBCA*), a migratory bird is defined as the sperm, eggs, embryos, tissue cultures, and parts of the following groups of bird species: waterfowl, cranes, rails and coots, shorebirds, gulls, terns, pigeons, doves, insectivorous songbirds (excluding blackbirds), seabirds, loons, grebes, herons, egrets and bitterns. The Act prohibits the unauthorized possession, purchasing, selling, or exchanging of migratory birds or their nests. It also prohibits the unauthorized introduction of harmful substances into areas frequented by migratory birds. Species not protected under the MBCA include owls, eagles, Osprey, hawks, falcons, cormorants, kingfishers, blackbirds, crows, ravens and jays.

The Migratory Birds Regulations

The Migratory Birds Regulation (MBR) was established under the *MBCA* to govern the hunting, possession, sale, purchase, or shipment of migratory birds, their nests or eggs. The MBR also regulates aviculture, scientific collection, and taxidermy for migratory birds, as well as activities designed to reduce crop damage or aircraft danger posed by migratory birds. The MBR prohibits the disturbance, destruction, or taking of any nest, egg, or nest shelter of a migratory bird.

2.1.1.3 BC Wildlife Act

The *BC Wildlife Act* (*BCWA*) identifies wildlife as, "raptors, threatened species, endangered species, game and other species of vertebrates prescribed by regulation" (*Wildlife Act*, R.S.B.C. 1996, c. 488, s. 1). The *Act* controls the hunting, trapping, possession, purchase, and sale of wildlife. It also allows for the creation of special areas for wildlife management and preservation, within which special prohibitions apply.

Under the *BCWA*, some species are afforded special protection. The *Act* prohibits the harming or killing of species designated as endangered or threatened under the *Act*, which includes sea otter (*Enhydra lutris*; threatened), Burrowing Owl (*Athene cunicularia*; endangered), American White Pelican (*Pelecanus erythrorhynchos*; endangered), and Vancouver Island marmot (*Marmota vancouverensis*; endangered), none of which are found within the Project area. It also prohibits the unauthorized disturbance, molestation or destruction of muskrat houses or dens, or beaver houses, dens or dams. The *BCWA* also prohibits the possession, molestation, injury or destruction of a bird or its egg, any occupied bird nest, and the nest (whether occupied or not) of an eagle, Peregrine Falcon, Gyrfalcon, heron, or Burrowing Owl.

Provincial Red and Blue Lists

Species/ecological communities at risk in BC are placed on provincial lists according to their degree of endangerment. The Red List includes "*ecological communities, and indigenous species and subspecies that are extirpated, endangered or threatened in British Columbia. Red-listed species and sub-species have- or are candidates for- official Extirpated, Endangered or Threatened Status in BC. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation*" (Province of British Columbia 2011). The Blue List includes "*ecological communities, and indigenous species and subspecies of special concern (formerly vulnerable) in British Columbia*" (Province of British Columbia 2011). Taxa that are not considered at risk are placed on the Yellow List. Taxa may be transferred from one list to another list either because of an actual change in their ecological circumstance (change in risk), or because new data become available on their range, taxonomy, population trend or numbers to justify a change in status. The latter situation is especially relevant for taxa that have been little surveyed and for which even basic life history information may be sparse.

2.1.1.4 Forest and Range Practices Act

The *Forest and Range Practices Act* (*FRPA*) regulates the activities of forest and range licensees in BC, including requirements for planning, road building, timber harvest, reforestation, and grazing. It also provides for the management of wildlife alongside these forest and range activities. This includes the management of species known as Identified Wildlife as well as the designation of Ungulate Winter Ranges (UWRs) for the management of important ungulate habitat.

Identified Wildlife are species classified as Species At Risk or Regionally Important Wildlife under the Identified Wildlife Management Strategy (IWMS). The IWMS "provides direction, policy, procedures and guidelines for managing Identified Wildlife. The goals of the Strategy are to minimize the effects of forest and range practices on Identified Wildlife situated on Crown land and to maintain their limiting habitats throughout their current ranges and, where appropriate, their historic ranges" (Ministry of Water Land and Air Protection 2004). Identified Wildlife are managed through the establishment of Wildlife Habitat Areas (WHAs).

Within UWRs and WHAs, General Wildlife Measures (GWMs) are employed to protect important habitat or features. Sometimes they allow for restricted forest or range activities within the UWR or WHA (*e.g.* restriction of activities during sensitive periods, such as the breeding season) while other times they prohibit it completely.

The draft order for the Kamloops Timber Supply Area (TSA) Ungulate Winter Range states that "the general wildlife measures outlined in Schedule 1 do not apply for the purposes of exploration, development and production activities when these activities have been authorized for the purpose of subsurface resource exploration, development or production by the Mineral Tenure Act, the Coal Act, the Mines Act, the Petroleum and Natural Gas Act, the Pipeline Act or the Geothermal Resources Act".

2.1.2 Higher-Level Plans

The Kamloops Land and Resource Management Plan (LRMP) is intended to guide land use planning within the Kamloops Region (Kamloops Interagency Management Committee 1995). LRMPs generally describe Resource Management Zones of various types, in which a basic set of objectives and strategies guiding management of land, water, ecosystems and resources is applied. Implementation of the Plan is described, along with provisions for monitoring and amendment. Resource management zones such as critical deer and moose winter range are defined within the Plan area.

Canadian Forest Products (Canfor) developed a Sustainable Forest Management Plan (SFMP) in 2010 for the area within which the Project occurs. The SFMP was developed to meet Canadian Standards Association requirements, and outlines current and long-term management objectives and strategies for the area it encompasses. These objectives include maintaining ecosystem and species diversity, maintaining a diversity of forest attributes, and maintaining soil and water quality, as well as a number of economic and social objectives.

2.1.3 Best Management Practices

In addition to the above-mentioned legislative and policy frameworks, documents containing Best Management Practices (BMPs) are available for certain activities and species groups to provide guidance for maintaining environmental values during development. The BMP documents that are relevant to the Project include:

- Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia (Ovaska et al. 2004);
- *Best Management Practices for Hazard Tree and Non-Hazard Tree Limb Topping and Removal* (BC Ministry of Environment 2006a);
- Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia (Demarchi et al. 2005);
- Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia(BC Ministry of Environment 2012b);
- *Management Plan for the Mountain Goat (Oreamnos americanus) in British Columbia* (Mountain Goat Management Team 2010)
- Guidelines for Reduced Risk Instream Work Windows (BC Ministry of Environment 2006b); and
- *Standards and Best Practices for Instream Works* (BC Ministry of Water, Land and Air Protection 2004b).

In addition, Targeted Invasive Plant Solutions (TIPS) have been produced by the Invasive Plant Council of BC to recommend BMPs and Integrated Pest Management techniques for control of invasive plant introduction and spread (Invasive Plant Council of BC 2009).

2.2 Valued Component Background Information

This section describes background information on the Project VCs including general and regional biology and ecology, known occurrences within the LSA and RSA (as identified from reviewing past studies, including TLUS, as well as querying CDC and other provincial database records), and regional management areas for each VC.

2.2.1 Rare Plants

For this Project, “rare plants” were defined to include the following vascular plants, mosses, and lichens:

- species listed on Schedule 1 of the *Canadian Species at Risk Act* (SARA) as amended (Government of Canada 2002);

- species assigned a status of Extinct, Extirpated, Endangered, Threatened, or Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2012b); and
- species on the BC Ministry of Environment's provincial Red or Blue lists (BC Conservation Data Centre 2014a).

A list was prepared of rare plants either already known to occur in the Project vicinity, or with a global range that is likely to include the Project vicinity. The following sources were consulted:

- CDC records of known BC- and SARA-listed rare plant occurrences within the vicinity of the LSA (BC Conservation Data Centre 2012b; BC Conservation Data Centre 2014a; BC Conservation Data Centre 2012a);
- annotated checklist of the vascular flora of Wells Gray Park (Björk and Goward 2011);
- species distribution maps on the Electronic Atlas of the Flora of British Columbia website (Klinkenberg 2012b);
- published vascular floras (Hitchcock et al. 1955b; Cronquist et al. 1977; Moss and Packer 1983; Flora of North America Editorial Committee 1993; Cody 1996; Douglas et al. 1998a);
- moss and liverwort keys (Lawton 1971; Doyle and Stotler 2006; Flora of North America Editorial Committee 2007; Laine 2009);
- lichen keys (Goward et al. 1994; Goward 1999; Spribille 2006; Björk 2011); and
- online databases (NatureServe 2011; BC Conservation Data Centre 2012d).

These data were compiled to produce a list of target rare plant species with potential for occurrence within the LSA. The final list of target rare plants is presented in Appendix 1. It includes 36 vascular plants, 15 mosses, and 40 lichens. Eight observations of three rare plant species are known from past studies in the general vicinity of the Project, although none of these observations are within the LSA or RSA (Figure 2).

2.2.2 Ecological Communities at Risk

Ecological communities are defined as "the assemblage of species that co-occur in defined areas at certain times and that have the potential to interact with each other" (McPeek and Miller 1996, cited in BC Conservation Data Centre 2004). Ecological Communities At Risk (ECAR) are ecological communities that are listed by the CDC as Red- or Blue-listed in BC (BC Conservation Data Centre 2014a). They are placed on the Red or Blue lists according to the degree of threat, trend in area of occupancy, number of protected and managed occurrences, intrinsic vulnerability, specificity of habitat requirements, and other considerations (ibid).

A list was prepared of ECAR with the potential to occur in the Project vicinity. This list was developed by identifying the BGC variants within the LSA, and consulting CDC records of ECAR with the potential to occur in those BGC variants (BC Conservation Data Centre 2012b; BC Conservation Data Centre 2014a; BC Conservation Data Centre 2012a). Twelve ECAR were identified for the Project, including two Red-listed and ten Blue-listed communities (Table 2). No surveys were conducted prior to Project baseline studies that identify the locations of any ECAR in the LSA, and nor does the CDC identify any known locations.

Table 2: Ecological Communities at Risk Potentially Occurring Within the Study Area

Common Name	Scientific Name	BC List
Black spruce / buckbean / peat-mosses	*Picea mariana / Menyanthes trifoliata / Sphagnum* spp.	Blue
Buckbean - slender sedge	*Menyanthes trifoliata - Carex lasiocarpa*	Blue
Common cattail Marsh	*Typha latifolia Marsh*	Blue
Lodgepole pine / dwarf blueberry / peat-mosses	*Pinus contorta / Vaccinium caespitosum / Sphagnum* spp.	Blue
Mountain alder / red-osier dogwood / lady fern	*Alnus incana / Cornus stolonifera / Athyrium filix-femina*	Blue
Narrow-leaved cotton-grass - shore sedge	*Eriophorum angustifolium - Carex limosa*	Blue
Slender sedge / common hook-moss	*Carex lasiocarpa / Drepanocladus aduncus*	Blue
Swamp horsetail - beaked sedge	*Equisetum fluviatile - Carex utriculata*	Blue
Three-way sedge	*Dulichium arundinaceum Herbaceous Vegetation*	Red
Tufted clubrush / golden star-moss	*Trichophorum cespitosum / Campylium stellatum*	Blue
Western hemlock / velvet-leaved blueberry - falsebox	*Tsuga heterophylla / Vaccinium myrtilloides - Paxistima myrsinites*	Red
Western redcedar - paper birch / oak fern	*Thuja plicata - Betula papyrifera / Gymnocarpium dryopteris*	Blue

2.2.3 Wetlands

Wetlands are defined as areas of land saturated by water, permanently or intermittently, for a long enough time that the excess water and subsequent anoxic conditions results in a change in the plants and wildlife inhabiting the area to those that are adapted to aquatic conditions (The Wetland Stewardship Partnership 2010; BC Ministry of Forests 2000). Wetlands include five primary freshwater types: bogs and fens (both are peatlands), swamps, marshes, and shallow open waters such as sloughs and ponds (BC Ministry of Forests 2000). Wetlands cover approximately 5.6% of the province and perform essential hydrological and ecological functions (ibid). Wetlands absorb and filter sediments, pollutants and excess nutrients, control stream flow and erosion, as well as provide critical habitat for fish, birds and other wildlife (MacKenzie and Moran 2004; Bond et al. 1992). Wetlands are vulnerable to changes in hydrological regime, pollutants, siltation, compaction by livestock and vehicles, and the effects of invasive plant species (Cox and Cullington 2009; MacKenzie and Moran 2004). Eight specific wetland communiites with potential to occur within the LSA were identified as ECAR (Section 2.2.2).

2.2.4 Old-growth Forests

Old-growth forests are climax ecosystems characterized by relatively tall, old trees and structural diversity. Forty per cent of BC's forests are considered old growth – an area of 25 million hectares (British Columbia Ministry of Sustrainable Development and BC Market Outreach Network 2003). Old growth forests provide valuable habitat for plant and animal species that prefer large-diameter trees, multi-layered stands, high densities of snags and other characteristics that require many years to develop. Decaying woody materials such as standing dead trees and fallen trees provide nests, dens and food for many birds, mammals and amphibians as well as a rich nutrient base for lichen, mosses and other shade tolerant plants. Old-Growth Management Areas

Old Growth Management Areas (OGMAs) are areas within BC's Timber Supply Areas (TSA) set aside as areas where characteristics of old-growth forests are maintained. Some of these characteristics include coarse woody debris, arboreal lichen, broken tops on live and dead trees, and large old trees. OGMAs are also used to maintain other important sites such as rare ecosystems and wildlife habitat features. OGMAs identified within the LSA are shown on Figure 3.

2.2.5 Rock Outcrops

Rock outcrop ecosystems occur on areas of exposed rock and are characterized by shallow, poorly developed soil, high summer temperatures, drought, and sparse vegetation cover (Ware 1990). Vegetation cover typically consists of bunchgrasses, selaginella and scattered shrubs that are restricted to crevices and pockets of soil. These ecosystems are gently to steeply sloping, but are neither vertical nor dominated by shrubs. Rocky substrates have been shown to support high taxonomic richness, particularly for non-vascular plants (Vitt and Belland 1997; Sadler and Bradfield 2010, p.2). Rock outcrops also provide habitat and refuge to a number of different wildlife species. No rock outcrops have been identified by past studies in or near the LSA.

2.2.6 Butterflies

Four butterfly species are identified as being of concern and potentially occurring within the study area (Table 3). All of these species are Blue-listed, and the monarch (*Danaus plexippus*) is listed on SARA Schedule 1 as Special Concern (BC Conservation Data Centre 2014a).

Table 3: Butterflies of Conservation Concern for the Project Assessment.

Common Name	Scientific Name	BC List	SARA
Common Sootywing	*Pholisora catullus*	Blue	
Jutta Arctic, *chermocki* subspecies	*Oeneis jutta chermocki*	Blue	
Monarch	*Danaus plexippus*	Blue	Special Concern
Nevada Skipper	*Hesperia nevada*	Blue	

The Common Sootywing (Pholisora catullus) is a Blue-listed species that has limited range in BC, limited to very xeric areas in valley bottoms of the southern interior (SOSP 2008). BC is at the northern extent of its range, and thus the species is more susceptible to climatic extremes. Major threats to its population include agricultural and urban development, wildfires, pesticide application, noxious and invasive weeds, intensive grazing of habitat and trampling of habitat (Guppy and Shepard 2001), and it has experienced an estimated loss of 25-50% of its historic habitat within BC (BC Conservation Data Centre 2014b). There is currently no record of a BC foodplant, though in other areas the Common Sootywing is known to depend on *Chenopodium* and *Amaranthus* (Guppy and Shepard 2001). No known occurrences have been found within the LSA prior to baseline studies.

The Jutta Arctic (*Oeneis jutta chermocki*) is a Blue-listed species that occurs across northern BC, and in scattered locations throughout the Rockies and the Cariboo. The adults are typically found in lodgepole pine forest clearings, spruce bogs and pine forests (Guppy and Shepard 2001). The larvae are considered habitat specialists because they feed upon specific sedges such as *Eriophorum spissum*, *Carex geyeri*, and *Carex concinna* (Layberry et al. 1998). There are currently no threats to their habitat, and the long term population trend is considered relatively stable (+/- 25% change; B.C. Conservation Data Center 2014). No known occurrences have been found within the LSA prior to baseline studies.

The Monarch (*Danaus plexippus*) is a Blue-listed species that occurs mainly in the southern interior regions of BC, though periodically is observed on the south coast. Monarchs are migratory, hibernating in northern California, and feed upon showy milkweed (*Asclepias speciosa*; Guppy and Shepard 2001). The Monarch population in BC is rapidly declining due to urban/rural development in their habitats in the BC southern interior, and due to destruction of their hibernation sites in California (B.C. Conservation Data Center 2014a). Milkweed is also considered a noxious weed by the agricultural industry; the implementation of weed control programs is expected to negatively impact the monarch population (Guppy and Shepard 2001). No known occurrences have been found within the LSA prior to baseline studies.

The Nevada skipper (*Hesperia Nevada*) is a Blue-listed species that ranges throughout xeric habitats in the southern interior, Okanagan Valley and Thompson River valley (Guppy and Shepard 2001). Individuals are most often observed in lowland bunchgrass areas where foodplants such as Sheep Fescue (*Festuca ovina*), Western Needlegrass (*Stipa occidentalis*), and other perennial bunch grasses occur (Layberry et al. 1998). These areas are rapidly being developed for agricultural purposes and for urban expansion, which is expected to result in a decline in population by approximately 10-30% (South Okanagan Similkameen Conservation Program 2008). No known occurrences have been found within the LSA prior to baseline studies.

2.2.7 Damselflies and Dragonflies

Two damselfly species and one dragonfly species were identified as being of concern and potentially occurring within the study area (Table 4). One damselfly and the dragonfly are Red-listed, and the other damselfly is Blue-listed (BC Conservation Data Centre 2014a).

Table 4: Dragonflies and Damselflies of Conservation Concern for the Project Assessment

Common Name	Scientific Name	BC List	SARA
Familiar Bluet	*Enallagma civile*	Red	
Hagen's Bluet	*Enallagma hageni*	Blue	
Lance-tipped Darner	*Aeshna constricta*	Red	

The Familiar Bluet (*Enallagma civile*) is a Red-listed damselfly that is commonly observed east of the Rockies, but has only been recorded once in BC in the Cariboo region. The Familiar Bluet often colonizes temporary and newly created water bodies such as farm dugouts and gravel pit ponds (Cannings 2002). No known occurrences have been found within the LSA prior to baseline studies.

Hagen's Bluet (*Enallagma hageni*) is a Blue-listed damselfly found in BC from Kamloops north to the Peace and Laird River drainages, but most often observed in the Cariboo and Prince George regions. The Hagen's Bluet prefers somewhat acidic wetlands and mossy fens over marshy lakes and ponds (Royal British Columbia Museum and the Spencer Entomological Museum 2004). No known occurrences have been found within the LSA prior to baseline studies.

The Lance-tipped Darner (*Aeshna constricta*), is a Red-listed dragonfly occasionally found at small ponds and open, warm, nutrient-rich marshes dominated by cattails and bulrushes in the valleys of the southern interior of BC (Cannings 2002). Human development in their primary habitat is considered to be the greatest threat to this species (Klinkenberg 2012a). No known occurrences have been found within the LSA prior to baseline studies.

2.2.8 Western Toad

The western toad is widespread in British Columbia, occurring from the Rocky Mountains to the Pacific coast (Ministry of Water Land and Air Protection 2004). This toad is one of the few amphibians that can inhabit alpine habitats and it is absent only from the most arid areas (ibid.). It is provincially Blue-listed, is listed on Schedule 1 of *SARA*, and is designated as a species of Special Concern by COSEWIC (BC Conservation Data Centre 2014a).

The western toad typically selects terrestrial habitats that promote water conservation and provide cover from predators (Bartelt et al. 2004). Preferred habitats include moist areas with dense shrub cover, often in close proximity to wetlands (ibid.). However, they are known to successfully use a wide variety of habitats when not breeding (Ministry of Water Land and Air Protection 2004).

Western toads breed in permanent or temporary water including wetlands, ponds, stream edges, shallow lake margins, ditches and road ruts (Olson 1992; Reimchen 1992; Corkran and Thoms 1996; Gyug 1996). Aquatic habitats vary significantly in the amount of canopy cover, CWD and emergent vegetation, but shallow water with a sandy bottom appears to be preferred (Green and Campbell 1984; Matsuda et al. 2006), particularly in water bodies that retain water for the breeding season (early spring until mid to late summer; (Ministry of Water Land and Air

Protection 2004). Eggs are generally attached to submerged vegetation in water less than 0.5 m deep and hatchlings and tadpoles congregate in warm, shallow margins (Corkran and Thoms 1996; Matsuda et al. 2006).

Declines in western toad populations have been observed throughout their range, including in some relatively 'pristine' areas (Ministry of Water Land and Air Protection 2004). The reasons for these declines are not well understood but isolation, disease, pesticide poisoning, competition with introduced species (*e.g.,* American bullfrog *Lithobates catesbeianus*), road mortality and habitat loss from urban development, pollutants, road development and forestry are all believed to be contributing factors (Ministry of Water Land and Air Protection 2004; Slough 2004; BC Conservation Data Centre 2014a).

No studies were found during background research for the baseline that identified locations of western toad observations in the LSA, however they are found throughout most of the province where suitable habitat exists (Matsuda et al. 2006).

2.2.9 Barn Swallow

The Barn Swallow is a migratory swallow that breeds throughout North America, Europe and Asia (Brown and Brown 1999). It is common throughout BC, except in the Coast and Mountains ecoprovince, where high mountains, open oceans and dense forests occur (Campbell et al. 1997). The species is Blue-listed provincially and is designated as Threatened by COSEWIC (BC Conservation Data Centre 2014a).

Barn Swallows have been closely-associated with human structures since the mid-twentieth century (Brown and Brown 1999). They have been recorded nesting from sea level up to elevations of 2,400 m. Breeding habitat typically includes the presence of vertical or horizontal nest substrates under an overhang, and are typically associated with open areas for foraging (Campbell et al. 1997; Brown and Brown 1999). Individuals exhibit strong site fidelity, returning to the same nesting area, and occasionally the same nest, in successive years (Campbell et al. 1997).

Historically, Barn Swallows built nests in caves, and occasionally used rock crevices and tree cavities (Brown and Brown 1999). However, since the expansion of human habitation, Barn Swallows mainly nest in anthropogenic structures such as barns, bridges, culverts and outbuildings. In BC, only 1% of nests recorded were in natural sites (Campbell et al. 1997). Nests are built of mud mixed with grass stems and are lined with feathers, grass and hair (Brown and Brown 1999).

Generally, Barn Swallow populations have increased in North America since European settlement (ibid.). However, breeding bird surveys indicate that Barn Swallow populations may be declining in Canada (Campbell et al. 1997; Bird Studies Canada 2004), possibly due to changes in building and farming practices that may reduce the number of suitable nesting sites (Brown and Brown 1999), or due to the use of pesticides near nesting and foraging areas (Turner 1991).

No studies were found during background research for the baseline that identified locations of Barn Swallow observations in the LSA.

2.2.10 Common Nighthawk

The Common Nighthawk is an insectivorous bird with mottled grey-brown plumage (BC Conservation Data Centre 2014a). It is found across all regions of the province except the central and north coasts, and in all BGC zones except those in the alpine. The species.is provincially Yellow-listed, is listed on Schedule 1 of *SARA*, and is designated as Threatened by COSEWIC (ibid.).

Nighthawks usually forage aerially at dawn and dusk, although during inclement weather they will also forage during the day. Foraging occurs above nesting habitat as well as wetlands, rivers, ponds and estuaries, generally between <1 m above water and up to 80 m above forested areas (Brigham 1990). The species' diet is almost entirely flying insects, mainly flying ants (Hymenoptera), beetles (Coleoptera) and true bugs (Terres 1980). Flocks of foraging nighthawks are not uncommon where insect densities are high, especially during the fall when large numbers of birds may congregate to feed on swarming termites (Campbell et al. 2006; COSEWIC 2007a).

Common Nighthawks roost in trees or on the ground during the day, and may enter torpor while roosting to conserve energy during cold weather (Fisher et al. 2004); (Campbell et al. 2006). Individual birds may return to the same roost site repeatedly (Campbell et al. 2006), with females arriving about a week ahead of the males. They begin nesting shortly after the males' arrival (Campbell et al. 1990b), when the males court females with aerial and ground displays. Breeding males are territorial and defend areas varying in size from 4 to 28 ha (Campbell et al. 2006). The species is likely monogamous and sexual maturity is thought to be reached at the age of one year (Campbell et al. 2006).

Nesting habitats are open, sparsely vegetated areas, usually surrounded by forest. Females may exhibit some degree of nest site fidelity (COSEWIC 2007a). The nest itself is a scrape in the ground, occasionally lined with leaves, wood chips, and lichens. Eggs have been found in BC from May to August (Campbell et al. 1990b), but most eggs are laid in late June through July (Campbell et al. 2006). One to four eggs (usually two) are laid and incubated by the female for 16-20 days, and fledging occurs at 18-20 days (Campbell et al. 2006; Brigham et al. 2011; Fowle 1946). The male feeds both the female and the offspring (COSEWIC 2007a). Eggs or young may be moved short distances, presumably by one or both adults (Salt 1998). Nests and young in cultivated areas are susceptible to trampling by livestock and crushing by farm machinery (Campbell et al. 2006). Nesting takes about 40 days from egg-laying to fledging (ibid.). The adults will tend the young for up to 30 days and they may join with migrating flocks at 52 days (Dexter 1952). Migration to wintering areas in South America begins in mid-August (COSEWIC 2007a).

Common Nighthawks may forage over many types of open habitats where flying insects are abundant, including estuaries, pastures, marshes, beaches, mixed forests, urban habitats, river confluences, cultivated fields, clearcuts and transmission line corridors (Campbell et al. 2006). Birds roost singly or occasionally in groups (males) in a variety of habitats. Known roost sites include open forests, fence posts, buildings, transmission towers, the ground, and beach logs.

Females choose nesting substrates that will enable them to remain well-camouflaged. Areas used for nesting include burns, clearcuts, open pine (*Pinus* spp.) and aspen forests, sagebrush (*Artemesia* spp.), prairie, rock outcrops, gravel roofs in urban areas, dunes, beaches, grasslands, pastures, peat bogs, marshes, lakeshores, roadsides, reclaimed mines and river banks, in sites with little to no vegetation (Campbell et al. 1990b; Campbell et al. 2006; COSEWIC 2007a; Ontario Ministry of Natural Resources 2009; Brigham et al. 2011). Preferred sites have patchy herb, forb or grassy understories interspersed with bare soil (Campbell et al. 2006).

No studies were found during background research for the baseline that identified locations of Common Nighthawk observations in the LSA.

2.2.11 Great Blue Heron

The Great Blue Heron is the largest wading bird in North America (Vennesland and Butler 2011), and is primarily a wetland-associated species (Campbell et al. 1990a). Two subspecies occur within the province, with *A. h. herodias* occurring within the study area (BC Conservation Data Centre 2014a). That subspecies is provincially Blue-listed and is listed as an Identified Wildlife species under *FRPA* (ibid.).

Great Blue Herons use different habitats for nesting and feeding. Nesting takes place colonially in mature trees of a variety of forest types. Colonies in BC are known to range in size from 2 to 472 nests, with average colony sizes of 21-49 nests, depending on the region (Gebauer and Moul 2001). Proximity to suitable foraging areas is an important factor in placement of nesting colonies (Gibbs 1991; Vennesland and Butler 2011; Gebauer and Moul 2001) and often limits colonies to lowland habitats. Lowland riparian areas are often also preferred for human developments, and this has led to decreases in forested areas that are suitable for heron nesting (Butler 1997; Gebauer and Moul 2001; BC Ministry of Water, Land and Air Protection 2004a).

Great Blue Herons forage mainly in wetlands and other similar habitats (Campbell et al. 1990a). Diet during the breeding season mainly consists of fish such as gunnels, sculpins, perch, bass, bullhead, and pumpkinseed (*e.g.* (Butler 1997)), with perch being the preferred prey for meeting energy requirements (Butler 1995). However, the Great Blue Heron is a generalist, opportunistic predator, capturing secondary prey items such as other fish species, amphibians, reptiles, aquatic invertebrates, and small mammals of both wetland and upland habitats in order to supplement their preferred diet, especially during the winter months when energy requirements are lower (Forbes 1987; Butler 1995; Gebauer and Moul 2001). This opportunistic behaviour means that herons can be found foraging in any number of different marine or inland wetland habitats, as well as in upland habitats such as agricultural fields.

The greatest threats to Great Blue Herons in BC are the loss of habitat and the effects of eagle predation and anthropogenic disturbance on reproductive success (COSEWIC 2008). No studies were found during background research for the baseline that identified locations of Great Blue Heron observations in the LSA.

2.2.12 Harlequin Duck

The Harlequin Duck is a small, subarctic sea duck with two geographically distinct populations in Canada (BC Conservation Data Centre 2014a). The species is provincially Yellow-listed, and the western population is not listed by COSEWIC or *SARA* (ibid.). However, it is considered a species of regional concern in BC, due to its potential sensitivity to impacts on breeding streams and rivers. The male has a very distinctive dark blue breeding plumage, with white patches on the head and body, a small rufous line near the top of the head, and a patch along the flanks (Robertson and Goudie 1999). The female is dull brown with three white spots on the head (ibid.).

Harlequins spend the winter at sea along rough, rocky shores, but move inland in the spring to breed on fast-flowing, turbulent creeks across the province (Bellrose 1976; Campbell et al. 1990a; Rosenburg et al. 1994). They are also known to use glacial lakes and tundra ponds (Rosenburg et al. 1994). Few other birds are able to use these habitats due to the fast currents, boulders, and cold temperatures (ibid.).

Harlequin Duck breeding streams are generally characterized as areas with: fast-flowing waters with shallow gradients; gravel- to boulder-sized substrate; presence of riffle habitat; presence of islands and in-stream loafing sites created by boulders, cobble/gravel bars or logs; and densely forested bank vegetation (Cassirer et al. 1996; Machmer 2001). In-stream loafing habitat appears to be an important component of suitable habitat, possibly reducing the risk of predation or providing areas to rest temporarily out of fast-flowing water (Cassirer and Groves 1994; Machmer 2001). Recent studies by Esler et al. (2007) found that invertebrate abundance was the best predictor of Harlequin Duck presence on breeding streams.

Harlequins prefer nesting along stream reaches with adjacent mature and old-growth forest cover that provides suitable nesting sites in tree cavities, rock crevices, concealed hollows, and dense vegetation (Cassirer et al. 1993; Cassirer and Groves 1994). High value nesting habitats for Harlequin Ducks likely include riparian areas with dense vegetation (>50% shrub cover) and CWD, within 30 m of fast-flowing, turbulent creeks (Cassirer et al. 1993; BC Conservation Data Centre 2014a).

Pairs arrive at breeding grounds in late April to mid-May (BC Conservation Data Centre 2014a), shortly after spring thaw (Resources Inventory Committee 1998d). The male harlequin defends the female until incubation begins (mid-May to June), then the pair bond ends and males depart for the coast (Palmer 1976). Broods have been recorded in BC between mid-June and early September (Campbell et al. 1990a). Broods typically remain near the nesting site for the first few weeks, moving downstream as the summer progresses (Kuchel 1977; Cassirer and Groves 1989).

The primary prey of Harlequin Ducks are aquatic invertebrates (Robertson and Goudie 1999; Esler et al. 2007). Robertson and Goudie (1999) also found that they take advantage of seasonal abundances of fish fry as a food source. However, the presence of fish in streams has recently been found to have a negative relationship with Harlequin Duck presence, likely due to decreased abundances and/or activity levels of invertebrates, the duck's primary prey (Esler et al. 2007). Esler *et al.* (2007) also found that food quality and quantity on the breeding grounds are extremely important to nesting, as egg formation is solely dependent on these factors.

Evidence suggests that Harlequin Duck populations within BC are limited by productivity of breeding streams (ibid.), and potential impacts on this habitat are the greatest threat. No studies were found during background research for the baseline that identified locations of Harlequin Duck observations in the LSA.

2.2.13 Olive-sided Flycatcher

A large member of the family Tyrannidae, the Olive-sided Flycatcher has a large head, short tail, and grey-green body (Altman and Sallabanks 2012). It is found in coniferous forests across much of North America, and at higher elevations along the Rocky and Coastal Mountain Ranges (ibid.). Within BC, the species is Blue-listed, is listed on Schedule 1 of *SARA*, and is designated as Threatened by COSEWIC (BC Conservation Data Centre 2014a).

The Olive-sided Flycatcher is a breeding visitant to BC (Campbell et al. 1997). During the breeding season, it is strongly associated with coniferous forest openings and forested wetlands (COSEWIC 2007b). In particular, wetlands or forests that have been burned or logged and that contain scattered veteran trees or patches are preferred for nesting and perching while foraging (ibid.). During foraging, a prominent location (*e.g.*, the top of a dead tree), often serves as a perch from which they can fly catch (Fitzpatrick 1978; Wright 1997).

Olive-sided Flycatcher populations have shown a significant decline in North America over the past 40 years (COSEWIC 2007b). Provincial trends have been more difficult to assess due to smaller sample size, but there appear to be consistent declines across most provinces (ibid.). The cause of this decline is unknown, but loss of winter habitat, the increasing presence of ecological sinks in breeding habitat, or a reduction in insect prey due to pesticides have all been suggested as causes (Diamond 1991; Hutto and Young 1999; Altman and Sallabanks 2012).

No studies were found during background research for the baseline that identified locations of Olive-sided Flycatcher observations in the LSA.

2.2.14 Bald Eagle

Bald Eagles occur throughout BC, excluding alpine and subalpine areas, and populations in the province are estimated to be in the range of 20,000-30,000 (Gerrard 1983; Farr and Dunbar 1988). The species is provincially Yellow-listed, but is also considered a species of regional concern (BC Conservation Data Centre 2014a).

Bald Eagles are generally associated with large waterbodies, including lakes, rivers, large wetlands, estuaries, and the sea coast, as these habitats can generally provide abundant forage (Campbell et al. 1990b; Blood and Anweiler 1994). Waterfowl and fish are common food items for Bald Eagles (Blood and Anweiler 1994), with ungulate carrion forming an important part of their winter diet in some areas (Swenson et al. 1986).

Nesting commonly occurs in mature or old-growth forests located within 2 km of suitable foraging areas (Swenson et al. 1986; Buehler 2000). Large stick nests are constructed near the tops of trees that are dominant within the stand, to permit direct flight access and good visibility from many sides (Campbell et al. 1990b; Buehler 2000; Watts et al. 2006).

Historically, three factors have contributed to declines in Bald Eagle populations in British Columbia, including shooting mortality, pesticide contamination and habitat loss (Blood and

Anweiler 1994). Human activity is also believed to have a significant impact on eagle population density and reproductive success through disturbance (Booth and Merkens 2000; Newbrey et al. 2005; Watts et al. 2006).

No studies were found during background research for the baseline that identified locations of Bald Eagle observations in the LSA.

2.2.15 Northern Goshawk

Two subspecies of Northern Goshawk occur within BC: *Accipiter gentilis laingi* and *Accipiter gentilis atricapillus* (BC Ministry of Water, Land and Air Protection 2004a). The former of these subspecies is found on the coast of BC, including the Queen Charlotte Islands, Vancouver Island, and the coastal mainland, while the latter subspecies is found throughout the rest of the province according to the NGRT (2008). *A. g. atricapillus*, the subspecies found within the Project area, is Yellow-listed and listed as an Identified Wildlife species under *FRPA* (BC Conservation Data Centre 2014a).

The Northern Goshawk is sometimes considered a habitat generalist, because it uses a wide range of habitats and successional stages for meeting its needs (Cooper and Stevens 2000), and has been recorded in almost every forest type in the province (Campbell et al. 1990b). It is found across a wide range of elevations, from near sea level up to near the tree line, using habitats that include lakes, streams, avalanche tracks, agricultural areas, dry forests, average forests, wet forests, riparian forests, parkland and aspen copses (Stevens 1995). However, it is primarily a bird of mature or old-growth coniferous forests (see (Cooper and Stevens 2000).

Nesting habitat includes stands of large, old trees, with dense canopy cover and relatively open understory (BC Ministry of Environment, Lands and Parks 1998). These stands are typically found on gentle slopes, usually less than 30% and always less than 60% (ibid.), with optimum stand structure consisting of mature or old-growth forests with high canopy closure, moderate tree density, large trees and open understory (Hayward et al. 1983; Dietrich and Woodbridge 1994; Lilieholm et al. 1994; Siders and Kennedy 1996; Cooper and Stevens 2000).

Foraging areas typically comprise a wider range of habitats than nesting habitat (Cooper and Stevens 2000), with the choice of foraging habitats guided by prey abundance and availability (Squires and Reynolds 1997). Microhabitat features that characterize high quality foraging sites include: 1) adequate prey, 2) sufficient cover to conceal the goshawk’s approach, 3) low enough cover to facilitate access to the prey and flight manoeuvrability, and 4) suitable perches to hunt from (see Cooper and Stevens 2000). These habitat structures are most often found in mature or old-growth forests, which provide adequate CWD and other habitat features for higher prey abundance, sufficient canopy closure and shrub cover to hide the goshawk’s approach, structurally-varied and open vegetation to allow greater manoeuvrability, and a wide variety of perch sizes and heights. Goshawks may also use young forest stands (structural stage 5) when they present some of these habitat features, but these habitats are less preferred than older forests (ibid.).

The Northern Goshawk feeds mainly on small to medium-sized birds and mammals (*e.g.*, crows, jays, grouse, woodpeckers, hares, squirrels, etc.; (Cannings et al. 1987; Campbell et al. 1990b;

BC Ministry of Environment, Lands and Parks 1998), and overall prey preferences appear to be region and season-specific. In general, the Northern Goshawk is an opportunistic hunter that uses many different types of habitat to forage for a wide variety of prey (Squires and Reynolds 1997).

The loss of existing goshawk nest sites can be detrimental, because goshawks have a high fidelity to breeding areas (Northern Goshawk *Accipiter gentilis laingi* Recovery Team (NGRT) 2008).

No studies were found during background research for the baseline that identified locations of Northern Goshawk observations in the LSA.

2.2.16 Western Screech-owl

Within BC, two subspecies of Western Screech-owl occur: *Megascops kennicottii macfarlanei* and *Megascops kennicottii kennicottii* (BC Ministry of Water, Land and Air Protection 2004a). The latter of these occupies coastal and interior-coastal transition areas of BC, and is geographically separated from the former subspecies, which is often referred to as the "interior" western screech-owl (ibid.). *M. k. macfarlanei*, which will be the only subspecies further referred to during the assessment, is provincially Red-listed, is listed on Schedule 1 of *SARA*, and is designated as Threatened by COSEWIC (BC Conservation Data Centre 2014a).

Western Screech-owls are primarily found in deciduous or mixed, riparian forests of lakeshores, streams and floodplains (Hayward and Garton 1984; Cannings et al. 1987; Campbell et al. 1990b; Stevens 1995), and along forest edges and meadows (BC Environment 1996). In general, they prefer semi-open habitats with a deciduous component (Kirk 1995) of moderate height (4-8 metres; (Hayward and Garton 1988). They are highly dependent on forests in structural stage 6-7 - *i.e.,* age classes 7-9 (Kirk 1995; BC Environment 1996; BC Ministry of Water, Land and Air Protection 2004a).

Western Screech-owls are secondary cavity-nesters, and thus rely on pre-existing cavities, either natural or those excavated by woodpeckers (*e.g.,* Northern Flicker and Pileated Woodpecker; (BC Environment 1996). Nesting occurs in open deciduous, coniferous and riparian habitats associated with rivers, creeks, marshes, bogs, lakes and large ponds (Campbell et al. 1990b). Nests have been found in a variety of live and dead coniferous and deciduous tree species, but always in larger-diameter trees or snags (>25 cm diameter), and mostly situated near water (Cannings et al. 1987; Campbell et al. 1990b). The species has also been known to use nest boxes for nesting when available (Campbell et al. 1990b; Stevens 1995).

This owl is a generalist feeder, and its diet includes arthropods, voles, mice, shrews, small birds, amphibians, earthworms, reptiles and fish (Cannings et al. 1987; Kirk 1995; BC Environment 1996; Kaufman 1996); also see (Cannings and Angell 2001). Hunting occurs close to the ground in mixed deciduous-coniferous forests, usually near a creek or pond or along the edges of open fields (BC Environment 1996).

Habitat loss may explain the declines observed in the most-populated areas of the province (COSEWIC 2002b; BC Ministry of Water, Land and Air Protection 2004a). In addition, the range expansion of Barred Owls (*Strix varia*) has been proposed as another source of decline, through predation of screech-owls (COSEWIC 2002b).

No studies were found during background research for the baseline that identified locations of Western Screech-owl observations in the LSA.

2.2.17 Fringed Myotis

The fringed myotis is one of the largest *Myotis* species in the province, and inhabits south-central BC (Nagorsen and Brigham 1993). The name comes from the distinct fringe of small stiff hairs on the outer edge of the tail membrane that can be seen with the naked eye (ibid.). It is provincially Blue-listed, classified as Identified Wildlife, listed on Schedule 3 of *SARA*, and is listed by COSEWIC as data deficient (BC Conservation Data Centre 2014a). The fringed myotis is found in western North America from Canada to Mexico, and in BC is found in the south-central part of the province (Nagorsen and Brigham 1993; BC Conservation Data Centre 2014a).

Little is known about specific habitat requirements for fringed myotis. Maternal colonies have been found in agricultural areas, and bats have been captured near watercourses and in open grassland habitats (BC Ministry of Water, Land and Air Protection 2004a). Roost and maternity sites have been found in rock crevices, caves, buildings, and mine shafts as well as under loose bark of ponderosa pine (*Pinus ponderosa*) snags (ibid.).

Foraging habitat is thought to be arid grasslands, dry ponderosa pine and Douglas-fir forests, and riparian areas (Rasheed et al. 1995; COSEWIC 2004). Most fringed myotis forage 3 – 10 metres above ground. They are believed to be opportunistic invertivores, and possibly even omnivores (COSEWIC 2004). They migrate in some parts of their range (O'Farrell and Studier 1980), but very little is known of winter behaviour in BC (Rasheed et al. 1995).

No studies were found during background research for the baseline that identified locations of fringed myotis observations in the LSA.

2.2.18 Little Brown Myotis

The little brown myotis is a medium-sized *Myotis* species with an extremely variable fur colour ranging from yellow or olive to dark brown or black (Nagorsen and Brigham 1993). As of the writing of this report, the little brown myotis is provincially Yellow-listed, but was emergency-listed by COSEWIC on February 3, 2012 as Endangered due to the precipitous population declines in eastern Canada caused by white-nose syndrome (BC Conservation Data Centre 2014a; Forbes 2012), a fungal infection that attacks hibernating bats. The status of the little brown myotis was re-examined and confirmed by COSEWIC in November 2013 (Forbes 2012).

Little brown myotis are widespread throughout North America and are the most common and widely distributed of the Canadian bats (van Zyll de Jong 1984). They are found in all BGC zones (Nagorsen and Brigham 1993; BC Conservation Data Centre 2014a) and are known to live almost anywhere trees and water are present (van Zyll de Jong 1984). They are opportunistic insectivores, who prefer to hunt low over water, but have also been known to forage in trees at heights over 6 metres. They typically consume flying insects, especially mosquitoes, midges, caddisflies and moths, and also sometimes spiders and beetles (BC Conservation Data Centre

2014a). Individuals may consume their own weight in insects over the course of a single night (Verts and Carraway 1998).

This species is quite adaptable, using buildings and other man-made structures for summer roosts and nursery cavities, as well as tree cavities, caves, and rock crevices (Nagorsen and Brigham 1993; BC Conservation Data Centre 2014a); maternity colonies may number from a few individuals to over a thousand (van Zyll de Jong 1984).

The little brown myotis hibernates in caves and abandoned mines, although hibernation records in BC are limited to several old mines in the interior with only a few individuals located at each site (Nagorsen and Brigham 1993). In the northeast, they may migrate hundreds of kilometres between summer and winter habitats; in the west, it is believed that they hibernate near their summer range (BC Conservation Data Centre 2014a).

Although the little brown myotis is one of the most common bat species in North America, it is highly susceptible to White-nose Syndrome (WNS), a fungal disease with a high mortality rate. Massive mortality events were recorded in New Brunswick in 2011, with significant declines in Quebec and Ontario hibernacula (Forbes 2012). If the spread of WNS continues at its current rate, the entire Canadian population of little brown myotis could be affected within 11 – 22 years (ibid.).

No studies were found during background research for the baseline that identified locations of little brown myotis observations in the LSA.

2.2.19 Northern Myotis

The northern myotis, previously known as the northern long-eared myotis, is a small to medium-sized bat that is provincially Blue-listed and was emergency-listed by COSEWIC on February 3, 2012 as Endangered due to the precipitous population declines in eastern Canada caused by white-nose syndrome (COSEWIC 2014; BC Conservation Data Centre 2014a). The status of the northern myotis was re-examined and confirmed by COSEWIC in November 2013 (COSEWIC 2014). They can be identified by dark brown ears that extend, when pushed forward, 5 mm or more beyond the end of the nose (van Zyll de Jong 1984; Nagorsen & Brigham 1993).

They are generally associated with forested communities, and are found distributed widely across eastern Canada and the U.S, and to lesser extents, are also found further west, into British Columbia (Nagorsen and Brigham 1993; BC Conservation Data Centre 2014a). The northern myotis hunts over small ponds and forest clearings under the tree canopy, and has been observed drinking from small pools in forest clearings (Nagorsen and Brigham 1993). They are opportunistic insectivores, foraging 1 – 3 metres off the ground and almost exclusively among the trees of hillside and ridge forests (BC Conservation Data Centre 2014a). Northern myotis roost primarily in mature stands of deciduous trees (Vonhof and Wilkinson 1999).

It is believed that the northern myotis may migrate south for the winter, due to a lack of known hibernacula as well as a few observations that indicate this species is capable of moving relatively long distances (BC Conservation Data Centre 2014a). Hibernacula have been found in a variety of locations such as caves, mines, overhangs, and tunnels from late fall through early spring.

Due to the spread of WNS, catastrophic declines are expected across the entire North American population (COSEWIC 2014). If the spread of WNS continues at its current rate, the entire Canadian population of northern myotis could be affected within 11 – 22 years (ibid.).

No studies were found during background research for the baseline that identified locations of Northern myotis observations in the LSA.

2.2.20 Townsend's Big-eared Bat

Townsend's big-eared bat is found throughout southern British Columbia, including Vancouver Island, the Gulf Islands, and the mainland from Vancouver, east to Creston, and north to Williams Lake (Nagorsen and Brigham 1993). This species has a scattered distribution and is generally associated with the drier BGC zones of southern BC (Firman 2000). It is provincially Blue-listed (BC Conservation Data Centre 2014a).

Townsend's big-eared bat is strongly associated with caves and cave-like structures, such as mines (Blood 1998; Pierson and Rainey 1998; Cannings et al. 1999; Piaggio 2005), and local distribution of the species is dependent on the availability of suitable roost sites (Piaggio 2005; Gruver and Keinath 2006). Other studies in British Columbia confirmed the use of cavernous rock features and buildings for roosting maternity colonies and for solitary males (Sarell et al. 2004; Craig and Sarell 2006). Larger, more complex caverns offer more opportunities for suitable microclimates (Gruver and Keinath 2006). The species has also been observed using bridges and hollow trees as roost sites further south (Piaggio 2005), but never in BC.

Townsend's big-eared bat is particularly vulnerable to human activities due to its sensitivity to disturbance (Nagorsen and Brigham 1993; Cannings et al. 1999). Specifically, disturbance can cause abandonment of roost sites (to which there is often a high fidelity), and reduction of breeding success at maternity colonies. Repeated disturbance to hibernacula can increase winter mortality (Nagorsen and Brigham 1993; Piaggio 2005). Forest harvesting around hibernacula or roost sites may alter the microclimate of the site and reduce its suitability. Removal of forest canopy and alteration of wetlands can also have an effect on Townsend's big-eared bat foraging (Piaggio 2005; Gruver and Keinath 2006).

No studies were found during background research for the baseline that identified locations of Townsend's big-eared bat observations in the LSA.

2.2.21 Western Small-Footed Myotis

The western small-footed myotis is the smallest bat species in British Columbia (Nagorsen and Brigham 1993; BC Conservation Data Centre 2014a), and is provincially Blue-listed (BC Conservation Data Centre 2014a). This is an uncommon species, rarely caught in abundance and therefore, little is known about its basic biology or specific habitat requirements (Garcia et al. 1995). The range of the western small-footed myotis is restricted to the arid, low elevation valleys of the dry interior, and it has been found at elevations ranging from 300 – 850 m (ibid.).

Females give birth from mid-June to late July (Garcia et al. 1995). Maternity roost sites are not well known in BC, but are believed to include rock crevices, vertical banks, talus and rocky outcrops (Nagorsen and Brigham 1993). Those same habitats, as well as loose bark on large-diameter trees, are also thought to be used as day roosts.

This species has been documented hibernating in the province in caves and mine shafts (Nagorsen and Brigham 1993). Foraging habitat has been variously reported as arid grassland, old and mature forest, riparian areas, and rocky outcrops (ibid.). This species is an aerial insectivore that forages at heights between 1 and 3 metres, typically along the edges of cliffs, rocky slopes, riparian habitat, and occasionally over open water (Garcia et al. 1995).

No studies were found during background research for the baseline that identified locations of Western small-footed myotis observations in the LSA.

2.2.22 Fisher

The fisher is a medium-sized carnivore of the family Mustelidae (i.e., the weasel family). They are found throughout much of BC, inhabiting most BGC zones in the province (Stevens 1995). The species is Blue-listed and is an Identified Wildlife species under FRPA (BC Conservation Data Centre 2014a).

Fishers live in forested habitats, mostly at low- to mid-elevations (below 2,500 m; (BC Ministry of Water, Land and Air Protection 2004a). In western North America, fishers are associated with late-successional forests, often in hygric to hydric riparian and riparian-associated sites (ibid.). High-quality habitat generally consists of mature to old forests with moderate to high canopy closure, abundant large woody debris, diverse and abundant understory vegetation, and large snags and cavity trees (Banci 1989; Powell 1993; Weir 1995; Weir 2003). Riparian habitats are often considered important for fishers (Banci 1989). Powell and Zielinski (1994) observed that fishers avoid large forest openings, open hardwood forest, recent clear-cuts, grasslands, and areas above the treeline. Large amounts of these types of habitats may exclude fishers from an area, since fishers require abundant snow interception cover during the winter (Clark et al. 1987).

Fishers are opportunistic foragers (Powell and Zielinski 1994; Weir 1995). Fishers prey mainly on small mammals (e.g., porcupine (Erethizon dorsatum), snowshoe hare (Lepus americanus), voles (Microtus spp., Myodes spp.) and squirrels (Tamiasciurus spp.)), although berries, birds, carrion, eggs, fish, fungi, snakes, and vegetation may also be eaten (Banci 1989; Powell 1993; Powell and Zielinski 1994; Weir 1995; BC Ministry of Water, Land and Air Protection 2004a). Feeding habitat is generally associated with rivers, streams and edge habitats that support a wide variety of different prey species. Fishers hunt in or near overturned root wads, downed logs and brush piles (Banci 1989). During the winter, snow conditions likely influence prey access and foraging success for fishers (BC Ministry of Water, Land and Air Protection 2004a).

The size of fisher home ranges varies widely by region and sex. Male fisher home ranges vary from 19 to 79 km2, and female home ranges vary from 4 to 32 km2 (BC Ministry of Water, Land and Air Protection 2004a). In a compilation of studies completed in western Canada and the United States, the average home range for male fishers was 40-50 km2, and the average for females was 15-20 km2 (Powell and Zielinski 1994). Recent studies in central BC found the annual home ranges of male and female fishers to be 168.8 km2 and 35.2 km2, respectively. The range of one male may overlap with that of several females, but home range overlap does not appear to occur within sexes (Banci 1989; Weir et al. 2000).

The two biggest threats to fisher populations appear to be overharvesting due to trapping, and the loss or alteration of habitat through forest harvesting, hydroelectric development, and other resource developments (Clark et al. 1987; Powell and Zielinski 1994; Lewis and Stinson 1998; BC Ministry of Water, Land and Air Protection 2004a). BC MWLAP (2004a) suggested that fishers in BC likely have a lower resiliency to population reductions (such as trapper harvest) than elsewhere within their range in North America due to limited distributions, lower reproduction, and smaller home ranges. Habitat alteration appears to affect fishers differently at different scales, with large-scale habitat alteration or loss resulting in the exclusion of fishers from an area, while small-scale habitat alteration or loss could result in increased energetic requirements for individual fishers travelling between suitable habitat (ibid.), which could result in increased mortality or decreased reproductive success.

Simpcw (2012) identified fisher as occurring within the LSA, but no specific locations were provided.

2.2.23 Grizzly Bear

Historically, grizzly bears ranged throughout British Columbia (except for the coastal islands), but populations are considered extirpated from much of south and south central BC (BC Ministry of Water, Land and Air Protection 2004a). Grizzlies occur at all elevations from sea level to the alpine and they are found in all BGC zones except the Bunchgrass and Coastal Douglas-fir (ibid.). The grizzly bear is provincially Blue-listed, is an Identified Wildlife species under FRPA, has been designated as a species of special concern by COSEWIC (BC Conservation Data Centre 2014a).

Grizzly bears use three types of habitat: security, thermal, and foraging. Security habitat generally includes areas that are uninfluenced by human activity, with the exception of females with cubs, who may select areas under human influence in order to avoid aggressive males (Ross 2002). Security habitat also often includes mature or old forest with a diverse understory, and isolated rugged habitats (Pearson 1975). Thermal habitat generally includes day-bedding sites located in closed forests adjacent to high-quality foraging habitat (BC Ministry of Water, Land and Air Protection 2004a).

Although the presence of security and thermal habitat are important, grizzly bear habitat selection is mainly determined by the availability of suitable forage habitat, which varies according to the season (BC Ministry of Water, Land and Air Protection 2004a). Grizzlies are opportunistic omnivores, with between 19% and 96% of their diet consisting of vegetation, depending on the region (Hilderbrand et al. 1999)). Berries, grasses, horsetails (Equisetum spp.), roots, sedges (Carex spp.), and vetch (Vicia spp.) comprise the main portion of their diet, with carrion, insects, fish and small mammals also being consumed regularly (Cannings et al. 1999). Some bears hunt ungulates, especially new fawns and calves in the spring. High-quality foraging sites include: herbaceous avalanche chutes, wetlands, estuaries and riparian areas; berry patches; salmon-spawning areas (in the fall); and ungulate winter ranges and calving areas in appropriate seasons (BC Ministry of Water, Land and Air Protection 2004a).

Habitat loss, fragmentation, alienation, and human-caused mortalities (e.g., hunting, poaching, traffic collisions, and nuisance animal kills) are the primary factors affecting grizzly bear populations in BC (BC Ministry of Water, Land and Air Protection 2004a). The most significant effects on habitat degradation and mortality for grizzlies likely originate from the development of roads and other linear features (Ross 2002). Roads facilitate hunting and poaching of bears as well as resulting in vehicular collision, human-bear conflicts, and disruption of bear movement corridors (Ross 2002; BC Ministry of Water, Land and Air Protection 2004a).

Simpcw (2012) identified grizzly bear as occurring within the LSA, but no specific locations were provided.

2.2.24 Moose

Moose occur throughout the majority of BC, with the exception of Vancouver Island, the Queen Charlotte Islands and the southern coastal areas (Blood 2000a), and occur within all BGC zones except the Coastal Douglas-fir, Bunchgrass and Ponderosa Pine (Stevens 1995). The species is provincially Yellow-listed (BC Conservation Data Centre 2014a), but is also a species of regional concern.

Food abundance and quality (especially during winter) are considered two of the most important aspects of moose habitat (LeResche and Davis 1973; Franzmann 1978). Moose are generally browsers, although they will also graze during the summer (Franzmann 1978). Early-successional woody browse is used extensively (ibid.), with preferred browse plants consisting of bog birch (Betula glandulosa), high-bush cranberry (Viburnum edule), lodgepole pine, paper birch, red-osier dogwood (Cornus stolonifera), saskatoon, Sitka mountain-ash (Sorbus sitchensis), trembling aspen, and willows (Salix spp.; Westworth et al. 1989; Baker 1990; Renecker and Hudson 1992; Simpson 1992)). Leaves and other non-woody vegetation are preferred due to the higher quality and increased digestibility of these food sources, however winter often restricts forage choices to low-quality, difficult-to-digest, woody browse (Renecker and Hudson 1986).

Moose generally select shrubby foraging habitats in early successional stages or with open canopies, including cutblocks, wetlands, avalanche chutes, floodplains, and riparian communities (Stevens and Lofts 1988; Spalding 1990; MacCracken et al. 1997). Fire is also considered an important driver of local moose abundance (LeResche 1974; Gasaway et al. 1989), because of its ability to open up the canopy and increase the availability of shrubs.

Winter habitat availability is generally considered the limiting factor for moose populations (Kelsall and Prescott 1971; McNicol and Gilbert 1980; Thompson and Vukelich 1981; Risenhoover 1985; Hatler 1988). Winter habitats tend to be low-elevation, riparian communities with abundant early-seral riparian vegetation (Kelsall and Telfer 1974; LeResche et al. 1974; Doerr 1983; Risenhoover 1985; Van Drimmelen 1987; Thompson et al. 1989; Modaferri 1992). Moose also use clearcuts and burned areas during the winter (Westworth et al. 1989). Van Dyke (1995) described high-value winter feeding habitat as having greater than 30% shrub cover, low density of mature trees, and gentle slopes.

Although not considered at-risk in BC, moose populations are subjected to a number of threats throughout their range. The creation of large hydroelectric reservoirs (e.g. Williston Reservoir) has potentially affected a large area of winter range for moose, and hundreds of moose are killed each year on highways and railway lines (Blood 2000a).

Simpcw (2012) identified moose as occurring within the LSA, but no specific locations were provided.

2.2.24.1 Critical Moose Winter Range

Many ungulate management objectives are met through provincial strategies such as UWRs and selective harvesting, but to complement these strategies the Kamloops LRMP also identifies and manages Critical Moose Winter Range (CMWR). Critical habitats are managed in the LRMP using access management, harvest management, and forage management (Kamloops Interagency Management Committee 1995). In particular, CMWR is managed to "maintain thermal and visual cover for moose, and enhance browse production" (Kamloops Interagency Management Committee 1995). Figure 4 shows the location of CMWR in the LSA.

2.2.25 Mountain Caribou

Three ecotypes of woodland caribou species (*Rangifer tarandus*) are found in British Columbia: mountain, northern, and boreal. These ecotypes are differentiated based on distribution, behaviour and habitat requirements (Heard and Vagt 1998; Cichowski et al. 2004). Mountain caribou occur regularly in portions of the Rocky Mountains, the Cariboo, northern Monashee and northern Selkirk Mountains, as well as the eastern Quesnel and eastern Shuswap highlands. The southern mountain population (pop. 1) is expected to occur in the study area; this population is provincially Red-listed, listed on Schedule 1 of SARA, and designated as Threatened by COSEWIC (BC Conservation Data Centre 2014a).

Food habits of mountain caribou are closely tied to food availability, and show seasonal variation. In early winter, falsebox can be consumed in certain areas (Mountain Caribou Technical Advisory Committee 2002) with the caribou using valley bottoms and lower slopes in the ICH and lower ESSF zones (Stevenson et al. 2001; Mountain Caribou Technical Advisory Committee 2002; Cichowski et al. 2004). The dense forest canopies reduce initial snow depth and permit greater mobility and access to forage (Wilson and Hamilton 2003). As winter progresses and the snowpack increases, the caribou move to upper slopes and ridge tops where they switch to their winter diet, which consists almost exclusively of arboreal hair lichens (Bryoria spp., Alectoria sarmentosa and possibly Nodobryoria oregana) associated with mature and old forests (Stevenson et al. 2001; Mountain Caribou Technical Advisory Committee 2002; Cichowski et al. 2004).

As winter turns into spring, mountain caribou begin to move back down to lower elevations to feed on the fresh, green foliage at sites where vegetation comes up earliest (Wilson and Hamilton 2003). During summer and fall, the caribou will feed on grasses, sedges, horsetails, flowering plants such as Sitka valerian, and leaves of a variety of shrubs (Mountain Caribou Technical Advisory Committee 2002). During this time, they will travel back up to middle- and upper-elevation ESSF forests and alpine areas both because of forage availability as well as reduced predation pressure (Stevenson et al. 2001).

The mating season (rut) for the mountain caribou is late September to mid-October. During this time, the polygamous mountain caribou bulls will breed with a number of cows. Each dominant male will defend his harem from the potential competition of other bulls (Cichowski et al. 2004). The gestation period is about 230 days, with calves being born in late May or early June. Pregnant females will leave the spring feeding grounds earlier than other caribou, traveling to more rugged, higher elevations. Calving grounds are in the ESSF, usually near or above the snowline, and are typically in forests with high lichen densities due to the unavailability of vascular forage from late snowmelt (Scott and Servheen 1984). Pregnant females seek out secluded sites in alpine and subalpine habitats to calve (Mountain Caribou Technical Advisory Committee 2002).

Caribou populations have specific requirements when it comes to quantity and quality of habitat (COSEWIC 2002c). Human development combined with natural factors (e.g., fire, insects and diseases that kill trees, windstorms and extreme weather, predators and parasitic insects) often cause habitat loss, degradation, and fragmentation. Habitat access, isolation due to fragmentation, and low existing population numbers are all areas of high concern for mountain caribou conservation. Adequate quality of range, meaning access to nutritious food sources year round as well as calving and post-calving areas and other ‘security habitat,” are essential to the continued existence of this species (ibid.).

There are two southern mountain caribou planning units that overlap the Regional Study Area: the Revelstoke – Shuswap unit to the south (Planning Unit 3A; 205 individuals) and the Wells Gray – Thompson to the north (Planning Unit 4A; 274 individuals; Mountain Caribou Science Team 2005; BC Ministry of Agriculture and Lands 2007).

Mountain caribou have been reported by Simpcw (2012) within the LSA, and historic ungulate aerial census data obtained by Keystone Wildlife Research Ltd. (Keystone) included one mountain caribou observation within the LSA recorded in January 1979 (Ministry of Environment, unpubl. data). Other past studies have recorded caribou in the vicinity of the LSA (i.e. within 15 km; Figure 5), but those locations have primarily been on the north side of the North Thompson River (the Wells Gray subpopulation) as well as further to the east (the Groundhog subpopulation) outside of the LSA (Mowat et al. 1998; Furk 2008). These areas are actively managed using Wildlife Habitat Areas (WHAs), provincial parks, and other management strategies.

2.2.26 Mountain Goat

BC is home to more than 50% of the world’s population of mountain goats (Wilson 2005), and they are found throughout BC’s mountain ranges, on steep terrain at various elevations (Blood 2000b). The mountain goat is provincially Yellow-listed, but is also a species of regional concern (Reynolds 2002; BC Conservation Data Centre 2014a).

Mountain goat demographics are often determined by survival during the winter, as this is when food is limited and energy demands are high. Thus, mountain goat winter range is of critical importance to goat populations. Mountain goats require two general types of habitat during the winter: escape habitat and foraging habitat. These habitats must be in close proximity to each other, because winter home ranges for goats are often very small (< 250 ha; (Wilson 2005). Escape habitat consists of steep, rugged, warm aspect sites that shed snow easily and provide high visibility; south-facing rock bluffs and cliffs are often selected as preferred escape terrain (Blood 2000b; Wilson 2005).

Winter forage for mountain goats generally consists of forbs, ferns, conifers, lichens and mosses, which are obtained in forests adjacent to escape terrain (Wilson 2005). Snow interception cover, in the form of the forest canopy, improves availability of these food sources. Adequate snow interception is often found in mature or old-growth forests, which contain large-diameter trees, and multi-layered, closed canopies (Kirchhoff and Schoen 1987) cited in (Wilson 2005). Older forests also contain higher abundances of arboreal lichens and litter fall, which are important food sources during times of deep snow (Wilson 2005). These older forests have been shown to be associated with goat presence and winter home ranges (Taylor et al. 2004).

Declines in mountain goat populations have been linked to increased hunting pressure, which is directly related to increased road access (Rumsey et al. 2004). Disturbance of goats by development (e.g., construction-related noise) and recreational activities is also a concern, especially during the kidding season or during the winter when individuals are in their poorest condition (Blood 2000b). Helicopter activity is a significant source of disturbance, with distance from a helicopter overflight being inversely related to the level of disturbance observed in individual goats nearby (Cote 1996; Goldstein et al. 2005).

Simpcw (2012) identified mountain goats as occurring within the LSA, but no specific locations were provided.

2.2.26.1 Ungulate Winter Range – Mountain Goat

As stated within Section 2.1.1.4, UWRs are used for the management of important ungulate habitat. UWRs for mountain goats, hereafter referred to as Goat Winter Range (GWR), are typically placed in areas containing a complex of escape terrain and winter forage habitat. Several GWRs are located in the Dunn Peak Protected Area and Harper Creek watershed (Figure 6). All of these GWRs are located outside of the LSA and more than 3 km away from any proposed Project facilities.

2.2.27 Mule Deer

Mule deer (Odocoileus hemionus spp.) are the most widespread cervids (i.e., members of the deer family) within BC, and the province's population can be separated into three subspecies: mule deer (O. h. hemionus), Columbian black-tailed deer (O. h. columbianus), and Sitka black-tailed deer (O. h. sitkensis; (Bunnell 1990; Blood 2000c). Black-tailed deer are restricted to the coastal areas, with Columbian black-tailed deer found on the south coast and Vancouver Island, and Sitka black-tailed deer found on the north coast and Queen Charlotte Islands (ibid.). Mule deer (O. h. hemionus) occur throughout the rest of the province where deer are present, with the Coast Ranges generally considered the divide between black-tailed deer and mule deer, although interbreeding does occur in this area (ibid.). The term mule deer will be used to refer to the species, and no further differentiation will be made regarding subspecies. Within BC, the mule deer is provincially Yellow-listed (BC Conservation Data Centre 2014a).

The mule deer is an adaptable species that inhabits a broad range of habitats (Shackleton 1999). Within any given area, they use a patchwork of different habitats to meet their needs for food, security, thermal cover and snow interception cover (ibid.).

During the growing season, deer forage in open habitats such as recent clear-cuts, ROWs, meadows, roadsides, riparian habitats, cultivated fields, and wetlands (Thomas et al. 1979; Stevens and Lofts 1988; Shackleton 1999). During the winter, these habitats are used to a lesser amount, with use shifting (with increasing snow depth) to coniferous forests with higher canopy closures (Bunnell 1990; Shackleton 1999). Some common growing season forage plants include bracken fern (Pteridium aquilinum), Douglas-fir, fireweed (Epilobium angustifolium), pearly everlasting (Anaphalis margaritacea), red huckleberry (Vaccinium parvifolium), rose (Rosa spp.), salmonberry (Rubus spectabilis), saskatoon, snowberry (Symphoricarpos albus), thimbleberry, and willows (ibid.). Conversely, forage plant choices are much more limited during the winter, and can generally consist of arboreal lichens, Douglas-fir, red huckleberry, snowberry, snowbrush (Ceanothus velutinus), and western redcedar, as well as some forbs (e.g., bunchberry and deer fern [Blechnum spicant]) when they are available (Bunnell 1990; Simpson and Gyug 1991; Waterhouse et al. 1994; Shackleton 1999; Simpson and Simpson 2000).

Thomas et al. (1979) defined security cover as any habitat that can hide 90% of a mule deer when viewing from less than 60 m away. However, this distance has been defined as less by other authors (e.g., (Rahme 1991). This type of habitat can often be found in dense, young forested stands as well as old-growth stands with relatively dense understories (Bunnell 1990). Bunnell (1990) also states that patches of this type of habitat must be greater than 180 m in diameter to provide suitable security. Thermal cover, on the other hand, is less easily defined because it varies depending on the season and time of day and its use depends upon tradeoffs that individuals make between energy expenditure and energy intake (ibid.).

Snow depth is considered a major influence on mule deer winter distribution and abundance in the winter (D'Eon 2004). Mule deer prefer areas where snow depths are less than 30 cm, and are generally excluded from areas where snow depths exceed 50 cm (Telfer and Kelsall 1979) due to the high energetic requirements of moving through deep snow (Bunnell 1990). Deeper snow leads to decreased accessibility of food sources, which can also have significant effects on mule deer survival. Therefore, snow interception cover can be very important. High-quality mule deer winter range typically consists of south-facing, gentle to moderate slopes with mature or old-growth coniferous forests, which provide snow-interception cover as well as higher abundances of shrubs and arboreal lichens than younger forests (Armleder et al. 1986; Shackleton 1999).

Simpcw (2012) identified mule deer as occurring within the LSA, but no specific locations were provided.

2.2.27.1 Critical Deer Winter Range

Many ungulate management objectives are met through provincial strategies such as UWRs and selective harvesting, but to complement these strategies the Kamloops LRMP also identifies and manages Critical Deer Winter Range (CDWR). Critical habitats are managed in the LRMP using access management, harvest management, and forage management (Kamloops Interagency Management Committee 1995). In particular CDWR is managed to “maintain or enhance forage production and habitat requirements” (Kamloops Interagency Management Committee 1995). Figure 7 shows the location of CDWR in the LSA.

2.2.28 Wolverine

The wolverine is a large mustelid (weasel) found throughout British Columbia, with the exception of the southwestern corner of the province. Populations in the northern and eastern portions of the province are much larger than areas elsewhere (Dauphine and Kelsall 2003; Lofroth and Krebs 2007). The wolverine in BC, with the exception of the Vancouver Island population, is provincially Blue-listed, is an Identified Wildlife species under *FRPA*, and has been designated as a species of special concern by COSEWIC (BC Conservation Data Centre 2014a).

Wolverines are associated with relatively high-elevation montane areas and deep snow cover, and are concentrated in areas with alpine vegetation, alpine climates, and relatively high probabilities of spring snow cover (Copeland 1996; Krebs and Lewis 2000; BC Ministry of Water, Land and Air Protection 2004a; Aubry et al. 2007; Copeland et al. 2007; Ruggiero et al. 2007; Rohrer et al. 2008). At the landscape scale, elevation plays a major role in wolverine habitat use. Summer use occurs mostly near or above the treeline, while winter use occurs at elevations near or below the treeline, although these differences are not always dramatic (*i.e.*, <100 m elevation difference; (Hornocker and Hash 1981; Whitman et al. 1986; Copeland 1996; Landa et al. 1997; Krebs and Lewis 2000; Proulx 2003; BC Ministry of Water, Land and Air Protection 2004a; Copeland et al. 2007).

At the stand scale, wolverines generally show limited selection for specific habitat types for meeting their life history requirements (with the exception of reproductive denning, as described later); this may be due to their wide-ranging nature (Hatler 1989; BC Ministry of Water, Land and Air Protection 2004a). Existing information on stand-scale selection indicates that wolverines may use a combination of alpine habitats and coniferous forests during the summer, and mostly coniferous forests during the winter (Gardner 1985; Whitman et al. 1986; Banci 1987; Copeland 1996; BC Ministry of Water, Land and Air Protection 2004a; Copeland et al. 2007). Avalanche slopes may also be important habitats (Krebs et al. 2007), possibly as a source of carrion during the winter (as ungulates die in avalanches) and marmots during the summer.

Reproductive den sites are considered important components of wolverine home ranges (Magoun and Copeland 1998). Two types of reproductive den sites are known: natal den sites (*i.e.,* the site where kits are born) and maternal den sites (*i.e.,* sites where additional rearing of kits takes place, after initial departure from the natal den site). Due to the temporary nature of the latter, few data are available. Natal den sites are generally located at or near the treeline (Copeland and Yates 2008) in open (*i.e.,* non-forested), high-elevation cirque basins, or forested ravines (Copeland

1996; Magoun and Copeland 1998; Krebs and Lewis 2000; BC Ministry of Water, Land and Air Protection 2004a), with deep snow cover (often greater than 1 m deep) which may provide security and thermal cover (Magoun and Copeland 1998; Aubry et al. 2007). Magoun and Copeland (1998) found that wolverines don't generally den in closed forests, likely due to shallower snow depths in these habitats.

Throughout the range of the wolverine, the greatest threat is likely the overharvesting (*i.e.*, hunting and trapping) of the species (BC Ministry of Water, Land and Air Protection 2004a; Krebs et al. 2004; Squires et al. 2007). Wolverine survival is greater in unharvested populations, and human-caused mortality (including harvesting) is additive to natural causes of mortality (Krebs et al. 2004). In BC, Lofroth and Ott (2007) found that harvesting within 15 of 71 population units was too high to maintain populations without immigration.

Anthropogenic disturbance is also a concern for wolverine populations. Heli-skiing and backcountry skiing are of particular concern, as these activities often lead to displacement of wolverines (COSEWIC 2003; Krebs et al. 2007; Ruggiero et al. 2007). Disturbance of reproductive dens can also lead to den abandonment, although this is more likely to occur with maternal dens than natal dens (Copeland 1996; Magoun and Copeland 1998). Dens are often reused from year to year (Magoun and Copeland 1998), and denning females are more susceptible to additional stresses due to the energetic costs of lactation (Iverson 1972 and Persson 2005, as cited in (Krebs et al. 2007) and vulnerability of kits (Magoun and Copeland 1998; Krebs et al. 2007).

Simpcw (2012) identified wolverine as occurring within the LSA, but no specific locations were provided.

3.0 METHODOLOGY

3.1 Rare Plants

Effects assessment rare plant work for the Harper Creek Mine Project took place in 2011 and 2012. Two seasons of detailed site-specific fieldwork were undertaken in the LSA. The collected data were analyzed in the office and lab between the field portions of the study. Rare plant sites reported from previous botanical work in the vicinity of the Project were also included in the assessment process. Sources for this additional information were:

- BC CDC element occurrence data for tracked rare plants within the Local Study Area (BC Conservation Data Centre 2012b); and

- Data compiled by the 2011 lead botanist during the years 2005 to 2011 during botanical explorations in the Local Study Area (within two kilometres of the town of Vavenby).

RISC has not issued standards for conducting rare plant surveys, other than for the collection of voucher specimens (Resources Inventory Committee 1999b). However, a number of organizations in North America have developed guidelines for these studies. The methods used for the Project rare plant work are based on a synthesis of several of these guidelines (Bizecki-Robson 1998; Whiteaker et al. 1998; Alberta Native Plant Council 2000; California Native Plant Society 2001; Henderson 2009; Penny and Klinkenberg 2012).

3.1.1 Sampling Methods

3.1.1.1 Targeted-Meander Survey

Pre-field Review

Each year's rare plant investigation began with the development of a study plan to guide the methods, survey coverage, and timing of the work for that year. The first step was to prepare a list of rare plants either already known to occur in the Project vicinity, or with a global range that is likely to include the Project vicinity (see Section 2.2.1). It should be noted that the target list is used as a working guideline and can never be an exhaustive list of all potential rare plants for a given area. For this reason, botanists consider all described plant taxa while conducting surveys, including rare plants traditionally used by First Nations.

Secondly, in order to better predict where undiscovered target rare species might exist in the LSA, the botanists compared the habitat preferences of each target species with the ecosystem types found in the study area. These data were used to identify areas of possible high-suitability rare plant habitat in the Local Study Area, and thus guide placement of survey sites and transects. In 2012, the previous year's survey sites were also used to determine survey coverage gaps. Taking into account legal access restrictions and other field limitations (e.g., inaccessible areas, unusable roads, unsafe slopes, etc.), unsurveyed areas were prioritized for sampling during the field season. Individual survey transects were chosen to provide a representative coverage of all habitats within the study area, with particular emphasis on those habitats determined to contain a higher probability of target species occurrence. Finally, once the survey sites were selected, the phenologies of the target species were reviewed to determine the optimum survey periods for each habitat.

The completed field plan for each year specified the target plant species and their likely habitats, the areas to be surveyed that season, and the timing window for those surveys. The plans were reviewed and refined throughout the field seasons as new information became available (e.g., when ancillary sites were added to the proposed Project footprint, or when field studies revealed new high-suitability rare plant habitats).

In order to refine their search images for the target taxa, the 2012 surveyors studied photographs, herbarium specimens, and species descriptions. In addition, they reviewed similar data for species that might be confused with the target taxa. For certain particularly difficult groups of species, tables of summary identification characteristics were prepared for field use. The goals were to maximize detectability of the target species and to reduce observer bias during the surveys.

Field Methods

The field work for both years used the same general pedestrian survey methods, differing slightly in the types of transect walked and the specific data collected. All surveys were performed using the targeted-meander search pattern (Krichbaum 1998; Whiteaker et al. 1998).

The targeted-meander search pattern is employed to locate the most rare plant occurrences in the least amount of time. It is used in relatively large areas where a more thorough survey protocol would not be feasible. Figure 8 shows the location of all targeted-meander rare plant survey transects conducted in the LSA and vicinity.

When using the targeted-meander search pattern:

- surveyors walk a transect oriented toward an area of high-suitability rare plant habitat or a unique land form feature;
- surveyors specifically target a particular habitat or feature, and do not attempt to locate all high-suitability rare plant habitats that might be present in the overall area; and
- surveyors traverse low-suitability rare plant habitat in an opportunistic manner, making limited attempts to visit a representative cross-section within the area.

The targeted-meander survey technique is habitat-directed; that is, it preferentially covers high-suitability ecosystems over the more common low-suitability habitats (MacDougall and Loo 2002). The survey method is also floristic in nature, meaning that all plant taxa encountered are recorded and identified to a level necessary to determine their rarity (Alberta Native Plant Council 2012). Furthermore, the targeted-meander search pattern is variable-intensity, such that when a rare plant occurrence or high-suitability rare plant habitat is located, the surveyors increase the intensity of their survey by narrowing the spacing of the transect pattern they are walking. Depending on the kind of habitat being surveyed and the detectability of the target rare species, this can require very close, hands-and-knees survey work in certain areas.

The surveyors constantly monitor all areas traversed for changes in habitat and plant association, as well as for previously unrecorded plant species (common and rare). Lists are kept of all vascular plants and plant communities observed; unknown species are collected for later identification in the lab; global positioning system (GPS) units are used to mark location points as appropriate; and notes and photographs are taken to record plants of interest, landforms and unique features, habitat quality and disturbance, and areas requiring further survey.

During the surveys, when target rare plants were found, element occurrence data were recorded on a CDC rare plant survey form (BC Conservation Data Centre 2012c). This information was later transcribed into digital format to facilitate analysis of the sites. Digital photographs were taken of both the individual plants and of the surrounding habitat. Consistent with both the RISC guidelines and the rare plant survey guidelines on the BC E-Flora website (Resources Inventory Committee 1999b; Penny and Klinkenberg 2012), a voucher specimen was collected when doing so would not compromise the viability of the population. At each site, GPS units were used to record a point location for the rare plant occurrence. In addition, in 2012, the boundary of each occurrence (and subpopulation where applicable) was recorded into the GPS units to facilitate mitigation planning.

Table 5 provides a summary of the effort for both years of site-specific rare plant surveys.

Table 5: Rare Plant Field Survey Summary

Year	Dates	Botanist-Field-Days*
2011	Aug 4 Sept 7–10 Sept 21	6
2012	Aug 23–28	12

*Botanist-Field-Days: Number of days the survey crew was in the field multiplied by the number of botanists on the crew

3.2 Ecological Communities at Risk

Sites with the potential to support ECAR within the LSA were identified using Terrestrial Ecosystem Mapping (TEM). Terrestrial Ecosystem Mapping is a method of mapping that uses both terrain and vegetation characteristics to classify a landscape into map polygons. It has two components, bioterrain and ecosystems. Bioterrain characteristics include surficial materials, terrain expression (e.g. gullying) and drainage. Ecosystems are defined as sites with distinct vegetation communities and physical characteristics such as slope, aspect and moisture. This type of mapping can be used to provide quantitative information about the physical and vegetation characteristics for any area of interest, and to assess the potential impacts of various land management scenarios.

One attribute within TEM is site series. Site series can be defined as sites that have the potential to produce the same or similar late-seral or climax plant communities. Most ECAR can be related to a specific site series; the related site series has the potential to support the ECAR, though does not guarantee its presence.

3.2.1 Sampling Methods

3.2.1.1 Terrestrial Ecosystem Mapping

Existing TEM previously produced for the project was used (Clement 2009). TEM was produced at 1:20,000 scale for the LSA following methodology described in *Terrain Classification System for British Columbia* (Howes and Kenk 1997), *Guidelines and Standards for Terrain Mapping in British Columbia* (Resources Inventory Committee 1996) and *Standard for Terrestrial Ecosystem Mapping in British Columbia* (Resources Inventory Committee 1998g).

Pre-field Methods

Ecosystem mapping began on hardcopy aerial photographs (Clement 2009). The study area was expanded in 2011 to accommodate revised project footprints and the additional mapping was completed on digital photos using 3-D mapping software. The original mapping was revised and updated to match the most recent provincial subzone boundaries and regional ecosystem units (Lloyd et al. 2005).

Aerial colour photographs from 2000 were viewed in stereo by a qualified bioterrain mapper, who added polygons corresponding to bioterrain characteristics. The photos were then viewed by qualified ecosystem mappers, who subdivided the bioterrain polygons according to the characteristics of the ecosystems within them.

Field Methods

Field studies were undertaken to confirm the accuracy of the ecosystem mapping and the presence of habitat features. Protocols for field truthing and any preliminary habitat ratings were based on the *Field Manual for Describing Ecosystems* (BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998) and *British Columbia Wildlife Habitat Rating Standards* (Resources Inventory Committee 1999a).

FS882 (full plot) forms, Ground Inspection Forms and Wildlife Habitat Assessment forms were completed in the field. Photos were taken of sites representative of common habitats within the LSA during field truthing (Appendix 2). Data from the field truthing were entered into the VENUS data capture program (Version 5.1). Draft ecosystem mapping was revised where required, and a final digital ecosystem map produced.

Figure 9 shows the locations of field plots surveyed in 2011 as part of the TEM truthing.

3.2.2 Data Analysis

An accuracy assessment was performed of the TEM by comparing the results of field truthing plots with the attributes within the mapping. Following finalization of the TEM, it was queried to identify polygons containing site series that are associated with ECAR (Table 6) and the results were summarized.

Table 6: Ecological Communities at Risk and Their Associated Site Series

Common Name	Scientific Name	BC List	Site Series
Black spruce / buckbean / peat-mosses	*Picea mariana / Menyanthes trifoliata / Sphagnum* spp.	Blue	ICHmw3/Wb11
Buckbean - slender sedge	*Menyanthes trifoliata - Carex lasiocarpa*	Blue	ICHwk1/Wf06
Common cattail Marsh	*Typha latifolia Marsh*	Blue	IDFmw2/Wm05
Lodgepole pine / dwarf blueberry / peat-mosses	*Pinus contorta / Vaccinium caespitosum / Sphagnum* spp.	Blue	ESSFwc2/09
Mountain alder / red-osier dogwood / lady fern	*Alnus incana / Cornus stolonifera / Athyrium filix-femina*	Blue	ICHwk1/Fl02
Narrow-leaved cotton-grass - shore sedge	*Eriophorum angustifolium - Carex limosa*	Blue	ESSFwc2/Wf13
Slender sedge / common hook-moss	*Carex lasiocarpa / Drepanocladus aduncus*	Blue	ICHmw3/Wf05, ICHwk1/Wf05
Swamp horsetail - beaked sedge	*Equisetum fluviatile - Carex utriculata*	Blue	ICHmw3/Wm02
Three-way sedge	*Dulichium arundinaceum Herbaceous Vegetation*	Red	ICHmw3/Wm51
Tufted clubrush / golden star-moss	*Trichophorum cespitosum / Campylium stellatum*	Blue	ESSFwc2/Wf11, ICHmw3Wf11
Western hemlock / velvet-leaved blueberry - falsebox	*Tsuga heterophylla / Vaccinium myrtilloides - Paxistima myrsinites*	Red	ICHmw3/NA
Western redcedar - paper birch / oak fern	*Thuja plicata - Betula papyrifera / Gymnocarpium dryopteris*	Blue	IDFmw2/04

3.2.3 Limitations and Assumptions

TEM was mapped as 1:20,000-scale. Mapping at this scale has the potential to miss small habitat features in the LSA. The minimum polygon size, containing three deciles, for 1:20,000-scale TEM is recommended as 2.0 ha, and the minimum decile proportion is typically 20% (Resources Inventory Committee 1998g). Therefore features less than 0.4 ha (4,000 m^2 or approximately 63 m x 63 m) were potentially missed within the TEM.

3.3 Wetlands

Wetlands within the LSA were identified using TEM.

3.3.1 Sampling Methods

3.3.1.1 Terrestrial Ecosystem Mapping

TEM mapping was conducted following methods described in Section 3.2.1.1.

3.3.1.2 Regional Study Area Wetland Mapping

The Project TEM only extends to the limits of the LSA. To put the LSA wetlands into a larger context, Vegetation Resource Inventory (VRI) was used to assess wetland presence and distribution within the RSA as well. VRI contains basic information on wetland presence and distribution on the landscape. It is available at a lower resolution than TEM, but is readily accessible from the BC Government.

To identify wetlands in the RSA, Geographic Information System (GIS) analysis was conducted. VRI spatial files were overlaid with a spatial file of the RSA. A series of queries were run on the resulting file to identify polygons containing wetlands, and the spatial overlay was analyzed using standard spatial statistics within ArcGIS 9.2 to summarize the area of wetlands within the RSA.

3.3.2 Data Analysis

Following finalization of the TEM, it was queried to identify polygons containing wetland site series, and the results were summarized. The finalized TEM for the LSA contained eight wetland site series, including five fens and three swamps (Table 7).

Table 7: Wetlands Within the LSA as Described by Mackenzie and Moran (2004).

Common Name	Site Series
Water sedge / peat-moss	Wf03
Barclay’s willow / water sedge / glow moss	Wf04
Tufted clubrush / star moss	Wf11
Narrow-leaved cotton-grass / marsh-marigold	Wf12
Narrow-leaved cotton-grass / shore sedge	Wf13
Mountain alder / skunk cabbage / lady fern	Ws01
Mountain alder / pink spirea / sitka sedge	Ws02
Drummond’s willow / beaked sedge	Ws04

3.3.3 Limitations and Assumptions

Limitations of the use of TEM to identify and map ecosystems on the landscape are described in Section 3.2.3

3.4 Old-Growth Forests

Old-growth forests within the LSA were identified using TEM.

3.4.1 Sampling Methods

3.4.1.1 Terrestrial Ecosystem Mapping

TEM mapping was conducted following methods described in Section 3.2.1.1.

3.4.2 Data Analysis

Following finalization of the TEM, it was queried to identify polygons containing old-growth forest, and the results were summarized. Old-growth forests within the TEM were identified as all polygons containing structural stage 7 (Table 8).

Table 8: Structural Stage Within the TEM as Defined by BC Ministry of Environment, Lands and Parks and BC Ministry of Forests (1998).

Name	Description	Structural Stage
Sparse / bryoid	Initial stages of primary and secondary succession; bryophytes and lichens often dominant	1
Herb	Early successional stage or herb communities maintained by environmental conditions or disturbance (e.g., snow fields, avalanche tracks, wetlands, flooding, grasslands, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present	2
Shrub / herb	Early successional stage or shrub communities maintained by environmental conditions or disturbance; dominated by shrubby vegetation; seedlings and advance regeneration may be abundant	3
Pole / sapling	Trees > 10 m tall, typically densely stocked, have overtopped shrub and herb layers	4
Young forest	Self-thinning has become evident and the forest canopy has begun to differentiate into distinct layers (dominant, main canopy, overtopped)	5
Mature forest	Trees established after the last disturbance have matured; a second cycle of shade-tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance is generally 80-140 years for ICHdw3 and ICHmw3 variants and 80-250 years for IDFmw2, ICHwk1, and ESSFwc variants	6
Old forest	Old, structurally complex stands comprised mainly of shade-tolerant and regenerating tree species, although older seral and long-lived trees from a disturbance such as fire may still dominate the upper canopy; snags and coarse woody debris in all stages of decomposition typical, as are patchy understories; time since disturbance generally greater that 140 years for ICHdw3 and ICHmw3 and greater than 250 years for IDFmw2, ICHwk1, and ESSFwc variants	7

3.4.3 Limitations and Assumptions

Limitations of the use of TEM to identify and map ecosystems on the landscape are described in Section 3.2.3

3.5 Rock Outcrops

Rock outcrops within the LSA were identified using TEM.

3.5.1 Sampling Methods

3.5.1.1 Terrestrial Ecosystem Mapping

TEM mapping was conducted following methods described in Section 3.2.1.1.

3.5.2 Data Analysis

Following finalization of the TEM, it was queried to identify polygons containing rock outcrops, and the results were summarized. Rock outcrops are typically mapped within TEM as the code RO.

3.5.3 Limitations and Assumptions

Limitations of the use of TEM to identify and map ecosystems on the landscape are described in Section 3.2.3

3.6 Butterflies

3.6.1 Sampling Methods

3.6.1.1 Netting Surveys

Surveys for butterflies were carried out using RISC-standard hand-netting methods (Resources Inventory Committee 1998e).

Pre-field Review

Prior to conducting fieldwork, areas for butterfly surveys were identified by stratifying the LSA based on Project footprint locations and areas containing patches of suitable habitat. Areas considered suitable for butterflies included open habitats where flowering plants in bloom were expected to occur (e.g. grasslands, meadows, and open forests in the IDFmw2). These areas were identified by reviewing aerial photos of the LSA and through review of the TEM.

Field Methods

A combination of vehicle-based and pedestrian transects were used to survey for butterflies. Typically this included driving slowly along Project roads within areas stratified during the pre-field review. As surveyors drove, they watched for butterflies in flight as well as for patches of suitable habitat, stopping to do a more intensive search on foot when either was observed. Butterfly sampling took place concurrently with dragonfly and damselfly sampling, with sampling conducted at the same locations (Figure 10).

Surveys took place on June 21-22, July 29-August 1, and August 9-13, 2011, to maximize detection of the different species of butterflies in flight at different times of the season. Survey crews included a butterfly expert, a biologist, and one or two field assistants. Surveys took place during weather and at a time of day when butterflies were expected to be actively flying. Appropriate weather conditions included dry weather and when wind speeds were low or nonexistent. Surveys began at approximately 9:30 am and continued late into the afternoon.

Butterflies were detected visually and captured in hand nets. Captured individuals were identified in the hand by a butterfly expert and then released. Additional information collected during each survey UTM (NAD 83) coordinates of the survey, start and end time, ceiling, wind (Beaufort factor), cloud cover, temperature and precipitation.

3.7 Damselflies and Dragonflies

3.7.1 Sampling Methods

3.7.1.1 Netting Surveys

Surveys for damselflies and dragonflies were carried out using RISC-standard hand-netting methods (Resources Inventory Committee 1998e).

Pre-field Review

Prior to conducting fieldwork, general areas for damselfly and dragonfly surveys were identified by stratifying the LSA based on Project footprint locations and areas containing patches of suitable habitat. Areas considered suitable for damselflies and dragonflies included wetlands, waterbodies, and other habitats where these species are expected to occur as they metamorphose from aquatic larvae into aerial adults. These areas were identified by reviewing aerial photos of the LSA and through review of the TEM.

Field Methods

A combination of vehicle-based and pedestrian transects were used to survey for damselflies and dragonflies. Typically this included driving slowly along Project roads within and adjacent to areas stratified during the pre-field review. As surveyors drove, they watched for damselflies and dragonflies in flight as well as for patches of suitable habitat, stopping to do a more intensive search on foot when either was observed. Damselfly and dragonfly sampling took place concurrently with butterfly sampling, with sampling conducted at the same locations (Figure 10).

Surveys took place on June 21-22, July 29-August 1, and August 9-13, 2011, to maximize detection of the different species of damselfly and dragonfly adults in flight at different times of the season. Survey crews included a damselfly and dragonfly expert, a biologist, and one or two field assistants. Surveys took place during weather and at a time of day when insects were expected to be actively flying. Appropriate weather conditions included dry weather and when wind speeds were low or nonexistent. Surveys began at approximately 9:30 am and continued late into the afternoon.

Damselflies and dragonflies were detected visually and captured in hand nets. Captured individuals were identified in the hand by the expert and then released. Large dragonfly species can be particularly difficult to capture, so some large dragonfly individuals were identified visually through binoculars. Additional information collected during each survey UTM (NAD 83) coordinates of the survey, start and end time, ceiling, wind (Beaufort factor), cloud cover, temperature and precipitation.

3.8 Western Toad

Three types of surveys were conducted to identify presence and, where possible, relative abundance of western toads in the LSA: road encounter surveys, time-constrained pond surveys, and larval pond surveys. Wildlife habitat suitability mapping was also conducted for western toad.

3.8.1 Sampling Methods

3.8.1.1 Habitat Suitability Mapping

Habitat suitability is “the ability of the habitat in its current condition to provide the life requisites of a species” (Resources Inventory Committee 1999a). Western toad habitat suitability mapping was created following the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1999a).

Suitability mapping requires that habitat associations be developed by linking the physical characteristics (*e.g.*, plant community and topography) of each ecosystem unit within the TEM to important habitat features required by the species being considered. These associations act as assumptions that form the foundation of the suitability mapping.

Pre-field Review

A species-habitat model was developed as an explicit review of western toad ecology (Appendix 3). Western toad reproductive habitat was identified as the habitat to map for this species in the LSA, because it is typically the most limiting habitat for this species. Using the summarized ecology information within the model, a list of assumptions were developed that explicitly rated TEM characteristics based on their relative suitability. These assumptions were then translated into a ratings table, which when complete indicated the relative habitat suitability of each unique ecosystem unit with the LSA. Ratings for western toad followed a 4-class suitability scheme (Table 9). Using a series of database queries, this ratings table was applied to the TEM mapping database, assigning ratings to each polygon based on the ecosystem unit(s) it contained. For TEM polygons with multiple ecosystem units present, a weighted average was assigned for the polygons final suitability rating based on each ecosystem unit present and its proportion. The final result was a draft field map of western toad reproduction habitat suitability.

Table 9: Rating Scheme Used to Rate Habitat Suitability for Western Toad

% of Best Habitat in Province	Rating	4-Class Code
100 – 76%	High	H
75 – 26%	Moderate	M
25 – 1%	Low	L
0%	Nil	N

Field Methods

Field studies were undertaken to confirm the accuracy of the ratings assumptions and habitat mapping. Protocols for field truthing and habitat ratings were based on the *Field Manual for Describing Ecosystems* (BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998) and *British Columbia Wildlife Habitat Rating Standards* (Resources Inventory Committee 1999a).

Data was collected on FS882 (full plot) forms, Ground Inspection Forms and Wildlife Habitat Assessment forms were completed in the field. Data from the field truthing were entered into the VENUS data capture program (Version 5.1). Draft species-habitat models and ratings were revised and finalized where required, and a final digital habitat map produced.

Figure 9 shows the locations of wildlife habitat ratings field plots conducted.

3.8.1.2 Road Encounter Surveys

Road surveys were conducted along Jones Creek Forest Service Road (FSR) in 2008 by Summit Environmental (Summit), and along Birch Island Road in 2011 by Keystone Wildlife Research Ltd. (Keystone) following methods outlined in *Inventory Methods for Pond-Breeding Amphibians and Painted Turtle* (Resources Inventory Committee 1998c). Surveys included vehicle-based and pedestrian methods, which included driving slowly or walking along the road while surveyors looked for amphibians on the road (Figure 11).

Surveys took place on June 21, June 23, July 15-16, 2008, and June 23, 2011. Timing of surveys was focused on June and July when adults were potentially moving towards and away from breeding habitat. Amphibians are often more active in the evenings and early part of the night, and thus surveys were conducted at this time of day to maximize detections. Amphibians that were observed were recorded, including species, age class, and location of detection (UTM NAD 83).

3.8.1.3 Time-Constrained Pond Surveys

Time-constrained pond surveys were conducted in 2008 by Summit, and again in 2011 by Keystone. Surveys were conducted following standards outlined in *Inventory Methods for Pond-Breeding Amphibians and Painted Turtle* (Resources Inventory Committee 1998c).

Pre-field Review

Prior to conducting fieldwork, areas for pond surveys were identified by stratifying the LSA based on Project footprint locations and areas containing wetlands. Wetlands were identified based on a review of Terrain Information Resource Management (TRIM) layers and the TEM, in combination with field reconnaissance. Surveys focused on wetlands within footprint locations.

Field Methods

Searches took place on June 21-25, 2008, July 14-17, 2008, July 29-21 2011, and August 10 2011. Searches took place later in the summer in 2011 (compared to 2008) because June surveys in 2008 were restricted to large bodies of water only, since snow and ice had not yet melted on smaller waterbodies at that time.

Time-constrained searches were conducted at ponds and wetlands identified during the pre-field review (Figure 11). Surveys were conducted for up to two-person hours per wetland. The shoreline and shallow sections of each wetland were surveyed for egg masses, tadpoles and adult amphibians. General survey conditions were recorded at the start and end of all surveys, including date and time, cloud cover, wind speed and precipitation. Information collected at each time-constrained search site included UTM (NAD 83) location, and habitat type (i.e. marsh, fen, swamp, shallow water, lake). Additional data collected in 2011 included size of water body, percent open water, duration of habitat, pH, air and water temperature, and percentage of wetland surveyed.

All amphibians detected were recorded, including species, development stage, and count. Data collected in 2011 also included water depth of observation, distance from shore to observation, average water depth, water drop (slope from pond edge to deeper water), attachment substrate, bottom substrate and macrohabitat (stream, log jam, shoreline). All observations were noted on standard RISC datasheets that had been customized for the project.

3.8.1.4 Larval Pond Surveys

Larval surveys were conducted in 2008 by Summit Environmental Consultants Ltd. to gather additional information on amphibian breeding occurring within the LSA. Surveys followed standards outlined in *Inventory Methods for Pond-Breeding Amphibians and Painted Turtle* (Resources Inventory Committee 1998c). Searches occurred at wetlands that had been identified in the pre-field review for time-constrained pond surveys (see Section 3.8.1.3; Figure 11).

Surveys involved walking along pond and wetland edges, systematically searching with the dipnet at regular intervals. As surveyors walked the edge of each pond or wetland they scooped the water with a dipnet twice every five metres, with one scoop on either side of the surveyor. Each scoop was approximately 1 m in length. In smaller bodies of water, (diameters less than 6 m across and 1.5 m in depth) efforts were made to estimate the absolute abundance of larvae.

All amphibians observed were recorded including their species, age class, and total length. Additional information collected during each survey included UTM (NAD 83) coordinates of the survey, start and end time, ceiling, wind (Beaufort factor), cloud cover, temperature and precipitation.

3.9 Barn Swallow

Barn Swallow use within the study area was assessed using two survey methods: wildlife habitat suitability mapping and breeding bird surveys.

3.9.1 Sampling Methods

3.9.1.1 Habitat Suitability Mapping

Habitat suitability is "the ability of the habitat in its current condition to provide the life requisites of a species" (Resources Inventory Committee 1999a). Barn Swallow habitat suitability mapping was created following the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1999a).

Suitability mapping requires that habitat associations be developed by linking the physical characteristics (*e.g.*, plant community and topography) of each ecosystem unit within the TEM to important habitat features required by the species being considered. These associations act as assumptions that form the foundation of the suitability mapping.

Pre-field Review

A species-habitat model was developed as an explicit review of Barn Swallow ecology (Appendix 3). As a breeding visitant to BC, this species is only found in the province during the breeding season so reproductive habitat was chosen for mapping this species' habitat suitability. Using the summarized ecology information within the model, a list of assumptions were developed that explicitly rated TEM characteristics based on their relative suitability. These assumptions were then translated into a ratings table, which when complete indicated the relative habitat suitability of each unique ecosystem unit with the LSA. Ratings for Barn Swallow followed a 4-class suitability scheme (Table 10). Using a series of database queries, this ratings table was applied to the TEM mapping database, assigning ratings to each polygon based on the ecosystem unit(s) it contained. For TEM polygons with multiple ecosystem units present, a weighted average was assigned for the polygons final suitability rating based on each ecosystem unit present and its proportion. The final result was a draft field map of Barn Swallow reproduction habitat suitability.

Table 10: Rating Scheme Used to Rate Habitat Suitability for Barn Swallow

% of Best Habitat in Province	Rating	4-Class Code
100 – 76%	High	H
75 – 26%	Moderate	M
25 – 1%	Low	L
0%	Nil	N

Field Methods

Field studies were undertaken to confirm the accuracy of the ratings assumptions and habitat mapping. Protocols for field truthing and habitat ratings were based on the *Field Manual for Describing Ecosystems* (BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998) and *British Columbia Wildlife Habitat Rating Standards* (Resources Inventory Committee 1999a).

Data was collected on FS882 (full plot) forms, Ground Inspection Forms and Wildlife Habitat Assessment forms were completed in the field. Data from the field truthing were entered into the VENUS data capture program (Version 5.1). Draft species-habitat models and ratings were revised and finalized where required, and a final digital habitat map produced.

Figure 9 shows the locations of wildlife habitat ratings field plots conducted.

3.9.1.2 Breeding Bird Surveys

Breeding bird surveys were conducted in 2008 by Summit, and again in 2011 by Keystone. Surveys followed methods outlined in *Inventory Methods for Forest and Grassland Songbirds* (Resources Inventory Committee (RIC) 1999). Surveys used point counts placed along survey transects at intervals of 400 m apart in 2008, and 200 m apart in 2011. Transects were located in areas accessible by truck or foot throughout the LSA to sample as many representative habitats as possible (Figure 12).

Breeding bird surveys were conducted between late-May and mid-July, targeting the peak breeding season for most birds. Surveys started at sunrise on each survey day and continued until no later than four hours after sunrise. At each point count station, surveyors looked and listened for five minutes (or longer, if ambient noise conditions interfered with the surveyors' ability to detect birds), recording all birds seen or heard. For each bird detection, surveyors recorded: number of individuals observed, sex, age class, activity and if possible, distance and direction to the bird.

Birds heard while travelling between point count stations were recorded as incidental observations if those species had not been detected during previous point count stations. All observations were recorded on RISC datasheets customized for the project. Information collected at the start and end of each transect included UTM (NAD 83) coordinates, start and end time, ceiling, wind (Beaufort factor), cloud cover, temperature, and precipitation.

3.10 Common Nighthawk

3.10.1 Sampling Methods

Common Nighthawks were surveyed within the LSA using call-playback survey methods. These methods followed those outlined in Inventory Methods for Nighthawk and Poorwill (Resources Inventory Committee 1998b).

3.10.1.1 Call-Playback Surveys

Pre-field Methods

Prior to completing fieldwork, the LSA was stratified into two strata: open habitats and forested habitats. Habitats that were stratified as open included grasslands, cutblocks, wetlands, gravel pits, gravel bars, rock outcrops, and any other habitat types that contained large expanses of exposed ground on which Common Nighthawks could build their nest. Survey stations were placed in proximity to open habitats (Figure 13).

Field Methods

At each survey station, call-playback was conducted to elicit territorial responses from any Common Nighthawks in the area. Call-playback used the recording of a male nighthawk, broadcast from a FoxPro speaker unit. Five to six calls were broadcast in a series, followed by approximately 30 seconds of silence, during which time surveyors listened for a response and looked for any nighthawks flying overhead or at an unlimited radius surrounding the station. This sequence of calls followed by silence was repeated several times to achieve a total station time of five minutes.

Surveys were conducted in late-June, when nighthawks are most actively territorial in their responses. Common Nighthawks are crepuscular (i.e. most active at dawn and dusk). Therefore surveys began at sunset and continued no later than twilight. Surveys were performed in dry weather, and under low or nonexistent wind conditions. Survey crews included a biologist and one or two field technicians.

Information collected at each call-playback station included UTM (NAD 83) coordinates, start and end time, ceiling, wind (Beaufort factor), cloud cover, temperature and precipitation. If a nighthawk was observed, the sex and age class were recorded whenever possible, in addition to the time of response, call type and an estimation of the distance and direction to the detected individual(s).

3.11 Great Blue Heron

Great Blue Heron use within the study area was assessed using two survey methods: wildlife habitat suitability mapping and an aerial nest survey.

3.11.1 Sampling Methods

3.11.1.1 Habitat Suitability Mapping

Habitat suitability is “the ability of the habitat in its current condition to provide the life requisites of a species” (Resources Inventory Committee 1999a). Great Blue Heron habitat suitability mapping was created following the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1999a).

Suitability mapping requires that habitat associations be developed by linking the physical characteristics (*e.g.*, plant community and topography) of each ecosystem unit within the TEM to important habitat features required by the species being considered. These associations act as assumptions that form the foundation of the suitability mapping.

Pre-field Review

A species-habitat model was developed as an explicit review of Great Blue Heron ecology (Appendix 3). Great Blue Heron nesting is considered a sensitive time period for the species, and nests are protected year-round under the *BC Wildlife Act*, therefore suitability mapping was conducted for Great Blue Heron nesting habitat. Using the summarized ecology information within the model, a list of assumptions were developed that explicitly rated TEM characteristics based on their relative suitability. These assumptions were then translated into a ratings table, which when complete indicated the relative habitat suitability of each unique ecosystem unit with the LSA. Ratings for Great Blue Heron followed a 4-class suitability scheme (Table 11). Using a series of database queries, this ratings table was applied to the TEM mapping database, assigning ratings to each polygon based on the ecosystem unit(s) it contained. For TEM polygons with multiple ecosystem units present, a weighted average was assigned for the polygons final suitability rating based on each ecosystem unit present and its proportion. The final result was a draft field map of Great Blue Heron reproduction habitat suitability.

Table 11: Rating Scheme Used to Rate Habitat Suitability for Great Blue Heron

% of Best Habitat in Province	Rating	4-Class Code
100 – 76%	High	H
75 – 26%	Moderate	M
25 – 1%	Low	L
0%	Nil	N

Field Methods

Field studies were undertaken to confirm the accuracy of the ratings assumptions and habitat mapping. Protocols for field truthing and habitat ratings were based on the *Field Manual for Describing Ecosystems* (BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998) and *British Columbia Wildlife Habitat Rating Standards* (Resources Inventory Committee 1999a).

Data was collected on FS882 (full plot) forms, Ground Inspection Forms and Wildlife Habitat Assessment forms were completed in the field. Data from the field truthing were entered into the VENUS data capture program (Version 5.1). Draft species-habitat models and ratings were revised and finalized where required, and a final digital habitat map produced.

Figure 9 shows the locations of wildlife habitat ratings field plots conducted.

3.11.1.2 Great Blue Heron Nest Survey

To survey for large stick nests belonging to Great Blue Herons, an aerial survey was conducted within the LSA following methods outlined in Inventory Methods for Raptors (Resources Inventory Committee 2001). Although recommended in the RISC standards for large raptor stick nests, this method is also effective for locating Great Blue Heron nests given their conspicuous nature and propensity to be located in colonies.

Pre-field Review

Prior to conducting fieldwork, the LSA was stratified using the results of the wildlife habitat suitability mapping. Areas rated as suitable (moderate or high-rated habitat) were identified as areas to be surveyed during the aerial survey.

Field Methods

An aerial survey for large stick nests was completed of areas identified in the pre-field review. The survey was performed at a time prior to deciduous leaf-out, to maximize visibility of any nest structures below the canopy. A Bell 206 LongRanger helicopter was used during the survey, with three surveyors and a pilot taking part.

During the survey, the start and end UTM coordinates (NAD 83) were recorded, as well as the weather conditions (i.e., wind, cloud cover, precipitation, and temperature). If a large stick nest was observed, the location was recorded, as well as the species, occupancy status, and other information whenever possible.

3.12 Harlequin Duck

3.12.1 Sampling Methods

Harlequin Ducks were surveyed for within the LSA by Summit using ground-based surveys following protocols outlined in *Inventory Methods for Riverine Birds: Harlequin Duck, Belted Kingfisher and American Dipper* (Resources Inventory Committee 1998d). Methods are summarized from Summit (2009)

3.12.1.1 Brood Surveys

Pre-field Review

Prior to field surveys, creeks and rivers within the LSA were assessed for their potential to support Harlequin Ducks. Harper Creek was identified as the only creek with the potential for Harlequin Duck use, and was targeted for the survey.

Field Methods

Surveys occurred in late-July, during the period when Harlequin Duck females were expected to be present on the river with juveniles, but prior to fall migration. Surveys involved foot transects within suitable habitat along the shoreline of Harper Creek and tributaries, with surveyors looking for ducks on the river while walking alongside. Suitable habitat was identified by biologists in the field during the survey.

During the survey, the start and end UTM coordinates (NAD 83) were recorded, as well as the weather conditions (i.e., wind, cloud cover, precipitation, and temperature). Observations of riverine birds were recorded, including species observed as well as age-class or sex if possible.

3.13 Olive-sided Flycatcher

Olive-sided Flycatchers within the LSA was assessed using two survey methods: breeding bird surveys and wildlife habitat suitability mapping.

3.13.1 Sampling Methods

3.13.1.1 Habitat Suitability Mapping

Habitat suitability is "the ability of the habitat in its current condition to provide the life requisites of a species" (Resources Inventory Committee 1999a). Olive-sided Flycatcher habitat suitability mapping was created following the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1999a).

Suitability mapping requires that habitat associations be developed by linking the physical characteristics (*e.g.*, plant community and topography) of each ecosystem unit within the TEM to important habitat features required by the species being considered. These associations act as assumptions that form the foundation of the suitability mapping.

Pre-field Review

A species-habitat model was developed as an explicit review of Olive-sided Flycatcher ecology (Appendix 3). As a breeding visitant to BC, this species is only found in the province during the breeding season so reproductive habitat was chosen for mapping this species' habitat suitability. Using the summarized ecology information within the model, a list of assumptions were developed that explicitly rated TEM characteristics based on their relative suitability. These assumptions were then translated into a ratings table, which when complete indicated the relative habitat suitability of each unique ecosystem unit with the LSA. Ratings for Olive-sided Flycatcher followed a 4-class suitability scheme (Table 12). Using a series of database queries, this ratings table was applied to the TEM mapping database, assigning ratings to each polygon based on the ecosystem unit(s) it contained. For TEM polygons with multiple ecosystem units present, a weighted average was assigned for the polygons final suitability rating based on each ecosystem unit present and its proportion. The final result was a draft field map of Olive-sided Flycatcher reproduction habitat suitability.

Table 12: Rating Scheme Used to Rate Habitat Suitability for Olive-sided Flycatcher

% of Best Habitat in Province	Rating	4-Class Code
100 – 76%	High	H
75 – 26%	Moderate	M
25 – 1%	Low	L
0%	Nil	N

Field Methods

Field studies were undertaken to confirm the accuracy of the ratings assumptions and habitat mapping. Protocols for field truthing and habitat ratings were based on the *Field Manual for Describing Ecosystems* (BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998) and *British Columbia Wildlife Habitat Rating Standards* (Resources Inventory Committee 1999a).

Data was collected on FS882 (full plot) forms, Ground Inspection Forms and Wildlife Habitat Assessment forms were completed in the field. Data from the field truthing were entered into the VENUS data capture program (Version 5.1). Draft species-habitat models and ratings were revised based on survey observations and field truthing where required, and a final digital habitat map produced.

Figure 9 shows the locations of wildlife habitat ratings field plots conducted.

3.13.1.2 Breeding Bird Surveys

Breeding bird survey methods for Olive-sided Flycatcher followed the same methods described in Section 3.9.1.1. Figure 12 shows the locations of breeding bird survey stations.

3.14 Bald Eagle

Bald Eagles within the LSA were assessed using two survey methods: an aerial nest survey and wildlife habitat suitability mapping.

3.14.1 Sampling Methods

3.14.1.1 Habitat Suitability Mapping

Habitat suitability is “the ability of the habitat in its current condition to provide the life requisites of a species” (Resources Inventory Committee 1999a). Bald Eagle habitat suitability mapping was created following the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1999a).

Suitability mapping requires that habitat associations be developed by linking the physical characteristics (*e.g.*, plant community and topography) of each ecosystem unit within the TEM to important habitat features required by the species being considered. These associations act as assumptions that form the foundation of the suitability mapping.

Pre-field Review

A species-habitat model was developed as an explicit review of Bald Eagle ecology (Appendix 3). Bald Eagle nesting is considered a sensitive time period for the species, and nests are protected year-round under the *BC Wildlife Act*, therefore suitability mapping was conducted for Bald Eagle nesting habitat. Using the summarized ecology information within the model, a list of assumptions were developed that explicitly rated TEM characteristics based on their relative suitability. These assumptions were then translated into a ratings table, which when complete indicated the relative habitat suitability of each unique ecosystem unit with the LSA. Ratings followed a 4-class suitability scheme (Table 13). Using a series of database queries, this ratings table was applied to the TEM mapping database, assigning ratings to each polygon based on the ecosystem unit(s) it contained. For TEM polygons with multiple ecosystem units present, a weighted average was assigned for the polygons final suitability rating based on each ecosystem unit present and its proportion. The final result was a draft field map of Bald Eagle reproduction habitat suitability.

Table 13: Rating Scheme Used to Rate Habitat Suitability for Bald Eagle

% of Best Habitat in Province	Rating	4-Class Code
100 – 76%	High	H
75 – 26%	Moderate	M
25 – 1%	Low	L
0%	Nil	N

Field Methods

Field studies were undertaken to confirm the accuracy of the ratings assumptions and habitat mapping. Protocols for field truthing and habitat ratings were based on the *Field Manual for Describing Ecosystems* (BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998) and *British Columbia Wildlife Habitat Rating Standards* (Resources Inventory Committee 1999a).

Data was collected on FS882 (full plot) forms, Ground Inspection Forms and Wildlife Habitat Assessment forms were completed in the field. Data from the field truthing were entered into the VENUS data capture program (Version 5.1). Draft species-habitat models and ratings were revised based on survey observations and field truthing where required, and a final digital habitat map produced.

Figure 9 shows the locations of wildlife habitat ratings field plots conducted.

3.14.1.2 Bald Eagle Nest Survey

To survey for large stick nests belonging to Bald Eagles, an aerial survey was conducted within the LSA following methods outlined in Inventory Methods for Raptors (Resources Inventory Committee 2001).

Pre-field Review

Prior to conducting fieldwork, the LSA was stratified using the results of the wildlife habitat suitability mapping. Areas rated as suitable (moderate or high-rated habitat) were identified as areas to be surveyed during the aerial survey.

Field Methods

An aerial survey for large stick nests was completed of areas identified in the pre-field review. The survey was performed on April 15, 2012, at a time prior to deciduous leaf-out to maximize visibility of any nest structures below the canopy. A Bell 206 LongRanger helicopter was used during the survey, with three surveyors and a pilot taking part.

During the survey, the start and end UTM coordinates (NAD 83) were recorded, as well as the weather conditions (i.e., wind, cloud cover, precipitation, and temperature). If a large stick nest was observed, the location was recorded, as well as the species, occupancy status, and other information whenever possible.

3.15 Northern Goshawk

Northern Goshawk use within the study area was assessed using two survey methods: wildlife habitat suitability mapping and call-playback surveys.

3.15.1 Sampling Methods

3.15.1.1 Habitat Suitability Mapping

Mapping of habitat suitability for Northern Goshawk did not follow methods outlined in the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1999a), unlike other habitat modelling used for the Project. Instead, Habitat Suitability Index (HSI) methodology was used for this species.

HSI habitat modeling is a technique for predicting the suitability of habitat based on a species' known affinities with specific habitat attributes (*e.g.,* canopy closure). This methodology has been successfully applied to Northern Goshawk habitat modeling in a number of areas of BC (*e.g.,* Manning *et al.* 2002; Mahon *et al.* 2003; Rumsey *et al.* 2004; Marquis *et al.* 2005; Mahon *et al.* 2008), and in general the method can better capture and represent the forest attributes that goshawk rely upon than can Wildlife Habitat Ratings methods.

During HSI modeling, a suitability index is used to generate a probability that the habitat is suitable for the species, and hence a probability that the species will occur where that habitat occurs. Unlike Wildlife Habitat Ratings methodology, which involves assigning a rating to each unique ecosystem unit (Resources Inventory Committee 1999a), HSI methodology involves assigning index values (0.0-1.0, with 1.0 being the highest suitability) to individual habitat attributes that are important for a species and then using a mathematical formula (which accounts for each attribute) to calculate the final suitability for each polygon.

One benefit of using this methodology is that it allows for the use of continuous data (*i.e.,* data that can be any conceivable value), as well as discrete data, nominal data, etc. Northern Goshawks rely less on the type of forest (*i.e.,* a discrete variable) than on the structural attributes of that forest. Many structural attributes are mapped as continuous data (*e.g.,* tree height), or attributes with so many possibilities that they are best-treated as continuous for the purposes of modelling (*e.g.,* tree age, percent cover).

In comparison, standards for Wildlife Habitat Ratings, as outlined in RIC (1999), do not allow for the use of continuous data. Continuous data must be converted into discrete data (*e.g.,* convert percent cover data into discrete cover classes). This can lead to a loss of resolution for the model, particularly when dealing with the conversion of more than one attribute (*e.g.,* VRI data contains up to six tree species, with percent cover for each, in each polygon).

Pre-Field Review

A species-habitat model was developed as an explicit review of Northern Goshawk ecology (Appendix 3). Northern Goshawk nesting habitat preferences are more selective than general living or foraging habitat, so nesting habitat was chosen for modeling. The model used for the Project was developed by incorporating aspects of pre-existing models of Northern Goshawk habitat suitability (Manning *et al.* 2002; Mahon *et al.* 2003; Rumsey *et al.* 2004; Marquis *et al.* 2005) and updating these to be representative of habitat within the LSA. The final model contained a series of tables explicitly assigning HSI values to each attribute of interest: BGC subzone/variant, stand age, stand height, canopy closure, and tree species.

A spatially-enabled relational database was created by overlaying data from the TEM with VRI for the LSA. This final resultant database contained polygons with data on all of the above attributes, and a series of queries were run that assigned HSI values for each attribute to each polygon. A calculation of HSI values for each individual polygon was made using a multiplicative, non-compensatory equation; ecologically this meant that for a polygon to be rated as highly suitable, each of the separate component attributes within that polygon needed to have a high value. The deficiency of a single attribute could not be compensated for by high suitability of other attributes.

BNOGO_LA_RE = BGC Rating * ((Stand Height Rating + Stand Age Rating)/2) * Canopy Closure Rating * Tree Spp. Rating

The final HSI value for the polygon was then converted into a rating (Table 14).

Table 14: Rating Scheme Used to Rate Habitat Suitability for Northern Goshawk

HSI Value	Rating	4-Class Code
1.00 – 0.76	High	H

0.75-0.26	Moderate	M
0.25 – 0.01	Low	L
0.00	Nil	N

Field Methods

Field studies were undertaken to confirm the accuracy of the habitat mapping. Ecosystem data was collected on FS882 (full plot) forms or Ground Inspection Forms, and a field rating was assigned for each polygon based on the visual assessment of goshawk habitat attributes at the plot. Data from the field truthing were entered into the VENUS data capture program (Version 5.1). Draft species-habitat models and ratings were revised based on survey observations and field truthing where required, and a final digital habitat map produced.

Figure 9 shows the locations of wildlife habitat ratings field plots conducted.

3.15.1.2 Call-Playback Surveys

Call-playback surveys followed methods outlined in *Inventory Methods for Raptors* (Resources Inventory Committee 2001).

Pre-field Review

Prior to conducting fieldwork, the LSA was stratified using the results of the wildlife habitat suitability mapping. Areas rated as suitable (moderate or high-rated habitat) were targeted for call-playback surveys. Two transects were established in the study area in 2011, the first located on the Jones Creek FSR and the second near Vavenby. Two additional transects were established in 2012, with the first on the lower elevation portion of Jones Creek FSR and the second on the upper elevation portion of Jones Creek FSR.

In 2011 a stick nest reported as a potential Northern Goshawk stick nest was observed on the North side of the Thompson River near the proposed rail concentrate load-out facility. To confirm whether this was a goshawk nest, two stations were established in this area in 2012 to target small patches of habitat, as well as to look for the nest.

Field Methods

Each transect was surveyed twice, with the first visit occurring during the nesting period (June 1-30) and the second visit during the fledgling-dependency period (01 July – 31 August). Surveys were completed between 30 minutes after sunrise and 30 minutes before sunset. Each transect was surveyed by truck or on foot and consisted of call-playback stations placed approximately 400 m apart (Figure 14).

At each station, observers played a recording of an adult goshawk alarm call (if during the nesting period) or a juvenile goshawk begging call (if during the fledgling-dependency period) to elicit a response from any goshawks in the area. Playbacks consisted of 20 seconds of calls followed by 30 seconds of silence, during which time observers looked and listened for a response. This sequence of playback followed by silence was completed three times, followed by a final listening period of five minute for a total station time of eight minutes. Calls were broadcast using a FoxPro NX3 call-playback device, which was rotated 120 degrees after each 20-second call series. In addition to listening for goshawk responses, surveyors watched for birds during and between call-playback stations.

Information collected at each call-playback station included UTM (NAD 83) coordinates, start and end time, ceiling, wind (Beaufort factor), cloud cover, temperature and precipitation. If a raptor was observed, the species, sex and age class were recorded whenever possible, in addition to the time of response, call type and an estimation of the distance and direction to the detected individual(s). Incidental observations of any notable target taxa were also recorded, both during the survey as well as during travel to and from the study area.

Surveys were discontinued if adverse survey conditions (e.g. heavy precipitation or wind) persisted for longer than 30 minutes during the survey. Adverse weather conditions can decrease the activity levels of raptors, as well as decrease ability of observers to make detections.

3.16 Western Screech-owl

Western Screech-owl use within the study area was assessed using call-playback surveys.

3.16.1 Sampling Methods

3.16.1.1 Call-Playback Surveys

Nocturnal call-playback surveys were conducted for Western Screech-Owl following the survey methodology outlined in Inventory Methods for Owl Surveys (Hausleitner 2006).

Pre-field Review

Prior to conducting fieldwork, the TEM was queried to identify areas within the LSA that were dominated by riparian forests of black cottonwood forests or trembling aspen. Older stands of this forest type provide the most opportunities for Western Screech-owl nesting (COSEWIC 2012a). Lower-elevation areas near the North Thompson River were identified, and one transect was established on Birch Island Road to sample this habitat (Figure 15).

Field Methods

The Birch Island Road transect was surveyed three times. The transect was surveyed from a vehicle, using stations placed at 500 m intervals for the first survey and at 300 m intervals for subsequent repetitions. Surveys were completed between 30 minutes after sunset and 30 minutes before sunrise and were discontinued if adverse weather conditions (e.g. heavy precipitation or wind) persisted for longer than 30 minutes during the survey.

At each station, a pre-recorded call of a male territorial Western Screech-owl was broadbast for one-minute, followed by four minutes of silence during which surveyors looked and listened for any birds responding. This sequence was repeated a total of three times for a total station time of

15 minutes. Calls were broadcast using a FoxPro NX3 call-playback device, which was rotated 120 degrees after each 1-minute call series. If a spontaneously calling owl was heard that was not the target species, the detected species was noted and calls for the targeted species were broadcast as scheduled.

All observations were recorded on RISC datasheets customized for the project. Information collected at each call-playback station included UTM (NAD 83) coordinates, start and end time, ceiling, wind (Beaufort factor), cloud cover, temperature and precipitation. If an owl was detected, the species, sex and age class were recorded whenever possible, in addition to the time of response, call type, and the distance and direction to the detected individual(s) was estimated.

3.17 Bats

All five target species of bats (fringed myotis, little brown myotis, Northern myotis, Townsend's big-eared bat, and Western small-footed myotis) were sampled using two separate methods within the LSA: acoustic sampling and mist-netting.

3.17.1 Sampling Methods

3.17.1.1 Acoustic Detection

Collection and analysis of acoustic data is a cost-effective and non-intrusive way to sample bat species and activity (Parsons and Szewczak 2009). The number of bat calls recorded cannot be linked to absolute numbers of bats, but provides an index of the relative amount of bat activity at a site during the sampling period. Species identification from calls is possible for many species, given good-quality calls and an experienced analyst.

Bats were sampled during 2011 and 2012 using battery-powered, weatherproof SM2-BAT bat detectors (Wildlife Acoustics Inc.) that detect and record the ultrasonic calls of bats. Detectors were programmed to begin recording 30 minutes before sunset and cease recording 30 minutes after sunrise. The detectors recorded automatically each night until the battery power ran out or until they were retrieved.

Detectors were fastened with bungee cords onto live or dead trees in areas of suitable foraging and/or drinking habitat (near slow-moving waterbodies or open areas; Figure 16). Efforts were made to sample a variety of bat foraging habitats potentially affected by the project including riparian, grassland, and vegetated openings at low to high-elevations. The old Weyerhaeuser mill site was also sampled. Field crews downloaded the data from the detectors throughout the field session, and several detectors were re-deployed to other locations for additional sampling.

In total, eight sites were sampled over July and August 2011, and an additional ten sites were sampled over June, July and August 2012 (Table 15).

Recorded data files from each detector were converted from Wildlife Acoustics Inc. proprietary .wac format to zero-crossing files that could be viewed using AnalookW software. The Analook files were sent to a bat expert for analysis.

Files were analyzed in AnalookW 3.8s. A filter was used to sort high frequency from low frequency bats, and additional filters were then applied to further identify files to species or species group where possible. Files were manually viewed to verify identification. Selected full spectrum files (converted from .wac files) were viewed with Sonobat 2.9.7 to assist with identification. Files were summarized by site, night and hour. Summaries included numbers of files in each species label category by site, and a count of the minimum number of species identified at each site.

Table 15: Sites Sampled for Acoustic Bat Surveys in 2011 and 2012

Site ID	Location Description	Year/Month/Day Installed	Year/Month/Day Retrieved
1	Pit footprint	2011/07/05	2011/07/08
2	TMF wetland	2011/07/05	2011/07/08
2	TMF wetland	2012/07/27	2012/08/13
3	Birch Island wetland	2011/07/05	2011/07/08
4	Pit footprint – backed-up creek	2011/07/29	2011/08/09
4	Pit footprint – backed-up creek	2012/07/06	2012/08/13
5	Sheep farm pasture - birch	2011/07/29	2011/08/09
6	TMF – pond near road	2011/08/10	2011/08/13
7	Sheep farm pasture - snag	2011/08/09	2011/08/13
8	Pit footprint - pond	2011/08/09	2011/08/13
9	Jones Creek	2012/06/08	2012/06/19
10	Upper Baker Creek Road	2012/06/09	2012/06/19
11	Vavenby Mtn. Road meadow	2012/06/10	2012/07/05
12	Avery Lake	2012/06/10	2012/07/13
13	Weyerhaeuser site	2012/06/12	2012/07/13
14	Jones Creek Road meadow	2012/06/19	2012/07/27
15	Lower Baker Creek Road	2012/06/19	2012/07/04
16	Birch Island cottonwoods	2012/07/04	2012/08/13

The precision of the identification reflects the quality of the calls recorded. Call quality will vary depending on the distance of the bat from the detector microphone, the bat's direction of travel in relation to the detector, and the presence of additional noise (e.g. wind in vegetation; rain, flowing water). Diagnostic call characteristics for a species may or may not be discernible in a given call file as bats produce calls that vary with their environments (cluttered flight path versus clear), their purpose (navigation calls, feeding buzzes, social calls) and even reproductive status and age (Weller 2007).

3.17.1.2 Capture Surveys

Bat capture activities took place at sites on Crown land, or private lands for which access permission had been obtained from the landowner (Figure 16). Specific sites were chosen based on the habitat present and the suitability of the site for netting. Nets were located near wetlands, ponds, marshes and seepage areas, where roads crossed creeks, near bridges, in wet meadows and fields and forest clearings. Field crews searched for netting sites in the afternoon to confirm their suitability and obtain permission from private property owners, if required, and returned in the early evening to set up nets.

Mist-netting took place on July 4-9 and August 8-12, 2012 at nine sites, including two sites that were sampled twice (Table 16). Nets were placed near wetlands, ponds, marshes and seepage areas, where roads crossed creeks, near bridges, in wet meadows and fields and forest gaps.

Table 16: Bat Capture Locations and Effort

Site ID	Location Description	Year/Month/Day Netted	Effort (m2-hr)
1	Low-elevation meadow	2012/07/04	655.6
2	Pit footprint – backed-up creek	2012/07/05	711.8
2	Pit footprint – backed-up creek	2012/08/08	819.0
3	High-elevation road/creek intersection	2012/07/06	755.2
4	Sheep farm pasture	2012/07/07	967.2
5	Vavenby bridge	2012/07/08	617.5
6	Weyerhaeuser site	2012/07/09	692.2
6	Weyerhaeuser site	2012/08/12	703.1
7	TMF wetland	2012/08/09	1014.0
8	North topsoil stockpile wetland	2012/08/10	790.4
9	Plant site wet forest	2012/08/11	745.6
	Total		8471.6

Mist nets were set up before sunset and opened at dusk, when bird activity appeared to have diminished. Open nets were checked frequently and handheld bat detectors were used to monitor bat activity in the vicinity of the nets. Mist-netting continued until bat activity (as determined from the handheld bat detectors) was minimal or had ceased. Mist-net effort is generally expressed as the total area of net deployed in a single night, multiplied by the amount of time the nets were up. In total, 8471.6 m^2-hr of netting was completed over the 11 nights.

Mist nets were 2.6 or 5.2 metres high and ranged from 2.6 to 18 metres in length, depending on the availability of suitable netting opportunities at each site. Commercially-made sectional mist-net poles and 3 metre lengths of aluminum conduit were used to set nets at a variety of heights and configurations. Each mist-netting crew was composed of at least three persons, at least one of which had completed the RISC Bat Capture and Handling course. All personnel handling bats had been immunized against rabies.

Bat capture and handling methods generally were consistent with RIC (Resources Inventory Committee 1998f; Resources Inventory Committee 1998a), but also followed the most recent version of US Fish and Wildlife Service (USFWS) guidelines (US Fish and Wildlife Service 2011) for minimizing the possibility of transmission of white-nose syndrome (US Geological Survey 2011). Captured bats were immediately removed from nets and placed in individual cloth holding bags until they could be examined and processed. Data recorded for each bat included species (Nagorsen 2002), gender, age (as determined from the degree of ossification of finger joints), weight, reproductive condition and forearm length (Resources Inventory Committee 1998a). Ear length was also recorded for bats of the long-eared species complex (northern myotis/long-eared myotis).

The field protocol included examination of captured bats for signs of WNS (flaking/discoloured skin, irregular tears and holes in flight membranes and other signs of fungal damage to skin). The flight membranes of captured bats were examined and their condition scored using the US Fish and Wildlife Service (USFWS) guide to bat wing damage (Reichard 2009).

Wing-punch samples were taken from long-eared species complex individuals that were captured during netting. Tissue sampling followed the procedure described in Lausen (2006). No more than one sample was taken from an individual bat, using a sterile biopsy punch. The small holes left by the sampling heal quickly (Faure et al. 2009; Weaver et al. 2009). DNA samples were stored in 95% ethanol. Once processed, each bat was released at its point of capture.

3.18 Fisher

Fisher use within the LSA was assessed using snow-tracking surveys.

3.18.1 Sampling Methods

3.18.1.1 Snow-Tracking Surveys

Snow-tracking surveys were conducted by Wolfhound Wildlife Services in 2008 and 2011. Transect protocol followed recommended methodologies outlined in the *Standards for Ground-based Inventory Methods for Ungulate Snow-track Surveys* (Resources Inventory Committee 2006).

Pre-field Review

Aerial photos and field reconnaissance were used to stratify habitats into young or old forested habitats within the ICH and ESSF. Transects were laid out to focus sampling on these two habitat habitat types within the LSA and RSA. In 2008, three transects (Transects 1-3) were laid out as snowshoe transects, and two were laid out as snowmobile transects along the Harper Creek FSR and Saskum Lake FSR. In 2011, an additional two transects were laid out as snowshoe transects to conduct additional sampling in the LSA (Figure 17).

Snowshoe transects 1 and 5 were located in the ESSF zone, while snowshoe transect 2-4 were located in the lower-elevation ICH zone (Table 17). Snowshoe transects ranged from 350 – 2,000 m in length, and were conducted between approximately 900 and 1,850 m in elevation. Snowmobile transects along Harper Creek FSR and Saskum Lake FSR were located in the ICH zone at elevations from 640-1,300 m and were 12,000 and 20,000 m in length respectively.

Table 17: Snow-Tracking Survey Locations, Representative Biogeoclimatic Zone, Elevation Range, and Length of Transect

Transect	Location	Biogeoclimatic Zone	Elevation Range (m)
Transect 1	Project site area	ESSF	1753 – 1840
Transect 2	Eastern slope of Harper Creek drainage	ICH	1050 – 1115
Transect 3	Eastern slope of Saskum Creek drainage	ICH	1068 – 1120
Transect 4	Eastern slope of Baker Creek	ICH	900-980
Transect 5	Project site area	ESSF	1800 – 1850
Harper Creek FSR	Harper Creek FSR from North Barriere Lake to Transect 2	ICH	~ 640 – 1300
Saskum Lake FSR	Saskum Creek FSR from North Barriere Lake to Transect 3	ICH	~ 700 - 1200

Field Methods

Transects were traversed on foot or by snowmobile. Surveys were conducted by traveling along the transect, recording all animal tracks observed to cross the transect line. Transects were divided into 50-m segments within which all observations were recorded. Tracks were identified to species (where possible), and an age of the track was estimated. Any animal trail that crossed the transect more than once was recorded as a single occurrence.

Every 100 m along the transect, habitat data was recorded including: seral stage, dominant tree/shrub species, crown closure percentage, snow surface conditions (e.g. wet, crusted, powdery), and snow depth. The transect start and end locations were recorded in UTM (NAD 83) coordinates, as well as the start and end time, transect bearing, date, weather conditions, and time since last snowfall.

3.19 Grizzly Bear

Grizzly bear use in the LSA was characterized using three methods: habitat suitability mapping, den surveys, and road density analysis.

3.19.1 Sampling Methods

3.19.1.1 Habitat Suitability Mapping

Habitat suitability is “the ability of the habitat in its current condition to provide the life requisites of a species” (Resources Inventory Committee 1999a). Grizzly bear habitat suitability mapping was created following the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1999a).

Suitability mapping requires that habitat associations be developed by linking the physical characteristics (*e.g.*, plant community and topography) of each ecosystem unit within the TEM to important habitat features required by the species being considered. These associations act as assumptions that form the foundation of the suitability mapping.

Pre-field Review

A species-habitat model was developed as an explicit review of grizzly bear ecology (Appendix 3). Grizzly bear habitat selection is primarily, though not completely, driven by forage availability in the growing season. To capture this, feeding habitat was mapped for spring, summer and fall seasons. Using the summarized ecology information within the model, a list of assumptions were developed that explicitly rated TEM characteristics based on their relative suitability. These assumptions were then translated into a ratings table, which when complete indicated the relative habitat suitability of each unique ecosystem unit with the LSA. Ratings for grizzly bear followed a 6-class suitability scheme (Table 18). Using a series of database queries, this ratings table was applied to the TEM mapping database, assigning ratings to each polygon based on the ecosystem unit(s) it contained. For TEM polygons with multiple ecosystem units present, a weighted average was assigned for the polygons final suitability rating based on each ecosystem unit present and its proportion.

Table 18: Rating Scheme Used to Rate Habitat Suitability for Grizzly Bear

% of Best Habitat in Province	Rating	6-Class Code
100 – 76%	High	1
75 – 51%	Moderately High	2
50 – 26%	Moderate	3
25 – 6%	Low	4
5 – 1%	Very Low	5
0%	Nil	6

Field Methods

Field studies were undertaken to confirm the accuracy of the ratings assumptions and habitat mapping. Protocols for field truthing and habitat ratings were based on the *Field Manual for Describing Ecosystems* (BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998) and *British Columbia Wildlife Habitat Rating Standards* (Resources Inventory Committee 1999a).

Data was collected on FS882 (full plot) forms, Ground Inspection Forms and Wildlife Habitat Assessment forms were completed in the field. Data from the field truthing were entered into the VENUS data capture program (Version 5.1). Draft species-habitat models and ratings were revised based on survey observations and field truthing where required, and a final digital habitat map produced.

Figure 9 shows the locations of wildlife habitat ratings field plots conducted.

3.19.1.2 Grizzly Bear Den Surveys

Helicopter surveys were conducted in 2012 to identify grizzly den sites in the RSA. A larger area was used to survey for grizzly dens due to their wide-ranging nature and the distance they can travel between denning habitat and growing season habitat. The majority of potential grizzly bear denning habitat (steep slopes near the treeline) was found outside of the LSA, to the south and west. Three visits occurred: two in April during the early-spring period when bears are emerging from their dens (during this time period tracks are visible as bears emerge and travel away from the den site, assisting in locating dens), and one in July immediately following snowmelt (to look for visible den cavities in the ground, and to conduct ground visits of dens identified during previous surveys). Two to three surveyors and a pilot took part in each survey.

Surveys involved slow surveys along steep slopes near the tree line (Figure 18), where grizzly bears typically den, with surveyors looking for animal tracks, den excavations, and other evidence of wildlife use. During the survey, the start and end UTM coordinates (NAD 83) were recorded, as well as the weather conditions (i.e., wind, cloud cover, precipitation, and temperature). When wildlife sign was observed, the species (if possible), UTM coordinates, age/sex (if possible), number observed, and type of sign were recorded.

3.19.1.3 Road Density Analysis

Roads are often cited as having the greatest effects of disturbance on wildlife (Jalkotzy et al. 1997). Grizzly bear are one species that can be particularly susceptible to the effects of road density and related use (Apps and Hamilton 2002; Ross 2002). A road density analysis was conducted to determine the current road density within the LSA as part of the characterization of baseline conditions for grizzly bear.

In preparation for the analysis, TRIM roads were visually compared with forest tenure roads. Forest tenure roads that did not closely follow the TRIM roads were added to the road file, while roads that were close in path and distance to the TRIM roads were not added as they were assumed to be the same roads recorded at different resolutions. Digital air photo imagery was used to add additional roads that were not present in either the TRIM or the forest tenure road files.

A 500 m-radius, raster-based, moving-window analysis was completed to determine the density of roads within the study area. Conceptually, a circle of 500 m radius was drawn around each raster cell. Within the circle all road segments were identified, given equal weight, and their length was measured. The total lengths of all roads within the circle are summed and divided by the circle’s area to give a road density. All raster cells were then classified into one of 5 categories (Interagency Grizzly Bear Committee 1994):

1. 0 km/ km^2 – No roads;
2. 0.01 – 0.60 km/km^2 – Low road density;
3. 0.61 – 1.20 km/ km^2 – Moderate road density;
4. 1.21 – 2.40 km/ km^2 – High road density; or
5. >2.40 km/ km^2 – Very high road density.

3.20 Moose

Moose use in the LSA was characterized using three methods: habitat suitability mapping, snow-tracking surveys and review of existing CMWR.

3.20.1 Sampling Methods

3.20.1.1 Habitat Suitability Mapping

Habitat suitability is "the ability of the habitat in its current condition to provide the life requisites of a species" (Resources Inventory Committee 1999a). Moose habitat suitability mapping was created following the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1999a).

Suitability mapping requires that habitat associations be developed by linking the physical characteristics (*e.g.*, plant community and topography) of each ecosystem unit within the TEM to important habitat features required by the species being considered. These associations act as assumptions that form the foundation of the suitability mapping.

A species-habitat model was developed as an explicit review of moose ecology (Appendix 3). Habitat mapping for moose winter habitat has been conducted by the Ministry of Environment and identified using CMWR. Therefore only summer feeding, security and thermal habitat was modeled for the Project baseline. Using the summarized ecology information within the model, a list of assumptions were developed that explicitly rated TEM characteristics based on their relative suitability. These assumptions were then translated into a ratings table, which when complete indicated the relative habitat suitability of each unique ecosystem unit with the LSA. Ratings for Moose followed a 6-class suitability scheme (Table 19). Using a series of database queries, this ratings table was applied to the TEM mapping database, assigning ratings to each polygon based on the ecosystem unit(s) it contained. For TEM polygons with multiple ecosystem units present, a weighted average was assigned for the polygons final suitability rating based on each ecosystem unit present and its proportion.

Table 19: Rating Scheme Used to Rate Habitat Suitability for Moose

% of Best Habitat in Province	Rating	6-Class Code
100 – 76%	High	1
75 – 51%	Moderately High	2
50 – 26%	Moderate	3
25 – 6%	Low	4
5 – 1%	Very Low	5
0%	Nil	6

Moose habitat suitability modeling was conducted following the completion of baseline surveys. No field ratings were collected to truth the accuracy of this model.

3.20.1.2 Snow-Tracking Surveys

Snow-tracking surveys were conducted to identify use in the LSA by moose in the winter. Snow-tracking survey methods followed the same methods described in Section 3.18.1.1. Figure 17 shows the locations of snow-tracking transects.

3.20.1.3 CMWR Analysis

The CMWR was analyzed to determine how much of this area overlaps with the LSA. GIS spatial files of the CMWR were overlaid with spatial files of the LSA. The resulting overlay was analyzed to determine total area using standard spatial summary statistics within ArcGIS 9.2.

3.21 Mountain Caribou

Baseline studies to assess mountain caribou use in the LSA included habitat suitability mapping, snow-tracking surveys and road density analysis.

3.21.1 Sampling Methods

3.21.1.1 Habitat Suitability Mapping

Habitat suitability is “the ability of the habitat in its current condition to provide the life requisites of a species” (Resources Inventory Committee 1999a). Mountain caribou habitat suitability mapping was created following the British Columbia Wildlife Habitat Rating Standards (Resources Inventory Committee 1999a).

Suitability mapping requires that habitat associations be developed by linking the physical characteristics (*e.g.*, plant community and topography) of each ecosystem unit within the TEM to important habitat features required by the species being considered. These associations act as assumptions that form the foundation of the suitability mapping.

Pre-field Review

A species-habitat model was developed as an explicit review of mountain caribou ecology (Appendix 3). Mountain caribou were mapped for feeding habitat in four seasons (early winter, late winter, spring, and summer/fall), as well as for security/thermal habitat. Using the summarized ecology information within the model, a list of assumptions were developed that explicitly rated TEM characteristics based on their relative suitability. These assumptions were then translated into a ratings table, which when complete indicated the relative habitat suitability of each unique ecosystem unit with the LSA. Ratings for caribou followed a 6-class suitability scheme (Table 20). Using a series of database queries, this ratings table was applied to the TEM mapping database, assigning ratings to each polygon based on the ecosystem unit(s) it contained. For TEM polygons with multiple ecosystem units present, a weighted average was assigned for the polygons final suitability rating based on each ecosystem unit present and its proportion.

Table 20: Rating Scheme Used to Rate Habitat Suitability for Mountain Caribou

% of Best Habitat in Province	Rating	6-Class Code
100 – 76%	High	1
75 – 51%	Moderately High	2
50 – 26%	Moderate	3
25 – 6%	Low	4
5 – 1%	Very Low	5
0%	Nil	6

Field Methods

Field studies were undertaken to confirm the accuracy of the ratings assumptions and habitat mapping. Protocols for field truthing and habitat ratings were based on the *Field Manual for Describing Ecosystems* (BC Ministry of Environment, Lands and Parks and BC Ministry of Forests 1998) and *British Columbia Wildlife Habitat Rating Standards* (Resources Inventory Committee 1999a).

Data was collected on FS882 (full plot) forms, Ground Inspection Forms and Wildlife Habitat Assessment forms were completed in the field. Data from the field truthing were entered into the VENUS data capture program (Version 5.1). Draft species-habitat models and ratings were revised based on survey observations and field truthing where required, and a final digital habitat map produced.

Figure 9 shows the locations of wildlife habitat ratings field plots conducted.

3.21.1.2 Snow-Tracking Surveys

Snow-tracking surveys were conducted to identify use in the LSA by mountain caribou in the winter. Snow-tracking survey methods followed the same methods described in Section 3.18.1.1. Figure 17 shows the locations of snow-tracking transects.

3.21.1.3 Road Density Analysis

Southern mountain caribou avoid roads and other linear features because they are a source of mortality (through vehicle collisions and increased predator access), disturbance (through increased human access and use), and habitat alteration/fragmentation (Environment Canada 2014). Road density analysis for mountain caribou followed the same methods described in 3.19.1.3.

3.22 Mountain Goat

Mountain goats were assessed within the LSA using snow tracking surveys. Detailed wildlife habitat suitability mapping was not conducted for mountain goats in the LSA. Mountain goats in BC typically do not use extensive tracts of coniferous forests lacking escape terrain, instead preferring to stay in proximity to escape terrain (K. Simpson, pers. comm.). A biologist experienced with mountain goats assessed the LSA through review of the TEM combined with field reconnaissance, and did not identify escape terrain within the LSA. Thus it was assessed that goat use within the LSA would be limited.

3.22.1 Sampling Methods

3.22.1.1 Snow-Tracking Surveys

Although use of the LSA was assessed to be limited due to the lack of escape terrain present, snow-tracking surveys were conducted to identify if any mountain goat use could be confirmed within the LSA. Snow-tracking survey methods followed the same methods described in Section 3.18.1.1. Figure 17 shows the locations of snow-tracking transects.

3.23 Mule Deer

Mule deer use in the LSA was characterized using snow-tracking surveys and review of existing CDWR.

3.23.1 Sampling Methods

3.23.1.1 Snow-Tracking Surveys

Snow-tracking surveys were conducted to identify use in the LSA by mule deer in the winter. Snow-tracking survey methods followed the same methods described in Section 3.18.1.1. Figure 17 shows the locations of snow-tracking transects.

3.23.1.2 CDWR Analysis

The CDWR was analyzed to determine how much of this area overlaps with the LSA. Geographic Information System (GIS) spatial files of the CDWR were overlaid with spatial files of the LSA. The resulting overlay was analyzed to determine total area using standard spatial summary statistics within ArcGIS 9.2.

3.24 Wolverine

Wolverine use in the LSA was characterized using snow-tracking surveys and road density analysis.

3.24.1 Sampling Methods

3.24.1.1 Snow-Tracking Surveys

Snow-tracking surveys were conducted to identify use in the LSA by wolverine in the winter. Snow-tracking survey methods followed the same methods described in Section 3.18.1.1. Figure 17 shows the locations of snow-tracking transects.

3.24.1.2 Road Density Analysis

Anthropogenic disturbance plays a significant role in wolverine presence within an area, as they typically avoid all human activities (Copeland et al. 2007; Krebs et al. 2007). Road density was used as an index of anthropogenic disturbance within the LSA, because most of the roads are actively used by forestry, recreational users, travelers (driving between the towns of Vavenby and Barriere) and other users. Road density analysis followed the same methods described in 3.19.1.3.

4.0 RESULTS AND DISCUSSION

4.1 Rare Plants

4.1.1 Survey Results

4.1.1.1 Targeted-Meander Surveys

A total of 564 vascular plant taxa were recorded in the LSA over the two site-specific field study years (Appendix 4). An additional 146 mosses and 331 lichens were found during the 2005-2011 field surveys.

All of the moss, liverwort and lichen species found in the project area are native to B.C., while 60 vascular plants are exotic species, introduced to North America by human activity. Exotics tend to displace native species where human-caused disturbances are heavy and/or frequent. The spread of non-native species has been ranked as one of the most serious threats to biodiversity and ecosystem health (Wilson 2001). Hence, invasive plant issues are key when considering conservation of rare plants.

Rare Vascular Plants

Seven BC Red- or Blue-listed vascular plant taxa are known to occur within the LSA (**Error! Reference source not found.**; Figure 19). This includes occurrences found during the 2011 and 2012 site-specific surveys, as well as records from previous botanical work in the area. Of these seven taxa, two are Red-listed and the remaining five are Blue-listed. No SARA Schedule 1 vascular plant taxa were found. No vascular plant species' ranked by COSEWIC as Extinct, Extirpated, Endangered, Threatened, or Special Concern were found.

In addition, two other potential vascular plant taxa were found that appear to be undescribed species (see the bottom of **Error! Reference source not found.**). Research to determine the taxonomic authenticity of these two potential species is ongoing, although it is not expected that either will be formally described or accepted as a valid taxonomic entity for several years.

Table 21: Rare Vascular Plants Found within the Local Study Area

Species	Total Occurrences	BC List	Provincial Status	Global Status
Agoseris lackschewitzii (pink agoseris)	1	Blue	S2S3	G4
Carex praeceptorum (teacher's sedge)	1	Red	S1S3	G4G5
Carex scopulorum var. *bracteosa* (Holm's Rocky Mountain sedge)	1	Blue	S2S3	G5T3T5
Isoetes howellii (Howell's quillwort)	5	Red	S1	G4G5

Species	Total Occurrences	BC List	Provincial Status	Global Status
Pellaea gastonyi (Gastony's cliff-brake)	2	Blue	S2S3	G2G3
Sagina nivalis (snow pearlwort)	1	Blue	S2S3	G5
Stellaria obtusa (blunt-sepaled starwort)	1	Blue	S2S3	G5
Poa sp. (undescribed bluegrass)	1	–	–	–
Rorippa sp. (undescribed yellowcress)	2	–	–	–

Rare Mosses

Five BC-listed moss species were identified within the LSA during the 2011 field surveys (**Error! Reference source not found.**; Figure 19). Three of the taxa are Red-listed in BC and the remaining two are Blue-listed. No SARA Schedule 1 mosses were reported, nor were any COSEWIC Extinct, Extirpated, Endangered, Threatened, or Special Concern moss species located. One potentially new (previously undescribed) moss species (*Sphagnum* sp. nov.) was found in the LSA.

Table 22: Rare Mosses Found within the Local Study Area

Species	Total Occurrences	BC List	Provincial Status	Global Status
Encalypta brevipes (no common name)	1	Blue	S2S3	G3
Orthotrichum cupulatum (hooded bristle-moss)	1	Blue	S2S3	G4G5
Pseudoleskea incurvata var. tenuiretis (no common name)	1	Red	S1S3	G5TNR
Psilopilum cavifolium (little wolverine moss)	1	Red	S1S2	
Warnstorfia tundrae (tundra warnstorfia)	1	Red	S2	GU
Sphagnum sp. nov. (no common name)	1	–	–	–

Rare Lichens

The 2011 surveys documented 21 BC-listed lichen species (Appendix 5; Figure 19). No SARA Schedule 1 lichens were found. No COSEWIC Extinct, Extirpated, Endangered, Threatened, or Special Concern lichens were found.

Of note, four lichen species were discovered that are believed to be new records for BC (bottom of Appendix 5), and hence are not yet assigned a status by the CDC. In addition, two potential lichen taxa that appear to be new species were documented in the LSA.

Rare Plant Habitat

The majority of rare plants found within the LSA were located in subalpine wetlands, the associated wet and dry meadows, or on calcareous cliffs. The subalpine wetlands were typically fen wetlands or subalpine receding pool wetlands, and were concentrated within the Project site area (Figure 19).

The calcareous cliffs surveyed in the valley bottom near Vavenby contained the majority of the BC-listed lichens found within the Local Study Area (20 of the 21 lichen occurrences), as well as three of the five BC-listed moss occurrences. These calcareous cliffs are located outside of any proposed Project footprints.

4.1.2 Discussion

4.1.2.1 Species Descriptions

The following species descriptions cover all BC-Listed rare plants known to exist within the footprint of proposed Project facilities.

Agoseris lackschewitzii (pink agoseris)

Pink agoseris is a taprooted perennial of the Asteraceae (Aster Family) that inhabits moist to wet montane, subalpine, and alpine meadows (Douglas et al. 2001; BC Conservation Data Centre 2014a). The species is reported from numerous locations in southern BC, various sites in southwest Montana, and one occurrence in central Washington State (BC Conservation Data Centre 2014a; Klinkenberg 2012b). Pink agoseris has a global rank of G4 (Apparently Secure). In BC the taxon is ranked S2S3 (Imperilled and Vulnerable), and is on the province's Blue list (BC Conservation Data Centre 2014a).

One occurrence of pink agoseris is documented for the LSA. Site-specific rare plant surveys in 2011 located the species in a subalpine meadow and wetland complex in the north end of the proposed TMF. The pink agoseris plants were found scattered in a large wet meadow dominated by a diverse community of herbs and low shrubs.

It should be noted that although pink agoseris is treated as a valid species in the province of BC (Douglas et al. 2001; BC Conservation Data Centre 2014a), it is not recognized or tracked by other standard North American taxonomic authorities (Hitchcock et al. 1955a; Hitchcock and Cronquist 1973; Baird 2006; NatureServe 2011).

Carex praeceptorum (teacher's sedge)

Teacher's sedge, a tufted perennial in the Cyperaceae (Sedge Family), is found in wet meadows and on boggy soil around ponds or along streams, from the montane to alpine zones (Hitchcock et al. 1969; Hurd et al. 1998; Ball and Reznicek 2002). In BC, teacher's sedge is reported from several widely scattered locations in the central and southern parts of the province (BC Conservation Data Centre 2014a; Klinkenberg 2012b). The taxon's range extends south through the western US to California, and east into Montana, Wyoming, and Colorado (Ball and Reznicek 2002; NatureServe 2011; Klinkenberg 2012b).

Teacher's sedge is ranked G4G5 globally (Apparently Secure to Secure) (NatureServe 2011). The species' BC status is S1S3 (Critically Imperilled and Vulnerable), and is on the Red list for the province (BC Conservation Data Centre 2014a). Three other sub-national jurisdictions also rank teacher's sedge as rare: the states of Washington and Wyoming class the species as S2 (Imperilled), and Oregon ranks it as S3 (Vulnerable). The remaining jurisdictions where the sedge is known to occur do not provide a rank (Idaho, California, Utah, and Colorado) (NatureServe 2011).

One occurrence of teacher's sedge is reported within the Project site area. Site-specific rare plant surveys in 2011 discovered the species in a subalpine meadow and wetland complex in the north end of the proposed TMF. The sedge plants were found scattered in the wetter areas of a large meadow, which was characterized by a diverse community of herbs and shrubs.

Carex scopulorum var. bracteosa (Holm's Rocky Mountain sedge)

Holm's Rocky Mountain sedge is a sod-forming perennial herb of the Cyperaceae (Sedge Family). It grows in wet meadows, on the margins of lakes and streams, and on moist, open slopes in montane, subalpine, and alpine regions (Hitchcock et al. 1969; Hurd et al. 1998; Douglas et al. 2001; Ball and Reznicek 2002). The taxon is known from numerous sites in extreme southern BC, and ranges east into Alberta and south through the western US as far as California, Utah, and Colorado (Moss and Packer 1983; NatureServe 2011; BC Conservation Data Centre 2014a; Klinkenberg 2012b). The taxon is also reported from Yukon (Ball and Reznicek 2002).

Holm's Rocky Mountain sedge is classed G5T3T5 globally (Secure to Vulnerable) (NatureServe 2011). In BC, the taxon has a rank of S2S3 (Imperilled and Vulnerable) and is on the provincial Blue list (BC Conservation Data Centre 2014a). Outside of BC, the sedge is not considered rare and only one US state provides a rank (Montana S4 [Apparently Secure]) (NatureServe 2011).

One occurrence of Holm's Rocky Mountain sedge is reported within the Project site area. Site-specific rare plant surveys in 2011 located the taxon in a subalpine meadow and wetland complex in the north end of the proposed TMF. The sedge plants were found growing in an ephemerally wet opening in subalpine forest.

Isoëtes howellii (Howell's quillwort)

Howell's quillwort is a diminutive perennial herb in the Isoëtaceae (Quillwort Family). It is found from lowlands into montane regions in western North America. The species grows in or around areas of shallow water, including swales, vernal pools, seasonally-flooded sloughs, ponds, and temporary lakes (Hitchcock et al. 1969; Douglas et al. 2000; Taylor et al. 2002; COSEWIC 2006). In BC, Howell's quillwort is known from several historical and recent collections in the Kamloops and Shuswap Lake areas, and from one occurrence in the extreme southeast corner of the province (COSEWIC 2006; BC Conservation Data Centre 2014a; Klinkenberg 2012b). The taxon's range extends south through Washington State to southern California, and east through northern Idaho to western Montana (Hitchcock et al. 1969; Douglas et al. 2000; Taylor et al. 2002; NatureServe 2011). An historical disjunct occurrence is also reported from northern Utah (Hitchcock et al. 1969; Douglas et al. 2000; NatureServe 2011; Klinkenberg 2012b).

Howell's quillwort has a global status of G4G5 (Apparently Secure or Secure) (NatureServe 2011). In BC, the species is ranked S1 (Critically Imperilled), and is on the province's Red list (BC Conservation Data Centre 2014a). Two US states also classify the taxon as rare: Montana S2 (Imperilled), and Utah S1 (Critically Imperilled). The remaining jurisdictions where Howell's quillwort is found do not provide a rank for the species (Washington State, Oregon, Idaho, and California) (NatureServe 2011).

Five occurrences of Howell's quillwort were found within the Project site area. Site-specific rare plant surveys in 2011 and 2012 discovered the species at scattered locations in a forested subalpine basin. A wetland and meadow complex occupies much of the flatter north and central sections of this basin; the remaining areas are moderately sloped and have been logged or clear-cut in the recent past. Various road tracks and former staging areas are evident in the cut-over sections of the basin, as well as signs of active cattle grazing throughout. The Howell's quillwort occurrences were located in a north-south band, extending from the meadow complex area into one of the logged portions of the basin.

The Howell's quillwort plants were observed growing under water in shallow, temporary pools and ponds, and on mud around the margins of these areas, or in one instance on drying mud in an ephemeral swale. The quillworts, where growing submerged, were found to be the dominant or even sole, vascular plant species across the bottoms of the pools and ponds. Where growing emergent or terrestrially, the taxon was a dominant or co-dominant component of the wetland community that characterized these areas. Co-dominant vascular species included *Ranunculus flammula* (lesser spearwort), *Carex saxatilis* (russet sedge), *Torreyochloa pauciflora* (weak false-manna), and *Salix barclayi* (Barclay's willow).

Surveys in 2011 originally located one quillwort occurrence and initially identified the quillwort in the LSA as *Isoëtes bolanderi* (Bolander's quillwort). This is a SARA Schedule 1 species for which COSEWIC only recognizes three populations in Canada (all in the southwestern corner of Alberta) (Parks Canada 2011). However further surveys in 2012 revisited the one occurrence and located four additional occurrences, all of which were tentatively identified as Howell's quillwort (Taylor et al. 2002; COSEWIC 2006; Parks Canada 2011).

To clarify the identification, specimens from the Harper Creek Project site were sent to Daniel Brunton in Ottawa for review. Mr. Brunton is co-author of the 2006 COSEWIC status update for Bolander's quillwort, and is a member of the Bolander’s Quillwort Advisory Group that prepared the 2011 Parks Canada Recovery Plan for the species (COSEWIC 2006; Parks Canada 2011). In addition, he is listed as a co-author of the Flora of North America treatment of the quillwort genus (Taylor et al. 2002), and maintains an extensive herbarium collection of quillwort specimens. Mr. Brunton identified all specimens from the Harper Creek Project site as Howell's quillwort.

Placynthium asperellum (sandpaper ink)

Sandpaper ink is a crustose lichen with minute lobes belonging to the Placynthiaceae (Placynthia Family) (McCune and Goward 1995; Consortium of North American Lichen Herbaria 2012). The species grows on moist rock—usually along the margins of streams and lakes—in arctic and montane regions of North America, from Alaska, Nunavut, and Greenland south through Canada and the western US to northern Mexico (Nash III et al. 2001; NatureServe 2011; Consortium of North American Lichen Herbaria 2012). In BC, the lichen is reported from scattered locations in the northern Rocky Mountains as well as the Queen Charlotte Islands (Consortium of North American Lichen Herbaria 2012).

Sandpaper ink is classed as G3G5 globally (Vulnerable to Secure). The lichen's BC ranking is S3? (Vulnerable) and it is on the Blue list for the province (NatureServe 2011; BC Conservation Data Centre 2014a). Sandpaper ink is considered rare in Alberta (S1 [Critically Imperilled]) but ranked S4? (Apparently Secure) in Ontario; no other North American sub-national jurisdictions provide a rank for the species (NatureServe 2011).

One occurrence of sandpaper ink was found in the Project site area. Site-specific rare plant surveys in 2011 located the taxon in a subalpine meadow and wetland complex in the north end of the proposed TMF. The lichen was found growing on rocks in a small creek.

Sagina nivalis (snow pearlwort)

Snow pearlwort, a small cushion-forming perennial in the Caryophyllaceae (Pink Family), grows in moist, gravelly areas in subalpine, alpine, and arctic regions (Moss and Packer 1983; Douglas et al. 1998b; Crow 2005). The species is found across northern Canada, Alaska and Eurasia, and is also reported from Alberta and Montana (Crow 2005; NatureServe 2011). In BC, snow pearlwort is known from scattered locations in the central and northwestern parts of the province (BC Conservation Data Centre 2014a; Klinkenberg 2012b).

Snow pearlwort has a global rank of G5 (Secure); its status in BC is S2S3 (Imperilled and Vulnerable) and it is on the province's Blue list (NatureServe 2011; BC Conservation Data Centre 2014a). Outside of BC, four other North American jurisdictions also class the taxon as rare: Alberta S1 (Critically Imperilled), Montana S2 (Imperilled), and Yukon and Québec S3 (Vulnerable). The remaining four jurisdictions do not provide a rank for the species (Alaska, Northwest Territories, Nunavut, and Labrador) (NatureServe 2011).

One small occurrence of snow pearlwort was found in the Project site area. Site-specific rare plant surveys in 2011 discovered the taxon in a subalpine meadow and wetland complex in the north end of the proposed TMF. The snow pearlwort plants were found in a dry meadow dominated by a diverse community of herbs and low shrubs.

Stellaria obtusa (blunt-sepaled starwort)

Blunt-sepaled starwort is a low, matted perennial of the Caryophyllaceae (Pink Family). The taxon inhabits moist meadows, damp woodlands, stream banks and talus slopes in montane regions of western North America (Hitchcock et al. 1964; Hitchcock and Cronquist 1973; Moss and Packer 1983; Douglas et al. 1998b; Alberta Native Plant Council 2001; Morton 2005). Blunt-sepaled starwort has been recorded in numerous locations across southern BC, and is also known from an occurrence east of the town of Quesnel (BC Conservation Data Centre 2014a; Klinkenberg 2012b). The species has been collected in extreme southwest Alberta, and ranges south through Washington State, Idaho, and Montana into California, Utah, and Colorado (Morton 2005; NatureServe 2011).

Blunt-sepaled starwort is ranked G5 (Secure) globally (NatureServe 2011). Its BC status is S2S3 (Imperilled and Vulnerable), and it is on the Blue list for the province (BC Conservation Data Centre 2014a). Other subnational jurisdictions that also rank the species as rare include: Alberta (S1 [Critically Imperilled]); Wyoming and Utah (S2 [Imperilled]); and California (S3 [Vulnerable]). The remaining jurisdictions where blunt-sepaled starwort is found do not rank the species (Washington state, Oregon, Idaho, Montana, and Colorado) (NatureServe 2011).

A single occurrence of blunt-sepaled starwort was found in the Project site area. Site-specific rare plant survey work in 2012 located the taxon in an open area within previously logged subalpine fir forest.

Warnstorfia tundrae (tundra warnstorfia)

Tundra warnstorfia is a medium-sized green or yellowish-green moss in the Campyliaceae (Campylia Family). The species is found in fens and on streambanks and lakeshores, growing terrestrially or sometimes submerged, from lowland to montane regions (Hedenäs 2007). The moss' range extends from Alaska across northern Canada to Greenland, and south into Wyoming, Colorado, and Maine; it is also known from northern Eurasia (Hedenäs 2007; NatureServe 2011). In BC, the taxon has been observed in several widely-scattered locations in the far north and in the central interior (University of British Columbia Herbarium 2012).

Tundra warnstorfia currently has no global rank (GU), however, in BC the moss has a status of S2 (Imperilled) and is on the province's Red list (NatureServe 2011; BC Conservation Data Centre 2014a). The remaining reported sub-national rankings vary considerably; the species is classed S1 (Critically Imperilled) in Ontario and Wyoming, S2 (Imperilled) in Alberta, S3 (Vulnerable) in Québec, S1S3 (Critically Imperilled and Vulnerable) in Colorado, S5 (Secure) in Yukon, and SU (Unrankable) in Manitoba (NatureServe 2011).

One occurrence of tundra warnstorfia was found in the Project site area. Site-specific rare plant surveys in 2011 found the species in a subalpine meadow and wetland complex in the north end of the proposed TMF. The moss was found scattered throughout a large wet meadow, which was dominated by a diverse community of herbs and low shrubs.

4.2 Ecological Communities at Risk

4.2.1 Survey Results

4.2.1.1 Terrestrial Ecosystem Mapping

Final ecosystem mapping of the Harper Creek area was completed in 2011 (Keystone Wildlife Research 2011). The accuracy assessment found that 87% of site series were classified correctly within the mapping and 84% of structural stages were classified correctly.

Of the 12 ECAR identified as potentially occurring within the LSA, three were mapped within the TEM (Table 23; Appendix 6). Two of these ECAR are forested communities, while the third is associated with fens. All three of these ECAR are Blue-listed by the CDC.

Table 23: ECAR Identified within the LSA

Common Name	Latin Name	BC List	Site Series
Lodgepole pine / dwarf blueberry / peat-mosses	*Pinus contorta / Vaccinium caespitosum / Sphagnum* spp.	Blue	ESSFwc2/09
Tufted clubrush / golden star-moss	*Trichophorum cespitosum / Campylium stellatum*	Blue	ESSFwc2/Wf11,
Western redcedar - paper birch / oak fern	*Thuja plicata - Betula papyrifera / Gymnocarpium dryopteris*	Blue	IDFmw2/04

Site series that support the Western redcedar – paper birch / oak fern ECAR are the most common within the LSA (Table 24). They are found at lower elevations in the LSA, while the remaining two ECAR-associated site series are found at higher elevations.

Table 24: Area of Each ECAR within the LSA

Common Name	Latin Name	Area (ha)
Lodgepole pine / dwarf blueberry / peat-mosses	*Pinus contorta / Vaccinium caespitosum / Sphagnum* spp.	20.3
Tufted clubrush / golden star-moss	*Trichophorum cespitosum / Campylium stellatum*	3.4
Western redcedar - paper birch / oak fern	*Thuja plicata - Betula papyrifera / Gymnocarpium dryopteris*	104.2

Site series associated with the Lodgepole pine / dwarf blueberry / peat-mosses and Tufted clubrush / golden star-moss ECAR are found primarily near the proposed open pit footprint, with smaller proportions overlapping the TMF, mine access road, and non-PAG waste rock footprints (Figure 20).

Site series associated with the Western redcedar – paper birch / oak fern ECAR located along the valley bottom of the North Thompson River, with some overlapping the mine access road footprint (Figure 20).

A fourth ECAR, Western hemlock / velvet-leaved blueberry – falsebox (*Tsuga heterophylla / Vaccinium myrtilloides – Paxistima myrsinites*) could not be identified using the TEM because it is not associated with any specific site series. However, during 349 vegetation plots for the TEM truthing and 18 days of rare plant surveys, no velvet-leaved blueberry was observed within the LSA.

4.3 Wetlands

4.3.1 Survey Results

4.3.1.1 Terrestrial Ecosystem Mapping

The eight wetland site series were distributed amongst five of the BGC variants within the LSA. The most common wetland was water sedge / peat-moss, with 128.0 ha combined within the ESSFwc2 and ESSFwcp (Table 25). The majority of wetlands (96%) within the LSA were located at higher elevations, within the ESSF variants. Many of these wetlands are located in the Project site area (Figure 21).

4.3.1.2 Regional Study Area Wetland Mapping

Within the RSA 1,295.4 ha of wetlands were identified in the analysis of the VRI. Of these, 1,000.2 ha (77.2%) are found within the ESSF, at a similar elevation to the Project site area. The remaining 295.2 ha of wetlands were located at lower elevations in the RSA.

4.3.2 Discussion

About 1.8% of the LSA is wetlands, while 0.8% of the RSA is wetlands. The LSA contains approximately 16% of the wetlands within the larger RSA, and approximately 20% of the higher elevation (ESSF) wetlands, while only 7% of the area.

Table 25: Area of Wetlands Mapped within the LSA

BGC variant	Common Name	Site Series	Area (ha)
ESSFwc2	Water sedge / peat-moss	Wf03	125.2
	Barclay's willow / water sedge / glow moss	Wf04	33.9
	Tufted clubrush / star moss	Wf11	3.4
ESSFwcp	Water sedge / peat-moss	Wf03	2.8
ESSFwcw	Narrow-leaved cotton-grass / marsh-marigold	Wf12	1.6
	Narrow-leaved cotton-grass / shore sedge	Wf13	33.5
ICHmw3	Mountain alder / pink spirea / sitka sedge	Ws02	3.2
	Drummond's willow / beaked sedge	Ws04	2.8
IDFmw2	Mountain alder / skunk cabbage / lady fern	Ws01	1.0
	Mountain alder / pink spirea / sitka sedge	Ws02	1.3
Total Wetland Area			**208.7**

4.4 Old-Growth Forests

4.4.1 Survey Results

4.4.1.1 Terrestrial Ecosystem Mapping

The TEM portion of the LSA is a total of 11,021.3 ha large. Approximately 28% of the LSA was mapped as old-growth forest (structural stage 7) within the TEM (Table 26). Over half of this old-growth forest is located in the ESSF variants, at higher elevations of the LSA and overlapping with much of the proposed Project footprints (Figure 22).

Table 26: Structural Stage Composition of LSA

BGC variant	Structural Stage (area in ha)							
	N/A	**1**	**2**	**3**	**4**	**5**	**6**	**7**
ESSFwc2	2.3	1.3	173.8	1077.7	760.4	296.1	165.3	1972.8
ESSFwcp	0.0	0.3	7.3	0.0	0.0	0.0	0.0	50.9
ESSFwcw	0.0	0.0	35.1	210.3	66.8	0.0	0.0	441.9
ICHdw3	1.2	4.0	0.0	403.5	79.6	213.6	909.2	114.8
ICHmw3	1.4	0.0	0.0	545.8	188.8	3.2	667.2	409.0
ICHwk1	0.0	0.0	0.0	14.6	4.9	88.6	1.9	5.0
IDFmw2	347.8	6.8	480.2	122.2	200.3	176.2	670.1	99.2
Total	352.7	12.4	696.4	2374.1	1300.8	777.7	2413.7	3093.6

4.4.2 Discussion

Extensive logging in the LSA has greatly affected the quantity of old-growth forest historically. Much of the LSA is also classified as structural stages 3-4. Structural stage 3 is shrub-dominated habitat, and much of the 2,374 ha of this stand type are the result of logging in the past 20 years. Structural stage 4 is an additional 1,300 ha in the LSA, with much of this stand type being the result of logging from 20-40 years ago. The interspersion of cutblocks with old-growth forest, due to logging, has left the LSA very fragmented (Figure 22).

4.5 Rock Outcrops

4.5.1 Survey Results

No rock outcrops were identified within the TEM or during field surveys in the LSA.

4.6 Butterflies

4.6.1 Survey Results

4.6.1.1 Netting Surveys

In 198 person-hours of combined survey time for aerial invertebrates (butteflies, damselflies and dragonflies), 42 butterfly species were identified in the LSA (Appendix 7). No butterflies were observed that are of conservation concern (i.e. provincially or federally-listed).

4.7 Damselflies and Dragonflies

4.7.1 Survey Results

4.7.1.1 Netting Surveys

In 198 person-hours of combined survey time for aerial invertebrates (butteflies, damselflies and dragonflies), three species of damselflies and nine species of dragonflies were successfully identified in the LSA (Table 27). None of these were of conservation concern (i.e. provincially or federally-listed).

Table 27: Damselfly and Dragonfly Species Observed During Field Surveys in the LSA

Species	Group	Count
Boreal Bluet	Damselfly	9
Cherry-faced Meadowhawk	Dragonfly	6
Darner sp.	Dragonfly	1
Dot-tailed Whiteface	Dragonfly	2
Forktail spp.	Damselfly	1
Four-spotted Skimmer	Dragonfly	2
Meadowhawk sp.	Dragonfly	1
Northern Bluet	Damselfly	29
Northern Spreadwing	Damselfly	10
Paddle-tailed Darner	Dragonfly	27
Striped Meadowhawk	Dragonfly	23
Subarctic Darner	Dragonfly	1
Unknown Darner	Dragonfly	2
Variable Darner	Dragonfly	4
White-faced Hudsonian	Dragonfly	4
White-faced Meadowhawk	Dragonfly	16

4.8 Western Toad

4.8.1 Survey Results

4.8.1.1 Habitat Suitability Mapping

A total of 72.0 ha of suitable (high- and moderate-rated) western toad reproduction habitat was mapped in the LSA (Table 28). Much of this habitat is located at the Project site area due to the plateau present there, which has allowed the formation of numerous wetlands complexed with meadow and old-growth forest habitats (Figure 23). None of the habitat in the LSA was mapped as high-suitability.

Table 28: Habitat Suitability Summary for Western Toad in the LSA

Rating	Area (ha)
High	0.0
Moderate	72.0
Low	1078.3
Nil	9871.0
Total	11021.3

4.8.1.2 Road Encounter Surveys

During road encounter surveys in 2008, six juvenile and five adult western toads were observed on the Jones Creek FSR (Figure 23). These toads were observed crossing roads at various elevations along the FSR, moving between forested habitats as well as traveling along the FSR within wetlands. Surveys in 2011 observed an additional 25 adult western toads along Birch Island Road, at low elevation within the LSA.

4.8.1.3 Time-Constrained Pond Surveys

Time-constrained pond surveys located western toad tadpoles at five locations, all within the Project site area. The greatest occurrence was within a wetland at the south end of the Tailings Management Facility (TMF) footprint, where an estimated 30,000 tadpoles were observed. Another occurrence of approximately 5,000 tadpoles was recorded within a wetland in the open pit footprint. The other three locations had ten or less tadpoles recorded in each (Figure 23).

4.8.1.4 Larval Pond Surveys

No additional western toad observations were recorded during larval pond surveys in 2008. Surveyors did identify use of some ponds at the Project site area by Columbia spotted frog (*Rana luteiventris*) and long-toed salamander (*Ambystoma macrodactylum*).

4.8.1.5 Incidental Observations

Several incidental observations of western toad were made during other surveys within the LSA. These observations were of adult and juvenile western toads, primarily at small wetands within the Project site area. The largest occurrence was of approximately 200 juvenile toads in a wetland on the edge of the open pit footprint (Figure 23).

4.8.2 Discussion

Western toads have been observed throughout the LSA, at all elevations. Breeding has also been confirmed at the Project site area. The LSA is approximately 15 km long. Seasonal movements between breeding and summer habitats are typically limited to a few kilometres (Muths 2003; Bartelt et al. 2004), therefore it is likely the toads seen at the northern end of the LSA are breeding at sites different from those observed in the Project site area at the southern end.

Several large groups of tadpoles, including one estimated around 30,000 individuals, were observed at sites within proposed Project footprints. A single western toad female can produce clutches of 5,000 to 15,000 eggs, and once they hatch the tadpoles typically swim and feed in large schools (COSEWIC 2002a). Therefore a single observation of 30,000 tadpoles could be indicative of a few breeding females at a site.

4.9 Barn Swallow

4.9.1 Survey Results

4.9.1.1 Habitat Suitability Mapping

A total of 279.6 ha of suitable (high- and moderate-rated) Barn Swallow nesting habitat was mapped in the LSA (Table 29). This habitat is located at the North end of the LSA, in and around the town of Vavenby (Figure 24). Man-made structures provide the best opportunities for Barn Swallow nesting.

Table 29: Habitat Suitability Summary for Barn Swallow in the LSA

Rating	Area (ha)
High	215.9
Moderate	63.7
Low	17.4
Nil	10724.3
Total	11021.3

4.9.1.2 Breeding Bird Surveys

Breeding bird surveys took place in 2008 on May 26-29, June 18-21, and July 14-17. Additional surveys in 2011 occurred on June 7-9 and July 6-7. Fifty-two bird species were observed during 2008 surveys, and an additional 15 species were recorded in 2011, for a total of 67 species (Appendix 8). No Barn Swallows were observed during these surveys.

4.9.1.3 Incidental Observations

Six Barn Swallows were observed incidentally during other baseline surveys. These Barn Swallows were located at low elevations, along the valley bottom of the North Thompson River (Figure 24).

4.10 Common Nighthawk

4.10.1 Survey Results

4.10.1.1 Call-Playback Surveys

Surveys for Common Nighthawk took place on June 19-21, 2012. A total of 25 stations were surveyed over four transects. Total survey time was one hour 55 minutes. Nineteen adult Common Nighthawks were detected during these surveys, including three pairs and 13 individuals. The majority of nighthawks observed were seen flying over farm fields in the valley bottom.

4.10.1.2 Incidental Observations

Four adult nighthawks were detected incidentally feeding over fields during other surveys within the LSA. All Common Nighthawks that were observed were at low elevations near the North Thompson River.

4.11 Great Blue Heron

4.11.1 Survey Results

4.11.1.1 Habitat Suitability Mapping

A total of 1.3 ha of suitable (high- and moderate-rated) Great Blue Heron nesting habitat was mapped in the LSA (Table 30). This small patch of habitat is located in the valley bottom of the North Thompson River, at the western end of the study area where large cottonwood trees provide the best nesting opportunity (Figure 25).

Table 30: Habitat Suitability Summary for Great Blue Heron in the LSA

Rating	Area (ha)
High	1.3
Moderate	0.0
Low	42.5
Nil	10977.5
Total	11021.3

4.11.1.2 Great Blue Heron Nest Survey

The aerial survey for Great Blue Heron nests was completed on April 15, 2012. No herons or heron nests were observed during this survey, and no Great Blue Herons have been recorded within the LSA over the course of baseline surveys.

4.11.2 Discussion

No Great Blue Herons are known to have been observed within the LSA, during baseline surveys or historically. In addition, nesting habitat is extremely limited within the LSA. The lack of nesting habitat, combined with no observations of individual Great Blue Herons through nest surveys or incidentally during breeding bird or other surveys, indicates that use of the LSA by this species is limited or nonexistent.

4.12 Harlequin Duck

4.12.1 Survey Results

4.12.1.1 Brood Surveys

The following results have been summarized from the draft report written by Summit Environmental Consultants Ltd. (2009). Harlequin Duck brood surveys were conducted in the Harper Creek watershed over a three day period (July 19-21, 2008). Suitable habitat along Harper Creek and tributaries were surveyed, but no Harlequin Ducks were detected. Some suitable habitat was identified as being present along Harper Creek and at the confluences of some of the tributaries. But the tributaries themselves did not contain any suitable habitat.

4.13 Olive-Sided Flycatcher

4.13.1 Survey Results

4.13.1.1 Habitat Suitability Mapping

A total of 3,126.1 ha of suitable (high- and moderate-rated) Olive-sided Flycatcher nesting habitat was mapped in the LSA (Table 31). This habitat is distributed throughout the study area at all elevations (Figure 26).

Table 31: Habitat Suitability Summary for Olive-sided Flycatcher in the LSA

Rating	Area (ha)
High	1310.2
Moderate	1815.9
Low	7076.1
Nil	819.1
Total	11021.3

4.13.1.2 Breeding Bird Surveys

Breeding bird surveys took place in 2008 on May 26-29, June 18-21, and July 14-17. Additional surveys in 2011 occurred on June 7-9 and July 6-7. Fifty-two bird species were observed during 2008 surveys, and an additional 15 species were recorded in 2011, for a total of 67 species (Appendix 8).

Six Olive-sided Flycatcher's were observed during these breeding bird surveys, all in 2011. Two of these were located along the proposed mine access road, and four were within the proposed TMF area (Figure 26).

4.13.1.3 Incidental Observations

Seven Olive-sided Flycatchers were observed incidentally during other baseline surveys. Many of these flycatchers were located in the Project site area, but several were located at lower elevations along the proposed mine access road (Figure 26).

4.13.2 Discussion

The results of baseline surveys indicate that Olive-sided Flycatchers occur through much of the LSA due to large amounts of suitable habitat being present. This species is highly-associated with the edges along forest openings, which are very common throughout the LSA due to habitat fragmentation from forest harvesting practices (COSEWIC 2007b).

4.14 Bald Eagle

4.14.1 Survey Results

4.14.1.1 Habitat Suitability Mapping

A total of 769.3 ha of suitable (high- and moderate-rated) Bald Eagle nesting habitat was mapped in the LSA (Table 32). All of this habitat is located in the valley bottom of the North Thompson River where large cottonwood or Douglas-fir trees provide the most nesting opportunities (Figure 27).

Table 32: Habitat Suitability Summary for Bald Eagle in the LSA

Rating	Area (ha)
High	0.0
Moderate	769.3
Low	3045.6
Nil	7206.4
Total	11021.3

4.14.1.2 Bald Eagle Nest Survey

The aerial survey for Bald Eagle nests was completed on April 15, 2012. During the survey, two large stick nests were observed in the valley bottom of the North Thompson River (Figure 27). Both of these nests were actively in use by Bald Eagles.

4.14.1.3 Incidental Observations

One adult Bald Eagle was detected incidentally during baseline surveys, along Birch Island Road near the North Thompson River (Figure 27).

4.14.2 Discussion

Based on the results of baseline studies, Bald Eagle use of the LSA is primarily along the valley bottom of the North Thompson River. This area contains suitable nesting habitat as described above, as well as the best foraging opportunities. Bald Eagles feed primarily on fish and waterfowl (Blood and Anweiler 1994), and the North Thompson River is the best source of these two food sources in the LSA.

4.15 Northern Goshawk

4.15.1 Survey Results

4.15.1.1 Habitat Suitability Mapping

A total of 3,471 ha of suitable (high- and moderate-rated) Northern Goshawk nesting habitat was mapped in the LSA (Table 33). The majority of this habitat is located at lower elevations where the forest structure and tree species are better-suited to supporting the large stick nests of goshawks (Figure 28).

Table 33: Habitat Suitability Summary for Northern Goshawk in the LSA

Rating	Area (ha)
High	1113.3
Moderate	2157.7
Low	2432.2
Nil	5318.1
Total	11021.3

4.15.1.2 Call-Playback Surveys

In 2011, surveys for Northern Goshawk took place on June 7-8 and July 6-7. A total of 7 hours and 22 minutes of surveying was conducted. No detections of Northern Goshawk were made in 2011. A single Red-tailed Hawk was recorded during the surveys. No evidence of nesting was observed.

In 2012, surveys took place on June 8-10 and August 7-8, during which a total of 5 hours and 11 minutes of survey time were conducted. No detections of Northern Goshawk were made during 2012 surveys.

4.15.1.3 Incidental Observations

Two adult Northern Goshawks were detected incidentally during baseline surveys. One was observed along the upper Jones Creek FSR, while the second observation was along Road 5 on the plateau (Figure 28).

4.15.2 Discussion

Based on habitat suitability mapping, Northern Goshawks are expected to reside in greater densities at the lower elevations of the IDF and ICH within the LSA. Forests at lower elevations provide better structure for the nesting of goshawks in the way of larger trees and better stand structure. Douglas-fir and western hemlock both have suitable structural characteristics for supporting goshawk stick nests.

As evidenced by one incidental observation within the ESSF, goshawks will use higher elevation sites. But it is expected that this habitat use is primarily for feeding, as foraging habitat requirements are much less stringent than nesting habitat requirements (Squires and Reynolds 1997; Cooper and Stevens 2000).

4.16 Western Screech-Owl

4.16.1 Survey Results

4.16.1.1 Call-Playback Surveys

Surveys for Western Screech-Owl took place on June 23, July 4, and August 17, 2011. Thirteen stations were visited along the single transect surveyed, for a total of 39 station visits over the three surveys. This resulted in a cumulative survey time of 9 hours and 34 minutes.

No detections of Western Screech-Owl were made incidentally or during the species specific call-playback surveys. Four Barred Owl detections were recorded during the surveys, which included one pair. No evidence of nesting was observed.

4.16.2 Discussion

The closest known detection of a Western Screech-owl to the LSA is just outside of Kamloops, approximately 150 km to the south (BC Conservation Data Centre 2012b). Western Screech-owls are primarily found in deciduous or mixed, riparian forests of lakeshores, streams and floodplains (Hayward and Garton 1984; Cannings et al. 1987; Campbell et al. 1990b; Stevens 1995), and along forest edges and meadows (BC Environment 1996). The older deciduous forests along the valley bottom of the North Thompson River were targeted for baseline surveys because they contained the best representation of this habitat within the LSA. No detections within this habitat, combined with no known records in the vicinity of the LSA, indicates that Western Screech-owls are potentially not present.

4.17 Bats

4.17.1 Survey Results

4.17.1.1 Acoustic Detection

In 2011, 5759 Analook files were obtained from the recorded data. Of those, 810 files were clearly non-bat (noise). All but two of the 4949 remaining files were identified as being produced by bats (Table 34), with some files containing multiple bat detections. Over all sites, eight species were detected including long-eared myotis, little brown myotis, northern myotis, Yuma myotis, eastern red bat (*Lasiurus borealis*), big brown bat, silver-haired bat, and hoary bat (*Lasiurus cinereus*).

In 2012, 14652 Analook files were obtained, of which 589 were noise. The remaining 14063 were identified as being produced by bats (Table 34). Eight species were confirmed in acoustic recordings including Californian myotis, long-eared myotis, long-legged myotis, little brown myotis, northern myotis, Yuma myotis, silver-haired bat, and hoary bat. A potential ninth species, big brown bat, was also likely present in the 2012 recordings but its calls could not be differentiated from those of silver-haired bat. In 2011, an eastern red bat was acoustically detected at Site 4 within the pit footprint.

Table 34: Total Acoustic Recording Time and Bat Files Recorded in 2011 and 2012

Site ID	2011 Hours:Min Data Recorded	2011 Bat Files Recorded	2012 Hours:Min Data Recorded	2012 Bat Files Recorded
1	25:30	87	-	-
2	25:30	63	146:36	15
3	25:30	524	-	-
4	88:30	2545	304:41	7078
5	91:25	1106	-	-
6	30:20	288	-	-
7	40:20	165	-	-
8	40:20	171	-	-
9	-	-	92:04	1
10	-	-	83:40	9
11	-	-	124:52	17
12	-	-	491:57	1021
13	-	-	494:27	3705
14	-	-	247:34	301
15	-	-	123:06	172
16	-	-	119:46	1744

Site 4 was the location of the greatest bat detections in both years. It is unknown whether these detection rates correlate to high use of the site by a few individuals, use of the site by numerous individuals, or simply an artefact of the characteristics of the sampling location. Site 4 was a narrow, long pond formed by a backed-up creek. Narrow waterbodies can offer a better chance to detect bats using the site because bats are concentrated in a small area in front of the detector. This means that the same number of bat individuals can produce higher detection rates at small sites versus more dispersed use within large, open sites. Bat activity at a given site may also vary widely depending on weather conditions, insect populations and season, as well as local bat numbers (Hayes 1997), so the variation in bat activity recorded at different sites should not be interpreted as necessarily reflecting differences in habitat suitability.

4.17.1.2 Capture Surveys

Thirty-one bats were captured during surveys (Table 35), resulting in an overall capture rate of 0.0037 bats/m^2-hr of netting. All bats were captured at the four low-elevation sites, while the five sites within the Project site area yielded no captures.

Eight bat species were captured during netting surveys, including big brown bat, Californian myotis (*Myotis californicus*), fringed myotis, little brown myotis, long-eared myotis (*Myotis evotis*), long-legged myotis (*Myotis volans*), northern myotis and Yuma myotis (*Myotis yumanensis*). Twenty-nine of the 31 bats were adults and two were juveniles. Nineteen bats were male and 12 were female.

Table 35: Bat Capture Results Summary

Site ID	Number of Nights	Effort (m^2-hr)	Number of Bats Captured	Number of Bat Species Captured
1	1	655.6	1	1
2	2	1530.8	0	0
3	1	755.2	0	0
4	1	967.2	6	4
5	1	617.5	4	3
6	2	1395.3	20	7
7	1	1014.0	0	0
8	1	790.4	0	0
9	1	745.6	0	0
Total	11	8471.5	31	8

4.17.2 Species-Specific Discussion

4.17.2.1 Fringed Myotis

One fringed myotis, may have been detected at acoustic Site 5 in 2011, located in a sheep farm pasture along the valley bottom of the North Thompson River. The original sound files corresponding to the potential fringed myotis detections were sent back to the bat expert for additional analysis in an attempt to confirm the identification, but could only be identified to a maximum of 75% probability and must remain unconfirmed. One fringed myotis was captured at the Weyerhaeuser site during netting in 2012.

With the single capture in 2011, the species has been confirmed to occur within the LSA. However it appears to occur in low densities compared to other bat species. Little is known about specific habitat requirements of fringed myotis, although it is thought to forage in arid grasslands, dry ponderosa pine and Douglas-fir forests, and riparian areas (Rasheed et al. 1995; COSEWIC 2004). These types of habitats are only found at low elevations in the LSA.

4.17.2.2 Little Brown Myotis

The COSEWIC-listed little brown myotis was detected at all acoustic sites except Site 9, and was captured at all of the netting sites where bats were captured. It was one of the most common bat species found throughout the study area, in a variety of habitats at low to high elevations.

4.17.2.3 Northern Myotis

A northern myotis was detected at acoustic Site 8 in 2011, and then at acoustic Sites 4, 12 and 13 in 2012. Individuals field-identified as northern myotis were captured at the Vavenby bridge (capture Site 4) and in the sheep farm pasture (capture Site 5). These acoustic and capture detection sites are spread throughout the LSA, located at both low and high elevations.

It should be noted that northern myotis are very difficult to distinguish from long-eared myotis (*M. evotis*) based on physical characteristics and DNA analysis is required to confirm captures of northern myotis.

4.17.2.4 Townsend's Big-eared Bat

No Townsend's big-eared bats were observed during baseline surveys for the Project, and none have been confirmed historically within the vicinity of the LSA. This species is potentially not present.

4.17.2.5 Western Small-footed Myotis

No western small-footed myotis were observed during baseline surveys for the Project, and none have been confirmed historically within the vicinity of the LSA. This species is potentially not present.

4.17.2.6 Eastern Red Bat

Little is known about the Red-listed eastern red bat, and there have been few detections in the province (BC Conservation Data Centre 2014a). A bat expert identified a single pass by this species at one site, recorded shortly after 9 pm on August 8, 2011. The original .wac file corresponding to the Analook file was sent to a bat expert, who re-analysed the call using full-spectrum analysis. This type of analysis provides much greater call detail. The results of the re-analysis confirmed the original identification. An additional 16 files recorded at this site were identified as either little brown bat or eastern red bat in 2011 (more detailed analysis could not differentiate between the two species). This site was surveyed for an additional 34 nights in July and August 2012 with no red bat detections during that period, and no eastern red bats were observed during capture surveys.

The eastern red bat is a solitary, tree-roosting species that migrates between its summer and winter ranges. Little is known about its migration routes or timing in the province as the species has been so rarely detected in BC. It has previously been documented in northeastern BC and in the Skagit valley (BC Conservation Data Centre 2014a; Klinkenberg 2012c; Nagorsen and Paterson 2012).

4.18 Fisher

4.18.1 Survey Results

4.18.1.1 Snow-Tracking Surveys

Snow-tracking surveys took place on March 20-22, 2008 and March 30-April 2, 2011. Heavy snowfall prior to and during the surveys on March 20-21, 2008 resulted in suboptimal tracking conditions; animal movement tends to be reduced during periods of heavy snowfall and tracks are quickly obscured (Wolfhound Wildlife Services 2008). On March 22, 2008 and during all surveys in 2011, survey conditions met RISC standards (ibid.).

Seven mammal species were observed on the snow-tracking surveys conducted in 2008 (Table 36), as well as tracks of one unidentified weasel. Tracks of eleven mammal species and a number of unidentified weasels were observed during 2011 surveys (Table 37).

Table 36: Sets of Mammal Tracks Observed During 2008 Snow Tracking Surveys

Species	Transect 1	Transect 2	Transect 3	Harper Creek FSR	Saskum Lake FSR
Deer Mouse					2
Moose				1	1
Marten	2		2	3	2
Snowshoe Hare		1			4
Red Squirrel	3	8	5	20	24
Coyote					3
Weasel	1				
Red Fox				1	

Surveys in 2008 did not detect any fisher tracks, but in 2011 three sets of fisher tracks were recorded in the LSA. Two of these were recorded along Transect 1, while the third was observed along the Harper Creek FSR. Figure 17 shows the locations of snow tracking transects; exact observation locations were not recorded.

Table 37: Sets of Mammal Tracks Observed During 2011 Snow Tracking Surveys

Species	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Harper Creek FSR
Deer Mouse					1	
Moose			3			1
Marten	8		1		4	10
Snowshoe Hare	47		27			55
Red Squirrel	17		20	1	5	74
Weasel	6				4	9
Red Fox	1					
Wolverine						4
Lynx						1
Wolf			10			
Fisher	2					1
Mule Deer			1			

4.19 Grizzly Bear

4.19.1 Survey Results

4.19.1.1 Habitat Suitability Mapping

The LSA experiences a late snowmelt, sometimes not seeing upper elevations within the ESSF snowfree until well into June or later in some years. This limits potential spring forage to low elevations (Figure 29), which within the LSA are dominated by human presence around the town of Vavenby. These factors combine to limit spring grizzly bear forage opportunities, and only 120.1 ha of suitable (Classes 1-3) habitat for grizzly spring feeding were identified in the LSA (Table 38).

Suitable habitat (Classes 1-3) for summer grizzly feeding within the LSA is mapped as berry-producing habitats, avalanche slopes, and higher-elevation wetlands (Figure 30). A total of 2230.0 ha of suitable habitat was mapped within the LSA (Table 38).

Table 38: Habitat Suitability Summary for Grizzly Bear in the LSA

Class	Feeding-Spring	Feeding-Summer	Feeding-Fall
1	1.3	29.5	0.0
2	5.1	92.7	754.4
3	113.7	2107.8	3639.2
4	1583.9	7224.6	4569.3
5	3758.6	1275.3	1766.9
6	5558.7	291.4	291.5
Total	11021.3	11021.3	11021.3

Suitable (Classes 1-3) fall habitat for grizzly bear is mainly located at higher elevations in the LSA for the presence of late-summer and early-fall berry crops, and small mammal prey in high-elevation meadows (Figure 31). A total of 4,393.6 ha of suitable fall feeding habitat was identified (Table 38).

4.19.1.2 Grizzly Bear Den Surveys

Surveys were conducted on April 15, April 29, and July 23, 2012 to search for evidence of grizzly bear denning in the RSA. One den was observed while flying past Dunn Peak Protected Area (Plate 1) on April 29, through observation of grizzly tracks in the snow leaving the den. A ground visit could not be made at the time due to unsafe snow conditions.

The den was revisited on July 23, following snowmelt, for a ground visit with the goal of confirming it as a den and characterizing it. Upon examination, the den consisted of a natural cavity between several large rocks (Plate 2), and contained evidence of grizzly use including clumps of hair left at several locations within the den. Dunn Peak Protected Area is several kilometres away from the LSA (Figure32).

Plate 1: Grizzly Bear Den from Helicopter

Plate 2: Grizzly Bear Den Entrance

No dens were observed within the LSA. Grizzly bears typically den on steep sloves at high elevations, near the treeline (Gyug et al. 2004). Most of the LSA is located below the treeline.

4.19.1.3 Road Density Analysis

The results of the road density analysis showed a high (1.21-2.40 km/km^2) or very-high (>2.40 km/km^2) baseline road density for 81.7% of the LSA (Table 39). Areas with low or no road density were mainly concentrated along the southern and western boundaries of the LSA and within the area of the proposed TMF footprint (Figure 33).

Table 39: Road Densities in Local Study Area

Category	Road Density (km/km^2)	Area (ha)	Percent of Total
None	0	538.6	4.9
Low	0.01-0.60	646.3	5.8
Moderate	0.61-1.20	841.5	7.6
High	1.21-2.40	2,783.0	25.1
Very High	>2.40	6,275.1	56.6

4.19.1.4 Incidental Observations

Grizzly bear tracks were observed at an unknown location within the LSA during baseline surveys by Summit in 2008 (Summit Environmental Consultants Ltd 2009), and one set of grizzly bear tracks were recorded along a road during baseline surveys by Keystone in 2011 (Figure 32).

4.19.2 Discussion

Grizzly bears within the LSA are part of the Columbia-Shuswap Grizzly Bear Population Unit (GBPU). This GBPU is classified as viable by the BC Government and was estimated in 2012 to have 346 grizzlies within it, and a density of 20-30 bears per 1,000 km^2 (BC Ministry of Forests, Lands and Natural Resource Operations 2012). The portion of the GBPU within which the LSA is located was closed to grizzly bear hunting in 2012 (ibid.).

The LSA contains suitable habitat for grizzly bears in spring, summer and fall. Some use has been observed within the LSA during baseline surveys as well as by First Nations (Simpcw First Nation 2012). Denning has been confirmed at one location in an area adjacent to the LSA, but no suitable denning habitat is found within the LSA itself.

Road densities are high within most of the LSA. This likely negatively affects grizzly use in the LSA, as grizzly bears typically avoid areas with high road densities (Apps and Hamilton 2002; Ross 2002).

4.20 Moose

4.20.1 Survey Results

4.20.1.1 Habitat Suitability Mapping

Habitat suitability mapping identified feeding habitat for moose in the growing season to be limited withn the LSA, mainly restricted to higher elevation shrubby wetlands (Figure 34). In total, 72.6 ha of suitable (Classes 1-3) growing season feeding habitat for moose was identified (Table 40). Moose are primarily browsers, and many of the wetlands and meadows within the LSA are dominated by herbaceous vegetation which makes them of much lower suitability for feeding.

Table 40: Habitat Suitability Summary for Moose Growing Season Habitat in the LSA

Class	Feeding-Growing Season	Security/Thermal-Growing Season
1	0.0	0.0
2	15.9	204.4
3	56.7	7997.2
4	5670.6	2091.0
5	4568.5	19.1
6	709.6	709.6
Total	11021.3	11021.3

Suitable security/thermal habitat (Classes 1-3) for moose in the growing season is common throughout the LSA (Figure 35). A total of 8,201.6 ha of suitable habitat (74.4% of the LSA) was identified (Table 40).

4.20.1.2 Snow-Tracking Surveys

As described in Section 4.18.1.1, snow tracking surveys took place on March 20-22, 2008 and March 30-April 2, 2011. Heavy snowfall prior to and during the surveys on March 20-21, 2008 resulted in suboptimal tracking conditions; animal movement tends to be reduced during periods of heavy snowfall and tracks are quickly obscured (Wolfhound Wildlife Services 2008). On March 22, 2008 and during all surveys in 2011, survey conditions met RISC standards (ibid.).

Surveys in 2008 detected one set of moose tracks along Harper Creek FSR, and a second set along Saskum Lake FSR. In 2011, an additional four sets of moose tracks were observed, including three along Transect 3 and one set on the Harper Creek FSR. Figure 17 shows the locations of snow tracking transects; exact track observation locations were not recorded.

4.20.1.3 CMWR Analysis

A total of 1,012.4 ha of CMWR is located within the LSA. All of this is found at low-elevation areas along the valley bottom of the North Thompson River (Figure 4).

4.20.2 Discussion

Moose distribution within the LSA appears to be seasonally-dependent. During the winter, snow conditions typically limit moose to lower-elevation areas in the ICH and IDF, where the CMWR has been designated. Snow depths greater than 90 cm can severely restrict moose movement in an area (Ungulate Winter Range Technical Advisory Team 2005), and depths within the ESSFwc2 can typically be 200-300 cm. This assertion is consistent with observations made during winter track surveys, where all moose tracks observed were along lower-elevation survey transects.

During the growing season, moose distribution is expected to be less-concentrated, spreading throughout the LSA. Security/thermal habitat is common in the LSA and likely not limiting. However growing season forage habitats, according to the habitat suitability mapping, may be more restricted. Higher-suitability foraging habitat was mapped as moist or wet sites (moist forests, wet forests, wetlands, etc.) with browsing or grazing opportunities (structural stages 2-3, and to a lesser extent 6-7), and limited suitable habitat was identified. Some of this suitable foraging habitat was identified as the wetlands located within the proposed TMF footprint.

4.21 Mountain Caribou

4.21.1 Survey Results

4.21.1.1 Habitat Suitability Mapping

Five life requisites were mapped for mountain caribou habitat suitability as a part of the baseline (Table 41). Four of these were seasonal feeding habitats, to reflect changing distribution and forage items throughout the year.

Table 41: Habitat Suitability Summary for Mountain Caribou in the LSA

Class	Feeding-Early Winter	Feeding-Late Winter	Feeding-Spring	Feeding-Summer/Fall	Security/ Thermal
1	51.3	1442.7	0.0	22.9	1546.1
2	1645.1	1271.4	238.6	91.4	1118.9
3	405.3	454.1	1445.6	514.8	1567.2
4	3517.4	1618.8	6472.0	7302.1	3626.9
5	5107.7	4083.7	2570.6	992.0	2867.7
6	294.5	2150.6	294.5	2098.1	294.5
Total	11021.3	11021.3	11021.3	11021.3	11021.3

Early winter foraging habitats were mapped primarily at mid-elevations within the LSA (Figure 36), with approximately 2,101.7 ha of suitable (Classes 1-3) habitat available within the LSA.

Late-winter habitats were mapped at higher elevations than early-winter habitats (Figure 37), reflecting the movement of caribou to higher elevations where deeper snow improves access to arboreal lichens. A total of 3,168.2 ha of suitable (Classes 1-3) late-winter feeding habitat was mapped in the LSA.

During the spring, caribou move back to lower elevations to obtain fresh, green vegetation in the first areas free of snow (Figure 38). A total of 1,684.2 ha of suitable (Classes 1-3) habitat was mapped for this season. No high-suitability habitat was mapped in the LSA due to the lack of lower-elevation wetlands, riparian forests, and other moist sites with extensive forb and graminoid vegetation.

Summer/fall habitat is the least common feeding habitat in the LSA, as many caribou will move up to higher-elevation sites with herbaceous vegetation present (Figure 39). A total of 629.1 ha of suitable (Classes 1-3) habitat was mapped for this season.

Security/thermal habitat within the LSA is common, with 4,232.2 ha of suitable (Classes 1-3) habitat available. It is distributed throughout the LSA, wherever mature or old forest are present (Figure 40). This model of security/thermal habitat suitability does not account for the effects of forest fragmentation.

4.21.1.2 Snow-Tracking Surveys

Snow-tracking surveys within the LSA are described in Section 4.18.1.1. During surveys in 2008 and 2011, no caribou tracks were observed along any transect.

4.21.1.3 Road Density Analysis

The results of the road density analysis are reported in Section 4.19.1.3.

4.21.1.4 Incidental Observations

A single set of caribou tracks were reported at an unspecified location along Harper Creek FSR by Summit (2009), observed during baseline surveys in 2008. In 2011, an additional two sets of caribou tracks were identified within the LSA by Keystone (Figure 41).

4.21.2 Discussion

The LSA contains approximately 3,093 ha of old-growth forest, and an additional 2,413 ha of mature forest (see Section 4.4.1.1). Caribou are typically associated with old-growth forest, and this association is apparent within the habitat suitability mapping. In particular, late winter foraging habitat is very common in the LSA due to the presence of old-growth forest and the opportunities it provides for lichen forage.

However, the habitat suitability mapping does not account for the effects of human presence and forest fragmentation on caribou. As seen in the road density analysis, the LSA has been heavily fragmented by roads (Figure 33), and old-growth forest has been further fragmented by forest harvesting (Figure 22).

Mountain caribou prefer large, contiguous patches of old forest, which provide security and thermal shelter, as well as food resources (Cichowski et al. 2004). Southern mountain caribou typically avoid roads due to mortality, disturbance and habitat alteration (Environment Canada 2014). The limited observations of caribou sign within the LSA during baseline surveys as well as historically indicate very low use of the Project site likely due to road density, and timber harvesting resulting in extensive habitat fragmentation.

4.22 Mountain Goat

4.22.1 Survey Results

4.22.1.1 Snow-Tracking Surveys

Snow-tracking surveys within the LSA are described in Section 4.18.1.1. During surveys in 2008 and 2011, no mountain goat tracks were observed along any transects.

4.22.2 Discussion

No mountain goats have been observed within the LSA during any field surveys for the Project.

4.23 Mule Deer

4.23.1 Survey Results

4.23.1.1 Snow-Tracking Surveys

Snow-tracking surveys within the LSA are described in Section 4.18.1.1. Surveys in 2008 did not detect any mule deer tracks along the survey transects. In 2011, one set of mule deer tracks were recorded along Transect 3. Figure 17 shows the locations of snow tracking transects; exact observation locations were not recorded.

4.23.1.2 CDWR Analysis

A total of 355.6 ha of CDWR is located within the LSA. All of this is found at low-elevation areas along the valley bottom of the North Thompson River (Figure 7).

4.23.2 Discussion

Mule deer distribution within the LSA is likely seasonally-dependent similar to moose. Snow depth has an even greater effect on deer distribution than moose (Ungulate Winter Range Technical Advisory Team 2005), and thus the snow depths within the ESSF are expected to be too deep for deer in most years. Deer are likely concentrated within the CDWR during this time.

During the growing season, mule deer are expected to be well-distributed in the LSA due to their adaptability and diverse habitat preferences (Shackleton 1999).

4.24 Wolverine

4.24.1 Survey Results

4.24.1.1 Snow-Tracking Surveys

Snow-tracking surveys within the LSA are described in Section 4.18.1.1. No wolverine tracks were recorded during surveys in 2008. In 2011, four sets of wolverine tracks were observed along the Harper Creek FSR transect. Figure 17 shows the locations of snow tracking transects; exact observation locations were not recorded.

4.24.1.2 Road Density Analysis

The results of the road density analysis are reported in Section 4.19.1.3.

4.24.2 Discussion

At the stand scale, wolverines generally show limited selection for specific habitat types for meeting their life history requirements, with the exception of denning habitat (Hatler 1989; BC Ministry of Water, Land and Air Protection 2004a). This may be due to their wide-ranging nature; wolverine home ranges can be very large (Hornocker and Hash 1981; Gardner 1985; Magoun 1985; Whitman et al. 1986; Banci 1987; Krebs and Lewis 2000), with reported values ranging from 76 km^2 (Banci and Harestad 1990) to 1,582 km^2 (Copeland 1996).

Natal den sites are generally located at or near the treeline (Copeland and Yates 2008) in open (*i.e.*, non-forested), high-elevation cirque basins, or forested ravines (Copeland 1996; Magoun and Copeland 1998; Krebs and Lewis 2000; BC Ministry of Water, Land and Air Protection 2004a), with deep snow cover (Magoun and Copeland 1998; Aubry et al. 2007). Magoun and Copeland (1998) found that wolverines don't generally den in closed forests.

Most of the LSA is dominated by closed-canopy forests with the exception of the ESSFwcp (parkland) at the southern tip, as the elevation climbs towards alpine habitats further outside the LSA (Figure 41). The dominance of closed-canopy forests limits the potential for wolverine denning within the LSA itself.

As evidenced by the observations of wolverine during snow-tracking transects, wolverine are known to use the LSA. However, wolverine generally avoid human activities (*e.g.*, Carroll *et al.* 2001, Rowland et al. 2003, May et al. 2006, all as cited in (Copeland et al. 2007; Krebs et al. 2007), and the presence of high road density throughout the LSA permits easy access for many users. This easy access likely has some displacement effect on wolverine baseline distribution.

5.0 CONCLUSIONS

Baseline studies for the Project assessed 28 separate terrestrial VCs. This assessment included identifying, where possible and applicable the presence, distribution, and relative abundance of these VCs and their habitat.

Within the LSA 40 rare plant species have been confirmed to occur, including nine vascular species, six moss species and 25 lichen species. Eight of these species have confirmed occurrences within proposed Project footprints. The majority of occurrences are within the TMF footprint at the Project site area.

Three ECAR potentially occur in the LSA, based on the presence of site series that support these ECAR. Two of these ECAR potentially occur at the Project site in and around the open pit, TMF, mine access road, and non-PAG waste rock footprints. The third ECAR potentially occurs along the valley bottom of the North Thompson River, with small portions located along the mine access road footprint.

The LSA contains approximately 208 ha of wetlands, most of which is located within and adjacent to the Project site area. The proposed TMF footprint overlaps much of this wetland area. Placed in a regional context by comparing wetland proportions within the LSA to those within the RSA, the LSA contains a disproportionately large amount of wetland area, which may indicate that it is an important area for wetland representation on the landscape.

Old-growth forests are common within the LSA, making up almost 1/3rd of the total area. However these forests have been fragmented by road building and associated forest harvesting that has occurred in the past and is ongoing.

No rock outcrops have been observed or mapped within the LSA. No butteflies, damselflies or dragonflies of conservation concern were identified in the LSA.

Western toads occur throughout the LSA, and are considered to be relatively common throughout. Breeding sites were confirmed at higher elevations, within the Project site area and in particular within the TMF. It is expected that additional breeding sites are available at lower elevations, based on habitat suitability mapping and typical dispersal distances of western toads compared to observations of adults, but no additional sites were confirmed.

Barn Swallow and Common Nighthawk habitat and use is concentrated at low elevations of the LSA, near the North Thompson River. These migratory birds are not present in the LSA year-round.

No Great Blue Herons were observed during baseline studies, and very minimal suitable nesting habitat was identified. This species may not be present within the LSA.

No Harlequin Ducks were observed in the LSA. Suitable habitat was identified by field surveyors along Harper Creek. The presence of suitable habitat indicates the species may occur in the LSA, but may not have been present during the year of surveys.

One active Bald Eagle nest was observed along the valley bottom of the North Thompson River, at the western edge of the LSA and away from any Project footprints. Additional suitable nesting habitat was identified along the valley bottom as well.

Northern Goshawks were observed within the LSA, and suitable nesting habitat identified primarily at lower elevations. No nest sites were observed.

No Western Screech-owls were observed in the LSA. The nearest known observation of a Western Screech-owl is near Kamloops, approximiately 150 km away. This species may not be present within the LSA.

Of the five bat species identified as VCs three were confirmed to be present within the LSA: fringed myotis, little brown myotis, and northern myotis. Fringed myotis appears to exist in low densities within the LSA, while little brown myotis and northern myotis are much more common and found throughout. The remaining two bat species, Townsend's big-eared bat and western small-footed myotis, were not observed and may not be present. Eastern red bat was confirmed in one acoustic recording. This species is migratory and little is known about its full range, habitat preferences or migration habits.

Grizzly bear sign was observed on several occasions during baseline studies, and suitable spring, summer and fall feeding habitat is available in the LSA. One grizzly bear den was observed several km away from the LSA, within Dunn Peak Protected Area, but no denning habitat appears to be present in the LSA itself. Grizzly bears are expected to use most of the LSA, but likely at lower densities than habitat suitability alone would predict based on the high road densities and human use in the LSA.

Moose and mule deer distributions are greatly affected by snow depths in the winter. Most individuals of these species concentrate within the valley bottoms in the winter to avoid deep snow, which can be energetically taxing. During the growing season, these species are likely distributed throughout the LSA.

Mountain caribou appear to use the LSA infrequently. The species is highly-associated with old-growth forests, which comprise almost 1/3rd of the LSA. However, much of the old-growth is fragmented by logging and road development, greatly reducing its effectiveness as mountain caribou habitat. Of the habitat remaining, much of it is fragmented and located in the Project site area and surroundings.

Mountain goats have not been recorded within the study area during baseline surveys. The nearest GWR is located several kilometres to the south of the LSA, in the Harper Creek valley.

Baseline studies recorded wolverine sign within the LSA. This species has a large home range size, traveling extensively throughout much of the year in search of prey. They show limited habitat selection with the exception of denning habitat, of which the majority of the LSA is at elevations too low for typical wolverine denning. Road development and ongoing anthropogenic activities within the LSA likely negatively affect wolverine use of the area through ongoing displacement.

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7.0 APPENDICES

Appendix 1: Rare Plants Potentially Occurring within the Local Study Area

Species	BC List[1]	SARA[2]	COSEWIC[3]	BC Status[4]	Global Status[5]
VASCULAR PLANTS					
Agoseris lackschewitzii (pink agoseris)	Blue			S2S3	G4
Antennaria corymbosa (flat-top pussytoes)	Red			S1	G5
Azolla mexicana (Mexican mosquito fern)	Red	1-T	T	S2	G5
Botrychium ascendens (upswept moonwort)	Red			S2	G3
Botrychium crenulatum (dainty moonwort)	Blue			S2S3	G3
Botrychium hesperium (western moonwort)	Blue			S2S3	G4
Botrychium lineare (Linear-leaf moonwort)	Red			S1	G2?
Botrychium montanum (mountain moonwort)	Red			S1S2	G3
Botrychium paradoxum (two-spiked moonwort)	Red			S1S2	G3G4
Botrychium pedunculosum (stalked moonwort)	Red			S2	G2G3
Botrychium simplex var. compositum (least moonwort)	Blue			S2S3	G5TNR
Botrychium spathulatum (spoon-shaped moonwort)	Red			S1	G3
Carex adusta (lesser brown sedge)	Red			S1	G5
Carex comosa (bearded sedge)	Red			S2	G5
Carex praeceptorum (teacher's Sedge)	Red			S1S3	G4G5
Carex scopulorum var. prionophylla (saw-leaved sedge)	Red			S2	G5T3?

Species	BC List[1]	SARA[2]	COSEWIC[3]	BC Status[4]	Global Status[5]
Carex tenera (tender sedge)	Blue			S2S3	G5
Draba cinerea (gray-leaved draba)	Blue			S2S3	G5
Draba densifolia (Nuttall's draba)	Blue			S2S3	G5
Draba fladnizensis (Austrian draba)	Blue			S2S3	G4
Draba lonchocarpa var. vestita (lance-fruited draba)	Blue			S2S3	G5T3Q
Draba ruaxes (coast mountain draba)	Blue			S2S3	G4
Draba ventosa (Wind River draba)	Blue			S2S3	G3
Dryopteris cristata (crested wood fern)	Blue			S2S3	G5
Epilobium davuricum (northern swamp willowherb)	Red			S1S3	G5
Epilobium halleanum (Hall's willowherb)	Blue			S2S3	G5
Epilobium oregonense (Oregon willowherb)	Blue			S2S3	G5
Epilobium saximontanum (Rocky Mountain willowherb)	Red			S1S3	G5
Impatiens aurella (orange touch-me-not)	Blue			S2S3	G4?
Isoetes bolanderi (Bolander’s quillwort)	Red		T	S1S2	G4
Juncus stygius (bog rush)	Blue			S2S3	G5
Mitella caulescens (leafy mitrewort)	Blue			S2S3	G5
Pellaea gastonyi (Gastony's cliff-brake)	Blue			S2S3	G2G3
Pinus albicaulis (whitebark pine)	Blue	1-E	E	S2S3	G3G4
Salix boothii (Booth's willow)	Blue			S2S3	G5
Stellaria obtusa (blunt-sepaled starwort)	Blue			S2S3	G5

Species	BC List[1]	SARA[2]	COSEWIC[3]	BC Status[4]	Global Status[5]
MOSSES					
Andreaea sinuosa (small-spored rock-moss)	Red			S1S2	G2
Atrichum tenellum (slender smoothcap)	Blue			S2S3	G4G5
Bartramia halleriana (Haller's apple-moss)	Red	1-T	T	S2	G4G5
Claopodium pellucinerve (no common name)	Red			S1S2	G3G5
Dicranum flagellare (whip heron's-bill moss)	Blue			S3	G5
Dicranum montanum (mountain heron's-bill moss)	Blue			S3	G5
Encalypta brevipes (no common name)	Blue			S2S3	G3
Grimmia mollis (no common name)	Blue			S2S3	G5
Orthotrichum cupulatum (hooded bristle-moss)	Blue			S2S3	G4G5
Orthotrichum hallii (no common name)	Red			S2	G4
Schistidium venetum (no common name)	Red			S1	GNR
Sphagnum jensenii (no common name)	Red			S1S2	GU
Steerecleus serrulatus (no common name)	Red			S1S2	G5
Ulota curvifolia (no common name)	Blue			S3	G3G5
Warnstorfia tundrae (no common name)	Red			S2	GU
LICHENS					
Ahtiana sphaerosporella (whitebark candlewax)	Blue			S2S3	G5
Baeomyces carneus (scale beret)	Red			S1	GNR
Catolechia wahlenbergii (tundra lemon)	Red			S1	G3G5

Species	BC List[1]	SARA[2]	COSEWIC[3]	BC Status[4]	Global Status[5]
Cladonia cyanipes (greater greenhorn)	Blue			S2S4	GNR
Cladonia luteoalba (lemon thatch)	Blue			S2S3	G2G3
Cladonia parasitica (fence-rail thatch)	Red			S1S2	G3G5
Collema bachmanianum (tar tarpaper)	Red			S2	GNR
Collema cristatum var. marginale (fingered tarpaper)	Red			S2	G3G5TNR
Collema polycarpon (shaly tarpaper)	Red			S2	GNR
Dermatocarpon atrogranulosum (charred stippleback)	Red			S1	GNR
Dermatocarpon leptophyllodes (jigsaw stippleback)	Blue			S2S4	GNR
Dermatocarpon moulinsii (shag stippleback)	Red			S1	GNR
Fuscopannaria aurita (eared crackers)	Blue			S2S3	G3G5
Hypogymnia canadensis (canuckle bone)	Blue			S3	GNR
Hypogymnia recurva (recoiling bone)	Red			S1S3	GNR
Lasallia pensylvanica (blistered rocktripe)	Blue			S3	G3G5
Lempholemma polyanthes (chewing-gum tar)	Blue			S2S3	GNR
Leptogium intermedium (fourty-five vinyl)	Blue			S2S3	GNR
Leptogium plicatile (starfish vinyl)	Blue			S3?	G3?
Leptogium tenuissimum (lilliput vinyl)	Red			S2?	GNR
Nephroma helveticum ssp. helveticum (dog's paw)	Blue			S3	G4G5TNR
Parmeliella parvula (poor-man's crisps)	Blue			S2S3	GNR

Species	BC List[1]	SARA[2]	COSEWIC[3]	BC Status[4]	Global Status[5]
Peltigera castanea (chestnut pelt)	Red			S1	GNR
Peltigera gowardii (waterfan)	Red		SC	S1S2	G4GNR
Phaeophyscia adiastola (granulated shadow)	Red			S1	G4?
Phaeophyscia decolor (lesser eye shadow)	Blue			S2S3	G3G5
Phaeophyscia kairamoi (whiskered shadow)	Blue			S3	G3G4
Phaeophyscia nigricans (one-horse shadow)	Red			S1	G4
Physciella chloantha (downside shade)	Blue			S3	G5?
Placynthium stenophyllum var. isidiatum (sepia ink)	Blue			S3	G2G4T2T4
Santessoniella saximontana (mountain dust bunnies)	Red			S1	G1
Solorina bispora (lesser tundra owl)	Blue			S2S3	G3G5
Solorina octospora (greater tundra owl)	Blue			S3	G3G5
Solorina spongiosa (fringed owl)	Red			S2	G4G5
Stereocaulon glareosum (alpine soil-foam)	Blue			S2S3	G5
Stereocaulon symphycheilum (two-toned foam)	Red			S1S2	G3
Synalissa symphorea (eyed rockgorgon)	Blue			S3	GNR
Thallinocarpon nigritellum (black rocklicorice)	Blue			S3	G4G5
Thyrea confusa (candied gummybear)	Blue			S2S3	G3G5
Umbilicaria lambii (windward rocktripe)	Blue			S3	G2G4

Table Notes

BC List[1] (BC Conservation Data Centre 2014a):

Red List: Includes any ecological community, and indigenous species and subspecies that is extirpated, endangered, or threatened in British Columbia. Extirpated elements no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered elements are facing imminent extirpation or extinction. Threatened elements are likely to become endangered if limiting factors are not reversed. Red-listed species and sub-species may be legally designated as, or may be considered candidates for legal designation as Extirpated, Endangered or Threatened under the Wildlife Act. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.

Blue List: Includes any ecological community, and indigenous species and subspecies considered to be of special concern (formerly vulnerable) in British Columbia. Elements are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed elements are at risk, but are not Extirpated, Endangered or Threatened.

SARA[2] – Species at Risk Act (Government of Canada 2002):

1-E: Schedule 1 Endangered – the species is "...facing imminent extirpation or extinction"

1-T: Schedule 1 Threatened – the species is "...likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction"

1-SC: Special Concern – the species "...may become threatened or endangered because of a combination of biological characteristics and identified threats."

COSEWIC[3] – Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2012b):

E: Endangered – the species is "...facing imminent extirpation or extinction."

T: Threatened – the species is "...likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction."

SC: Special Concern – the species "...may become threatened or endangered because of a combination of biological characteristics and identified threats."

PREP: Status report for the species is in preparation

BC Status[4] and Global Status[5]: BCCDC and NatureServe rankings. 'S' ranks refer to the taxon's status in BC, while 'G' ranks refer to the taxon's global status. 'T' ranks are reserved for infraspecific taxa (subspecies and varieties). The number or letter following the 'S', 'G', or 'T' rank indicates the taxon's degree of rarity based on the following scale (NatureServe 2011):

X: Presumed Extinct—Not located despite intensive searches and virtually no likelihood of rediscovery.

H: Possibly Extinct—Missing; known from only historical occurrences but still some hope of rediscovery.

1: Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.

2: Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.

3: Vulnerable—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.

4: Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

5: Secure—Common; widespread and abundant.

U: Unrankable

NR: Unranked

Appendix 2: Local Study Area – Photos of Representative Habitat

Plate 3: IDF Dry Young Forest

Plate 4: IDF Dry Mature Forest

Plate 5: IDF Mesic Young Forest

Plate 6: IDF Moist Mature Forest

Plate 7: IDF Wet Young Forest

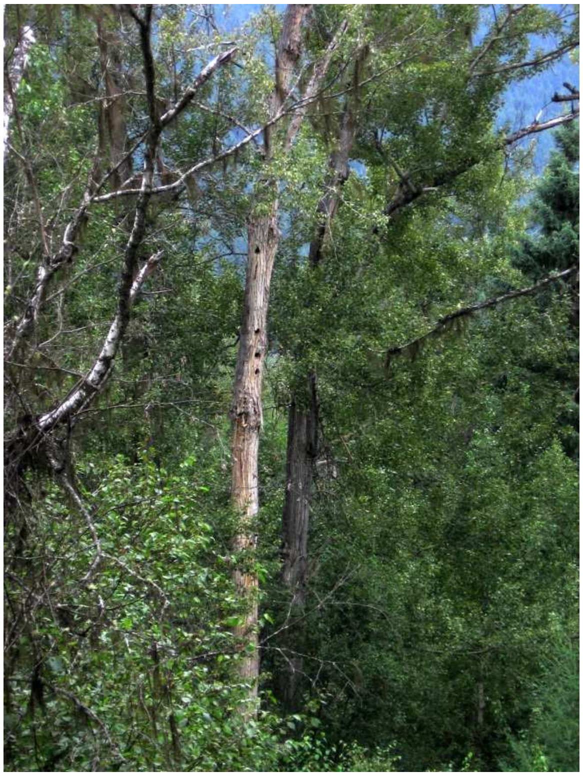

Plate 8: IDF Riparian Forest

Plate 9: IDF Grassland

Plate 10: IDF Anthropogenic Site (Closed Lumber Mill)

Plate 11: ICH Mesic Young Forest

Plate 12: ICH Mesic Mature Forest

Plate 13: ICH Moist Young Forest

Plate 14: ICH Moist/Wet Old-Growth Forest

Plate 15: ICH Shrub Avalanche Path

Plate 16: ESSF Dry Young Forest

Plate 17: ESSF Mesic Regenerating Forest

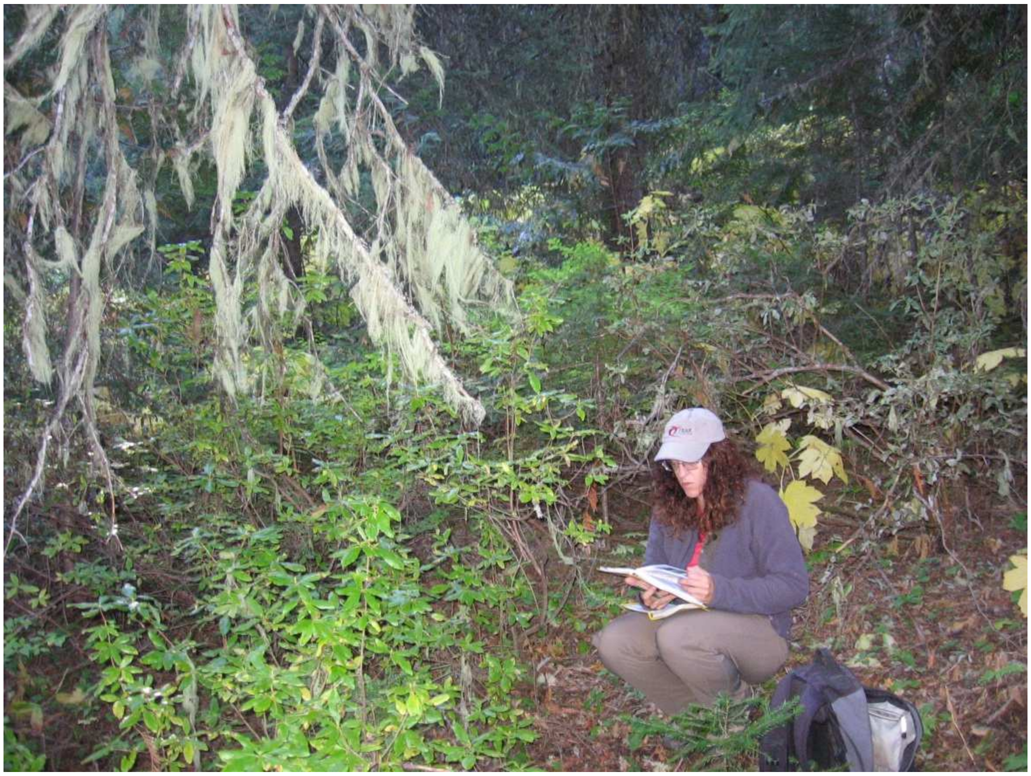

Plate 18: ESSF Moist Old-Growth Forest

Plate 19: ESSF Meadow

Plate 20: ESSF Wetland

Plate 21: Talus Slope

Appendix 3: Wildlife Habitat Ratings Species – Habitat Models

Western Toad

Species data

Latin Name: Anaxyrus boreas

Species Code: A-ANBO

Provincial Status: Blue-listed

COSEWIC-status: Special Concern (November 2012)

SARA-status: Schedule 1

Identified Wildlife: No

Ecology and Habitat Requirements

General

The western toad is a widely-distributed species within the province. It is identified by its dry, bumpy skin, conspicuous parotid glands at the back of its head, a cream or white dorsal stripe, and reddish warts all over its back and legs, which consist of poison glands that secrete a fluid that deters predators. Like all toads, it also has horny tubercles on its hind feet to assist it when digging burrows for escaping dryness or for hibernation (Green and Campbell 1984; Wind and Dupuis 2002).

Eggs of the western toad are laid in long strings that entwine amongst submerged vegetation, and when they hatch (6 to 8 weeks after fertilization) the tadpoles that emerge are small and black with a square snout that juts forward from their round body (Green and Campbell 1984; Corkran and Thoms 1996). These tadpoles form tight feeding clumps that eventually aggregate at the water's edge during transformation, possibly for thermoregulatory reasons (Green and Campbell 1984; Wind and Dupuis 2002).

Western toads use a broad spectrum of habitats within all BGC zones (Wind and Dupuis 2002), which can be separated into terrestrial habitat and aquatic habitat. Terrestrial habitat is utilized outside of the breeding season, and generally consists of moist forested areas, often located close to wetlands (Jones 1999). Aquatic habitats can be either natural or artificial, with toads showing a particular preference for shallow water with a sandy bottom (Green and Campbell 1984).

Western toad adults feed on a variety of invertebrates including worms, spiders, bees, beetles, ants, crayfish, grasshoppers, sow bugs, trichopterans, lepidopterans, and dipterans (Stebbins 1951; Verner and Boss 1980; Leonard *et al.* 1993; Sullivan 1994). Tadpoles, however, feed mostly on algae and detritus, and have also been known to feed on carrion (Wind and Dupuis 2002).

Foraging habitat for tadpoles is within breeding wetlands. Adult western toads forage on the surface of the ground or in burrows, waiting in these locations for prey to approach them unawares.

Distribution

Provincial Range

The western toad ranges from southern California up to southern Alaska, and extends inland from the coast to the Rocky Mountains. Within BC it occurs within most areas, except for being absent within the Taiga Plains Ecoprovince and the north-central Northern Boreal Mountains Ecoprovince (Wind and Dupuis 2002).

Western toads appear to be common to abundant throughout their range of occurrence within BC, and are likely most abundant within eastern Vancouver Island and the Lower Mainland (Wind and Dupuis 2002).

Distribution in the Project Area

Expected occurrence of western toads in the study area by BGC variant is summarized in Table 42.

Table 42: Expected western toad occurrence within the ecosection - BGC variant combinations found within the Project study area

Ecoprovince	Ecoregions	Ecosection	BGC Variants	Occurrence?
SIM	COH	NSH	ESSFwc2, ESSFwcp, ESSFwcw, ICHdw3, ICHmw3, ICHwk1, IDFmw2	Yes

Elevation Range

One of the few amphibians that occurs within the alpine regions of BC, the western toad can be found from sea level up to 3660m (Jones 2000).

Food/cover Life Requisites and Habitat-uses

Western toad breeding habitat, generally consisting of wetlands and small ponds, is important for the persistence of the species (Davis 2002). Because of this, and because of the limited availability of these types of sites on the landscape, reproducing habitat was the habitat that was rated for this species (Table 43).

Table 43: Life requisites that were rated for western toad for the Project

Life Requisite	Season	Months	Ratings Column Title
Reproducing-Eggs	N/A	Apr-Jul	AANBO_RE

Reproducing-Eggs

During the breeding season, western toads utilize a variety of aquatic habitats (both natural and artificial), including ponds, stream edges, lake margins, and ditches (Olson 1992; Reimchen 1992; Corkran and Thoms 1996; Gyug 1996). They have even been known to breed in small puddles in the middle of dirt roads (C. Albrecht, *pers. obs.*). The choice of aquatic habitats by toads shows no preference for specific quantities of canopy cover, course woody debris or emergent vegetation, and chosen habitats can be either temporary or permanent (Wind and Dupuis 2002), but the species definitely prefers shallow water with a sandy bottom (Green and Campbell 1984). Wind and Dupuis (2002) stated that wetlands that are relatively shallow and retain water for the three months from early spring until mid to late summer (for breeding) are ideal.

Seasons of Use

Western toads are explosive breeders, with breeding only lasting up to two weeks per year (at any given locality), and generally coinciding with maximum daily temperatures rising above 10°C (Wind and Dupuis 2002). This temperature dependence means that breeding initiation would be variable between years, and would be elevation dependent as well. In the Project area, breeding would generally be expected to occur between April and July (depending on elevation). Table 44 summarizes monthly life requisites that were rated for western toad for the Southern Interior Mountains ecoprovince.

Table 44: Monthly life requisites being rated for western toad for the Project

Month	Season*	Life Requisites
April	Winter	Reproducing-Eggs
May	Growing (Early Spring)	Reproducing-Eggs
June	Growing (Late Spring)	Reproducing-Eggs
July	Growing (Summer)	Reproducing-Eggs

*Seasons defined for the Southern Interior Mountains as per British Columbia Wildlife Habitat Rating Standards Version 2.0 (1999).

Habitat Use and Ecosystem Attributes

Table 45 summarizes the specific attributes that western toads utilize for reproducing.

Table 45: Summary of habitat attributes for western toad reproduction

Habitat Use	Specific Attributes for Suitable Western Toad Habitat	Structural Stage
Reproducing-Eggs	Presence of emergent vegetation (*e.g.*, grasses or sedges) within shallow, permanent or temporarily-inundated waterbodies, preferably with sandy substrates	2-3 (4-7)

Table 46 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 46: Ecosystem attributes used for western toad habitat mapping in the Project study area

Life Requisite	Mapping Attributes
Reproducing-Eggs	Regional: BGC variant Site: Site map code, structural stage

Wildlife Habitat Ratings

There is an intermediate level of knowledge on the habitat requirements of the western toad in British Columbia and thus, a 4-class rating scheme was used (Table 47).

Table 47: Habitat capability and suitability rating scheme (from RIC 1999)

% of Provincial Best	Rating	Class
76% - 100%	High	H
26% - 75%	Moderate	M
1% - 25%	Low	L
0%	Nil	N

Provincial Benchmark

No provincial benchmark has been identified for western toad. The following benchmark was used for the reproducing-eggs life requisite of the species:

Ecosection: Northern Shuswap Highlands (NSH)

Biogeoclimatic Zone: IDF (Interior Douglas-fir)

Habitats: Shallow, wetland sites with sandy substrates and abundant emergent vegetation

Habitat Ratings Model Assumptions

The assumptions used within the western toad habitat suitability model are presented in Table 48.

Table 48: Habitat suitability ratings assumptions for western toad – reproducing-eggs.

Attribute	Assumption
BGC variant	ICH and IDF will be rated up to class H
	ESSF will be rated up to class M
Site map code	OW, PD, Wf, Wm and Ws units will be rated up to class H
	Floodplain and wet forest units will be rated up to class L
	All other units will be rated class N
Structural stage	Structural stages 2-3 will be rated up to class H
	Structural stages 4-7 will be rated up to class M
	Structural stage 1 will be rated class N

Field Ratings Summary

One field plot was rated moderate for western toad, in a wet, structural stage 5 forest in the ICHmw3. In addition, western toads were observed along the roads and near wetlands and small lakes at all elevations of the Project area.

Table 49: Number of field ratings in each class for western toad

	H	M	L	N	Total
AANBO_RE	0	1	2	56	59

Rating Adjustments

No adjustments were required for the western toad habitat suitability model.

References

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Wind, El and L.A. Dupuis. 2002. COSEWIC status report on the western toad *Bufo boreas* in Canada, *in* COSEWIC assessment and status report on the western toad *Bufo boreas* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-31 pp.

Personal Communications and Observations

Albrecht, Chris. Biologist. Keystone Wildlife Research Ltd., Surrey, BC.

Bald Eagle

Species data

Latin Name: Haliaeetus leucocephalus

Species Code: B-BAEA

Provincial Status: Yellow-listed

COSEWIC-status: Not at Risk (May 1984)

SARA-status: None

Identified Wildlife: No

Ecology and Habitat Requirements

General

The Bald Eagle is a large bird of prey with a white head, white tail, brownish-black body, and a yellow bill. It occurs throughout North America, and is only absent from alpine and subalpine habitats (Campbell *et al.* 1990; Blood and Anweiler 1994).

Bald Eagles are generally associated with large waterbodies, including lakes, rivers, large wetlands, estuaries, and the ocean, as these habitats can generally provide abundant forage (Campbell *et al.* 1990; Blood and Anweiler 1994). Common food items for Bald Eagles consist of waterfowl and fish (Blood and Anweiler 1994), with ungulate carrion forming an important part of their winter diet in some areas (Swenson *et al.* 1986).

Nesting generally occurs in mature or old-growth forests located within 2 km of suitable foraging areas (Swenson *et al.* 1986; Buehler 2000). Large stick nests are constructed near the tops of trees that are dominant within the stand, to allow for direct flight access and good visibility from many sides (Campbell *et al.* 1990; Buehler 2000; Watts *et al.* 2006).

Nesting occurs between mid-February and the end of August (Campbell *et al.* 1990). One to three eggs are generally laid in early March, and hatch after just over a month of incubating (Blood and Anweiler 1994). Time to fledging is dependent on location, but generally occurs between late June and late August (ibid.).

Distribution

Provincial Range

The Bald Eagle occurs throughout the entire province, excluding alpine and subalpine areas (Campbell *et al.* 1990; Blood and Anweiler 1994).

Distribution in the Project Area

Blood and Anweiler (1994) ranked the IDF and ICH within the Southern Interior Mountains as having good habitat locally along valley bottoms. Expected occurrence of Bald Eagles in the study area by BGC variant is summarized in Table 50.

Table 50: Expected Bald Eagle occurrence within the ecosection - BGC variant combinations found within the Project study area

Ecoprovince	Ecoregions	Ecosection	BGC Variants	Occurrence ?
SIM	COH	NSH	ICHdw3, ICHmw3, ICHwk1, IDFmw2	Yes
SIM	COH	NSH	ESSFwc2, ESSFwcp, ESSFwcw	No

Elevation Range

Nesting has been observed from sea-level up to 1,370m, with non-breeding individuals observed up to 2,380m (Campbell *et al.* 1990). However, most Bald Eagles nest at low elevations (Blood and Anweiler 1994).

Food/cover Life Requisites and Habitat-uses

Nesting habitat is locally abundant along valley bottoms in the SIM, but not regionally abundant (Blood and Anweiler 1994). Therefore, reproducing habitat was chosen as the habitat to be rated for this species (Table 51).

Table 51: Life requisites that were rated for Bald Eagle for the Project

Life Requisite	Season	Months	Ratings Column Title
Reproducing-Eggs	N/A	Feb-Aug	BBAEA_RE

Reproducing-Eggs

Bald Eagles nest in mature to old forests in close proximity to waterbodies that provide suitable foraging opportunities (Buehler 2000). These waterbodies generally consist of large, low-gradient rivers, lakes, floodplains, large wetlands, and the ocean (Blood and Anweiler 1994). They construct stick nests in large, dominant trees with direct flight access and good visibility (Buehler 2000; Watts *et al.* 2006). Mature forests are used more than younger stands and adjacent foraging areas appear to be the key factor influencing reproductive success (Blood and Anweiler 1994; Watts *et al.* 2006). Successful nests are often reused and stick nests last an average of 5 years.

Seasons of Use

Nesting occurs between mid-February and the end of August (Campbell *et al.* 1990). One to three eggs are generally laid in early March, and hatch after just over a month of incubating

(Blood and Anweiler 1994). Time to fledging is dependent on location, but generally occurs between late June and late August (ibid.). Table 52 summarizes monthly life requisites that were rated for western toad for the Southern Interior Mountains ecoprovince.

Table 52: Monthly life requisites being rated for Bald Eagle for the Project

Month	Season*	Life Requisites
February	Winter	Reproducing-Eggs
March	Winter	Reproducing-Eggs
April	Winter	Reproducing-Eggs
May	Growing (Early Spring)	Reproducing-Eggs
June	Growing (Late Spring)	Reproducing-Eggs
July	Growing (Summer)	Reproducing-Eggs
August	Growing (Summer)	Reproducing-Eggs

*Seasons defined for the Southern Interior Mountains as per British Columbia Wildlife Habitat Rating Standards Version 2.0 (1999).

Habitat Use and Ecosystem Attributes

Table 53 summarizes the specific attributes that Bald Eagles utilize for reproducing.

Table 53: Summary of habitat attributes for Bald Eagle reproduction

Habitat Use	Specific Attributes for Suitable Bald Eagle Habitat	Structural Stage
Reproducing-Eggs	Mature or old-growth forest located adjacent to large waterbodies (*e.g.*, large rivers, lakes), with moderate-to-large diameter trees available	6-7

Table 54 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 54: Ecosystem attributes used for Bald Eagle habitat mapping in the Project study area

Life Requisite	Mapping Attributes
Reproducing-Eggs	Regional: BGC variant Site: Site map code, structural stage Vegetation: Tree species

Wildlife Habitat Ratings

There is an intermediate level of knowledge on the habitat requirements of the Bald Eagle in British Columbia and thus, a 4-class rating scheme was used (Table 55).

Table 55: Habitat capability and suitability rating scheme (from RIC 1999)

% of Provincial Best	Rating	Class
76% - 100%	High	H
26% - 75%	Moderate	M
1% - 25%	Low	L
0%	Nil	N

Provincial Benchmark

No provincial benchmark has been identified for Bald Eagle. The following benchmark was used for the reproducing-eggs life requisite of the species, based on information provided in Blood and Anweiler (1994):

Ecosection: Skidegate Plateau (SKP)

Biogeoclimatic Zone: CWH (Coastal Western Hemlock)

Habitats: Mature or old-growth coniferous forests composed of sitka spruce or Douglas-fir, located close to the ocean or large rivers, lakes, estuaries or wetlands

Habitat Ratings Model Assumptions

Based on the provincial benchmark proposed above the suitability of habitat for Bald Eagle reproduction in the Project area will be rated up to a maximum of Moderate (M). The assumptions used within the Bald Eagle habitat suitability model are presented in Table 56.

Table 56: Habitat suitability ratings assumptions for Bald Eagle – reproducing-eggs

Attribute	Assumption
BGC variant	IDF will be rated up to class M
	ICH will be rated up to class L
	ESSF will be rated class N
Site map code	Forested/treed units will be rated up to class M
	All other units will be rated class N
Structural stage	Structural stages 6-7 will be rated up to class M
	Structural stage 5 will be rated up to class L
	Structural stages 0-4 will be rated class N

Field Ratings Summary

Two plots were rated as moderate suitability for Bald Eagle, both mesic to moist older forests in the IDFmw2. The remainder of plots were mainly rated nil. One Bald Eagle nest was observed in the study area, and another just outside the study area, during field surveys for the Project.

Both of these nests were in cottonwood floodplain forests of the IDFmw2, along the North Thompson River near Vavenby.

Table 57: Number of field ratings in each class for Bald Eagle

	H	M	L	N	Total
BBAEA_RE	0	2	3	30	35

Rating Adjustments

No adjustments were required for the Bald Eagle habitat suitability model.

References

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Barn Swallow

Species data

Latin Name: Hirundo rustica

Species Code: B-BASW

Provincial Status: Blue-listed

COSEWIC-status: Threatened (May 2011)

SARA-status: None

Identified Wildlife: No

Ecology and Habitat Requirements

General

The Barn Swallow (*Hirundo rustica*) is a cosmopolitan member of the swallow family, Hirundinidae (Brown and Brown 1999). It is a small songbird that is metallic blue above and whitish to orange below, with a red throat, and a deeply forked tail. It is sexually dimorphic, with the male having a longer, more deeply forked tail (Pyle 1997).

It is found throughout North America, from central Yukon to Newfoundland and south to Mexico, although it is absent from the southeast and southwest United States (Brown and Brown 1999). It is a breeding visitor in North America, and is found in southern Mexico to Argentina in the winter. Recently some have been found in winter along the Pacific coast from California to BC (Brown and Brown 1999).

Ancestral breeding habitat of Barn Swallows consisted of mountainous and coastal areas that could provide caves, crevices, and occasionally hollow trees as nesting sites (Speich *et al*. 1986). Currently, breeding occurs in a wide variety of habitats, provided there are artificial structures on which it can attach its nests. Nesting occurs in buildings, bridges, culverts, or any other structure that has sheltered walls and ledges (Brown and Brown 1999). Nesting still occurs in caves, cliffs or crevices, although very rarely; <1% in British Columbia (Campbell *et al*. 1997). The species has been described as a facultative colony nester (*i.e.*, colony-nesting does not increase breeding success, and colonies are nothing more than a passive aggregation of nests; Snapp 1976).

Preferred foraging habitat for Barn Swallows usually includes large, open areas such as fields, meadows, and wetlands (Brown and Brown 1999). As a diurnal forager on flying insects, large grassy areas are frequently the most productive areas for obtaining food (ibid.). They generally forage lower to the ground or over water more often than most other swallows, which may be an adaptation to surviving in colder weather (ibid.).

Distribution

Provincial Range

The Barn Swallow is found across British Columbia during the breeding season, and occasionally on southern Vancouver Island and the Lower Mainland in winter (Campbell *et al*. 1997). It is most common across the southern two-thirds of the province and is less common from the northern third of the province and is often absent from highest elevations (Campbell *et al*. 1997).

Distribution in the Project Area

Expected occurrence of Barn Swallow in the study area by BGC variant is summarized in Table 58.

Table 58: Expected Barn Swallow occurrence within the ecosection - BGC variant combinations found within the Project study area

Ecoprovince	Ecoregions	Ecosection	BGC Variants	Occurrence ?
SIM	COH	NSH	ICHdw3, ICHmw3, ICHwk1, IDFmw2	Yes
SIM	COH	NSH	ESSFwc2, ESSFwcp, ESSFwcw	No

Elevation Range

Barn Swallows are known to nest up to 2400 m in the province (Campbell *et al*. 1997). They are primarily found in lower elevations, but this is mostly tied to greater human habitation at lower elevations (ibid.).

Food/cover Life Requisites and Habitat-uses

Although there are some records of Barn Swallows over wintering in BC, the species is generally considered to be a breeding visitant to the province (Campbell *et al*. 1997). Thus, reproducing habitat was the habitat that was rated for this species (Table 59).

Table 59: Life requisites that were rated for Barn Swallow for the Project

Life Requisite	Season	Months	Ratings Column Title
Reproducing-Eggs	N/A	Apr-Sept	BBASW_RE

Reproducing-Eggs

Barn Swallows require artificial structures for nesting (Campbell *et al*. 1997; Brown and Brown 1999). Rarely, they will also utilize natural features such as cliffs for nesting (ibid.). Adjacent areas for foraging, including fields, meadows and wetlands, are also considered very important (ibid.)

Seasons of Use

Barn Swallow is primarily a breeding visitor to British Columbia (Campbell *et al*. 1996). It has a long breeding season lasting from April to September, and it will often raise two broods in a season (ibid.). Table 60 shows how the life requisites being rated for Barn Swallow are divided up between months of the year.

Table 60: Monthly life requisites being rated for Barn Swallow for the Project

Month	Season*	Life Requisites
April	Winter	Reproducing-Eggs
May	Growing (Early Spring)	Reproducing-Eggs
June	Growing (Late Spring)	Reproducing-Eggs
July	Growing (Summer)	Reproducing-Eggs
August	Growing (Summer)	Reproducing-Eggs
September	Growing (Fall)	Reproducing-Eggs

*Seasons defined for the Southern Interior Mountains as per British Columbia Wildlife Habitat Rating Standards Version 2.0 (1999).

Habitat Use and Ecosystem Attributes

Table 61 summarizes the specific attributes that Barn Swallow utilize for reproducing.

Table 61: Summary of habitat attributes for Barn Swallow reproduction

Habitat Use	Specific Attributes for Suitable Barn Swallow Habitat	Structural Stage
Reproducing-Eggs	Artificial structures, such as buildings, bridges, etc.	N/A

Table 62 outlines how each life requisite relates to specific ecosystem attributes (*e.g.,* site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 62: Ecosystem attributes used for Barn Swallow habitat mapping in the Project study area

Life Requisite	Mapping Attributes
Reproducing-Eggs	Regional: BGC variant Site: Site map code

Wildlife Habitat Ratings

There is an intermediate level of knowledge on the habitat requirements of the Barn Swallow in British Columbia and thus, a 4-class rating scheme was used (Table 63).

Table 63: Habitat capability and suitability rating scheme (from RIC 1999)

% of Provincial Best	Rating	Class
76% - 100%	High	H

26% - 75%	Moderate	M
1% - 25%	Low	L
0%	Nil	N

Provincial Benchmark

No provincial benchmark has been identified for Barn Swallow. The following benchmark was used for the reproducing-eggs life requisite of the subspecies:

Ecosection: Fraser Lowland (FRL)

Biogeoclimatic Zone: CWH (Coastal Western Hemlock)

Habitats: Urban/rural areas with adjacent open areas, fields, meadows or wetlands.

Habitat Ratings Model Assumptions

The assumptions used within the Barn Swallow habitat suitability model are presented in Table 64.

Table 64: Habitat suitability ratings assumptions for Barn Swallow – reproducing-eggs

Attribute	Assumption
BGC variant	IDF will be rated up to class H
	ICH will be rated up to class L
	ESSF will be rated class N
Site map code	RW and UR units will be rated up to class H
	CL units will be rated up to class L
	All other units will be rated class N

Field Ratings Summary

Three plots were rated as high or moderate for Barn Swallow during field truthing in the Project area. The high-rated plot was located at the old Weyerhauser mill site in Vavenby, where Barn Swallows were observed nesting inside the mill buildings. The two moderate ratings were in cultivated fields with buildings located nearby, in the valley bottom near Vavenby.

Table 65: Number of field ratings in each class for Barn Swallow

	H	M	L	N	Total
BBASW_RE	1	2	0	55	58

Rating Adjustments

Mapping adjustments to habitat ratings were used to reflect the tendency of Barn Swallows to nest in proximity to fields, meadows, and wetlands. Adjustments used for the Barn Swallow habitat suitability model are presented in Table 66.

Table 66: Adjustments for the Barn Swallow habitat suitability model

Rating Life Requisite	Attribute	Adjustment
Reproducing-Eggs	Proximity to CF, OW, PD, and RI map units	Buffer features by 500 m and decrease ratings to a maximum of class L outside of the buffer

References

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Great Blue Heron

Species data

Latin Name: Ardea herodias herodias

Species Code: B-GBHE-HE

Provincial Status: Blue-listed

COSEWIC-status: None

SARA-status: None

Identified Wildlife: Yes (June 2006)

Ecology and Habitat Requirements

General

The Great Blue Heron is the largest wading bird in North America (Butler 1992). It has a long neck and bill, a short tail, and long, rounded wings. It has a blue-grey body, a white head, a yellow bill, and black stripes over its eyes.

Great Blue Herons initiate breeding in late-March in the interior (Gebauer and Moul 2001). Typically, three to five eggs are laid per nesting pair (BCMWLAP 2004), with those eggs hatching after an average of 27 days of incubation (Butler 1992). Juvenile development then takes a further two months before they leave the nest (BCMWLAP 2004).

Great Blue Herons utilize differing habitats for reproduction and feeding. Nesting habitat generally consists of mature forests within a variety of forest types, with nesting generally being colonial in nature. Colonies in BC are known to range in size from 2 to 472 nests per colony, with average colony sizes of 21-49 nests, depending on the region (Gebauer and Moul 2001). Proximity to suitable foraging areas is an important factor in placement of nesting colonies (Gibbs 1991; Butler 1992; Gebauer and Moul 2001) and often limits these colonies to lowland habitats. These lowland habitats are often also preferred for human habitation, and this has lead to decreases in forested areas that are suitable for nesting (Butler 1997; Gebauer and Moul 2001; BCMWLAP 2004), making this a possible limiting factor for the species.

With the exception of nesting habitat, Great Blue Herons are primarily a wetland-associated species, utilizing these types of habitats for the majority of their foraging needs (Campbell *et al.* 1990). Diet during the breeding season mainly consists of fish such as gunnels, sculpins, perch, bass, bullhead, and pumpkinseed (Forbes 1987; Butler 1995), with perch being the preferred prey for meeting energy requirements of the heron (Butler 1995). However they are a generalist, opportunistic predator, capturing secondary prey items such as other fish species, amphibians, reptiles, aquatic invertebrates, and small mammals of both wetland and upland habitats in order to supplements their preferred diet, especially during the winter months when energy requirements are lower (Forbes 1987; Butler 1995; Gebauer and Moul 2001). This opportunistic behaviour means that they can be found foraging in any number of different marine or inland wetland habitats, as well as in upland habitats such as agricultural fields.

Distribution

Provincial Range

The Great Blue Heron is widely distributed throughout southern BC, south of 52°N. Breeding mainly occurs within the Strait of Georgia on the coast, as well as in the southern interior (Campbell *et al.* 1990). Two subspecies are known to occur in the province, *A. h. fannini* (coastal subspecies) and *A. h. herodias* (interior subspecies).

Distribution in the Project Area

Expected occurrence of Great Blue Herons in the study area by BGC variant is summarized in Table 67.

Table 67: Expected Great Blue Heron occurrence within the ecosection - BGC variant combinations found within the Project study area

Ecoprovince	Ecoregions	Ecosection	BGC Variants	Occurrence ?
SIM	COH	NSH	IDFmw2	Yes
SIM	COH	NSH	ICHdw3, ICHmw3, ICHwk1, ESSFwc2, ESSFwcp, ESSFwcw	No

Elevation Range

Nesting has been observed from sea-level up to 1,100m, with non-breeding individuals observed up to 2,100m (Campbell *et al.* 1990). However, most herons occur close to sea level or in low-elevation valleys (BCMWLAP 2004).

Food/cover Life Requisites and Habitat-uses

Nesting habitat is likely a significant limiting factor for Great Blue Herons in BC. Because of this, reproducing habitat was the habitat that was rated for this species (Table 68).

Table 68: Life requisites that were rated for Great Blue Heron for the Project

Life Requisite	Season	Months	Ratings Column Title
Reproducing-Eggs	N/A	Mar-Oct	BGBHE_HE_RE

Reproducing-Eggs

Nest colonies are located in mature forests within a variety of coniferous, deciduous, or mixed-forest habitats, and can be found in contiguous forest, fragmented forest, and solitary trees (Butler 1997; Gebauer and Moul 2001). They are always located in close proximity to wetlands or estuaries, for foraging (Campbell *et al.* 1990; Butler 1991; Butler 1997; Gibbs and Kinkel 1997). Nesting colonies generally show a higher preference for black cottonwood as you move inland (Gebauer 1995).

Seasons of Use

Great Blue Herons are found in the province year-round (Campbell *et al.* 1990; Gebauer and Moul 2001). Reproduction is usually initiated with nest-building in March, with the first eggs being laid in April, and the last eggs being laid as late as early July (Campbell *et al.* 1990; Butler 1992; Gebauer and Moul 2001; BCMWLAP 2004). Egg incubation takes approximately 25 to 29 days (Harrison 1978; Ehrlich *et al.* 1988; Butler 1992), and subsequent fledging takes as much as two months (Ehrlich *et al.* 1988). Butler (1991) determined that fledglings become fully independent of their parents approximately three weeks after their first flight. Table 69 shows how the life requisites for Great Blue Heron are divided up between months of the year.

Table 69: Monthly life requisites being rated for Great Blue Heron for the Project

Month	Season*	Life Requisites
March	Winter	Reproducing-Eggs
April	Winter	Reproducing-Eggs
May	Growing (Early Spring)	Reproducing-Eggs
June	Growing (Late Spring)	Reproducing-Eggs
July	Growing (Summer)	Reproducing-Eggs
August	Growing (Summer)	Reproducing-Eggs
September	Growing (Fall)	Reproducing-Eggs
October	Growing (Fall)	Reproducing-Eggs

*Seasons defined for the Southern Interior Mountains as per British Columbia Wildlife Habitat Rating Standards Version 2.0 (1999).

Habitat Use and Ecosystem Attributes

Table 70 summarizes the specific attributes that Great Blue Herons utilize for reproducing.

Table 70: Summary of habitat attributes for Great Blue Heron reproduction

Habitat Use	Specific Attributes for Suitable Great Blue Heron Habitat	Structural Stage
Reproducing-Eggs	Mature or old-growth forest composed primarily of black cottonwood, with moderate to large-diameter trees	(5) 6-7

Table 71 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 71: Ecosystem attributes used for Great Blue Heron habitat mapping in the Project study area

Life Requisite	Mapping Attributes
Reproducing-Eggs	Regional: BGC variant Site: Site map code, structural stage

Wildlife Habitat Ratings

There is an intermediate level of knowledge on the habitat requirements of the Great Blue Heron in British Columbia and thus, a 4-class rating scheme was used (Table 72).

Table 72: Habitat capability and suitability rating scheme (from RIC 1999)

% of Provincial Best	Rating	Class
76% - 100%	High	H
26% - 75%	Moderate	M
1% - 25%	Low	L
0%	Nil	N

Provincial Benchmark

No provincial benchmark has been identified for Great Blue Heron. The following benchmark was used for the reproducing-eggs life requisite of the species:

Ecosection: Fraser Lowland (FRL)

Biogeoclimatic Zone: CWHdm (Coastal Western Hemlock-dry maritime)

Habitats: Mature or old-growth riparian forests composed of black cottonwood or red alder, located close to large estuaries or wetlands

Habitat Ratings Model Assumptions

The assumptions used within the Great Blue Heron habitat suitability model are presented in Table 73.

Table 73: Habitat suitability ratings assumptions for Great Blue Heron – reproducing-eggs

Attribute	Assumption
BGC variant	IDF will be rated up to class H
	ICH will be rated up to class L
	ESSF will be rated class N
Site map code	Act-leading units will be rated up to class H
	All other units will be rated class N
Structural stage	Structural stages 6-7 will be rated up to class H

	Structural stage 5 will be rated up to class M
	Structural stages 0-4 will be rated class N

Field Ratings Summary

No high ratings for Great Blue Heron reproducing habitat were identified during field surveys for the Project. Two plots were rated as moderate suitability, both in mature/old mesic to moist forest in the IDFmw2. Five low ratings were in young to mature, dry to mesic forest in the IDFmw2. No Great Blue Herons were observed during field surveys.

Table 74: Number of field ratings in each class for Great Blue Heron

	H	M	L	N	Total
BGBHE_RE	0	2	5	52	59

Rating Adjustments

No adjustments were required for the Great Blue Heron habitat suitability model.

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Northern Goshawk

Species data

Latin Name: Accipiter gentilis

Species Code: B-NOGO

Provincial Status: Yellow-listed

COSEWIC-status: None

SARA-status: None

Identified Wildlife: No

Ecology and Habitat Requirements

General

A forest-dwelling raptor, the Northern Goshawk (*Accipiter gentilis*) is characterized by short, rounded wings, a long tail, a conspicuous grey supercilium (on adults), a black crown and blue-grey back. It is considered a habitat generalist, because it uses a wide range of habitats and successional stages for meeting its needs (Cooper and Stevens 2000), and thus has been recorded in almost every forest type in the province (Campbell *et al.* 1990). It is found across a wide range of elevations, from near sea level up to near the tree line, using habitats including lakes, streams, avalanche tracks, agricultural areas, dry forests, average forests, wet forests, riparian forests, parkland and aspen copses to meet its life requirements (Stevens 1995). However, it is primarily a bird of mature or old-growth coniferous forests (see Cooper and Stevens 2000).

Nesting habitat includes stands of large, old trees, with dense canopy cover and relatively open understory (BC Environment 1997). They are typically found on gentle slopes, usually less than 30% and always less than 60% (BC Environment 1997). Optimum stand structure consists of mature or old-growth forests with high canopy closure, moderate tree density, large trees and open understorey (Hayward *et al.* 1983 Lilieholm *et al.* 1994; Siders and Kennedy 1994; Woodbridge and Deitrich 1994; Cooper and Stevens 2000). High canopy closure is considered very important, because it may provide protection from predators and promote more open spaces under the canopy and in the undergrowth that allows clear flight paths (Cooper and Stevens 2000).

Nesting occurs in a wide variety of forest-types, but is generally concentrated in areas with significant mature to old-growth forests (see Cooper and Stevens 2000). In general in BC, breeding habitat is mainly coniferous forests, including ponderosa pine, Douglas-fir, lodgepole pine, western hemlock, and various spruce spp., but deciduous or mixed forests dominated by trembling aspen and paper birch are also used for breeding (Campbell *et al.* 1990; Squires and Reynolds 1997).

Nest trees are often large, living coniferous or deciduous trees in mature stands (Campbell *et al.* 1990; Lilieholm *et al.* 1994). Nests are placed in the main crotches of trees, in forks of branches against the trunk or on broken tops of trees (Campbell *et al.* 1990). Goshawks have been found to nest in a wide variety of tree species in BC, including Douglas-fir, western hemlock, lodgepole pine, spruce, trembling aspen, red alder, balsam (true firs), western larch, ponderosa pine and black cottonwood (Campbell *et al.* 1990; Chytyk and Danwant 1997; Mahon and Franklin 1997; McClaren 1997).

Northern Goshawks prefer nesting on gentle to moderate slopes near valley bottoms, with high soil moisture content (Hayward *et al.* 1983; Iverson *et al.* 1996; Ethier 1999). Many nests have been reported to occur near perennial water sources (Reynolds *et al.* 1982; Campbell *et al.* 1990; Cooper and Stevens 2000), but this feature does not appear to be a requirement. In addition, Bosakowski and Speiser (1994) found that nest sites were significantly farther from human habitation and paved roads than random.

Foraging area typically comprises a wider range of habitats than nesting habitat (Cooper and Stevens 2000). Prey abundance and availability are believed to be the key attributes when considering foraging quality for goshawk habitat (Squires and Reynolds 1997). Microhabitat features that facilitate high quality foraging sites include 1) adequate prey, 2) sufficient cover to conceal the goshawk's approach, 3) low enough cover to facilitate access to the prey and flight maneuverability, and 4) suitable perches to hunt from (see Cooper and Stevens 2000). These habitat structures are most often found in mature or old-growth forests, with adequate CWD and other habitat features for higher prey abundance, sufficient canopy closure and shrub cover to hide the goshawks approach, structurally-varied and open vegetation to allow easier maneuverability, and a wide variety of perch sizes and heights. Goshawks may also use younger (ST=5) forest stands when they present some of these habitat features, but these habitats are less preferred than older forests (see Cooper and Stevens 2000).

The goshawk avoids open habitats when foraging, instead preferring to use sites with more and larger trees and increased canopy closure (BC Environment 1997). However, they do utilize edge habitats overlooking open areas for foraging, but to a lesser degree than old-growth forests (Campbell *et al.* 1988; Cooper and Stevens 2000). Open habitats that they use include creeks, rivers, lakeshores, lagoons, sea coasts, islands and estuaries (Campbell *et al.* 1990)

The Northern Goshawk feeds mainly on small to medium-sized birds and mammals within these habitats (e.g. crows, grouse, woodpeckers, hares, squirrels, etc.)(Cannings *et al.* 1987; Campbell *et al.* 1990; BC Environment 1997), and overall prey preferences appear to be region and season-specific. For example, Cannings *et al.* (1987) observed that the goshawk often forage for California Quail in the fall, while the main prey in the winter is ring-necked pheasant or hares in the lowlands and highlands, respectively. In general, the Northern Goshawk is an opportunistic hunter that utilizes many different types of habitat to forage for a wide variety of prey (Squires and Reynolds 1997).

Territoriality

Goshawk home ranges generally consist of three parts: the nesting area, post-fledging area, and foraging area (Reynolds *et al.* 1992). Nest areas consist of multiple alternative nest trees, roost trees, and plucking posts, and are the centre of courtship behaviour (BCMWLAP 2004). Nest areas vary in size based on topography and habitat availability, but in the Morice and Lakes IFPA areas, Mahon and Doyle (2006) described a nest area of 24 ha. Conversely, on Vancouver Island they have been conservatively-estimated by McClaren (2001) to be 200 ha in size. Post-fledging areas are used by fledgings before they become independent of adults and disperse (Kennedy *et al.* 1994), and on the coast are estimated to be similar in size to nest areas (BCMWLAP 2004). In the Kootenays, the post-fledging areas were found to be between 10 and 70 ha in size, and fledglings were found to avoid forest less than 40 years old (Harrower *et al* 2010). Foraging areas, the largest home range area, comprise the area where adult goshawks hunt (BCMWLAP 2004). No estimates have been done of goshawk foraging area size, but it is assumed that the extent of goshawk movement throughout their range coincides with foraging area (BCMWLAP 2004).

Site fidelity for the goshawks appears to be sex-specific, with males having much higher fidelity than females (BCMWLAP 2004). This is true for both the interior and coastal subspecies (ibid.). Studies in California (Detrich and Woodbridge 1994) and Arizona (Reynolds and Joy 1998) have shown that, for the interior subspecies, females are more likely to move to new nest areas and mate with other males, while males are more likely to remain at the same nest area over multiple years. On the coast, radio-tagged males in Alaska have exhibited high site fidelity (Iverson *et al.* 1996), while conversely the females have shown much lower site fidelity (Iverson *et al.* 1996; McClaren 2003).

Distribution

Provincial Range

Within British Columbia, two subspecies of Northern Goshawk occur: *A. g. atricapillus* and *A. g. laingi*. In general, the species occur across the entire province, in all but the highest elevations (i.e. Alpine Tundra; BC Environment 1997).

A. g. atricapillus is an uncommon resident of British Columbia, and its range extends to most areas of the provincial mainland (Campbell *et al.* 1990), excluding the area west of the coast ranges, where the population may be *A. g. laingi* (Cooper and Stevens 2000). It is known to breed throughout this range, but information is scarce as to the extent that it breeds, due to its secretive nature (Campbell *et al.* 1990). It is Yellow-listed in the province (BC CDC 2007a).

A. g. laingi is known to be a resident on Vancouver Island and the Queen Charlotte Islands (Campbell *et al.* 1990). It is also suspected to occur on the coastal mainland (Cooper and Stevens 2000), but researchers have yet to positively identify which of the two subspecies occurs in this area. The *laingi* subspecies has been found in the CDFmm, CWHdm, CWHmm, CWHvh, CWHvm, CWHwh, CWHxm, MHmm and MHwh subzones (BCMWLAP 2004). The Northern Goshawk Recovery Team (NGRT) assumes that this subspecies follows the distribution of the CWH subzones/variants in BC, with submaritime subzones/variants assumed to be transitional between *A. g. laingi* and the interior *A. g. atricapillus* (NGRT 2008).

Distribution in the Project Area

Expected occurrence of the Northern Goshawk in the study area by BGC variant is summarized in Table 75.

Table 75: Expected Northern Goshawk occurrence within the ecosection - BGC variant combinations found within the Project study area

Ecoprovince	Ecoregions	Ecosection	BGC Variants	Occurrence?
SIM	COH	NSH	ESSFwc2, ESSFwcp, ESSFwcw, ICHdw3, ICHmw3, ICHwk1, IDFmw2	Yes

Elevation Range

Goshawks have been recorded to range from sea level up to 2,290 m elevation, with nests ranging from sea level to at least 1,400 m (Campbell *et al.* 1990). *A. g. atricapillus* has been found to breed in the Cariboo at an average of 1,042 m (Bosakowski and Rithaler 1997), to breed in the Okanagan mostly at elevations exceeding 1,000 m (Cannings *et al.* 1987), and to breed in Utah between 2,350 m and 3,100 m, corresponding with ponderosa pine forests in the state (Johansson *et al.* 1994). Conversely, the *A. g. laingi* is generally found to breed between sea level and 900 m (Iverson *et al.* 1996; McClaren 2003), but may use higher elevations for foraging (McClaren 1997, 1998, 1999; BCMWLAP 2004).

Food/cover Life Requisites and Habitat-uses

Nesting habitat is likely a significant limiting factor for Northern Goshawks in BC. Because of this, reproducing habitat was the habitat that was rated for this species (Table 76).

Table 76: Life requisites being rated for Northern Goshawk, *atricapillus* subspecies, for the Project

Life Requisite	Season	Months	Ratings Column Title
Reproducing-Eggs	N/A	Apr-Aug	BNOGO_AT_RE

Reproducing-Eggs

Accipiter gentilis laingi typically nests in mature or old-growth coniferous stands, with relatively closed canopies and open understories (Kennedy 1988; Hayward and Escano 1989; Reynolds *et al.* 1992; Mahon *et al.* 2003; Desimone and Hays 2004). They generally use structural stage 6-7, but will use structural stage 5 in highly-productive forests, where mature forest characteristics are present (BCMWLAP 2004; NGRT 2008). Forest composition in the nest area is typically dominated by old (>140 years) western hemlock, Douglas-fir, spruce or red alder, with canopy closure greater than 55% (Fleming 1987; Iverson *et al.* 1996; Chytyk and Danwant 1997; McClaren 1997; Ethier 1999; Mahon and Doyle 1999; Schaffer *et al.* 1999; Finn 2000; Finn *et al.* 2002a; Finn *et al.* 2002b; Mahon *et al.* 2003; McClaren 2003; BCMWLAP 2004; Desimone and Hays 2004; NGRT 2008). Finn *et al.* (2002b), in a study of goshawks on the Olympic Peninsula of Washington, found that canopy closure in nest areas averaged as much as 78%. Multi-layered canopies, high structural diversity, large-diameter trees, and presence of snags and coarse woody debris are all considered important (BCMWLAP 2004; NGRT 2008). In addition, goshawks on the coast appear to prefer lower or toe slopes, in addition to slope gradients less than 40% (BCMWLAP 2004).

Seasons of Use

Northern Goshawks are territorial during the breeding season, and initiate territory establishment as early as mid-March (Beebe 1974). Most egg-laying probably takes place from mid-April to mid-May, with brood dates ranging from late-May to mid-August (Campbell *et al.* 1990). Fledging can occur as late as the end of August (Campbell *et al.* 1990), but the Northern Goshawk has a post-fledging dependency that lasts into September (Titus *et al.* 1995). Therefore, the total breeding season extends from March to September (Table 77).

Table 77: Monthly life requisites being rated for Northern Goshawk for the Project

Month	Season*	Life Requisites
April	Winter	Reproducing-Eggs
May	Growing (Early Spring)	Reproducing-Eggs
June	Growing (Late Spring)	Reproducing-Eggs
July	Growing (Summer)	Reproducing-Eggs
August	Growing (Summer)	Reproducing-Eggs

*Seasons defined for the Southern Interior Mountains as per British Columbia Wildlife Habitat Rating Standards Version 2.0 (1999).

Habitat Use and Ecosystem Attributes

Table 78 summarizes the specific attributes that Northern Goshawks utilize for reproducing.

Table 78: Summary of habitat attributes for Northern Goshawk reproduction

Habitat Use	Specific Attributes for Suitable Northern Goshawk Habitat	Structural Stage
Reproducing -Eggs	Presence of mature or old-growth, coniferous forests, with closed, multi-layered canopies, open understories, large-diameter trees, and abundant snags and coarse woody debris. Preferably located on shallow slope gradients.	(5), 6-7

Table 79 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 79: Ecosystem attributes used for Northern Goshawk habitat mapping in the Project study area

Life Requisite	Mapping Attributes
Reproducing-Eggs	Regional: BGC variant

	Site: Canopy closure Vegetation: Tree species, age, height

Wildlife Habitat Ratings

One currently accepted method for modelling habitat for *Accipiter gentilis laingi* in British Columbia is the use of Habitat Suitability Index (HSI) methodology (*e.g.*, Manning *et al.* 2002; Mahon *et al.* 2003; Rumsey *et al.* 2004; Marquis *et al.* 2005; Mahon *et al.* 2008). This methodology follows that which has been developed by the US Fish and Wildlife Service, and consists of assigning values, ranging from 0 (low suitability) to 1 (high suitability), to each attribute used in the model. A multiplicative, non-compensatory equation is then used to calculate a final habitat suitability value (between 0 and 1) for each ecosystem polygon. The final suitability value is then converted into a rating for the polygon.

One benefit of using this methodology is that it allows for the use of continuous data (*i.e.*, data that can be any conceivable value), as well as discrete data, nominal data, etc. The use of continuous data (*e.g.,* percent cover of individual tree species) can be very beneficial. In comparison, standards for Wildlife Habitat Ratings, as outlined in RIC (1999), do not allow for the use of continuous data. Continuous data must be converted into discrete data (*e.g.,* convert percent cover data into discrete cover classes). This can lead to a loss of resolution for the model, particularly when dealing with the conversion of more than one attribute (*e.g.*, Vegetation Resource Inventory [VRI] data contains up to six tree species, with percent cover for each, in each polygon).

Northern Goshawks rely less on the type of forest (*i.e.*, a discrete variable) than on the structural attributes of that forest. Many structural attributes are mapped as continuous data (*e.g.,* tree height), or attributes with so many possibilities that they are best-treated as continuous for the purposes of modelling (*e.g.,* tree age, percent cover). Thus, to incorporate these continuous structural attributes into the model for *Accipiter gentilis* for the Project, HSI methodology was used.

The model used for the Project was developed by incorporating aspects of pre-existing models of Northern Goshawk habitat suitability in coastal BC (Manning *et al.* 2002; Mahon *et al.* 2003; Rumsey *et al.* 2004; Marquis *et al.* 2005). These pre-existing models were similar in structure to each other, but contained some substantial differences in the attributes used, as well as some minor differences in the values assigned.

In addition, the model for the Project was altered to match the inputs that were available for the Project assessment, as well as to incorporate specific study area differences (*e.g.,* tree species present in the Project study area that were not present in the original model areas). The Project model utilized the following attributes: BGC subzone/variant; stand age; stand height; canopy closure; and tree species. The model was a multiplicative, non-compensatory model; this meant that the value of one attribute could not compensate for the deficiency in another. Ecologically, this meant that for habitat to be rated as highly suitable, all of the separate component attributes needed to have a high value. The equation used to calculate the habitat suitability was the following:

BNOGO_LA_RE = BGC Rating * ((Stand Height Rating + Stand Age Rating)/2) * Canopy Closure Rating * Tree Spp. Rating

The final value from the calculation was converted into a ratings scheme, similar to the scheme used for other species (Table 80). There is an intermediate level of knowledge on the habitat requirements of the Northern Goshawk in British Columbia and thus, a 4-class rating scheme was used.

Table 80: Habitat capability and suitability rating scheme

Value	Rating	Class
0.76-1.00	High	H
0.26-0.75	Moderate	M
0.01-0.25	Low	L
0.00	Nil	N

Provincial Benchmark

No provincial benchmark has been identified for Northern Goshawk. The following benchmark was proposed for the reproducing-eggs life requisite of the subspecies:

Ecosection: None

Biogeoclimatic Zone: None

Habitats: Old-growth forests composed primarily of Douglas-fir, with closed, multi-layered canopies, open understories, large-diameter trees, and abundant snags and coarse woody debris.

Habitat Ratings Model Assumptions

The assumptions used within the Northern Goshawk habitat suitability model, including values assigned to each attribute, are presented below.

The first attribute, BGC subzone/variant, was used as a surrogate for elevation. Higher elevation BGC subzones/variants are given lower value in the model (Table 81). In addition, the subspecies only occurs in the CDF, CWH and MH zones (BCMWLAP 2004), so all other zones are assigned a value of zero.

Table 81: Value assigned to each BGC variant for Northern Goshawk habitat suitability ratings

BGC Variant	Value
ICHdw3	1.0
ICHmw3	1.0
ICHwk1	1.0
IDFmw2	1.0
ESSFwc2	0.75

ESSFwcw	0.25
ESSFwcp	0.0

Structural maturity can best be represented, for the purposes of modelling goshawk nesting habitat, by using stand age and stand height (Table 82 and Table 83).

Table 82: Value assigned to stand age data for Northern Goshawk habitat suitability ratings

Stand Age	Value
>120	1.0
101-120	0.84
81-100	0.677
61-80	0.5
41-60	0.342
21-40	0.17
0-20	0.0

Table 83: Value assigned to stand height data for Northern Goshawk habitat suitability ratings

Stand Height	Value
>28.4	1.0
19.5-28.4	0.8
10.5-19.4	0.4
0.0-10.4	0.1

Stand age and stand height are both known to correlate closely, but sometimes young stands with high productivity (i.e. tall height) can be moderately suitable (BCMWLAP 2004), and conversely older stands with low productivity may be of low suitability. Therefore, using only stand age or stand height is insufficient. However, to avoid the effect of correlation, which could skew the model output, an average of the age and height values was used. Table 84 describes the ratings for each forest canopy closure class for Northern Goshawk.

Table 84: Value assigned to canopy closure data for Northern Goshawk habitat suitability ratings

Canopy Closure	Value
>85	0.8
56-85	1.0
46-55	0.8
36-45	0.6
26-35	0.4
16-25	0.2
0-15	0.0

Tree species have been assessed for their ability to support nest structures based on tree characteristics (size, shape, and branching) and use by the interior subspecies, as well as incorporating ratings that were used by Mahon *et al.* (2008) and other earlier models. Those tree species with (assumed) potential to be used for nesting have been rated higher than those without (Table 85).

Table 85: Value assigned to tree species for Northern Goshawk habitat suitability ratings

Tree Species Code	Tree Species Name	Value
At	Trembling aspen	1.0
Ac	Poplar	0.7
B, Bl	Subalpine fir	0.25
Cw	Western redcedar	0.25
Ep	Paper birch	0.25
Fd	Douglas-fir	1.0
H, Hw	Western hemlock	1.0
Hm, Lw	Western larch	0.3
Pl, Pw, Py	Lodgepole pine, western white pine	0.3
S, Se, Sw	Engelmann spruce, white spruce	0.6

Overall tree species suitability is calculated by multiplying the species rating by its percentage composition (0-1) and summing the individual species ratings for all types in the stand, as outlined in the example calculation below:

E.g., $Hw_{50}Se_{30}Cw_{20}$=0.5(1.0)+0.3(0.6)+0.2(0.25)=0.73

Field Ratings Summary

High-rated plots for Northern Goshawk were located in old-growth forests in the IDF and ICH zones. All were in dry to moist stands. All moderate-rated plots were in the IDF and ICH as well, and most were in dry to moist forests that were structural stage 5-7.

Table 86: Number of field ratings in each class for Northern Goshawk

	H	M	L	N	Total
BNOGO_RE	6	19	28	31	84

Rating Adjustments

No adjustments are required for the Northern Goshawk habitat suitability model.

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Olive-Sided Flycatcher

Species data

Latin Name: Contopus cooperi

Species Code: B-OSFL

Provincial Status: Blue-listed

COSEWIC-status: Threatened (November 2007)

SARA-status: Schedule 1

Identified Wildlife: No

Ecology and Habitat Requirements

General

The Olive-sided Flycatcher is a widespread member of the flycatcher family, Tyrannidae, and has a large head, short tail, and grey-green body (Altman and Sallabanks 2000). It is a breeding visitor found in coniferous forests across much of North America, and at higher elevations along the Rocky and Coastal Mountain Ranges (ibid.). In winter it is primarily found along the Panama and Andes mountains, but also casually occurs across Central America and northern South America (ibid.).

This species is highly-associated with forest openings or edge habitat, with a particular preference for forested wetlands (COSEWIC 2007). The breeding habitat of Olive-sided Flycatchers is primarily coniferous forest, although mixed forest is occasionally used (Altman and Sallabanks 2000). Preferred habitat consists of recently (<25 years) burned or logged forests, but can also include open forests or forests adjacent to open areas (*e.g.*, bogs, meadows, wetlands; ibid.). The nest itself is an open-cup structure and is placed well out on a horizontal branch (ibid.).

Foraging by Olive-sided Flycatchers often occurs in openings within or adjacent to forested habitat (Altman and Sallabanks 2000). A prominent location, such as the top of a dead tree, often serves as a perch from which they can fly catch (Fitzpatrick 1978; Wright 1997). When breeding, this species is often monogamous and defends territories between 10 ha and 45 ha large (COSEWIC 2007).

Distribution

Provincial Range

The Olive-sided Flycatcher is found across British Columbia during the breeding season (Campbell *et al*. 1997; COSEWIC 2007). It is more common at higher elevations, especially in southern British Columbia (Campbell et *al*. 1997).

Distribution in the Project Area

Expected occurrence of Olive-sided Flycatcher in the study area by BGC variant is summarized in Table 85.

Table 87: Expected Olive-sided Flycatcher occurrence within the ecosection - BGC variant combinations found within the Project study area

Ecoprovince	Ecoregions	Ecosection	BGC Variants	Occurrence ?
SIM	COH	NSH	ESSFwc2, ESSFwcp, ESSFwcw, ICHdw3, ICHmw3, ICHwk1, IDFmw2	Yes

Elevation Range

Olive-sided Flycatcher is known to nest up to 2,200 m in the province (Campbell *et al.* 1997). They are primarily found at upper elevations in the southern portion of the province, but at lower elevations further north (ibid.).

Food/cover Life Requisites and Habitat-uses

Olive-sided Flycatchers are breeding visitants to the province (Campbell *et al*. 1997). Thus, reproducing habitat was the habitat that was rated for this species (Table 88).

Table 88: Life requisites that were rated for Olive-sided Flycatcher for the Project

Life Requisite	Season	Months	Ratings Column Title
Reproducing-Eggs	N/A	May-August	BOSFL_RE

Reproducing-Eggs

Nesting habitat is generally early-seral forest with scattered veterans, openings adjacent to forested habitat, or open-canopied forests and wetlands (Altman and Sallabanks 2000; COSEWIC 2007).

Seasons of Use

Olive-sided Flycatchers generally arrive in BC in mid- to late-May, and migrate south beginning in August (Campbell *et al*. 1997; COSEWIC 2007). Table 89 shows how the life requisites being rated for Olive-sided Flycatcher are divided up between months of the year.

Table 89: Monthly life requisites being rated for Olive-sided Flycatcher for the Project

Month	Season*	Life Requisites
May	Growing (Late Spring)	Reproducing-Eggs
June	Growing (Summer)	Reproducing-Eggs
July	Growing (Summer)	Reproducing-Eggs
August	Growing (Summer)	Reproducing-Eggs

*Seasons defined for the Southern Interior Mountains as per British Columbia Wildlife Habitat Rating Standards Version 2.0 (1999).

Habitat Use and Ecosystem Attributes

Table 90 summarizes the specific attributes that Olive-sided Flycatcher utilize for reproducing.

Table 90: Summary of habitat attributes for Olive-sided Flycatcher reproduction

Habitat Use	Specific Attributes for Suitable Olive-sided Flycatcher Habitat	Structural Stage
Reproducing-Eggs	Olive-sided Flycatcher nest in open-canopied coniferous forests and wetlands.	3-7

Table 91 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 91: Ecosystem attributes used for Olive-sided Flycatcher habitat mapping in the Project study area

Life Requisite	Mapping Attributes
Reproducing-Eggs	Regional: BGC variant Site: Site map code, structural stage, stand composition, canopy closure

Wildlife Habitat Ratings

There is an intermediate level of knowledge on the habitat requirements of the Olive-sided Flycatcher in British Columbia and thus, a 4-class rating scheme was used (Table 92).

Table 92: Habitat capability and suitability rating scheme (from RIC 1999)

% of Provincial Best	Rating	Class
76% - 100%	High	H
26% - 75%	Moderate	M

1% - 25%	Low	L
0%	Nil	N

Provincial Benchmark

No provincial benchmark has been identified for Olive-sided Flycatcher. The following benchmark was used for the reproducing-eggs life requisite of the subspecies:

Ecosection: Unknown

Biogeoclimatic Zone: Unknown

Habitats: Wetlands and forest openings with scattered veteran trees for nesting and perching.

Habitat Ratings Model Assumptions

The assumptions used within the Olive-sided Flycatcher habitat suitability model are presented in Table 93.

Table 93: Habitat suitability ratings assumptions for Olive-sided Flycatcher – reproducing-eggs

Attribute	Assumption
BGC variant	IDF, ICH and ESSFwc2 will be rated up to class H
	ESSFwcw will be rated up to class L
	ESSFwcp will be rated class N
Site map code	Upland coniferous forested and forested wetland units will be rated up to class H
	Upland broadleaf or mixed forested units will be rated up to class L
	All other units will be rated class N
Structural stage	Structural stages 2-3 will be rated up to class H
	Structural stage 4-7 will be rated up to class L
	Structural stages 0-1 will be rated class N

Field Ratings Summary

No field ratings were collected for Olive-sided Flycatcher habitat within the Project area.

Rating Adjustments

Adjustments were used for mapping Olive-sided Flycatcher habitat to account for their preferred use of stands with low canopy-closure and edge habitats.

Attribute	Adjustment
Canopy closure	Polygons with canopy closure of 1-5% will not be adjusted
	Polygons with canopy closure of 6-10% will be adjusted down by 1 class
	Polygons with canopy closure of 11-20% will be adjusted down by 2 classes
	Polygons with canopy closure of 0% or >20% will be adjusted to class N
Edge	Habitat that is structural stage 5-7 that is <50 m from a polygon that is structural stage 1-3 will be adjusted up by 2 classes

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Grizzly Bear

This model is based on those developed by Keystone Wildlife Research (1999) for the Adams Lake Innovative Forest Practices Agreement and Young & Wahl (2001) for the North Barriere Landscape Unit, and updated using recent grizzly bear biology and project field ratings.

Species data

Latin Name: Ursus arctos

Species Code: M-URAR

Provincial Status: Blue-listed

COSEWIC-status: Special Concern (May 2002)

SARA-status: None

Identified Wildlife: Yes (May 2004)

Ecology and Habitat Requirements

General

Grizzly bears are mostly solitary, intra-specifically aggressive omnivores that typically have large seasonal and annual home ranges. Reproductive rate is low and offspring remain with their mothers for 26-28 months.

Grizzly bears are omnivorous and opportunistic in their feeding habitats. Grasses, herbs, roots, corms, and berries comprise 60 to 90 percent of grizzly bear's diet (Bunnell and McCann 1993). Habitat selection is governed by forage availability during the growing season (Hadden *et al.* 1985). Forest cover is required for security, but its importance varies according to individual vulnerability and type of cover. Grizzly bear diet also changes with the seasons to make use of the most digestible foods. For example, grizzly bears will take advantage of palatable early spring forage. Feeding on ungulates (especially winter-kills and new calves) is important during early spring, and for many bears, salmon comprises a significant fall diet item.

Some variation occurs in the feeding patterns between coastal and interior grizzly bears. On the coast, beginning in the spring, grizzly bears feed on early green vegetation such as skunk cabbage and sedges located in the estuaries and seepage sites that become snow-free first. As the season advances, the bears follow the receding snow up the avalanche chutes feeding on emerging vegetation and roots. Ripe berries attract the grizzlies down onto the floodplain and sidehills where they eat devil's club (*Oplopanax horridus*), salmonberry, raspberry (*Rubus idaeus*), black twinberry (*Lonicera invonucrata*), elderberry (*Sambucus spp.*), and a variety of blueberries (*Vaccinium* spp.). They begin to feed on salmon as they become available in the spawning channels and continue to do so until late fall, feeding on live and eventually dead salmon. Once salmon supplies dwindle, grizzlies return to feeding on skunk cabbage and other vegetation.

In the interior, beginning in the spring, grizzlies feed mainly on the roots of hedysarum and on carrion, and opportunistically prey on winter-weakened ungulates. As the green vegetation emerges the bears begin to graze on grasses, horsetails, rushes and sedges. During this time, they also prey on ungulates on their calving grounds. In the berry season they feed almost exclusively on buffalo berries, blueberries, and huckleberries. Fall feeding focuses mainly on the roots of hedysarum once again. Throughout the active season, interior grizzlies will prey on small mammals, especially ground squirrels. Both coastal and interior grizzlies will feed on insects and grubs when available (MELP 1994).

Breeding occurs between the end of April and end of June (Mundy and Flook 1973; Aune 1985), but because of delayed implantation, cubs are born in the den between January and March. The average age of first reproduction for females in southeastern BC is 6 years. The time period between litters is 2.7 years, and the mean number of cubs per litter is 2.3 (McLellan 1988). In southern grizzly populations, cubs tend to stay with the mother for approximately 2.5 years.

Territoriality

Home range size for grizzly bears varies greatly depending on the concentration of suitable food resources, with home range generally increasing in poorer quality habitat. Gender also affects home range size, with male bears having larger home ranges than females. Adult males and females in the Flathead Valley, BC have been recorded to have home ranges of 446 km^2 and 200 km^2, respectively (McLellan 1981), while Pearson (1975) found adult males and females in the Yukon with home ranges of 287 km^2 and 86 km^2, respectively. Home ranges of barren ground grizzly bears appear to be much larger, with male home ranges being as large as 7,245 km^2 (McLoughlin *et al.* 2003). In the Khutzeymateen, home ranges were found to be as small as 57 km^2 for males and 23 km^2 for females (MacHutchon *et al.* 1996).

In addition to habitat suitability, social intolerance and the security needs of young bears act to distribute grizzlies widely over their range. Grizzly bears, except females with cubs and sibling groups, are solitary for most of the year except during the mating season. Mothers and daughters tend to have overlapping home ranges, while male home ranges are large and overlap with those of several adult females (Bunnell and McCann 1993). In many areas, adult females (particularly those with cubs) may inhabit marginal ranges or disturbed areas such as road margins, where human activities typically exclude larger males (McLellan 1988).

Distribution

Provincial Range

Historically, grizzly bears ranged throughout BC (except for the coastal islands), but populations are now considered extirpated from much of south and south central BC (BC MWLAP 2004). Grizzly bears are essentially continuous throughout the rest of BC (Environment Canada 2006). They occur in all biogeoclimatic zones except BG and CDF (BC MWLAP. 2004).

Distribution in the Project Area

The British Columbia grizzly bear population is estimated to be 16,014 (Hamilton 2008), approximately half of all grizzlies in Canada. The Project area overlaps with the Wells Grey population unit and the Columbia-Shuswap population unit, both of which are classified as viable with 374 grizzly bears and 396 grizzly bears for each respective population. Expected occurrence of grizzly bears in the study area by BGC variant is summarized in Table 94.

Table 94: Expected grizzly bear occurrence within the ecosection - BGC variant combinations found within the Project study area

Ecoprovince	Ecoregions	Ecosection	BGC Variants	Occurrence ?
SIM	COH	NSH	ESSFwc2, ESSFwcp, ESSFwcw, ICHdw3, ICHmw3, ICHwk1, IDFmw2	Yes

Elevation Range

Grizzly bears are found at all elevations from sea level to high alpine meadows (BCMWLAP 2004).

Food/cover Life Requisites and Habitat-uses

Habitat selection by grizzly bears is generally governed by forage availability during the growing season (Hadden *et al.* 1985; Bunnell and McCann 1993; BCWLAP 2004). Therefore feeding habitat is the most important habitat during this season, and was the habitat that was rated. Feeding habitats differ between seasons, and thus were rated separately. No feeding habitat is generally required during the winter, because grizzly bears hibernate, but feeding habitat was rated for the spring, summer and fall seasons (Table 95).

Table 95: Life requisites that were rated for grizzly bear for the Project

Life Requisite	Season	Months	Ratings Column Title
Food (FD)	Early Spring	May-Jun	MURAR_FDPE
Food (FD)	Summer	Jul-Aug	MURAR_FDS
Food (FD)	Fall	Sep-Oct	MURAR_FDF

Feeding-Early Spring

Spring diet for grizzly bears consists of roots, succulent green vegetation [e.g. grasses, horsetails, rushes, sedges, skunk cabbage, and other lush forbs (Mace and Bissell 1986; Wiegus 1986; McClellan and Hovey 1995; McCann 1997; Young and Wahl 2001; BCMWLAP 2004; McClellan *pers. comm.*)], and winterkilled or weakened ungulates at low elevations (BCMWLAP 2004). Forest openings such as meadows, wetlands and seepage areas, and southerly and westerly aspect, low-elevation, herb-dominated avalanche paths provide the most abundant spring foods. Riparian areas are heavily used, specifically at low gradients with back channels and meandering streams that provide the most favourable conditions for succulent forb and grass production (Ash 1985; NCGBRT 2004). Ungulate winter ranges are the most likely habitats within which bears will encounter winterkilled ungulates. Lower elevation areas are also preferred in the spring (NCGBRT 2004) while snow levels are still high at higher elevations. NCGBRT (2004) described important spring (March-April to June) habitat types for the Northern Cascades Grizzly Bear Population Unit as riparian areas, including wetlands; avalanche tracks and run out zones; and *Hedysarum* and glacier lily complexes.

Young and Wahl (2001) detailed the spring grizzly bear feeding habitat in the study area:

The forested riparian habitats found in upper ends of the Harper, Bendelin, Vermelin and Fennell Creeks and the Barriere River above Saskum Lake were rated moderate with some moderately high values in the CwHw-Devils club-lady fern and CwHw-Devils club-horsetail site series associations. These nutrient rich units in the ICH will provide suitable feeding habitat for grizzly bears in the spring and early summer, however this habitat is limited in the study area. The wetland areas present are predominantly sphagnum bogs and fens and are not rich in preferred grizzly food items (i.e. skunk cabbage, Equisetum spp. and Carex spp).

Feeding-Summer

Important late spring and early summer foods are horsetails (*Equisetum spp.*), graminoids, willow catkins (*Salix spp.*), and lush forbs. Preferred forbs are cow parsnip (*Heraculum lanatum*), peavine (*Lathyrus spp.*), clover (*Trifolium spp.*), colts foot (*Petasites spp.*), desert-parsley (*Lomatium spp.*), angelica *(Angelica lucida)*, and dandelion (*Taraxacum spp.*) (Mace & Bissell 1986; Wiegus 1986; McLellan & Hovey 1995; McCann 1997; B. McLellan *pers. comm.*). Important habitats are avalanche chutes, low to mid elevation riparian habitats, wetlands, alpine meadows, seep areas, cutblocks, and floodplains.

Wet areas providing forbs on northern aspects continue to be used during the summer, but berry sites are the preferred foraging habitat. Bears generally move to higher elevations where berries are most abundant; however, some low elevation habitats also supply some berries and a variety of other foods. Huckleberries (*Vaccinium spp.*), soopolallie (*Shepherdia canadensis*), and saskatoon (*Amelanchier alnifolia)* are the most important berry species for grizzlies, while kinnikinnick (*Arctostaphylos uva-ursi),* crowberry (*Empetrum nigrum*), cranberry (*Viburnum edule*), buckthorn (*Rhamnus alnifolia*) and rose hips (*Rosa spp.*) are also consumed (Mace and Bissell 1986; McLellan and Hovey 1995; MacHutchon 1996; McCann 1997; McLellan *pers. comm.*). Berries tend to be most abundant in natural openings as well as those areas that have been recently disturbed through fire or clear-cut logging. As a result, structural stage can be an important variable when correlated with the availability of berries. Regenerating burns and 10-20 year old clear-cuts typically provide abundant berries and receive relatively high summer use. In forested habitats, canopy closures of 20-50% are optimal for berry production (Ash 1985).

Young and Wahl (2001) describe that there is some moderate summer habitat within the ESSFwc2 in the study area, but in general sites with high berry production (dry site series) are relatively rare.

Feeding-Fall

Where sizeable salmon runs exist, grizzly bears often use these salmon runs as an important source of protein during the fall (Hildebrand *et al. 1999*). The North Thompson River contains numerous salmon runs (FISS 2012), but the human presence at Vavenby limits the foraging on these runs within the local study area for grizzly bear. In addition, surrounding creeks such as Harper Creek, Barriere River and Fennell Creek all have low salmon escapements, making them poor areas for salmon foraging (Young and Wahl 2001).

Where salmon is unavailable, grizzly bears forage in riparian areas, wetlands, avalanche tracks and run-out zones, sub-alpine parkland meadows, and berry-producing sites (NCGBRT 2004). Prominent food sources in early fall include soopalallie and huckleberry, while late fall food sources often include ungulates, roots and tubers, and bearberry and cranberry (McLellan and Hovey 1995).

Seasons of Use

Grizzly bears require habitats differentially throughout the year. Table 96 summarizes monthly life requisites that were rated for grizzly bear

Table 96: Monthly life requisites being rated for grizzly bear for the Project

Month	Season*	Life Requisites
May	Growing (Early Spring)	Feeding
June	Growing (Late Spring)	Feeding
July	Growing (Summer)	Feeding
August	Growing (Summer)	Feeding
September	Growing (Fall)	Feeding
October	Growing (Fall)	Feeding

*Seasons defined for the Southern Interior Mountains as per British Columbia Wildlife Habitat Rating Standards Version 2.0 (1999).

Habitat Use and Ecosystem Attributes

Table 97 summarizes the specific attributes that grizzly bear utilize for feeding.

Table 97: Summary of habitat attributes for grizzly bear feeding

Habitat Use	Specific Attributes for Suitable Grizzly Bear Habitat	Structural Stage
Spring Feeding	High forage plant diversity in lush herb layer with an abundance of grasses, sedges (Carex spp.) horsetails (Equisetum spp.); cow parsnip, stinging nettle, hellebore, dandelion, skunk cabbage, etc.	2-3, (6), 7

Habitat Use	Specific Attributes for Suitable Grizzly Bear Habitat	Structural Stage
Summer Feeding	Moist forests with abundant forage plants; high-elevation forage on root plants and small mammals; low-elevation berry-producing habitats (structural stage 3, 15-30% total shrub cover, >15% Vaccinium, often in conjunction with other berry producers [e.g., soopolallie, twinberry, devil's club, elderberry, highbush-cranberry]); shrub height < 2.5 m; high coarse woody debris.	2-3, (6), 7
Fall Feeding	High elevation berry producing habitats; high elevation meadows for small mammals; high coarse woody debris; rivers with significant salmon runs.	2-3, (6), 7

Table 98 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 98: Ecosystem attributes used for grizzly bear habitat mapping in the Project study area

Life Requisite	Mapping Attributes
Reproducing-Birthing	Regional: BGC variant Site: Site map code, structural stage, aspect

Wildlife Habitat Ratings

There is a detailed level of knowledge on the habitat requirements of the grizzly bear in British Columbia, and thus a 6-class rating scheme was used (Table 99).

Table 99: Habitat capability and suitability rating scheme (from RIC 1999)

% of Provincial Best	Rating	Class
76% - 100%	High	1
51% - 75%	Moderately High	2
26% - 50%	Moderate	3
6% - 25%	Low	4
1% - 5%	Very Low	5
0%	Nil	6

Provincial Benchmark

<u>Interior British Columbia benchmarks</u>

Ecosection: Border Ranges (BRR)

Biogeoclimatic Zone: ESSFdk (Englemann Spruce Subalpine Fir dry cool) and MSdk (Montane Spruce dry cool)

Habitats: Avalanche chutes, the Flathead Valley

Habitat Ratings Model Assumptions

The assumptions used within the grizzly bear habitat suitability model are presented below:

General Assumptions

1. Feeding habitat is assumed to be the greatest limiting factor for grizzly bears in the study area.
2. Although it is recognized that other factors such as predation, disease, intra/inter specific competition and hunting influence grizzly bear population growth and distribution, this model does not include these factors. Grizzly bear habitat use is strongly influenced by intraspecific social interactions and the presence and activities of people. Grizzly bear habitat selection takes place at multiple scales and feeding habitats are scattered throughout large home ranges (Hamilton & Bunnell 1992).
3. Biogeoclimatic subzones at lower elevations will be rated higher than middle and higher-elevation subzones for grizzly bear spring, feeding habitat, due to the presence of snow at higher elevations.
4. Biogeoclimatic subzones at middle and higher elevations will be rated higher than lower-elevation subzones for grizzly bear summer feeding habitat, due to grizzly bears following the snowmelt and higher-elevation green-up.

Detailed Assumptions – Early Spring Feeding Habitat

1. Wetland units within the ICH and IDF will be rated class 1.
2. Floodplain forest units within the ICH and IDF will be rated class 1 when they are structural stage 3, 6 and 7. Similar units that are structural stages 4 and 5 will be rated class 3.
3. Wet forest units within the ICH and IDF will be rated class 2 when they are structural stage 3 and 7. Similar units that are structural stage 6 will be rated class 3, and structural stages 4-5 will be rated class 4.
4. Moist forest units within the ICH and IDF will be rated class 4 when they are structural stage 3, 6 and 7. Similar units that are structural stages 4-5 will be rated class 5.
5. Cultivated field, grasslands units, roadways and railways will be rated class 4 for the presence of herbaceous forage vegetation.
6. All other forested units within the ICH and IDF will be rated class 5.
7. The ESSF will be rated class 6.
8. All other units will be rated class 6.

Detailed Assumptions – Summer Feeding Habitat

1. Herbaceous avalanche slopes will be rated up to class 1
2. Floodplain forest units within the ICH and ESSF will be rated class 1 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 2, and structural stages 4 and 5 will be rated class 4.

3. Dry forest units in the ICH will be rated class 3 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 4, and structural stages 4 and 5 will be rated class 5.
4. Mesic and wet forest units in the ICH will be rated class 3 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 4, and structural stages 4 and 5 will be rated class 5.
5. Dry to mesic forest units in the IDF and ESSFwc2 will be rated class 3 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 4, and structural stages 4 and 5 will be rated class 5.
6. Moist to wet forest units in the ESSFwc2 will be rated class 2 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 3, and structural stages 4 and 5 will be rated class 5.
7. Dry to wet forest units in the ESSFwcw will be rated class 4 when they are structural stages 3, 6 and 7. Similar units that are structural stages 4 and 5 will be rated class 5.
8. Mesic to wet forest units in the IDF will be rated class 3 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 4, and structural stages 4 and 5 will be rated class 5.
9. Floodplain forest units within the IDF will be rated class 2 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 3, and structural stages 4 and 5 will be rated class 4.
10. Wet meadows and shrub-carrs in the ESSF will be rated class 2.
11. Wetland units in the ESSF and ICH will be rated class 3.
12. Wetland units in the IDF will be rated class 4.
13. Cultivated field, grasslands units, roadways and railways will be rated class 4 for the presence of herbaceous forage vegetation.
14. Dry meadows, very dry forest units and parkland forest units will be rated class 5.
15. All other units will be rated class 6.

Detailed Assumptions – Fall Feeding Habitat

1. No class 1 habitat is available in the local study area. Class 1 habitat for this area would consist of rivers containing spawning salmon, of which only the North Thompson is present in the local study area. Grizzly bears will generally avoid this area of the North Thompson River because of the human presence at Vavenby.
2. Herbaceous avalanche slopes will be rated class 3.
3. Wet meadows and shrub-carrs in the ESSF will be rated class 2.
4. Floodplain forest units will be rated class 3 when they are structural stage 3, 6 and 7. Similar units that are structural stages 4 and 5 will be rated class 4.
5. Dry to wet forest units in the ICH will be rated class 3 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 4, and structural stages 4 and 5 will be rated class 5.
6. Dry to wet forest units in the IDF will be rated class 4 when they are structural stage 3, 6 and 7, and structural stages 4 and 5 will be rated class 5.
7. Dry forest units in the ESSFwc2 will be rated class 3 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 4, and structural stages 4 and 5 will be rated class 5.

8. Mesic to wet forest units in the ESSFwc2 will be rated class 2 when they are structural stage 3. Similar units that are structural stages 6 and 7 will be rated class 3, and structural stages 4 and 5 will be rated class 5.
9. Mesic to wet forest units in the ESSFwcw will be rated class 3 when they are structural stage 3, 6 and 7. Similar units that are structural stages 4 and 5 will be rated class 4.
10. Dry forest units in the ESSFwcw will be rated class 4 when they are structural stage 3, 6 and 7. Similar units that are structural stages 4 and 5 will be rated class 5.
11. Wetland units will be rated up to class 4.
12. Cultivated field, grasslands units, roadways and railways will be rated class 5 for the presence of herbaceous forage vegetation.
13. Dry meadows, very dry forest units and parkland forest units will be rated class 5.
14. All other units will be rated class 6.

Field Ratings Summary

Fifty-nine plots were rated for spring feeding habitat. No class 1 ratings for grizzly bear spring feeding habitat were made during field truthing. Class 2 and 3 ratings for spring were mostly located in sites with abundant herbaceous vegetation at low elevations (Table 100).

Eighty-four plots were rated for summer feeding. Class 1, 2 and 3 ratings for grizzly bear summer feeding habitat were mostly located in mid- to high-elevation forests with a high abundance of shrubs (e.g. young cutblocks) or herbaceous forage plants (e.g. older forest with herb-dominated understory).

Of the 84 plots rated for fall feeding habitat, none were rated as Class 1. Sixteen Class 2 and 3 plots were conducted, which were mainly located in the ICH and ESSF in shrubby or old-growth forest communities.

Table 100: Number of field ratings in each class for grizzly bear

	1	2	3	4	5	6	Total
MURAR_FDP	0	2	2	3	14	38	59
MURAR_FDS	1	3	14	17	28	21	84
MURAR_FDF	0	3	13	15	33	20	84

Rating Adjustments

No adjustments were made to the grizzly bear habitat suitability model.

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Moose

Portions of this species account have been extracted from the provincial template for this species (BC Ministry of Environment, n.d.). Text from the template is indicated by indentation.

Species data

Latin Name:	Alces americanus (formerly Alces alces)
Species Code:	M-ALAM
Provincial Status:	Yellow-listed
COSEWIC-status:	None
SARA-status:	None
Identified Wildlife:	No

Ecology and Habitat Requirements

General

The moose is the largest ungulate in Canada, and is a species adapted to cold climates and deep snow (Lemke 2001). Moose are generally solitary except for cows accompanied by calves of the year, and during the fall rut. The rut takes place during early September to late October (Shackleton 1999). Cows give birth in June, and often produce twin calves where nutritional conditions are favourable. Cows may breed as early as two years of age (Shackleton 1999).

Moose prefer semi-open successional stages of forest habitat with an abundance of browse (Stevens and Lofts 1988). Floodplains of major rivers, riparian communities along smaller streams and lakes, wetlands, regenerating burns and cut blocks, and avalanche chutes in early successional stages with fine-textured soils and abundant shrubs are used heavily. In British Columbia, moose prefer the sub-climax stages of forest succession, which are dominated by deciduous trees and shrubs. Favoured habitat types include recent burns, logged areas, lake and river shores, alder (*Alnus* spp.) and willow (*Salix* spp.) swamps, and river deltas and other wetland areas (Spalding 1990; MacCracken et al. 1997). Burns are often a major factor in local abundance of moose, with densities peaking 20-25 years after fire (LeResche 1974); this may occur sooner after fire on east slopes. Studies have shown that moose populations are often denser in burned areas where browse is of higher quality and greater abundance, in comparison to adjacent, unburned areas (Gasaway et al. 1989). Food (including quality of forage) and climate are considered the most important aspects of habitat for moose (Franzmann 1978). Analyses of moose range commonly stress abundance, production, and use of large woody shrubs during winter (LeResche and Davis 1973).

While moose are primarily browsers, they occasionally graze during summer (Franzmann 1978). Food habits of moose vary considerably, but are characterized in general by extensive use of early successional woody browse, such as early stages of regrowth following disturbances created by fire, logging, clearing, and others (Franzmann 1978). In winter, moose feed on woody, low quality, difficult-to-digest browse; however, when snow cover allows, they may consume non-woody vegetation and succulent species (LeResche and Davis 1973). Crête (1989) found a positive correlation between the percent deciduous browse available and moose density in eastern Quebec.

During spring and summer, moose forage primarily on the leaves of woody plants and forage more selectively whereas plant dormancy during winter imposes logistic constraints on foraging behaviour (Renecker and Hudson 1986). During winter, opportunities to forage selectively generally decrease while rumination time increases, primarily due to the diet, which is composed of highly lignified woody stems. In addition to varying seasonal foraging rates, plant form and twig diameter have also been shown to affect digestion rates that influence moose winter foraging patterns (Vivås et al. 1991).

In the forests of British Columbia and Alberta, preferred browse plants typically include willows (*Salix* spp.), red-osier dogwood (*Cornus stolonifera*), Saskatoon (*Amelanchier alnifolia*), aspen (*Populus tremuloides*), high-bush cranberry (*Viburnum edule*), bog birch (*Betula glandulos*a), lodgepole pine (*Pinus contorta*), paper birch (*Betula papyrifer*a) and mountain ash (*Sorbus sitchensis*) (Baker 1990; Westworth et al. 1989; Renecker and Hudson 1992; Simpson 1992). Each of these browse species may be used preferentially according to their height and growth form (i.e. accessibility). For example, some researchers have documented intra-specific variation in moose preference for willows (Risenhoover 1985); but most willow species (<2.5 m tall) provide potential winter browse. As snow depths increase, subalpine fir regeneration can be browsed heavily in the mid-late winter if other browse species become less accessible.

Moose often use a foraging technique called 'bark-stripping' where long, linear strips of bark are peeled from the tree (LeResche and Davis 1973; Miquelle and Van Ballenberghe 1989). This behaviour can adversely affect the canopy and subcanopy of the forest, because while browsing on shrubs primarily affects the survival and productivity of understory plants, stripping the bark from trees may ultimately result in their death (Miquelle and Van Ballenberghe 1989). Bark stripping occurs in habitats with low availability of twigs and leaves, and bark is usually a relatively small component of the diet of wild moose (Miquelle and Van Ballenberghe 1989).

Renecker and Hudson (1986) cite other studies that have shown that moose alter daily patterns of behaviour and habitat use to stay cool. Moose often find relief from summer heat by immersing their bodies in water (Flook 1959).

Winter range is a critical limiting factor for moose populations, with moose winter ranges generally restricted to below 900 m. Moose start to move to winter ranges once snow depths exceed 40 cm (Modaferri 1992; Coady 1974). Movements of moose can be severely restricted when snow depths exceed 70 cm (Kelsall and Prescott 1971).

Moose generally tend to stay at higher elevations until snow depth decreases mobility and food (browse) becomes difficult to find; some bulls will remain until late December. In mild winters with low snow loading, moose can remain at higher elevation winter ranges (e.g., regenerating burns).

Predation is recognized as a major factor affecting the dynamics of moose populations (Gasaway et al. 1992; Van Ballenberghe and Ballard 1994). In the "predator pit", densities may be 2 - 3 orders of magnitude lower than in other areas. Gasaway *et al.* (1992) cite moose densities of 0.45 - 4.17/10 km^2 of moose habitat where wolves and bears were abundant and preying on them. In areas where humans influenced wolf and/or bear populations, moose densities increased to 1.69 – 14.47/10 km^2 of moose habitat.

Home Range

The size of moose home ranges varies widely. Not all moose populations are migratory; some move to distinctly separate winter ranges while others live year round in the same area. Home range size for non-migratory populations have been estimated at 6 to 27 km2 during winter and 2 to 35 km2 during summer (Petticrew and Munro 1979; Stevens and Lofts 1988). Seasonal home ranges in the southern interior of the province have been estimated at 2.2 km2 in summer, 10 km2 in fall, and 5.8 km2 in winter for males (Stevens and Lofts 1988). For females, the estimates are 6.2 km2 in summer, 7.4 km2 in fall, and 6 km2 in winter (Stevens and Lofts 1988).

Densities of moose are as variable as home range size (Maier et al. 2005). Bergerud and Manuel (1968) reported densities of a minimum of 0.75/10 km2 in central Newfoundland. Gasaway et al.(1983) cited historical densities from the 1960's of 0.15/10 km2, and 0.02/10 km2 in 1975, and in their study in the late 1970's, found densities ranging from 0.006 - 0.148/10 km2. Van Ballenberghe and Ballard (1994) cite densities ranging from 0.45 - 8.0/10 km2 in Alaska and the Yukon. Crête (1989) found that densities of moose were 17.5 and 20.3 moose/10 km2, respectively for 1983 and 1984.

Distribution

Moose are found throughout the boreal forests of North America and Eurasia. Their range includes Maine and Nova Scotia west to BC, north to Alaska, Yukon and Northwest Territories, and south into Wyoming, Idaho, Michigan and Minnesota (Franzmann 1981).

Provincial Range

In BC, moose are one of the most widely distributed ungulate species across the province (Rea and Child 2007). Moose can be found throughout the province with the exception of Queen Charlotte and Vancouver Islands, the coastal fjords, and the interior grasslands in the Thompson and Okanagan (Rea and Child 2007; BC Ministry of Environment, n.d.). They are found in all biogeoclimatic zones except for Coastal Douglas-fir (CDF), Bunchgrass (BG) and Ponderosa Pine (PP) (Stevens 1995).

Moose are commonly found throughout most of the province’s mountainous valleys, with reports that their range extends west into the coastal temperate rainforests (Rea and Child 2007). The central and sub-boreal forests of the interior, the northern boreal mountains, and the boreal plains of the northeastern corner of the province are the areas of BC with highest moose abundance (*ibid*.). The majority of BC moose, over 70%, live in the northern part of the province, with the remaining 30% found in the Cariboo-Chilcotin, Thompson-Okanagan, and Kootenay regions (*ibid*.).

Distribution in the Project Area

Moose are found in a wide variety of biogeoclimatic zones throughout the province, including all three that occur within the LSA (Stevens 1995). As snow depths can restrict movement and forage opportunities in the winter months, a higher anticipated occurrence of moose in the spring, summer, and fall months in the LSA is expected (Coady 1974).

Although not considered at-risk in BC, moose populations are subjected to a number of threats throughout their range. In 2013, an approximate 60 percent decline in moose densities was recorded in parts of the North Thompson (BC Ministry of Forests, Lands and Natural Resource Operations 2013; Ministry of Forests, Lands and Natural Resource Operations 2013). Expected occurrence in the study area by BEC variant is summarized in Table 101.

Table 101: Expected moose occurrence within the ecosection - BEC variant combinations found within the Project study area

Ecoprovince	Ecoregions	Ecosection	BEC Variants	Occurrence?
SIM	COH	NSH	ESSFwc2, ESSFwcw, ESSFwcp, ICHdw3, ICHmw3,ICHwk1, IDFmw2	Yes

Elevation Range

Moose can be found at all elevation ranges, from sea level to subalpine or tundra areas in the mountains during summer (Eder and Pattie 2001); areas higher than 1300 m are seldom used in the winter (BC Ministry of Environment, n.d.).

Food/cover Life Requisites and Habitat-uses

Habitat selection by moose is generally governed by forage selection, with a secondary focus on security and thermal requirements. As snow conditions in winter months will limit moose movement, the majority of moose use in the LSA is expected to occur during the growing season (spring/summer/fall). Attributes for security and thermal habitats are very similar, and therefore were ranked together as one life requisite called security/thermal. Life requisites were rated separately for food and security/thermal as certain structural stages and BEC variants offer more in the way of cover than they do forage (Table 102).

Table 102: Life requisites that were rated for moose for the Project

Life Requisite	Season	Months	Ratings Column Title
Food (FD)	Growing	May-Oct	MALAM_FDG
Security/Thermal (ST)	Growing	May-Oct	MALAM_STG

Feeding

Food habits of moose are closely tied to food availability, and show seasonal variation. Moose foraging habitat in general consists of wetlands (Wall et al. 2011) and successional stands with palatable browse species (Table 3; Shackleton 1999).

Early Spring

Spring and summer foods may include aquatic vegetation and/or new leaves from woody plants, especially willows. Deciduous-leading stands on south-facing slopes are considered to provide the most suitable spring range conditions. These areas typically provide relatively open conditions, young aspen trees and abundant preferred browse species.

In general, moose spring range consists primarily of areas that provide early green forage (e.g., herbs, new leaf buds of woody plants). Moose have also been reported to strip bark from willow and aspen trees during spring (Miquelle and Van Ballenberghe 1989). Although the nutritional benefits of bark stripping remain unclear, some researchers suggest feeding on bark by moose is related to mineral requirements (McIntyre 1972) and or scarcity of higher quality browse (Miquelle and Van Ballenberghe 1989).

Spring food sources are not well documented. Vaccinium spp., freshly exposed herbaceous vegetation, and grasses have been identified as important spring foods (Ritcey 1992; Peek 1974). Singleton (1976) indicated that there is an overlap between winter foods and spring foods so most riparian shrubs, including willow and cottonwood, will still be selected. This may explain the use of creeks and riparian areas.

Late Spring / Summer / Fall

During summer, moose continue to browse (especially willows) by stripping leaves and reducing the amount of consumed woody forage. Depending on availability, moose can also increase the proportion of succulent vegetation in their diet. Studies of moose habitat relationships have indicated that moose seek aquatic macrophytes during summer as their primary source of succulent vegetation. The concentration of minerals in aquatic vegetation (particularly sodium) has been suggested as the limiting nutrient that moose attempt to replenish during the summer (Belovsky and Jordan 1981). Thus, many moose populations (particularly cow/calves) tend to concentrate their feeding activities during early and mid-summer in and around wetland areas where aquatic vegetation is most accessible (shallow open ponds and small lakes) and where the cool water may provide relief from warm ambient temperatures. Potential aquatic food plants include yellow water lily (Nuphar lutea); pondweed (Potamogeton spp.), horsetails (Equisetum spp.); water arum (Calla palustris) and sedges (Carex spp.).

Not all wetlands will provide optimum feeding conditions. The capability of wetlands to produce aquatic macrophytes and preferred browse species has been shown to vary with substrate, pH, soil temperatures and flow rates (Fraser et al. 1984). Therefore, Adair et al. (1991) suggested that small lakes (1-5 ha) with organic bottoms, slow streams and beaver ponds provide higher abundance of aquatic macrophytes and higher summer habitat values than other wetland types.

Although sedges are eaten by moose, many studies have reported relatively low forage preference for sedges (Renecker and Hudson 1992; Eastman and Ritcey 1987, cited in Renecker and Hudson 1992). However, moose may use open areas dominated by sedges for other reasons (e.g., to bed down to reduce thermal stress and attacks by biting insects).

Besides aquatic vegetation, preferred terrestrial species include willow, horsetails and bog birch (Singleton 1976). Willows and horsetails have both been identified as the most important non-aquatic species (Peek 1974; Singleton 1976). Other important browse species for this season include red-osier dogwood, highbush cranberry, trembling aspen, Saskatoon, and twinberry (Lonicera involucrata).

Table 103: Summary of important forage species for moose during the growing season.

	Growing Season Forage Species
Trees	black cottonwood *Populus balsamifera* trembling aspen *Populus tremuloides*
Shrubs	willow *Salix* spp. red-osier dogwood *Cornus stolonifera* high bush cranberry *Viburnum edule* sitka mountain ash *Sorbus sitchensis* Saskatoon *Amelanchier alnifolia* false box *Pachistima myrsinites* dwarf birch *Betula glandulosa* kinnikinnick *Arctostaphylos uva-ursi* prickly rose *Rosa acicularis* *Vaccinium* spp. thimbleberry *Rubus parviflorus* twinflower *Linnaea borealis* red alder *Alnus rubra* Sitka alder *Alnus sitchensis* trailing rubus *Rubus pedatus*
Forbs	lupine *Lupinus* spp. fireweed *Epilobium* spp. horsetail *Equisetum* spp. goldenrod *Solidago* spp. *Penstemon* spp. Solomon's seal *Smilacina* spp. broadleaf arnica *Arnica latifolia* *Aster* spp. wild strawberry *Fragaria virginiana* *Anemone* spp. sitka valerian *Valeriana sitchensis* clasping twisted stalk *Streptopus amplexifolius*
Aquatic and herbaceous plants	yellow pond-lily *Nymphaea polysepala* mare's tail *Hippurus vulgaris* pondweed *Potamogeton spp.* sedges *Carex* spp. grasses (*Poa*, *Festuca*, *Agrostis* spp.)

	Growing Season Forage Species
	rushes *Juncus* spp. narrow-leaved cotton-grass *Eriophorum angustifolium*
Ferns	oak fern *Gymnocarpium dryopteris*
Lichens	*Peltigera* spp. *Cladonia* spp. *Lobaria linita*

Catton (2007) examined moose use of lodgepole pine around wetlands near Williams Lake and reported that moose track density was higher in shrubby wetlands than non-shrubby wetlands. The probability of moose presence (tracks) increased with shrub height and levelled at 4 metres.

Security Habitat (SH)

Security cover for moose is most critical during spring calving when cow moose seek out islands and gravel bars on river floodplains for calving; landscape features adjacent to water provide escape from predators. At calving time, dense growth of tall shrubs (e.g., willows) and mature stands of white spruce-poplar with at least a moderately dense understorey also provide cover for moose. Cow moose and calves can find secure habitat during calving season in dense deciduous stands, or tall shrubs with canopy cover > 50% (Miquelle et al. 1992; MacCracken et al. 1997).

During summer/fall, security cover is provided by the same habitat types mentioned above. As well, moose at upper elevations use coniferous and mixed forests, shrub thickets in riparian habitats, and willow thickets on plateaus as cover.

The thick vegetation cover, provided by dense conifer forests and regeneration patches provide security cover for moose (Lemke 1998). Keystone Bio-Research (1991) recorded most use of mature lodgepole pine when this habitat type was adjacent to forage-producing openings. Mature pine was thought to provide bedding and security cover.

Thermal Habitat (TH)

Kelsall and Telfer (1974) suggest that shelter is important in high wind chill conditions. In a study of winter moose bedding behaviour, McNicol and Gilbert's data (1978) suggests that moose choose a bedding site that is downwind from the prevalent wind direction because of lower snow depths. Rasaputra (1994) concurs, and also suggests that wind cover is even important in feeding habitat selection allowing increased food accessibility. Habitat suitable for shelter from the wind is usually topographic but young coniferous stands are also used (McNicol and Gilbert 1978). The small coniferous stands, especially low density stands, allow for wind protection but also provide exposure to solar radiation (Forbes and Theberge 1993).

Overhead cover is provided by forested stands >6 m in height (Keystone Wildlife Research Ltd 2006).

Temperature regulation has also been suggested as an important factor in summer habitat selection (Ritcey 1992; Kelsall and Telfer 1974; Renecker and Hudson 1986; Demarchi and

Bunnell 1995; Doerr 1983; Schwab 1985; Rasaputra 1994). Renecker and Hudson (1986) indicate that moose will experience heat stress at temperatures as low as 14 °C. Several authors have suggested that water is used to reduce temperatures (Ritcey 1992; Renecker and Hudson 1986), but cool shaded forests are considered more important (Ritcey 1992; Schwab et al. 1987; Doerr 1983; Rasaputra 1994; Demarchi and Bunnell 1993). The structure and species composition do not appear to influence forest selection other than the requirement for 60% canopy cover (Demarchi and Bunnell 1995). Movement to cooler upper elevation sites would also reduce the possibility of heat stress.

Security cover for moose is most critical during spring when cow moose seek out dense vegetation on islands and vegetated gravel bars on river floodplains for calving since landscape features adjacent to water provide escape from predators. At calving time, dense growth of tall shrubs (e.g., willows) and mature stands of white spruce-poplar with at least a moderately dense understorey provide cover for moose. Cow moose and calves can find secure habitat during the calving season in dense deciduous stands, or tall shrubs with canopy cover > 50% (MacCracken et al. 1997).

Seasonal Habitat Use

Abundant moose forage is produced in early forest seral stages within the ICH subzone (Keystone Wildlife Research Ltd 2006). Moist sites may provide important winter range in the IDF. Very deep snow generally excludes moose from the ESSF subzones during the winter, but those areas may be used as summer range and calving habitat. The IDF is considered a shallow snowpack zone where snow depth is rarely limiting to moose (Keystone Wildlife Research Ltd 2006).

Seasons of Use

Moose require security/thermal and feeding habitat throughout the year. Because the majority of moose use in the LSA is expected to occur in the growing season, those are the months that life requisites were rated for moose (Table 104).

Table 104: Monthly life requisites being rated for moose for the Project

Month	Season	Life Requisites
May	Growing (Spring)	Food, Security/Thermal
June	Growing (Spring)	Food, Security/Thermal
July	Growing (Summer)	Food, Security/Thermal
August	Growing (Summer)	Food, Security/Thermal
September	Growing (Fall)	Food, Security/Thermal
October	Growing (Fall)	Food, Security/Thermal

*Seasons defined for the Southern Interior Mountains as per British Columbia Wildlife Habitat Rating Standards Version 2.0 (1999).

Habitat Use and Ecosystem Attributes

The relationship between moose life requisite and ecosystem attribute is outlined in Table 105. In the spring, summer, and fall, moose require a variety of herbaceous plant species, both aquatic and terrestrial, in addition to shrub heavy diet they are subject to year-round.

Moose require security and thermal habitat throughout the year, however, the thermal requirements vary between seasons. In the summer, cool, shaded forest stands are very important to moose thermoregulation (Ritcey 1992; Schwab et al. 1987; Doerr 1983; Rasaputra 1994; Demarchi and Bunnell 1993; Wall et al. 2011). Table 105 summarizes the specific attributes that moose utilize for feeding and security/thermal shelter.

Table 105: Summary of habitat attributes for moose feeding and shelter

Habitat Use	Specific Attributes for Suitable Moose Habitat	Structural Stage
Growing Feeding	Abundant summer forage in ICH. ESSF has abundance of wetlands. Feeding on abundant and succulent vegetation: herbaceous green vegetation and shrubs including willows, grasses, sedges, buds, lichens, and flowering plants.	(6) 3, 7
Growing Security/Thermal	Select sites where obstruction to visibility and movement are low; relatively open, older age class forest stands (increase in crown closure provides more shade); gentle to moderate slopes; water bodies can assist in thermoregulation.	(4, 5, 6) 3, 7

Table 106 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 106: Ecosystem attributes used for moose habitat mapping in the Project study area

Life Requisite	Mapping Attributes
Feeding, Security/Thermal	Regional: BEC variant Site: Site map code, structural stage

Wildlife Habitat Ratings

There is a detailed level of knowledge on the habitat requirements of moose in British Columbia, and thus a 6-class rating scheme was used (Table 107).

Table 107: Habitat capability and suitability rating scheme (from RIC 1999)

% of Provincial Best	Rating	6 Class
76% - 100%	High	1
51% - 75%	Moderately High	2
26% - 50%	Moderate	3
6% - 25%	Low	4

% of Provincial Best	Rating	6 Class
1% - 5%	Very Low	5
0%	Nil	6

Provincial Benchmark

RIC (1999) defines the benchmark for moose habitat in the Boreal Plains Ecoprovince as the following:

<u>Winter</u>

Ecosection: Peace Lowlands (PEL)

Biogeoclimatic Zone: Boreal White and Black Spruce (BWBS)

Habitat: Boreal White Spruce-Trembling Aspen

<u>Growing</u>

Ecosection: Peace Lowlands (PEL)

Biogeoclimatic Zone: Boreal White and Black Spruce (BWBS)

Habitat: White Spruce-Balsam Poplar Riparian

Ecosection Benchmark

<u>Growing</u>

Ecosection: Southern Interior Mountains

Biogeoclimatic Zone: Interior Cedar Hemlock (ICH) / Montane Spruce (MS)

Habitat: White Spruce-Balsam Poplar Riparian / Marsh

Habitat Ratings Model Assumptions

1. Of the biogeoclimatic subzones present in the study area, the ICHmk2 and ICHmw3 are assumed to provide the highest quality moose habitat.

2. Security cover is assumed to also provide adequate thermal cover, so thermal cover is not rated separately.

3. Because the provincial benchmark (BWBS) has a much greater density of use, no habitat s were rated higher than class 2.

The assumptions used within the moose habitat suitability model are presented in Table 108 and Table 109 below:

Table 108: Habitat suitability ratings assumptions for moose feeding – growing season

Attribute	Assumption
BEC variant	ESSFwc2, ESSFwcw, ICH, IDF rated up to class 2
	ESSFwcp rated up to class 4
Site map code	Wetlands, and riparian forest units rated up to class 2
	Wet forests, moist forests, and shallow water units rated up to class 3
	Avalanche tracks, dry and mesic forest units rated up to class 4
	Grasslands, meadows, cultivated fields, talus slopes, and all non-vegetated units rated class 6
Structural stage	Structural stage 3 rated up to class 2
	Structural stages 2, 6 and 7 rated up to class 3
	Structural stage 5 rated up to class 4
	Structural stage 4 rated up to class 5
	Structural stage 1 rated class 6

Table 109: Habitat suitability ratings assumptions for moose security/thermal – growing season

Attribute	Assumption
BEC variant	ESSFwc2, ESSFwcw, ICH, IDF rated up to class 2
	ESSFwcp rated up to class 4
Site map code	Wetlands, moist, riparian, and wet forest units rated up to class 2
	Mesic forest and shallow water units rated up to class 3
	Avalanche tracks and dry forest units rated up to class 4
	Grasslands, meadows, cultivated fields, talus slopes, and all non-vegetated units rated class 6
Structural stage	Structural stages 3, 5, 6 and 7 rated up to class 2
	Structural stage 4 rated up to class 3
	Structural stage 2 rated up to class 5
	All other structural stages rated class 6

Field Ratings Summary

No field ratings were collected for moose feeding or security/thermal habitat during the growing season within the Project area.

Rating Adjustments

No adjustments were made to the moose habitat model.

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Mountain Caribou

Species data

Latin Name: *Rangifer tarandus* pop. 1 (southern mountain population)

Species Code: M-RATA-01

Provincial Status: Red-listed

COSEWIC-status: Threatened (May 2000)

SARA-status: Schedule 1

Identified Wildlife: Yes (May 2004)

Ecology and Habitat Requirements

General

Mountain caribou are one of three ecotypes of woodland caribou species (*Rangifer tarandus*) found in British Columbia. The non-taxonomic ecotype classification is based on distinct patterns of distribution, behaviour and habitat requirements (Heard and Vagt 1998; Cichowski et al. 2004). The mountain caribou ecotype inhabit mature forests and alpine areas in southeastern and east-central BC (Shackleton 1999).

In winter, they feed almost exclusively on arboreal hair lichens (*Bryoria* spp., *Alectoria sarmentosa* and possibly *Nodobryoria oregana*) associated with mature and old forests (Stevenson et al. 2001; Mountain Caribou Technical Advisory Committee 2002; Cichowski et al. 2004). In addition to arboreal lichens, falsebox (*Pachistima myrsinites*) is significant forage during the early winter in some areas (Mountain Caribou Technical Advisory Committee 2002). Other shrubs such as willows (*Salix* spp.) and *Vaccinium* spp. may be consumed, but they are of lesser importance. During the remainder of the year, mountain caribou feed extensively on a variety of foods including grasses, sedges, horsetails, flowering plants (particularly Sitka valerian, and leaves of numerous shrubs (Mountain Caribou Technical Advisory Committee 2002).

Mountain caribou make elevational movements in response to factors such as snow conditions, forage availability, and predation pressure (Stevenson et al. 2001). Although there is regional variation in habitat use, mountain caribou migration patterns in BC can be described using four seasonal time periods (Stevenson and Hatler 1985).

In the early winter, during the snow accumulation period, mountain caribou use valley bottoms and lower slopes in the Interior Cedar-Hemlock (ICH) and lower Engelmann Spruce-Subalpine Fir (ESSF) biogeoclimatic zone forests (Stevenson et al. 2001; Mountain Caribou Technical Advisory Committee 2002). The dense forest canopies reduce snow depths and allow greater mobility and access to forage (Hamilton and Wilson 2003). By late winter, when snow has consolidated and sinking depths are reduced, mountain caribou move to upper slopes and ridge tops, where they graze on arboreal lichen in the upper ESSF parkland zone (Stevenson et al. 2001; Mountain Caribou Technical Advisory Committee 2002). Mountain caribou move to lower elevations to obtain fresh, green vegetation in the spring and back to middle- and upper-elevation ESSF forests, ESSF parkland and alpine areas in the summer (Mountain Caribou Technical Advisory Committee 2002).

Mountain caribou are polygynous, with dominant bulls breeding with a number of cows in late September to mid-October. During the rut, mature bulls defend harems of up to a dozen (Cichowski et al. 2004). Gestation is about 230 days and calves are born in late May or early June in the ESSF, usually near or above the snowline. Pregnant females seek secluded sites in alpine and subalpine habitats to calve (Mountain Caribou Technical Advisory Committee 2002).

Home Range

Home range size can vary due to age, sex, reproductive status, distribution of food sources and season. For mountain caribou, home ranges of 150 – 600 km^2 are typical, but vary from <100 to >800 km^2 (Cichowski et al. 2004).

Distribution

Provincial Range

In BC, mountain caribou occur regularly in portions of the Rocky Mountains west slope from the Anzac through Morkil river drainages and from the Wood through Bush river drainages (BC CDC 2012). Distribution in the Rockies is fairly continuous with that in the Cariboo, northern Monashee and northern Selkirk Mountains and the eastern Quesnel and eastern Shuswap highlands (BC CDC 2012). Discontinuous range occurs to the northwest in the Fraser Plateau and to the south in: the southern Monashee Mountains, the northern Purcell and central Selkirk Mountains, the Purcell Mountains, and the southern Selkirk Mountains (BC CDC 2012).

The range of mountain caribou corresponds closely with the distribution of the Interior Wetbelt in southeastern and east-central BC (Stevenson et al. 2001). The Interior Wetbelt is composed of the wet and very wet subzones of the ESSF beogeoclimatic zone, wet and very wet subzones of the ICH zone, and very wet subzones of the Sub-Boreal Spruce (SBS) zone (Stevenson et al. 2001). Caribou in the northern end of the distribution use the SBS instead of or in addition to ICH, while portions of the South Purcell local population are seldom found to use the Mountain Spruce (MS) zone where it occurs in place of ICH (Cichowski et al. 2004). At high elevations, the AT zone is used by mountain caribou to varying degrees (Cichowski et al. 2004).

Within BC, mountain caribou consist of 13 sub-populations, with a loosely connected population distributed from the northern end of their range to the Trans-Canada Highway between Salmon Arm and Golden. South of the Trans-Canada Highway, the sub-populations are smaller and are largely isolated from each other (Stevenson et al. 2001). The most current population estimate (2004) provided by the Mountain Caribou Technical Advisory Committee was 1669 animals (BC CDC 2012).

Distribution in the Project Area

The project area overlaps with two mountain caribou planning units: 3A, the Revelstoke – Shuswap unit to the south and 4A, the Wells Gray – Thompson to the north (Mountain Caribou Science Team 2005). The caribou populations in these areas were estimated in 2006 to be 205 animals and 274 animals, respectively.

Within the project study area, the ESSFwc, ICHmw, and ICHwk biogeoclimatic variants are expected to be used by mountain caribou more than others (Cichowski et al. 2004). Expected occurrence in the study area by BGC variant is summarized inTable 110.

Table 110: Expected mountain caribou occurrence within the ecosection - BGC variant combinations found within the Project study area

Ecoprovince	Ecoregions	Ecosection	BGC Variants	Occurrence ?
SIM	COH	NSH	ESSFwc2, ESSFwcw, ESSFwcp, ICHdw3, ICHmw3,ICHwk1, IDFmw2	Yes

Elevation Range

Mountain caribou activity is found in a wide variety of elevations throughout the year. Populations occurring near the center of the current range and in areas with greater extremes of elevation tend to make more extensive use of elevations as low as 600 m for foraging, particularly in early winter and spring (Cichowski et al. 2004). Sometimes elevations up to 2500 m are used, particularly in the summer (Cichowski et al. 2004).

Food/cover Life Requisites and Habitat-uses

Habitat selection by mountain caribou is generally governed by forage selection, with a secondary focus on security and thermal requirements. Caribou feeding habitat often coincides with security/thermal cover in the winter, but growing season forage selection isn't as well-associated with security/thermal requirements (Hamilton and Wilson 2003). Females select higher-elevation habitats in the spring for calving to avoid predators. Therefore, life requisites were rated separately for food, security/thermal, and reproducing (Table 111).

Table 111: Life requisites that were rated for mountain caribou for the Project

Life Requisite	Season	Months	Ratings Column Title
Food (FD)	Early Winter	Nov – mid-Jan	MRATA_FDWE
Food (FD)	Late Winter	mid-Jan – mid-Apr	MRATA_FDWL
Food (FD)	Spring	mid-Apr - May	MRATA_FDP
Food (FD)	Summer/Fall	Jun - Oct	MRATA_FDS/F
Security/Thermal (ST)	All	All	MRATA_ST

Feeding

Food habits of mountain caribou are closely tied to food availability, and show seasonal variation.

Early Winter

Forage habitat is often dominated by *Paxistima myrisinites*, but generally also includes a variety of winter-green shrubs, forbs, graminoids and terrestrial lichens (Seip 1992; Cichowski et al. 2004). As snowfall increases, their diet shifts to arboreal lichens (*Alectoria* spp. and *Bryoria* spp.) obtained from litterfall and on windthrown trees or branches (Simpson et al. 1985; Hamilton and Wilson 2003).

Late Winter

In late winter, deep snowpack in high-elevations is used as a platform by mountain caribou who move to upper slopes and ridge tops where they graze on arboreal lichen (Stevenson et al. 2001; Mountain Caribou Technical Advisory Committee 2002; Cichowski et al. 2004). Lichens are either pulled directly from the branches of conifers, picked from the snow having been blown from the tree, or grazed from windthrown branches and trees (Simpson et al. 1985; Antifeau 1987; Ketcheson et al. 2001; Mountain Caribou Technical Advisory Committee 2002). Their diet consists almost entirely of *Bryoria* spp., with some *Alectoria sarmentosa* and possibly *Nodobryoria oregano* (Cichowski et al. 2004).

Spring

In mid-April, mountain caribou move to lower elevations to obtain fresh, green vegetation. Early spring feeding sites are those that are first to be free of snow, providing early season green-up and succulent vegetation (Hamilton and Wilson 2003). Areas used overlap with early-winter ranges but green vegetation, not lichen, is the main food source. The use of forbs and graminoids increases dramatically in the spring season (Cichowski et al. 2004).

These areas are important for animals recovering from a lichen dominated diet, and for cows preparing for the demands of lactation in relatively food-deficient calving areas (Scott and Servheen 1985).

Summer/Fall

Mountain caribou use middle- and upper-elevation ESSF forests, ESSF parkland and alpine areas in the summer (Mountain Caribou Technical Advisory Committee 2002). Summer/Fall forage includes a wide range of herbaceous and shrub vegetation including grasses, sedges, lichens, fungi, and numerous flowering plants and shrubs including Sitka valerian, horsetails, scrub birch, black huckleberry, willow species, and falsebox (Ketcheson et al. 2001; Mountain Caribou Technical Advisory Committee 2002; Cichowski et al. 2004).

Security/Thermal Shelter

Mountain caribou prefer large, contiguous patches of old forest, which provide security and thermal shelter (Cichowski et al. 2004). Structural stage 7 is consistently preferred throughout the year, while structural stage 6 also provides useful habitat, particularly at the older and more open end of the stage (Cichowski et al. 2004). This dominant pattern of selecting forested habitat for security and thermal value is recognized as a caribou preference for every season. Security and thermal preferences of mountain caribou are similar for every season.

Security cover provides mountain caribou with a sense of security or a means of escape from the threat of predators. Caribou prefer areas with high visibility for predator detection, seeking older forest habitats characterized by low shrub cover, low levels of conifer regeneration and gentle to moderate slopes (<45%). They spread out over large areas of suitable habitat, where it is difficult for predators to find them, showing a strong preference for old-growth forest over young forest in all seasons (Stevenson et al. 2001; Mountain Caribou Science Team 2005).

Thermal habitat allows caribou to expend less energy to maintain body temperature and allow allocation of conserved energy to growth and reproduction (Hamilton and Wilson 2003). Thermal habitat is more important for caribou in the winter, as this is when they are nutritionally stressed and need to conserve energy (Ketcheson et al. 2001). If winter conditions become unfavorable, caribou will retreat to the forest and bed down to conserve heat. In summer, mountain caribou have increased metabolic costs associated with heat dissipation that can lead to decreased summer weight gain while in winter animals lacking sufficient energy reserves are more vulnerable to winter-spring mortality (Mautz 1978).

Seasons of Use

The exact times of seasonal migrations and habitat used vary annually but four distinct seasonal habitat use patterns are generally recognized (Simpson and Woods 1987). Table 112 summarizes monthly life requisites that were rated for mountain caribou.

Table 112: Monthly life requisites being rated for mountain caribou for the Project

Month	Season	Life Requisites
January	Early Winter/Late Winter	Food, Security/Thermal
February	Late Winter	Food, Security/Thermal
March	Late Winter	Food, Security/Thermal
April	Late Winter	Food, Security/Thermal
May	Spring	Food, Security/Thermal
June	Spring	Food, Security/Thermal
July	Summer	Food, Security/Thermal
August	Summer	Food, Security/Thermal
September	Fall	Food, Security/Thermal
October	Fall	Food, Security/Thermal
November	Early Winter	Food, Security/Thermal
December	Early Winter	Food, Security/Thermal

*Seasons defined for the Southern Interior Mountains as per British Columbia Wildlife Habitat Rating Standards Version 2.0 (1999).

Habitat Use and Ecosystem Attributes

Mountain caribou require primarily feeding habitat in the winter and feeding and security/thermal habitat in the spring, summer and fall. Table 113 summarizes the specific attributes that mountain caribou utilize for feeding and security/thermal shelter.

Table 113: Summary of habitat attributes for mountain caribou feeding and shelter

Habitat Use	Specific Attributes for Suitable Mountain Caribou Habitat	Structural Stage
Early Winter Feeding	Mid to lower elevation ICH and ESSF/ICH ecotone forested habitat that support arboreal lichens. Feed on low shrubs (especially *Paxistima* spp.) when available.	(6), 7
Late Winter Feeding	High elevation forested ESSF habitat, feeding entirely on arboreal lichens (primarily *Bryoria* spp and *Alectoria sarmentosa*) found on live and dead standing trees, blowdown and litterfall. Some conifer foliage consumed.	(6), 7
Spring Feeding	Lower elevation, snow-free clearings and wetlands in the ICH and ICH/ESSF ecotone. Feed on new green vegetation in snow free habitats.	2, 3, (6), 7
Summer/Fall Feeding	Upper ICH/ESSF ecotone and ESSF zone, feeding on abundant and succulent vegetation: herbaceous green vegetation and shrubs including grasses, sedges, buds, lichens, and flowering plants.	(6), 7
Security/Thermal	Select sites where obstruction to visibility and movement are low; relatively open, older age class forest stands; gentle to moderate slopes.	(6), 7

Table 114 outlines how each life requisite relates to specific ecosystem attributes (e.g., site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 114: Ecosystem attributes used for mountain caribou habitat mapping in the Project study area

Life Requisite	Mapping Attributes
Feeding, Security/Thermal	Regional: BGC variant Site: Site map code, structural stage, aspect, slope, elevation

Wildlife Habitat Ratings

There is a detailed level of knowledge on the habitat requirements of the mountain caribou in British Columbia, and thus a 6-class rating scheme was used (Table 115).

Table 115: Habitat capability and suitability rating scheme (from RIC 1999)

% of Provincial Best	Rating	Class
76% - 100%	High	1
51% - 75%	Moderately High	2
26% - 50%	Moderate	3
6% - 25%	Low	4
1% - 5%	Very Low	5
0%	Nil	6

Provincial Benchmark

RIC (1999) defines the benchmark for Mountain Caribou habitat in the Southern Interior Mountains Ecoprovince as the following:

Winter

Ecosection: Cariboo Mountains (CAM)

Biogeoclimatic Zone: ESSFwk

Habitat: EF/6 - White Spruce-Subalpine Fir

Growing

Ecosection: Cariboo Mountains (CAM)

Biogeoclimatic Zone: ESSFwk

Habitat: SM – Subalpine Meadow

Habitat Ratings Model Assumptions

The assumptions used within the mountain caribou habitat suitability model are presented below:

Table 116: Habitat suitability ratings assumptions for mountain caribou feeding – early winter

Attribute	Assumption
BGC variant	ICHmw3 and ICHwk1 rated up to class 1
	ICHdw3 rated up to class 2
	ESSFwc2 rated up to class 4
	ESSFwcw, ESSFwcp and IDFmw2 rated up to class 5
Site map code	Dry forest units rated up to class 1
	Very dry and mesic forest units rated up to class 2
	Moist forest units rated up to class 3

	Wet forest units rated up to class 4
	Seral forest units and herbaceous and shrub units rated up to class 5
	All non-vegetated units and avalanche slopes rated class 6
Structural stage	Structural stage 7 rated up to class 1
	Structural stage 6 rated up to class 2
	Structural stage 5 rated up to class 4
	Structural stage 1 rated class 6
	All other structural stages rated up to class 5
Stand composition	Coniferous stands rated up to class 1
	Broadleaf and mixed stands rated up to class 5
Slope	Level sites, gentle slopes and moderate slopes rated up to class 1
	Steep slopes rated up to class 4

Table 117: Habitat suitability ratings assumptions for mountain caribou feeding – late winter

Attribute	Assumption
BGC variant	ESSFwc2, ESSFwcw and ESSFwcp rated up to class 1
	ICHmw3 and ICHwk1 rated up to class 4
	ICHdw3 rated up to class 5
	IDFmw2 rated class 6
Site map code	Non-seral forest units rated up to class 1
	Seral forest units rated up to class 5
	All non-forested units rated class 6
Structural stage	Structural stage 7 rated up to class 1
	Structural stage 6 rated up to class 2
	Structural stage 5 rated up to class 4
	Structural stage 1 rated class 6
	All other structural stages rated up to class 5
Stand composition	Coniferous stands will be rated up to class 1
	Broadleaf and mixed stands rated up to class 5
Slope	Level sites, gentle slopes and moderate slopes rated up to class 1
	Steep slopes rated up to class 4

Table 118: Habitat suitability ratings assumptions for mountain caribou feeding – spring

Attribute	Assumption
BGC variant	ICHmw3 and ICHwk1 rated up to class 1
	ICHdw3 rated up to class 2
	ESSFwc2 and IDFmw2 rated up to class 4
	ESSFwcw and ESSFwcp rated up to class 5
Site map code	Riparian forest, meadow and wetland units rated up to class 1
	Moist and wet forest units rated up to class 2
	Dry and mesic forest units rated up to class 3
	All other vegetated units rated up to class 5
	All non-vegetated units rated class 6
Structural stage	Structural stage 2 rated up to class 1
	Structural stages 6 and 7 rated up to class 2
	Structural stage 3 rated up to class 3
	Structural stage 1 rated class 6
	All other structural stages rated up to class 5
Slope	Warm aspect, level and gentle slope sites rated up to class 1
	Cool aspect sites rated up to class 4
	Steep slopes rated up to class 5

Table 119: Habitat suitability ratings assumptions for mountain caribou feeding – summer/fall

Attribute	Assumption
BGC variant	ESSF rated up to class 1
	ICH rated up to class 4
	IDF rated class 6
Site map code	Wet forest, moist forest, meadow and wetland units rated up to class 1
	Riparian forest and avalanche units rated up to class 2
	Dry and mesic forest units rated up to class 4
	All other vegetated units rated up to class 5
	All non-vegetated units rated class 6
Structural stage	Structural stages 6-7 rated up to class 1
	Structural stage 2 rated up to class 2
	Structural stages 3 rated up to class 3
	Structural stage 1 rated class 6
	All other structural stages rated up to class 5

Slope	Level, gentle slopes rated up to class 1
	Cool and warm aspect sites rated up to class 2
	Steep slopes rated up to class 4

Table 120: Habitat suitability ratings assumptions for mountain caribou security/thermal

Attribute	Assumption
BGC variant	ESSF and ICH rated up to class 1
	IDF rated class 5
Site map code	Moist, wet and riparian forest units rated up to class 1
	Mesic and dry forest units rated up to class 2
	All other vegetated units rated up to class 5
	All non-vegetated units rated class 6
Structural stage	Structural stages 6-7 rated up to class 1
	Structural stage 5 rated up to class 2
	Structural stage 4 rated up to class 3
	Structural stage 3 rated up to class 4
	All other structural stages rated class 6

Field Ratings Summary

Table 121 shows the distribution of ratings collected during field plots within the study area for the various caribou seasons and life requisites.

Table 121: Number of field ratings in each class for caribou

	1	2	3	4	5	6	Total
MRATA_FDWE	2	3	7	2	11	34	59
MRATA_FDWL	3	4	3	2	4	43	59
MRATA_FDP	2	0	1	2	20	34	59
MRATA_FDSF	0	2	6	6	14	31	59
MRATA_ST	11	7	10	9	1	21	59

Rating Adjustments

No adjustments were made to the caribou habitat model.

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Appendix 4: Vascular Plants Found within the Local Study Area

Scientific Name	Common Name
Abies lasiocarpa	subalpine fir
Acer glabrum var. douglasii	Douglas maple
Achillea millefolium var. alpicola	yarrow
Achillea millefolium var. lanulosa	yarrow
Achnatherum nelsonii ssp. dorei	Columbia needlegrass
Achnatherum richardsonii	spreading needlegrass
Acmispon denticulatus	meadow birds-foot trefoil
Actaea rubra	baneberry
Adenocaulon bicolor	pathfinder
Agoseris aurantiaca	orange agoseris
Agoseris glauca	short-beaked agoseris
Agoseris lackschewitzii	pink agoseris
Agoseris sp.	no common name
Agrostis exarata	spike bentgrass
Agrostis gigantea	redtop
Agrostis humilis	alpine bentgrass
Agrostis idahoensis	Idaho bentgrass
Agrostis mertensii	northern bentgrass
Agrostis scabra	hair bentgrass
Agrostis stolonifera	creeping bentgrass
Alnus incana ssp. tenuifolia	mountain alder
Alnus viridis ssp. sinuata	sitka alder
Alopecurus aequalis	little meadow-foxtail
Amelanchier alnifolia	saskatoon
Amelanchier alnifolia var. semiintegrifolia	saskatoon
Anaphalis margaritacea	pearly everlasting
Anemone multifida var. multifida	cut-leaved anemone
Anemone multifida var. saxicola	cut-leaved anemone
Anemone occidentalis	western pasqueflower
Angelica genuflexa	kneeling angelica
Antennaria alpina	alpine pussytoes
Antennaria anaphaloides	showy pussytoes
Antennaria howellii ssp. canadensis	Howell's pussytoes
Antennaria howellii ssp. howellii	Howell's pussytoes
Antennaria lanata	woolly pussytoes

Scientific Name	Common Name
Antennaria monocephala	one-headed pussytoes
Antennaria parvifolia	Nuttall's pussytoes
Antennaria racemosa	racemose pussytoes
Antennaria rosea	rosy pussytoes
Antennaria umbrinella	umber pussytoes
Apocynum androsaemifolium var. androsaemifolium	spreading dogbane
Aquilegia formosa	sitka columbine
Arabidopsis lyrata ssp. kamchatica	Kamchatka rockcress
Arabidopsis thaliana	mouse-ear
Arabis eschscholtziana	Eschscholtz's rockcress
Aralia nudicaulis	wild sarsaparilla
Arctium minus	common burdock
Arctostaphylos uva-ursi	kinnikinnick
Arenaria serpyllifolia	thyme-leaved sandwort
Arnica chamissonis ssp. chamissonis	meadow arnica
Arnica cordifolia	heart-leaved arnica
Arnica gracilis	tall mountain arnica
Arnica latifolia	mountain arnica
Arnica mollis	hairy arnica
Arnica parryi	Parry's arnica
Artemisia borealis ssp. borealis	northern wormwood
Artemisia campestris ssp. pacifica	northern wormwood
Artemisia frigida	prairie sagewort
Artemisia michauxiana	Michaux's mugwort
Artemisia norvegica ssp. saxatilis	mountain sagewort
Asparagus officinalis	garden asparagus
Astragalus miser var. serotinus	timber milk-vetch
Athyrium filix-femina	lady fern
Balsamorhiza sagittata	arrowleaf balsamroot
Berteroa incana	hoary alyssum
Betula papyrifera	paper birch
Bistorta vivipara	alpine bistort
Boechera collinsii	Collin's suncress
Boechera drepanoloba	pointing suncress
Boechera grahamii	Graham's suncress
Boechera lemmonii	Lemmon's suncress
Boechera macounii	littleleaf suncress

Scientific Name	Common Name
Boechera retrofracta	dangling suncress
Boechera stricta	straight-up suncress
Botrychium multifidum	leathery grape fern
Botrychium virginianum	rattlesnake fern
Bromus carinatus	California brome
Bromus ciliatus	fringed brome
Bromus inermis	smooth brome
Bromus riparius	meadow brome
Bromus tectorum	cheatgrass
Bromus vulgaris	Columbia brome
Buglossoides arvensis	corn gromwell
Calamagrostis canadensis	bluejoint reedgrass
Calamagrostis canadensis var. langsdorfii	bluejoint reedgrass
Calamagrostis purpurascens	purple reedgrass
Calamagrostis rubescens	pinegrass
Calamagrostis stricta	slimstem reedgrass
Callitriche hermaphroditica	northern water-starwort
Callitriche palustris	spring water-starwort
Caltha leptosepala var. leptosepala	white mountain marsh-marigold
Calypso bulbosa	fairy-slipper
Campanula rotundifolia	common harebell
Canadanthus modestus	great northern aster
Capsella bursa-pastoris	shepherd's purse
Cardamine oligosperma	little western bittercress
Cardamine umbellata	umbel bittercress
Carex aquatilis var. aquatilis	water sedge
Carex atrosquama	black-scaled sedge
Carex aurea	golden sedge
Carex brunnescens	brownish sedge
Carex canescens ssp. canescens	grey sedge
Carex capillaris	hairlike sedge
Carex chordorrhiza	cordroot sedge
Carex concinna	low northern sedge
Carex concinnoides	northwestern sedge
Carex cordillerana	mountain-range sedge
Carex deflexa	bent sedge
Carex disperma	soft-leaved sedge

Scientific Name	Common Name
Carex garberi	Garber's sedge
Carex gynocrates	yellow bog sedge
Carex hoodii	Hood's sedge
Carex illota	sheep sedge
Carex interior	inland sedge
Carex lachenalii	two-parted sedge
Carex laeviculmis	smooth-stemmed sedge
Carex lenticularis var. lipocarpa	Kellogg's sedge
Carex leptalea	bristle-stalked sedge
Carex leptopoda	short-scaled sedge
Carex limosa	shore sedge
Carex macloviana	Falkland Island sedge
Carex magellanica ssp. irrigua	poor sedge
Carex media	Scandinavian sedge
Carex mertensii	Merten's sedge
Carex microptera	small-winged sedge
Carex nigricans	black alpine sedge
Carex pachystachya	thick-headed sedge
Carex paysonis	Payson's sedge
Carex phaeocephala	dunhead sedge
Carex praeceptorum	teacher's sedge
Carex praticola	meadow sedge
Carex preslii	Presl's sedge
Carex rossii	Ross' sedge
Carex rupestris ssp. drummondiana	curly sedge
Carex saxatilis	russet sedge
Carex scopulorum var. bracteosa	Holm's Rocky Mountain sedge
Carex sitchensis	Sitka sedge
Carex spectabilis	showy sedge
Carex stylosa	long-styled sedge
Carex tahoensis	Tahoe sedge
Carex tracyi	Tracy's sedge
Carex utriculata	beaked sedge
Cassiope mertensiana	white mountain-heather
Cassiope mertensiana var. mertensiana	white mountain-heather
Castilleja hispida	harsh paintbrush
Castilleja miniata	scarlet paintbrush

Scientific Name	Common Name
Castilleja rhexiifolia	alpine paintbrush
Castilleja septentrionalis	sulphur paintbrush
Ceanothus sanguineus	redstem ceanothus
Ceanothus velutinus var. velutinus	snowbrush
Centaurea stoebe	spotted knapweed
Cerastium arvense	field chickweed
Cerastium fontanum	mouse-ear chickweed
Chenopodium album	lamb's-quarters
Chenopodium fremontii	Fremont's goosefoot
Chenopodium simplex	maple-leaved goosefoot
Chimaphila umbellata ssp. occidentalis	prince's pine
Cichorium intybus	chicory
Cinna latifolia	nodding wood-reed
Circaea alpina	enchanter's-nightshade
Cirsium arvense	Canada thistle
Cirsium flodmanii	Flodman's thistle
Cirsium foliosum	leafy thistle
Cirsium hookerianum	Hooker's thistle
Cirsium vulgare	bull thistle
Claytonia sarmentosa	Alaska springbeauty
Clematis occidentalis	Columbia bower
Clintonia uniflora	queen's cup
Collomia linearis	narrow-leaved collomia
Comandra umbellata var. pallida	pale comandra
Comarum palustre	marsh cinquefoil
Conyza canadensis	horseweed
Corallorhiza maculata	spotted coralroot
Corallorhiza striata	striped coralroot
Corallorhiza trifida	yellow coralroot
Cornus canadensis	bunchberry
Cornus stolonifera	red-osier dogwood
Corydalis aurea	golden corydalis
Corylus cornuta var. cornuta	beaked hazelnut
Crataegus douglasii	black hawthorn
Crepis atribarba	slender hawksbeard
Crepis tectorum	annual hawksbeard
Cryptogramma stelleri	slender rock-brake

Scientific Name	Common Name
Cypripedium montanum	mountain lady's-slipper
Cystopteris fragilis	fragile fern
Dactylis glomerata	orchard-grass
Danthonia intermedia	timber oatgrass
Danthonia spicata	poverty oatgrass
Delphinium nuttallianum	upland larkspur
Deschampsia elongata	slender hairgrass
Descurainia nelsonii	Nelson's tansymustard
Descurainia pinnata ssp. brachycarpa	short-fruited tansymustard
Diphasiastrum alpinum	alpine club-moss
Diphasiastrum sitchense	Alaska club-moss
Draba albertina	slender draba
Draba cana	lance-leaved draba
Draba nemorosa	woods draba
Draba praealta	tall draba
Drosera rotundifolia	round-leaved sundew
Dryas drummondii	yellow mountain-avens
Drymocallis convallaria	white cinquefoil
Dryopteris carthusiana	toothed wood fern
Dryopteris expansa	spiny wood fern
Eleocharis quinqueflora	few-flowered spike-rush
Elymus glaucus	blue wildrye
Elymus glaucus ssp. glaucus	blue wildrye
Elymus hirsutus	hairy wildrye
Elymus lanceolatus	thickspike wildrye
Elymus repens	quackgrass
Elymus trachycaulus ssp. subsecundus	slender wheatgrass
Elymus trachycaulus ssp. trachycaulus	slender wheatgrass
Elymus violaceus	arctic wheatgrass
Epilobium anagallidifolium	alpine willowherb
Epilobium angustifolium	fireweed
Epilobium brachycarpum	tall annual willowherb
Epilobium ciliatum	purple-leaved willowherb
Epilobium ciliatum ssp. glandulosum	purple-leaved willowherb
Epilobium clavatum	club-fruited willowherb
Epilobium hornemannii ssp. hornemannii	Hornemann's willowherb
Epilobium lactiflorum	white-flowered willowherb

Scientific Name	Common Name
Epilobium latifolium	broad-leaved willowherb
Epilobium leptocarpum	small-fruited willowherb
Equisetum arvense	common horsetail
Equisetum fluviatile	swamp horsetail
Equisetum hyemale	scouring-rush
Equisetum laevigatum	smooth scouring-rush
Equisetum palustre	marsh horsetail
Equisetum pratense	meadow horsetail
Equisetum sylvaticum	wood horsetail
Equisetum variegatum	northern scouring-rush
Eremogone capillaris var. americana	thread-leaved sandwort
Erigeron acris var. kamtschaticus	bitter fleabane
Erigeron compositus	cut-leaved daisy
Erigeron peregrinus ssp. callianthemus	subalpine daisy
Erigeron speciosus	showy daisy
Eriophorum angustifolium	narrow-leaved cotton-grass
Erysimum inconspicuum	small wallflower
Erythronium grandiflorum	yellow glacier lily
Eucephalus engelmannii	Engelmann's aster
Euphrasia nemorosa	eastern eyebright
Euphrasia subarctica	arctic eyebright
Eurybia conspicua	showy aster
Eurybia merita	arctic aster
Festuca idahoensis	Idaho fescue
Festuca occidentalis	western fescue
Festuca rubra ssp. rubra	red fescue
Festuca rubra ssp. vallicola	mountain red fescue
Festuca saximontana	Rocky Mountain fescue
Festuca subulata	bearded fescue
Fragaria vesca var. bracteata	wood strawberry
Fragaria virginiana var. glauca	wild strawberry
Fragaria virginiana var. platypetala	wild strawberry
Gaillardia aristata	brown-eyed Susan
Galium aparine	cleavers
Galium boreale	northern bedstraw
Galium trifidum	small bedstraw
Galium trifidum ssp. trifidum	small bedstraw

Scientific Name	Common Name
Galium triflorum	sweet-scented bedstraw
Gaultheria hispidula	creeping-snowberry
Gaultheria humifusa	alpine-wintergreen
Gentiana glauca	glaucous gentian
Gentianella amarella	northern gentian
Geranium bicknellii	Bicknell's geranium
Geum macrophyllum ssp. macrophyllum	large-leaved avens
Glyceria striata	fowl mannagrass
Goodyera oblongifolia	rattlesnake-plantain
Goodyera repens	dwarf rattlesnake orchid
Gymnocarpium dryopteris	oak fern
Hackelia deflexa	nodding stickseed
Heracleum maximum	cow-parsnip
Heterotheca villosa	golden-aster
Heuchera cylindrica var. cylindrica	round-leaved alumroot
Hieracium albiflorum	white hawkweed
Hieracium aurantiacum	orange-red king devil
Hieracium caespitosum	yellow king devil
Hieracium gracile	slender hawkweed
Hieracium scouleri	Scouler's hawkweed
Hieracium triste	woolly hawkweed
Hieracium umbellatum	narrow-leaved hawkweed
Huperzia haleakalae	alpine fir-moss
Hypericum perforatum	common St. John's-wort
Isoetes bolanderi	Bolander's quillwort
Isoetes howellii	Howell's quillwort
Juncus articulatus	jointed rush
Juncus drummondii	Drummond's rush
Juncus ensifolius	dagger-leaf rush
Juncus filiformis	thread rush
Juncus mertensianus	Mertens' rush
Juncus parryi	Parry's rush
Juncus regelii	Regel's rush
Juncus tenuis	slender rush
Juniperus communis	common juniper
Juniperus scopulorum	Rocky Mountain juniper
Kalmia microphylla	western bog-laurel

Scientific Name	Common Name
Koeleria macrantha	junegrass
Lappula occidentalis var. occidentalis	western stickseed
Lappula squarrosa	bristly stickseed
Lathyrus ochroleucus	creamy peavine
Lepidium densiflorum	prairie pepper-grass
Leptarrhena pyrolifolia	leatherleaf saxifrage
Leucanthemum vulgare	oxeye daisy
Lilium columbianum	tiger lily
Linaria genistifolia ssp. dalmatica	Dalmatian toadflax
Linnaea borealis	twinflower
Listera cordata	heart-leaved twayblade
Lithophragma glabrum	smooth fringecup
Lithophragma parviflorum	small-flowered fringecup
Logfia arvensis	field filago
Lolium perenne	perennial ryegrass
Lomatium dissectum var. multifidum	fern-leaved desert-parsley
Lomatium macrocarpum	large-fruited desert-parsley
Lonicera involucrata	black twinberry
Luetkea pectinata	partridge-foot
Lupinus arcticus ssp. subalpinus	arctic lupine
Lupinus latifolius var. latifolius	broadleaf lupine
Luzula multiflora	many-flowered wood-rush
Luzula parviflora	small-flowered wood-rush
Luzula piperi	Piper's wood-rush
Lycopodium annotinum	stiff club-moss
Lycopodium clavatum var. clavatum	running club-moss
Mahonia repens	creeping Oregon-grape
Maianthemum racemosum	false Solomon's-seal
Maianthemum stellatum	star-flowered false Solomon's-seal
Malus pumila	cultivated apple
Matricaria discoidea	pineapple weed
Medicago lupulina	black medic
Medicago sativa	alfalfa
Melica subulata	Alaska oniongrass
Melilotus alba	white sweet-clover
Menziesia ferruginea ssp. ferruginea	false azalea
Micranthes lyallii	red-stemmed saxifrage

Scientific Name	Common Name
Micranthes lyallii	red-stemmed saxifrage
Micranthes occidentalis	western saxifrage
Microseris nutans	nodding microseris
Mimulus moschatus var. moschatus	musk-flower
Minuartia rubella	boreal sandwort
Mitella breweri	Brewer's mitrewort
Mitella pentandra	five-stamened mitrewort
Moehringia lateriflora	blunt-leaved sandwort
Monarda fistulosa var. menthaefolia	wild bergamot
Moneses uniflora	single delight
Mycelis muralis	wall lettuce
Myosotis laxa	small-flowered forget-me-not
Oenothera biennis	common evening-primrose
Oplopanax horridus	devil's club
Orobanche fasciculata	clustered broomrape
Orthilia secunda	one-sided wintergreen
Orthilia secunda var. secunda	one-sided wintergreen
Oryzopsis asperifolia	rough-leaved ricegrass
Osmorhiza berteroi	mountain sweet-cicely
Osmorhiza depauperata	blunt-fruited sweet-cicely
Osmorhiza purpurea	purple sweet-cicely
Oxycoccus oxycoccos	bog cranberry
Oxyria digyna	mountain sorrel
Packera cana	woolly groundsel
Packera indecora	rayless mountain butterweed
Packera pauciflora	rayless alpine butterweed
Parietaria pensylvanica	Pennsylvania pellitory
Parnassia fimbriata	fringed grass-of-Parnassus
Paxistima myrsinites	falsebox
Pedicularis bracteosa var. bracteosa	bracted lousewort
Pedicularis racemosa	sickletop lousewort
Pellaea gastonyi	Gastony's cliff-brake
Pellaea glabella ssp. simplex	simple cliff-brake
Penstemon fruticosus var. fruticosus	shrubby penstemon
Penstemon serrulatus	coast penstemon
Petasites frigidus var. palmatus	palmate coltsfoot
Petasites frigidus var. sagittatus	arrow-leaved coltsfoot

Scientific Name	Common Name
Phacelia hastata	silverleaf phacelia
Phacelia linearis	thread-leaved phacelia
Phalaris arundinacea	reed canarygrass
Phleum alpinum	alpine timothy
Phleum pratense	common timothy
Phyllodoce empetriformis	pink mountain-heather
Phyllodoce glanduliflora	yellow mountain-heather
Picea engelmannii	Engelmann spruce
Picea engelmannii x glauca	hybrid white spruce
Pinus contorta var. latifolia	lodgepole pine
Pinus monticola	western white pine
Piperia unalascensis	Alaska rein orchid
Plantago major	common plantain
Plantago patagonica	woolly plantain
Platanthera aquilonis	northern green rein orchid
Platanthera dilatata	fragrant white rein orchid
Platanthera stricta	slender rein orchid
Poa alpina ssp. alpina	alpine bluegrass
Poa annua	annual bluegrass
Poa arctica	arctic bluegrass
Poa compressa	Canada bluegrass
Poa cusickii ssp. epilis	Cusick's bluegrass
Poa glauca	glaucous bluegrass
Poa glauca ssp. rupicola	glaucous bluegrass
Poa leptocoma	bog bluegrass
Poa nemoralis ssp. interior	interior bluegrass
Poa pratensis ssp. alpigena	Kentucky bluegrass
Poa pratensis ssp. pratensis	Kentucky bluegrass
Poa secunda ssp. juncifolia	Nevada bluegrass
Poa secunda ssp. secunda	Sandberg's bluegrass
Poa sp.	bluegrass
Poa wheeleri	Wheeler's bluegrass
Polygonum aviculare	common knotweed
Polygonum douglasii	Douglas's knotweed
Polygonum spergulariiforme	spurry knotweed
Polystichum lonchitis	northern holly fern
Populus tremuloides	trembling aspen

Scientific Name	Common Name
Populus trichocarpa	black cottonwood
Potamogeton pusillus	small pondweed
Potentilla argentea	silvery cinquefoil
Potentilla drummondii	Drummond's cinquefoil
Potentilla hookeriana ssp. hookeriana	Hooker's cinquefoil
Potentilla norvegica	Norwegian cinquefoil
Potentilla recta	sulphur cinquefoil
Prosartes hookeri	Hooker's fairybells
Prunella vulgaris ssp. lanceolata	self-heal
Prunus emarginata	bitter cherry
Prunus pensylvanica	pin cherry
Prunus virginiana	choke cherry
Pseudognaphalium macounii	sticky cudweed
Pseudognaphalium sp.	cudweed
Pseudoroegneria spicata	bluebunch wheatgrass
Pseudotsuga menziesii	Douglas-fir
Pterospora andromedea	pinedrops
Pyrola asarifolia	pink wintergreen
Pyrola chlorantha	green wintergreen
Pyrola minor	lesser wintergreen
Ranunculus acris	meadow buttercup
Ranunculus eschscholtzii	subalpine buttercup
Ranunculus flammula	creeping spearwort
Ranunculus gmelinii	small yellow water-buttercup
Ranunculus repens	creeping buttercup
Ranunculus sceleratus var. multifidus	celery-leaved buttercup
Ranunculus uncinatus	little buttercup
Rhinanthus minor	yellow rattle
Rhododendron albiflorum	white-flowered rhododendron
Rhus glabra	smooth sumac
Ribes lacustre	black gooseberry
Ribes oxyacanthoides ssp. oxyacanthoides	northern gooseberry
Rorippa curvisiliqua	western yellowcress
Rorippa sp.	yellowcress
Rosa acicularis	prickly rose
Rosa gymnocarpa	baldhip rose
Rosa woodsii	prairie rose

Scientific Name	Common Name
Rubus idaeus	red raspberry
Rubus parviflorus	thimbleberry
Rubus parviflorus var. parviflorus	thimbleberry
Rubus pedatus	five-leaved bramble
Rubus pubescens	dwarf red raspberry
Rumex acetosella	sheep sorrel
Sagina nivalis	snow pearlwort
Sagina procumbens	bird's-eye pearlwort
Sagina saginoides	arctic pearlwort
Salix alaxensis var. longistylis	Alaska willow
Salix barclayi	Barclay's willow
Salix barrattiana	Barratt's willow
Salix bebbiana	Bebb's willow
Salix commutata	under-green willow
Salix discolor	pussy willow
Salix drummondiana	Drummond's willow
Salix glauca	grey-leaved willow
Salix melanopsis	dusky willow
Salix pedicellaris	bog willow
Salix planifolia	plane-leaved willow
Salix pseudomonticola	serviceberry willow
Salix scouleriana	Scouler's willow
Salix sitchensis	sitka willow
Sambucus racemosa	red elderberry
Saxifraga bronchialis ssp. austromontana	spotted saxifrage
Scirpus cyperinus	woolgrass
Sedum lanceolatum var. lanceolatum	lance-leaved stonecrop
Sedum stenopetalum	worm-leaved stonecrop
Selaginella scopulorum	cliff selaginella
Selaginella wallacei	Wallace's selaginella
Senecio integerrimus var. exaltatus	western groundsel
Senecio triangularis	arrow-leaved groundsel
Shepherdia canadensis	soopolallie
Sibbaldia procumbens	sibbaldia
Silene antirrhina	sleepy catchfly
Silene latifolia ssp. alba	white cockle
Silene menziesii	Menzies' campion

Scientific Name	Common Name
Silene parryi	Parry's campion
Sisyrinchium montanum	mountain blue-eyed-grass
Solidago lepida	western Canada goldenrod
Solidago simplex var. simplex	spikelike goldenrod
Sorbus scopulina	western mountain-ash
Sorbus sitchensis	sitka mountain-ash
Sparganium emersum	emersed bur-reed
Sparganium hyperboreum	northern bur-reed
Spergularia rubra	red sand-spurry
Spiraea betulifolia ssp. lucida	birch-leaved spirea
Spiranthes romanzoffiana	hooded ladies' tresses
Stellaria calycantha	northern starwort
Stellaria crispa	crisp starwort
Stellaria longipes var. monantha	long-stalked starwort
Stellaria media	common chickweed
Stellaria nitens	shining starwort
Stellaria obtusa	blunt-sepaled starwort
Streptopus amplexifolius	clasping twistedstalk
Streptopus amplexifolius var. chalazatus	clasping twistedstalk
Streptopus lanceolatus var. curvipes	rosy twistedstalk
Symphoricarpos albus var. laevigatus	common snowberry
Symphyotrichum ciliolatum	Lindley's aster
Symphyotrichum ericoides	tufted white prairie aster
Symphyotrichum foliaceum var. apricum	alpine leafybract aster
Symphyotrichum foliaceum var. foliaceum	leafy aster
Tanacetum vulgare	common tansy
Taraxacum alaskanum	Alaska dandelion
Taraxacum ceratophorum	horned dandelion
Taraxacum officinale	common dandelion
Taxus brevifolia	western yew
Thalictrum occidentale	western meadowrue
Thalictrum venulosum	veiny meadowrue
Thinopyrum intermedium	intermediate wheatgrass
Thuja plicata	western redcedar
Tiarella trifoliata var. trifoliata	three-leaved foamflower
Tiarella trifoliata var. unifoliata	one-leaved foamflower
Torreyochloa pauciflora	weak false-manna

Scientific Name	Common Name
Toxicodendron rydbergii	poison ivy
Toxicoscordion venenosum	meadow death-camas
Tragopogon dubius	yellow salsify
Triantha glutinosa	sticky false asphodel
Triantha occidentalis	western false asphodel
Trichophorum cespitosum	tufted clubrush
Trientalis europaea ssp. arctica	northern starflower
Trifolium aureum	yellow clover
Trifolium hybridum	alsike clover
Trifolium pratense	red clover
Trifolium repens	white clover
Triglochin palustris	marsh arrrow-grass
Trisetum canescens	tall trisetum
Trisetum cernuum	nodding trisetum
Trisetum spicatum	spike trisetum
Triticum aestivum	wheat
Trollius albiflorus	globeflower
Tsuga heterophylla	western hemlock
Turritis glabra	tower mustard
Typha latifolia	common cattail
Urtica dioica	stinging nettle
Utricularia minor	lesser bladderwort
Vaccinium caespitosum	dwarf blueberry
Vaccinium membranaceum	black huckleberry
Vaccinium ovalifolium	oval-leaved blueberry
Vaccinium uliginosum	bog blueberry
Vahlodea atropurpurea	mountain hairgrass
Valeriana sitchensis	sitka valerian
Veratrum viride	Indian hellebore
Verbascum thapsus	great mullein
Veronica arvensis	wall speedwell
Veronica beccabunga ssp. americana	American speedwell
Veronica serpyllifolia var. humifusa	thyme-leaved speedwell
Veronica wormskjoldii	alpine speedwell
Veronica wormskjoldii var. wormskjoldii	alpine speedwell
Viburnum edule	highbush-cranberry
Viburnum opulus var. americanum	American bush-cranberry

Scientific Name	Common Name
Vicia americana	American vetch
Viola adunca	early blue violet
Viola canadensis	Canada violet
Viola epipsila	dwarf marsh violet
Viola glabella	stream violet
Viola macloskeyi	small white violet
Viola nephrophylla	northern bog violet
Viola orbiculata	round-leaved violet
Viola palustris	marsh violet
Vulpia octoflora	six-weeks grass
Woodsia scopulina	mountain cliff fern

Appendix 5: Rare Lichens Found within the Local Study Area

Species	Total Occurrences	BC List	Provincial Status	Global Status
Collema bachmanianum (Caesar's tarpaper)	1	Red	S2	GNR
Collema cristatum var. marginale (fingered tarpaper)	1	Red	S2	G3G5TNR
Collema polycarpon (gilled tarpaper)	1	Red	S2	GNR
Dermatocarpon atrogranulosum (charred stippleback)	1	Red	S1	GNR
Dermatocarpon leptophyllodes (jigsaw stippleback)	1	Blue	S2S4	GNR
Hypogymnia recurva (recoiling bone)	1	Red	S1S3	GNR
Lempholemma polyanthes (mourning phlegm)	1	Blue	S2S3	GNR
Leptogium intermedium (fourty-five vinyl)	1	Blue	S2S3	GNR
Leptogium plicatile (starfish vinyl)	1	Blue	S3?	G3?
Peltigera castanea (chestnut pelt)	1	Red	S1	GNR
Phaeophyscia adiastola (granulating shadow)	1	Red	S1	G4?
Phaeophyscia ciliata (greater eye shadow)	1	Blue	S2S3	G4G5
Phaeophyscia decolor (lesser eye shadow)	1	Blue	S2S3	G3G5
Phaeophyscia kairamoi (five o'clock shadow)	1	Blue	S3	G3G4
Phaeophyscia nigricans (least shadow)	1	Red	S1	G4
Physciella chloantha (downside shade)	1	Blue	S3	G5?

Species	**Total Occurrences**	**BC List**	**Provincial Status**	**Global Status**
Placynthium asperellum (sandpaper ink)	1	Blue	S3?	G3G5
Placynthium stenophyllum var. isidiatum (sepia ink)	1	Blue	S3	G2G4T2T4
Synalissa symphorea (eyed rockgorgon)	1	Blue	S3	GNR
Thallinocarpon nigritellum (black rocklicorice)	1	Blue	S3	G4G5
Thyrea confusa (candied gummybear)	1	Blue	S2S3	G3G5
Anema nodulosum (no common name)	1	–	–	–
Lempholemma chalazanum (no common name)	1	–	–	–
Lichinella sp. nov. (no common name)	1	–	–	–
Peccania subnigra (no common name)	1	–	–	–
Physconia isidiomuscigena (no common name)	1	–	–	–
Placidiopsis sp. nov. (no common name)	1	–	–	–

Appendix 6: Ecosystem Composition of Local Study Area (in hectares)

BGC Variant	Site Series	Map Code	Structural Stage								Total Area
			0	1	2	3	4	5	6	7	
ESSFwc2	01					533.7	517.6	99.1	66.6	1298.2	2515.3
ESSFwc2	02				0.4	74.2	42.2	29.9	7.5	100.7	254.9
ESSFwc2	03					148.5	115.0	146.7	52.3	337.1	799.7
ESSFwc2	04				0.6	272.6	77.2	18.8	24.7	194.4	588.2
ESSFwc2	05					3.6		1.7		0.2	5.5
ESSFwc2	06					24.3	8.5		8.8	28.3	69.9
ESSFwc2	07					1.8				0.4	2.2
ESSFwc2	09					1.4			5.5	13.5	20.3
ESSFwc2	73			0.8							0.8
ESSFwc2	79				24.9						24.9
ESSFwc2	92					0.5					0.5
ESSFwc2	Sc03				2.5						2.5
ESSFwc2	Wf03				125.2						125.2
ESSFwc2	Wf04				16.8	17.1					33.9
ESSFwc2	Wf11				3.4						3.4
ESSFwc2	00	CL		0.5							0.5
ESSFwc2	00	OW	2.3								2.3
ESSFwcp	Sc03				1.9						1.9
ESSFwcp	Wf03				2.8						2.8
ESSFwcp	00	FJ								9.9	9.9
ESSFwcp	00	FL								5.3	5.3
ESSFwcp	00	FR								34.0	34.0
ESSFwcp	00	FV			0.7					1.7	2.3
ESSFwcp	00	HL			1.9						1.9
ESSFwcp	00	TA		0.3							0.3
ESSFwcw	01					137.0	45.8			261.5	444.2
ESSFwcw	02					2.2				92.1	94.3
ESSFwcw	03					1.4				6.2	7.6
ESSFwcw	04					4.5				1.4	5.9
ESSFwcw	06					65.2	21.1			80.7	167.0
ESSFwcw	Wf12				1.6						1.6
ESSFwcw	Wf13				33.5						33.5
ICHdw3	01					316.4	51.7	167.6	655.8	50.8	1242.3
ICHdw3	02					7.0	3.6		11.3		21.9
ICHdw3	03					49.2	14.6	19.6	127.2	13.9	224.3
ICHdw3	04					18.8	6.7	14.8	99.0	39.8	179.1
ICHdw3	05					9.6		11.6			21.2
ICHdw3	06					2.5	3.0		15.9	10.3	31.6

BGC Variant	Site Series	Map Code	Structural Stage								Total Area
			0	1	2	3	4	5	6	7	
ICHdw3	00	CL		3.4							3.4
ICHdw3	00	GP		0.6							0.6
ICHdw3	00	UR	1.2								1.2
ICHmw3	01					367.8	16.1	3.2	421.5	263.4	1072.1
ICHmw3	02								3.4		3.4
ICHmw3	03					8.6					8.6
ICHmw3	04					1.7			3.9	2.7	8.3
ICHmw3	05					63.9	149.0		173.1	46.4	432.3
ICHmw3	06					59.8	21.0		49.9	77.9	208.5
ICHmw3	08					28.4	2.7		15.4	18.7	65.2
ICHmw3	10					9.6					9.6
ICHmw3	Ws02					3.2					3.2
ICHmw3	Ws04					2.8					2.8
ICHmw3	00	RZ	1.4								1.4
ICHwk1	01					2.6	4.9	8.1		5.0	20.6
ICHwk1	02							0.8			0.8
ICHwk1	03							14.9	0.4		15.3
ICHwk1	04					4.0		59.7	1.1		64.8
ICHwk1	06					8.0		5.1	0.4		13.5
ICHwk1	07					0.0			0.0		0.0
IDFmw2	01					98.8	119.9	125.5	432.4	46.5	823.1
IDFmw2	02					1.9	2.7	3.4	9.0		16.9
IDFmw2	03					7.7	36.1	3.9	96.1	5.2	148.9
IDFmw2	04					6.6	6.4	18.9	52.7	19.7	104.2
IDFmw2	05					1.5	10.9	19.1	57.8	27.9	117.2
IDFmw2	06					1.9	16.2		20.0		38.1
IDFmw2	08								0.8		0.8
IDFmw2	82				2.8						2.8
IDFmw2	83				8.1						8.1
IDFmw2	Fm01						8.1	5.4			13.6
IDFmw2	Fm02								1.3		1.3
IDFmw2	Ws01					1.0					1.0
IDFmw2	Ws02					1.3					1.3
IDFmw2	00	CB		0.7							0.7
IDFmw2	00	CF			469.3	1.5					470.8
IDFmw2	00	CL		2.5							2.5
IDFmw2	00	ES		3.5							3.5
IDFmw2	00	RI	72.1								72.1
IDFmw2	00	RN	10.9								10.9
IDFmw2	00	RW	74.2								74.2

BGC Variant	Site Series	Map Code	Structural Stage								Total Area
			0	1	2	3	4	5	6	7	
IDFmw2	00	RZ	11.0								11.0
IDFmw2	00	UR	179.6								179.6
TOTAL			**352.7**	**12.4**	**696.4**	**2374.1**	**1300.8**	**777.7**	**2413.7**	**3093.6**	**11021.3**

Appendix 7: Butterfly Species Observed During Netting Surveys

Species	Individuals Observed
Aphrodite Fritillary	10
Boisduval's Blue	8
Cabbage White	13
Canadian Swallowtail	14
Clouded Sulphur	52
Common Ringlet	6
Common Wood-nymph	40
Compton Tortoiseshell	12
Dreamy Dusky Wing	3
European Skipper	80
Green Comma	8
Greenish Blue	7
Hoary Comma	2
Hydaspe Fritillary	1
Lorquin's Admiral	1
Mariposa Copper	3
Milbert's Tortoiseshell	24
Mountain Emerald	25
Mourning Cloak	13
Northern Cloudywing	10
Northern Crescent	49
Northwestern Fritillary	1
Orange Sulphur	4
Pale Crescent	1
Pink-edged Sulphur	2
Purplish Copper	5
Red Admiral	1
Ringed Emerald	17
Roadside Skipper	11
Satyr Anglewing	2
Silvery Blue	3
Stella Orange Tip	1
Tawny-edged Skipper	4
Unknown Emerald	5
Unknown Fritillary	6
Unknown Sulphur	2
Unknown Swallowtail	3
Western Branded Skipper, harpalus subspecies	1
Western Meadow Fritillary	8
Western Spring Azure	3

Species	Individuals Observed
Western Tailed Blue	16
Western Tiger Swallowtail	3
Western White	13
White Admiral	15
Whitehouse's Emerald	1
Woodland Skipper	3

Appendix 8: Bird Species Observed During Breeding Bird Surveys

English Name	Scientific Name	BC List	SARA Status
American Crow	*Corvus brachyrhynchos*	Yellow	
American Redstart	*Setophaga ruticilla*	Yellow	
American Robin	*Turdus migratorius*	Yellow	
Bald Eagle	*Haliaeetus leucocephalus*	Yellow	
Black-capped Chickadee	*Poecile atricapillus*	Yellow	
Black-headed Grosbeak	*Pheucticus melanocephalus*	Yellow	
Boreal Chickadee	*Poecile hudsonicus*	Yellow	
Canada Goose	*Branta canadensis*	Yellow	
Cassin's Vireo	*Vireo cassinii*	Yellow	
Cedar Waxwing	*Bombycilla cedrorum*	Yellow	
Chipping Sparrow	*Spizella passerina*	Yellow	
Common Raven	*Corvus corax*	Yellow	
Common Yellowthroat	*Geothlypis trichas*	Yellow	
Dark-eyed Junco	*Junco hyemalis*	Yellow	
Dusky Flycatcher	*Empidonax oberholseri*	Yellow	
Evening Grosbeak	*Coccothraustes vespertinus*	Yellow	
Fox Sparrow	*Passerella iliaca*	Yellow	
Golden-crowned Kinglet	*Regulus satrapa*	Yellow	
Golden-crowned Sparrow	*Zonotrichia atricapilla*	Yellow	
Gray Catbird	*Dumetella carolinensis*	Yellow	
Gray Jay	*Perisoreus canadensis*	Yellow	
Hammond's Flycatcher	*Empidonax hammondii*	Yellow	
Hairy Woodpecker	*Picoides villosus*	Yellow	
Hermit Thrush	*Catharus guttatus*	Yellow	
Hooded Merganser	*Lophodytes cucullatus*	Yellow	
Killdeer	*Charadrius vociferus*	Yellow	
Least Flycatcher	*Empidonax minimus*	Yellow	
MacGillivray's Warbler	*Oporornis tolmiei*	Yellow	
Mountain Chickadee	*Poecile gambeli*	Yellow	
Nashville Warbler	*Oreothlypis ruficapilla*	Yellow	
Northern Flicker	*Colaptes auratus*	Yellow	
Northern Waterthrush	*Parkesia noveboracensis*	Yellow	
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Yellow	
Orange-crowned Warbler	*Oreothlypis celata*	Yellow	
Olive-sided Flycatcher	*Contopus cooperi*	Blue	1-T (Feb 2010)
Pine Grosbeak	*Pinicola enucleator*	Yellow	
Pine Siskin	*Spinus pinus*	Yellow	
Pileated Woodpecker	*Dryocopus pileatus*	Yellow	
Red-breasted Nuthatch	*Sitta canadensis*	Yellow	

English Name	Scientific Name	BC List	SARA Status
Ruby-crowned Kinglet	*Regulus calendula*	Yellow	
Red Crossbill	*Loxia curvirostra*	Yellow	
Red-eyed Vireo	*Vireo olivaceus*	Yellow	
Red-naped Sapsucker	*Sphyrapicus nuchalis*	Yellow	
Red-tailed Hawk	*Buteo jamaicensis*	Yellow	
Savannah Sparrow	*Passerculus sandwichensis*	Yellow	
Sora	*Porzana carolina*	Yellow	
Song Sparrow	*Melospiza melodia*	Yellow	
Spruce Grouse	*Falcipennis canadensis*	Yellow	
Spotted Sandpiper	*Actitis macularius*	Yellow	
Swainson's Thrush	*Catharus ustulatus*	Yellow	
Tennessee Warbler	*Oreothlypis peregrina*	Yellow	
Townsend's Warbler	*Dendroica townsendi*	Yellow	
Tree Swallow	*Tachycineta bicolor*	Yellow	
Varied Thrush	*Ixoreus naevius*	Yellow	
Veery	*Catharus fuscescens*	Yellow	
Violet-green Swallow	*Tachycineta thalassina*	Yellow	
Warbling Vireo	*Vireo gilvus*	Yellow	
White-crowned Sparrow	*Zonotrichia leucophrys*	Yellow	
Western Tanager	*Piranga ludoviciana*	Yellow	
Willow Flycatcher	*Empidonax traillii*	Yellow	
Wilson's Warbler	*Wilsonia pusilla*	Yellow	
Western Wood-Pewee	*Contopus sordidulus*	Yellow	
Yellow Warbler	*Dendroica petechia*	Yellow	
Yellow-rumped Warbler	*Dendroica coronata*	Yellow	

Appendix 9: Terrestrial Baseline Report Map Figures

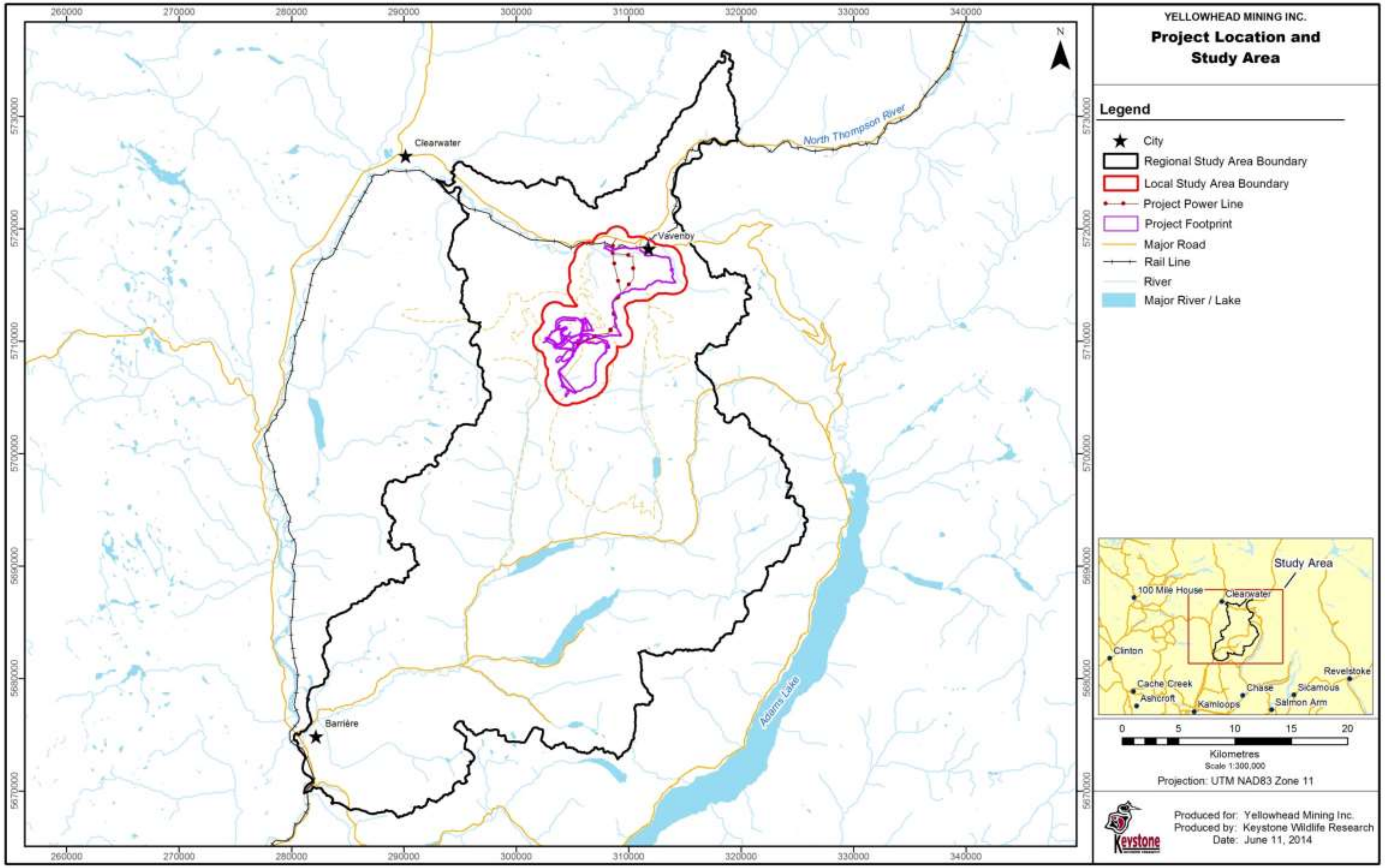

Figure 1: Project Location and Study Area

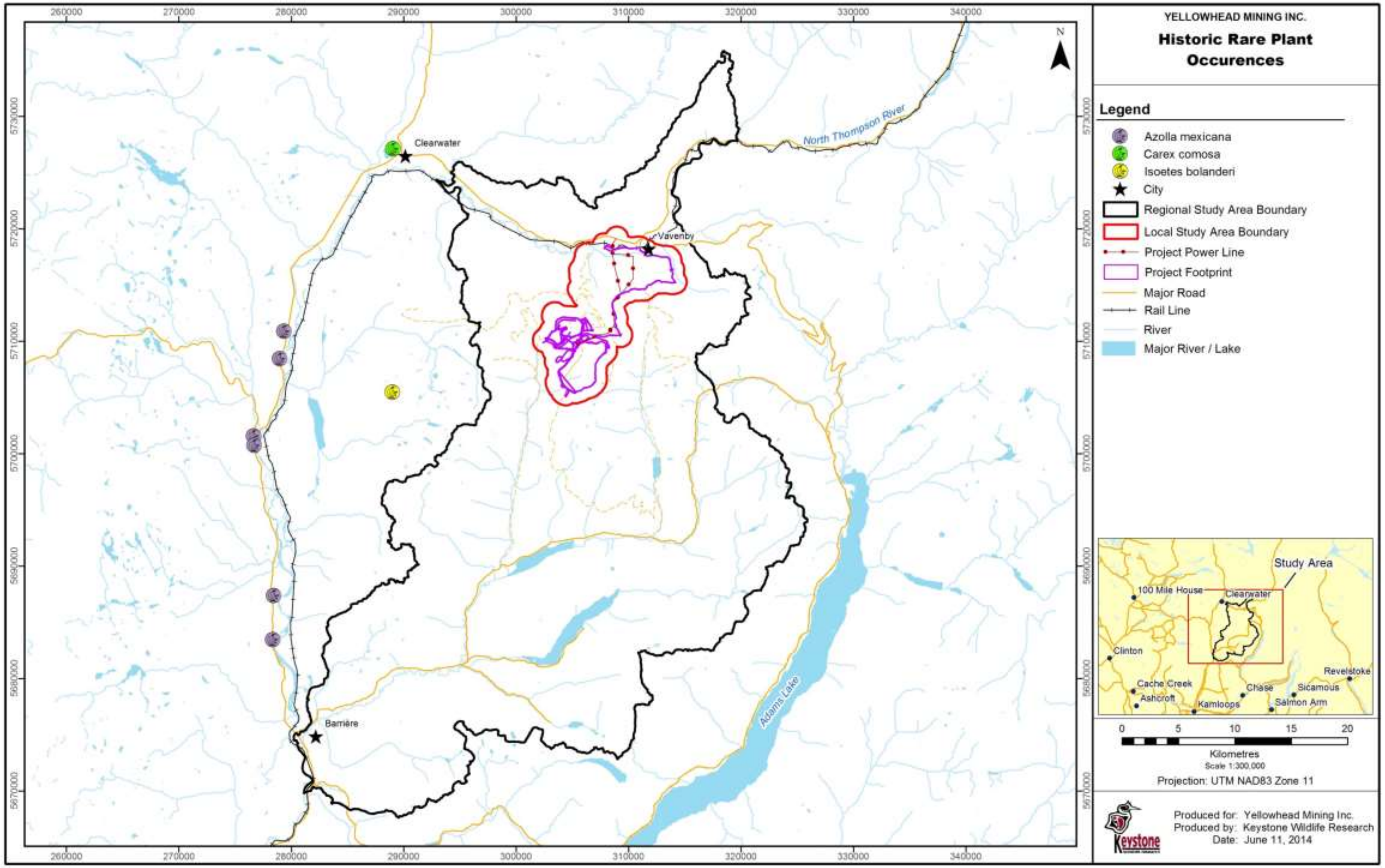

Figure 2: Historic Rare Plant Occurrences in the Project Vicinity

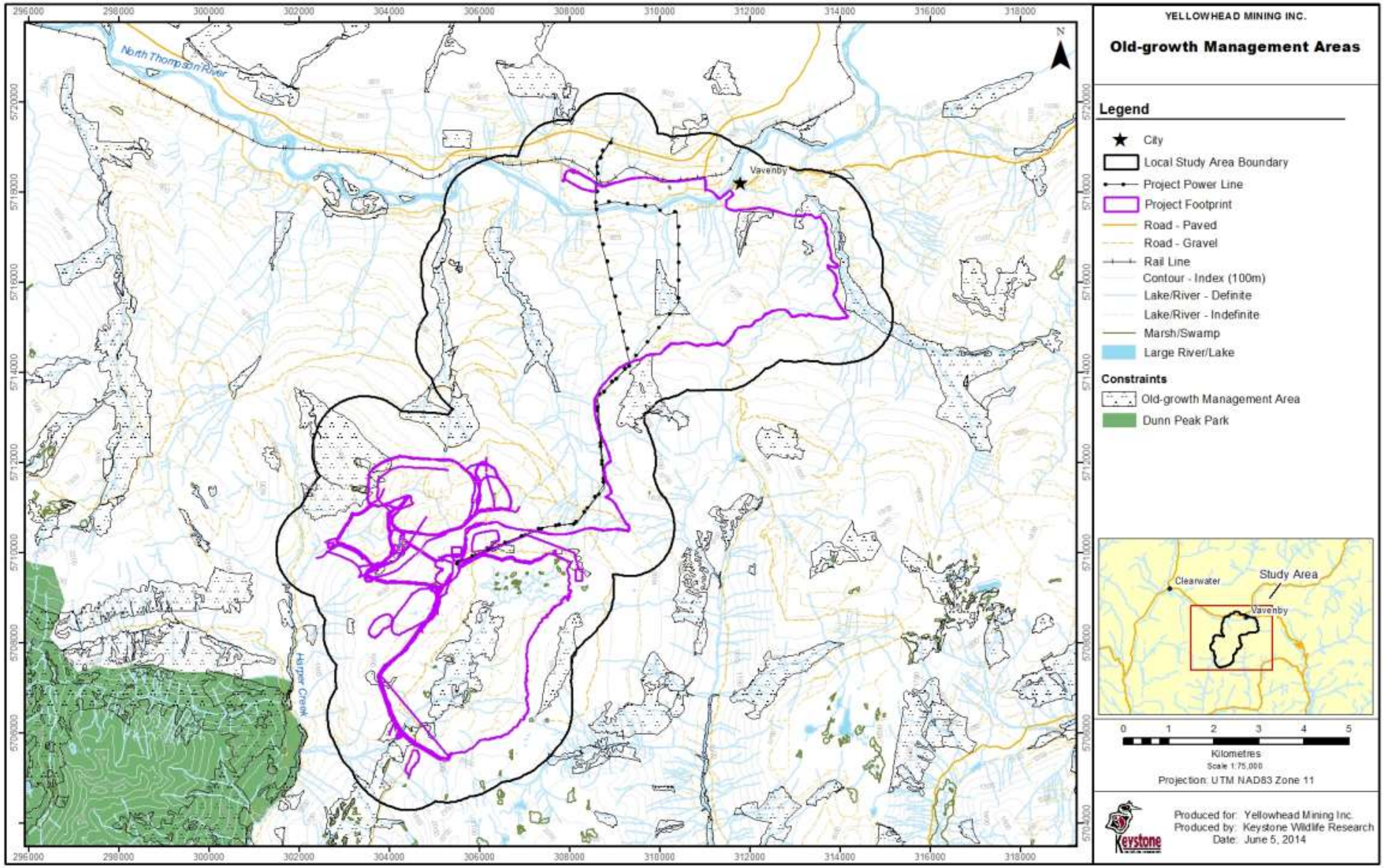

Figure 3: Old-Growth Management Areas within the LSA

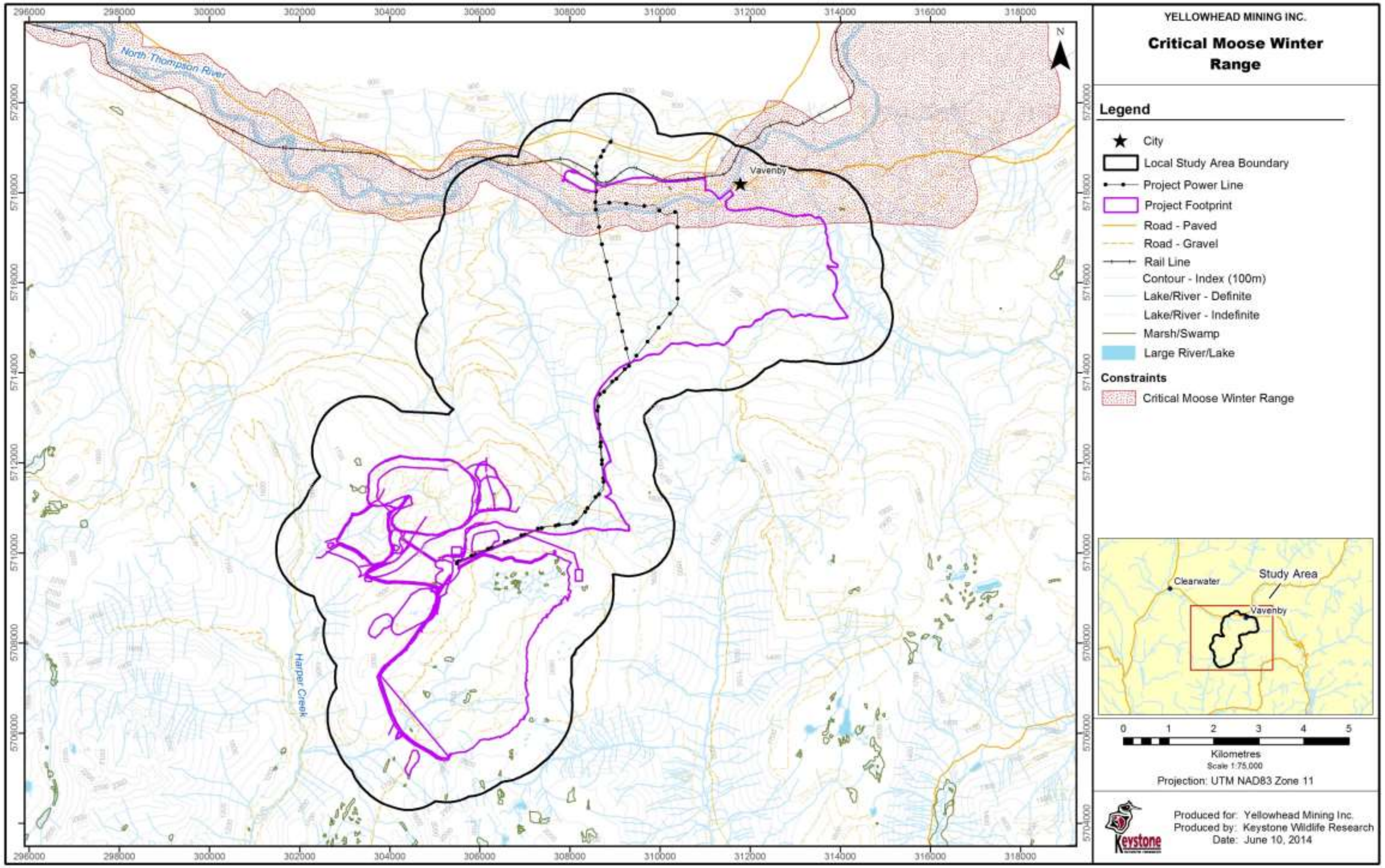

Figure 4: Critical Moose Winter Range (CMWR) in the LSA

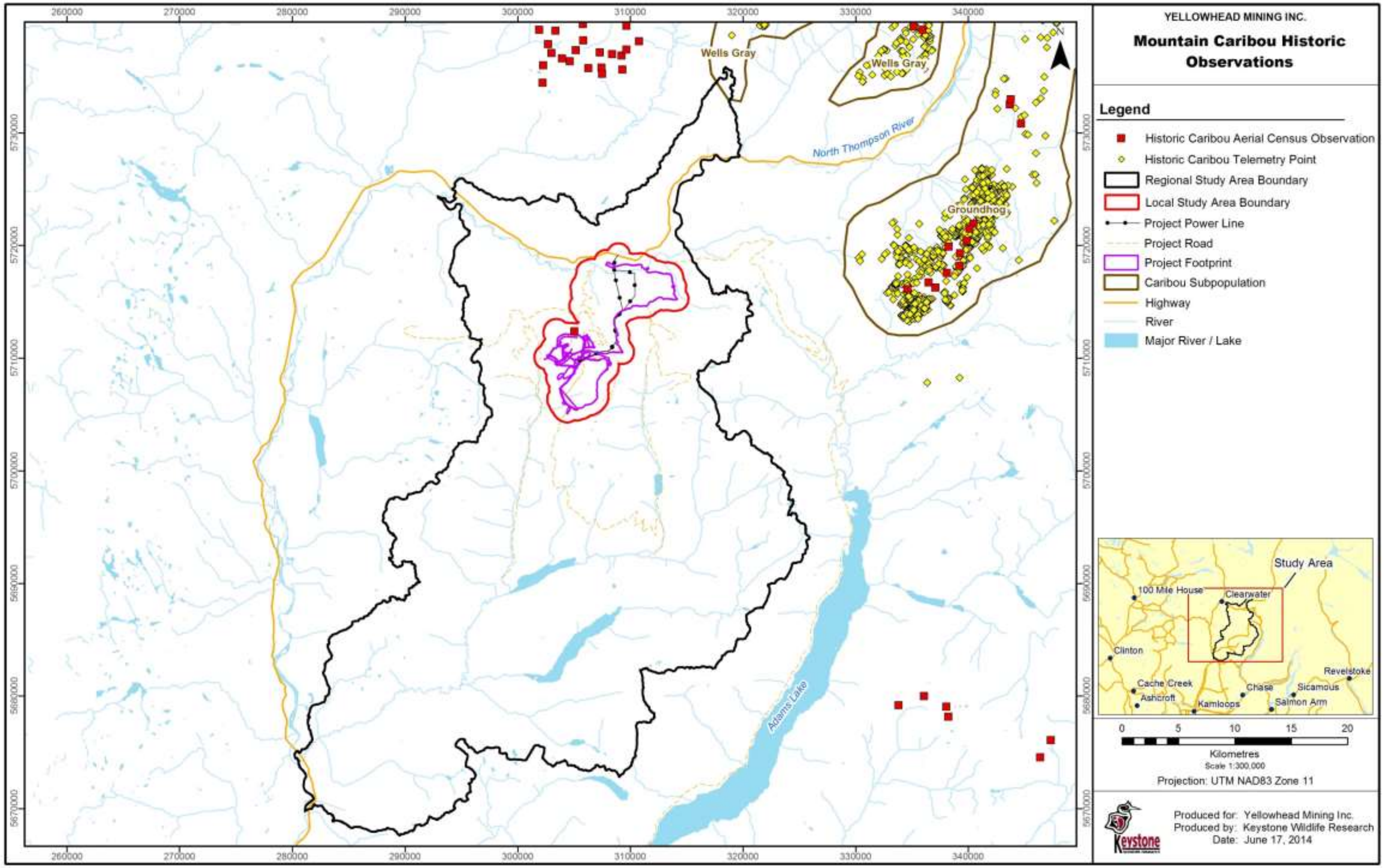

Figure 5: Mountain Caribou Historic Observations in the Project Vicinity

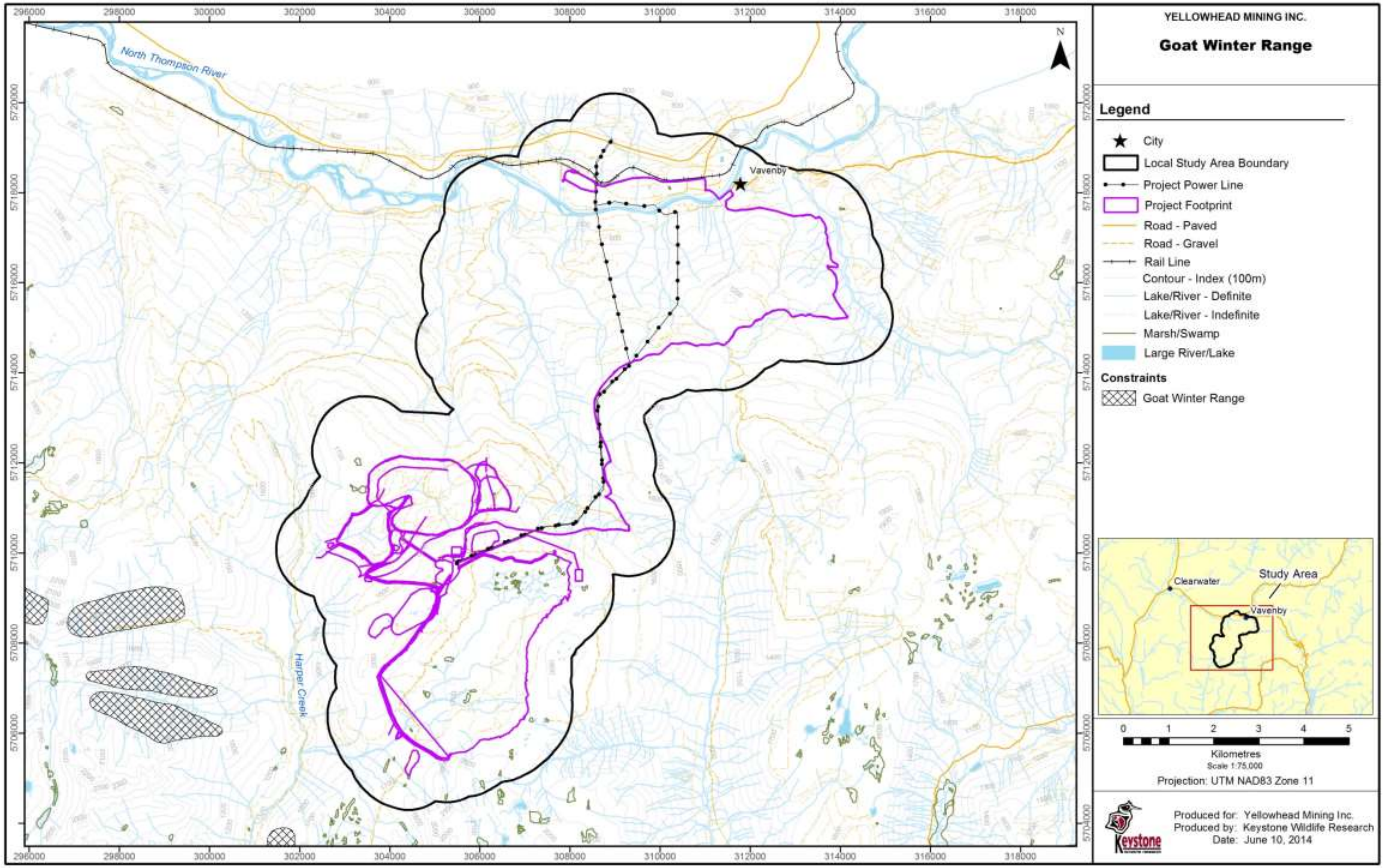

Figure 6: Goat Winter Range (GWR) in the Project Vicinity

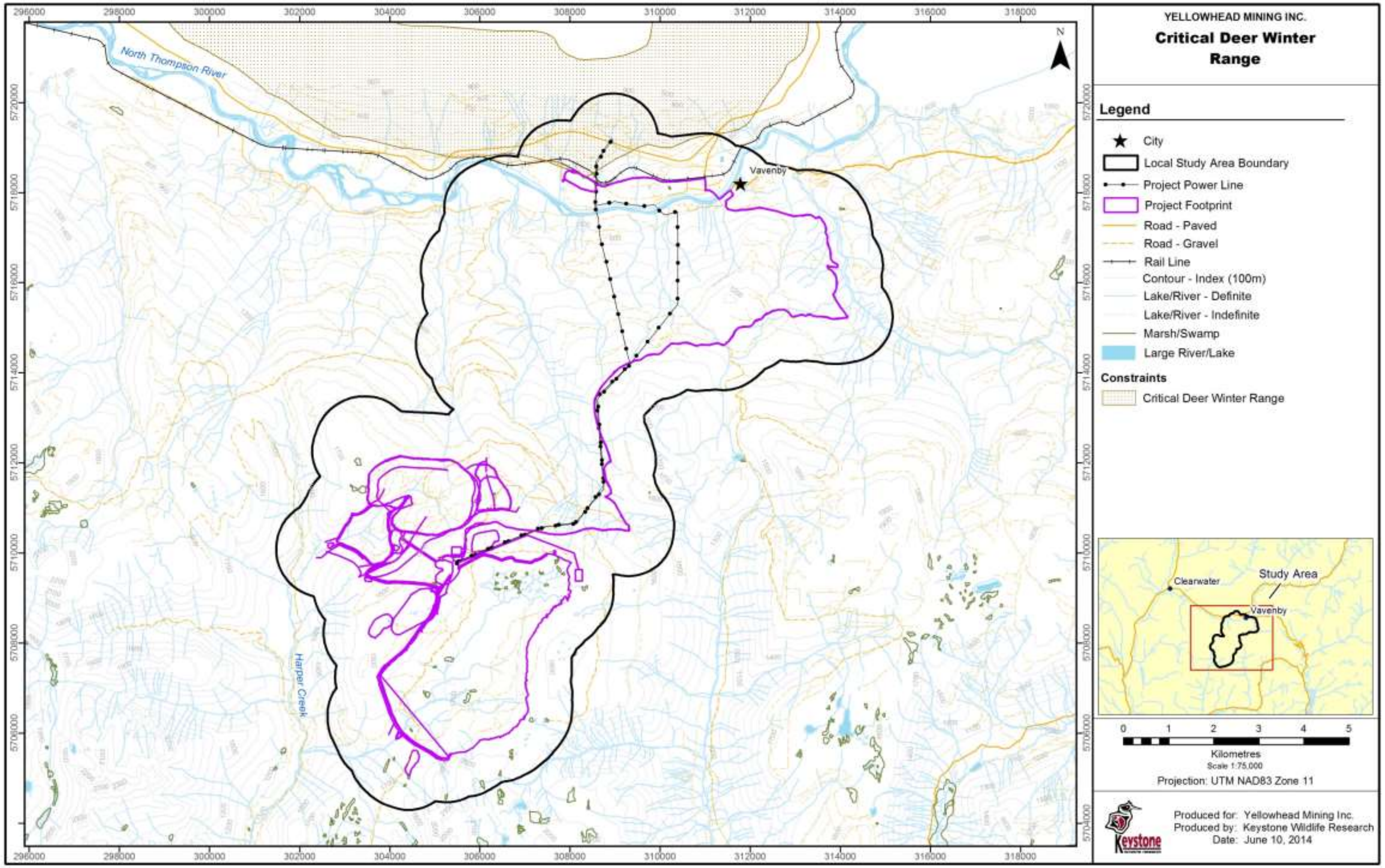

Figure 7: Critical Deer Winter Range in the Project Vicinity

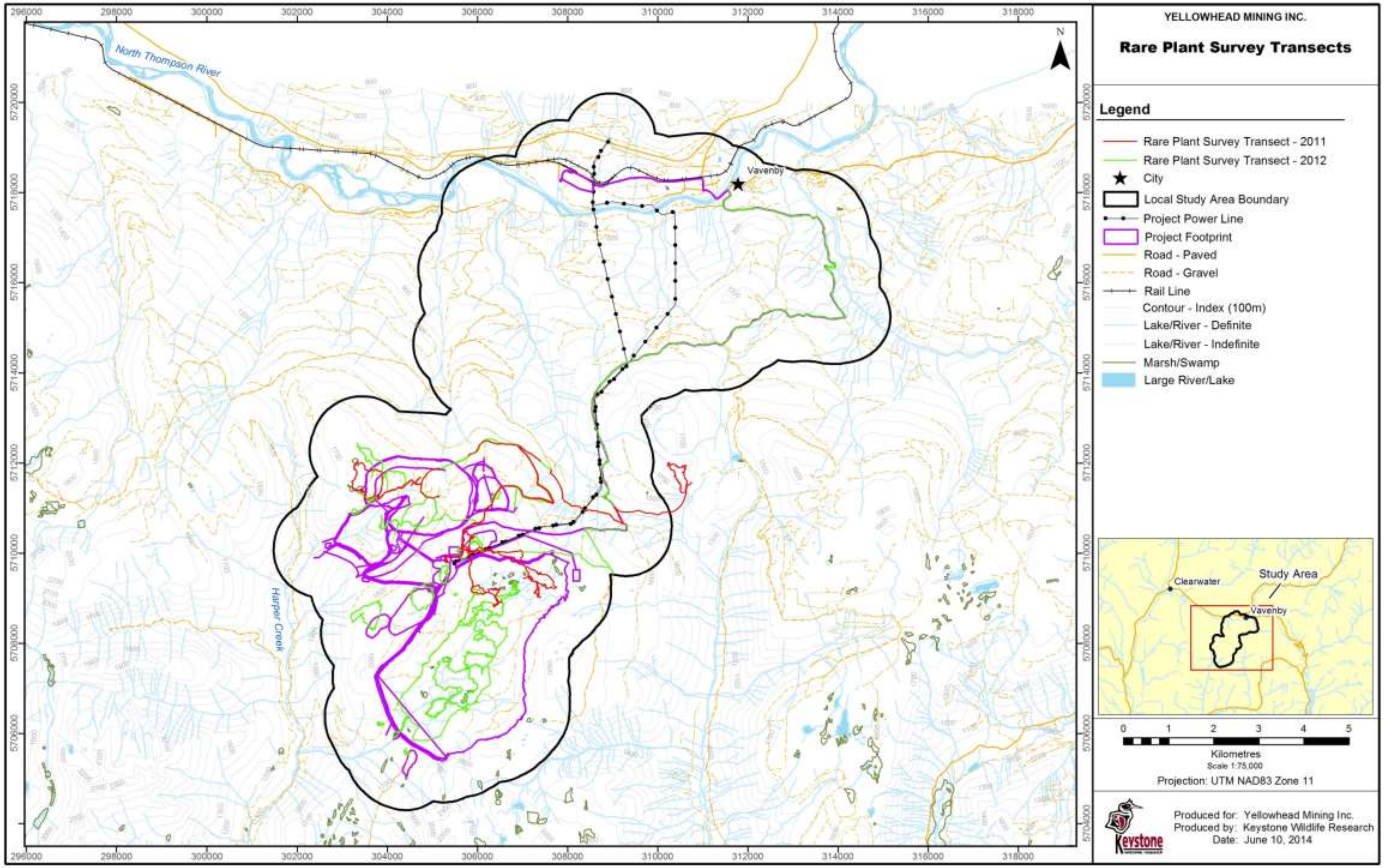

Figure 8: Rare Plant Survey Transects

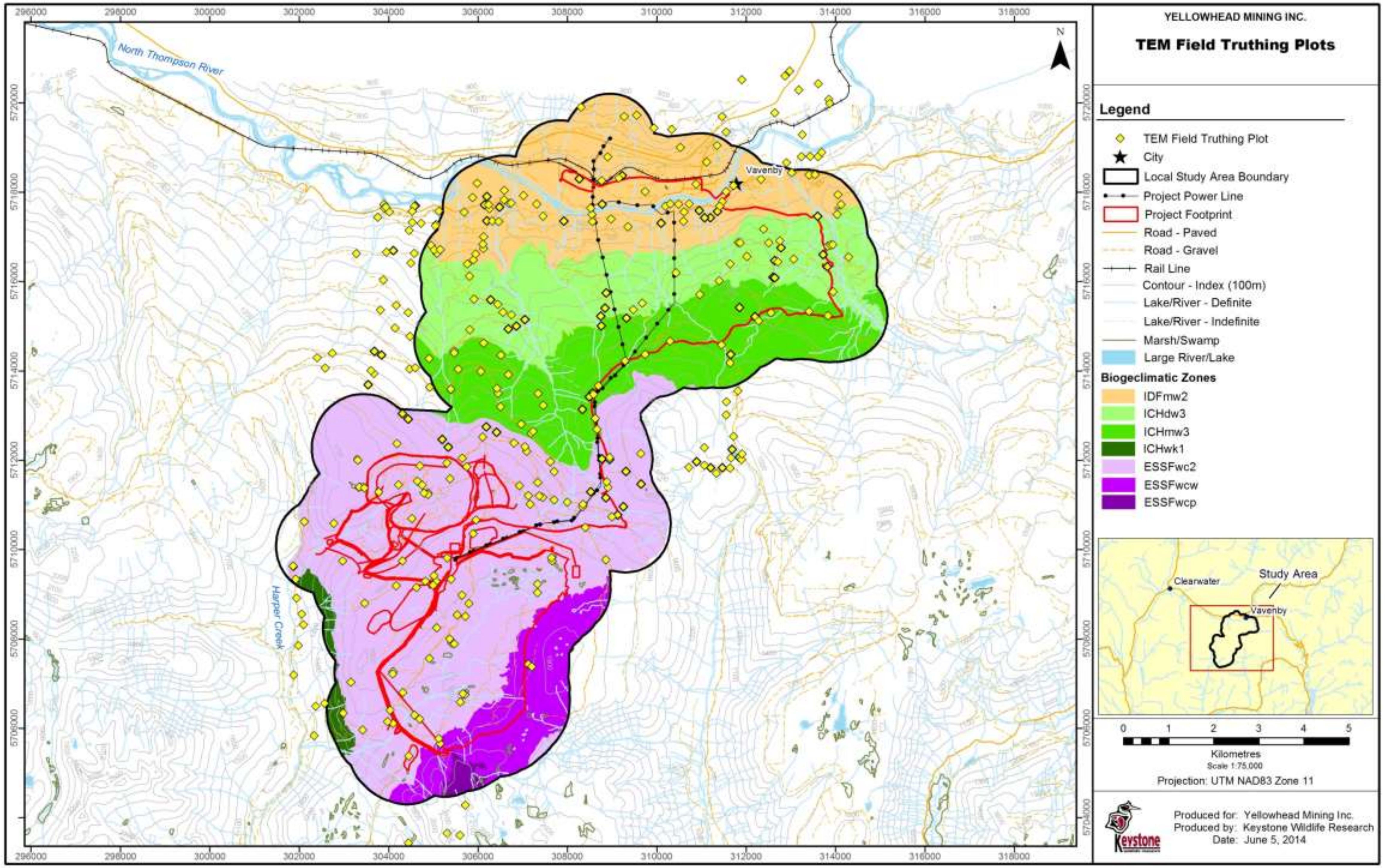

Figure 9: Field Plots Conducted to Field Truth the Terrestrial Ecosystem Mapping (TEM) and Wildlife Habitat Suitability Mapping

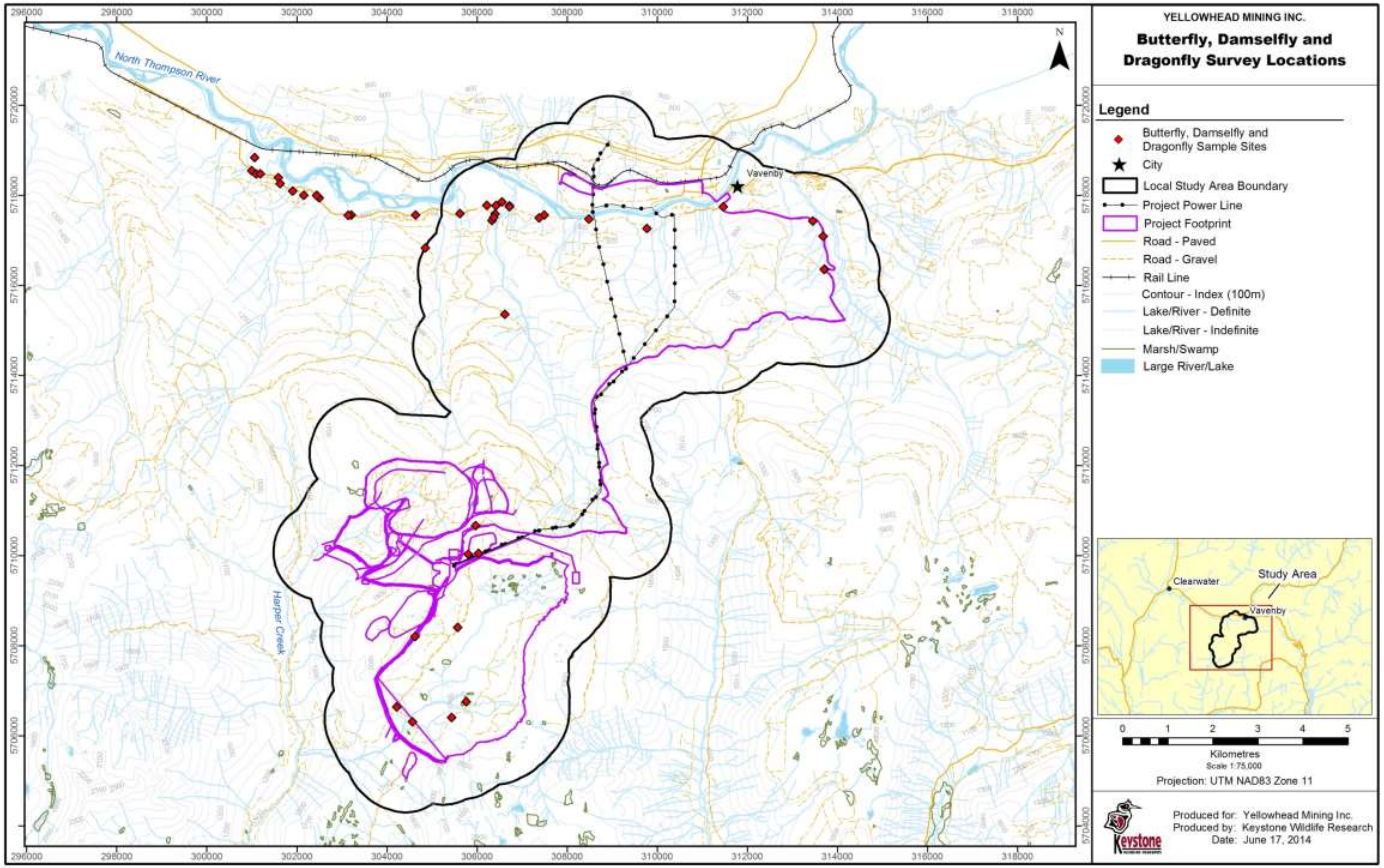

Figure 10: Sampling Locations for Butterflies, Damselflies and Dragonflies

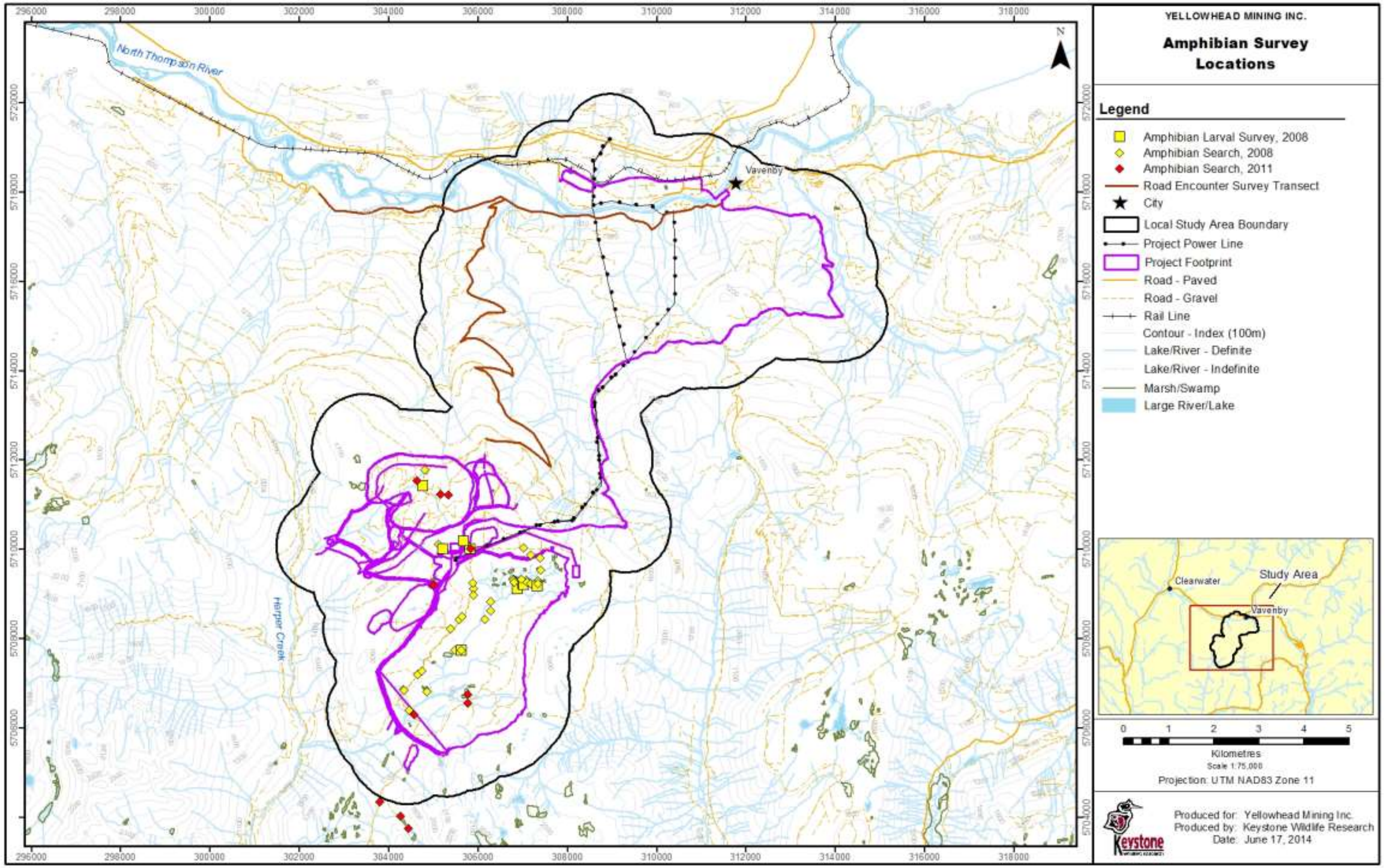

Figure 11: Sampling Locations for Amphibians

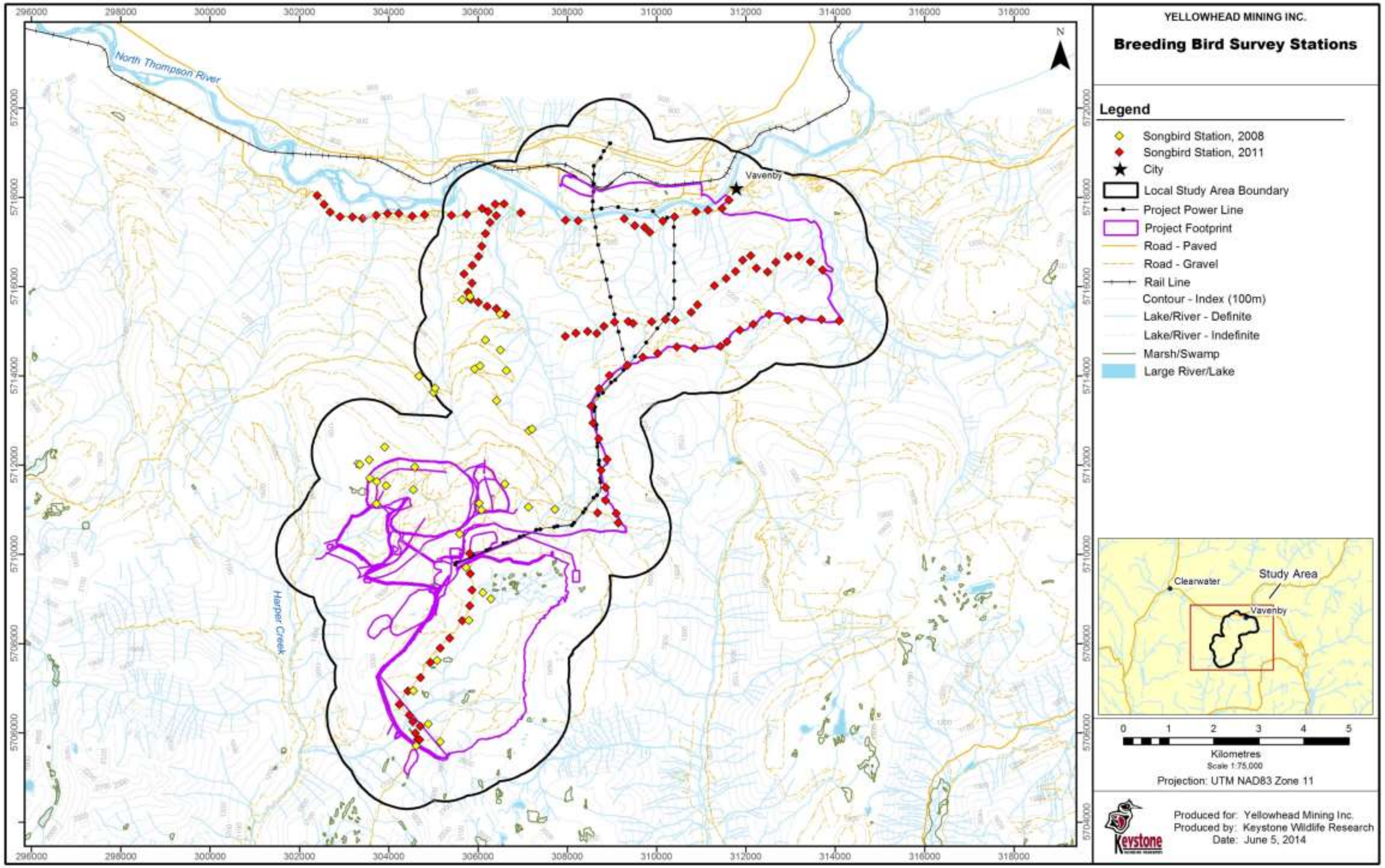

Figure 12: Breeding Bird Survey Stations

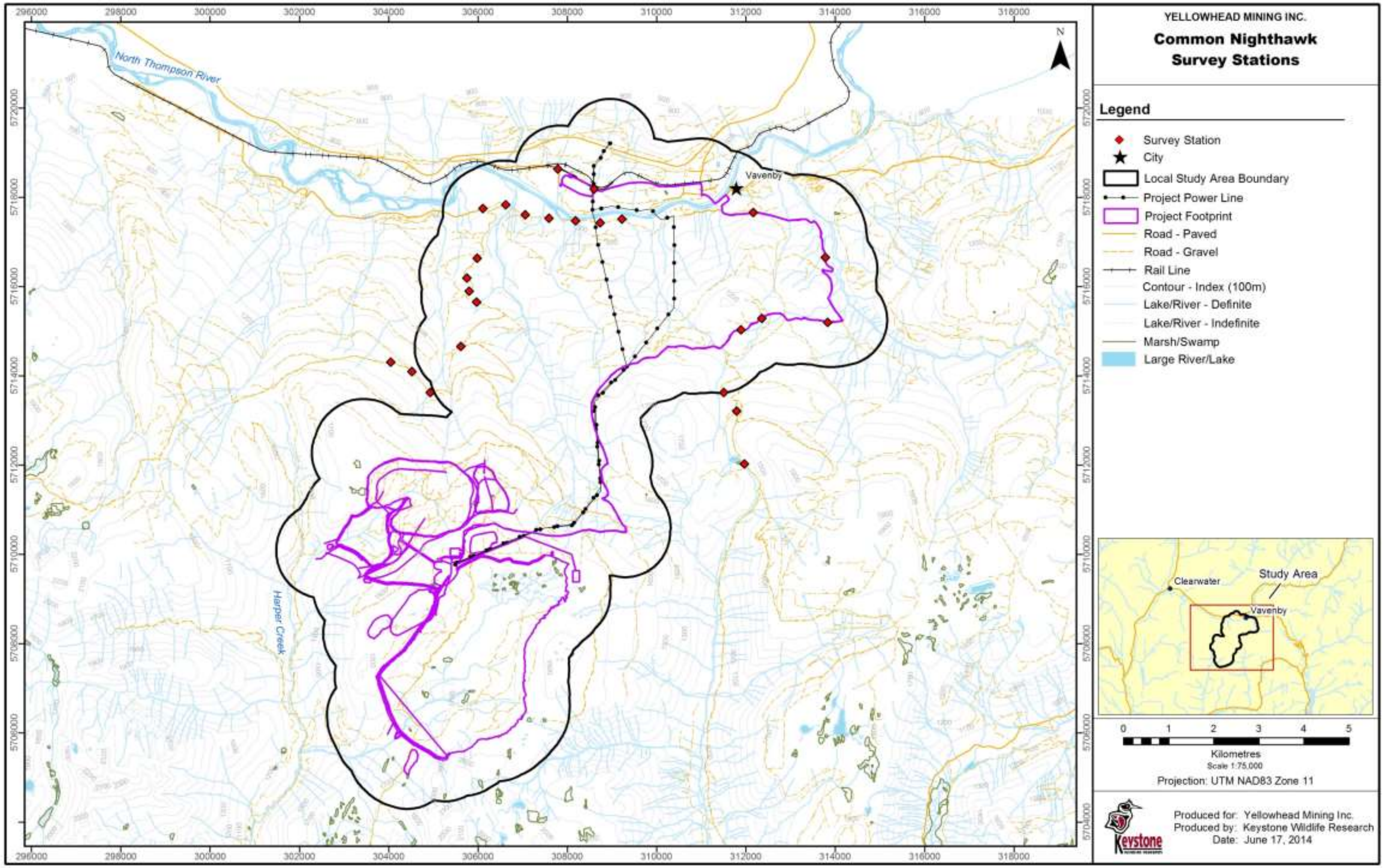

Figure 13: Common Nighthawk Survey Stations

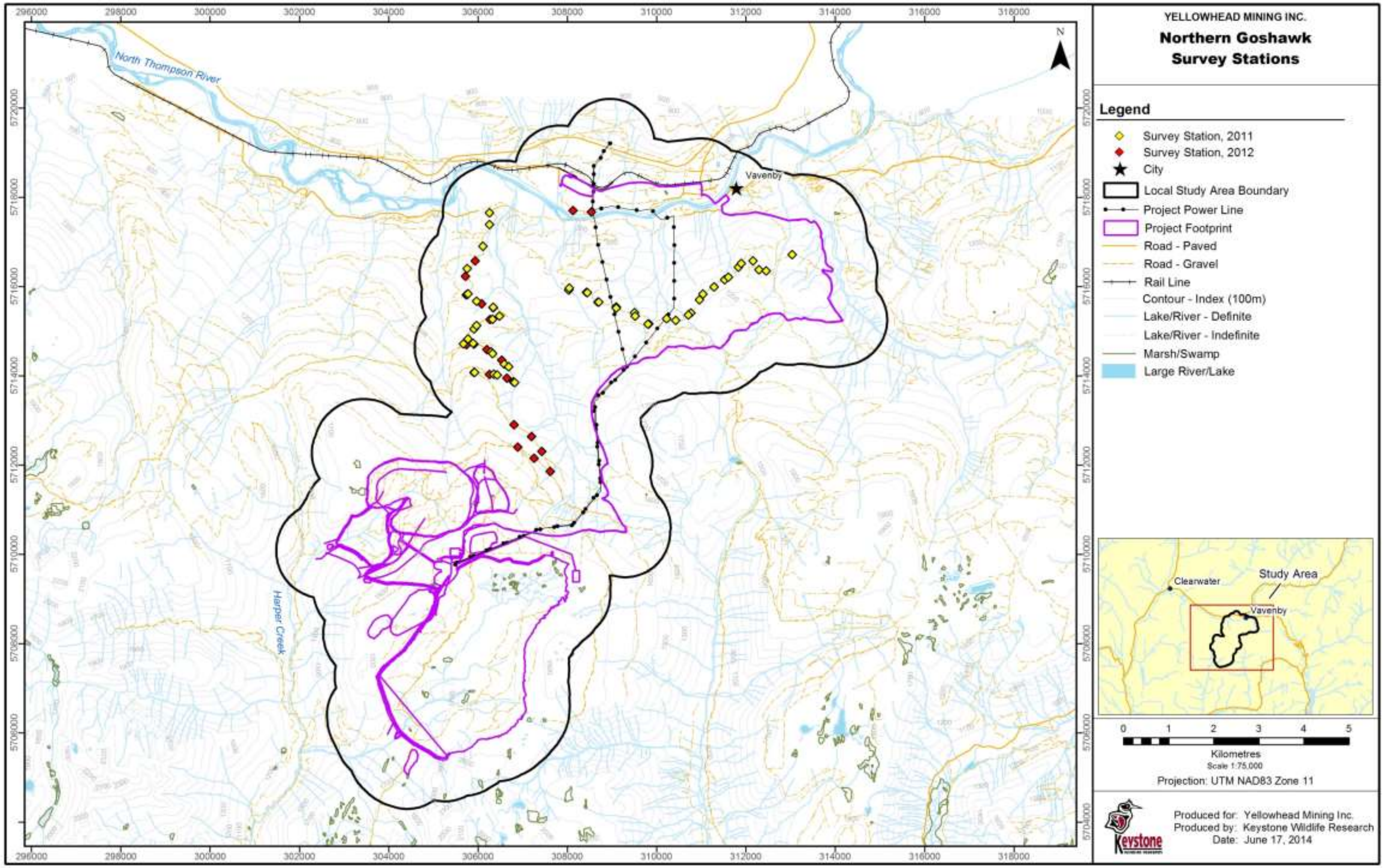

Figure 14: Northern Goshawk Survey Stations

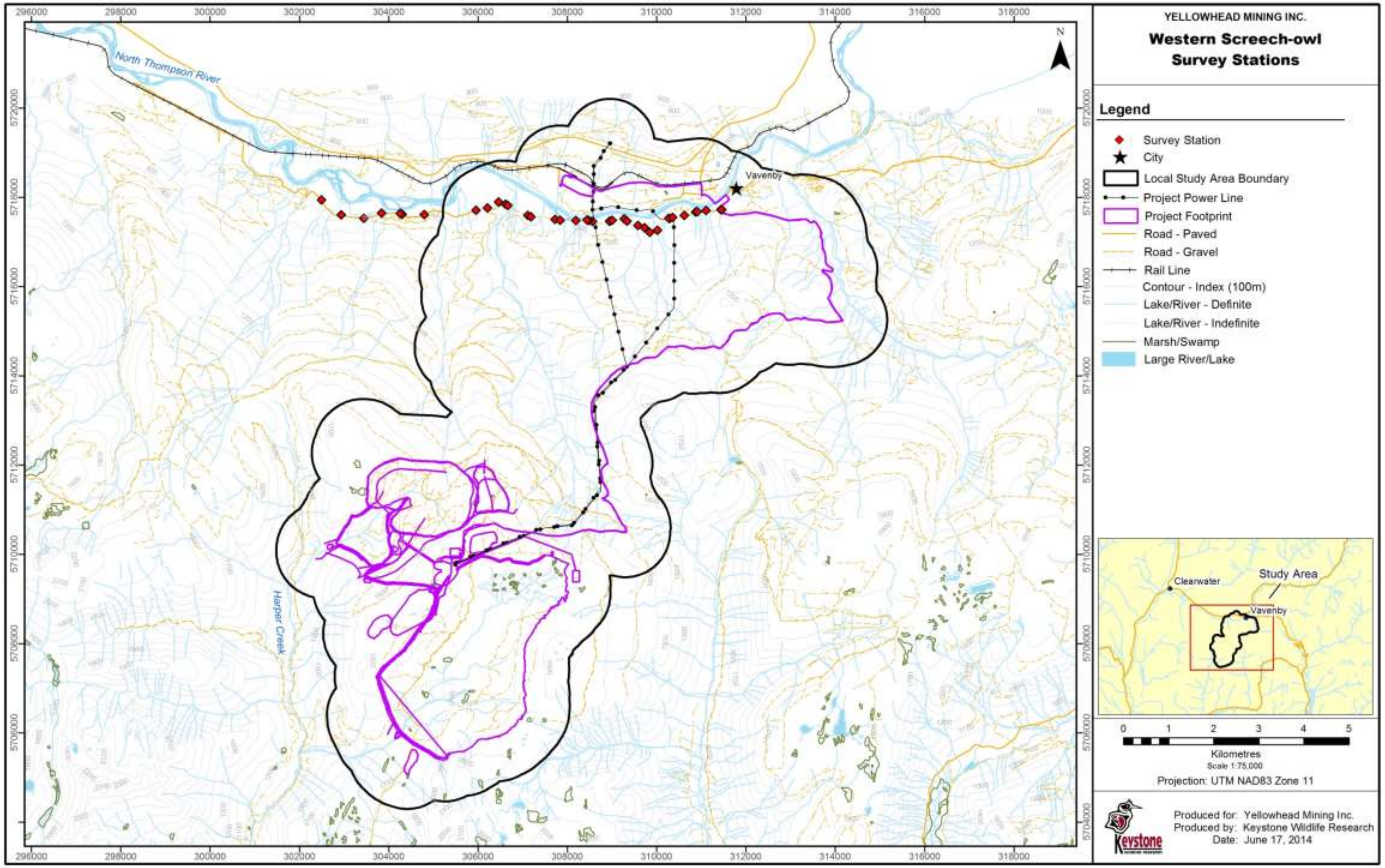

Figure 15: Western Screech-owl Survey Stations

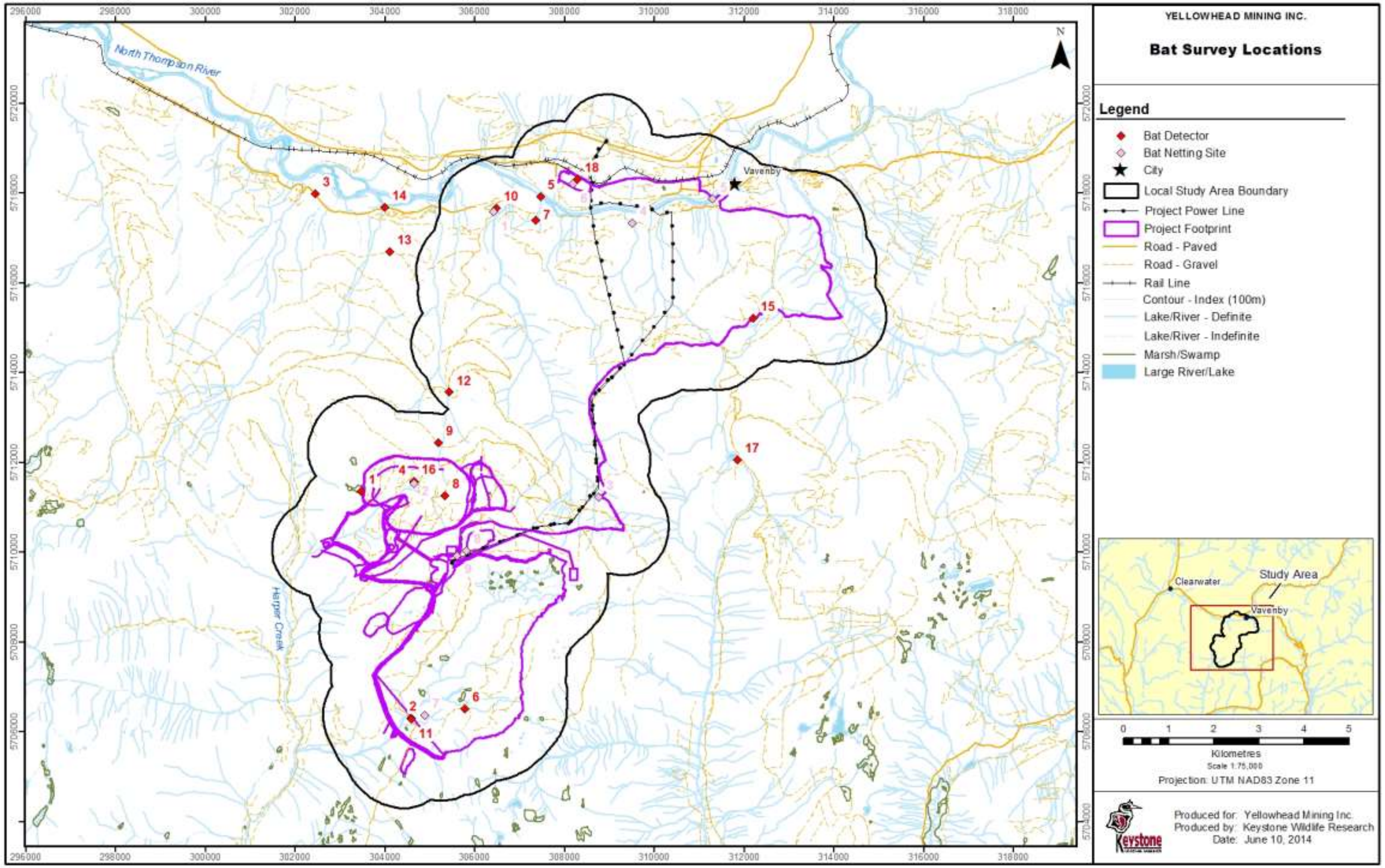

Figure 16: Bat Sampling Sites

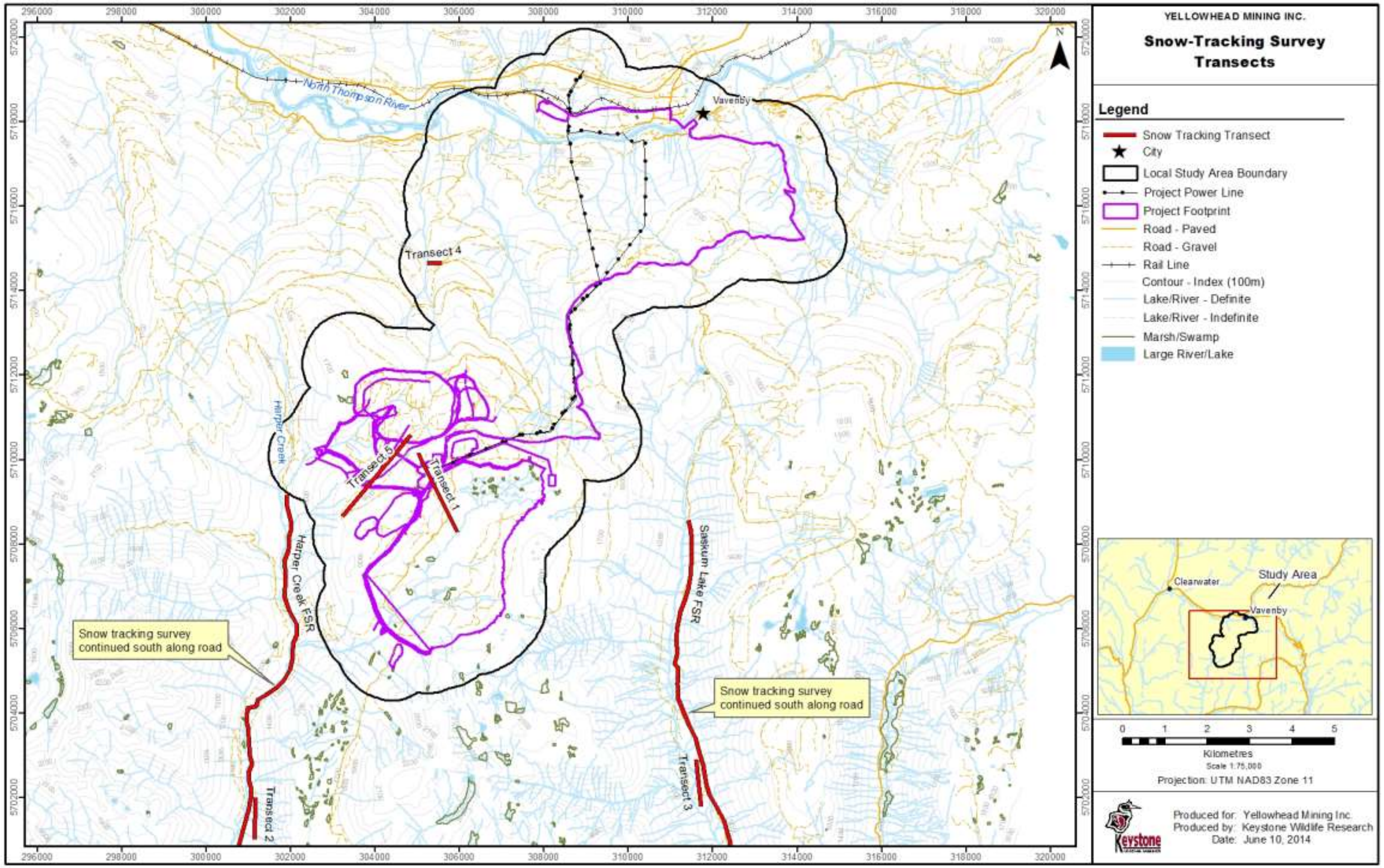

Figure 17: Snow-Tracking Survey Transects

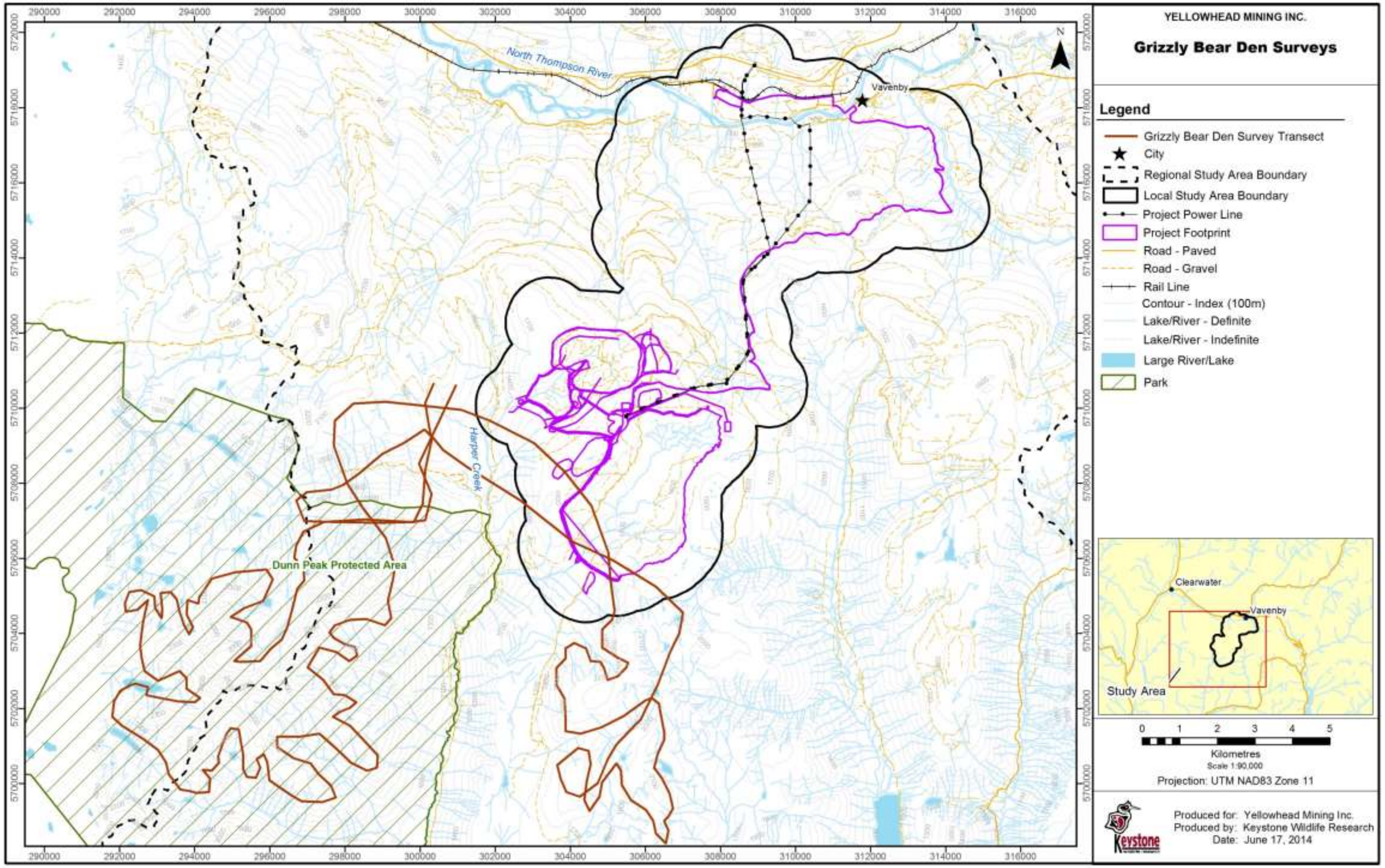

Figure 18: Grizzly Bear Den Survey Transects

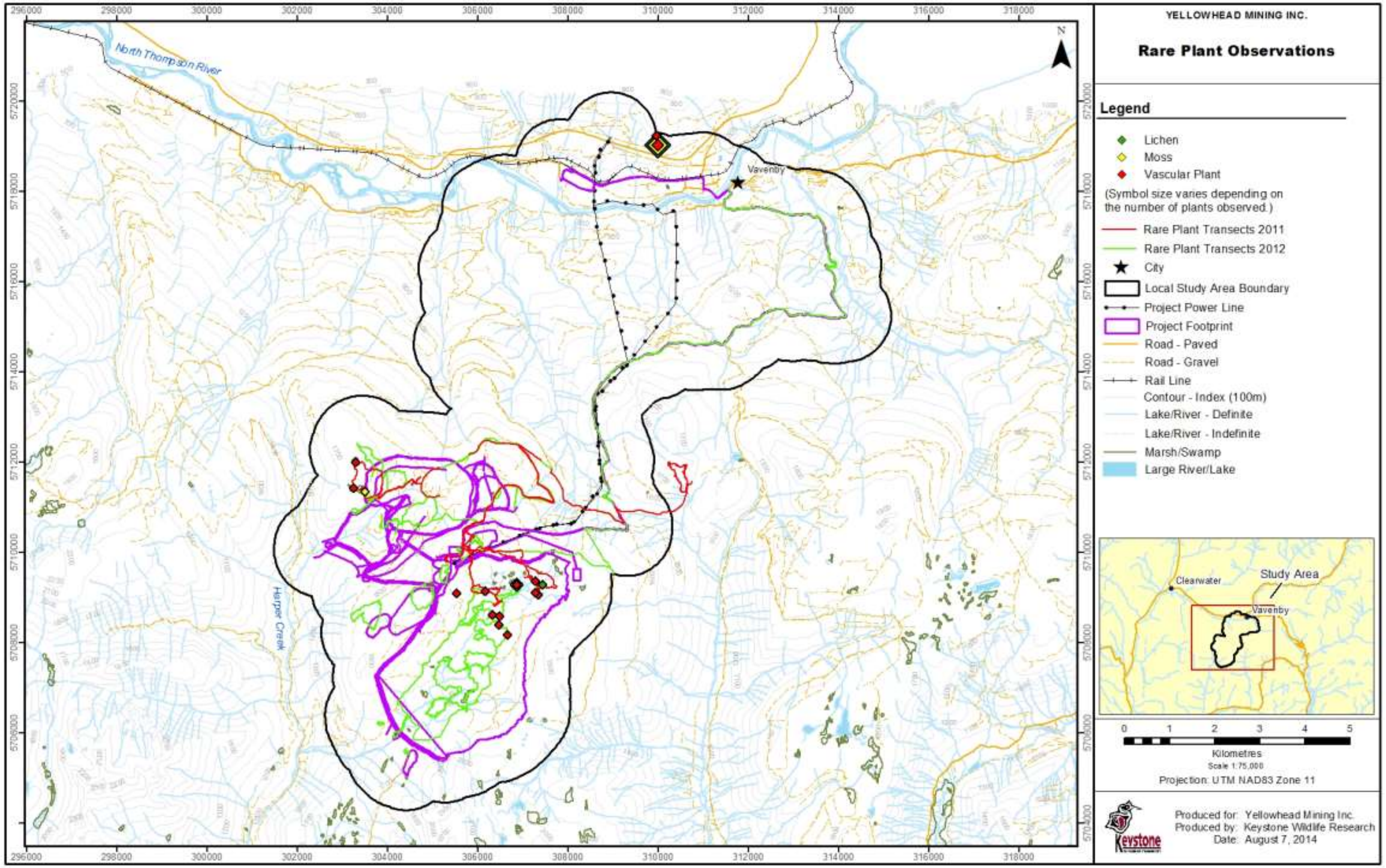

Figure 19: Rare Plants Observed During Baseline Surveys

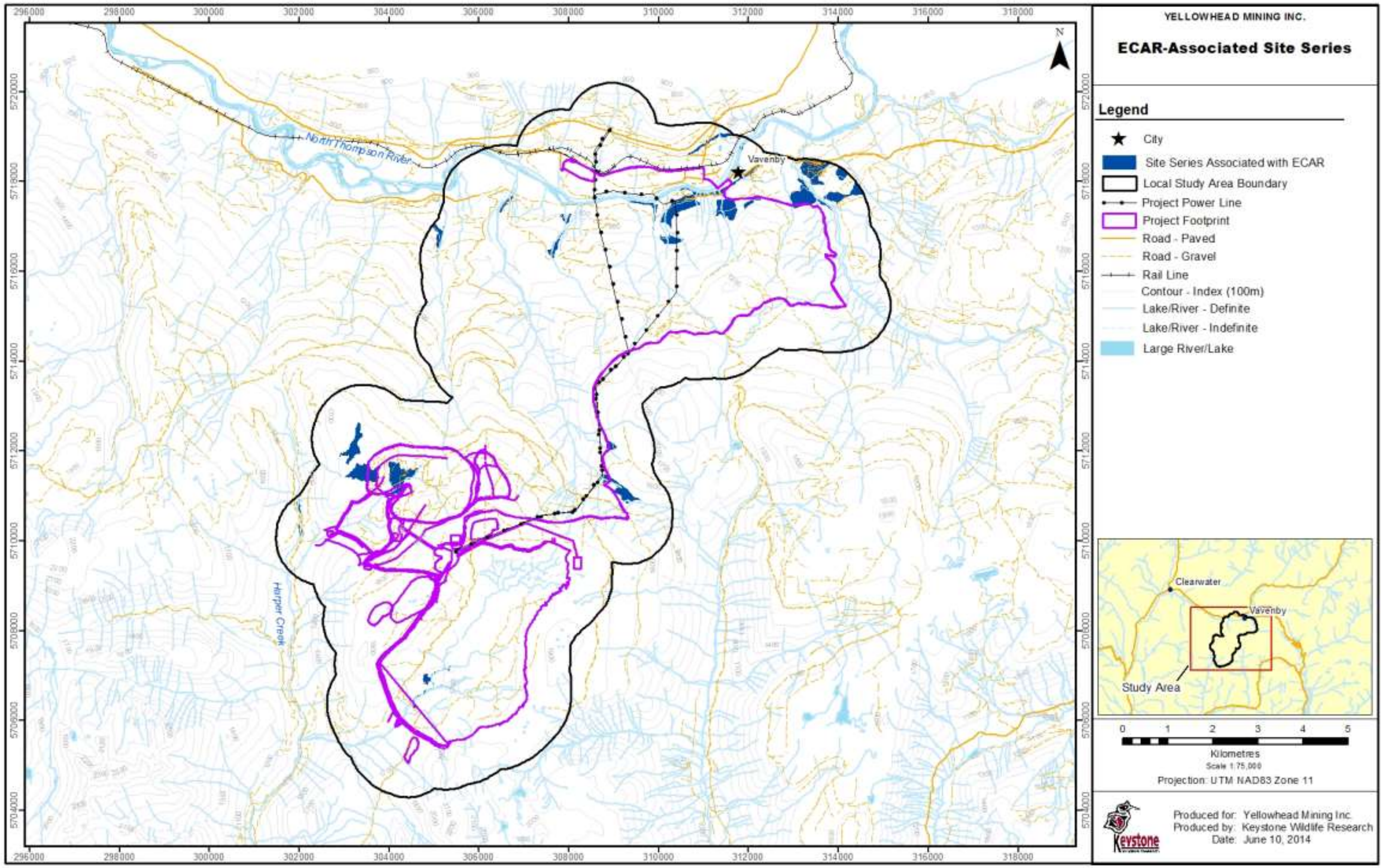

Figure 20: ECAR-Associated Site Series Within the LSA as Identified in the TEM

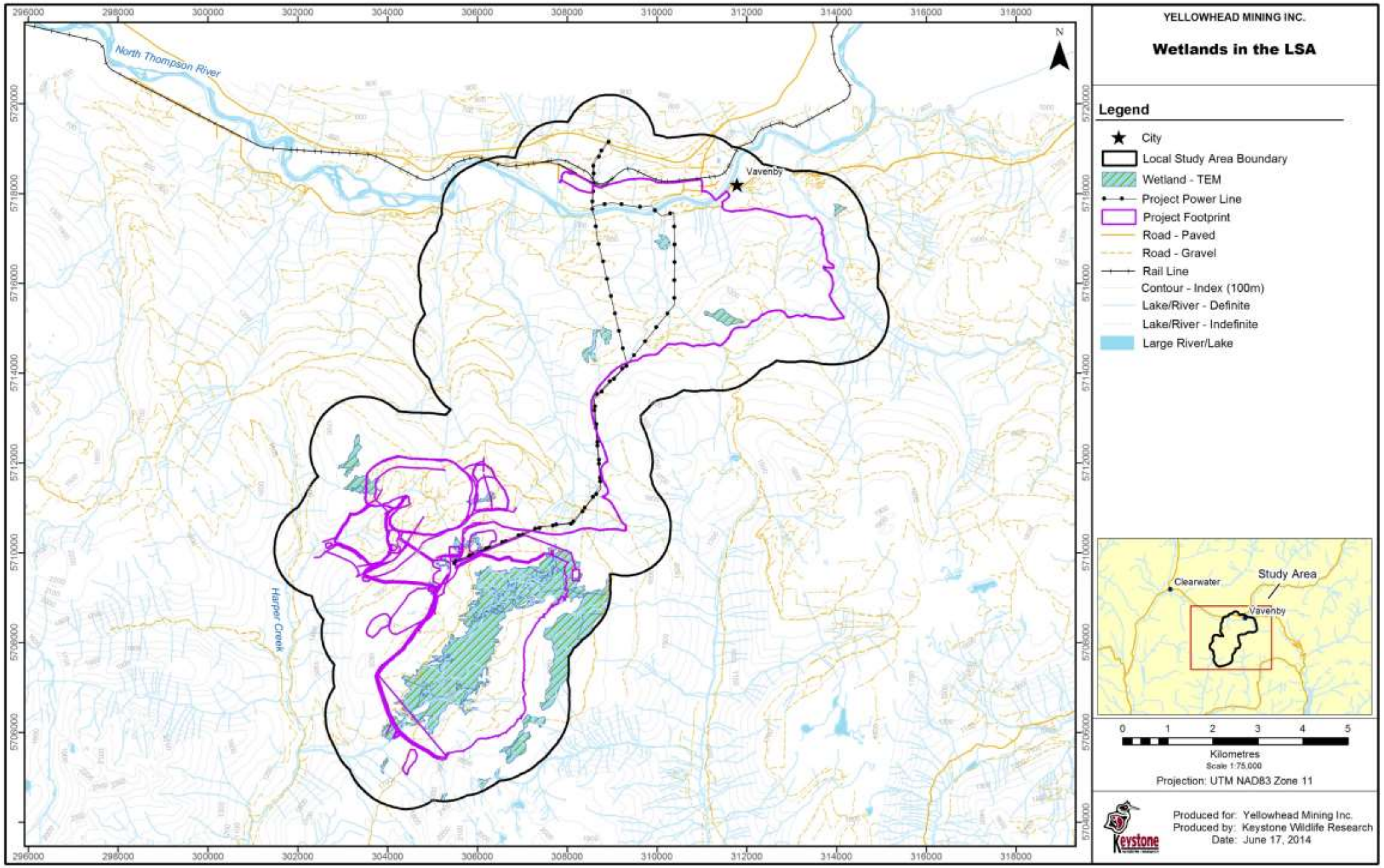

Figure 21: Wetlands Within the LSA as Identified in the TEM

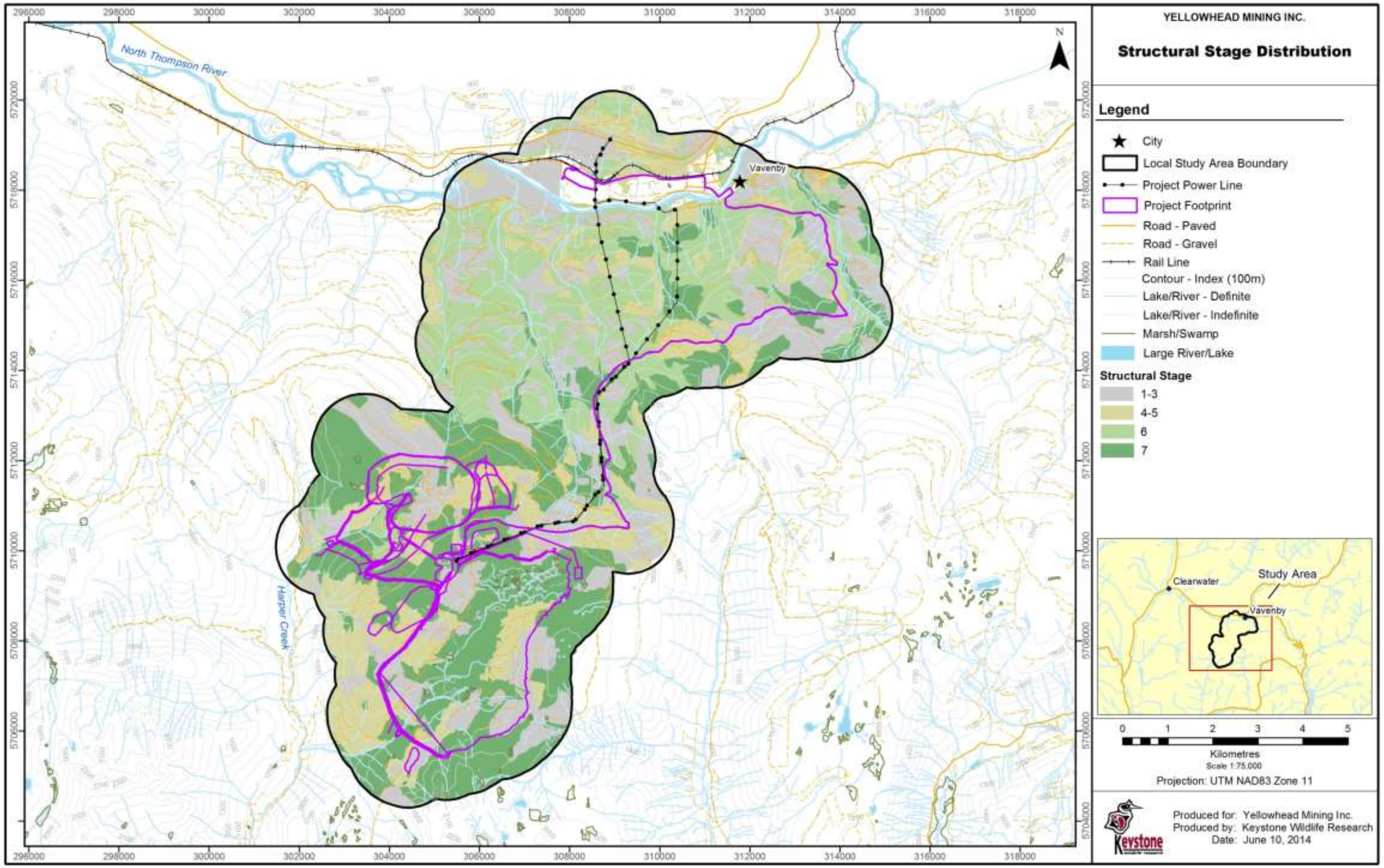

Figure 22: Structural Stage Distribution in the LSA

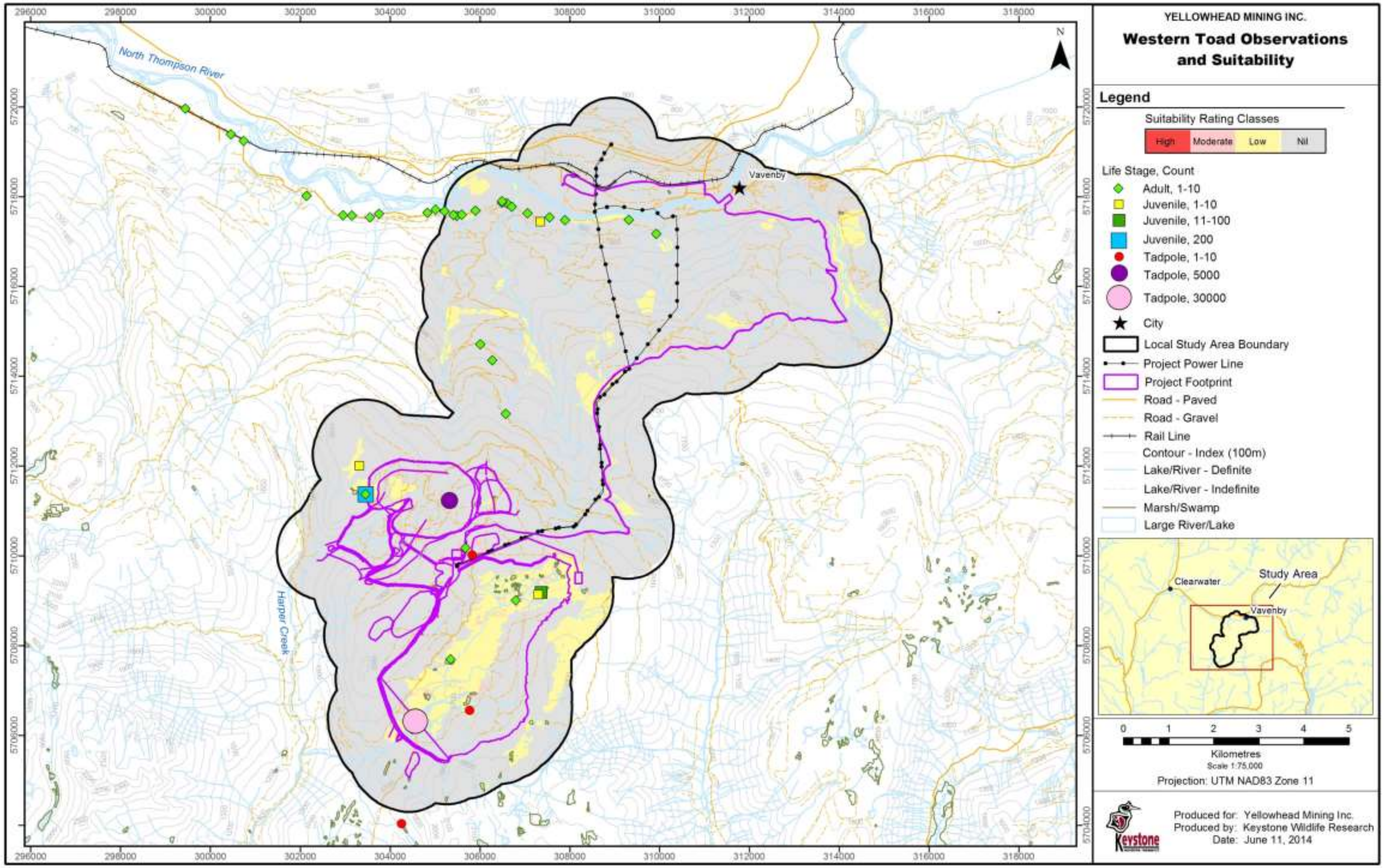

Figure 23: Western Toad Survey Observations and Suitability Mapping

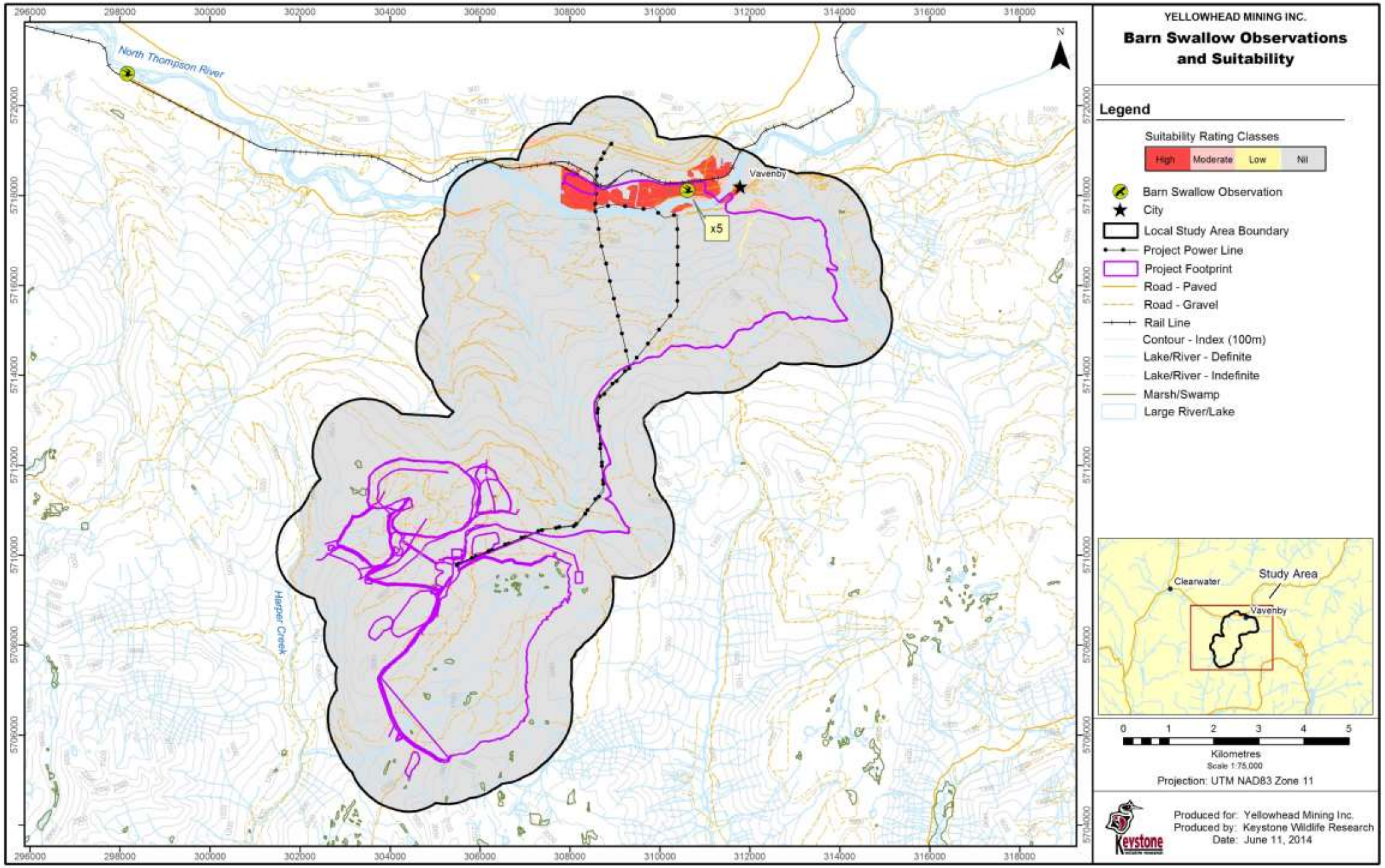

Figure 24: Barn Swallow Suitability Mapping and Survey Observations

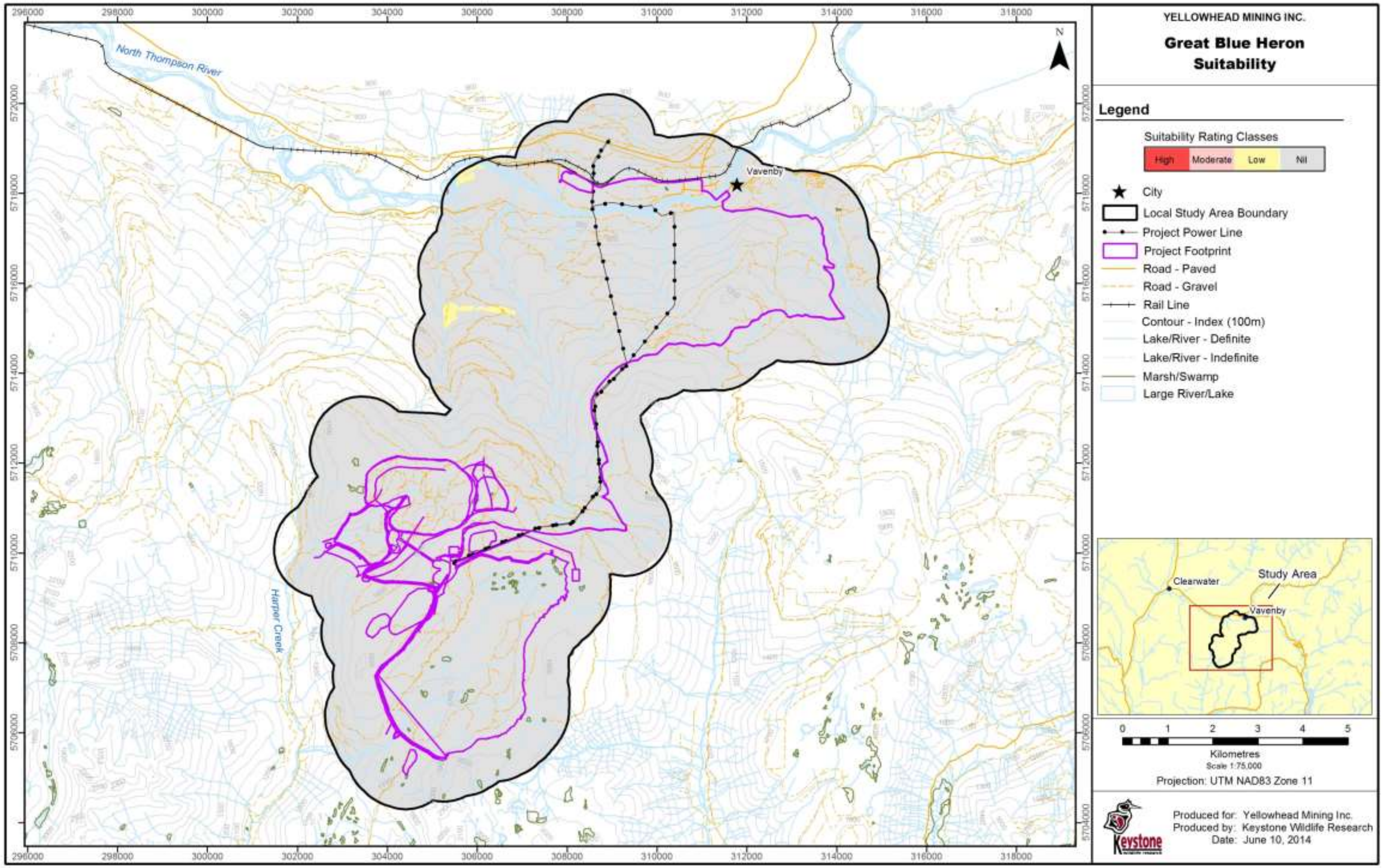

Figure 25: Great Blue Heron Suitability Mapping

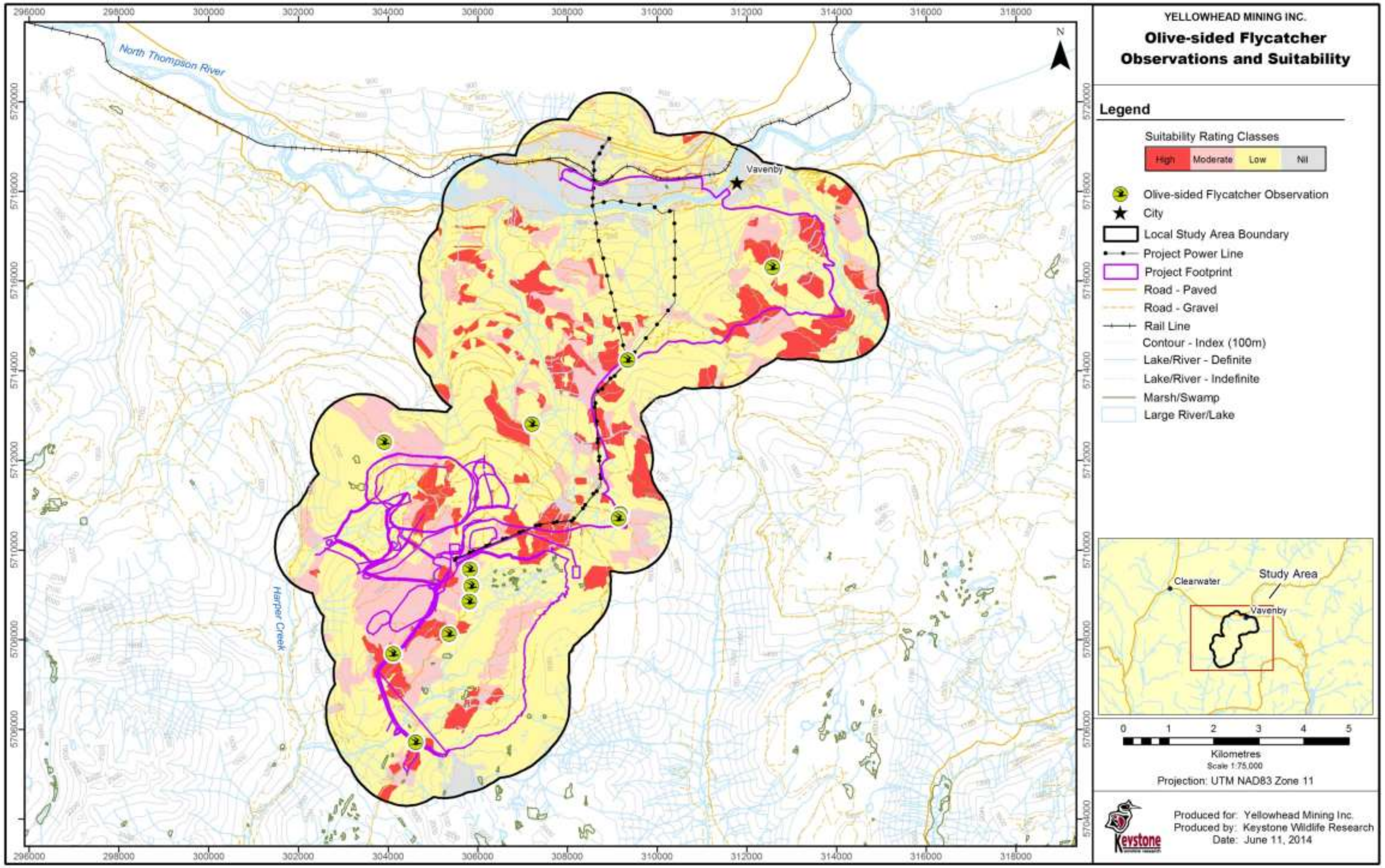

Figure 26: Olive-sided Flycatcher Suitability Mapping and Survey Observations

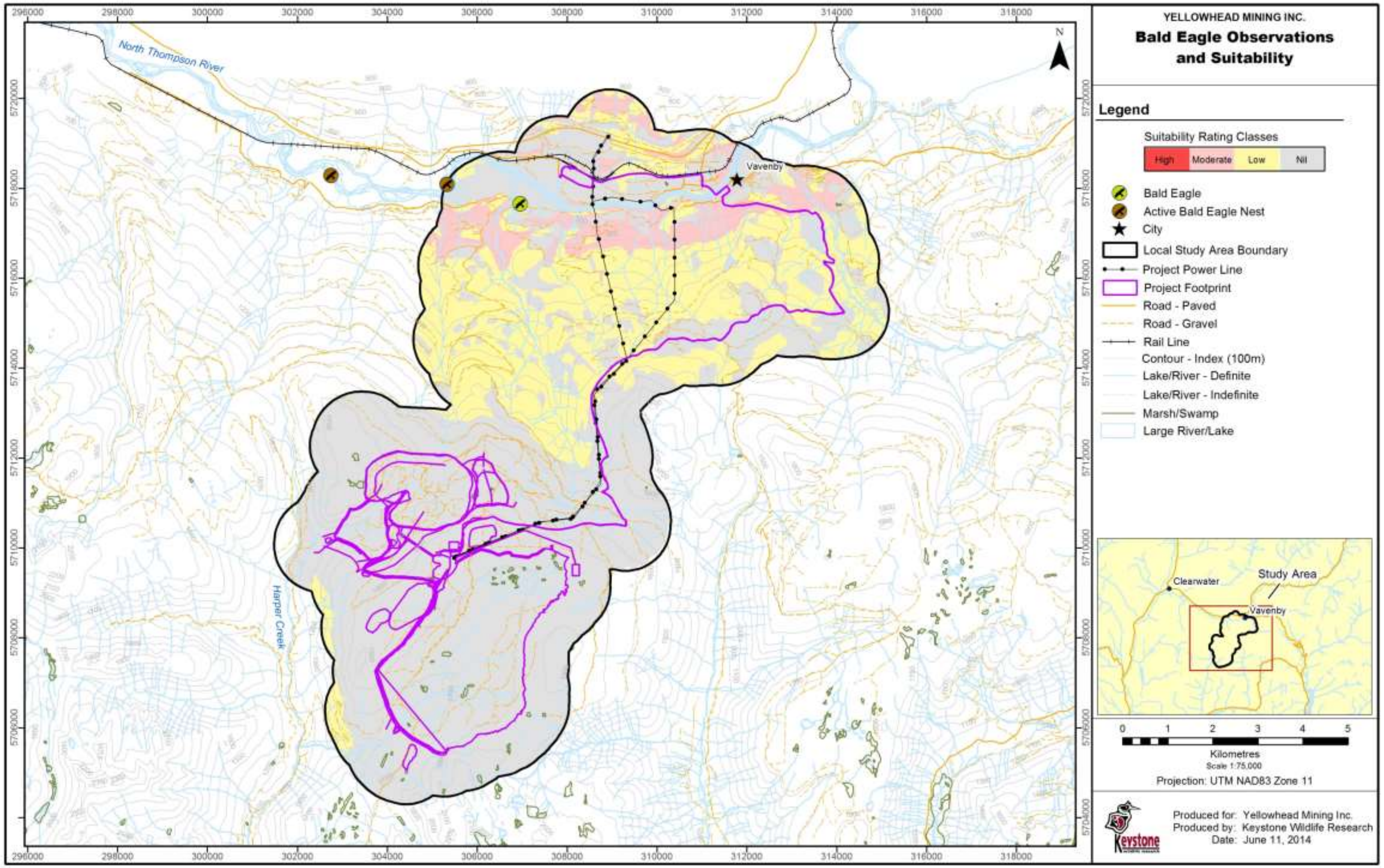

Figure 27: Bald Eagle Suitability Mapping and Survey Observations

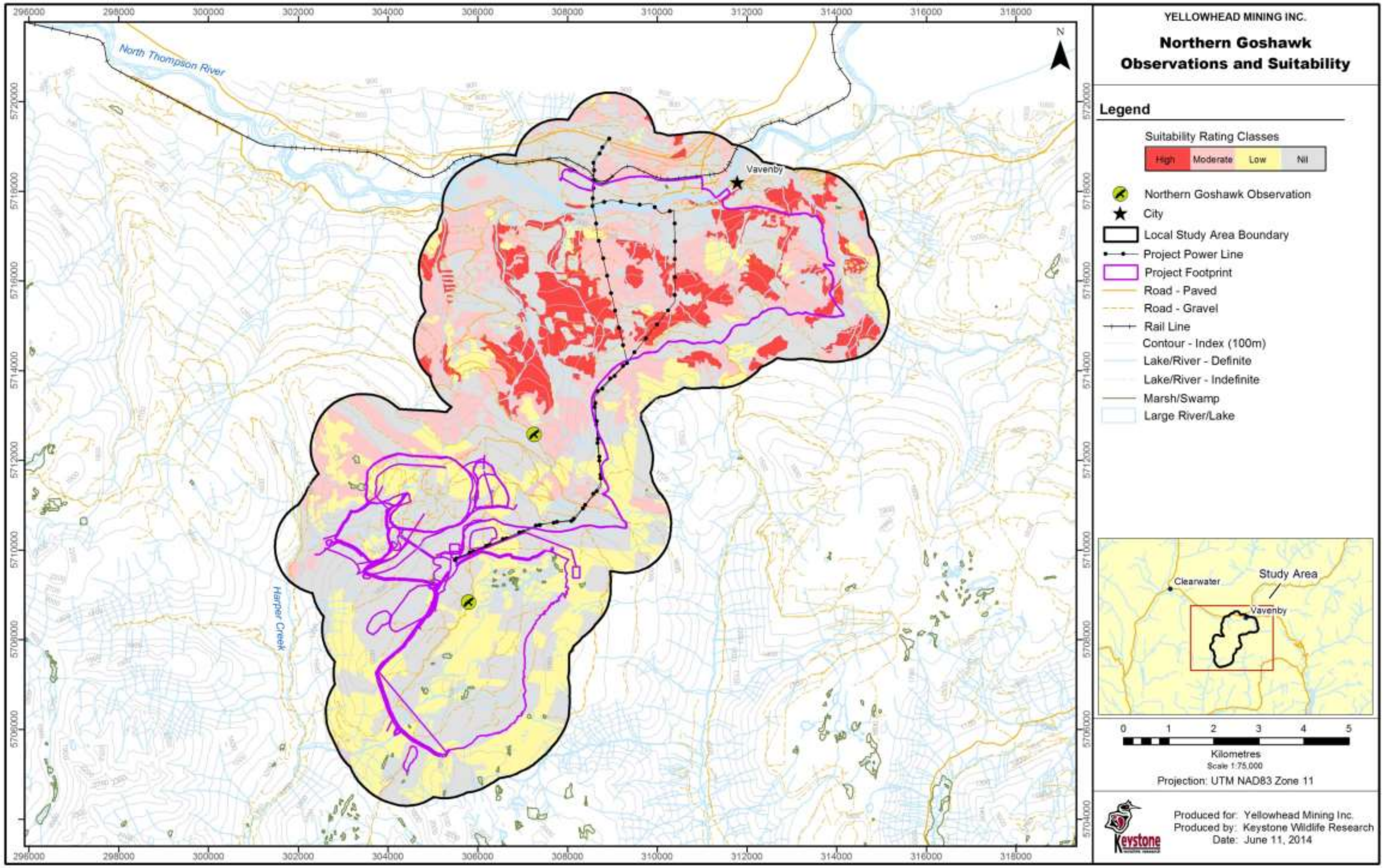

Figure 28: Northern Goshawk Suitability Mapping and Survey Observations

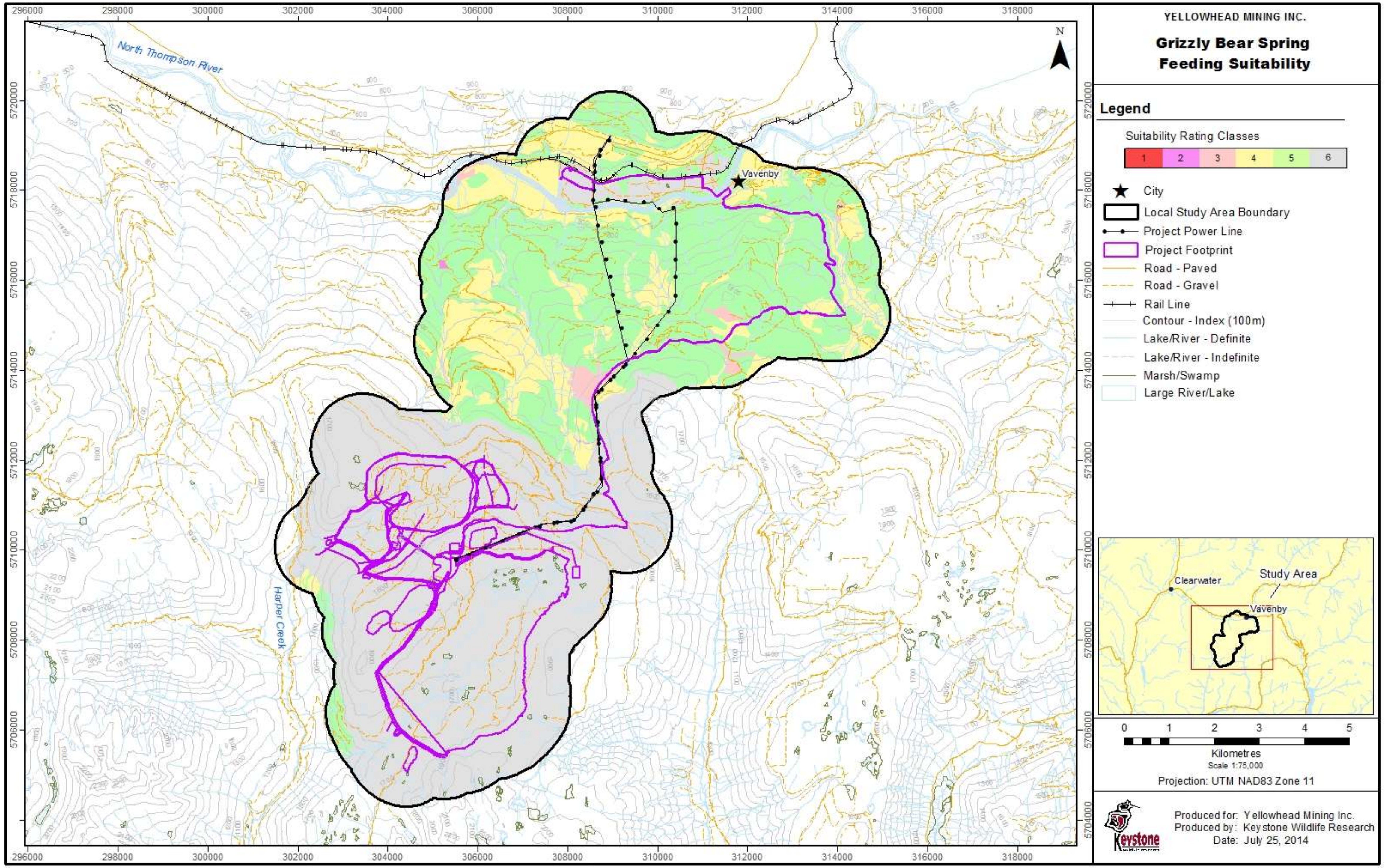

Figure 29: Grizzly Bear Spring Feeding Habitat Suitability Mapping

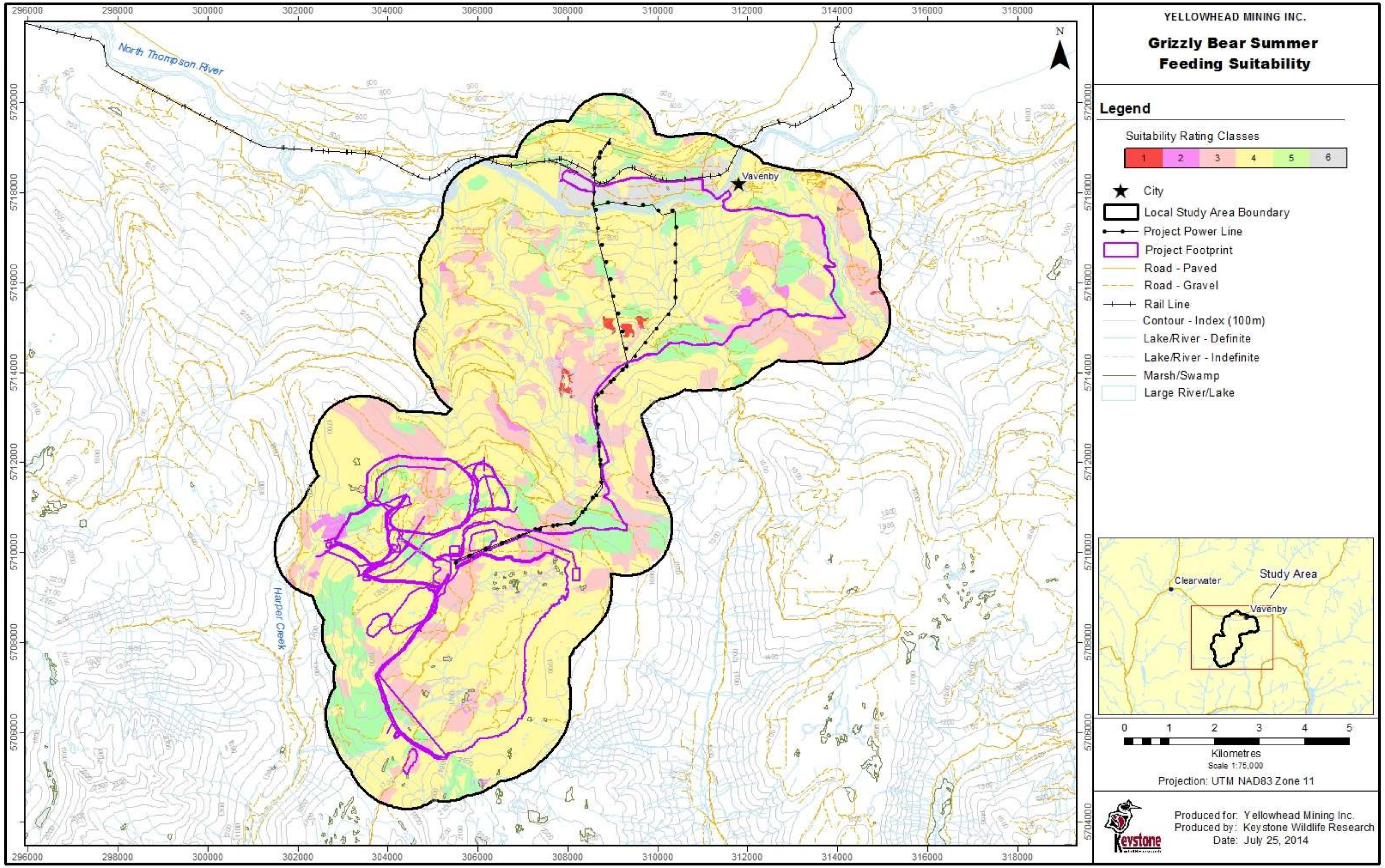

Figure 30: Grizzly Bear Summer Feeding Habitat Suitability Mapping

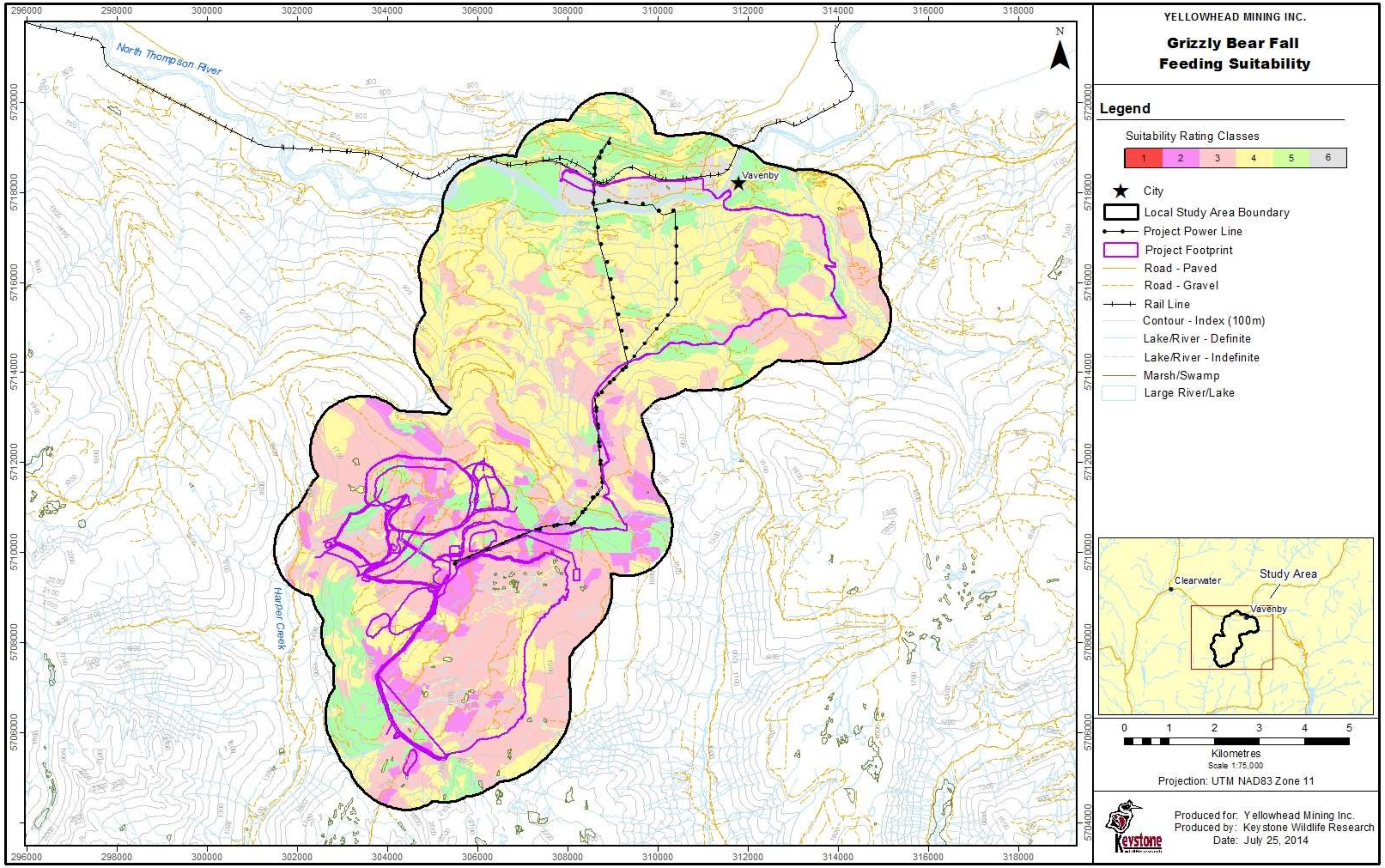

Figure 31: Grizzly Bear Fall Feeding Habitat Suitability Mapping

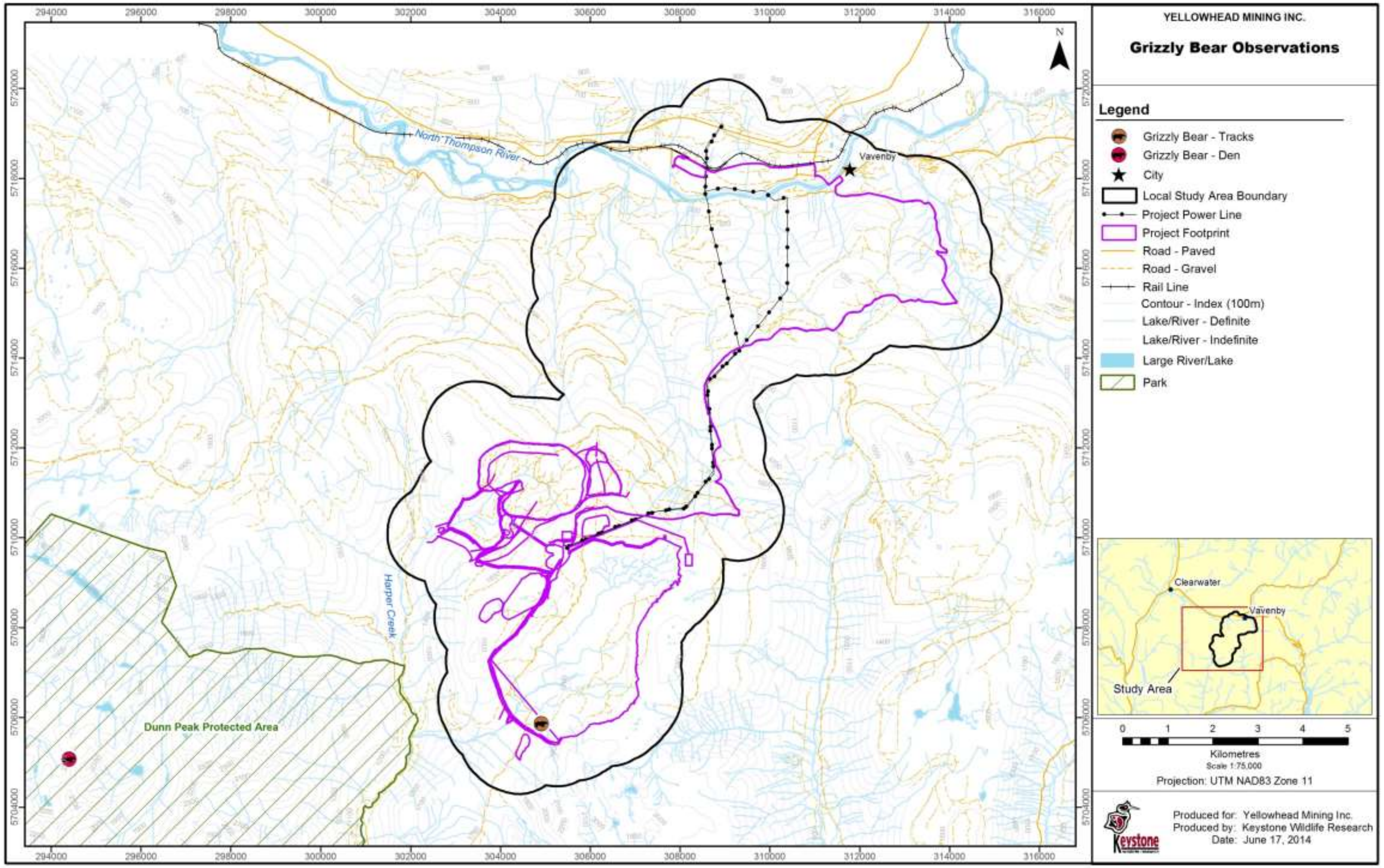

Figure 32: Grizzly Bear Sign Observed in and Adjacent to the LSA During Baseline Studies

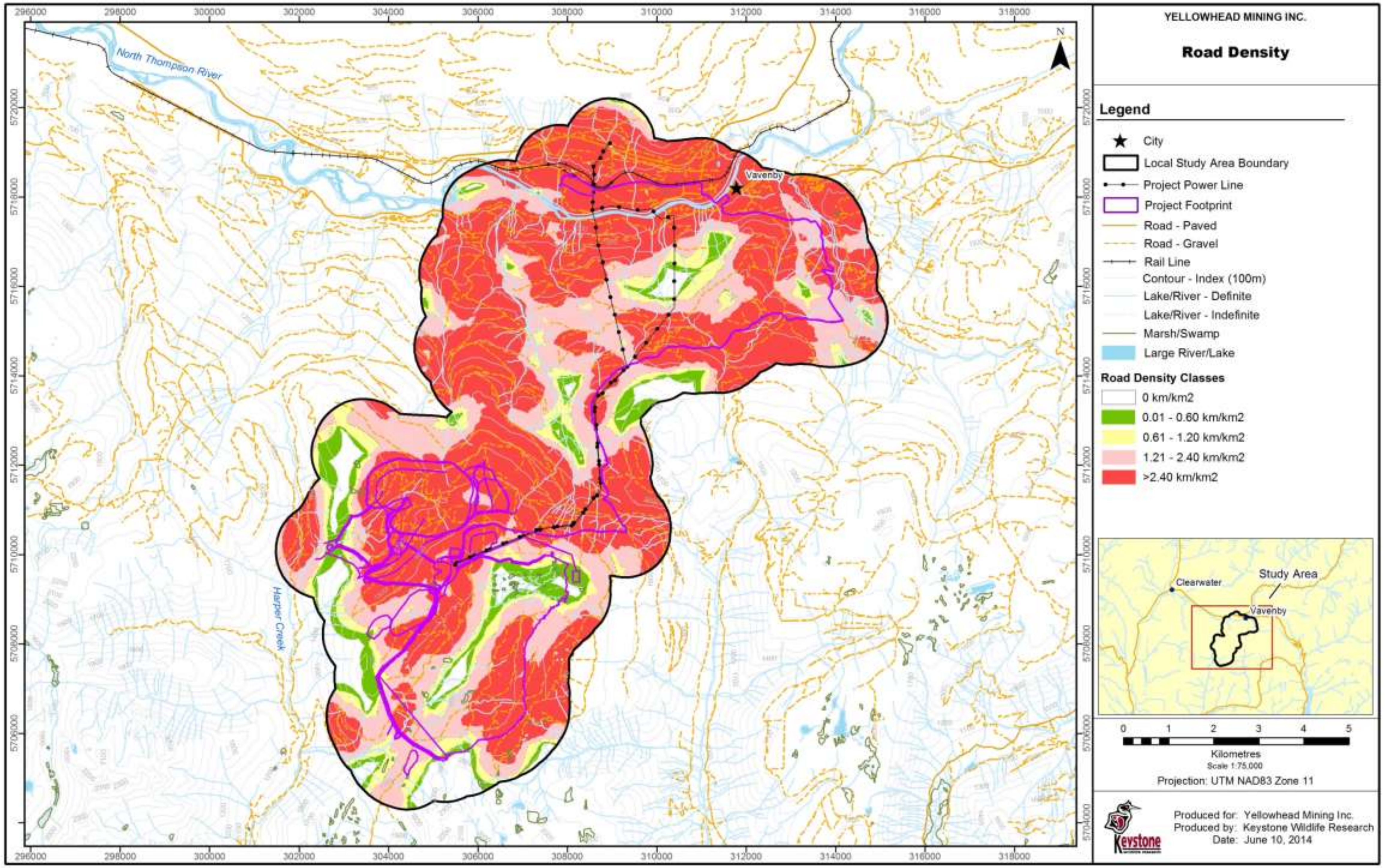

Figure 33: Road Density in the LSA

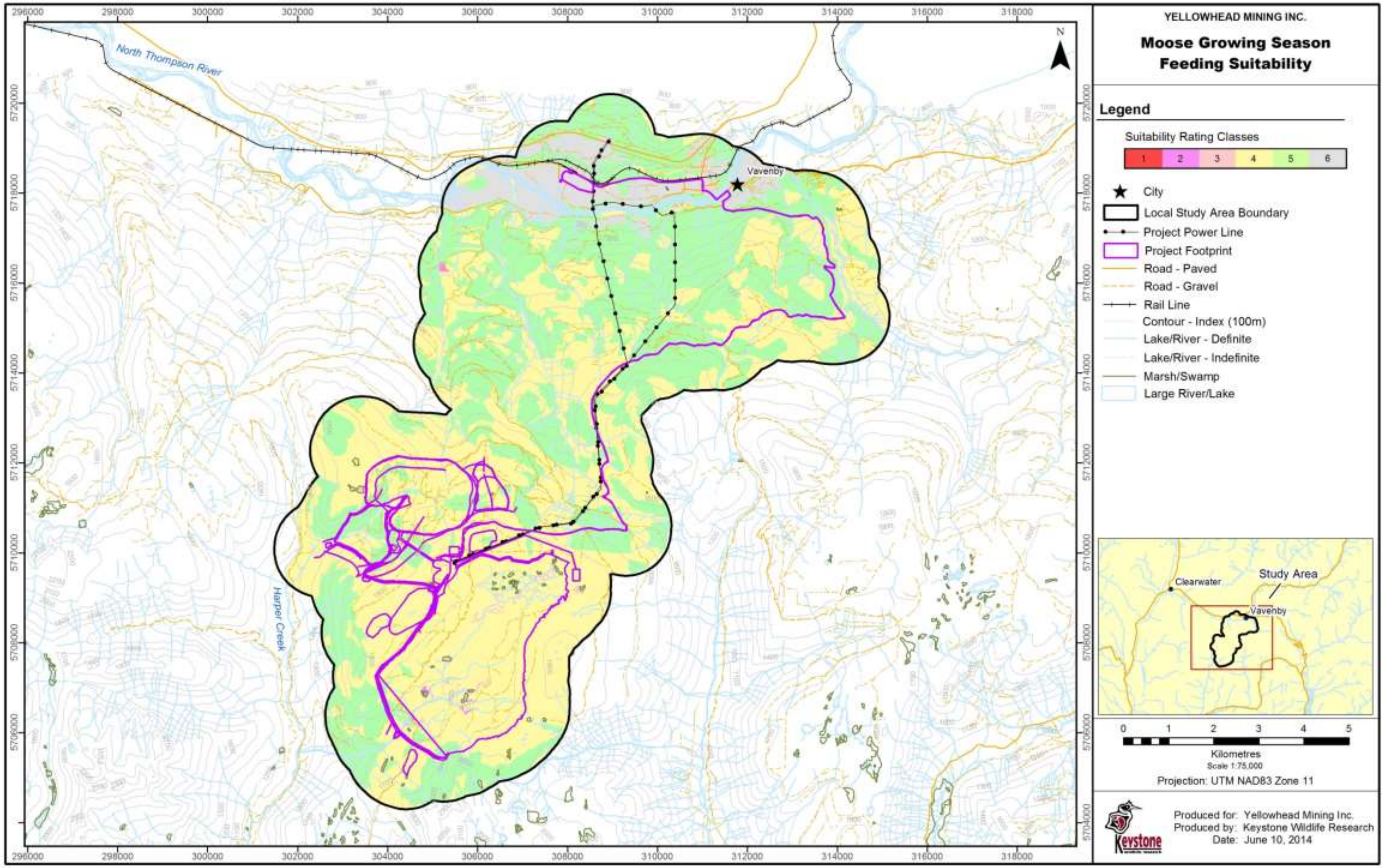

Figure 34: Moose Growing Season Feeding Habitat Suitability Mapping

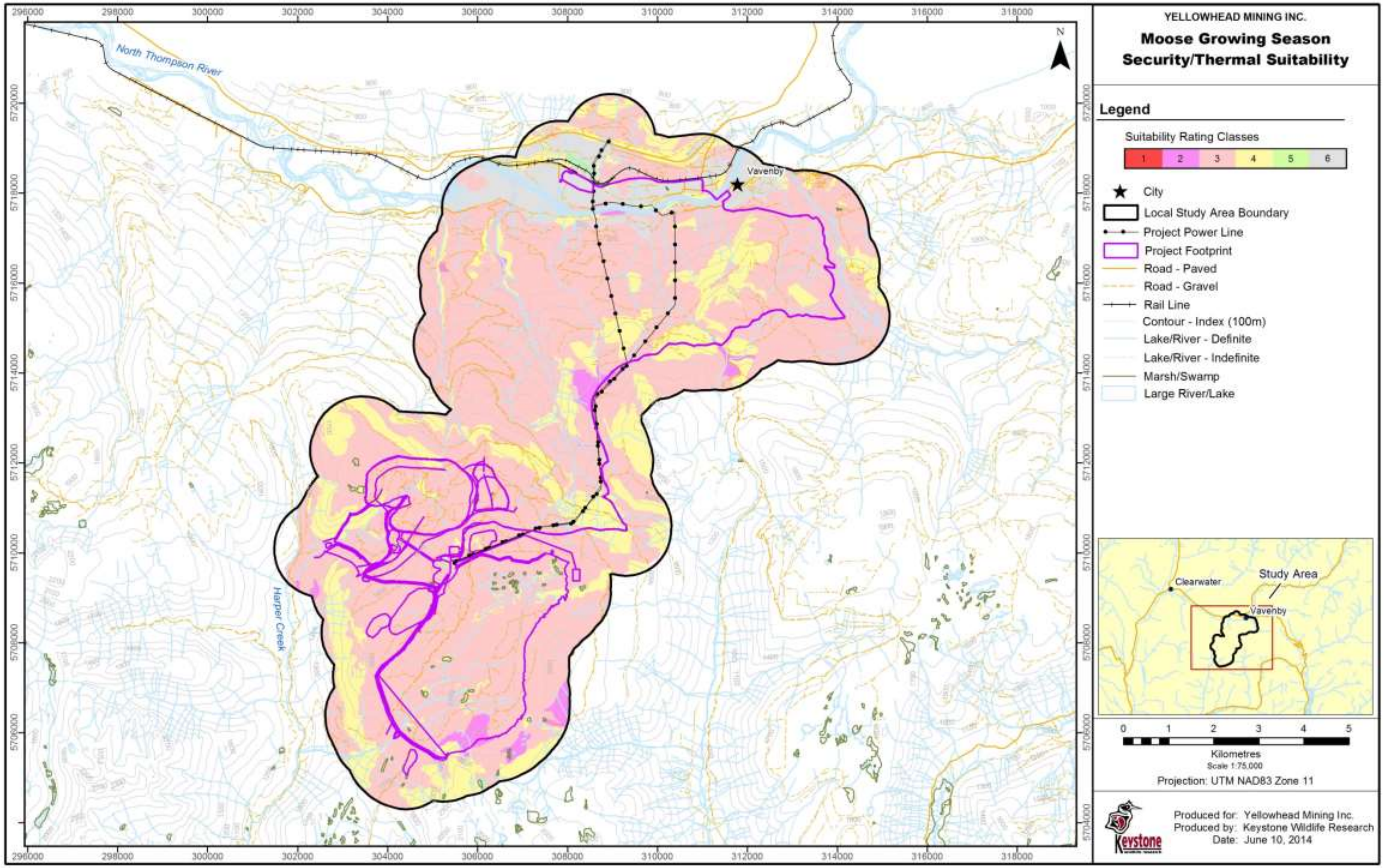

Figure 35: Moose Growing Season Security/Thermal Habitat Suitability Mapping

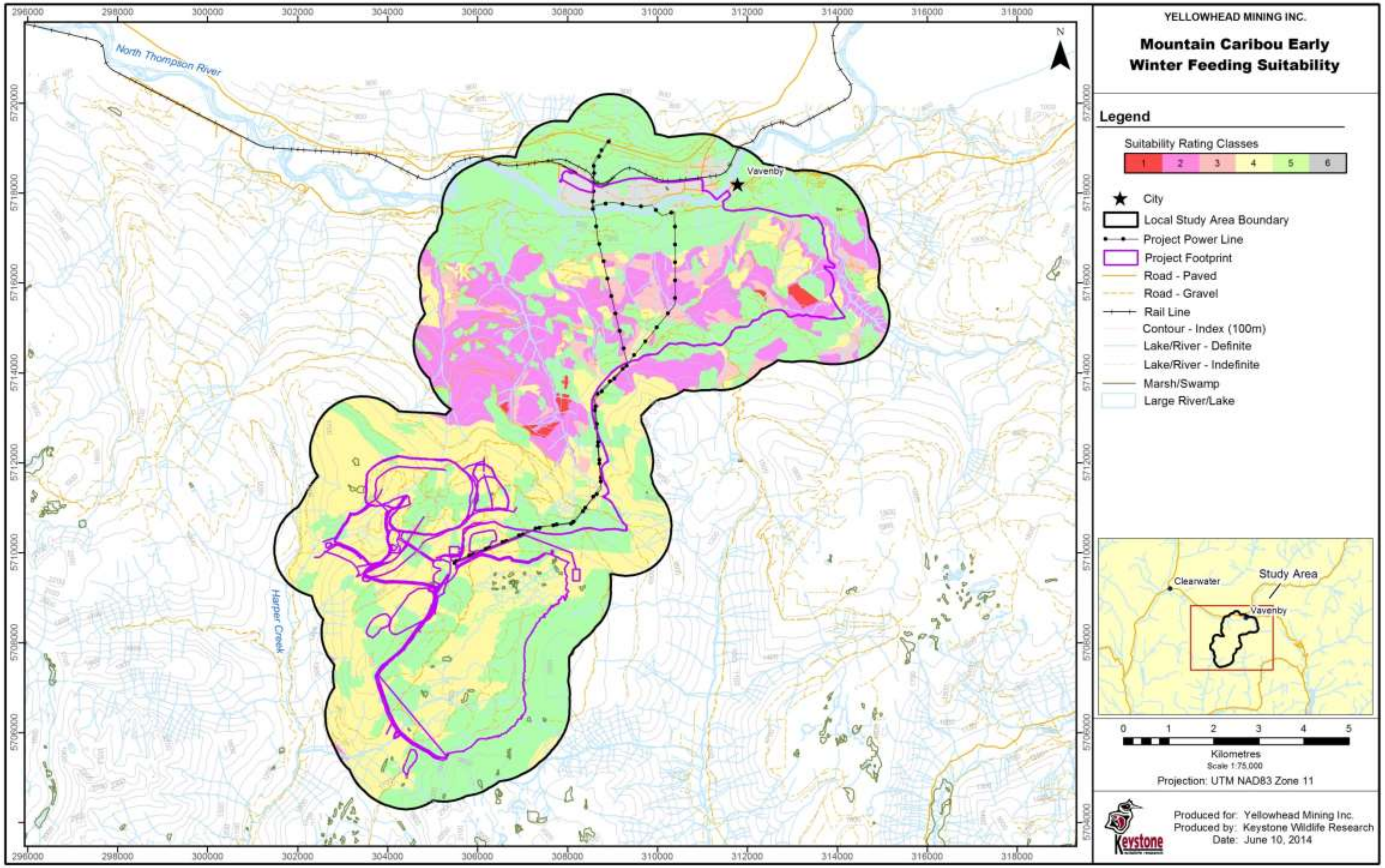

Figure 36: Mountain Caribou Early Winter Feeding Habitat Suitability Mapping

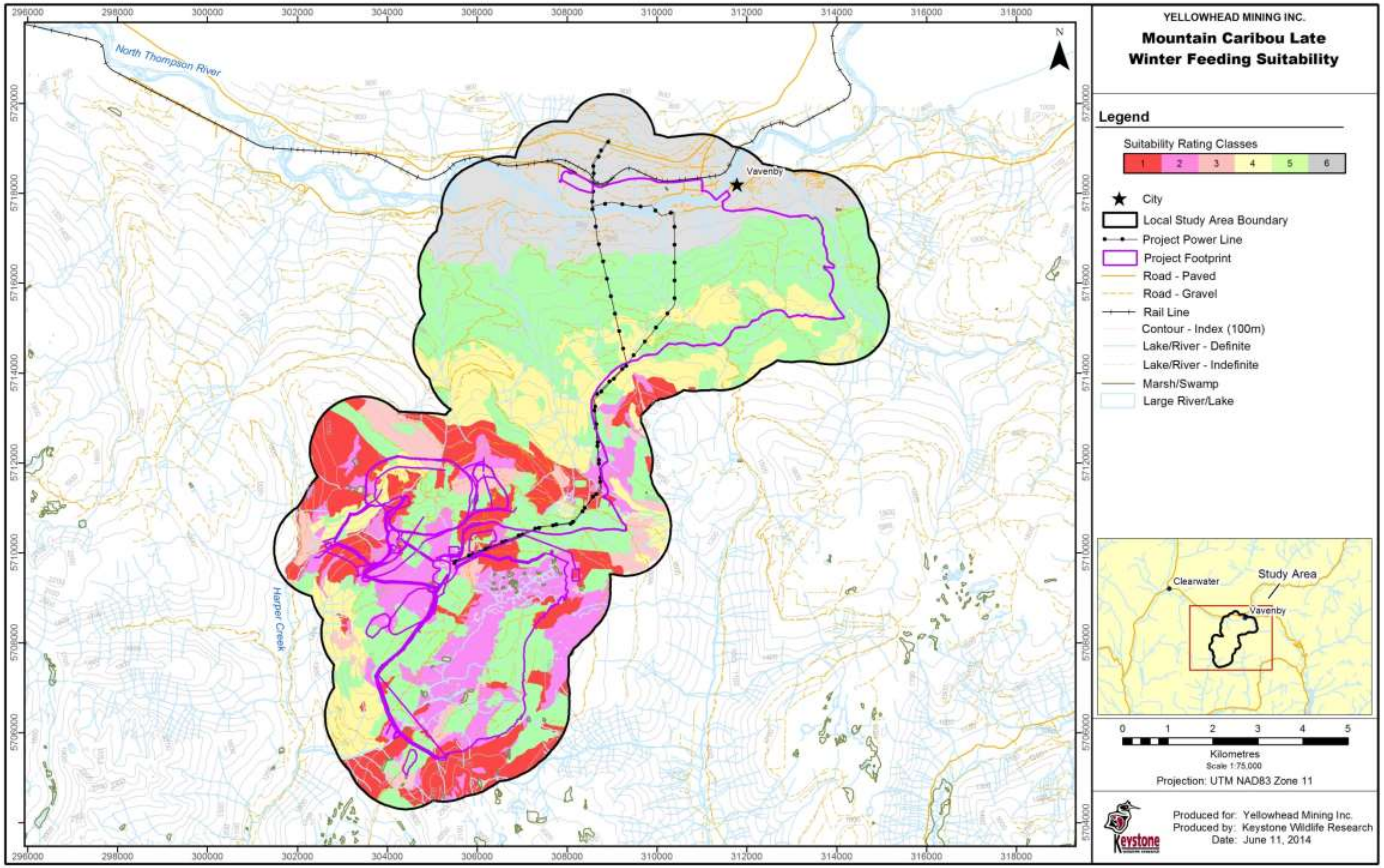

Figure 37: Mountain Caribou Late Winter Feeding Habitat Suitability Mapping

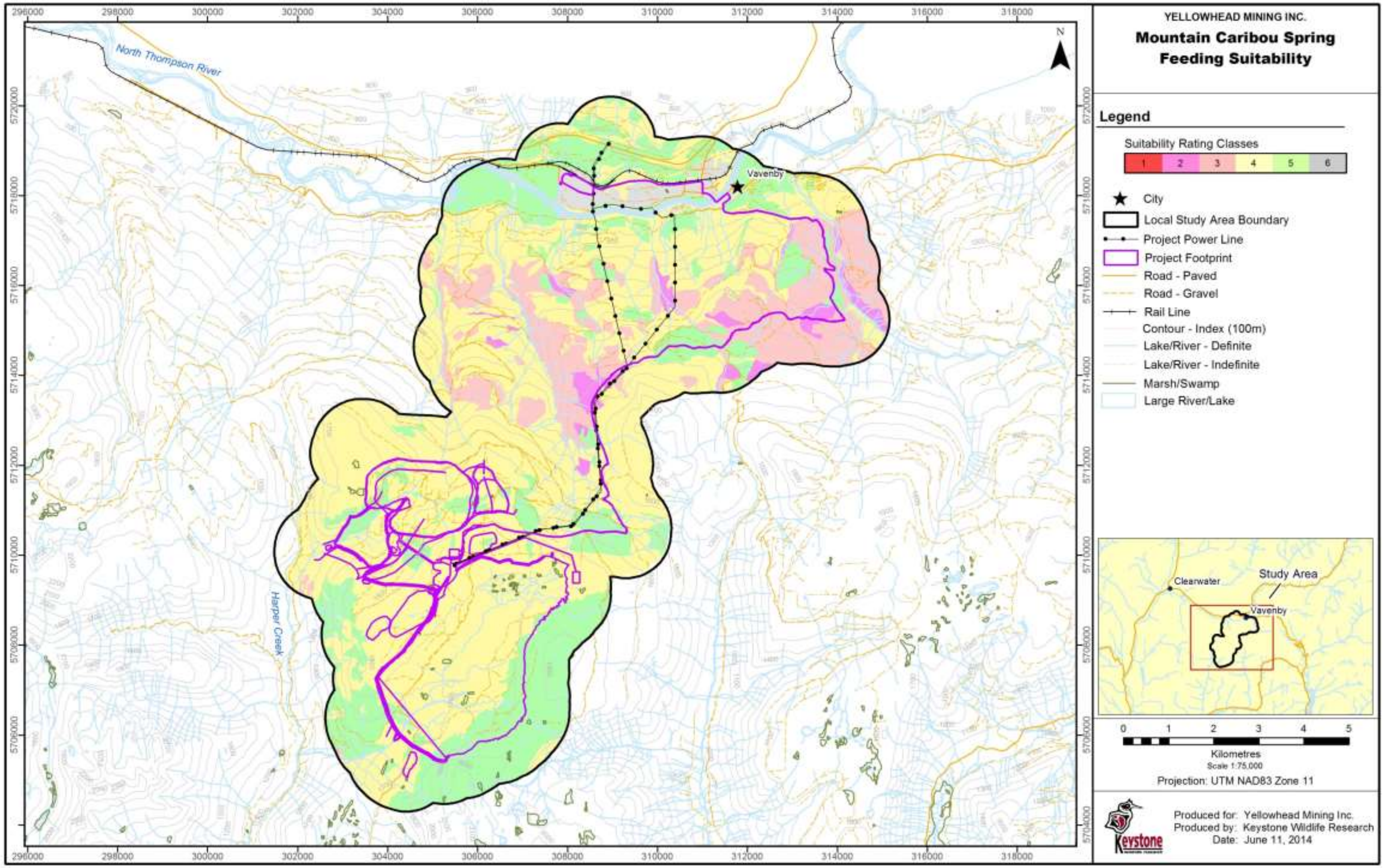

Figure 38: Mountain Caribou Spring Feeding Habitat Suitability Mapping

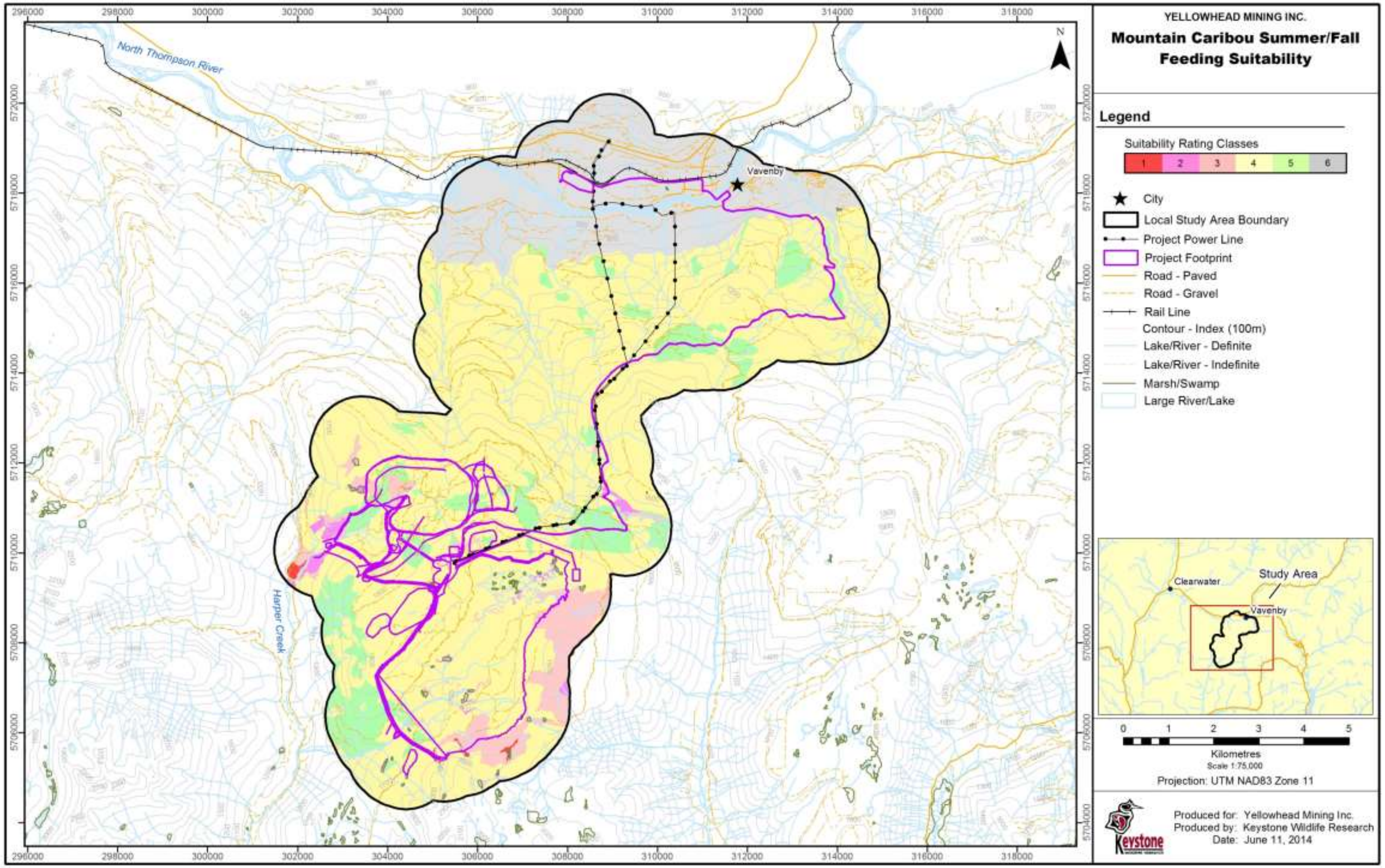

Figure 39: Mountain Caribou Summer/Fall Feeding Habitat Suitability Mapping

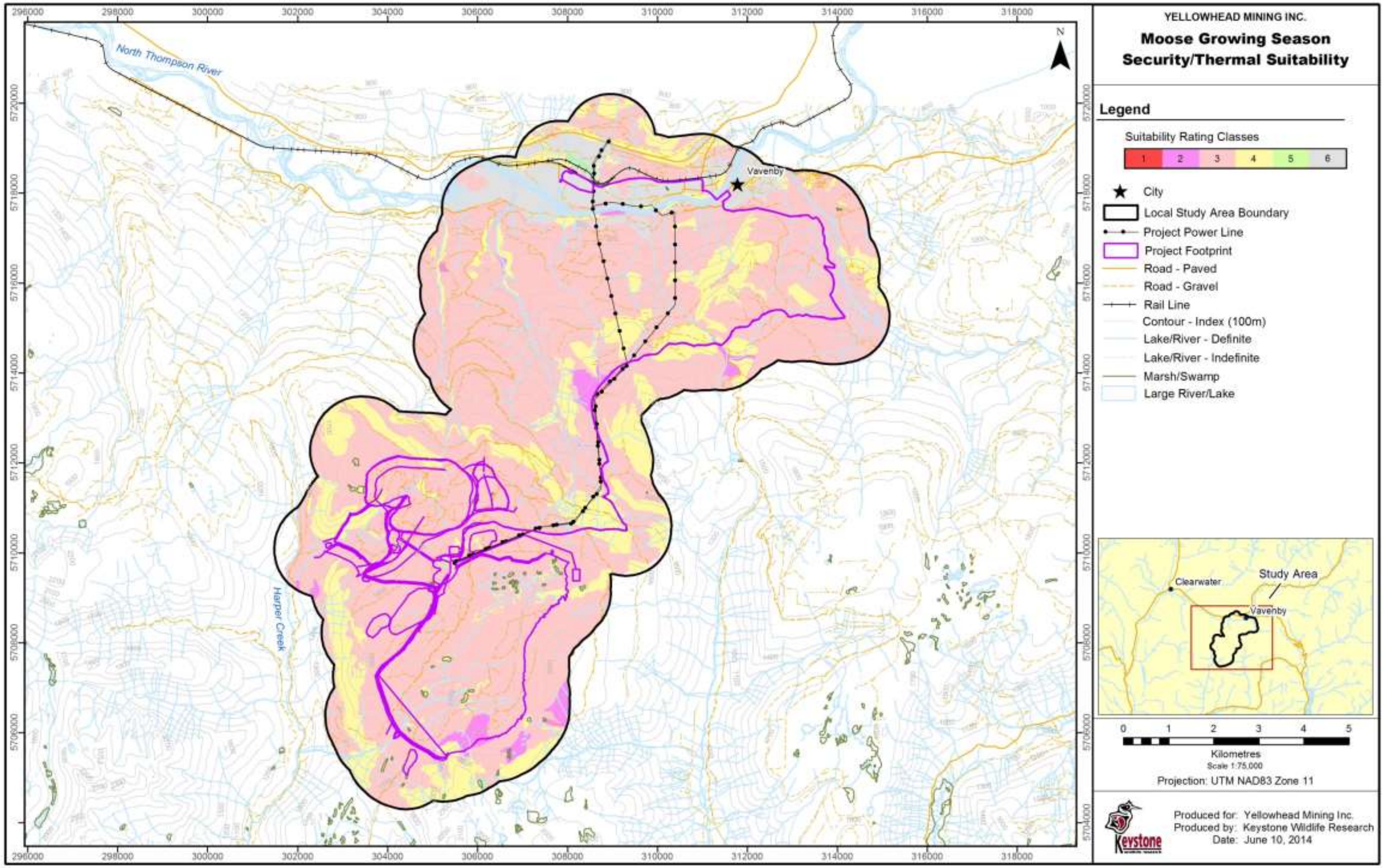

Figure 40: Mountain Caribou Security/Thermal Habitat Suitability Mapping

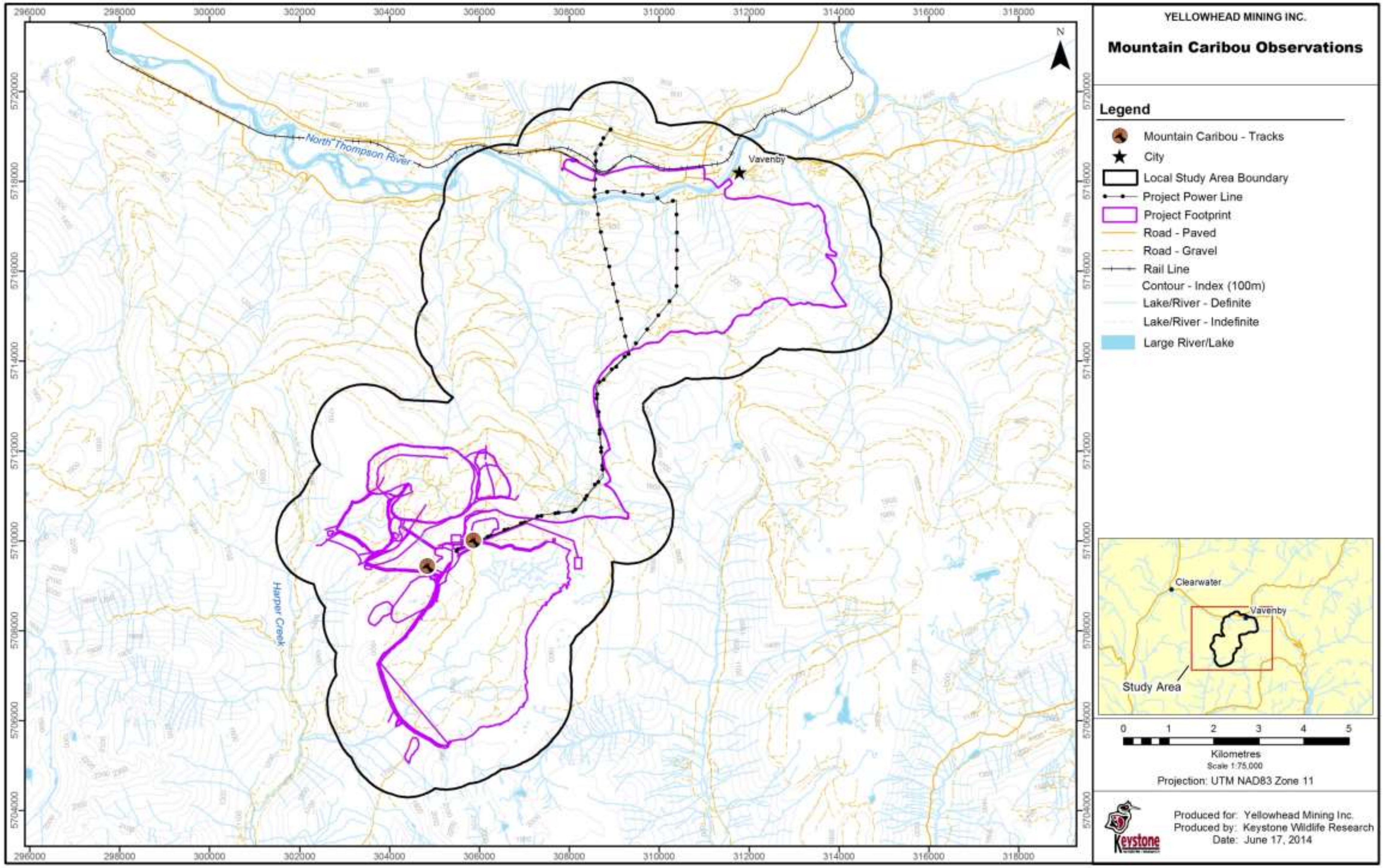

Figure 41: Mountain Caribou Sign Observed in the LSA During Baseline Studies

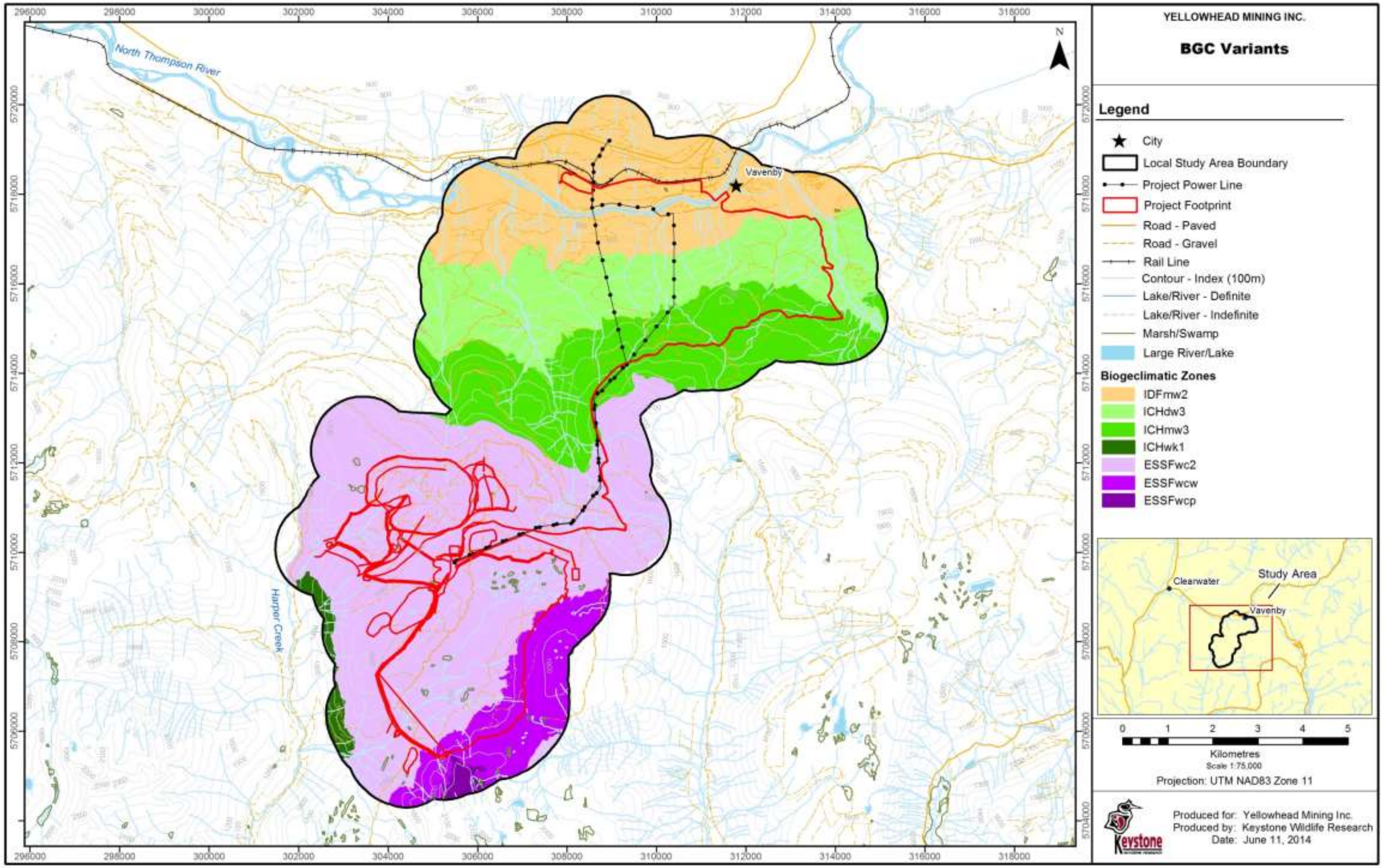

Figure 42: BGC Variants in the LSA