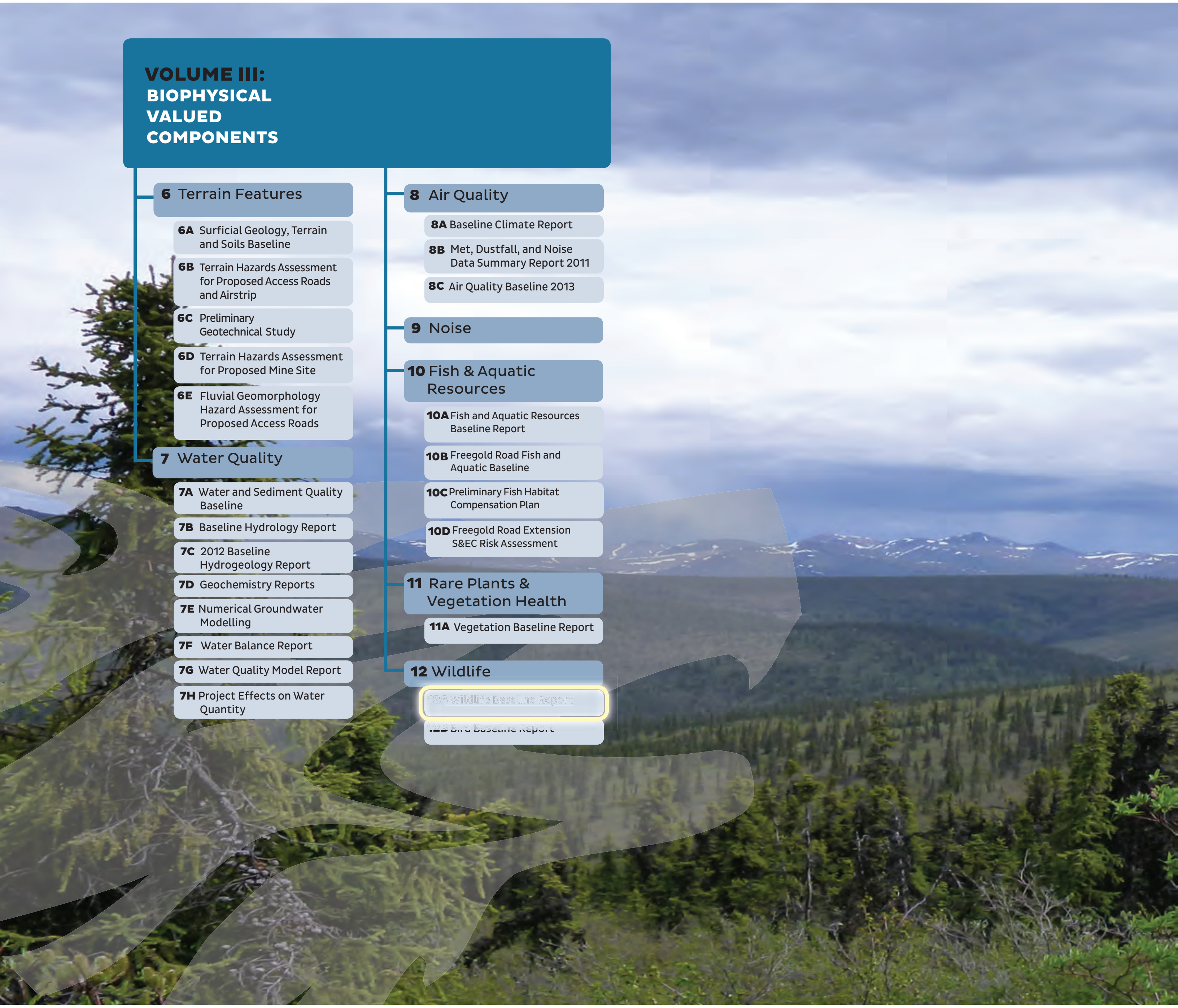
APPENDIX 12A: WILDLIFE BASELINE REPORT



Casino Project: Wildlife Baseline Report

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2012 ENVIRONMENTAL EMPLOYER OF THE YEAR

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EXECUTIVE SUMMARY

The Casino Project (the Project) is a proposed copper-molybdenum-gold mine located in the Boreal Cordillera Ecozone of the Yukon Territory, approximately 300 km northwest of Whitehorse. In 2010, Casino Mining Corporation (CMC) requested that Environmental Dynamics Inc. (EDI) collect and summarize terrestrial wildlife data for the Project area.

Caribou (*Rangifer tarandus caribou*) and moose (*Alces alces*) dominate the landscape in this region and also play an integral role in the region's culture by providing sustenance and resource opportunities. Woodland caribou herds within the region include the Klaza, Aishihik, and Forty Mile herds; however, the Project interacts primarily with the Klaza herd. Woodland caribou from the Klaza herd are present within the Project's Regional Study Area (RSA) year-round, with parts of the herd's annual range overlapping with the proposed Freegold Road upgrade and extension. The Klaza herd has experienced a population increase since the early 1990s. The herd, once numbering approximately 440 animals is now estimated at 1,179 animals. Moose are the largest ungulate within the RSA and are considered the primary harvest species for resident hunters. Moose are distributed throughout the RSA, likely selecting available burned and treed riparian areas. Moose densities in the area are considered low for the Yukon.

Other ungulates present within the RSA include Dall's sheep (*Ovis dalli*), wood bison (*Bison bison athabascae*; Aishihik herd), and mule deer (*Odocoileus heminonus*). Dall's sheep are known to use traditional seasonal ranges in three main areas in the RSA. Wood bison are only sporadically present in the very southern section of the RSA, and mule deer are occasionally observed on south-facing slopes near the Yukon River (western RSA).

The dominant carnivores in the RSA include grizzly (*Ursus arctos horribilis*) and black bears (*Ursus americanus*), wolves (*Canis lupus*), and wolverine (*Gulo gulo*), which occur at relatively low densities; however, little is known about these species in the region. Lynx (*Lynx canadensis*), American marten (*Martes americana*), coyote (*Canis latrans)*, and red fox (*Vulpes vulpes*) are also present. Collared pika (*Ochotona collaris*) are known to inhabit alpine areas close to the proposed mine site.

This report summarizes and integrates the history of regional government surveys and studies, harvest data, habitat use, and Project-specific wildlife studies to provide a robust account of baseline conditions within the proposed Project area.

ACKNOWLEDGEMENTS

The information summarized in this report reflects a large amount of effort and resources from a number of people and organizations. This report would not be possible without them. CMC commissioned Project specific baseline studies since 2006. This work is included and referenced in this report and the results were helpful for planning further studies.

The Government of Yukon funded and staffed much of the data summarized in this report. Mark O'Donoghue (Biologist, Northern Tutchone Region) and Troy Hegel (Ungulate Biologist) designed, coordinated, and implemented the recent studies on the Klaza caribou herd, moose, and Dall's sheep. They provided data, advice, and comments. Joe Bellmore (Fish and Wildlife Technician) and Kyle Russell (Program Technician, Caribou/Sheep/Goat) participated in CMC funded surveys in 2012 and 2013, respectively. Their time and effort are greatly appreciated.

Local Carmacks residents who assisted with surveys include Willis Allen, Troy Fairclough, Terry Hanlon, Lauren Skookum, Gill Tulk, and Gary Wheeler. Their patience during weather delays, vigilance during long hours of work, and companionship were greatly appreciated and we look forward to working with them again in the near future. Safe and professional fixed wing and helicopter services were provided by Alpine Aviation (Gerd Mannsperger and Martin Hebert), Capital Helicopters (Andy Robertson) and Whitehorse Air (Tom Hudgin, Dave Hiltenkamp, and Jim Healy). Rick Farnell (consulting wildlife biologist) provided perspective and knowledge that supplemented his original work on the Klaza caribou herd. His knowledge of caribou ecology was very helpful. Finally, we would like to thank Jesse Duke (Ibex Valley Environmental Consulting) who considered and supported our suggestions. Without his confidence in EDI we could not have completed this work.

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ACRONYMS

AIC .... Akaike's Information Criterion

AUC .... Area Under Curve

BC .... British Columbia

BMU .... Bear Management Unit

BOH .... Boreal High

BOL .... Boreal Low

CEA .... Cumulative Effects Assessment

CESCC .... Canadian Endangered Species Conservation Council

CMC .... Casino Mining Corporation

COSEWIC .... Committee on the Status of Endangered Wildlife in Canada

CWMMU .... Carmacks West Moose Management Unit

DC .... Disturbance Coefficient

DEM .... Digital elevation model

EDI .... Environmental Dynamics Inc.

ELC .... Ecological Land Classification

EOSD .... Earth Observation for Sustainable Development

GIS .... Geographic information system; a program used for spatial analysis and mapping

GME .... Geospatial modelling environment

GMS(s) .... Game Management Subzone(s)

GPS .... Global positioning system

HE .... Habitat Effectiveness

HSI .... Habitat Suitability Index

KCH .... Klaza Caribou Herd

KDE(s) .... Kernel Density Estimator(s)

LSCFM .... Little Salmon Carmacks First Nation

masl .... Metres above sea level

NMP .... Northern mountain population (woodland caribou)

NT .... Northwest Territories

PDA .... Potential disturbance area

PH .... Potential habitat

RH .... Realized habitat

ROC .... Receiver operating characteristic

RSA .... Regional Study Area

RSF(s) .... Resource Selection Function(s)

RTC .... Registered trapline concession

SARA .... *Species at Risk Act*

SFN .... Selkirk First Nation

TK .... Traditional knowledge

USA .... United States of America

USDA .... United States Department of Agriculture

VHF .... Very high frequency (conventional radio collars that must be located using radio signals)

YESAA .... Yukon Environmental and Socio-economic Assessment Act

YESAB .... Yukon Environmental and Socio-economic Assessment Board

YEWG .... Yukon Ecoregions Working Group

YMMU .... Yukon Moose Management Units

GLOSSARY

Casino area	General term describing the area surrounding the Casino Project (the Project).
Grizzly Bear Study Area (GBSA)	The grizzly bear study area is used for the grizzly bear habitat modeling and includes GMS 509, 510, 511, 522, 523, 524, and 526.
Ivlev's electivity index	A calculated number used in the caribou resource selection function (RSF) model indicating the degree of choice a caribou shows in selecting habitat. Ivlev's ratio scales the use/availability ratio between -1 and 1, 1 being maximum selection and -1 being maximum avoidance (Krebs 1999). The index is useful for describing and visualizing selection.
Kernel density estimators and/or contours (KDEs)	A method used to estimate the probability of an animal being located within a given area of its home/seasonal range. Range is defined by a set of locations (often collar locations). KDE contours represent the boundary of an area containing a certain percent (e.g. 50%, 95%, 99%) of the volume of the probability density distribution.
The Project	The Casino Project, a proposed copper-molybdenum-gold mine at the Casino Mine property located at latitude 62° 44' N and longitude 138° 50' W, approximately 300 km northwest of Whitehorse, Yukon.
Project area	A general term referring to the broader landscape encompassing the Casino Project area.
Regional study area (RSA)	The maximum extent of an area that was used to survey for and assess the Casino Project effects on terrestrial wildlife. The RSA includes the species-specific study areas for the Klaza caribou herd, moose and grizzly bear.
Resource selection function (RSF)	A method used of identifying areas within a landscape that are highly used by a population of animals. The method uses radio collar or other sources of information to inform researchers about "use" of habitat. The location data is then associated with slope, aspect, elevation, habitat type, etc.

1 INTRODUCTION

1.1 PROJECT DETAILS

Casino Mining Corporation (CMC) is proposing to develop the Casino Project (the Project), a copper-molybdenum-gold mine at their Casino Mine property located at latitude 62º 44' N and longitude 138º 50' W, approximately 300 km northwest of Whitehorse, Yukon (Figure 1.1). The proposed Project will have a mine life of 33 years comprised of four phases: construction (3 years), operation (22 years), closure and decommissioning (3 years), and post closure (5 years).

The primary components of the Project, as shown in Figure 1.1, are:

- Mine site — includes open pit; stockpiles for low grade ore, gold ore, topsoil and topsoil/overburden; a plant site; heap leach facility;
- Tailings management facility;
- Extension and upgrade of the Freegold Road (previously referred to as the Casino Trail) — the Freegold Road will be upgraded and extended to connect the mine site to Carmacks, Yukon. The existing 70 km of the Freegold Road will require upgrading and route adjustments to meet design standards. The final road will be approximately 200 km long and maintained as an all-season gravel road suitable for ore and fuel transport;
- Construction and operation of a new airstrip; and
- Access road and water pipeline to the Yukon River.

All proceeding figures in this report display the Potential Disturbance Area (PDA) — an estimate of the amount of disturbance the Casino Project components and activities are likely to cause based on current available information. The PDA is a conservative estimate used to represent the maximum potential loss of habitat from the Project footprint and encompasses an 80.57 km² area.

The Project expects to process 120,000 tonnes of material per day; equivalent to 43.8 million tonnes per year. Anticipated volumes of metals produced over the life of the mine are:

- Gold: 5.72 million ounces
- Silver: 30.26 million ounces
- Copper: 3.58 billion pounds; and
- Molybdenum: 325 million pounds

Since the 1950s the Dawson Range has been a focal point for mineral resource exploration (Spencer Environmental Management Services Ltd. 1985; Pearse and Weinstein 1988; Jingfors 1989; Casino Trail Local Resource Group 1990). The proposed Freegold Road (previously called the Casino Trail) project was first introduced in the early 1960s — an idea that lay dormant until 1980 when mineral interest in the area redeveloped. In 1985 a formal proposal from the Yukon Chamber of Mines requested an all-weather road be built from Carmacks to the Casino mine property. The Government of Yukon began construction of the

Freegold Road in 1986, but ended construction in 1988 prior to completing the road. Several concerns were raised during construction, particularly by the Selkirk First Nations (SFN) and Little Salmon Carmacks First Nations (LSCFN) who were negotiating land claims at the time. Concerns were that the road would allow public access and increase hunting pressure on their traditional lands.

Terrestrial wildlife baseline work began on this Project in the late 1980s. Recent work funded by CMC started in 2006 and has continued through 2013. Preliminary wildlife surveys completed during the initial stages of environmental baseline studies were conducted by the Government of Yukon and a number of consultants, more recently AECOM at the mine site and Summit Environmental Consultants Inc. along the road. Information in this report relies heavily on publicly available information from the Government of Yukon.

EDI Environmental Dynamics Inc. (EDI) was retained by CMC in 2010 to complete the wildlife baseline studies and prepare a terrestrial wildlife baseline report in support of the eventual Project Proposal submission to the Yukon Environmental and Socio-Economic Assessment Board (YESAB). This report summarizes existing information on terrestrial wildlife in the Project area.

1.2 OBJECTIVES

To obtain the required regulatory approvals to proceed, the Project must be assessed under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA). During this process, potential effects that the Project many have on environment and socio-economic valued components are identified, and where possible, mitigation measures are developed to reduce or eliminate those effects. To properly assess potential effects, a thorough understanding of baseline conditions is required.

YESAB's Proponents Guide of Information and Requirements for Executive Committee Project Proposal Submissions (YESAB 2005) recommends that for wildlife, Project Proposals should:

- Describe abundance and distribution characteristics of major wildlife species within the project area and vicinity. Include information on mammals, amphibians, birds, and reptiles (including rare and endangered species);
- Describe the habitat classifications used in the project area, and any implications concerning the distribution and abundance of habitat types that may influence the project; and
- Identify and describe transportation corridors and critical, sensitive and key habitats, including periods of habitat use in the project area and vicinity.

This document summarizes baseline information related to terrestrial wildlife within the Project area and was prepared in support of the environmental effects assessment that will be included in the Casino Project Proposal which is scheduled for submission to YESAB in the fourth quarter of 2013.

Specific objectives of the wildlife baseline report are to:

- Summarize available wildlife information in the study area, including abundance and distribution of key species; and identification of critical and sensitive habitats and transportation corridors; and
- Complete a baseline inventory of wildlife species in the study area to gain an understanding of regional wildlife ecology as a basis for assessing and mitigating potential Project effects on wildlife.

1.3 STUDY AREA

A wildlife Regional Study Area (RSA) was selected to include an area that is biologically relevant, consistent with wildlife management boundaries, and provides a regional context for Project-related effects at the population level. The Klaza caribou herd (KCH) has a relatively discrete and well defined range that intersects the Project and many species that occur within the RSA are managed as big game species within designated Game Management Subzones (GMSs; e.g., caribou, moose and grizzly bear); therefore, the RSA was delineated to include the KCH range and the GMSs that intersect the Project footprint (Figure 1.1). The total area of the RSA is 10,786 km². Species-specific study areas are discussed further in the species sections of this report. Generally, these species-specific study areas include the areas where the species is expected to interact with the Project infrastructure or associated activities. More detailed surveys and inventories were conducted for some species at smaller scales; for example, bear den surveys were conducted within 5 km of the proposed access road and snow track surveys for small animals were conducted along the proposed access road.

The LSA includes the length of the Freegold Road extension plus a roughly 1 km buffer on either side of the road alignment. The 1 km buffer was used to delineate terrestrial ecosystem mapping. All terrain polygons within the 1 km buffer were mapped and vegetation types assigned to the polygon's extent, often outside of the 1 km buffer. Surrounding the mine site, the LSA encompasses the watersheds of Britannia Creek and its tributary Canadian Creek, as well as upper Dip Creek and its tributary Casino Creek. The Yukon River defines the northern boundary of the LSA. The LSA encompasses an area that is approximately 886.4 km². Only collared pika (Section 12) is examined at the scale of the LSA.

1.3.1 Ecological Description

The Project is located in the Boreal Cordillera Ecozone within the Klondike Plateau and Yukon Plateau-Central Ecoregions (Figure 1.2). The following ecological description of the Boreal Cordillera Ecozone is largely adapted from Smith et al. (2004). Descriptions of the Klondike Plateau and Yukon Plateau-Central Ecoregions are adapted from the Yukon Ecoregions Working Group (YEWG 2004 in Smith et al. 2004) unless otherwise noted.

The Boreal Cordillera Ecozone is characterized by long, cold winters and short, warm summers. Mean temperatures range from below -27°C in winter to 15°C in summer. Mean annual precipitation ranges from 30 mm in the west to 1,000 mm in the east over the interior ranges and is greater at higher elevations.

Klondike Plateau Ecoregion

The Project is mostly located in the Klondike Plateau Ecoregion with the deposit situated at Patton Hill. The region has an estimated mean annual temperature of -2.7ºC, with January being the coldest month at -18.1°C and July the warmest at 11.1ºC. Mean annual precipitation is estimated to be 500 mm with most precipitation falling in July. Although the Dawson Range is mostly unglaciated there is evidence of minor glaciation in the subalpine. Permafrost is sporadic and discontinuous on north-facing slopes with less consistency on south-facing slopes. Soil development ranges from coarse talus and immature soil horizons at higher elevations to mature soils with thick organic matter accumulating in valleys.

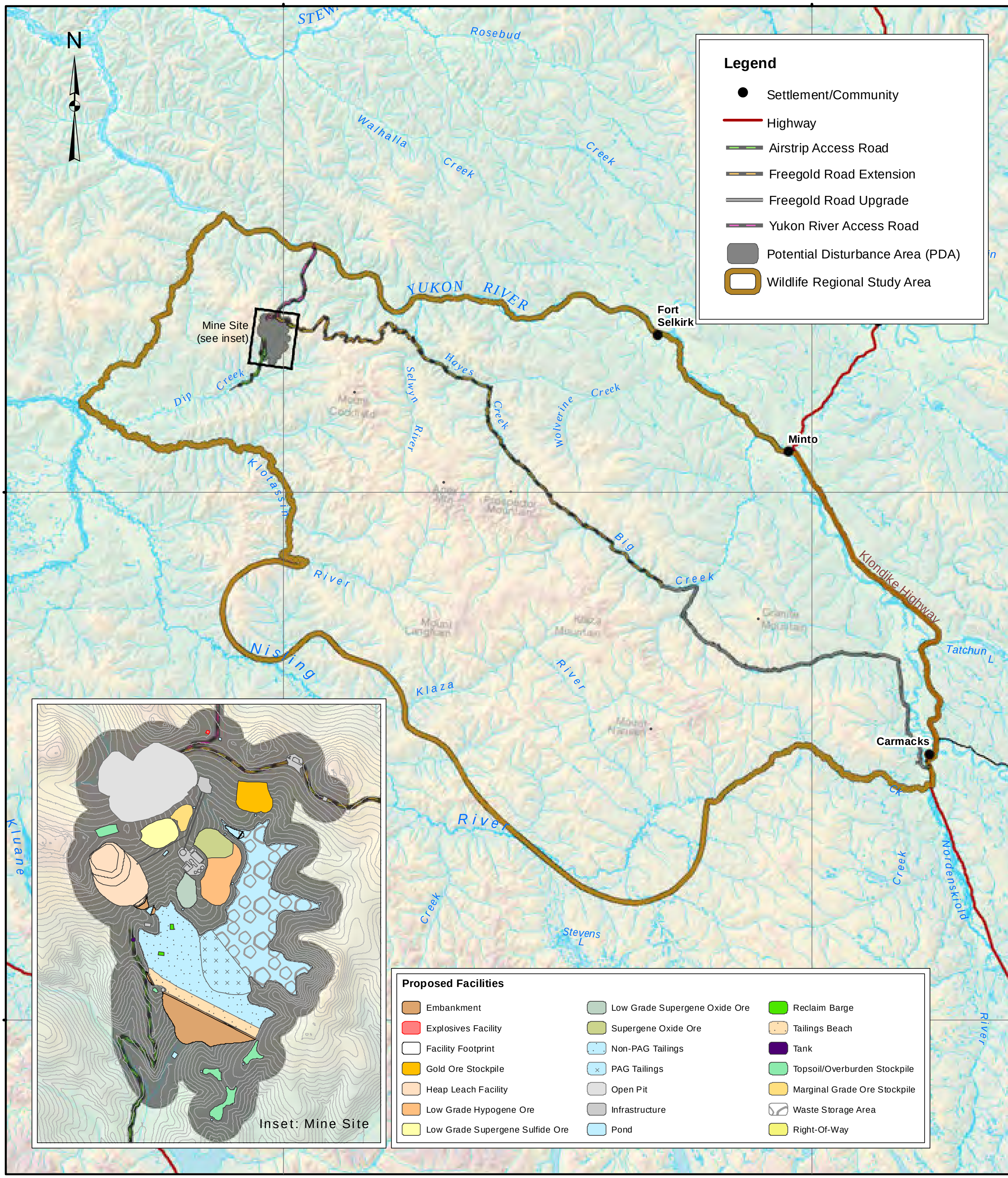
The topography of the ecoregion is typical of unglaciated terrain with rounded, rolling hills, V-shaped valleys, and sparsely vegetated alpine tundra hill tops. There is a high frequency of forest fires in the area and the dominant forest type is pure and mixed stands of white (*Picea glauca*) and black spruce (*Picea mariana*). Balsam poplar (*Populus balsamifera*) is typical of floodplains, while black spruce and paper birch (*Betula papyrifera*) are found in permafrost areas. Scrub birch (*Betula nana*) and willow (*Salix* spp.) stands extend from valley bottoms to subalpine. Understory communities vary across aspect and slope position with warmer south-facing slopes supporting ground shrubs, diverse forbs and feather mosses, while poorly drained depressions and upland sites include sphagnum mosses (*Sphagnum* spp.), tussock grass, sedges (*Carex* spp.), shrubs, and lichens (e.g. *Cladina* spp.).

Yukon Plateau-Central Ecoregion

The Yukon Plateau-Central Ecoregion has a strong continental climate with annual precipitation ranging from 250 to 300 mm. In the west, the ecoregion is dry as a result of being located in the rainshadow of the coastal ranges. The western boundary of this ecoregion coincides with the limit of Cordilleran Pleistocene glaciation. Glacial activity in the area has produced rounded and rolling hills, plateaus, and broad shaping valleys with high mountain ranges.

Permafrost is widespread and intermittently discontinuous in the ecoregion. Plateaus are too low for alpine permafrost, therefore ice-rich ground is typically found in valleys. Dominant soils in the ecoregion include Brunisolic (i.e., immature soils with a brownish B horizon) and Cryosolic soils (i.e., those affected by permafrost-related processes; Canadian Agricultural Services Coordinating Committee 1998). Unique to the ecoregion and formed in association with Pleistocene glacial drift are paleosol soils that are found nowhere else in Canada.

This ecoregion is dominated by the boreal forest zone. The boreal zone is modified within the cordillera by strong gradients of elevation, temperature, and precipitation. Dominant tree species are white spruce, black spruce, lodgepole pine (*Pinus contorta* var. *latifolia*), subalpine fir (*Abies lasiocarpa*), trembling aspen (*Populus tremuloides*), balsam poplar, and paper birch with climax communities typically of white and black spruce forests. Lower slopes are dominated by white spruce with a range of understory species including feather mosses, red bearberry (*Arctostaphylos rubra*), grasses, lichens, roses (*Rosa* spp.), horsetails (*Equisetum* spp.), willows and alders (*Alnus* spp.). Higher elevation areas are mostly subalpine fir and white spruce with an understory of scrub birch, willow, blueberry (*Vaccinium membranaceum*), crowberry (*Empetrum nigrum*), Labrador tea (*Ledum groenlandicum*), moss and lichen. Forest fires are common, resulting in a predominance of lodgepole pine and trembling aspen at lower elevations. On dry sites understory communities are commonly lichen, kinnikinnick (*Arctostaphylos uva-ursi*) and grass matrix, whereas moister sites contain alder, willow, lingonberry (*Vaccinium vitis-idaea*), soapberry (*Shepherdia canadensis*), and mosses. Floodplains are colonized by balsam poplar, horsetail, and willow. Extensive grassland communities are found on south and west-facing slopes.



1:250,000 Topographic Spatial Data, National Road Network; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Potential Disturbance Area (PDA), roads, contours and mine site facilities provided by Knight Piesold Ltd. October, 2013.

Wildlife Regional Study Area produced by EDI Environmental Dynamics Inc. 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

The Casino Project overview and wildlife Regional Study Area

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MP/LG	MAS	16/10/2013	1.1

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kilometres

Map scale 1:1,000,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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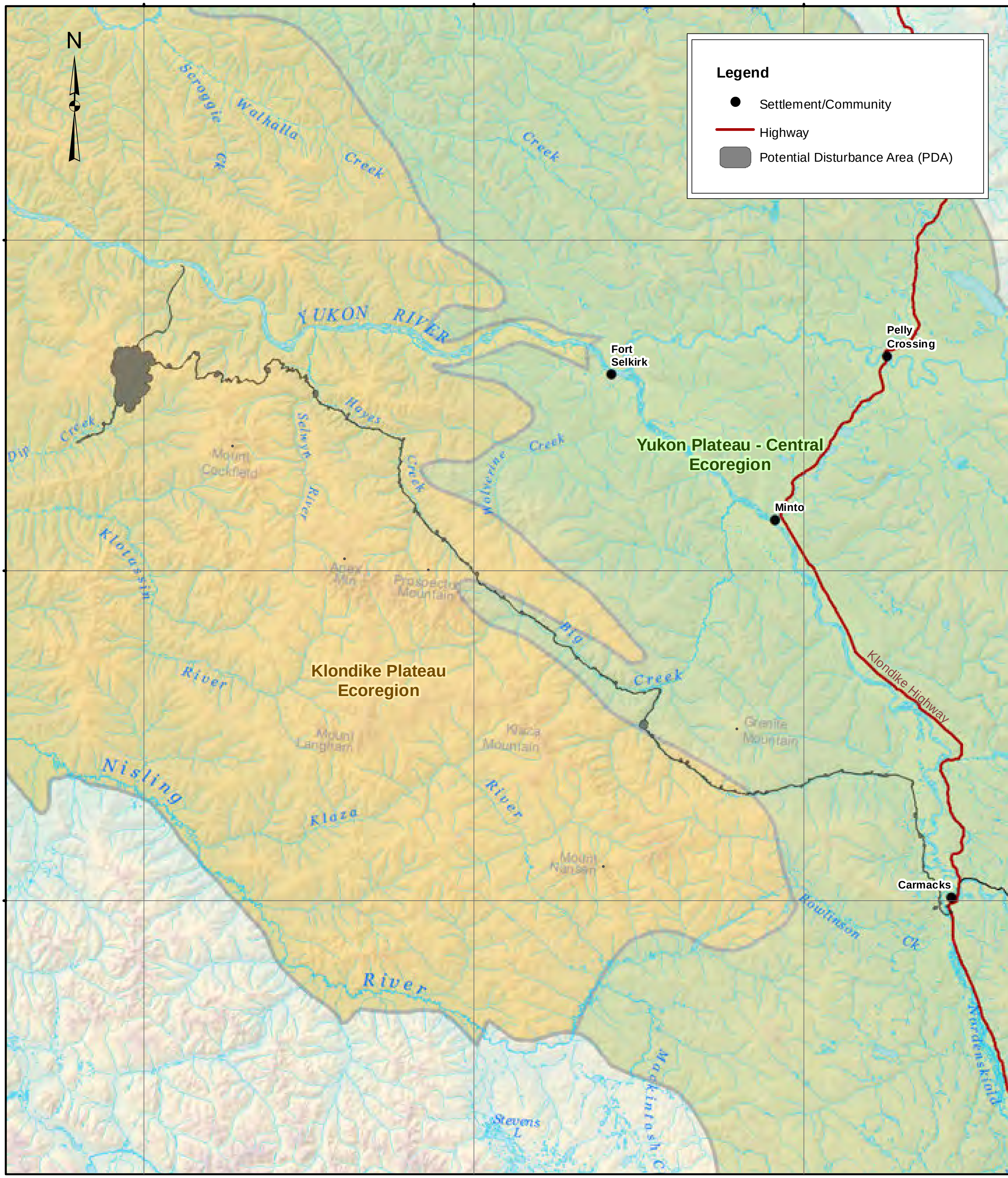
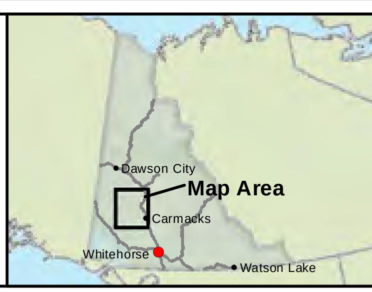


Notes:

Ecoregions, 1:250,000 Topographic Spatial Data, National Road Network; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. September, 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Ecoregions in the RSA

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MP/LG	MAS	16/10/2013	1.2

0 5 10 15 20 25 30
kilometres

Map scale 1:800,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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2 EXISTING INFORMATION

In response to local concerns and because there was very little documented information on wildlife in the Dawson Range, the Government of Yukon conducted the initial wildlife baseline studies in the region in the late 1980s. Government biologist completed the first inventory of the Klaza caribou herd, estimated the local moose density, identified sheep distribution and conducted raptor nest surveys. That information was supplemented by additional surveys during the following three decades up to and including the present work.

More recent baseline surveys conducted to generate data on wildlife presence, abundance, distribution, and habitat use within the RSA concentrated on focal wildlife — details of which are described in each species' section. Focal species for wildlife baseline studies are species that are known to occur in the RSA and are of local or cultural value, or of conservation concern.

Wildlife species that have cultural or economic value are species harvested by subsistence and trophy hunters, and local trappers. Subsistence hunters primarily target large ungulates, such as moose and caribou. Hunters that harvest for subsistence in the RSA are primarily from Carmacks and Pelly Crossing, and residents of Whitehorse. One outfitter is active in the area, Mervyn's Yukon Outfitting Ltd. Several traplines intersect the RSA; some are active.

Species of conservation concern in the Yukon, assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and/or listed on the *Species at Risk Act* (SARA), that are known to occur in the RSA include woodland caribou (Special Concern), wood bison (Threatened), grizzly bear (Special Concern), wolverine (Special Concern), and collared pika (Special Concern).

Characteristic wildlife species that are known or have the potential to occur in the RSA include woodland caribou, moose, thinhorn sheep (Dall's sheep), wood bison, mule deer, grizzly bear, black bear, grey wolf, coyote, red fox, wolverine, lynx, American marten, weasels (*Mustela* spp.), porcupine (*Erethizone dorsatum*), Arctic ground squirrel (*Spermophilus parryii*), red squirrel (*Tamiasciurus hudsonicus*), snowshoe hare (*Lepus americanus*), and collared pika. A number of other mammals are likely present in the RSA, including Canada beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), hoary marmot (*Marmota caligata*), river otter (*Lontra canadensis*), and other small rodents. The area is also home to a number of bird species; however, birds are described in a separate baseline report.

3 CARIBOU

Caribou occur throughout Canada's forest and arctic ecosystems. The Canadian population of caribou is composed of five subspecies: Peary (*Rangifer tarandus pearyi)*, barren-ground (*R. t. groenlandicus)*, Dolphin and Union (*R. t. groenlandicus* x *pearyi*), Grant's caribou, (*R. t. granti*), and woodland caribou (*R. t. caribou*) (COSEWIC 2011a; Festa-Bianchet et al. 2011). Grant's and woodland caribou are the only subspecies that occur in the Yukon. There are five populations of woodland caribou that currently occupy regions of Canada: boreal, southern mountain, northern mountain, Newfoundland, and Atlantic-Gaspésie populations (Thomas and Gray 2002; COSEWIC 2011a). A sixth population known as the Queen Charlotte Islands population is now extinct. Woodland caribou are found in all jurisdictions in Canada except Nova Scotia, New Brunswick, Prince Edward Island and Nunavut. The total estimate of woodland caribou across Canada is roughly 184,000 (Thomas and Gray 2002). Throughout their range they occupy diverse habitats including mature and old-growth coniferous forests, alpine tundra, peatlands, marshes, and bogs (Environment Canada 2012; Thomas and Gray 2002).

The northern mountain population (NMP) of woodland caribou is distributed across the Yukon, western Northwest Territories, and northwestern British Columbia with an approximate area of occurrence of 308,000 km² (Thomas and Gray 2002; Environment Canada 2012). The NMP was assessed as a species of Special Concern by COSEWIC, and in 2005 was listed on Schedule 1 of the federal government's *Species at Risk Act* (SARA). The listing provides protection of the population under SARA and a management plan was developed to ensure that the population's conservation status is not elevated to Threatened. The conservation status determination was based on declines within specific herds of the population from habitat degradation, hunting pressure, disturbance by humans (e.g., fragmentation by roads), fire, and predation (e.g., wolves, bears, and coyotes; Environment Canada 2012). Also, there is some uncertainty in the population trends of some herds within the NMP; trends for 22 of the herds are unknown, seven are considered stable, four are increasing, and three are decreasing (Environment Canada 2012). The latest population estimate for the NMP in 2008 was of about 45,000 animals, which increased from 35,000 animals in 2002 (Environment Canada 2012).

The Project occurs within the historic range of the Forty Mile caribou herd and the current range of the Klaza caribou herd (KCH), formerly known as the Klotassin herd (Jingfors 1989). Archived written records and local knowledge indicate that the area was historically occupied by the Forty Mile caribou herd. Forty Mile caribou are currently absent from this area; the last documented occurrence of Forty Mile caribou in the study area was in 1941 (McDonald and Cooley 2004). The KCH is the main caribou herd that currently interacts with the Project (Figure 3.1). The KCH range is centered on and includes much of the Dawson Range mountains (Figure 3.2), and as of 2007 the size of the KCH range was estimated at 6,200 km² (Environment Yukon 2012). The northern extent of the Aishihik caribou herd's range slightly overlaps with the southern portion of the Klaza herd's range (Yukon Department of Environment 2012; Figure 3.2). Interaction between the Aishihik herd and the Project is expected to be limited to infrequent individual interactions.

The first formal study of the KCH was the 1987–1990 Klaza caribou inventory program that was initiated by the construction of the "Casino Trail" (Farnell et al. 1991). At the time, the road was being constructed by the Government of Yukon to provide access to the Casino mine site and other mineral resources in the area. Construction of the road ended in 1988 prior to being completed. The 1987–1990 studies included collaring of 17 cow caribou fitted with very high frequency collars (VHF; Table 3.1). By the end of the study, 12 collars remained active; two caribou cast the collars soon after capture, two caribou died, and one collar failed (Farnell et al. 1991). Relocation surveys were conducted 19 times during the study to document the seasonal distribution of caribou. After the completion of the inventory program, additional VHF collars were deployed and monitored until 2000 as part of an intensive study of the Aishihik caribou herd (Hayes et al. 2003). The KCH was monitored as part of the Aishihik study because a small portion of the two herds' ranges overlap in the southern portion of the KCH's range (Figure 3.2). The Government of Yukon initiated another collar study of the KCH in 2012 in response to renewed interest in the Casino Project and other exploration in the region. The study included collaring 30 female caribou (Hegel 2013a; Photo 1; Table 3.1) and is described further in the following sections.

Photo 1. A female caribou collared by the Government of Yukon in 2012, along with four other Klaza caribou.

The first documented aerial survey of the KCH was completed during the summer of 1985; its goal was to document the distribution of the KCH. Inventories of the KCH started in 1987, with the collaring of 17 female caribou described above, and continued through 1989. The inventory included composition surveys (i.e., rut counts) in 1987 and 1988, and a population census conducted during the late-winter in 1989. Following the 1989 survey, the KCH was not surveyed again until 1993. The commencement of surveys in

1993 coincided with the Aishihik wolf control program (Hayes et al. 2003). Regular composition surveys and irregular summer and late-winter surveys, were conducted from 1993–2003.

With an increase in mineral exploration activity and renewed interest in the Casino Project, yearly late-winter (March) surveys were conducted during early March between 2011 and 2013. The objective of the surveys was to document regional distribution of ungulates (moose, caribou, and sheep) during the late-winter. The survey area was defined by the KCH range and all GMSs that intersect the Casino mine site and access road footprints. At the time of the 2011 and 2012 surveys, the access road alignment had not been finalized and other road options were being explored; the large survey area was expected to include all access road options. The final road alignment was selected in early 2013, so the 2013 survey area was reduced to a 10 km buffer of the Casino project footprint (Figure 3.3).

The survey area was sampled using survey blocks to guide effort. Each block was sized at 5 minutes longitude by 2 minutes latitude (approximately 4 km x 4 km at the survey latitude), and four passes were flown through each block, which is roughly equivalent to 1 km transect spacing (Figure 3.3). Passes were flown within the blocks following terrain to maximize sightability of animals. In 2011 and 2012, two fixed-wing aircraft were required to survey the entire 11,371 km² survey area within a reasonable amount of time; however, in 2013, only one plane was required to survey the reduced 4,247 km² survey area. All wildlife sightings and tracks were recorded as waypoints, with sex (cow, bull) and age class (adult, yearling, or calf) noted when possible. All surveys were flown around 100–300 m above ground level at approximately 150 km/h, depending on terrain and weather conditions. Composition and population surveys were conducted in the fall of 2012 (Hegel 2013a). Table 3.2 summarizes the 29 year period (1985–2013) of available caribou observations.

Ground-based surveys for snow tracks and range condition were conducted within the range of the KCH. These surveys were conducted twice in 2012 (15–19 February and 19–21 March) and once in 2013 (18–21 February). A second track survey was planned for March 2013, but snow cover was insufficient and the survey was cancelled. The primary objective of the work was to document the occurrence of species along the Freegold Road upgrade and extension that are not easily observed during aerial surveys. Each survey consisted of snowmobiling the proposed Freegold Road upgrade and extension as far as conditions permitted and recording the presence of animal tracks, summed within 1 km intervals (Figure 3.4).

The different survey methods sample different segments of the population, with the collars sampling only adult cow caribou, and the observational surveys and track counts sampling all age and sex cohorts within the population.

Table 3.1 Number of collar location data points for the Klaza caribou herd.

Year	Collar type	Late-winter	Spring/Calving	Summer	Fall/Rut	Early-winter
1987	VHF	12 (12)	12 (12)	13 (12)	-	10 (10)
1988	VHF	15 (15)	14 (14)	15 (15)	13 (13)	14 (14)
1989	VHF	38 (15)	31 (14)	14 (14)	12 (12)	11 (11)
1990	VHF	23 (12)	12 (12)	-	-	-
1991	VHF	9 (9)	-	-	-	-
1993	VHF	24 (12)	12 (12)	12 (12)	12 (12)	11 (11)
1994	VHF	17 (17)	14 (14)		15 (15)	12 (12)
1995	VHF	20 (16)	16 (16)	15 (15)	15 (15)	10 (10)
1996	VHF	36 (21)	20 (20)	20 (20)	39 (19)	-
1997	VHF	19 (19)	18 (18)	11 (11)	17 (17)	34 (20)
1998	VHF	16 (16)	-	-	-	-
1999	VHF	-	-	-	9 (9)	-
2000	VHF	-	-	-	2 (2)	-
2012	GPS	298 (3)	270 (2)	512 (2)	4,509 (28)	7,011 (28)
2013	GPS	6,702 (27)	-	-	-	-

Notes:

Values in parentheses indicate the number of collared female caribou.

Seasons are defined in Section 3.1.

Data were provided by the Government of Yukon.

Table 3.2 Klaza caribou herd counts collected during seasonal surveys.

Year	Early-winter	Late-winter	Spring/calving	Summer	Fall/rut	Total
1985				181 (14)		181 (14)
1987					319 (17)	319 (17)
1988					174 (12)	174 (12)
1989		363 (42)				363 (42)
1993		151 (11)			251 (13)	402 (24)
1994					167 (8)	167 (8)
1995		190 (14)		133 (15)	268 (9)	591 (38)
1996		238 (28)		237 (14)	262 (18)	737 (60)
1997				265 (6)	197 (18)	462 (24)
1999					230 (8)	230 (8)
2000					651 (14)	651 (14)
2001					593 (20)	593 (20)
2002					348 (18)	348 (18)
2003					466 (31)	466 (31)
2011		125 (13)				125 (13)
2012		267 (16)			2245 (102)	2512 (118)
2013		27 (3)				27 (3)
Total	0	1361 (127)	0	816 (49)	6171 (288)	8348 (464)

Notes:

Values in parentheses indicate the number of groups observed during the surveys. Data were collected by CMC (2011–2013) and Government of Yukon (1985–2012).

Notes:

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Caribou ranges provided by YG - Environment (received 2011).

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Current caribou herd ranges in Yukon

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.1

0 50 100 200 300
kilometres

Map scale 1:7,000,000 (printed at 8.5x11)
North American Datum 1983 BC Environment Albers

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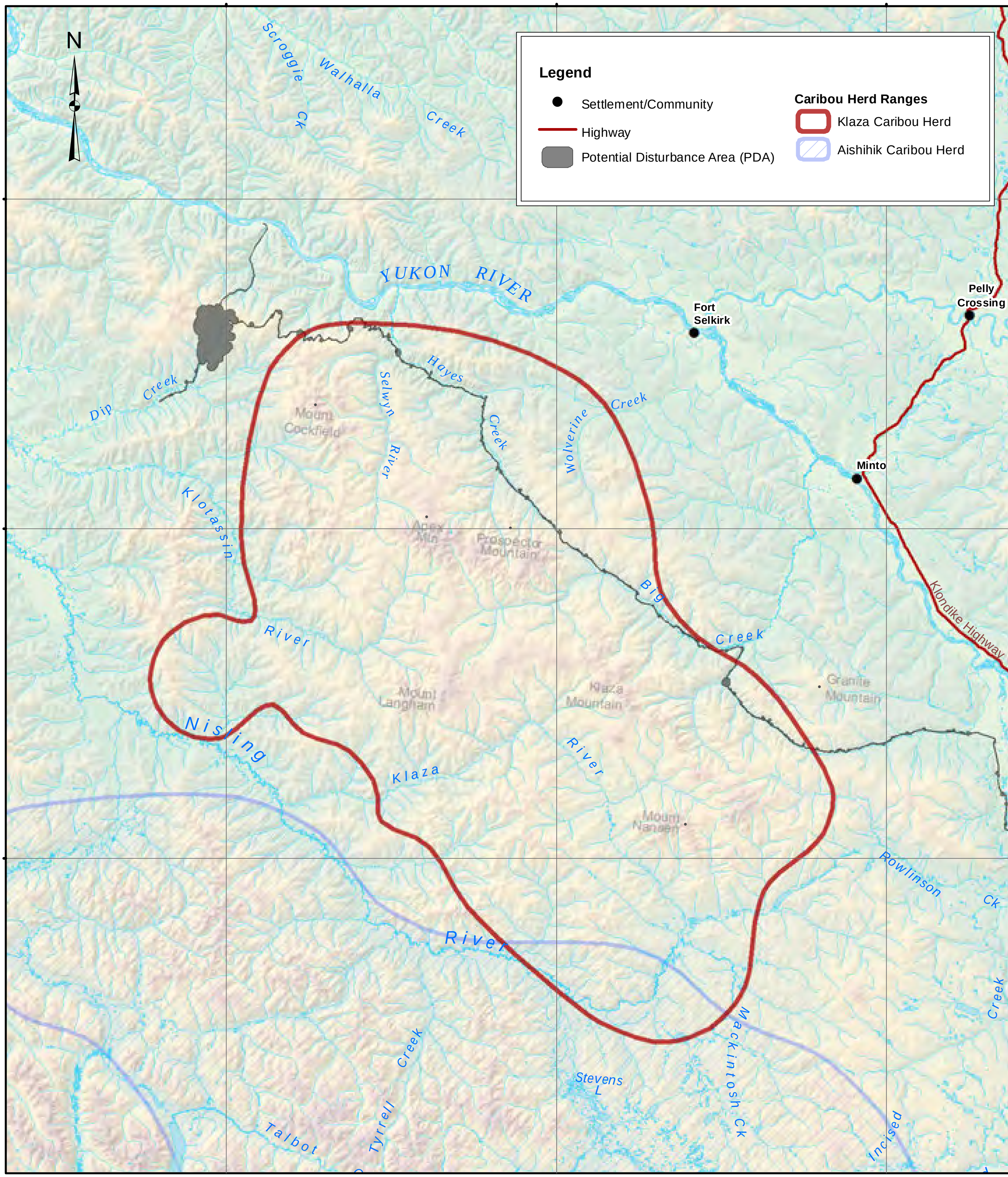

Current ranges of the Klaza and Aishihik caribou herds

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.2

0 5 10 15 20 25 30
kilometres

Map scale 1:800,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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1:250,000 Topographic Spatial Data, National Road Network, Ecoregions; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources.

Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. September, 2013.

Caribou herd ranges provided by YG - Environment (received 2011).

Wildlife Key Areas, Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

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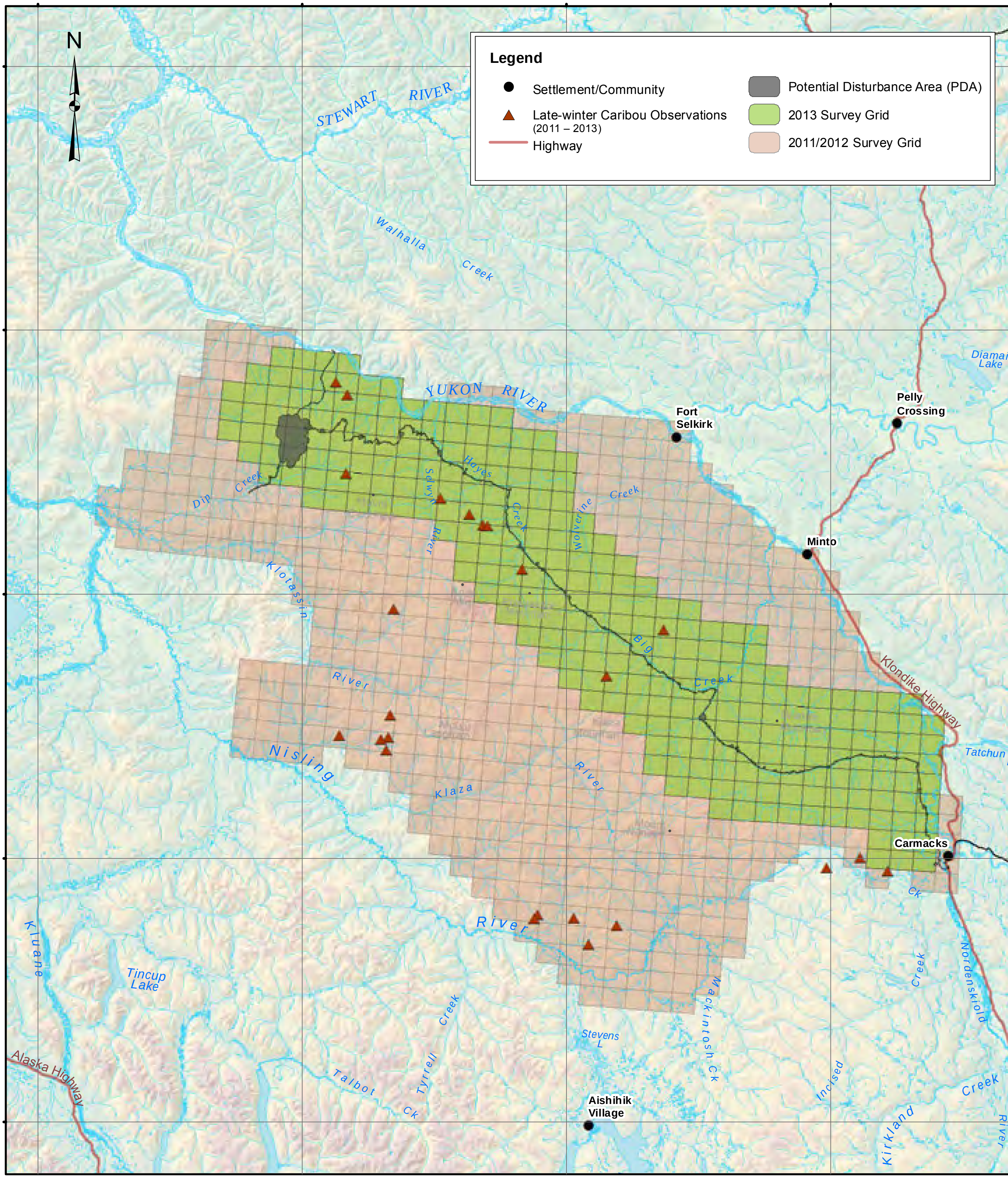

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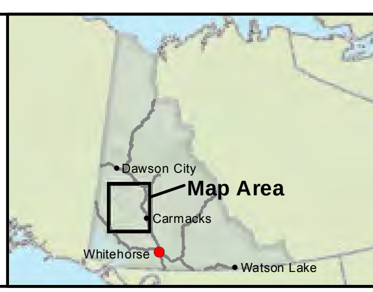
Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. September, 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Late-winter aerial survey areas

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.3

0 5 10 15 20 25 30 35 40
kilometres

Map scale 1:1,000,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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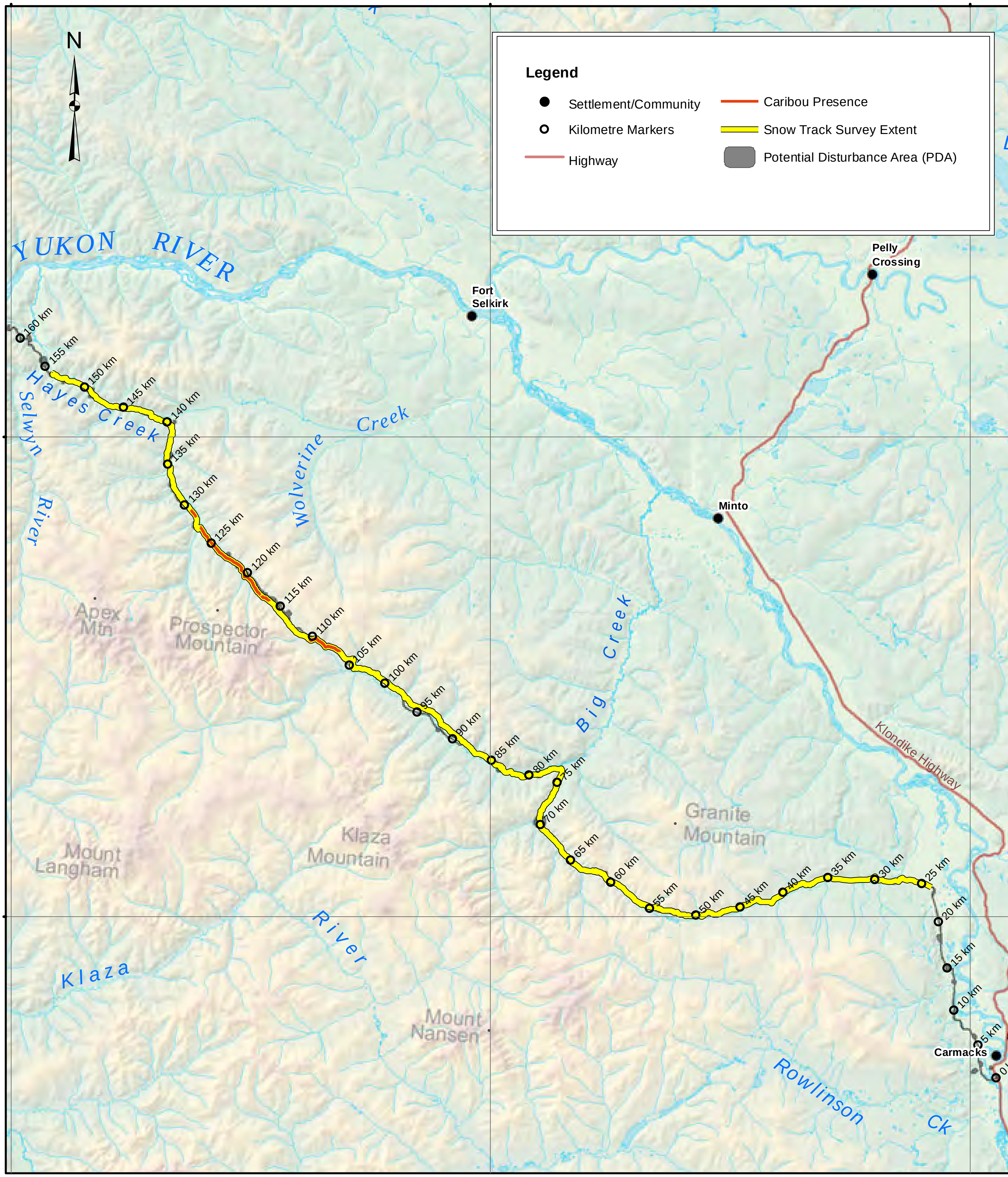

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Potential Disturbance Area (PDA) and kilometre markers provided by Knight Piesold Ltd., Sept., 2013.

2012 - 2013 snow tracking surveys designed and conducted by EDI.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Snow track survey area and caribou presence

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.4

0 5 10 15 20
kilometres

Map scale 1:550,000 (printed at 8.5x11)
North American Datum 1983 UTM Zone 8N

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3.1 DISTRIBUTION

The KCH range is centered on the Dawson Range, and is characterized by abundant alpine and subalpine terrain. KCH caribou spend the majority of the year using alpine and subalpine habitats (Figure 3.5). Average estimated tree line within the range is 1,175 masl, and the amount of alpine and subalpine terrain is estimated at 2,848 km² (46%) of the KCH herd range.

Most of Yukon's woodland caribou exhibit seasonal elevational movements between winter and growing season ranges. Caribou tend to use habitat at lower elevation in winter because of easier access to terrestrial lichen, while during summers caribou move to higher elevation terrain to avoid predators and insects. KCH caribou show seasonal elevational movements consistent with the behaviour of other northern mountain population caribou herds (Figure 3.5). The herd tends to be above tree line during the growing season and use lower elevation habitat during the winter.

Detailed descriptions of caribou habitat use are provided below. The information is described in five biologically relevant seasons:

- Spring/Calving (1 May – 14 June);
- Summer (15 June – 10 September);
- Fall/rut (11 September – 31 October);
- Early-winter (1 November – 31 January); and
- Late-winter (1 February – 30 April).

The KCH's seasonal ranges were defined using kernel density estimates (KDE) derived from VHF (1987–1991, 1993–1998) and GPS (2012–2013) collar data. Given the nature of KDEs, seasonal ranges are largely influenced by the more numerous 2012–2013 GPS collar data than the VHF collar data. The data were analyzed using the 'kde' and 'isopleth' tools available in Geospatial Modeling Environment (GME; Beyer 2012). Seasonal ranges were created in GME using a fixed Gaussian kernel with the plug-in estimator as the smoother method and a pixel resolution of 20 m. KDEs are widely used and appropriate for estimating animal ranges (Fieberg 2007). The most commonly used kernel density contour for defining home ranges is the 95% contour; however, when there are abundant data available, which is the case for most KCH seasonal ranges, there is a tendency to exclude areas where data exists (i.e. type 1 errors; Fieberg and Börger 2012). Consequently, 99% KDE contours for seasons where collar data were available are displayed and reported. For some seasons (i.e., spring/calving and summer) the number of GPS collar locations are limited and the kernels may over-represent VHF collar locations (Figure 3.6 and Figure 3.7). Any substantial deviation from ranges derived from the collar data and other seasonal location data are noted below where relevant.

Wildfires are common in the RSA (YEWG 2004), which impacts habitat availability and use by the herd. Fire destroys forage for caribou, such as terrestrial ground-lichens, which take decades to regenerate (Klein 1982; Collins et al. 2011); however, recently burned areas also provide fresh vegetative forage in the short-term, eventually leading to the regeneration of pine and lichen species in the long-term (Environment

Canada 2012). Burned areas are considered as a variable of habitat selection in the habitat models discussed below.

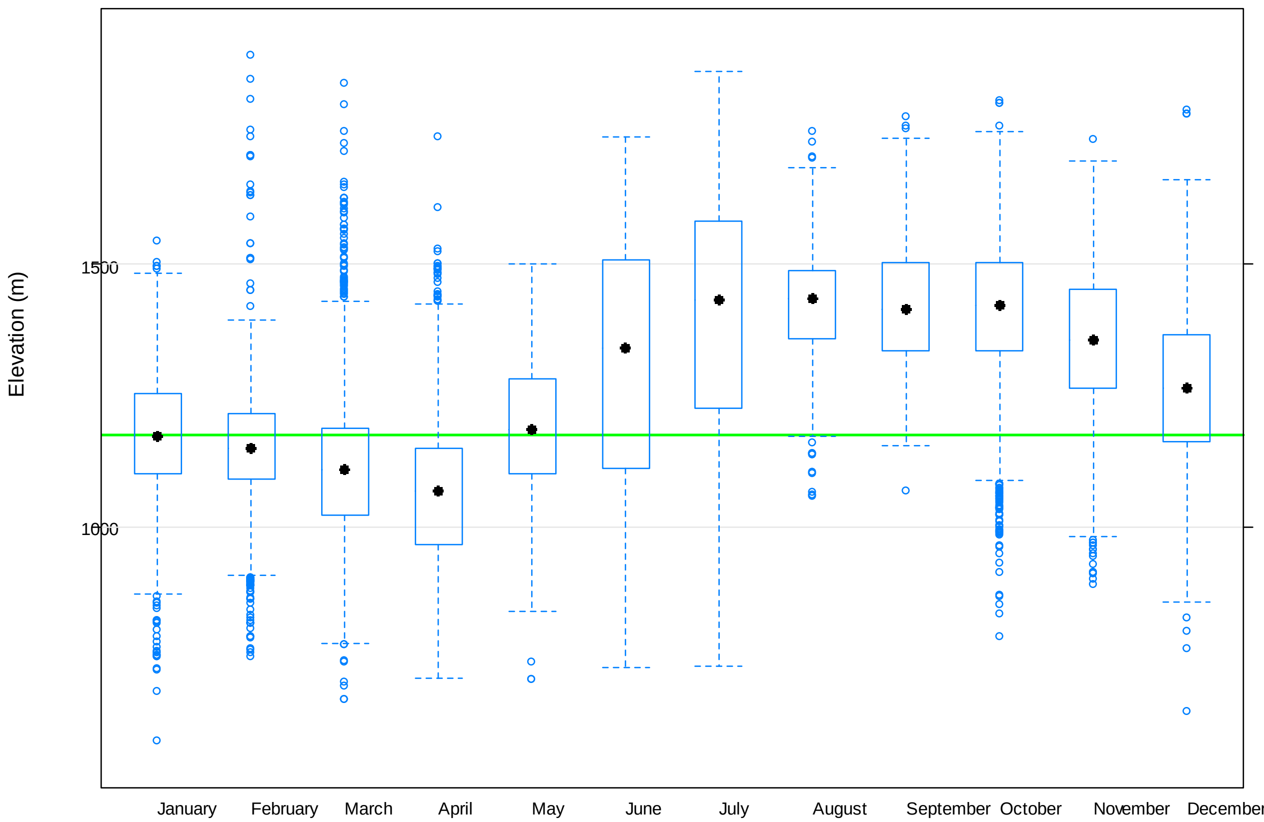


Figure 3.5 Boxplot of caribou observations by elevation and month using all available location data (1987–2013; 464 caribou observations, 18,171 collar locations).

The green line represents the average tree line estimate at 1,175 masl.

3.1.1 Spring/Calving

During the spring and calving season, woodland caribou cows disperse from their wintering habitats to higher elevation terrain as a predator avoidance tactic. Woodland caribou cows do not exhibit traditional use of calving areas commonly observed in migratory caribou herds. Parturient (i.e., about to give birth) female ungulates isolate themselves from larger groups, possibly to reduce encounter rates with predators and reducing offspring mortality risk (Farnell et al. 1996; Hebblewhite and Pletscher 2002). Higher elevation terrain reduces predation risk for caribou and their calves through spatial segregation from potential predators that tend to occur at lower elevations (Bergerud et al. 1984; Bergerud and Page 1987).

Distribution surveys have limited success during the calving season because parturient caribou are dispersed throughout higher elevation habitat and patchy snow makes spotting caribou difficult. The best available information on KCH spring and calving distribution is from collared cow caribou. Collar location data for parturient caribou collected during eight years between 1987 and 2012 indicate that the majority of caribou are using habitat above tree line (Figure 3.5); 64% of female caribou locations were above tree line (251 of 393 locations). The data also show that caribou are distributed broadly throughout their range during the spring/calving season (Figure 3.6). There were no previous survey data to compare the spring/calving range derived from the collar 99% KDE contours. Observations from the Casino wildlife log during the spring/calving season include 19 caribou from 2010–2013.

3.1.2 Summer

Summers are a time of the year when adult caribou recover from winter and replenish body fat. For lactating cow caribou the summer is important for milk production required to grow their young. Calves must grow quickly during the summer to survive their first winter. Consequently, summer range can be an important factor limiting population growth of large caribou herds that may be able to overgraze their summer range (e.g., George River caribou herd; Messier et al. 1988).

Yukon's northern mountain caribou herds, including the KCH, use higher elevation alpine and sub-alpine habitats during summers (Oosenbrug and Theberge 1980; Farnell et al. 1991; Quayle and Kershaw 1996). Higher elevation habitat provides relief from insects and high temperatures that are known to affect caribou behaviour (Toupin et al. 1996; Mörschel and Klein 1997; Wilson et al. 2012). Caribou use snow patches for cooling during hot days (Kuzyk et al. 1999b). KCH caribou are distributed throughout most of the high elevation terrain within their range (Figure 3.7; Farnell et al. 1991); 92% of caribou observations are above tree line (45 of 49) and 95% of female caribou collar locations are above tree line (487 of 512 locations). The range defined by the 99% KDE contours of the collar data encompasses all previous survey observations (Figure 3.7). Most summer observations and collar locations occurred in central and eastern portions of the herd's range. Observations from the Casino wildlife log during the summer season include 260 caribou from 2008–2013.

3.1.3 Fall/Rut

Caribou aggregate in the alpine and subalpine during the fall, including during the rut (breeding season). The fall is the final opportunity for caribou to acquire the necessary fat reserves to survive the coming winter. The rut occurs in late-September to early October. Bulls move through their range in search of breeding opportunities with estrous cows.

Large groups of caribou were observed throughout the herd's range during 13 years of rut surveys conducted between 1987 and 2012 (mean group size=21, max group size=224). Caribou collar data and observations indicate that caribou occupy the alpine and subalpine habitat throughout their range during the fall and rut, focused primarily on the central and eastern portions of the range (Figure 3.8); 90% of caribou observations are above tree line (260 of 288) and 96% of collar locations are above tree line (2,834 of 2,966).

3.1.4 Early and Late-winter

Winter is the most limiting time of the year for woodland caribou. Forage is poorer quality and is less abundant because it is covered in snow. Animals spend more energy moving and cratering for forage during winters, and greater snow depth increases energy expenditure. Consequently, caribou select areas that have shallower snow. Habitat attributes such as presence of trees, wind exposure, slope, aspect and elevation are factors that contribute to local snow conditions. For example, forest canopies intercept snow and wind can scour snow from particular aspects. At coarser scales, large geologic formations may determine caribou distribution in winter. The Dawson Range, which includes the KCH herd range, receives relatively less snow compared to many other parts of the Yukon because it is in a snow-shadow of the St. Elias Mountains (Table 3.3; Kuzyk et al. 1999a). Long-term weather stations managed by the Government of Yukon exist within the RSA (Figure 3.9 and Figure 3.10). Snow depths were also collected along the Freegold Road upgrade and extension during the 2013 snow track surveys; the data indicate an average snow depth of 53 cm (n=15, sd=5.5). A snow survey was also conducted in 1990 as part of the KCH inventory study. The survey found relatively shallow (mean=48 cm, n=85, sd=19.2) and uniform snow depths across the KCH's range (Farnell et al. 1991). Caribou tracks were observed intermittently between km 107 and 129, a 22 kilometre section of road, during 2012 snow track surveys. No caribou tracks were observed during the 2013 survey. Caribou distribution during early-winter is the most extensive of any season, yet by late-winter the central and eastern portions of the range are largely devoid of caribou as animals shifted closer to the Nisling and Klotassin rivers and Hayes Creek (Figure 3.9 and Figure 3.10).

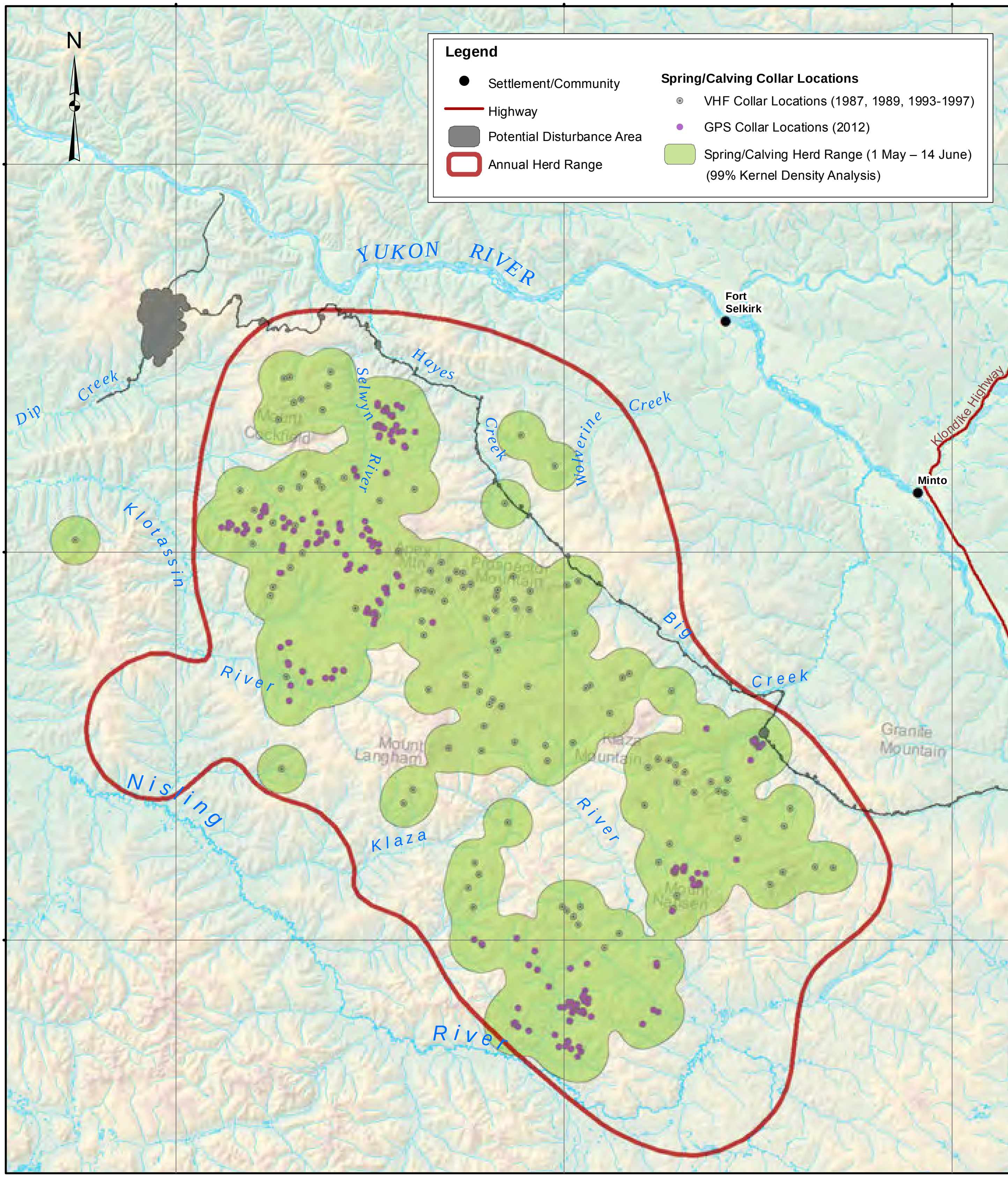
The KCH winter range conditions were determined to be relatively good in the late 1980s, as the caribou late-winter diet was composed of 78% lichen and contained very little low quality forage, particularly moss (Farnell et al. 1991). Moss is not easily digestible so is ingested incidentally when caribou are feeding on other forage. If range conditions are poor and caribou are required to search for smaller patches of lichen, then moss content in their diet tends to increase (Farnell pers. comm. 2013). To begin assessing current range conditions, caribou fecal pellets were collected on 20 March 2013 from four sample locations to describe caribou late-winter diet. The sample locations were based on the most recent collar location data provide by Environment Yukon and were chosen to cover the latitudinal extent of KCH range. Samples were collected from discrete pellet groups and kept frozen until they could be dried. The diet analysis was not available at the time of reporting because of a nine month sample backlog at the laboratory.

Table 3.3 Snow measurements in March at snow stations within or near the RSA.

Weather Station	Years of data	Measurement	Average (Range)	Coefficient of variation	2013
Casino	1977–2013	Snow depth	66.4 cm (43–99)	18.0%	60.9 cm
		Water equivalent	123.0 mm (68–225)	27.8%	109 mm
Nansen	1976–2013	Snow depth	45.6 cm (26–63)	20.5%	58.7 cm
		Water equivalent	79.5 mm (42–158)	30.4%	105 mm
Williams Creek	1995–2013	Snow depth	49.8 cm (27–70)	21.5%	59.0 cm
		Water equivalent	93.9 mm (43–146)	29.3%	110 mm

Note: Data provided by the Government of Yukon

Values in parentheses indicate the range of values recorded during all years of available data.



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Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

Klaza caribou herd collar data provided by YG - Environment. Spring/calving herd range was derived by EDI using YG collar data. Annual herd range provided by YG - Environment (received 2011).

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Klaza caribou herd spring/calving range

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.6

0 5 10 15 20
kilometres

Map scale 1:680,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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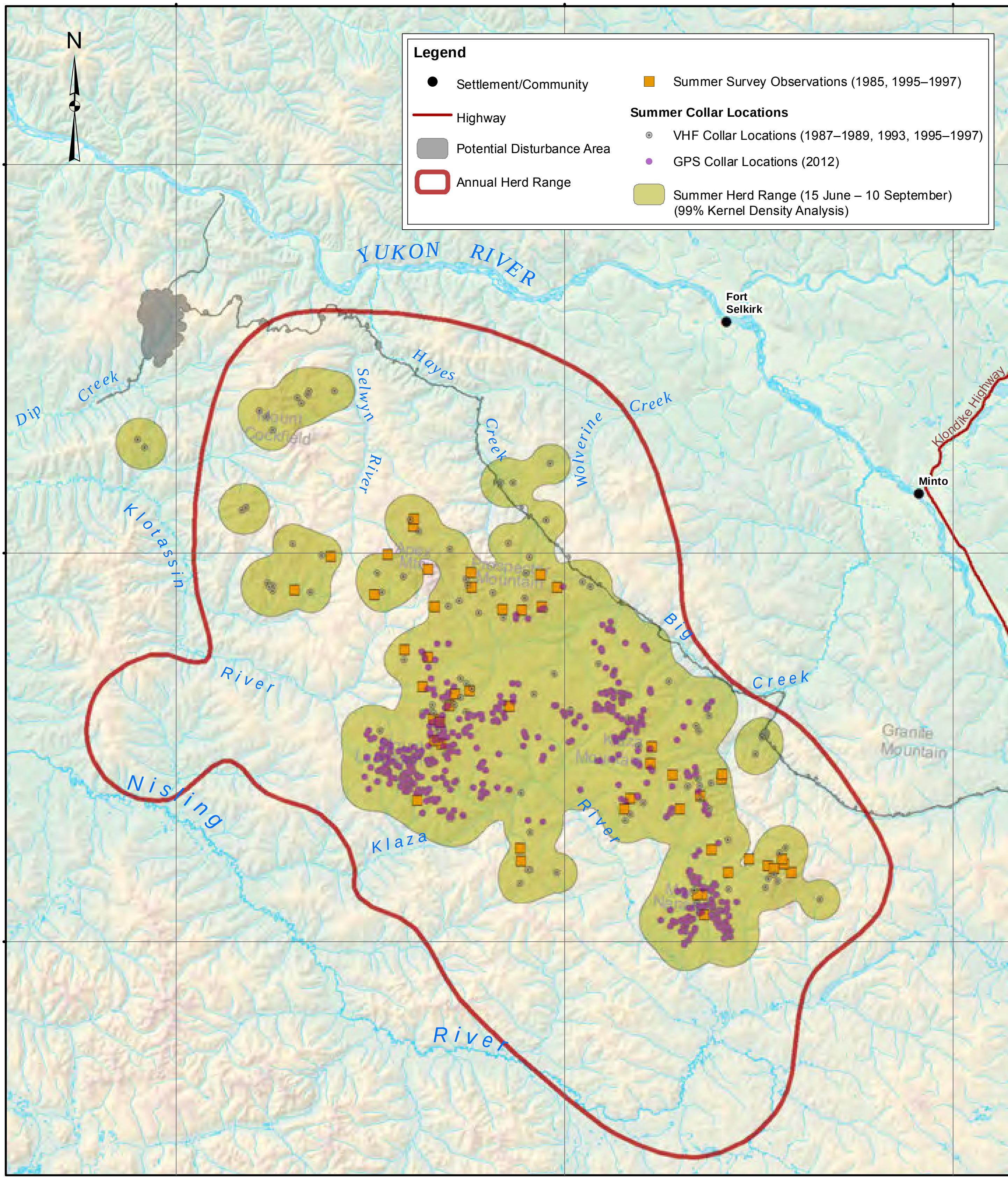

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Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

Klaza caribou herd collar and survey data provided by YG - Environment. Summer herd range was derived by EDI using YG collar data. Annual herd range provided by YG - Environment (received 2011).

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Klaza caribou herd summer range

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.7

0 5 10 15 20
kilometres

Map scale 1:680,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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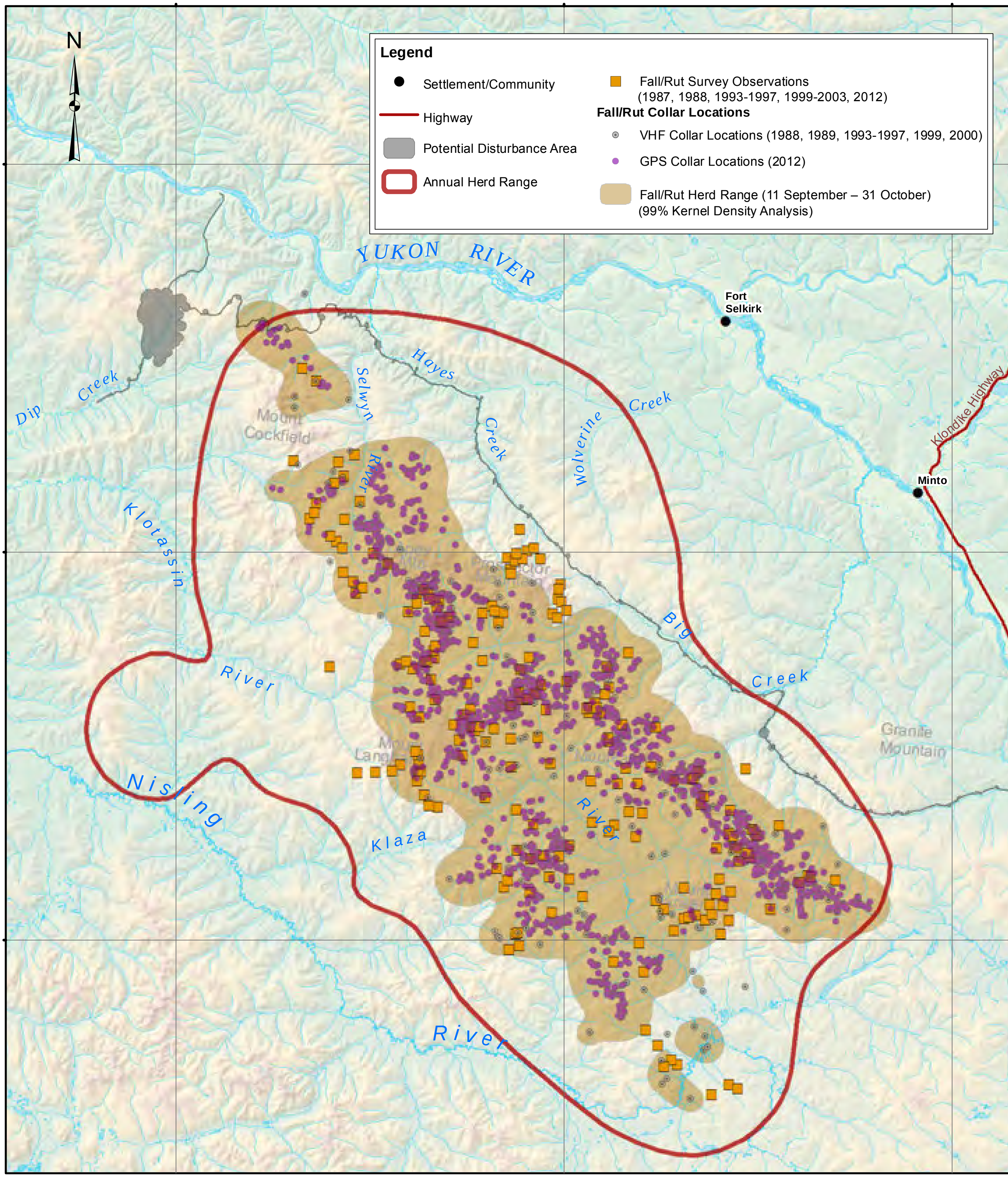

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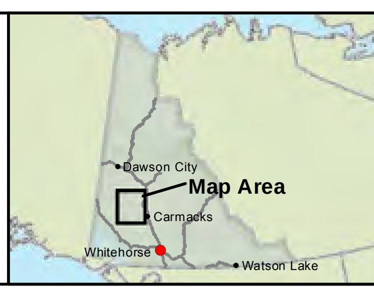
Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

Klaza caribou herd collar and survey data provided by YG - Environment. Fall/rut herd range was derived by EDI using YG collar data. Annual herd range provided by YG - Environment (received 2011).

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Klaza caribou herd fall/rut range

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.8

0 5 10 15 20
kilometres

Map scale 1:680,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

EDI

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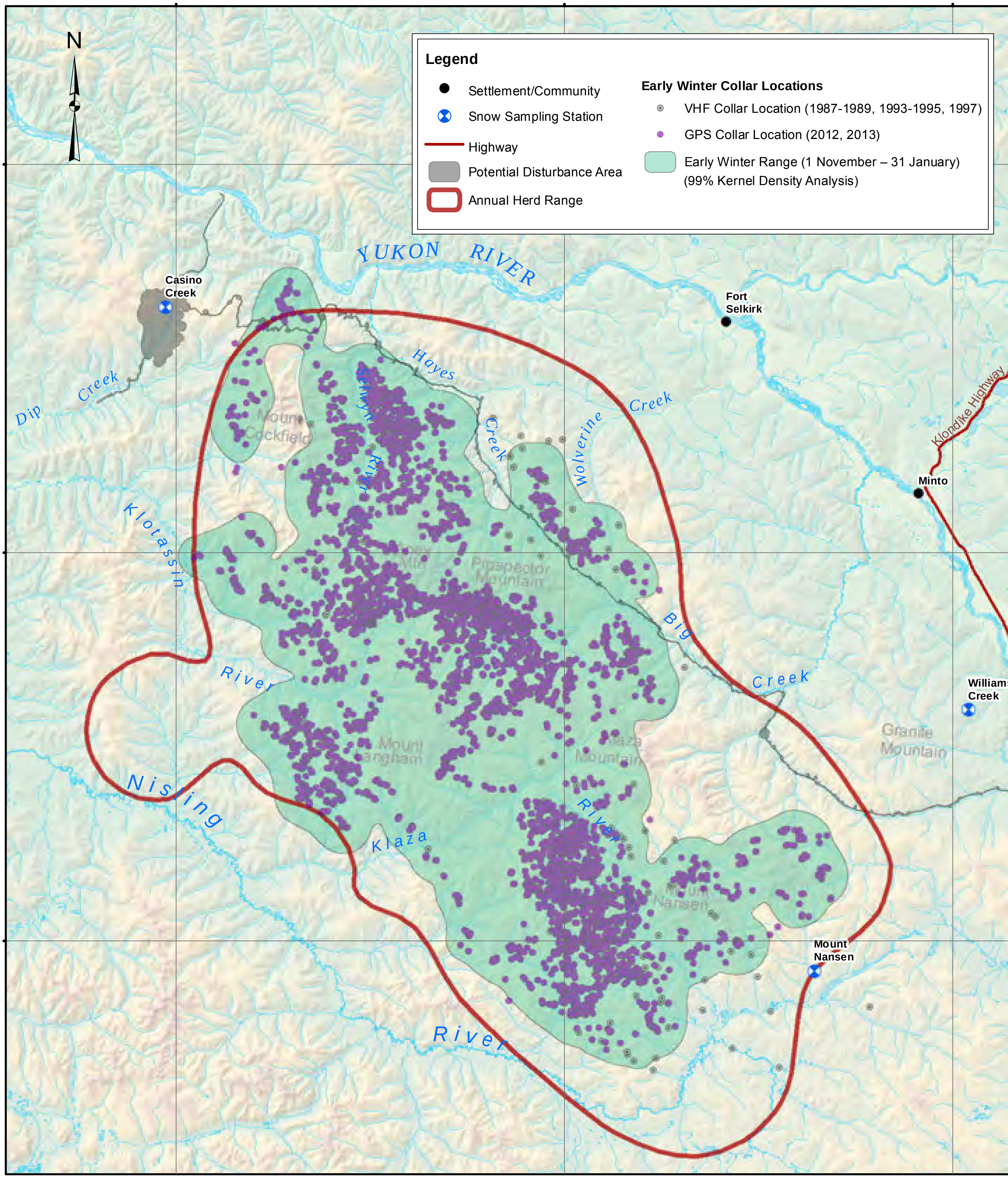

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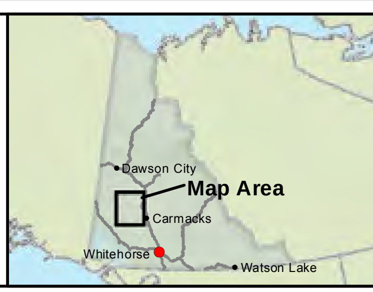
Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

Snow sampling stations provided by YG - Environment Yukon - Water Resources Branch (accessed October 10, 2013).

Klaza caribou herd collar data provided by YG - Environment. Early-winter herd range was derived by EDI using YG collar data. Annual herd range provided by YG - Environment (received 2011).

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Klaza caribou herd early-winter range

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.9

0 5 10 15 20
kilometres

Map scale 1:680,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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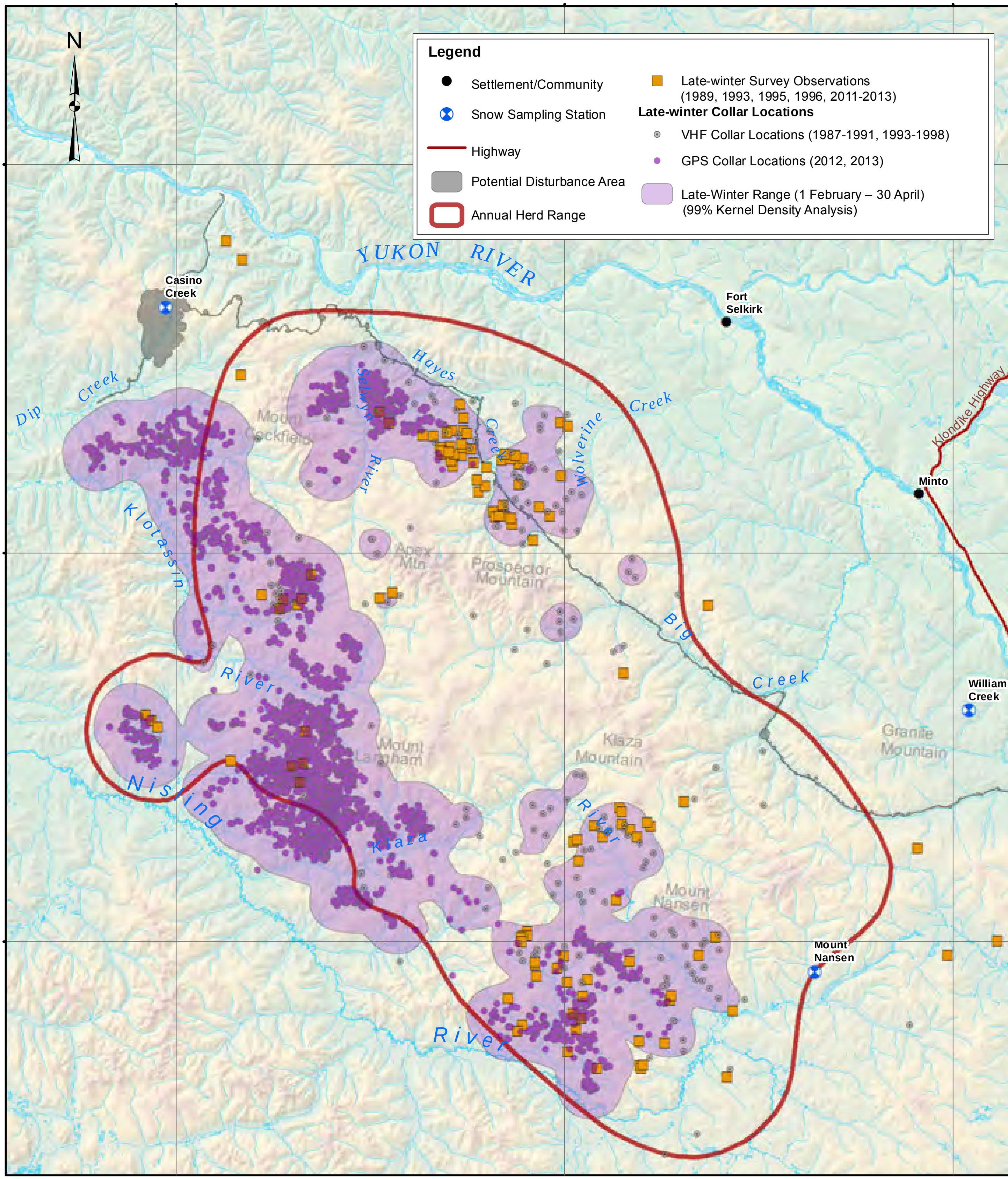
Path: J:\Yukon\Projects\2013\13_Y_0045_CMC_CasinoEA\Mapping\450_Wildlife\Baseline_Sept2013\450_Fig_3_9_KlazaEarlyWinterRange.mxd



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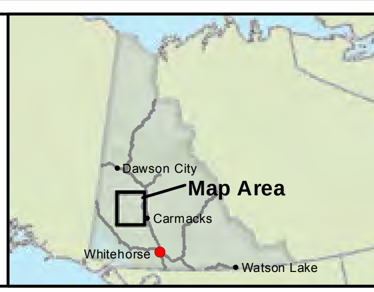
Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

Snow sampling stations provided by YG - Environment Yukon - Water Resources Branch (accessed October 10, 2013).

Klaza caribou herd collar data provided by YG - Environment. Survey data provided by YG-Environment and EDI. Late-winter herd range was derived by EDI using YG collar data (2013). Annual herd range provided by YG - Environment (received 2011).

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Klaza caribou herd late-winter range

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.10

0 5 10 15 20
kilometres

Map scale 1:680,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD
EDI

Path: J:\Yukon\Projects\2013\13_Y_0045_CMC_CasinoEA\Mapping\450_Wildlife\Baseline_Sept2013\450_Fig_3_10_KlazaLateWinterRange.mxd

3.2 CARIBOU WINTER HABITAT SUITABILITY MODEL

Given the importance of the winter habitat to woodland caribou herds in Yukon (Farnell 1991, Kuzyk 1999a, Florkiewicz et al. 2007), habitat selection modeled GPS-collared female caribou during the early and late-winter of 2012/2013 using resource selection functions (RSFs). RSFs are commonly used to describe habitat selection by wildlife by contrasting habitat use with available habitat. When habitat characteristics are used more or less than their availability on the landscape, then habitat use is described as selected or avoided, respectively. To derive the use versus availability values, the 2012/2013 GPS collar locations were compared to an equal number of random points within the herd's range.

Data preparation and summary — Data were obtained from GPS collars on 28 KCH female caribou. Collars were programmed to obtain 3 locations (fixes) per day and had a fix success (i.e. ability to relocate the collar) of 97%, suggesting the locations are not habitat-biased (Frair et al. 2010; Hegel 2013b). For the winter models, data used were limited to fixes obtained from 01 November 2012 through 30 April 2013. One collared caribou died on 13 December 2012; the 117 fixes obtained before its death were included in the early-winter model. Models were derived for two seasons based on observed changes in elevation and knowledge of caribou behaviour: early-winter and late-winter (Table 3.4).

Winter habitat selection by northern mountain caribou and the Forty Mile caribou herd was previously described using fire history, vegetation cover and terrain variables (e.g., Florkiewicz et al. 2007; Collins et al. 2011; Barker and Hegel 2012). Consistent and comparable vegetation cover data are not available across the entire KCH range, so vegetation could not be included in the modeling. In the absence of detailed vegetation cover, three broad categories of land cover were developed: burned, unburned and alpine/subalpine (Table 3.5). The burned areas were identified using the current wildfire database (Yukon Fire History 2011). Fire history for the KCH range and adjacent areas includes fires from 1951 to 2011, corresponding to burns aged 1–60 years before 2011. All burns were grouped into one category because lichen biomass, the primary winter forage for caribou, does not regenerate sufficiently for caribou to start selecting the habitat until more than 60 years after a fire (Joly et al. 2003, Collins et al. 2011).

Forest Inventory Area (2011) was used to derive unforested (unburned) areas (i.e., subalpine and alpine), which were then overlaid by a digital elevation model (DEM) to determine an estimated tree line elevation. The average tree line elevation was 1,175 masl, roughly corresponding to the tree line estimate of 1,200 masl for the Yukon Plateau-Central Ecoregion (Yukon Ecoregions Working Group 2004).Within the model, the 1,175 masl DEM value was used to identify areas that were unforested and not prone to forest fires (i.e., subalpine and alpine land cover). The forestry database was not used as vegetation base data because the data are generated by 1:50,000 mapsheets which were digitized using different scales or methods within the KCH range. Terrain variables were derived from the DEM. The DEM was used to describe elevation, and to create aspect and slope layers. Aspect was grouped into five categories: north, east, south, west, and flat (where flat = 0 degrees; Table 3.6). The final explanatory variables used to build the models included 3 land cover classes plus terrain variables derived from the DEM (Table 3.6). Quadratic (squared) terms for elevation and slope were included to allow for non-linear fit to the data. Interaction terms between land cover class and elevation were considered in model development. Available habitat was described by selecting random points from within the KCH range created using the 99% contour of a KDE developed from all available winter GPS collar data. The herd range developed from that analysis was buffered by 5 km as a conservative estimate of potential range availability. One point was randomly selected per GPS fix, and paired used and available points.

Given the high accuracy of GPS collars in the study area (<15 m), data associated with the exact GPS or random location point was extracted. The raw data were screened using the methods of Zuur et al. (2010). Explanatory variables were checked for correlation (Table 3.7). Data were modeled using a mixed-effects logistic regression and the 'lme4' package in R (R Core Team 2012; Bates et al. 2012). Individual caribou were included as a random effect to model variation among animals. Model selection was based on Akaike's Information Criterion (AIC) values and the protocol of Zuur et al. (2009). Assessment of fit was done through consideration of the Area Under the Curve (AUC) values for Receiver Operating Characteristic (ROC) curves (calculated using pROC; Robin et al. 2011) and K-fold cross validation (calculated using package DAAG, Maindonald and Braun 2012). Ivlev's electivity index was calculated for land cover and elevation classes, although elevation was a continuous variable in the multivariate regression. Ivlev's ratio scales the use/availability ratio between -1 and 1, 1 being maximum selection and -1 being maximum avoidance (Krebs 1999). The index is useful for describing and visualizing selection. The 95% confidence intervals for the index were generated by resampling and recalculating 1,000 times using package 'boot' (Canty and Ripley 2012).

***Model development* —** The full mixed effects model was initially run on all data and on the two seasonal subsets. Model fit, as assessed by ROC curve analysis and K-fold cross-validation, was improved by subsetting the data by season. The full model was the top model for both the early-winter and late-winter subsets (Table 3.8). Early and late-winter model coefficients of the top models are described in the Early and Late-winter RSF descriptions below. Land cover class and aspect were categorical variables, so deviation coding was required to examine the effect of each level of the factor in relation to the mean effect of the variable, allowing generation of coefficients for each level of the variable. Caribou ID (identified as collar ID) was included in both the early and late-winter models as a random effect. The inclusion of caribou ID indicates that some of the variance observed in the models can be partly explained by individual caribou behaviour.

***Interaction between elevation and land cover class* —** The top-ranking multivariate models for both early and late-winter RSFs include an interaction term for the effects of land cover class and elevation (Table 3.7). The interaction between elevation and land cover class means that model coefficents cannot be interpreted independently when examining the model to see how different explanatory variables are included. In some cases, selection for each of the interacting variables must be considered with respect to the state of the other — in the Klaza caribou data set, selection or avoidance of a land cover class may change depending on elevation.

To explore the effects of the interaction term, the distribution of used and available points across land cover classes were examined, and then across land cover classes were broken in a range of elevation classes. Although elevation is a continuous variable in the multivariate model, it was divided into classes to allow us to calculae the Ivlelv's electivity index for each class to better illustrate the implications of the interaction term. The results illustrate the effects of the interaction term — the change in selection or avoidance of unburned and unforested sites depending on elevation.

Model fit — For both early and late-winter RSF models, AUC values for ROC curves suggested the models performed adequately. Model performance, or the model predictive power, was moderate (AUC of ~0.77 for both season models; Table 3.8), as an AUC value of 0.5 indicates no predictive power (i.e., totally random), whereas an AUC value of 1.0 indicates complete accuracy (Boyce et al. 2002). Considering the nature and quality of the input data (i.e., caribou locations have inherent randomness and the lack of available vegetation land cover data), model fit was relatively good.

Table 3.4 The number of animals monitored, number of fixes per animal, and total number of fixes in datasets used to model winter habitat of the Klaza caribou herd.

Season	Date range	Number of collared caribou	Range of fixes per animal	Total number of fixes
Early-winter	1 November 2012 – 31 January 2013	28	117 – 256	7,011
Late-winter	1 February 2013 – 30 April 2013	27	168 – 291	6,702

Table 3.5 Summarized land cover classes and their origin used to develop habitat models for the Klaza caribou herd.

Land cover class	Years since fire	Data source
Burned forest	6–61	Yukon Fire History 2011
Unburned forest	Forested; no record of burns	Yukon Fire History 2011
Unforested	Subalpine/alpine	DEM

Table 3.6 Land cover and terrain variables used to develop habitat models for the Klaza caribou herd.

Variable	Name	Levels (of factors) or units
Land cover	fire3	1: burned, 2: unburned, 3: unforested
Aspect class	aspect	1 – 5; 1=north (315° - <45°), 2 =east (45° - <135°), 3=south (135° - <225°), 4=west (225° - <315°), 5=flat
Slope	slope	Degrees
$Slope^2$	$slope^2$	$Degrees^2$/ 10
Elevation	elev	m
$Elevation^2$	$elev^2$	m^2/ 1,000

Table 3.7 Spearman-rank correlation coefficients for the four main variables in early and late-winter.

Early-winter					Late-winter				
	slope	*aspect*	*elev*	*land cover class*		*slope*	*aspect*	*elev*	*land cover class*
slope	1.000	0.045	0.059	0.005	slope	1.000	-0.013	0.079	-0.005
aspect	0.045	1.000	0.015	-0.002	aspect	-0.013	1.000	0.000	0.018
elev	0.059	0.015	1.000	0.699	elev	0.079	0.000	1.000	0.610
land cover class	0.005	-0.002	0.699	1.000	land cover class	-0.005	0.018	0.610	1.000

Note: Coefficients were calculated by the cor() function and categorical variables (aspect and land cover class) were coded with dummy integers.

Table 3.8 Candidate models, AIC values, and measures of fit for developing winter RSFs for the Klaza caribou herd.

Season	Model	Parameters: Fixed effects: Cover class (3 levels)	Aspect class (5 levels)	Slope + slope^2	Elevation + elevation^2	Fire * Elevation	Random effects: Caribou ID	k (fixed effects)	AIC	ΔAIC	AUC	K-fold[1]
Early-winter	**Fm01: Full**	**X**	**X**	**X**	**X**	**X**	**X**	**17**	**15648**	**0**	**0.769**	**0.710**
	Fm02: DEM only		X	X	X		X	9	15914	266	0.758	0.698
	Fm03: no aspect	X		X	X	X	X	12	15674	26	0.768	0.708
	Fm04: no interaction	X	X	X	X		X	14	15734	87	0.767	0.706
Late-winter	**Fm01: Full**	**X**	**X**	**X**	**X**	**X**	**X**	**17**	**15177**	**0**	**0.767**	**0.705**
	Fm02: DEM only		X	X	X		X	9	15940	763	0.729	0.676
	Fm03: no aspect	X		X	X	X	X	12	15398	221	0.754	0.698
	Fm04: no interaction	X	X	X	X		X	14	15211	34	0.764	0.704

Note: [1]K-fold: a way of describing how the model results generalize to an independent data set (i.e., cross-validation error) by dividing data into *k* equal subsamples.

3.2.1 Early-winter RSF

The final resource selection function (RSF) model for early-winter included all terrain and land cover variables and an interaction term between land cover and elevation. Variables included in the early-winter habitat selection model include slope, aspect, elevation and land cover classes (Table 3.9). Caribou selected low angle slopes (~<40°) and avoided steeper angle slopes, as indicated by the significant negative effect of slope^2. Aspect was a factor in early-winter habitat selection, as northern aspects were avoided in early winter (Table 3.9). The negative quadratic term for elevation (elev^2) indicated selection for mid-elevations with a peak selection at about 1,320 m. Land cover and elevation are both important effects on caribou habitat selection; however, the interaction between the two variables complicates interpretation because the variables cannot be considered independently. For example, unburned sites are avoided when considered independently from elevation, but the strength and direction of selection depends on elevation. At most elevations, unburned sites are avoided, but there is neutral or slight selection for higher elevation unburned sites (1,000–1,200 m; Figure 3.11 and Figure 3.12). Burned areas are avoided, and the avoidance of burned habitat is shown across all elevations (Figure 3.11) with a negative Ivlev for burned habitats at each elevation class (Figure 3.12). The resulting RSF within the early-winter range is illustrated in Figure 3.15.

Table 3.9 Estimates and 95% confidence intervals (CI) for model parameters for Klaza caribou early-winter (1 November – 31 January).

Variable	Estimate	Lower CI	Upper CI	z	P
(Intercept)	-26.251	-29.773	-22.730	-14.610	<0.001
Slope	-0.044	-0.063	-0.025	-4.520	<0.001
Slope²	-0.001	-0.013	-0.001	-2.300	0.020
Aspect class					
1: north	-0.176	-0.333	-0.019	-2.190	0.030
2: east	-0.026	-0.182	0.130	-0.330	0.740
3: south	0.123	-0.034	0.280	1.540	0.120
4: west	0.074	-0.082	0.231	0.930	0.350
5: flat	0.004	-0.564	0.573	0.020	0.990
Land cover class					
1: burned	3.966	2.992	4.940	7.980	<0.001
2: unburned	-0.739	-1.810	0.332	-1.350	0.180
3: unforested	-3.227	-4.691	-1.763	-4.320	<0.001
Elevation	0.041	0.035	0.047	13.590	<0.001
Elevation²	-0.000	-0.018	-0.013	-12.050	<0.001
Land cover class * elevation					
1:burned*elevation	-0.004	-0.005	-0.003	-9.290	<0.001
2:unburned*elevation	0.001	0.000	0.002	2.370	0.020
3:unforested*elevation	0.003	0.002	0.004	4.670	<0.001

To quantify habitat quality, a habitat suitability index (HSI) was developed from the early-winter RSF model by scaling RSF values to 1. The index values on a scale of 0 to 1 were further classified into discrete habitat quality classes (low: 0–0.3, moderate: 0.3–0.7, and high: 0.7–1.0; Table 3.10).

Table 3.10 Area of available Klaza caribou early-winter habitat quality classes.

Early-winter habitat quality	Area (km²) available	% of total available
Low	2623	67.5
Moderate	1265	32.5
High	63	1.6

3.2.2 Late-winter RSF

The final resource selection function (RSF) model for late-winter included all terrain and land cover variables and an interaction term between land cover and elevation. Variables included in the late-winter habitat selection model include slope, aspect, elevation and land cover classes (Table 3.11). During late-winter, caribou avoided low angle slopes and avoided steeper angle slopes, with peak selection at about 12°. North facing habitats were avoided, while south and west facing habitats were selected. The negative quadratic term for elevation ($elev^2$) again indicated selection for mid-elevations with a peak selection almost 300 m lower than during early-winter, at about 1,040 m. The effect of land cover and elevation are both significant effects on caribou habitat selection; however, the interaction between the two variables complicates interpretation because the variables cannot be considered independently. Caribou select mid-elevation habitat that are unburned or alpine/sub-alpine, and avoid high and low elevation habitat. Burned habitats at all elevations are avoided regardless of elevation. Unburned habitats are avoided below 800 m, used as available at 800–1,000 m, and selected above 1,000 m (Figure 3.13 and Figure 3.14). Caribou select for unforested habitat at mid-elevations, but avoidance occurs at higher elevations (Figure 3.13 and Figure 3.14). The resulting RSF within the late-winter range is illustrated in Figure 3.16.

Table 3.11 Estimates and 95% confidence intervals for model parameters for the Klaza caribou herd in late-winter (1 February – 30 April).

Variable	Estimate	CI lower	CI upper	z	P
(Intercept)	-18.894	-22.533	-15.256	-10.180	<0.001
Slope	0.103	0.082	0.124	9.680	<0.001
$Slope^2$	-0.004	-0.050	-0.036	-12.330	<0.001
Aspect class					
1: north	-0.467	-0.653	-0.281	-4.920	<0.001
2: east	0.152	-0.032	0.335	1.620	0.105
3: south	0.339	0.155	0.522	3.620	<0.001
4: west	0.291	0.108	0.473	3.120	0.002
5: flat	-0.314	-0.997	0.370	-0.900	0.368
Land cover class					
1: burned	-3.666	-4.631	-2.701	-7.450	<0.001
2: unburned	-2.357	-3.424	-1.290	-4.330	<0.001
3: unforested	6.023	4.391	7.655	7.230	<0.001
Elevation	0.036	0.030	0.043	11.020	<0.001
$Elevation^2$	-0.000	-0.021	-0.015	-11.790	<0.001
Land cover class * elevation					
1:burned*elevation	0.002	0.001	0.003	4.840	<0.001
2:unburned*elevation	0.002	0.001	0.003	5.050	<0.001
3:unforested*elevation	-0.005	-0.006	-0.003	-6.480	<0.001

The late-winter RSF was also scaled to develop a habitat suitability index (HSI). The index values on a scale of 0 to 1 were further classified into discrete habitat quality classes (low: 0–0.3, moderate: 0.3–0.7, and high: 0.7–1.0; Table 3.12).

Table 3.12 Area of available Klaza caribou late-winter habitat quality classes.

Late-winter habitat quality	Area (km^2) available	% of total available
Low	1,762	56.8
Moderate	960	31.0
High	378	12.2

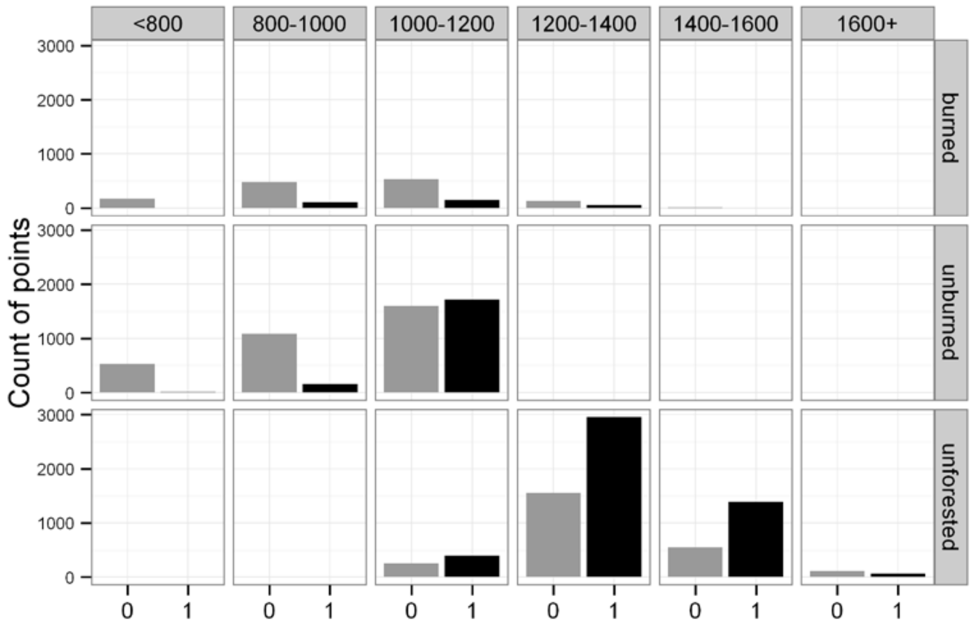


Figure 3.11 **The availability (0) and use (1) of burned, unburned, and unforested habitats across elevation (m) for the early-winter season.**

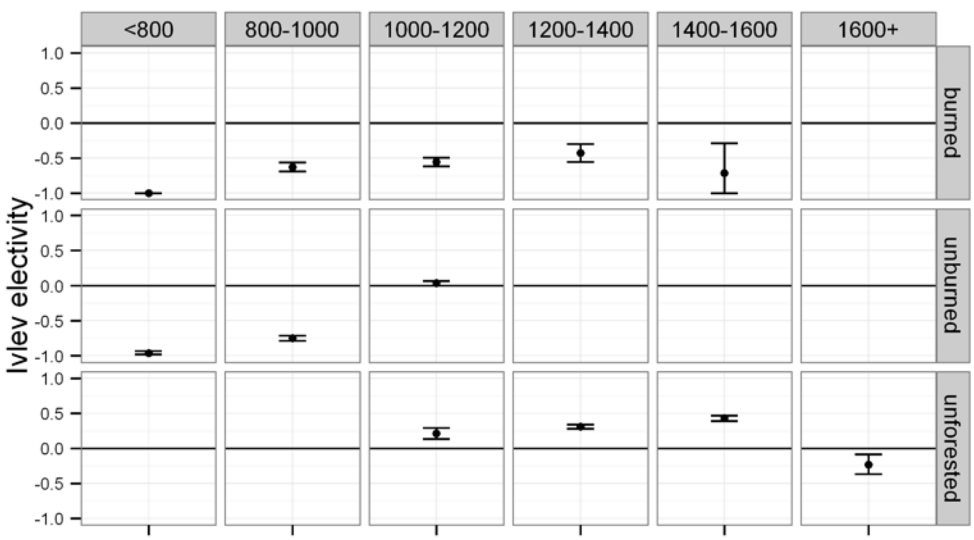


Figure 3.12 **Ivlev Electivity Index and 95% CI for caribou early-winter selection of the three land cover classes across elevation (m).**

Note: Ivlev's ratio scales the use/availability ratio between -1 and 1, 1 being maximum selection, -1 being maximum avoidance, and 0 being where use is equal to availability (Krebs 1999).

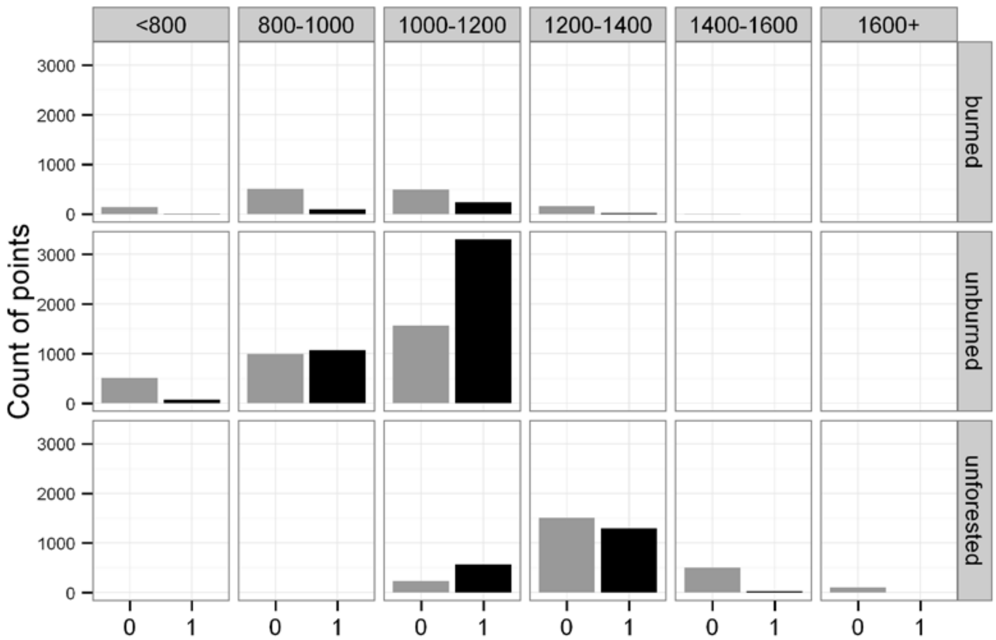


Figure 3.13 **The availability (0) and use (1) of burned, unburned, and unforested habitats across elevation (m) for the late-winter season.**

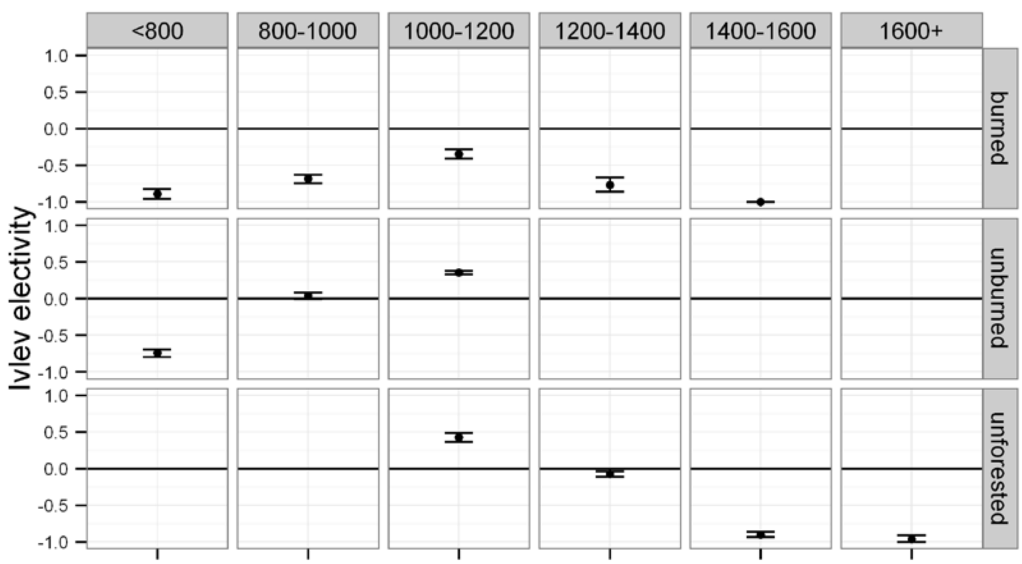
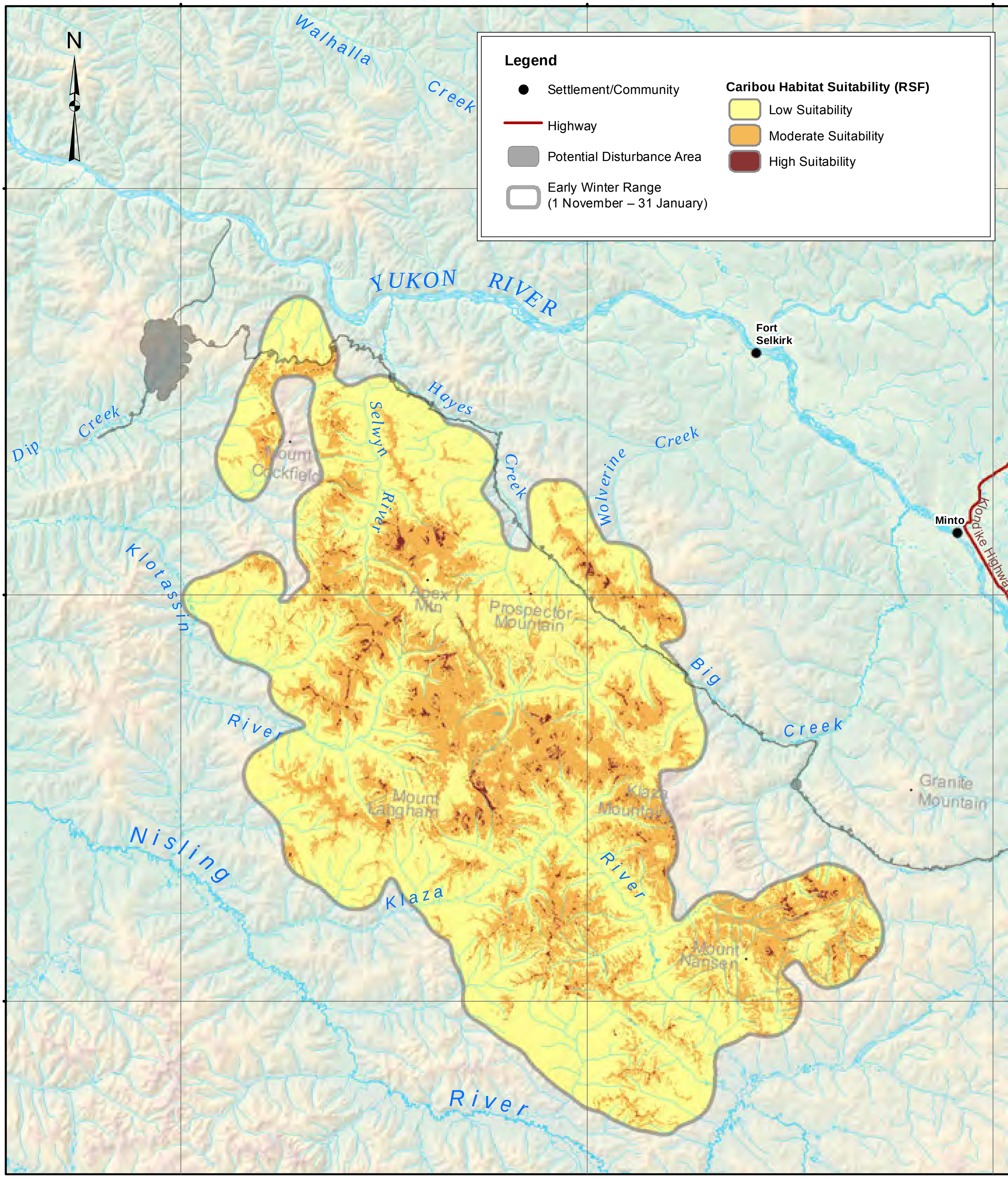


Figure 3.14 **Ivlevs Electivity Index and 95% CI for caribou early-winter selection of the 3 land cover classes across elevation (m).**

Note: Ivlev's ratio scales the use/availability ratio between -1 and 1, 1 being maximum selection, -1 being maximum avoidance, and 0 being where use is equal to availability (Krebs 1999).



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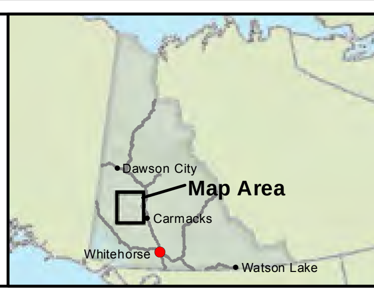
Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

Resource selection function (RSF) model produced by EDI, 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Early-winter habitat suitability for the Klaza caribou herd

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.15

0 5 10 15 20
kilometres

Map scale 1:650,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

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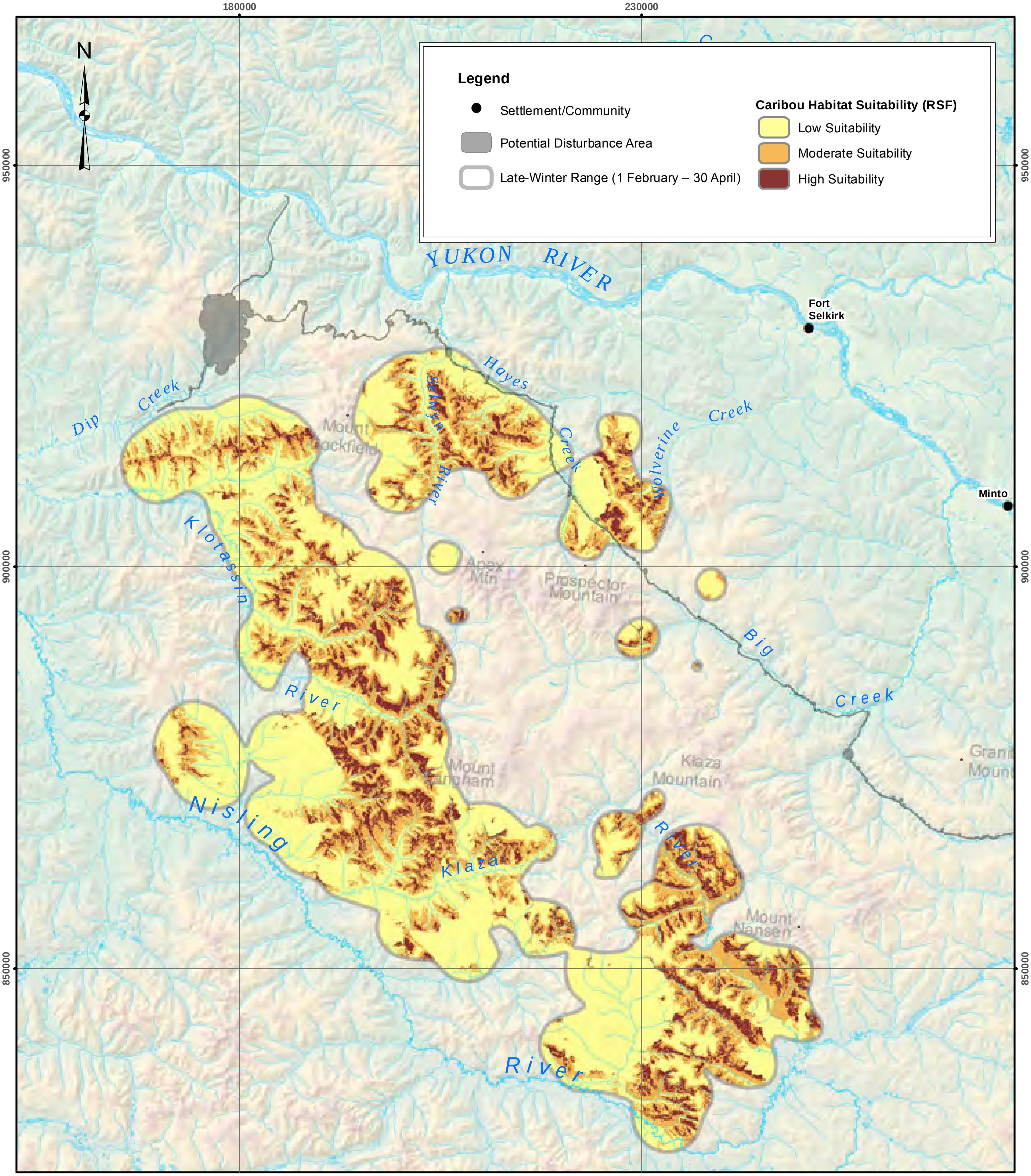

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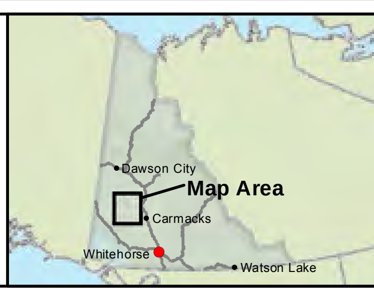
Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

Resource selection function (RSF) model produced by EDI, 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Late-winter habitat suitability for the Klaza caribou herd

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.16

0 5 10 15 20
kilometres

Map scale 1:650,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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3.3 ABUNDANCE

The 2012 population estimate for the KCH was 1,179 caribou (95% CI = 952–1461; Hegel 2013a). The current population estimate represents a 70% increase compared to the 2000 minimum count (700 caribou; Hegel 2013a). Population estimates from 1989–2012 suggest that the herd has increased; however, the actual amount of change in the herd size cannot be determined because survey methods and boundaries differ among study years (Hegel 2013a). The southern portion of the herd's range was not included in the 1989 inventory (441 caribou; Farnell et al. 1991). The population estimate from 2000 is a minimum count and is likely an underestimate of the number of caribou in the herd at the time. The objective of the 2000 survey was to collect fall composition data; however, a large number of observations lead to a minimum population estimate (Hegel 2013a).

Data from the fall 2012 herd composition survey found low calf recruitment (14 calves/100 cows) and adult sex ratio (27 bulls/100 cows). These results suggest a declining population that is experiencing heavy hunting pressure, but are inconsistent with other data and the accuracy of the composition data is suspect (Hegel 2013a). The 2012 calf recruitment is the lowest calf to cow ratio ever reported for the KCH. Past recruitment surveys have averaged about 25 calves/100 cows (range 17–47; Hegel 2013a). Boreal caribou recruitment rates that indicate positive population growth are 26–29 calves/100 cows (Environment Canada 2008); however, a review of the demography of Yukon's NMP herds indicates that the threshold for positive population growth is 20–25 calves/100 cows (Hegel 2013a). The most recent data suggest that the herd has been increasing in size since 2000, and the harvest data indicates that the herd experiences little harvest pressure (Table 3.13). The timing of the 2012 composition survey was consistent with other composition surveys, but the fall of 2012 was abnormally warmer than usual (up to 20°C) and the caribou groups may not have adequately mixed prior to the survey (Hegel pers. comm.); consequently, these data should be interpreted with caution. Another fall composition survey is planned for fall 2013 to estimate the sex and calf ratios.

3.4 HARVEST

There are no data available describing current First Nation people's harvest practices within the RSA. Caribou are an important subsistence species for some First Nations in the Yukon. Subsistence hunting in the Casino area was believed to be low during the original road construction (Spencer Environmental Management Services Ltd. 1985). The Freegold Road area was not being used regularly by local First Nations for subsistence hunting of caribou during the 1980s (Spencer Environmental Management Services Ltd. 1985, Pearse and Weinsten 1988), likely because access to the area was difficult. The local First Nations have not relied on caribou in the Dawson Range for subsistence hunting since the late 1940s when the Forty Mile caribou herd was extirpated from the region (Pearse and Weinsten 1988).

Caribou licensed harvest data are available 1979 to present in most Yukon GMSs. The 2013/2014 regulations restrict caribou harvest in all GMSs that intersect the Project footprint (Figure 3.18): GMSs 509 and 510 are closed to caribou hunting, and licensed hunters are required to enter a permit hunt lottery to harvest caribou in the GMSs 511 and 522 to 526 (Table 3.13). The majority of licensed harvest of the KCH in the last ten years (2002–2012) was concentrated in GMSs 523 and 526 (Table 3.13 and Figure 3.17). Resident harvest is mostly from GMS 526 likely because of access to caribou along the Mount Nansen Road. Non-resident harvest pressure is mostly within GMS 523, presumably from guided hunters accessing more remote areas using aircraft.

The Government of Yukon considers a sustainable harvest rate on woodland caribou to be between 2–3% of the population estimate. Based on the current population estimate, a sustainable harvest rate for the KCH is 24–35 caribou per year. Harvest from licensed hunters during the previous ten years has been 7–8 caribou per year, which is equivalent to 0.6–0.7% of the 2012 population estimate. Any First Nation harvest would be additive to these values.

Table 3.13 Summary of the latest ten years (2002–2012) of caribou harvest in GMSs that overlap with the Casino Project footprint.

GMS	Harvest regulation (2013/14)	Total harvest		Mean yearly harvest	
		Resident	Non-resident	Resident	Non-resident
509	Closed	0	0	0	0
510	Closed	0	0	0	0
511	Lottery Permit Hunt, 1 bull	0	0	0	0
522	Lottery Permit Hunt, 1 bull	2	0	1	0
523	Lottery Permit Hunt, 1 bull	5	35	0.5	3.5
524	Lottery Permit Hunt, 1 bull	1	0	0.1	0
526	Lottery Permit Hunt, 1 bull	37	0	3.7	0
TOTAL		**45**	**35**	**4.5**	**3.5**

Note: Government of Yukon data, unpublished

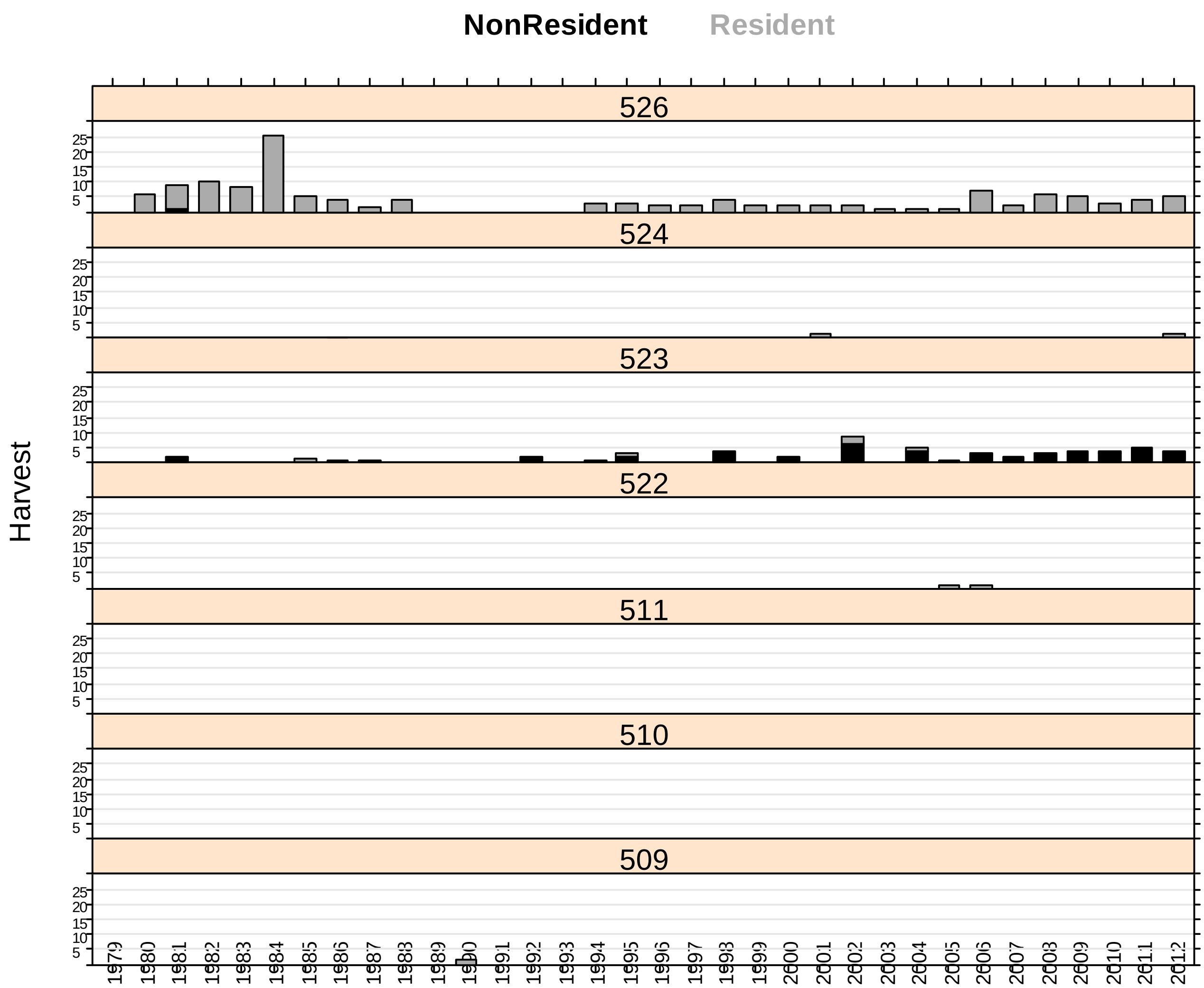
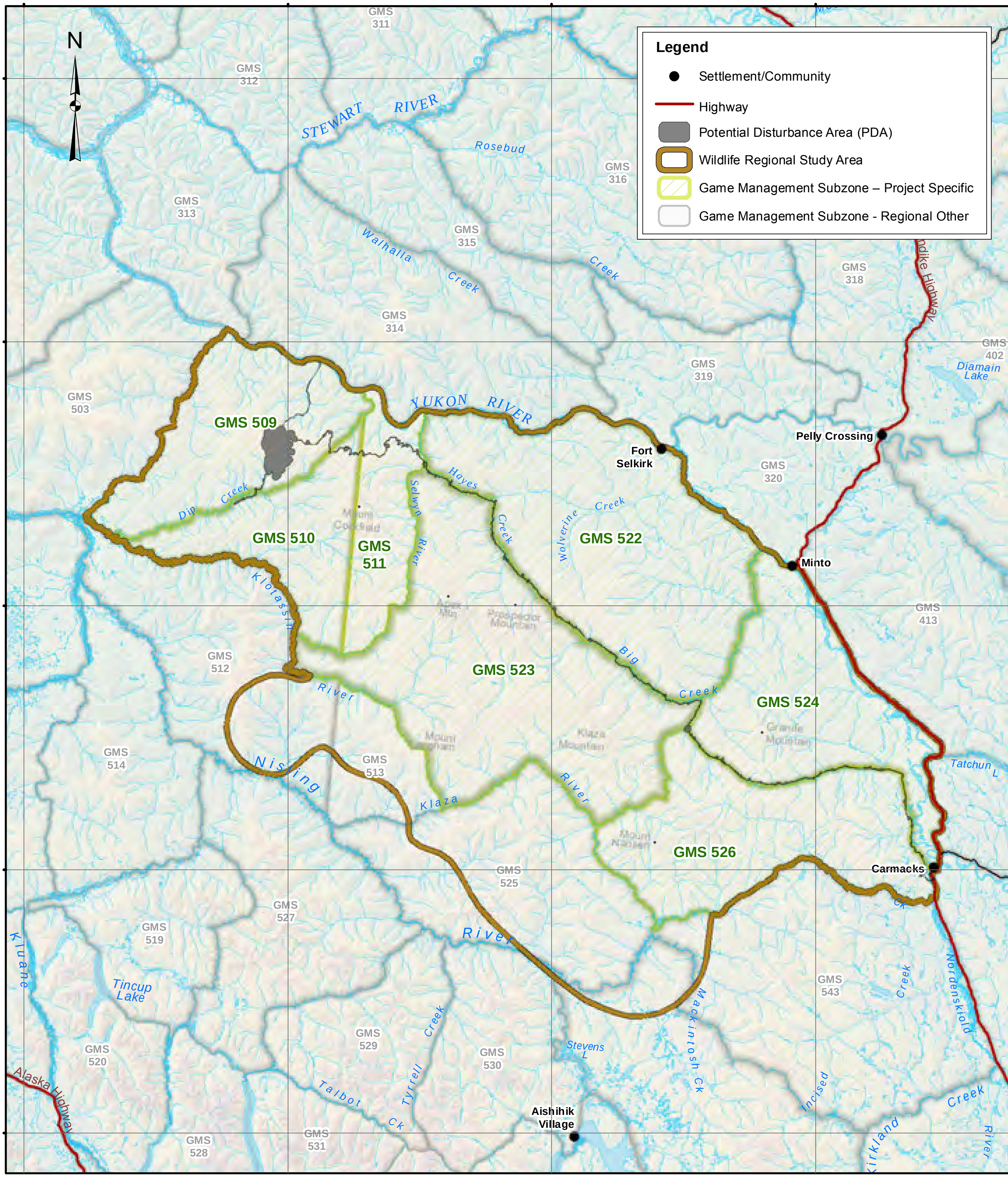


Figure 3.17 **Licensed caribou harvest within the GMSs that intersect the Project footprint, 1979–2012.** The black bars indicate non-resident harvest and the gray bars indicate resident harvest.



Notes:

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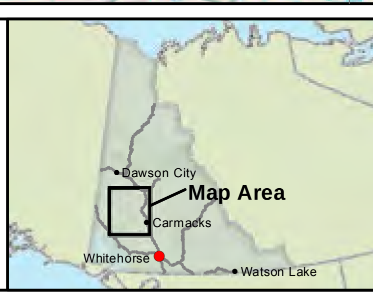

Game Management Subzones (GMS)

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	3.18

0 5 10 15 20 25 30 35 kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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3.5 NATURAL MORTALITY

The natural mortality rate of the KCH was roughly 5% in the late 1980s (Farnell et al. 1991). Predation by wolves is likely the primary factor limiting population growth of the KCH (Hayes et al. 2003); however, wolverine can be an important predator of caribou calves during the first month after birth (Gustine et al. 2006). The amount of predation on the KCH is largely unknown. Previously, wolf numbers in the region were believed to be low due to the low density of prey in the region (Baer and Hayes 1987; Jingfors 1989). Wolves generally target alternative prey species that are more abundant and/or provide greater rewards. Caribou segregate themselves from wolves by using habitats where alternative prey (i.e., moose) are less abundant (James et al. 2004). The segregation of caribou from wolves may be an important tactic reducing predation rates.

Severe weather events (e.g., deep snow) have been suggested as a source of natural mortality for caribou. During the winter, forage availability is limited to ground-lichen and caribou must access the lichen under the snow, resulting in greater energy expenditure from digging craters (Bradshaw et al. 1998). Snow depths greater than 74 cm are considered adverse to caribou for digging craters to access forage (Farnell et al. 1991). Snow conditions can further limit the availability of forage based on snow depth, density, and hardness. Snow conditions do not seem to be a factor affecting population growth of the KCH, because snow depth in this herd's range rarely exceeds thresholds that are considered limiting to caribou (Farnell et al. 1991).

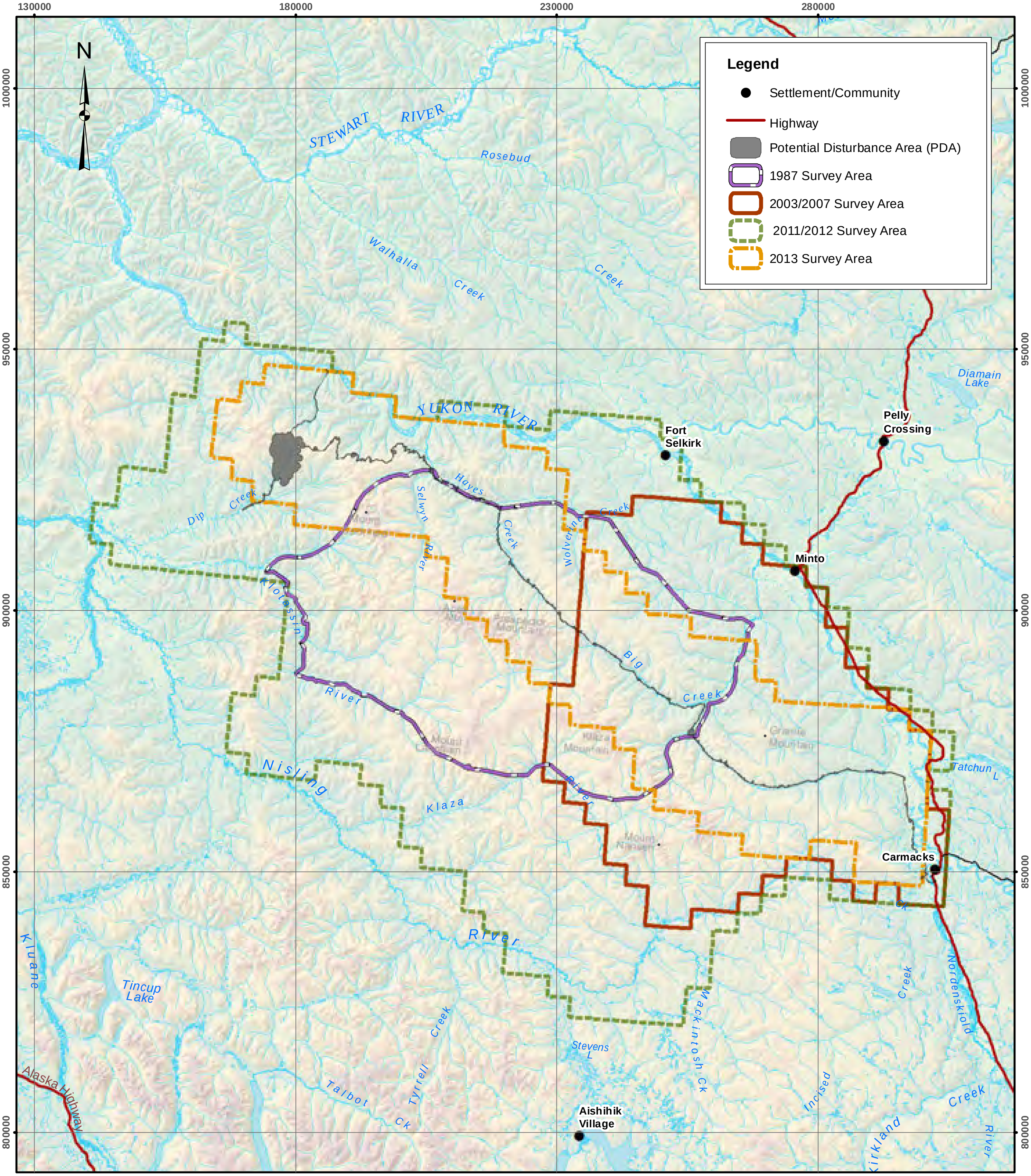
4 MOOSE

Moose is a highly valued harvest species in the Yukon and is considered the primary harvest species in the Project region. In the Yukon, moose management is defined by Yukon Moose Management Units (YMMU), which were developed for consistent long-term monitoring and management of moose (O'Donoghue 2008a). The Carmacks West Moose Management Unit (CWMMU) overlaps primarily with the eastern half of the RSA (Figure 4.1). The CWMMU, along with GMSs intersecting Project components helped to guide the delineation of study areas for baseline moose surveys.

Baseline studies of moose in the Casino area began in the late 1980s and have included population censuses, composition, early-winter and late-winter distribution surveys, and incidental observations (Table 4.1; Markel and Larsen 1988; Jingfors 1989; O'Donoghue et al. 2008a, 2008b; O'Donoghue and Bellmore 2011). Results of these surveys provide information on the distribution and abundance of moose in the RSA. The study areas for moose are illustrated in Figure 4.1.

Table 4.1 History of moose surveys conducted in the Casino area from 1987–2013.

Date	Type of survey	Survey area	Survey Team
November 1987	Population census	Casino Trail area	YG Environment
November–December 2003	Population census	Carmacks West Moose Management Unit; KCH range; GMSs 524, 526, and parts of 522 and 523	YG Environment
November–December 2007	Population census	Same as 2003	YG Environment
March 2011	Late-winter distribution	Extension of 2003 and 2007 survey area to include the mine site and all GMSs that spatially overlap with the Project	YG Environment and CMC
February–March 2012	Late-winter distribution	Same as 2011	YG Environment and CMC
	Snow tracking	Freegold Road and extension	CMC
February–March 2013	Late-winter distribution	Streamlined from 2011 and 2012 surveys to select survey blocks within 10 km of the mine site and the Freegold Road extension and upgrade	YG Environment and CMC
	Snow tracking	Freegold Road and extension	CMC



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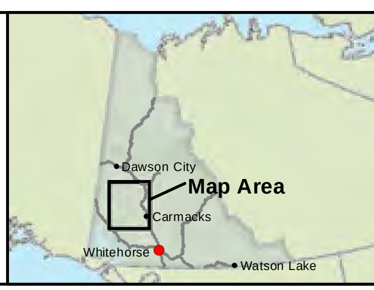
Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Moose aerial survey areas

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	4.1

0 5 10 15 20 25 30 35
kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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4.1 DISTRIBUTION

Moose naturally occur in all Canadian provinces and territories, except Prince Edward Island and with introduced populations in Newfoundland (Geist et al. 2008). Moose are generally abundant across their range and are considered Secure in Canada (CESCC 2011). In some areas, such as the southern boreal forest and the eastern Canadian provinces (e.g., Nova Scotia), moose range has decreased since the turn of the century; however, in other regions their range has expanded (e.g., coastal rainforests of BC; Geist et al. 2008). In the Yukon, moose are considered Secure (CESCC 2011) with a population of approximately 70,000 animals (Government of Yukon 2013a). Moose are distributed throughout the territory except Hershel Island, with unevenly high densities in southern Yukon, which represents only 15 percent of the land area (Government of Yukon 2010a).

Throughout their range moose prefer a mosaic of riparian and subalpine habitats, openings, and recent burn areas where they feed on tree leaves, woody and dwarf shrubs, herbs, and aquatic plants (Geist et al. 2008). Generally, moose select for habitats that provide abundant browse and foraging opportunities, thermal cover and protection from predators (Hamilton et al. 1980; Blood 2000). In an effort to better understand moose habitat use in the Dawson Land Use Planning Area, Morrison and Wong (2013) created late-winter habitat selection models for adult moose and cows with young (one or more calves) to determine which areas moose selected and which were avoided. The models were based on moose late-winter aerial survey data from surveys conducted in the Dawson Land use Planning Area in 2008–2010 and 2012. Adult moose selected areas close to forest, treed riparian areas, wide linear disturbances (>8 m wide), and 11–25 year old burned areas of intermediate elevation, on north-facing slopes, and with a high abundance of riparian forest (Morrison and Wong 2013). Cows with calves selected similar habitat, but did not select for wide linear disturbances or areas close to forest. Both adult moose and cows with calves avoided areas with a high proportion of wetlands, shrub cover, conifer forest, and mixed-wood forest, while only adult moose avoided areas close to recent burns (<10 years old; Morrison and Wong 2013). The avoidance of areas with high proportions of wetlands, shrub cover, conifer forest, and mixed-wood forest was unexpected, considering the requirements for shelter and forage (Morrison and Wong 2013). The avoidance of these habitats may have been a result of pooling all ages of vegetation types (i.e. young forest stands with little to no cover pooled with older, sheltering stands), misclassification error, or moose may have selected multiple vegetation types and avoided individual types (Morrison and Wong 2013).

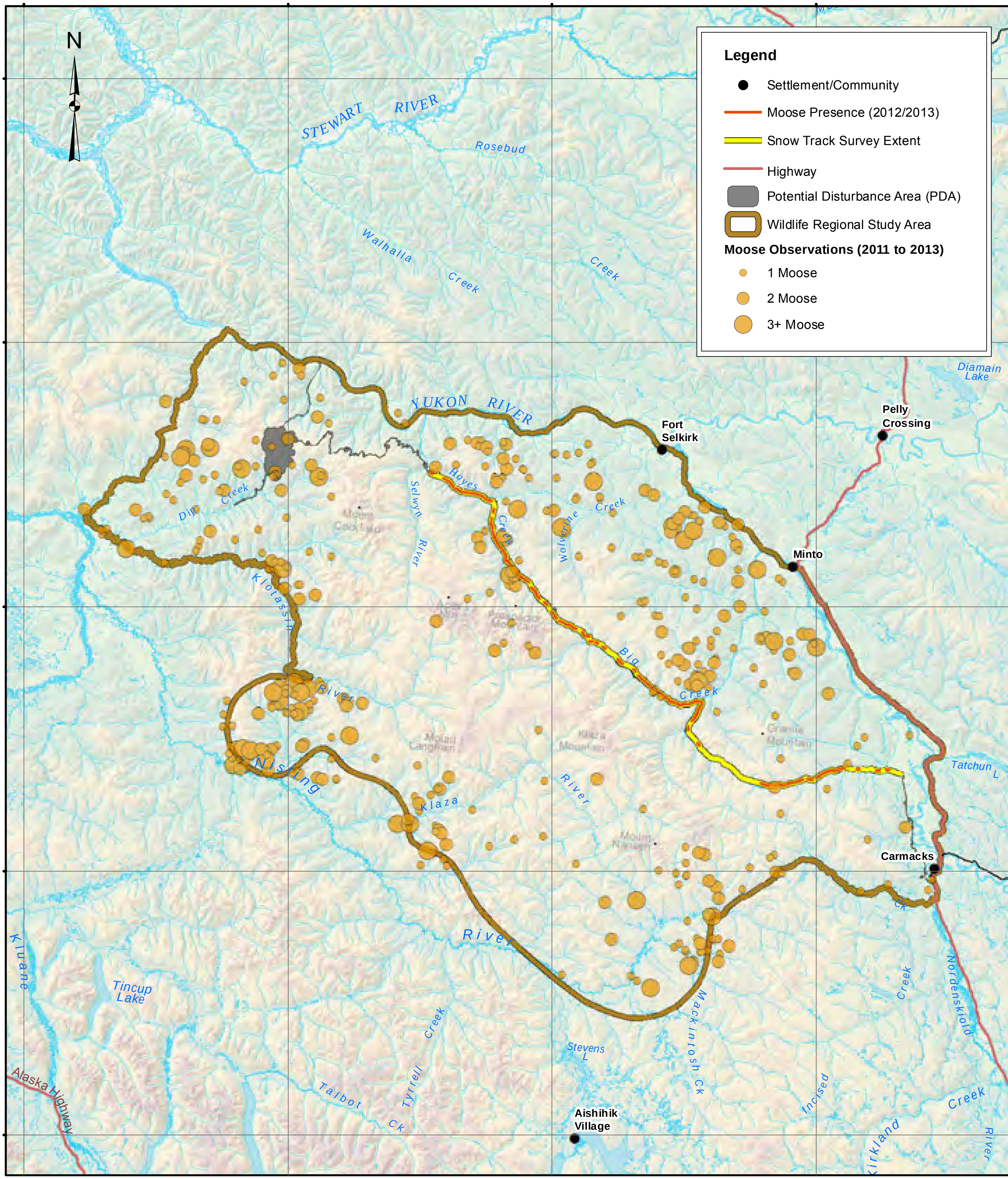
In the RSA, previous examination of aerial photographs and helicopter reconnaissance led Spencer Environmental Management Services Ltd. (1985) to believe that higher elevation areas are not suitable habitat for moose during early spring and summer, whereas lower elevation areas (e.g., Big Creek) provide good habitat for feeding, thermoregulation, predator protection, and calving opportunities. Low elevation valleys and creeks provide abundant aquatic vegetation that moose highly prefer (MacCracken et al. 1993). Frequent moose sightings have been reported in both the Casino Creek and Britannia/Canadian Creek watersheds in late summer and early fall (Knight Piésold Limited 1997). These findings highlight the importance of low elevation forested valleys and waterways for moose, where they can be found browsing new buds and fresh growth such as willow and birch (Government of Yukon 2000; USDA Forest Service

2010). In fall, during the rut, moose congregate in subalpine willow flats and creek draws where there is abundant willow. Observations of moose during fall and early-winter surveys noted moose using subalpine areas, feeding on willow and shrub birch where snow depths remain shallow enough until mid-winter (Markel and Larsen 1988; Jingfors 1989; O'Donoghue and Bellmore 2011).

Winter can be a critical season for moose survival due to reduced forage availability and the energetic cost of moving through deep snow (Pierce and Peek 1984; Markel and Larsen 1988; Poole and Smith 2006; USDA Forest Service 2010). Key winter ranges for moose in mid to late-winter are low elevation forested valleys where tree canopy cover intercepts snow, resulting in shallower snow conditions, lower energy costs, greater forage availability, and cover from predators (Government of Yukon 2010a). Willows generally make up the bulk of moose winter diet; therefore, areas with extensive shrubs and saplings provide good winter habitat, such as riparian areas, subalpine plateaus, shrub dominated draws, and early-successional forests (Government of Yukon 2010a). Lightning strikes causing wildfires are common in the Casino area (YEWG 2004), which benefit moose by providing high quality vegetative forage in recent burn areas. The most recent forest fire was in 2013, just west of the Freegold Road near Carmacks, and the most expansive fires occurred in 1994 and 1995 (O'Donoghue and Bellmore 2011).

During the 2011, 2012, and 2013 surveys, moose were widely distributed across the survey areas along creeks, open forest, and willow-rich habitats in previously burned or disturbed areas (e.g., near placer mine operations; Photo 2; Figure 4.2). In 2011, large concentrations of moose were observed in the northern and western portions of the survey area in open spruce forests and lower valleys along Klotassin River, Dip Creek, and Coffee Creek. In 2012, high concentrations of moose were observed in burned areas and river valleys; however, they were evenly distributed throughout the survey area. The study area in 2013 was restricted to survey blocks 10 km or less from the existing Freegold Road and the proposed upgrade and extension. Moose sightings in 2013 were distributed throughout the survey area, with minor concentrations noted north of the road alignment, between the Yukon River and Hayes Creek, and in the Big Creek area. Survey observations of moose distribution in late-winter corresponded with known suitable winter habitats, especially areas that were likely to receive less snowfall and provided adequate winter browse. In general, observations from 2011 to 2013 were concentrated east of the proposed Freegold Road extension, in the Dip Creek area, and in the Nisling River valley (Figure 4.2). Observations from the Casino wildlife log include 76 moose from 2008 to 2013.

Photo 2. Three moose observed browsing on willow in disturbed habitat (cleared area near a placer mine) along the proposed Freegold Road extension during snow track surveys, 2013.



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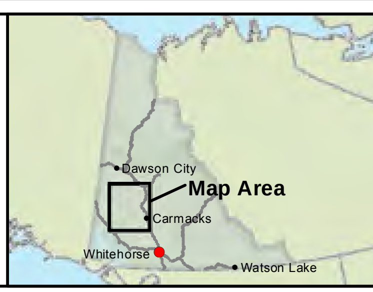
2012 – 2013 snow tracking surveys (EDI), 2011 – 2013 aerial surveys (EDI/YG).

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Late-winter moose observations and snow track survey results

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MP/LG	MAS	16/10/2013	4.2

0 5 10 15 20 25 30 35
kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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4.2 MOOSE WINTER HABITAT SUITABILITY MODEL

In consideration of the energetic costs to moose during winter, late-winter habitat suitability modelling was conducted within the moose RSA. Habitat suitability indices (HSI) were assigned to habitat variables based on a review of literature and species distribution models (Resource Selection [Probability] Functions, [RSFs or RSPFs]) from nearby areas (Dawson Land Use Planning Area, Morrison and Wong 2013; Faro, YG unpublished data) and comparing the proportion of moose observations to the proportion of available habitat quality classes.

When choosing habitat variables to qualify habitat within the moose RSA, the process was limited by the lack of available land cover data (Earth Observation for Sustainable Development [EOSD] is typically used). Based on the moose RSF models completed in the Dawson Land Use area and Faro, four variables were used to qualify late-winter moose habitat in the RSA: bioclimate zone; aspect; proximity to watercourses; and proximity to burned areas. The bioclimate zones included in the model are:

- **Alpine** — High elevations associated with mountainous conditions throughout Yukon. Dwarf shrubs, herb/cryptograms and low-growing and scattered krummholtz trees are the predominant vegetation condition. In very high elevation areas, bare rock, colluvium or ice/snow may be the dominant conditions.
- **Subalpine** — Sparsely forested areas at moderate to higher elevations on steep slopes above the boreal high. Subalpine areas form a transitional zone between forested boreal and the higher elevation non-forested, alpine bioclimate zones. Open canopy conifer forests (tree cover <20%) and tall shrub communities are characteristic vegetation conditions. Subalpine fir is the predominant tree species. Winters are long and cold, while summers are short, cool, and moist.
- **Boreal High** — Middle to upper elevations of forested areas in all mountain valley and plateau ecoregions of southern and central Yukon. Found above the boreal low in large valleys. Characterized by steep slopes in southern mountainous ecoregions and gentle rolling plateaus in the central ecoregions. Summers are brief, cool and moist, with long cold winters. Forests are dominated by white spruce, lodgepole pine, and subalpine fir.
- **Boreal Low** — Continuously forested areas at low to middle elevations, below the boreal high of all mountain valley and plateau ecoregions of southern and central Yukon. Landscapes are generally wide valleys. Winters are long and cold, with short, cool, and dry summers. Forests are generally mixedwood (lodgepole pine, white spruce, and aspen) with moderately[1] developed understories. Wetlands are common.

The variables were assigned an index value (shown in parenthesis) that reflected moose selection, avoidance, or use as available (neutral). Ratings ranged from 0.1 to 0.9, with 0.1 representing habitat with little to no value to moose and 0.9 representing habitat that is very valuable to moose. The variables, with index value ratings, are:

[1] Some publications consider the understory of boreal low to be "well" developed. This is a relative term that will become more explicit as Yukon vegetation classification is established.

- Bioclimate zone:
  - Selection for subalpine (0.9)
  - Avoidance of alpine and boreal low (0.1)
  - Use as available for boreal high (0.5)
- Aspect:
  - Selection of northern aspects (0.9)
  - Use as available for east, south, west, and flat aspects (0.5)
- Proximity to watercourses:
  - Selection for areas within 300 m of watercourses (0.9)
  - Use as available for area more than 300 m from watercourses (0.5)
- Proximity to burned areas:
  - Selection for burned areas between 11 and 25 years old (0.9)
  - Use as available for unburned areas, burned areas less than ten years old, or burns greater than 25 years old (0.5)

The resulting values were categorized into low, moderate, and high quality late-winter habitat. Based on this modelling, it appears that the majority of late-winter moose habitat in the moose study area is of moderate quality (69%). Low quality and high quality moose winter habitat represented 27 and 4%, respectively, of the total moose study area (Figure 4.4, Table 4.2). This habitat qualification reflects findings of relatively low moose densities in the area (Yukon Fish and Wildlife Management Board 1996), potentially a result of limited high quality habitat during the late-winter season. Observations of moose from 2011–2013 baseline surveys were then used to validate the findings by examining the relative proportion of total moose and moose groups in each habitat quality class (Figure 4.3). For both total moose and moose groups, high quality habitat was used more than its availability, whereas low quality habitat was used less than its availability (Figure 4.3). Moderate quality habitat was used as it was available (proportionally the same amount of use as availability) or slightly more than was available (Figure 4.3). The fit of the survey data to modeled habitat appeared reasonable, with greater agreement around and north of the Freegold Road and extension than in areas further south.

Table 4.2 Availability of late-winter moose habitat in the moose study area

Habitat quality	Baseline area (km^2)	% of total available
Low	2,399	27
Moderate	6,159	69
High	369	4

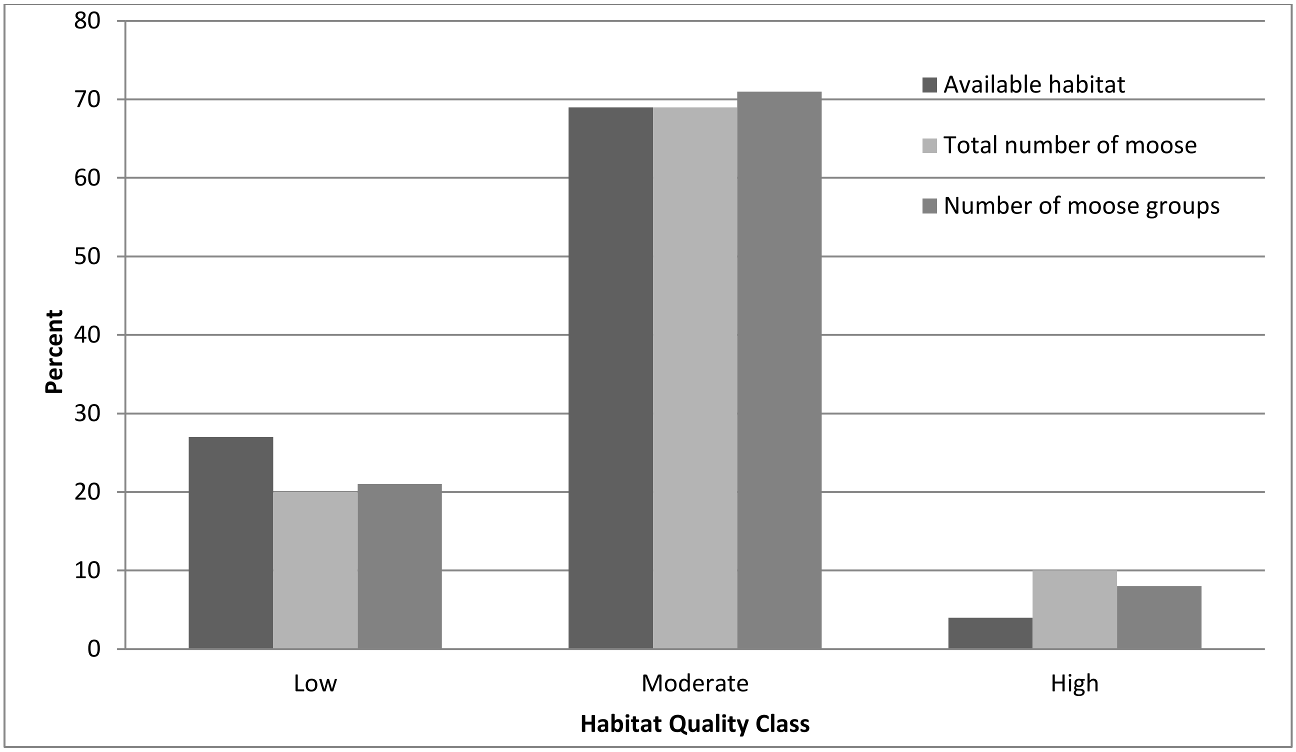
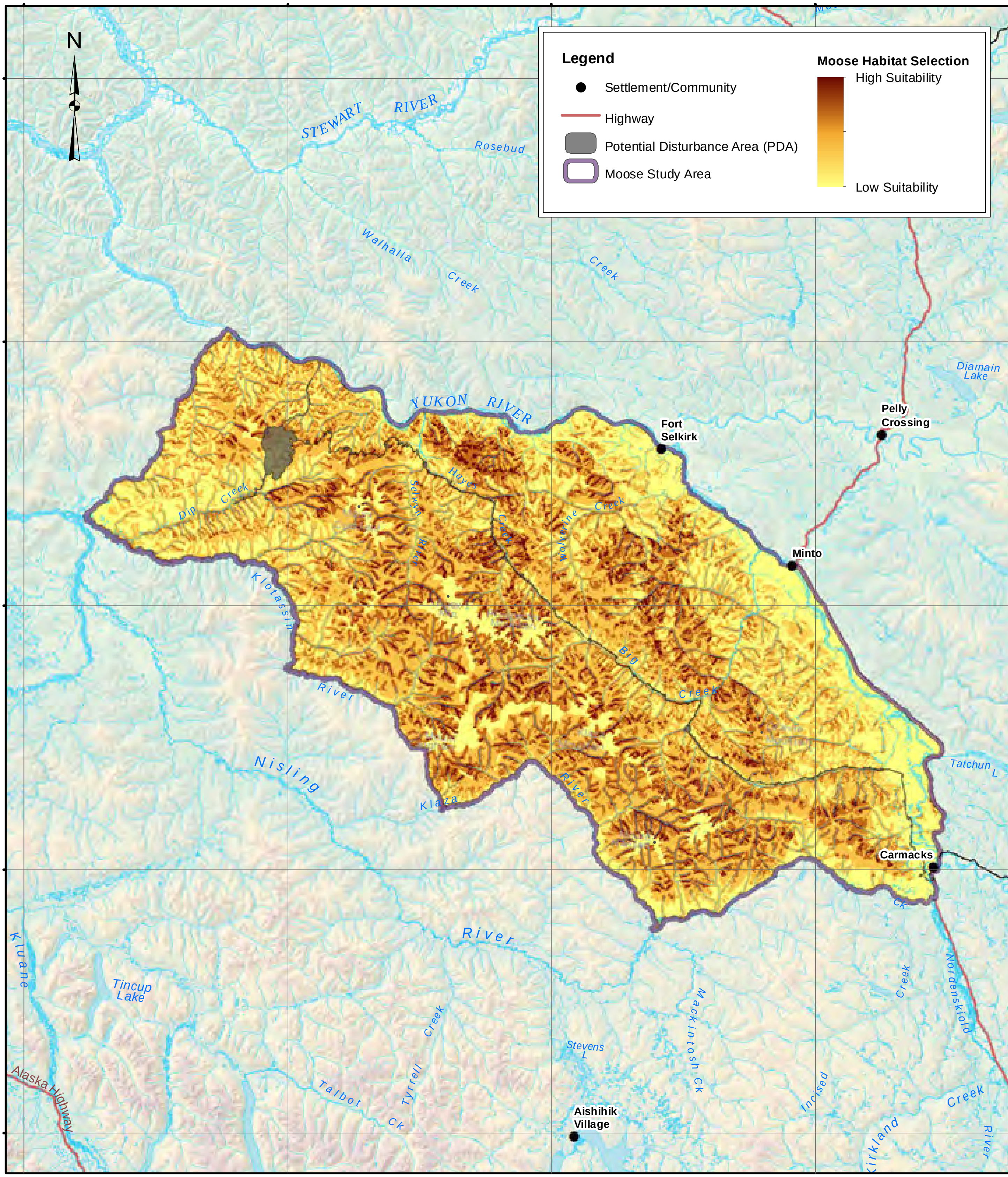


Figure 4.3 **Proportion of habitat available in each habitat quality class compared with the proportion of total moose and moose groups observed in each class during late-winter surveys, 2011–2013**



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Habitat Suitability Index developed by EDI, 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Late-winter habitat suitability for moose

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	4.4

0 5 10 15 20 25 30 35
kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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4.3 ABUNDANCE

The first moose survey conducted near the RSA was part of a larger study in 1975 covering Game Management Zone 5 and found relatively low densities of moose (Hoefs and Lortie 1975). The first survey targeting moose in the Casino area was conducted by the Government of Yukon in 1987 in response to the growing concern surrounding the potential impacts of the Freegold Road extension on moose and other wildlife populations (Markel and Larsen 1988). The Government of Yukon continued to conduct surveys in the Casino area in 2003, 2007, and 2011; however, the 2003 survey was only partially completed due to poor weather conditions (Table 4.3).

Moose densities in the RSA are relatively low, but may be increasing (Table 4.4); difference in survey timing and study area size confound rigorous trend analysis. Density estimates from 2003 are low and likely biased because of poor survey conditions, thus the apparent upward population trend from 2003 to 2007 may be somewhat unfounded (O'Donoghue et al. 2008b); however, there is a considerable increase in density from 1987 to 2007. Moose densities in the RSA are lower than the Yukon average, which generally ranges between 150 and 249 moose/1,000 km² (Yukon Fish and Wildlife Management Board 1996).

An estimate of moose composition could not be determined in 1987 and 2003 due to low sample size (O'Donoghue et al. 2008a). Estimates from 2007 and 2011 suggest that recruitment was relatively low in the RSA, below what is considered necessary for maintaining stable moose populations and lower in comparison to late-winter distribution surveys done elsewhere in the Yukon (O'Donoghue et al. 2008b; O'Donoghue and Bellmore 2011). In general, moose populations in areas with typical mortality rates require about 25–30 calves per 100 adult cows to maintain stable moose populations (O'Donoghue et al. 2008b). Likewise, about 10–20 yearlings per 100 adults are necessary for maintaining stable moose populations. The number of mature bulls to adult cows (75 bulls per 100 cows) was slightly higher than the Yukon average (67 bulls per 100 cows) at the time of the survey and above the minimum target level of 30 bulls per 100 cows (Yukon Fish and Wildlife Board 1996).

In 2011, the observed number of calves in the population (4%) was low, suggesting low calf survival; however, this composition index is likely biased because the survey was aimed at determining moose distribution in the survey area (O'Donoghue and Bellmore 2011). Regardless, moose composition can be compared with results from similar late-winter surveys done elsewhere in the Yukon, which suggests that calf survival in the study area was low in 2011.

Table 4.3 Results of moose surveys conducted in or near the Casino area, 1987–2013.

Year of survey	Type of survey	Abundance/# Moose Observed	Density[1]
1987	Early-winter population census	137 ± 59% (90% CI)	40 moose/1,000 km²
2003[2]	Early-winter population census	215 ± 48% (90% CI)	53 moose/1,000 km²
2007	Early-winter population census	520 ± 21% (90% CI)	127 moose/1,000 km²
2011	Late-winter distribution	278 individuals	n/a
2012	Late-winter distribution	272 individuals	n/a
2013[3]	Late-winter distribution	54 individuals	n/a

Notes:

[1]Density is based on moose observed in suitable habitat only (does not include entire study area).

[2]Results of this survey are biased low due to poor weather conditions.

[3]The number of moose observed in 2013 reflects the reduced survey area size (Figure 4.1).

Table 4.4 Moose densities in GMSs that interact with the Project, based on early-winter census survey results and discussion with regional biologists.

Game Management Subzone	# Moose/1,000 km²	Total Moose
509	200	205
510	200	142
511	100	47
522	125	252
523	145	319
524	100	117
526	125	166

Notes:

Rows in grey are not based on census data from that GMS. Within these GMSs, moose density is estimated from nearby censuses (Beaver Creek and or Casino Trail early-winter surveys) and discussions with the Regional Biologist.

Data source: Government of Yukon 2012, unpublished data

4.4 HARVEST

Moose is a highly valued wildlife species in central and southern Yukon for recreational and trophy hunting and as subsistence food for First Nations (Spencer Environmental Management Services Ltd. 1985). Hunter questionnaire results from 1985 found that the demand for moose by resident hunters (licensed and unlicensed) was higher than all other big game species (Larsen et al. 1985). Although unlicensed (i.e., First Nation) harvest cannot be directly quantified, interviews with LSCFN and SFN members suggest that the Casino area is not highly used for subsistence hunting (Pearse and Weinstein 1988); however, this may have changed since that information was collected. Historical harvest data for moose are limited and harvest estimates do not include unlicensed harvest. Harvest records from the LSCFN and SFN are voluntary;

therefore, total harvest is unknown and can only be speculated based on personal communication or interviews with First Nation hunters.

Historically, moose numbers were found to be low in the Casino area and susceptible to overharvest (Spencer Environmental Management Services Ltd. 1985; Markel and Larsen 1988; Jingfors 1989; O'Donoghue et al. 2008a). Harvest data from 1979 to 2012 covers GMSs 510, 511, 522, and 523, with most harvest in the last ten years (2002–2012) from licensed resident users in GMS 509 (Table 4.5), corresponding with access from the Yukon River. Peak harvest was reported in 1984, and by 1987 GMSs 522–524 and 526 were closed to licensed hunting due to low moose numbers (Jingfors 1989; O'Donoghue et al. 2008a). In the RSA, these GMSs overlap with the CWMMU, which has been closed to licensed hunting since 1987. However, First Nation harvest is unrestricted. At the time of writing this report, GMSs 522–524 and 526 are still closed, while 509–511 are open for the 2013–2014 hunting season, subject to a bag limit of one moose (Table 4.5).

Table 4.5 Summary of the latest ten years (2002–2012) of moose harvest data in GMSs that interact with the Project.

GMS	Harvest regulations (2013–2014 season)	Total harvest			Mean yearly harvest		
		Resident	Non-resident	Special Guided	Resident	Non-resident	Special Guided
509	Open; Bag limit 1	11	1	1	1.1	0.1	0.1
510	Open; Bag limit 1	1	3	0	0.1	0.3	0
511	Open; Bag limit 1	3	0	0	0.3	0	0
522	Closed	1	0	0	0.1	0	0
523	Closed	0	3	0	0	0.3	0
524	Closed	2	0	0	0.2	0	0
526	Closed	0	0	0	0	0	0
TOTAL		**18**	**7**	**1**	**1.8**	**0.7**	**0.1**

Note: Government of Yukon data, unpublished

4.5 NATURAL MORTALITY

The main source of natural mortality for moose in the RSA is likely predation by grizzly bears on newborn calves, followed by wolf predation on calves and adults (Larsen et al 1989). Predation levels are unknown in the Casino area, but studies from southern Yukon and east central Alaska strongly suggest that predation by grizzly bears limits moose population growth (Boertje et al. 1987; Markel and Larsen 1988; Jingfors 1989; Larsen et al. 1989).

Grizzly bear densities in the RSA are unknown, but likely range from 10–16 bears/1,000 km², based on studies southwest of Whitehorse and north of Tok, Alaska (Markel and Larsen 1988; Jingfors 1989; Larsen and Markel 1989). In spring, grizzly bears are in the subalpine, which exposes moose and newborn calves to predation (Government of Yukon 2000). Grizzly bear mortality on moose tends to occur during the calving season before calves reach eight weeks of age, when they are weak and can be easily preyed upon (Larsen et al. 1989; Government of Yukon 2000). In late June, grizzly bears prey less on moose calves and wolves become the dominant predator during the remainder of the year and through winter (Larsen et al. 1989).

Another factor affecting natural mortality for moose in northern ecosystems is snow depth (Markel and Larsen 1988; Ballard et al. 1996). Snow depth is an important factor that influences forage availability and the energetic cost of moving across the landscape; however, moose may still select winter habitats primarily based on the overall availability of food (Serrouya and D'Eon 2002; Poole and Smith 2006). In the RSA, moose have been observed feeding on willow in areas of high snow depths (60–74 cm), suggesting that forage preference might be more important than snow depth in terms of habitat selection (O'Donoghue and Bellmore 2011). Although moose have evolved long legs to tolerate deep snow conditions, depths of 65–75 cm are known to restrict movements of cows and calves, and depths of 70–80 cm are considered critical to survival (Pierce and Peek 1984; Markel and Larsen 1988; Larsen et al. 1989). Generally, the average annual snowfall in the Yukon is not high enough to be a significant cause of natural mortality in moose (Government of Yukon 2010a).

5 DALL'S SHEEP

There are two subspecies of thinhorn sheep in Canada: Stone's sheep (*Ovis dalli stonei*) and Dall's sheep (*Ovis dalli dalli*). There is also a colour morph referred to as Fannin's sheep, which is a result of cross-breeding between Dall's and Stone's sheep (Worley et al. 2004; Government of Yukon 2010b). Dall's sheep occur throughout Canada's northwest including northern British Columbia, Yukon, Northwest Territories, and in Alaska (Loehr et al. 2006; Festa-Bianchet 2008) and are the only subspecies that exists within the RSA. They are distributed throughout the Yukon, extending as far north as the Arctic coast (Barichello et al. 1989a; Government of Yukon 2000b) with scattered pockets that extend across the territory in a broad band that follows the mountain ranges (Government of Yukon 1996, 2000b).

Sheep typically have a clustered distribution in traditionally used areas due to heavy reliance on key habitats for seasonal life functions (e.g., winter range, lambing areas, and mineral licks; Heimer 1973; Festa-Bianchet 2008; Loehr et al. 2006). Dall's sheep are not migratory and their home ranges are usually not large (Spencer Environmental Management Services Ltd. 1985; Government of Yukon 1996; Geist 1999; Worley et al. 2004), but they do inhabit distinct seasonal ranges that can be as little as a few kilometers apart (Government of Yukon 2000, 2010b). Adult male sheep may occupy as many as six seasonal ranges including pre-rutting, fall rutting, mid-winter, late-winter, spring, salt lick, and summer ranges; whereas adult females typically have four seasonal ranges including winter, spring, lambing, and summer (Bowyer and Leslie 1992; Valdez and Krausman 1999). Lambing areas are re-used annually as an important source of suitable forage and protection from predators.

Dall's sheep inhabit dry mountainous regions where there is access to subalpine meadows, shrublands, and terrain with rocky slopes, ridges, and cliffs to help avoid predation and provide safe lambing grounds (Bowyer and Leslie 1992; Festa-Bianchet 2008). Nearby grasslands and meadows provide habitat for feeding on grasses, sedges, and the leaves and buds of forbs and shrubs (Bowyer and Leslie 1992; Government of Yukon 2010b).

In summer (July/August), Dall's sheep can be found in alpine meadows where there is suitable forage and steep terrain for predator avoidance (Government of Yukon 2000). In fall (August/September), they move to winter ranges on wind-swept, south-facing alpine or subalpine slopes where snow is shallow and strong winds improve access to forage (Bowyer and Leslie 1992; Government of Yukon 2000, 2010b; Festa-Bianchet 2008). Winter ranges consist of scree slopes and broken cliffs located near prime lambing grounds, providing security from predators when the spring lambing season approaches (May/June; Valdez and Krausman 1999). A late-winter habitat selection model for sheep in the Dawson region found that areas with high elevation, high convexity, high ruggedness, and a southerly aspect were selected by sheep, while areas distant from escape terrain with northerly aspects were avoided (Barker 2012).

Mineral licks also provide important habitat, because they provide a source of mineral uptake and balance for sheep. Dall's sheep diet typically consists of grasses (and grass-like species; 46.3%), forbs (36.8%), browse (16.1%), and lichens and mosses (0.8%; Bowyer and Leslie 1992).

Few sheep-specific surveys have been conducted in or near RSA (Table 5.1); however, due to the traditional use of seasonal ranges by sheep, the existing historical information provides valuable data that are still relevant today.

Table 5.1 History of Dall's sheep surveys, including incidental sightings in or near the RSA from 1974–2013.

Year of survey	Type of survey	Location
1974	Population census	Dawson Range
1986	Population census	Dawson Range/Casino Trail area
2011	Moose late-winter distribution	Carmacks West Moose Management Unit
2012	KCH re-sight survey	Klaza caribou herd range
2013	Late-winter	Dawson Range

The first survey to identify Dall's sheep wintering areas within the Dawson Range was in 1974, as part of a survey covering the greater area of GMZ 5 (Hoefs and Lortie 1975). In June and July 1986, the Government of Yukon conducted the first sheep surveys in the Casino area, focusing on the Freegold Road extension and in search of key habitat features (i.e., winter ranges; Jingfors 1989). Wintering areas in the Dawson Range were determined from direct observations and sporadic indirect sign (e.g., tracks, pellets, mineral licks). These surveys resulted in the definition of two separate "western" and "eastern" populations in the Dawson Range. The western population was located on a low mountain range between the Klotassin and Nisling Rivers, and was believed to be *"…far removed from any influence of the Casino Trail"* (Jingfors 1989). The eastern population was found primarily on the mountains facing Klaza Creek, which are connected by alpine habitat to Apex, Prospector, and Klaza Mountains — areas that were believed to be used on a seasonal basis (Jingfors 1989). Winter range and suspected lambing areas for the eastern population were also located on the Klaza River — the same area that sheep were located in the 1974 survey (Hoefs and Lortie 1975; Jingfors 1989). In late-winter 2013, a sheep survey conducted by the Government of Yukon in the Dawson Range found sheep winter range on Mount Langham, Apex Mountain, and near Klaza Mountain (O'Donoghue, pers. comm. 2013), suggesting that sheep distribution in the Casino area has likely experienced little change since the mid-1970s.

Sheep are believed to be common in the RSA and are typically associated with alpine habitats. During aerial ungulate surveys in 2011 and the Klaza caribou herd re-sight surveys in 2012, Dall's sheep were observed on Mount Langham (five groups ranging from 2 to 12 individuals), Prospector Mountain (one group of 11; Photo 3), and near Klaza Mountain (one group of 5; Figure 5.1). This is consistent with historical observations and Wildlife Key Areas (Figure 5.1) for sheep in the area and demonstrates the importance of traditional seasonal habitats.

Photo 3. A group of 11 Dall's sheep observed on Prospector Mountain in October 2012.

In the Yukon, population estimates of all thinhorn sheep subspecies were made in 1974 and 1983, and totaled about 22,000 sheep in both years (Hoefs and Barichello 1985). Of this, 19,000 were Dall's sheep and 3,000 were Stone's sheep. This estimate is believed to have remained relatively stable through the 1970s and 1980s, based on repeated surveys of certain populations. The current population estimates for Dall's sheep in the Yukon is 20,000 (Government of Yukon 2013b), with the population listed as Secure (CESCC 2011).

Dall's sheep are considered a valued sport-hunting resource in the Yukon. Hunters usually target old, large trophy rams. Historically, there were few harvest reports of Dall's sheep in the Dawson Range and harvest since 1979 has been limited to GMSs 523, 524, and 526, with the majority of reports coming from guided non-resident hunts (Table 5.2; Jingfors 1989; Government of Yukon, unpublished data). Sheep hunting remains open across the GMSs overlapping with the RSA; however, harvest in the last ten years has been limited to GMS 523 only (Table 5.2). Licensed hunters are restricted to one full curl ram per year. First Nation harvest statistics are unknown.

Table 5.2 Summary of the latest ten years (2002–2012) of sheep harvest data in GMSs associated with the Project.

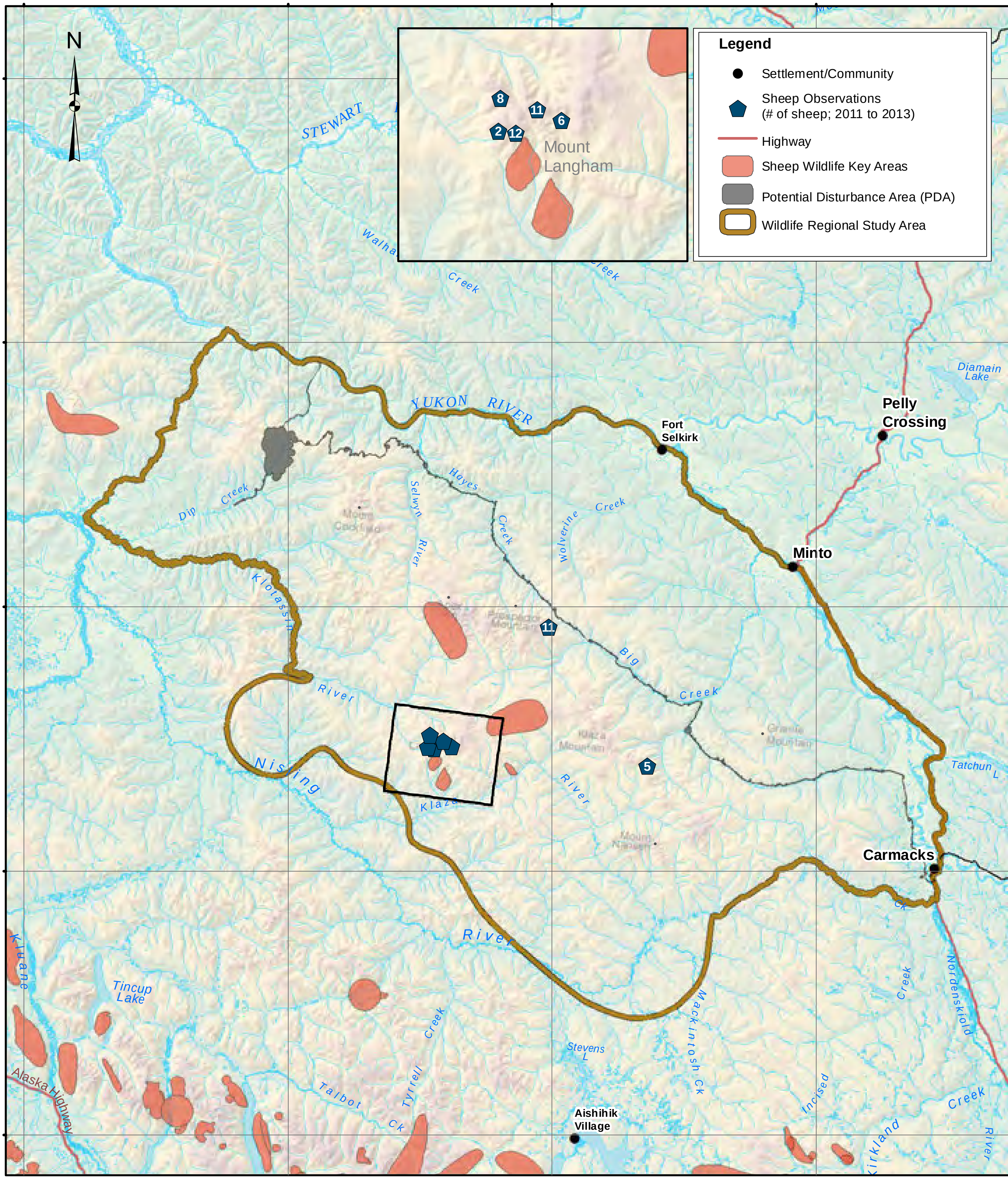
GMS	Harvest regulations (2013–2014 season)	Total harvest		Mean yearly harvest	
		Resident	Non-resident	Resident	Non-resident
509	Open; Bag limit 1	0	0	0	0
510	Open; Bag limit 1	0	0	0	0
511	Open; Bag limit 1	0	0	0	0
522	Open; Bag limit 1	0	0	0	0
523	Open; Bag limit 1	1	6	0.1	0.6
524	Open; Bag limit 1	0	0	0	0
526	Open; Bag limit 1	0	0	0	0
TOTAL		**1**	**6**	**0.1**	**0.6**

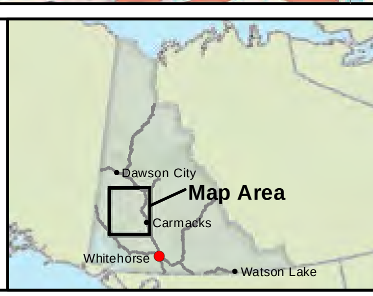
Note: Government of Yukon data, unpublished

Wolves, coyotes, golden eagles, wolverine, lynx, and grizzly bear are known predators of Dall's sheep (Hoefs and Cowan 1980; Stephenson et al. 1991; Arthur 2003); however, sheep are believed to be a minor part of most predators' diets. Wolves may limit populations when alternative prey is not available; however, in the Yukon, Dall's sheep populations are not known to be strongly influenced by wolf predation (Barichello et al. 1989b; Hayes et al. 2003).

Severe winter conditions (e.g., deep snow, icing events), high population density, low-quality forage, disease and over hunting have the potential to influence the productivity and/or carry capacity of sheep populations (Geist 1971; Bower and Leslie 1992; Government of Yukon 1996). Pregnant ewes typically experience a negative energy balance during the winter from high energy expenditures and/or low quality forage, potentially resulting in miscarriage if too much weight is lost (Geist 1971; Hoefs and Barichello 1985). Likewise, severe weather and poor forage quality during spring lambing can increase lamb mortality. The number of lambs entering the population is believed to be the driving force in sheep population dynamics, rather than the number of animals leaving the population through predation or hunting.

There are a number of diseases that are known to occur in sheep populations (Bower and Leslie 1992; Hoefs and Bunch 2001). High rates of a mandibular disease, known as lumpy jaw, have been found in Dall's sheep populations in the Yukon, with southern populations having a higher frequency and severity of infection than northern populations (Barichello et al. 1989c; Hoefs and Bunch 2001). Lumpy jaw disease may lower life expectancy of adult rams from the abnormal wearing of the teeth, loss of teeth, infection by oral bacteria, and subsequent impaired nutrient uptake; however, there is no evidence that it increases mortality (Barichello et al. 1989c).





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Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. Sept., 2013.

Wildlife key areas provided by YT - Environment (2012).

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Dall's sheep wildlife key areas and observations

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kilometres

Map scale 1:900,000 (printed at 8.5x11)
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6 WOOD BISON

Historically, the distribution of wood bison covered northeastern BC, northern Alberta, northwestern Saskatchewan, Yukon, southwestern Northwest Territories, and much of Alaska (Carbyn and Trottier 1988; Gates et al. 2001), with an estimated 168,000 animals in the early 1800s (Government of Yukon 2012). Due to heavy human exploitation, wood bison declined dramatically to a few hundred animals by the late 19th century, leading to extirpation in the Yukon in the early 20th century. In 1978 wood bison became a Species at Risk in Canada and were designated by COSEWIC as Endangered, leading to the creation of the National Wood Bison Recovery Program and a recovery goal of four free-ranging populations of at least 400 individuals (the number needed to support a minimal viable population; Gates et al. 2001). As part of this fulfillment, 170 bison were introduced to the Yukon between 1986 and 1992 (Gates et al. 2001; Government of Yukon 1998, 2012). These recovery efforts led COSEWIC to upgrade wood bison status to Threatened with legal protection under the federal *SARA*'s Schedule 1 (Government of Canada 2012).

Presently, wood bison inhabit BC, Alberta, Yukon, southwestern Northwest Territories, and Manitoba (Gates et al. 2001). In 2006 the Canadian population was estimated at 3,536 animals with 2,828 free-roaming (comprising six wild herds), 708 in captivity (comprising four captive herds), and with only two wild herds exceeding the minimum viable population threshold of 400 animals (Government of Canada 2012).

Yukon's wood bison were introduced to the Nisling River valley and have now extended their range south into the Aishihik, Sekulmun, and Hutshi Lakes watersheds (Government of Yukon 1998, 2012). Wood bison are not considered a migratory species; however, they do migrate locally between summer and winter ranges (Larter and Gates 1991; Gates et al. 2001; Government of Yukon 2012). The Aishihik herd's early and late-winter range extends north of Aishihik Lake, along the North Klondike Highway, to approximately 30 km south of Carmacks (Figure 6.1; Government of Yukon 2012) with the herd's core range encompassing the area from the Nisling River valley eastward to the North Klondike Highway, lying largely south of the RSA.

Wood bison generally prefer open boreal and aspen forests, with a variety of habitat preferences which vary by herd and season (Reynolds et al. 1978; Larter and Gates 1991; Gates et al. 2001; Gardner and DeGange 2003). The diet of wood bison varies by herd, but generally consists of a variety of grasses, sedges, and willow with seasonal variation (Larter and Gates 1991; Reynolds et al. 1978; Gardner and DeGange 2003). In winter, sedges (*Carex* spp.) make up most of the diet, whereas a mix of grasses (e.g., *Calamagrostis* spp.), sedges, and willows (*Salix* spp.) comprises summer diet. For some herds, lichen (e.g., *Cladina mitis*) is the main forage component in the fall (Larter and Gates 1991).

A population census of the Yukon's Aishihik bison herd is typically conducted every two years, with the first survey in 1998 estimating close to 500 animals and the latest survey in 2011 estimating 1,230 animals. Two other transboundary herds occur seasonally in southeastern Yukon, known as the Nahanni and Nordquist herds (Government of Yukon 2012).

Following extirpation and subsequent reintroduction of wood bison into the Yukon, hunting was prohibited to promote population growth. In 1998, the requirement of a minimum viable population of 400 animals was fulfilled, allowing for their addition to the Yukon *Wildlife Act* as a harvestable species. The 2013–2014 hunting season is open to permit (non-lottery) hunting of wood bison across all GMSs, subject to a bag limit of one. Harvest data since 2002 for total and mean yearly bison harvest within the GMSs associated with the Project demonstrates that harvest is quite low and is concentrated primarily in GMS 526 (Table 6.1).

Table 6.1 Summary of the latest ten years (2002–2012) of wood bison harvest data in GMSs associated with the Project.

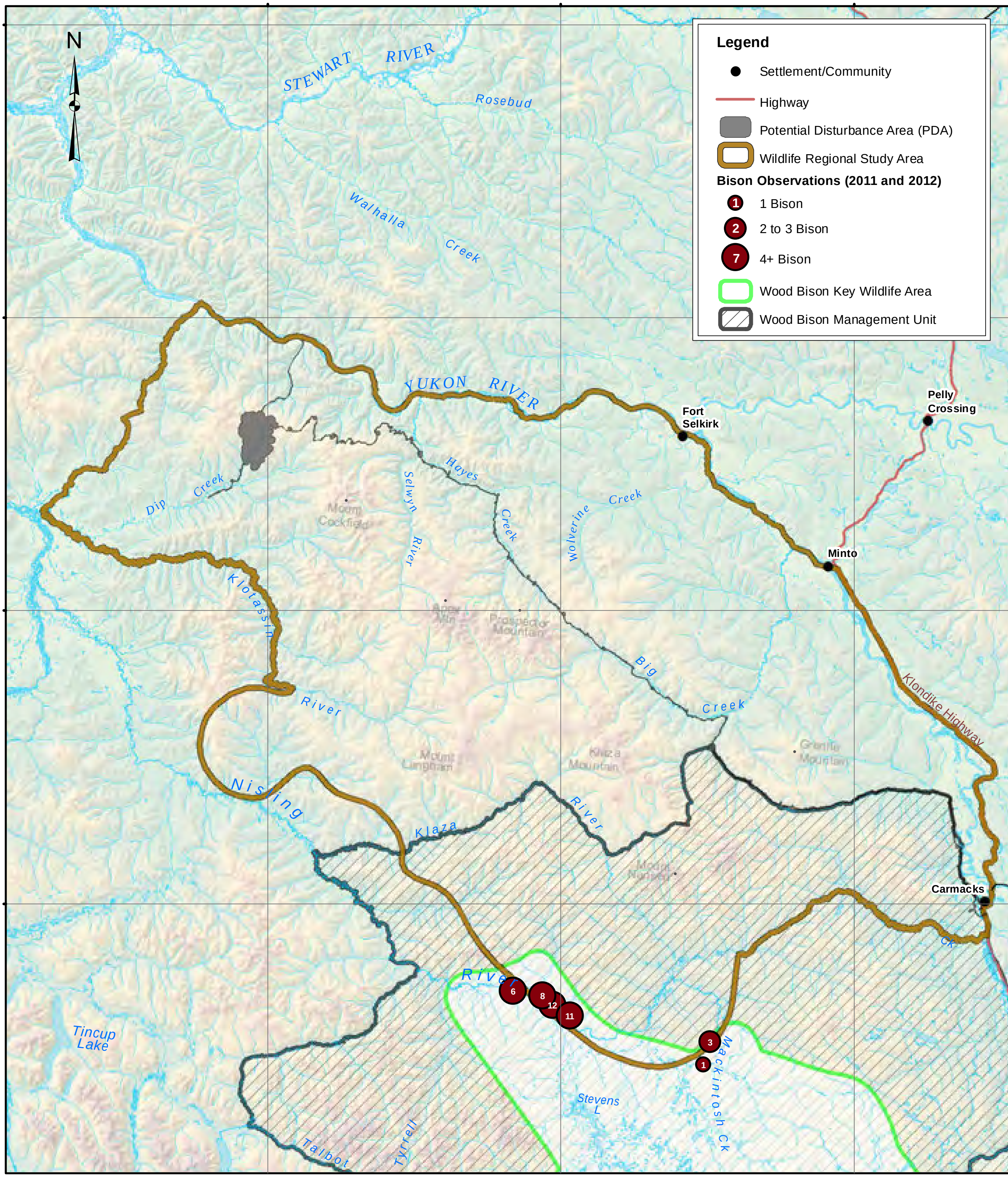
GMS	Harvest regulations (2013–2014 season)	Total harvest	Mean yearly harvest
		Resident	Resident
509	Permit required; Bag limit 1	0	0
510	Permit required; Bag limit 1	0	0
511	Permit required; Bag limit 1	0	0
522	Permit required; Bag limit 1	0	0
523	Permit required; Bag limit 1	1	0.1
524	Permit required; Bag limit 1	0	0
526	Permit required; Bag limit 1	4	0.4
TOTAL		**5**	**0.5**

Note: Government of Yukon data, unpublished

Grizzly bears and wolves are known to prey on wood bison; however, they are not considered the primary prey for either predator (Gardner and DeGange 2003) and in Yukon predation on bison is considered rare (Jung 2011). Wolf and wood bison have a history of predator-prey interactions and in some isolated herds wolves can limit bison populations (Carbyn and Trottier 1988; Gates et al. 2001; Gardner and DeGange 2003). The first record of a wolf-killed Aishihik bison occurred in 2007, with few other accounts after this (Government of Yukon 2011).

Other mortality factors include vehicle collisions (Hayes 1992) and disease. Three diseases are a problem for free-ranging wood bison populations in northern Canada, including tuberculosis (*Mycobacterium bovis*), brucellosis (*Brucella abortus*), and anthrax (caused by the bacterium *Bachillus anthracis*; Gates et al. 2001; Joly and Messier 2004; Government of Canada 2012). The Aishihik herd is considered disease-free and protecting the herd from disease is one of the main management objectives (Government of Yukon 2012).

Wood bison are expected to occur in the southern sections of the RSA only, due to limited suitable habitat. During the 2011 aerial ungulate survey, 18 bison, in two groups, were observed on the south edge of the RSA in their winter range on the edge of their core range. During the 2012 late-winter survey, 23 bison in four groups were observed in the southern section of the study area, located in river valleys or on snow-free south-facing slopes (Figure 6.1).



Notes:

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Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. Sept., 2013.

Wood bison observations collected by EDI and YG, 2011 and 2012.

Wildlife key areas provided by YT - Environment.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Wood bison wildlife key areas and observations of Aishihik herd

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MP/LG	MAS	16/10/2013	6.1

0 5 10 15 20 25 30
kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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7 MULE DEER

Mule deer are distributed throughout most of western North America, naturally occurring in most provinces across Canada (Mule Deer Working Group 2004; Sanchez and Tessaro 2008; CESCC 2011). In the Yukon, mule deer are designated as Sensitive (CESCC 2011), mostly due to the suspected small population size.

Mule deer have been slowly moving north into the territory for the past few decades, with reported sightings dating back to the 1930s (Hoefs 2001). It is believed the Yukon represents the northern extent of their range, with some sightings as far north as Dawson City and the Dempster Highway by the 1980s (Hoefs 2001). White-tailed deer have also been reported in the southern Yukon, but they are considered very rare. They were first observed at Tagish Lake near the British Columbia border in 1975, and as far north as Moose Creek on the North Klondike Highway in 1998 (Hoefs 2001). Mule deer occur in the RSA, likely concentrated in areas providing high quality habitat (e.g. open, south-facing slopes). During a moose survey in 2007, a mule deer and many mule deer tracks were observed on open ridges overlooking the Yukon River near Carmacks (O'Donoghue et al. 2008b) and two mule deer were observed on open ridges overlooking the Yukon River during baseline aerial ungulate surveys in 2011 and 2012.

Mule deer migrate locally within mountainous areas moving seasonally from high elevation summer ranges in alpine and subalpine habitats to low elevation forested winter ranges in valleys (Schoen and Kirchoff 1990; Hayden et al. 2008). They have been known to disperse distances of 100–200 km (Anderson and Wallmo 1984) and occupy areas as little as 30–40 hectares (Chapman and Feldhamer 1982).

Typical mule deer habitat in the Yukon consists of open, grassy areas and south-facing slopes bordered by aspen, where sunlight and high wind help expose forage and promote early green-up (Hoefs 2001; Government of Yukon 2013c). Mule deer can also be found along roadsides and highways feeding on grasses, forbs, foliage, and twigs (Government of Yukon 2013c). Their slender legs are not well suited for efficient travel in deep snow, making south-facing slopes and wind-swept areas prime habitat in the winter (Government of Yukon 2013c).

There is no population estimate of mule deer in the Yukon; however, their abundance is expected to be much lower than neighboring provinces and territories, but increasing. Due to their small population, mule deer harvest is by permit hunt only for all GMSs and is subject to a bag limit of one (Government of Yukon 2013d). There are no records of mule deer being harvested in the RSA. Natural predators of mule deer in the Yukon include bears, wolves, cougars, and coyotes (Government of Yukon 2013c). Other important factors influencing population dynamics includes habitat alterations, human-use patterns, forage availability and quality, weather, and disease. In northern climates, mule deer can be limited by cold and deep snow conditions (Mule Deer Working Group 2004; Sanchez and Tessaro 2008).

8 GRIZZLY BEAR

In the Yukon, there are an estimated 6,000 to 7,000 grizzly bears (COSEWIC 2012) that range across the territory from the BC border to the Beaufort Sea. Yukon's grizzly bear population represents about 25% of Canada's grizzly bear population (COSEWIC 2012). In Canada, grizzly bears are assessed as Special Concern because of threats from human-caused mortalities, including hunting, poaching, defense of life and/or property, and accidental mortality; incursions into grizzly bear habitat; and habitat loss (COSEWIC 2002). In Yukon, grizzly bears are listed as Sensitive by the Canadian Endangered Species Conservation Council (CESCC 2011).

Grizzly bears are opportunistic omnivores (Ross 2002), primarily feeding on vegetation but opportunistically preying on animals. Their diet and behaviour are dependent on local habitat and are highly variable. In Yukon, grizzly bears are the primary predator of moose calves each spring (Larsen et al. 1989). Other spring vegetation includes roots, the previous year's berries, and other old vegetation. Once new vegetation is available, grizzly bear forage switches primarily to grasses and then berries (Government of Yukon 2010c).

8.1 DISTRIBUTION AND ABUNDANCE

There is limited available information on grizzly bear distribution or abundance in the Project area. Grizzly bear densities for the project area are unknown; however, Markel and Larsen (1989) estimated densities between 10 to 16 bears/1,000 km², based on studies completed in nearby areas. The working estimate for the two ecoregions that overlap the study area is 15 grizzly bears/1,000 km² (Maraj pers. comm.). Grizzly bears are assumed to use the entire RSA as they have been harvested from all GMSs that intersect the Project footprint, with the exception of GMS 510. In the last ten years of available harvest data, a total of 11 bears were taken in GMSs 522–524 and 526 (Table 8.1).

To determine grizzly bear habitat use and distribution within the Project, a grizzly bear study area, herein referred to in Section 8 as the study area, was delineated (Figure 8.1). The study area encompasses all GMSs that overlap with the Project (GMSs 509, 510, 511, 522, 523, 524, and 526; Figure 8.2) and has a total size of 8,921 km². This study area was then used for the grizzly bear habitat modeling. A focal survey area around the proposed Project facilities was delineated for the bear den surveys (Figure 8.1).

During baseline studies conducted between 2010 and 2013, 15 grizzly bears have been observed in the RSA. These observations include one grizzly bear observed during the den surveys, photos of two grizzly bears taken by a game camera near Dip Creek and 12 bears observed as incidental observations during the baseline studies. In addition to the observations during the baseline studies, 25 grizzly bear observations were recorded by Project staff in the Casino wildlife log between August 2008 and August 2013.

Table 8.1 Summary of the latest ten years (2002–2012) of grizzly bear harvest data in GMSs associated with the Project.

GMS	Harvest regulations (2013–2014)	Total harvest		Mean yearly harvest	
		Resident	Non-resident	Resident	Non-resident
509	Open; Bag limit 1 every 3 years	0	0	0	0
510	Open; Bag limit 1 every 3 years	0	0	0	0
511	Open; Bag limit 1 every 3 years	0	0	0	0
522	Open; Bag limit 1 every 3 years	2	0	0.2	0
523	Open; Bag limit 1 every 3 years	1	5	0.1	0.5
524	Open; Bag limit 1 every 3 years	1	0	0.1	0
526	Open; Bag limit 1 every 3 years	2	0	0.2	0
TOTAL		**6**	**5**	**0.6**	**0.5**

Note: Government of Yukon data, unpublished

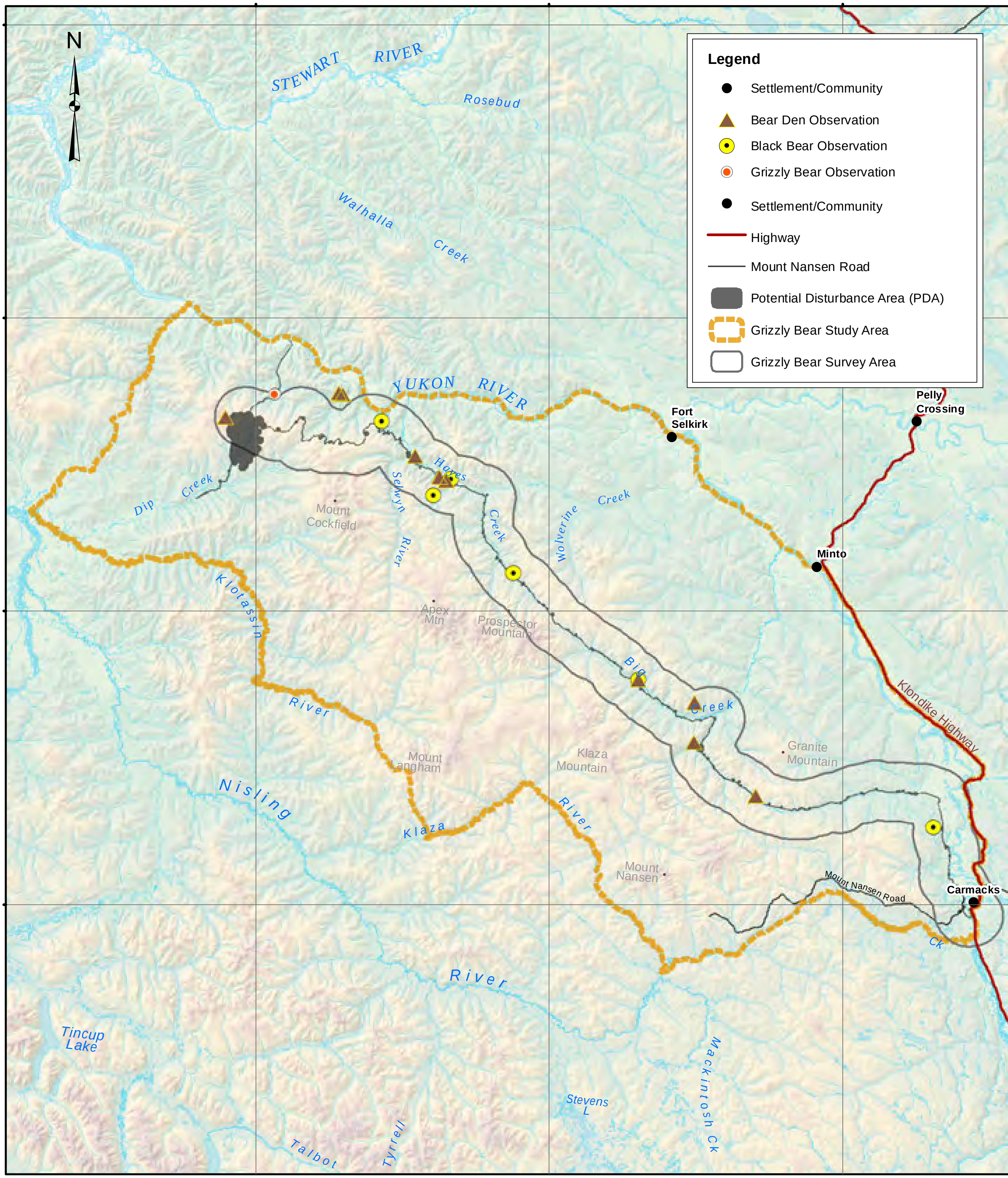
8.2 DEN SURVEYS

Grizzly bear den surveys were conducted during the spring of 2012 to document bear dens within close proximity to the Casino project. Using the denning spatial analysis (see Section 8.3.4), a survey area was defined as a 5 km buffer surrounding the footprint of the proposed Project, including the Freegold Road upgrade and extension (Figure 8.1). This survey area was then divided into 313 blocks, each 6.25 km^2 in size. Each block was then stratified into high, moderate or low probability den habitat by summing the number of 30 m pixels that contained suitable denning habitat (see Section 8.3.4) within each block. The high and low probability blocks were the upper and lower 25% of the blocks, respectively; while the moderate probability habitat was the middle 50% of the blocks.

All blocks classified as high probability denning habitat were surveyed during at least one of the surveys, while other classes were covered as much as flight time allowed. Surveys were conducted by fixed-wing aircraft (Alpine Aviation, Maule M-7), flying as low to the ground as possible. Four surveys were attempted between 20 April and 12 May 2012, but the 2 May survey was cancelled mid-survey due to extreme winds. Total survey time was 12.3 hours. The surveys were scheduled to coincide with the emergence of bears; however, the area receives relatively little snow and an early spring melt resulted in no snow at the time of the first survey. The presence of snow assists in locating active dens.

Nine dens were observed during the three 1-day surveys (Figure 8.1). Dens were primarily observed in higher probability habitat along Hayes Creek and Big Creek. All dens were excavated on relatively steep south facing slope, usually in the middle to upper parts of the slope. One den, observed west of the proposed Casino mine site was excavated under the embankment of an old mining road. Due to the lack of snow, it could not be determined if any of these dens were active during the winter of 2011/2012. No ground-truthing was done as part of this survey.

The survey area is dominated by forested slopes that make spotting dens difficult and the lack of spring snow in the area further reduces the probability of detecting dens. Consequently, observations of dens on open south facing slopes could be because bears use these habitat types, and because these are the only areas where survey crews get a good view of the ground.

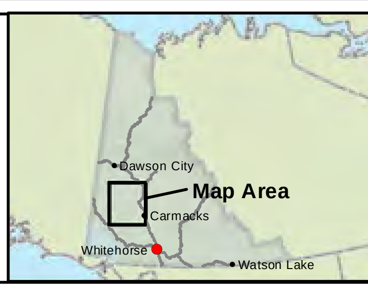


1:250,000 Topographic Spatial Data, National Road Network; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. Sept., 2013.

Bear habitat suitability created by EDI, 2013. Bear and bear den observations collected by EDI, 2012.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Bear den survey area and bear observations

Drawn:	Checked:	Date:	Figure:
MP/LG	LP/MAS	16/10/2013	8.1

0 5 10 15 20 25 30 35 40
kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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8.3 GRIZZLY BEAR HABITAT MODELS

To determine the amount of effective seasonal grizzly bear habitat within the study area, the following models were developed and are summarized in this report:

- Habitat effectiveness model;
- Security areas model;
- Linkage zones model, and
- Denning habitat spatial analysis.

These models are often included as components of a grizzly bear cumulative effects assessment (CEA) and are used as tools to review the potential effects that a project may have on grizzly bears. Although this baseline report does not include an effects assessment, the habitat effectiveness, security areas and linkage zone models and the denning habitat spatial analysis have been used to assess the quality and quantity of grizzly bear habitat currently within the study area.

The CEA for grizzly bear was originally developed by the US Department of Agriculture (USDA 1990). The Geographic Information System (GIS) based methods used in this report are based on the work conducted by Purves and Doering (1998) and by Gibeau et al. (1996).

8.3.1 Habitat Effectiveness Model

The habitat effectiveness (HE) model examines habitat quality and human activities to estimate the overall effectiveness of grizzly bear habitat. This model is used to quantify the area's potential ability to support bears (Gibeau 1998). The inputs for the habitat effectiveness model are habitat type and disturbance. The habitat component (HC) is a qualitative assessment of the spatial and temporal distribution of potential habitat (PH) for grizzly bear foraging. The disturbance component (DC) is a quantitative assessment of human disturbance.

Habitat Component (HC) — Vegetation and land cover data for the study area were limited. EOSD data were available for portions of the study area but there were significant gaps in imagery due to cloud cover. Only broad-level vegetation data were available for the entire study area, so bioclimate zone data prepared by the Ecological and Landscape Classification Technical Working Group (ELC TWG 2012) was used for the habitat component. Bioclimate zones that occur in the study area include: alpine, subalpine, boreal highland and boreal lowland (Table 8.2). Definitions for the bioclimate zones that occur in the project area are (YECMWG 2003 and EBA 2003):

- **Alpine** — High elevations associated with mountainous conditions throughout Yukon. Dwarf shrubs, herb/cryptograms and low-growing and scattered krummholtz trees are the predominant vegetation condition. In very high elevation areas, bare rock, colluvium or ice/snow may be the dominant conditions.

- **Subalpine** — Sparsely forested areas at moderate to higher elevations on steep slopes above the boreal high. Subalpine areas form a transitional zone between forested boreal and the higher elevation non-forested, alpine bioclimate zones. Open canopy conifer forests (tree cover <20%) and tall shrub communities are characteristic vegetation conditions. Subalpine fir is the predominant tree species. Winters are long and cold, while summers are short, cool and moist.
- **Boreal High** — Middle to upper elevations of forested areas in all mountain valley and plateau ecoregions of southern and central Yukon. Found above the boreal low in large valleys. Characterized by steep slopes in southern mountainous ecoregions and gentle rolling plateaus in the central ecoregions. Summers are brief, cool and moist, with long cold winters. Forests are dominated by white spruce, lodgepole pine, and subalpine fir.
- **Boreal Low** — Continuously forested areas at low to middle elevations, below the boreal high of all mountain valley and plateau ecoregions of southern and central Yukon. Landscapes are generally wide valleys. Winters are long and cold, with short, cool and dry summers. Forests are generally mixedwood (lodgepole pine, white spruce and aspen) with moderately[2] developed understories. Wetlands are common.

The study area was divided into twelve bear management units (BMUs; Figure 8.2). Where possible, BMUs included entire drainage basins and their subordinate drainages, extending from the hydrological divide down to the valley bottom. The size of each BMU is based on the average home range size for a female grizzly bear. In the Kluane Region, Maraj (2007) noted that the weighted average multi-annual female home range size was 305 km². In the Mackenzie Mountains, the average home range size of six adult females was estimated to be 265 km² (Miller et al. 1982). The BMUs for this study range in size from 301 km² to 698 km².

Ecological Land Classification (ELC) mapping was completed during the vegetation baseline studies for the vegetation LSA. Bear foraging habitat within each bioclimate zone was inferred from the vegetation communities identified by the ELC mapping (Table 8.2). To reflect the spatial and temporal importance of food, a value between 0 and 1 was assigned for each bioclimate zone within each BMU, by season. A rating of 0 was used for bioclimate zones with no value to grizzly bears and a rating of 1 was used for the areas with the best possible habitat available.

Three seasons were used in this analysis: spring (late March through May), summer (June to mid-August) and fall (mid-August through October). The habitat ratings are summarized in Table 8.3. Habitat use during the winter/denning period (November to mid-March) was evaluated separately in the Denning Spatial Analysis (Section 8.3.4). The output from this analysis is the habitat rating component for the habitat effectiveness model (Purves and Doering 1998).

[2] Some publications consider the understory of boreal low to be "well" developed. This is a relative term that will become more explicit as Yukon vegetation classification is established.

Table 8.2 Bioclimatic zones and vegetation communities and their importance to grizzly bear

Bioclimate zone	Vegetation communities	Importance to grizzly bear
Alpine	Tors; Dryas-Sparse Herb; Felsenmeer	Provides suitable habitat for denning. Includes forage species such as mountain cranberry, crowberry, *Hedysarum*, sedges and grasses; Provides habitat for prey, including thinhorn sheep, woodland caribou, marmots and ground squirrels; Carcasses from winter kills
Subalpine	Mid to High Elevation Dry Shrub; Subalpine Moist Shrub; Tall Shrub; Mid to High Elevation Wet Shrub	Provides suitable habitat for denning. Includes forage species such as mountain cranberry, bog blueberry, common bearberry, *Hedysarum*, sedges and grasses. Provides habitat for prey, particularly calves of woodland caribou and moose; marmots; and ground squirrels. Carcasses from winter kills
Boreal High	Sloping Grassland; Dry Broadleaf Forest; Moist Broadleaf Forest; Coniferous Forest; Mixedwood Forest; Sparse Coniferous Forest; Riparian Shrub; Riparian Broadleaf; Riparian Coniferous; Coniferous Treed Bog; Shrubby Fen	Provides security habitat. Includes forage species such as rosehips, mountain cranberry, low bush cranberry, currants, grasses, sedges, horsetails. Provides habitat for prey species such as moose and caribou calves
Boreal Low	Riparian Shrub; Riparian Broadleaf; Riparian Coniferous; Coniferous Treed Bog; Shrubby Fen	Provides security habitat. Includes forage species such as rosehips, mountain cranberry, low bush cranberry, grasses, sedges, horsetails. Provides habitat for prey species such as moose and caribou calves

Table 8.3 Grizzly bear habitat ratings for each bioclimate zone by season

Season	Boreal High	Boreal Low	Sub-alpine	Alpine	Notes
Spring	1.0	1.0	0.5	0	Boreal high and boreal low spring/early summer, over-wintered berries, sedges, roots; riparian areas important. Little habitat available in alpine until snow melts (except winter kills).
Summer	1.0	1.0	1.0	1.0	Alpine and subalpine important; berries available in all bioclimate zones; spawning salmon in boreal high and low.
Fall	1.0	1.0	0.5	0.5	During the early fall, subalpine and alpine used; berries important.

Disturbance Component (DC) — The disturbance component of the habitat effectiveness model is based on human activity. Each activity is assigned a disturbance coefficient (DC) and zone of influence. DCs range from 0 to 1; a DC of 0 implies total displacement and a DC of 1 implies no displacement (Purves and Doering 1998).

Areas of disturbance were identified using various sources, including YESAB's online registry (2013) and Google Earth with imagery collected by Landsat (4/9/2013). Larger known projects in the area that are assumed to cause >100 disturbance events per month, including the existing Casino exploration work, were delineated using the Landsat imagery. A disturbance coefficient of 0.16 and 800 m zone of influence was assigned to each disturbance used in this analysis, including access roads, infrastructure, etc. (Purves and Doering 1998).

The cumulative DC for each BMU is the sum of each individual disturbance within that BMU. The potential habitat (PH) value is combined with the cumulative disturbance coefficient to calculate the realized habitat (RH). The RH measures the ability of grizzly bears to continue using the habitat when human disturbance is considered. A BMU with a RH rating of 0 is interpreted as having no value to grizzly bears, while a RH rating of 1 is interpreted as having high value to bears.

***Habitat Effectiveness (HE)* —** Habitat effectiveness assesses an area's actual ability to support grizzly bears and it compares the potential habitat with the realized habitat, once disturbance has been accounted for (Gibeau 1998). The analysis of the habitat and disturbance components provides HE values for each BMU that represent the percentage of potential habitat available for that season. The habitat effectiveness value calculated for each BMU is the percentage of the habitat available once an account was made for human disturbance.

***Assumptions* —** The modeling for all components was conducted using available data sets. Limitations of the data were identified and assumptions were required to complete the modeling, which include:

- Due to the lack of detailed site-specific habitat and vegetation data, TEM mapping data from the mine site collected in 2010 was used as a surrogate for vegetation communities within each bioclimate zone.
- Detailed disturbance mapping was not available for the study area; however, existing data was mapped using the Landsat imagery; assumptions were made about the type and amount of disturbance.
- Assumptions, such as frequency of use and zone of influence, were made on the effects of human use intensity and linear feature buffers on habitat use by grizzly bear.
- No ground truthing was completed as part of this modeling exercise.
- Habitat effectiveness, security areas and linkage zone models cannot predict the future. These models are based on the existing information available at the time of the analysis.
- These models quantify concerns about the viability of grizzly bear populations in the study area, but do not confirm them.
- As with most modeling efforts, it is challenging to simulate the effects of a highly complex environment in which cumulative effects of environmental, social, and individual variations on habitat use are not well understood. Very little grizzly bear information was available for the study area, so other projects in other parts of the Yukon, Alberta, and BC were used as reference for these models.

The habitat component provides a measure of inherent potential or productivity of the landscape for grizzly bears during the spring, summer and fall seasons. The disturbance component then addresses habitat productivity when human influences are considered. The habitat effectiveness value quantifies the extent of the landscape that is available to bears when human influences are considered (Gibeau 1998). Table 8.4 shows the habitat effectiveness values for each BMU.

Table 8.4 Grizzly bear habitat effectiveness for each BMU

BMU	Habitat effectiveness (HE)		
	Spring	Summer	Fall
1	89%	100%	90%
2	92%	100%	92%
3	91%	100%	91%
4	82%	100%	83%
5	53%	100%	58%
6	75%	100%	78%
7	100%	100%	100%
8	92%	100%	92%
9	73%	100%	75%
10	58%	100%	62%
11	60%	99%	65%
12	94%	100%	94%
13	97%	97%	97%
14	51%	100%	58%
15	55%	100%	59%
16	93%	100%	93%
17	75%	99%	76%
18	64%	99%	67%
19	72%	100%	73%
20	92%	100%	92%

8.3.2 Security Areas Model

Secure areas, away from human disturbance, allow bears to remain in areas for longer periods. This is an important factor for minimizing potential human-bear interactions and conflict. The habitat effectiveness model described above does not take habitat security into account. The security areas model identifies areas where a female grizzly bear can forage for 24 to 48 hours without human disturbance (Purves and Doering 1998). Security area models are run in conjunction with HE models because HE models (1) do not address habitat security; and (2) do not address the areas between zones of human influence that are considered to be too small to provide secure habitat for bears (Gibeau et al., 2001). The security model developed for the Casino project uses the methods summarized in Purves and Doering (1998) and Gibeau (2001).

In this model, security areas are defined as:

1. Areas below 2,300 masl and vegetated;
2. Areas greater than 800 m from human activity where activity use is greater than 100 disturbance events per month, and
3. Contiguous areas greater than 9 km².

The following data sets were used in the security areas model:

- **Elevation** — Derived from the National Topographic Series 1:250,000 contour data;
- **Bear Management Units** — Described above;
- **Vegetation cover** — Bioclimate data from the Ecological and Landscape Classification Technical Working Group (2012), and
- **Human activity** — A variety of sources were used to determine anthropogenic activity in the study area. The majority of this activity is from mining exploration and placer mining (YESAB online registry 2013). One quartz mine is currently operating (the Minto Mine; Capstone Mining Corp 2013) and one quartz mine (Mt. Nansen) is currently undergoing remediation and closure work (Assessment and Abandoned Mines 2012). Other activity is likely ongoing in the project area, but specific locations of these sites were not available. It was assumed that other activity, not included in this analysis, occurs less than 100 times per month, and is therefore not considered. Areas with human activity were mapped as existing disturbed areas, such as existing camp locations, roads, and other activity using publically available Landsat imagery.

To calculate the amount of secure habitat within each BMU, and in the overall study area, areas that are <u>not</u> considered to be secure habitat for grizzly bear were removed:

- Areas >2,300 masl;
- Areas within the zone of influence (within 800 m of human activity), and
- Areas smaller than 9 km².

The remaining area is considered to provide secure habitat for grizzly bear. Typically non-vegetated areas, such as rock and ice, are also removed from this analysis; however, these data were not available for the study area. Table 8.5 provides the results of the security areas modeling based on the parameters listed above. Figure 8.3 depicts the four non-security areas in the study area. Within the entire study area, 8,566 km² (96%) is considered to be secure and 355 km² (4%) is considered to be not secure either from human activity or size (i.e., the patch is <9 km²).

Table 8.5 Grizzly bear security ratings for each BMU

BMU	Total area (km²)	Secure habitat	
		Area (km²)	% of BMU
1	511.35	477.73	93%
2	698.32	683.43	98%
3	369.43	369.43	100%
4	321.71	321.71	100%
5	395.06	395.06	100%
6	576.59	576.59	100%
7	331.94	326.98	99%
8	579.21	573.37	99%
9	346.42	346.42	100%
10	369.65	369.65	100%
11	709.04	694.60	98%
12	585.21	583.56	100%
13	348.93	296.11	85%
14	376.95	376.95	100%
15	302.87	302.87	100%
16	531.56	445.99	84%
17	523.62	476.11	91%
18	301.76	280.09	93%
19	384.97	311.00	81%
20	356.46	309.76	87%
Total	8921.07	8517.43	95%

8.3.3 Linkage Zone Prediction Model

Linkage zones are areas that provide foraging habitat, connectivity between home ranges and avenues of dispersal (Riddell 2005). Linkage zones are also important for maintaining genetic diversity (Ruediger 2000). Maintaining linkage zones is especially important in heavily fragmented landscapes (Riddell 2005). The Linkage Zone Prediction Model assesses a combination of landscape factors that affect wildlife movement through areas impacted by human activity (Purves and Doering 1998). It also identifies potential movement corridors in areas within intense human activity that still support high quality grizzly bear habitat. The output of this model is a scored map identifying four danger levels from human disturbance: minimal danger, low danger, moderate danger and high danger. Areas with a low danger rating represent potential linkage zones.

For the linkage zone prediction model, methods were based on Purves and Doering (1998). Their method used four inputs: access route density; intensity to developed sites; presence or lack of hiding cover; and proximity to riparian areas. The model developed by Purves and Doering (1998) assesses grizzly bear habitat in areas with intense human activity. With less than 4% of the area disturbed, the study area is considered to have minimal intense human activity. The latter two variables (presence or lack of hiding cover and proximity to riparian areas) were removed since grizzly bears can and will travel through areas that lack cover and are outside the riparian zone when they are not influenced by human disturbance. However, it is recognized that cover and riparian areas are extremely important for linkage zones in fragmented landscapes.

Access Route Density — Two sources of data were used to depict access features: National Road Layer (NRL) v.9.0 and Google Earth imagery. Features not part of the NRL layer, such as major access routes to mines (placer and quartz), were digitized using Google Earth. Features were merged into one file and converted to a raster file using ArcGIS Conversion tool; Polyline to Raster.

The Polyline to Raster conversion resulted in a raster file made up of 10 m x 10 m pixels following the access routes within the study area. Once the raster was created, spatial analysis was performed to obtain a density of access in units of km/km² using ArcGIS Spatial Analyst Tool: Focal Statistics. The neighborhood was set to *circular* with a radius of 564 which represents the radius (in metres) of 1 km². The lengths of the access within each cell were summed to get a total density. Finally, the final step to creating the access route density layer involved a reclassification of the densities into four classes:

- 0 km/km² Class 2
- 0 – 0.625 km/km² Class 3
- 0.625 – 1.250 km/km² Class 4
- >1.250 km/km² Class 5

Intensity of Developed Human Sites — Existing human disturbance (i.e., active mine sites, mining exploration, access roads) was represented by points and was obtained from various sources (YESAB 2012; YG Geomatics Yukon 2013). Points that were considered to have use-levels of <100 disturbance events per month or less were buffered by 120 m. For activities that are considered to have >100 disturbances per month, such as Fort Selkirk and the Minto, Carmacks Copper, and Mount Nansen mine sites, the areal extents were digitized and then a 240 m buffer was applied. These areas were considered high use-level sites. Digitizing the perimeter of these locations was completed in Google Earth.

All buffered features were merged into one file. The Euclidian distance tool was applied to the buffered feature dataset. The resulting raster file contained distances from each feature. The raster was then reclassified to represent a danger classification as follows:

- Within Influence Zone Class 6
- Within 100 m of Influence Zone Class 5
- Within 100 – 200 m of Influence Zone Class 4
- Beyond 200 m of Influence Zone Class 2

The sum of the two layers used in this analysis (access route density and intensity of developed human sites) provides a single combined danger score ranging from 4 to 11. High danger scores (i.e., danger score of 10 to 11) were given to areas with high human influence that are of greater danger to grizzly bears. Low danger scores (4–5) were given to areas with little to no human disturbance. The linkage zone model identified four danger score categories: minimal danger, low danger, moderate danger, and high danger. Table 8.6 provides the linkage zone results for each BMU. Linkage zones are shown in Figure 8.4.

Table 8.6 Grizzly bear habitat linkage zone model results by BMU

BMU#	BMU size (km²)	Danger categories: Minimal		Low		Moderate		High	
		Area (km²)	% of BMU	Area (km²)	% of BMU	Area (km²)	% of BMU	Area (km²)	% of BMU
1	511.35	491.45	96	18.69	4	0.99	0	0.22	0
2	698.32	688.98	99	4.12	1	2.30	0	2.92	0
3	369.43	369.43	100	0.00	0	0.00	0	0.00	0
4	321.71	321.70	100	0.00	0	0.00	0	0.00	0
5	395.06	395.06	100	0.00	0	0.00	0	0.00	0
6	576.59	576.59	100	0.00	0	0.00	0	0.00	0
7	331.94	328.99	99	1.11	0	1.84	1	0.00	0
8	579.21	576.25	99	1.53	0	1.44	0	0.00	0
9	346.42	346.43	100	0.00	0	0.00	0	0.00	0
10	369.65	369.65	100	0.00	0	0.00	0	0.00	0
11	709.04	702.40	99	5.99	1	0.56	0	0.09	0
12	585.21	584.76	100	0.35	0	0.10	0	0.00	0
13	348.93	312.75	90	20.18	6	12.54	4	3.46	1.0
14	376.95	376.95	100	0.00	0	0.00	0	0.00	0
15	302.87	302.87	100	0.00	0	0.00	0	0.00	0
16	531.56	482.04	91	46.10	9	2.55	0	0.86	0
17	523.62	497.40	95	25.54	5	0.53	0	0.15	0
18	301.76	289.07	96	6.43	2	2.43	1	3.84	1
19	384.97	342.79	89	42.18	11	0.00	0	0.00	0
20	356.46	329.78	93	26.68	7	0.00	0	0.00	0
Total	8921.07	8714.58	98	176.09	2	21.99	0	8.41	0

8.3.4 Denning Spatial Analysis

Bears require dens, and consequently suitable denning habitat, to survive winters. Grizzly bear denning habitat is generally located in alpine and sub-alpine habitats. Bears typically select denning locations with deeper soils and vegetation that keeps den roofs from caving in. Denning habitats tend to be 20-40° slopes, and are most likely to be found on south facing slopes (Pearson 1975). Permafrost and increased soil moisture reduces suitability of potential den sites.

The objective of the denning spatial analysis was twofold:

1. To increase efficiency of the denning survey and increase probability of locating dens; and

2. To determine the amount of suitable denning habitat available in the study area.

Denning habitat was identified using GIS and available spatial data for the entire grizzly bear study area. Landscape and vegetation characteristics were used to determine suitable denning habitat within the study area. Criteria used to determine suitable denning habitat were based on the experience and professional opinion of Government of Yukon biologists who conducted similar surveys in other areas of the Yukon (Maraj pers. comm.). These criteria included:

- 20–45 degree slopes;
- 600 to 1,200 m elevation, and
- Exclude wet habitat types.

Spatial data describing high and low probability denning habitat were generated by applying the criteria above to data generated from a 30 m resolution digital elevation model (DEM) downloaded from Environment Yukon. Potential denning habitat was assigned a score of 1 and the remaining areas were assigned a score of 0. The resulting raster layer identified suitable denning habitat within the study area (Figure 8.5).

The denning spatial analysis identified areas suitable for grizzly bears to den. A total of 1672 km^2, or 23% of the study area was identified as suitable denning habitat for grizzly bears. Table 8.7 summarizes the size of suitable denning habitat within each BMU.

Table 8.7 Grizzly bear denning habitat suitability within the study area

BMU	Suitable denning (km²)	Percent suitable for denning
1	223	44
2	154	22
3	162	44
4	111	34
5	68	17
6	188	33
7	32	10
8	74	13
9	114	33
10	46	12
11	122	17
12	61	10
13	32	9
14	54	14
15	7	2
16	28	5
17	143	27
18	11	4
19	16	4
20	27	7
Total	1672	19

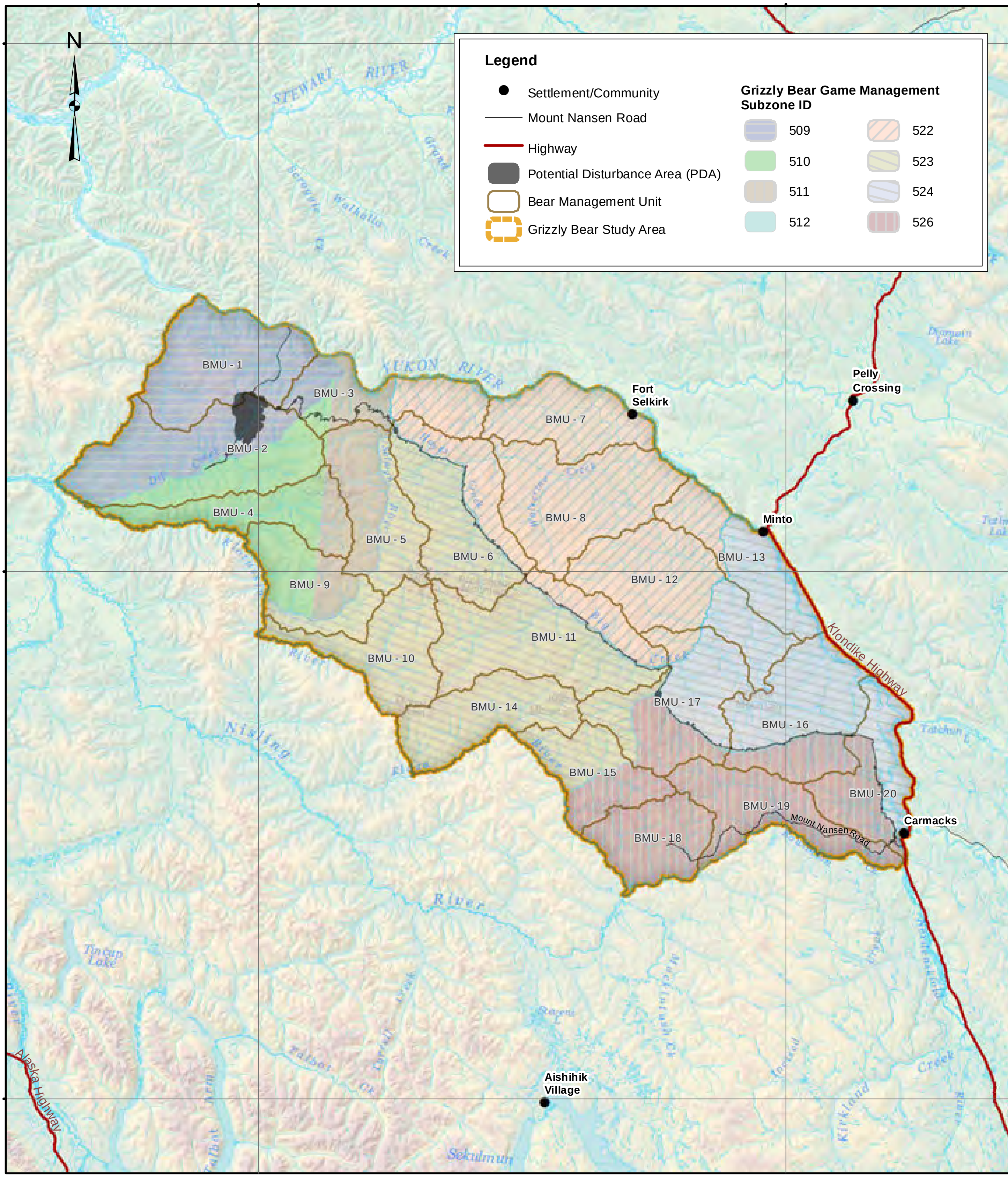
8.3.5 Grizzly Bear Habitat Model Summary

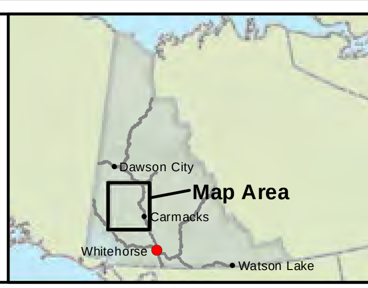
Results of the four models developed for the grizzly bear study area (habitat effectiveness, security areas, linkage zones and denning habitat) were developed to determine existing pressure on grizzly bears. Table 8.8 summarizes the results of the habitat effectiveness, security areas and linkage zone models.

During the summer period, all BMUs have a high percentage (i.e., >97%) of habitat available during the highest period of anticipated disturbance from activity within the study area. It is also important to note that the majority of the BMUs have a high percentage of secure areas and of linkage zones identified as having minimal danger. This indicates that there are currently extensive, safe travel corridors and secure feeding areas throughout the majority of the study area. Some disturbance currently exists, particularly in BMUs 1, 13, and 16 to 20. The majority of this disturbance is from existing access roads and mining, including exploration, operational and historic work.

Table 8.8 Grizzly bear BMU habitat effectiveness, secure areas and linkage zones summaries

BMUs		Habitat effectiveness (% of BMU)			Secure areas		Linkage zones (minimal danger)	
BMU #	Size (km²)	Spring	Summer	Fall	Area (km²)	% of BMU	Area (km²)	% of BMU
1	511	89%	100%	90%	478	93%	491	96%
2	698	92%	100%	92%	683	98%	688	99%
3	369	91%	100%	91%	369	100%	369	100%
4	322	82%	100%	83%	322	100%	322	100%
5	395	53%	100%	58%	395	100%	395	100%
6	577	75%	100%	78%	577	100%	577	100%
7	332	100%	100%	100%	327	99%	329	99%
8	579	92%	100%	92%	573	99%	576	99%
9	346	73%	100%	75%	346	100%	346	100%
10	370	58%	100%	62%	370	100%	370	100%
11	709	60%	99%	65%	695	98%	702	99%
12	585	94%	100%	94%	584	100%	585	100%
13	349	97%	97%	97%	296	85%	313	90%
14	377	51%	100%	58%	377	100%	377	100%
15	303	55%	100%	59%	303	100%	303	100%
16	532	93%	100%	93%	446	84%	482	91%
17	524	75%	99%	76%	476	91%	497	95%
18	302	64%	99%	67%	280	93%	289	96%
19	385	72%	100%	73%	311	81%	343	89%
20	356	92%	100%	92%	310	87%	330	93%
Total	8921.07				8517.43	95%	8714.58	98%





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Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. Sept., 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Grizzly bear management units

Drawn:	Checked:	Date:	Figure:
MP/LG	LP/MAS	16/10/2013	8.2

0 10 20 30 40 50
kilometres

Map scale 1:1,000,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD
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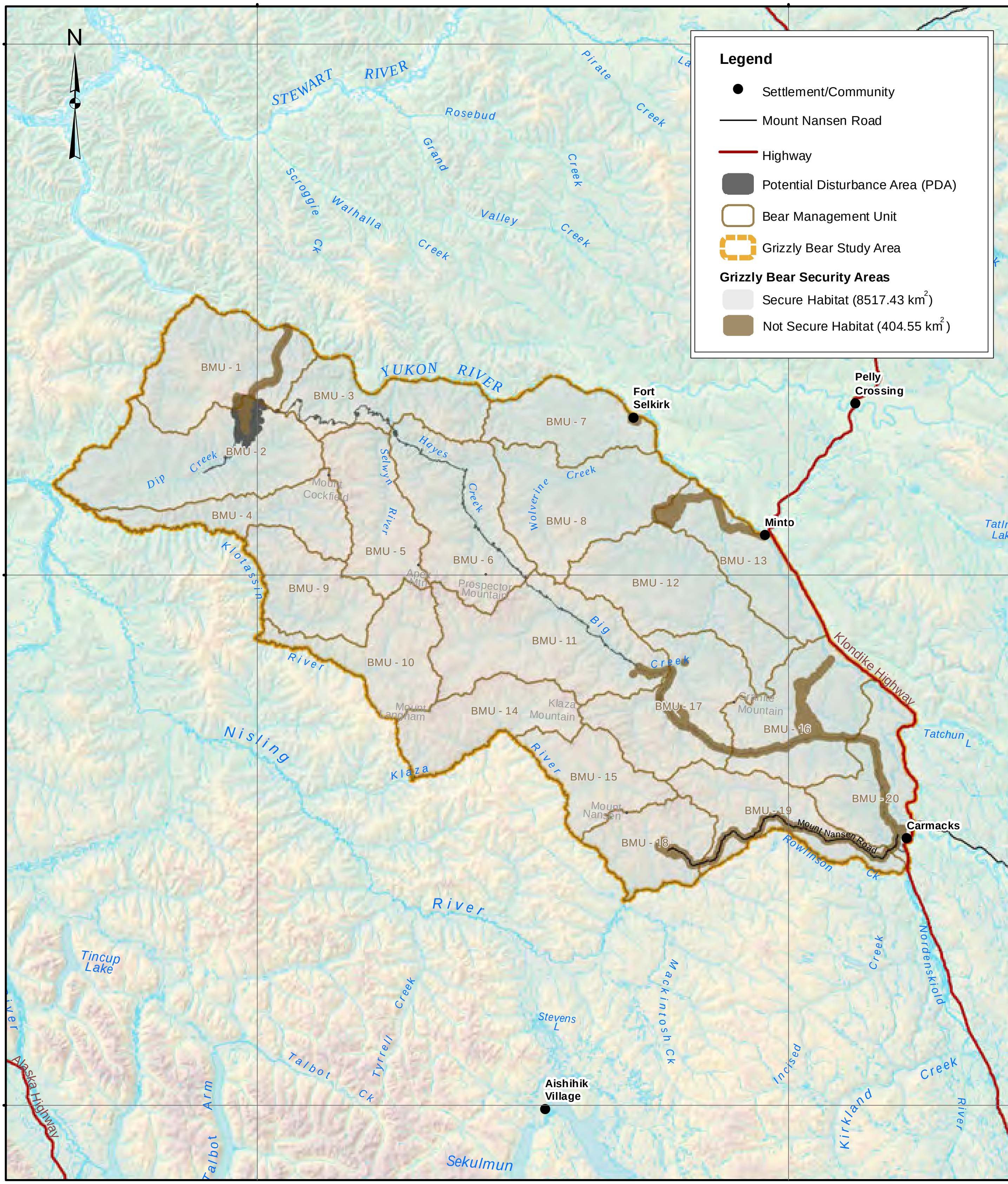

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Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. Sept., 2013.

Grizzly Bear Security Areas created by EDI, 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Grizzly bear security areas

Drawn:	Checked:	Date:	Figure:
MP/LG	LP/MAS	16/10/2013	8.3

0 10 20 30 40 50
kilometres

Map scale 1:1,000,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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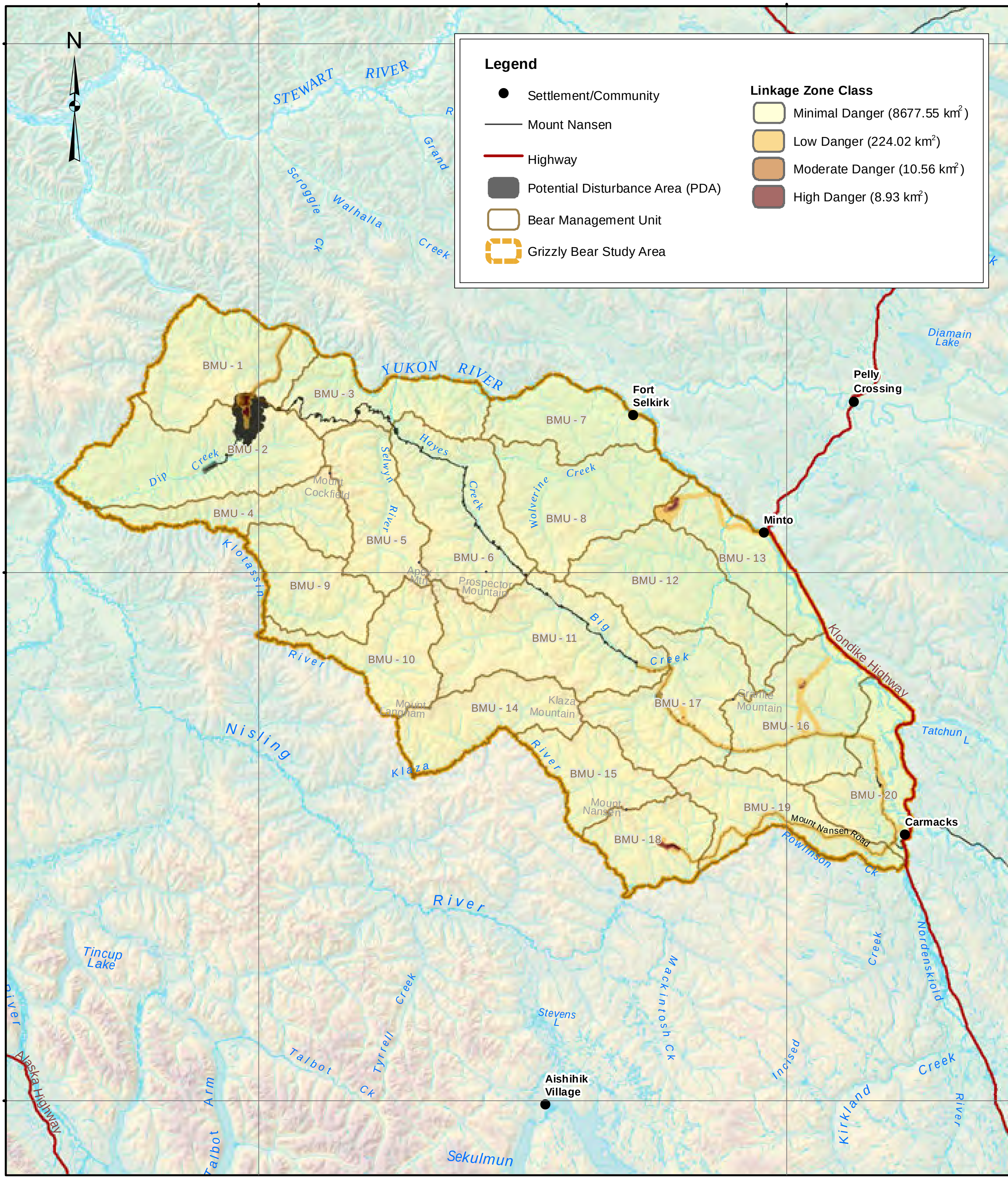

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Grizzly bear linkage zones created by EDI, 2013.

Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. Sept., 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Grizzly bear linkage zones

Drawn:	Checked:	Date:	Figure:
MP/LG	LP/MAS	16/10/2013	8.4

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kilometres

Map scale 1:1,000,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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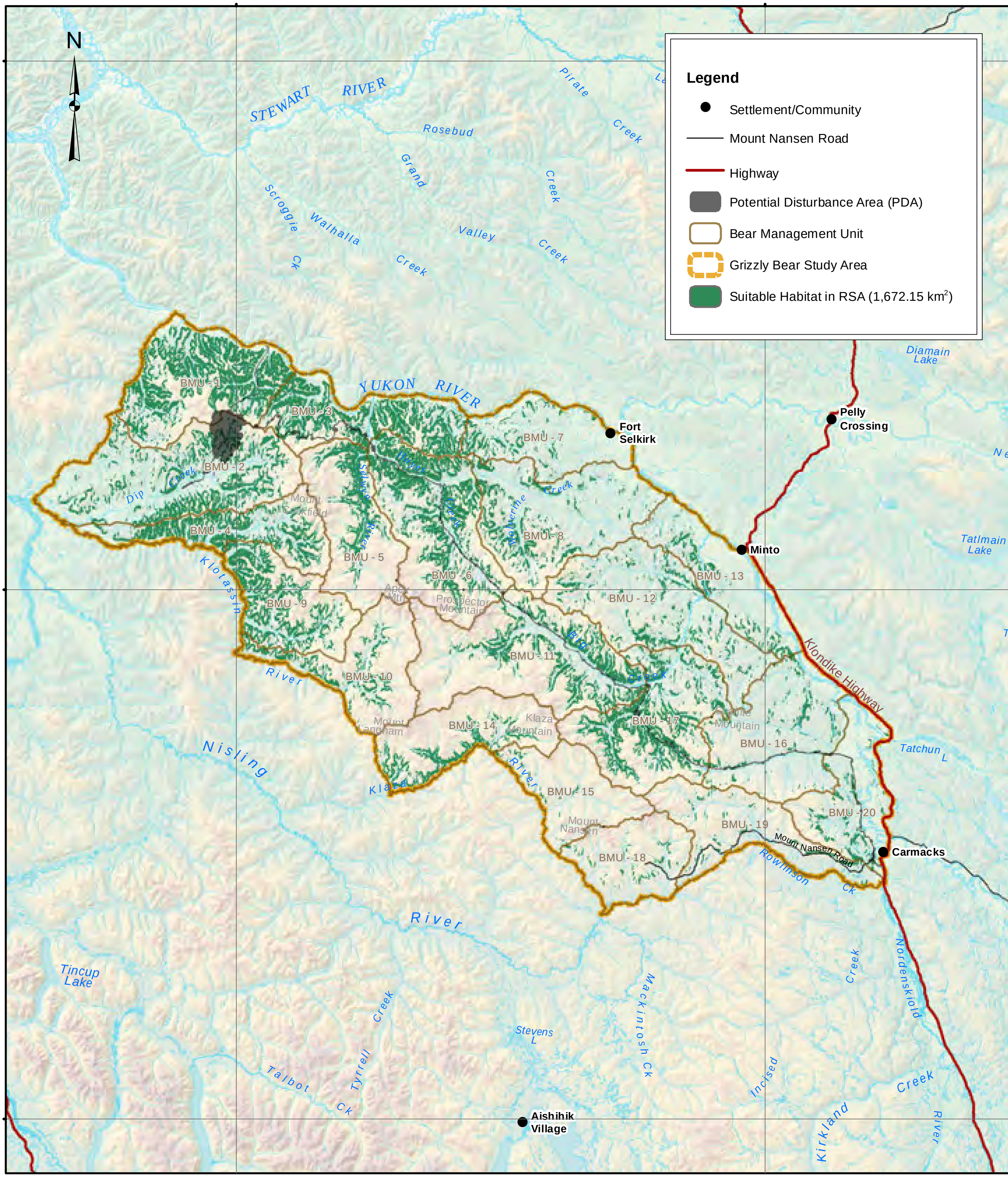

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PDA provided by Knight Piesold Ltd. 2013.

Bear den habitat suitability model produced by EDI, 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Grizzly bear den habitat suitability

Drawn:	Checked:	Date:	Figure:
MP/LG	LP/MAS	16/10/2013	8.5

0 10 20 30 40 50
kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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9 BLACK BEAR

Within the Yukon, the black bear is distributed from the southern border with B.C. to the Old Crow Flats; however, the highest densities are in the southern Yukon (Government of Yukon 2010d). Black bear was assessed by COSEWIC in 1998 and 1999 and was designated as Not at Risk (COSEWIC 2002). Within the Yukon, black bear is considered Secure (CESCC 2011), with an approximate population of 10,000 bears (Government of Yukon 2010d).

Black bears are omnivorous with plants (including berries) comprising up to 95% of their diet (MacHutchon 1989). Black bears typically den in mixed forest stands of aspen and spruce, or mature spruce stands, and excavate beneath the ground or under root masses (Tietje and Ruff 1980). Male bears generally emerge first from their dens, while females with cubs will emerge last and remain near the den for up to three weeks (Tietje and Ruff 1980).

Black bears are managed as a big game species in the Yukon, with all subzones open to spring and fall harvest and a bag limit of two bears per license year. Black bears are actively harvested in the subzones that interact with the Project, with subzones 509, 522, 524, and 526 reporting the greatest harvest (Table 9.1).

Between 2010 and 2013, a total of 13 black bears were observed in the RSA during the baseline programs. Of these, six black bears were observed during the den surveys, one was photographed by a remote wildlife camera and six were observed incidentally during other baseline surveys. A total of 66 black bear observations were recorded between August 2008 and August 2013 in the Casino Project wildlife log.

Table 9.1 Summary of the latest ten years (2002–2012) of black bear harvest data in GMSs associated with the Project.

GMS	Harvest regulations (2013–2014)	Total harvest		Mean yearly harvest	
		Resident	Non-resident	Resident	Non-resident
509	Open; Bag limit 2	2	0	0.2	0
510	Open; Bag limit 2	0	0	0	0
511	Open; Bag limit 2	1	0	0.1	0
522	Open; Bag limit 2	6	1	0.6	0.1
523	Open; Bag limit 2	0	0	0	0
524	Open; Bag limit 2	6	0	0.6	0
526	Open; Bag limit 2	3	0	0.3	0
TOTAL		**18**	**1**	**1.8**	**0.1**

Note: Government of Yukon data, unpublished

10 WOLF

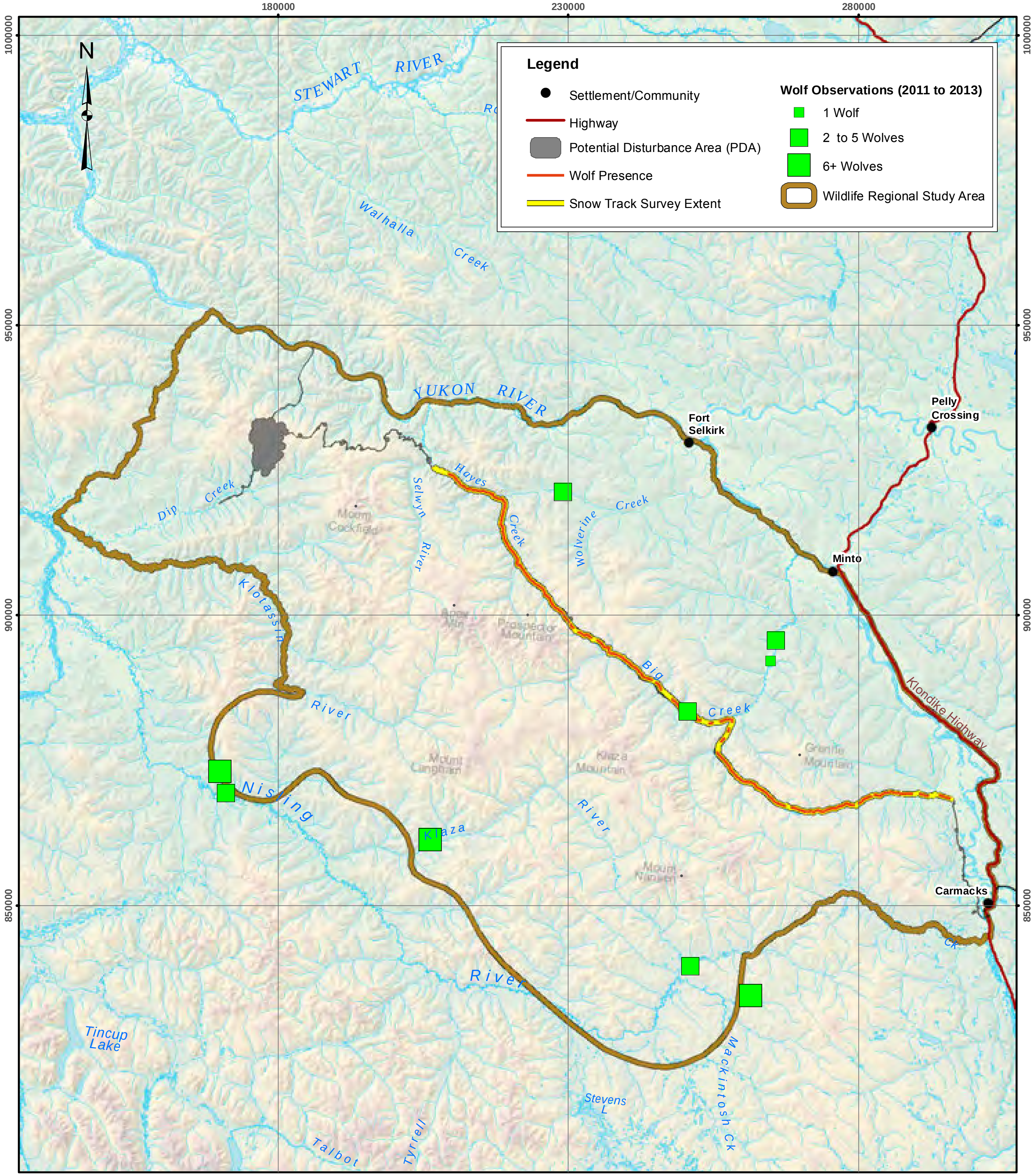
Wolf was once one of the most globally distributed species; however their range is has been considerably reduced (Mech and Boitani 2010). Currently, it is estimated that there are 4,500 to 5,000 grey wolves in Yukon, distributed throughout the territory (Yukon Wolf Conservation and Management Plan Review Committee 2011). Wolf numbers and distribution are largely dependent on the abundance of their primary prey species in the region — moose and caribou. In winter, wolves group together in packs to improve hunting success, and ultimately, winter survival. In summer, wolves are often solitary on the landscape.

A wolf population inventory was conducted in the Nisling River area (just south of the Casino study area) in 1986. The inventory study area included the upper reaches of the Klaza River and was bounded by Klaza Mountain and Rowlinson Creek to the north. Four wolf packs, with an estimated density of 3.2 wolves/1,000 km^2 were found. This was a comparatively low density of wolves, likely resulting from low ungulate densities or unreported harvest (Baer and Hayes 1987).

Currently, wolves are managed as both a big games species and a trapped furbearer in the Yukon, with an average of 60 wolves hunted and 155 wolves trapped each year in the territory (Yukon Wolf Conservation and Management Plan Review Committee 2011). According to trapline data from 1980–2010 (described in Section 11), a total of 38 wolves have been harvested on the ten registered trapline concessions that interact with the Project (Government of Yukon data). Hunting for wolves in the Yukon (all subzones) is open, with a bag limit of seven for residents and two for non-residents. There are no records of wolves being hunted in the GMSs that interact with the Project.

During the 2011 late-winter ungulate survey, 24 wolves were observed in six groups throughout the survey area. In 2012, 32 wolves were observed in three groups throughout the survey area, and no wolves were observed in the reduced 2013 survey area (Figure 10.1). One pack of 13 wolves was observed on a kill near the Klaza River, and another large pack of 16 was observed in the south end of the survey area traveling along a snowmobile track. Wolves were often observed near higher density moose areas and their tracks were noted in valleys or along creeks and rivers. The pack sizes observed are notably larger than mean pack sizes recorded in neighbouring regions (e.g., <4–5.6 wolves/pack in the Aishihik area and 6.1 wolves in the Mayo area; Hayes et al. 2003). This result could be a function of the higher visibility of larger packs; however, it is difficult to interpret these results as the surveys were not targeting wolves and sample sizes were small.

Snow tracking surveys (described in Section 11) detected wolves along the entire length of the surveyed section of the Freegold Road and Casino Road extension (Figure 10.1). It appeared wolves were using the road/trail to travel along, as most tracks followed the road/trail as opposed to crossing it. The Casino camp's wildlife log also recorded 22 wolves in the Project area from 2008 to 2013.



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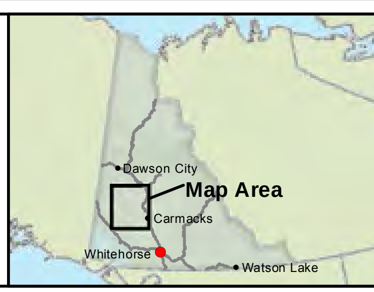
Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

Wolf observations collected by EDI and YG, 2011 to 2013.

2012 – 2013 snow tracking surveys (EDI), 2011 – 2013 aerial surveys (EDI/YG).

Wildlife Key Areas, Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Incidental wolf observations

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0 5 10 15 20 25
kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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11 FURBEARERS

Furbearing species present in the RSA include wolf, wolverine, lynx, marten, coyote, and red fox. Other mammals considered furbearers and which are likely present in the RSA, but are not described further include red squirrel, mink, muskrat, otter, weasel, and beaver. It is unlikely that fisher or Arctic fox occur in the Project RSA.

The Government of Yukon maintains records of mammals harvested from registered traplines. Ten registered trapline concessions (RTCs) intersect with the Project RSA, including RTCs 116, 121, 122, 131, 145, 146, 148, 149, and 150 (Figure 11.1). Harvest statistics for individual RTCs are considered private, thus trapline data provided by the Government of Yukon represents a partial view of total furbearer harvest in the RSA (Table 11.1).

Furbearer data in the Project area are primarily limited to harvest and/or trapline data, with some incidental sightings recorded during baseline or other regional studies. This was identified as an information gap, and late-winter snow tracking surveys were conducted to address it.

Snow tracking surveys were designed to examine the distribution of small mammals and/or furbearers; however, caribou and moose tracks were recorded whenever observed. The proposed Freegold Road upgrade and extension was used as the primary transect for the survey, which was conducted by snowmobile. Tracking surveys were conducted in February and March 2012 and in February 2013. These track surveys covered between km 101 and 133 along the proposed Freegold Road upgrade and extension (Figure 10.1). The road was surveyed in 1 km segments and a tally of the number and type of tracks (i.e., wolverine, marten, hare, etc.) entering or crossing the trail (including suspected re-crossings) was recorded (Thompson et al. 1989). Tracks for small mammals (snowshoe hare, marten, porcupine, and red fox), were counted only when the tracks were fresh (i.e., 1 day since last snowfall), whereas tracks of larger furbearers (wolverine and lynx) were recorded regardless of age. Presence/absence data was recorded for caribou, moose, and wolf.

The entire length of the proposed Casino Road extension was not surveyed each time as it became inaccessible due to open water conditions, overflow, and other terrain constraints. Track observations included those of moose, caribou, wolf, wolverine, lynx, porcupine, otter, marten, snowshoe hare, weasel, and red squirrel.

Table 11.1 Sum of furbearers harvested from 1980 to 2010 on registered trapline concessions 116, 121, 122, 131, and 145–150.

Animal	Total harvest	Mean annual harvest rate
Beaver	334	15.9
Coyote	30	1.4
Red fox	217	10.3
Arctic fox	1	0.05
Lynx	801	38.1
Squirrel	15,981	761.0
Marten	1,538	73.2
Mink	99	4.7
Muskrat	67	3.2
Otter	5	0.2
Weasel	378	18.0
Wolf	38	1.8
Wolverine	133	6.3

11.1 WOLVERINE

Wolverines are solitary carnivores that have a circumpolar distribution from Russia and Scandinavia to Alaska, throughout Canada, and south to California (Abramov et al. 2009). Within Canada, wolverines generally follow the extent of the boreal forest, with lower relative densities in the eastern provinces (COSEWIC 2003). Wolverines occur throughout the Yukon, typically in large areas of intact wilderness including forests, alpine and subalpine areas, and the Arctic tundra.

The western population of wolverine was listed as Special Concern by COSEWIC and SARA in 2003 (COSEWIC 2003) and is considered Sensitive in the Yukon (CESCC 2011). The COSEWIC designation largely reflects concerns regarding increased habitat fragmentation combined with naturally low reproductive rates (COSEWIC 2003).The western population is estimated at approximately 15,000–19,000 animals, with an estimated 3,500– 4,500 within the Yukon (Slough 2007). The Yukon's wolverine population is monitored using fur harvest data, winter track counts, and an annual trapper questionnaire, resulting in population estimates of 5.65/1,000 km² (in variable, unsaturated habitat) and 10.75/1,000 km² (in continuous, saturated habitat; Banci and Harestad 2006).

Primarily a scavenger, wolverine habitat use is less defined by geographic or vegetative features, than the presence and availability of ungulates and/or carrion, such as within undisturbed mountainous areas. Denning habitat is relatively specific, requiring security and thermal cover under boulders, felled trees, or snow tunnels (COSEWIC 2003).

Only one wolverine was observed during baseline studies; it was observed on a kill in the southern section of the study area during the 2012 aerial ungulate survey. Snow tracking surveys detected wolverines sporadically along the proposed Freegold Road extension and upgrade (Figure 11.2). Similar to wolves, wolverine tracks were most often observed following the road/trail as opposed to crossing it. One wolverine was also recorded by Casino staff in their wildlife log (July 2009). Although not one of the most commonly trapped species in the region (Table 11.1), wolverine pelts are the most highly valued of Yukon furbearer species (Government of Yukon, unpublished data).

11.2 LYNX

Lynx are present in forested regions across Canada, some parts of the northern United States, and Alaska (Hatler et al. 2008). In the Yukon, lynx are distributed throughout the territory, but, being primarily a forest species, they are not present on the Arctic coastal plain.

Numbers have declined in parts of its southern range, especially in New Brunswick and Nova Scotia; however, the overall Canadian population is considered Not at Risk by COSEWIC (Poole 2001). In Yukon, lynx are designated as Secure (CESCC 2011). Lynx population density typically follows 8 to 11 year cycles; demonstrating a 1 to 2 year lag following the cyclical abundance of its primary prey — snowshoe hare. Dens are typically constructed under deadfall or blow-down debris, mature or shrub subalpine fir, or willow thickets (Slough 1999).

During snow tracking surveys in 2012 and 2013, lynx tracks were recorded along most of the surveyed area (Figure 11.1). Hare tracks from snow-tracking surveys show that lynx were almost exclusively present where snowshoe hare were present (Figure 11.3). Lynx are also one of the most commonly trapped furbearers in the region (Table 11.1).

11.3 AMERICAN MARTEN

American marten are distributed across Canada and some of the northern United States (Reid and Helgen 2008); however, the subspecies that inhabits Yukon, Northwest Territories, and Alaska is much larger than those found in more southern regions (Government of Yukon 2010e). Marten has not been assessed by COSEWIC or listed under SARA, with the exception of the Newfoundland subspecies *Martes americana atrata,* which was listed as Threatened in 2007 (COSEWIC 2007). In Yukon, marten are considered Secure (CESCC 2011).

Marten are typically found in mature coniferous forests, which provide adequate cover, but they are also found moving through other, more open habitats such as alpine areas or burns (Slough 1989). Their diet consists primarily of microtine species (e.g., voles), but hunt and forage opportunistically, often feeding on berries (e.g., crowberry), birds, and snowshoe hare (Slough et al. 1989; Poole and Graf 1996). Denning habitat is usually an enclosed feature such as a hollow downed tree, tree cavity, burrow, rock pile, or slash/brush pile (Hatler et al. 2008).

Marten are a highly valued furbearer in the Yukon and were the second most commonly trapped furbearer in the Project region (Table 11.1). Marten tracks were consistently observed in multiple habitat types along the Freegold Road and extension during snow tracking surveys in 2012 and 2013 (Figure 11.4).

11.4 COYOTE

Coyotes are continentally distributed across North America, occurring as far south as Central America (Hatler et al. 1998). Coyotes are present in many habitat types including urban settings, and are primarily limited in areas with deep snow and high densities of grey wolves (Hatler et al. 2008). Coyotes have not been assessed by COSEWIC or listed under SARA, and are considered Secure within the Yukon (CESCC 2011).

Coyotes are ubiquitous throughout the landscape, with a preference for open spaces (Hatler et al. 2008). Their diet consists of a variety of small mammals such as voles and hare, but they are also known to eat ungulate calves, birds, plant material, livestock, and garbage (Hatler et al. 2008). Dens are often dug into the sides of hills or banks, or under other covering structures such as caves, tree root hollows, or downed trees (Hatler et al. 2008).

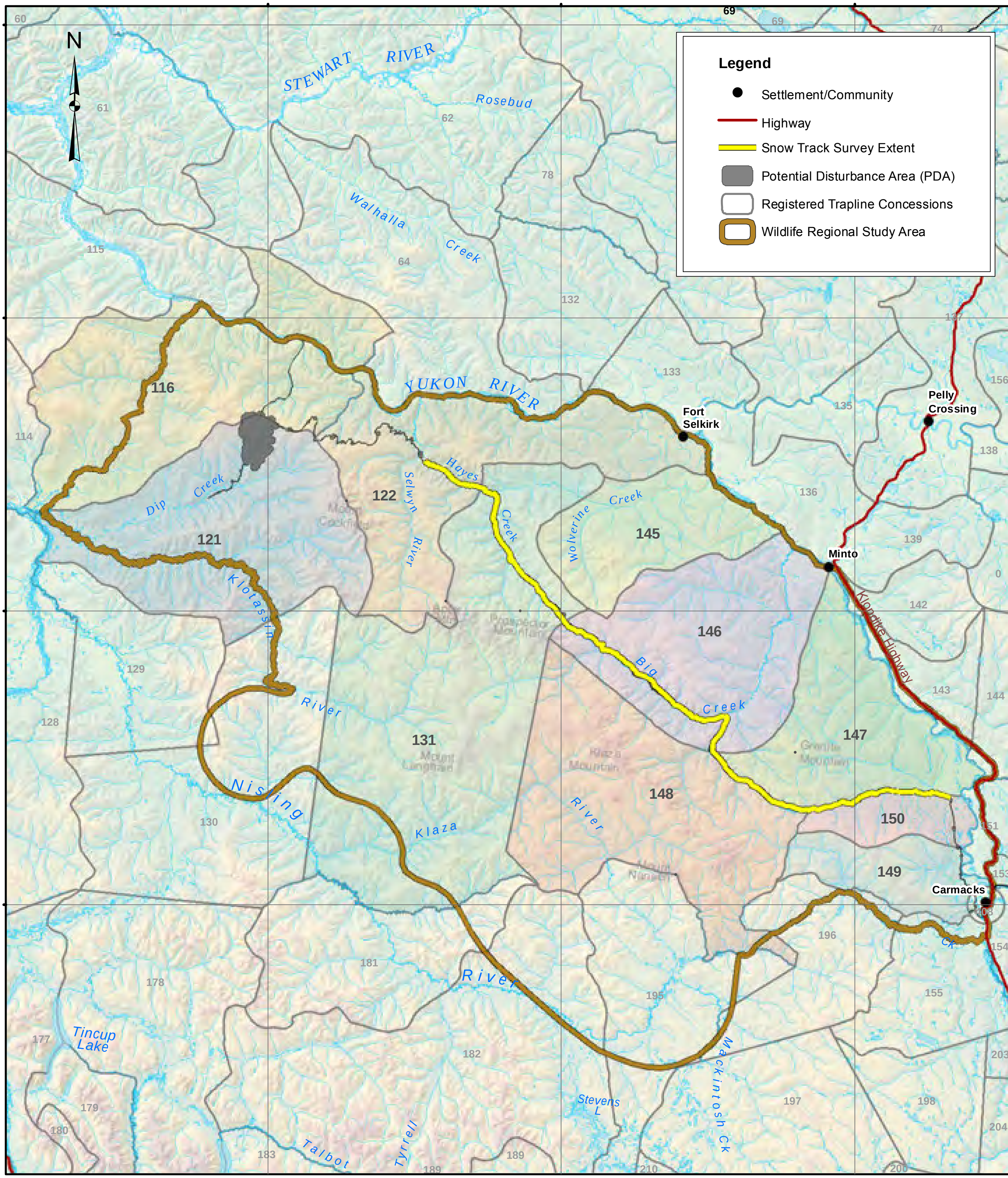
Coyote tracks were not observed along the Freegold Road extension during snow track surveys; however, based on their broad distribution and existing trapping records from RTCs in the area (Table 11.1) they are expected to occur at low densities in the area.

11.5 RED FOX

From Europe and Asia to North America, red fox is the most widely distributed global carnivore (Hatler et al. 2008). Red fox occurs throughout the Yukon, extending far north into the Arctic tundra. Red fox have not been assessed by COSEWIC and are listed as Secure in the Yukon (CESCC 2011).

Foxes feed upon many small mammals including voles, mice, ground squirrels, muskrats, and snowshoe hare. They also feed on birds, eggs, and some vegetation. Denning habitat is similar to that of coyotes; burrowing into the side of hills, under downed wood, caves, root hollows, or other animals' burrows (Hatler et al. 2008).

Red fox tracks were not observed along the Freegold Road extension during snow track surveys; however, based on their broad distribution and existing trapping records from RTCs in the area (Table 11.1) it is expected that they occur in the area.



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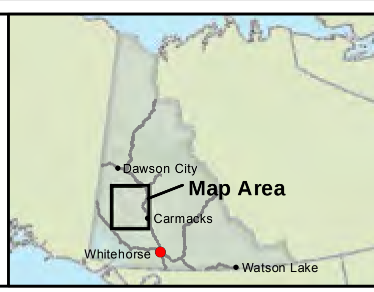
Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

2012 – 2013 snow tracking surveys (EDI), 2011 – 2013 aerial surveys (EDI/YG).

Wildlife Key Areas, Trapping Concessions, Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Registered trapline concessions and snow track survey extent

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MP/LG	MAS	16/10/2013	11.1

0 5 10 15 20 25 kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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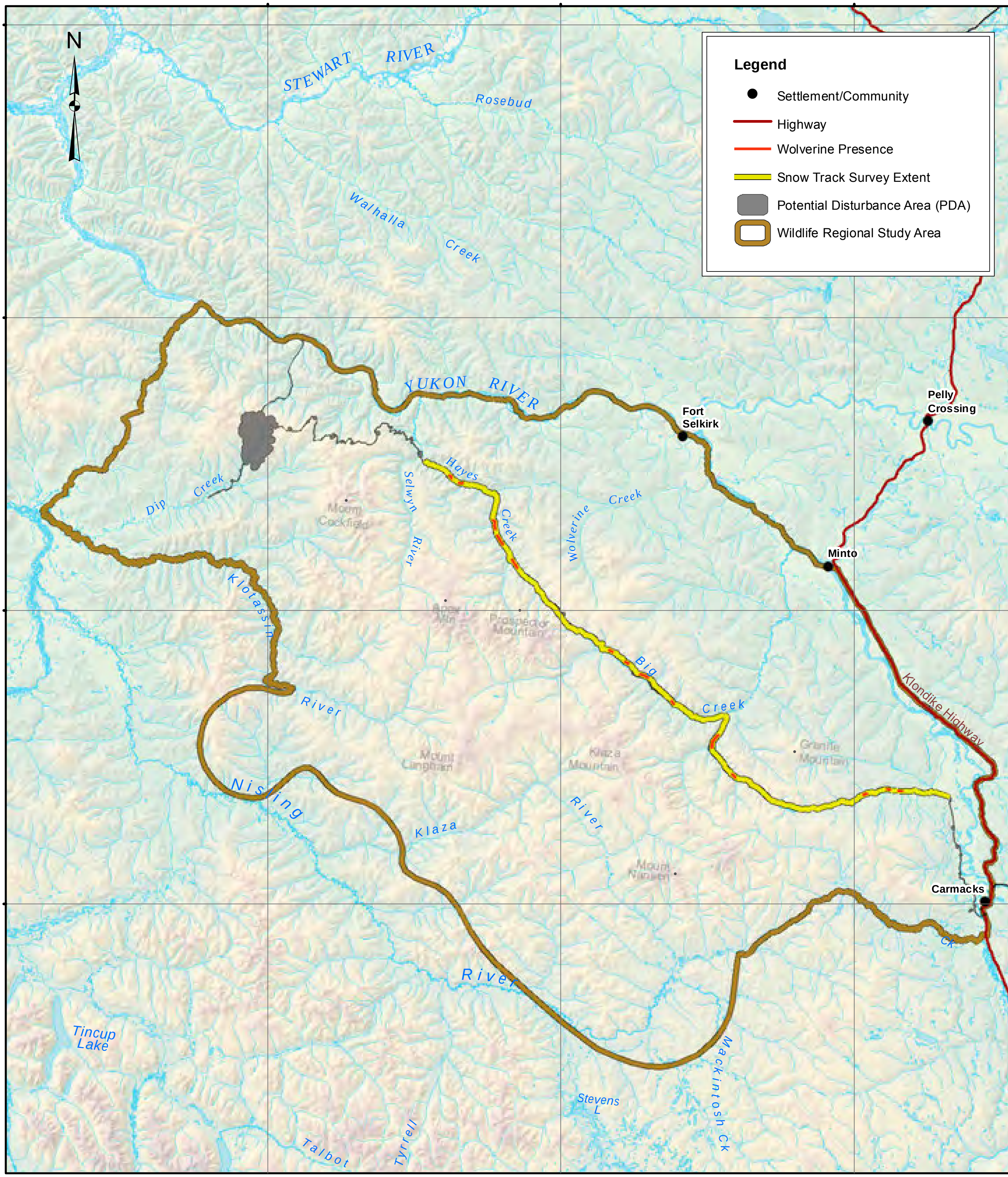

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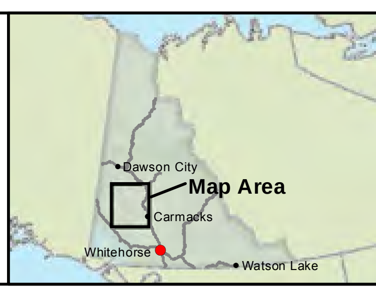
2012 – 2013 snow tracking surveys (EDI).

Wildlife Key Areas, Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Wolverine detections during the snow tracking surveys

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	11.2

0 5 10 15 20 25
kilometres

Map scale 1:800,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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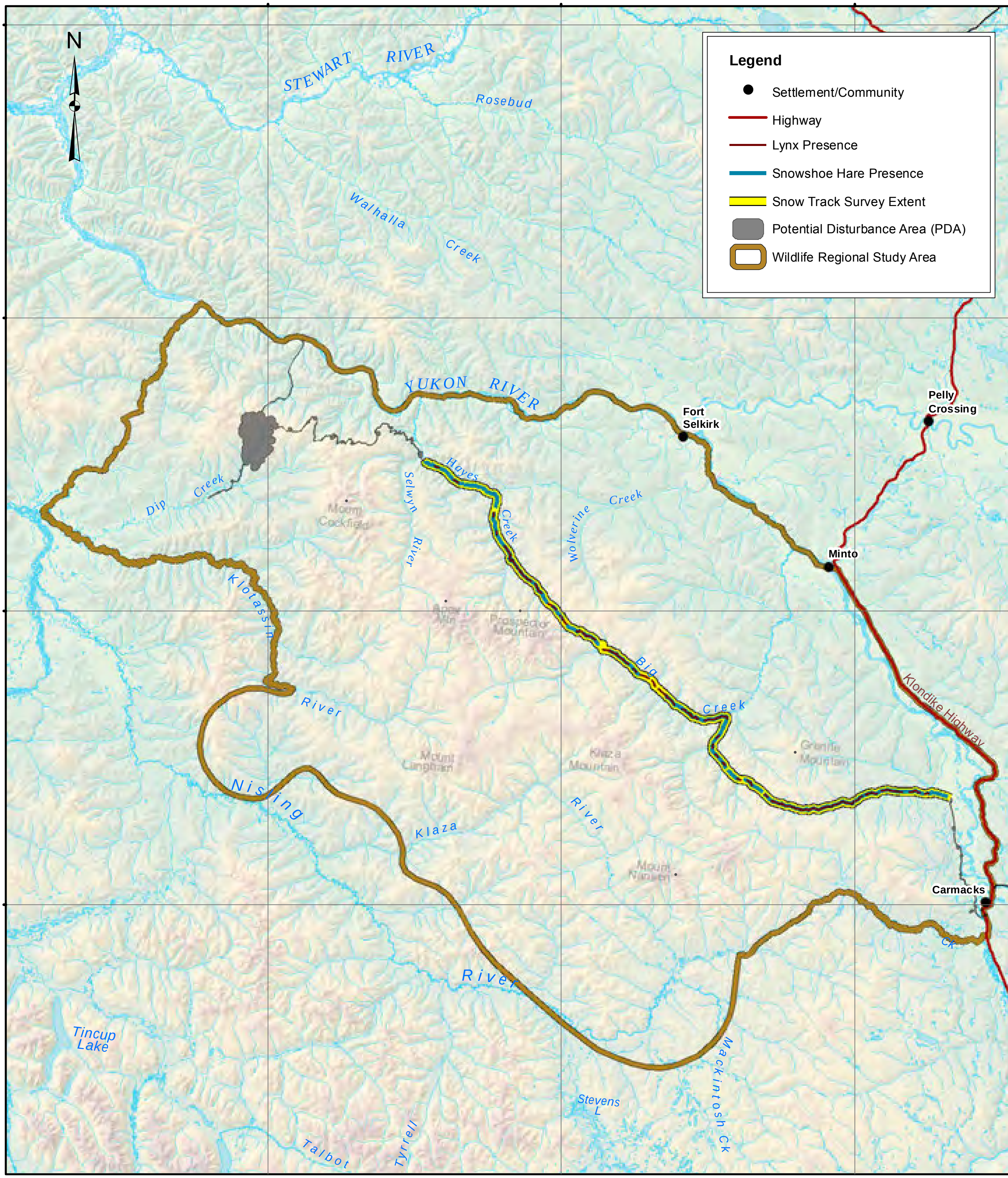

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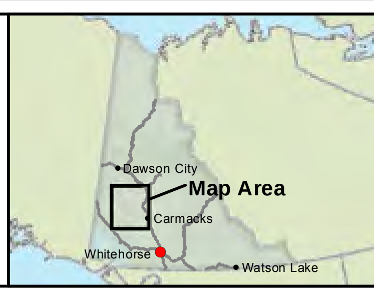
Potential Disturbance Area (PDA) provided by Knight Piesold Ltd., Sept., 2013.

2012 – 2013 snow tracking surveys (EDI).

Wildlife Key Areas, Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



Lynx and snowshoe hare detections during the snow tracking surveys

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	11.3

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kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

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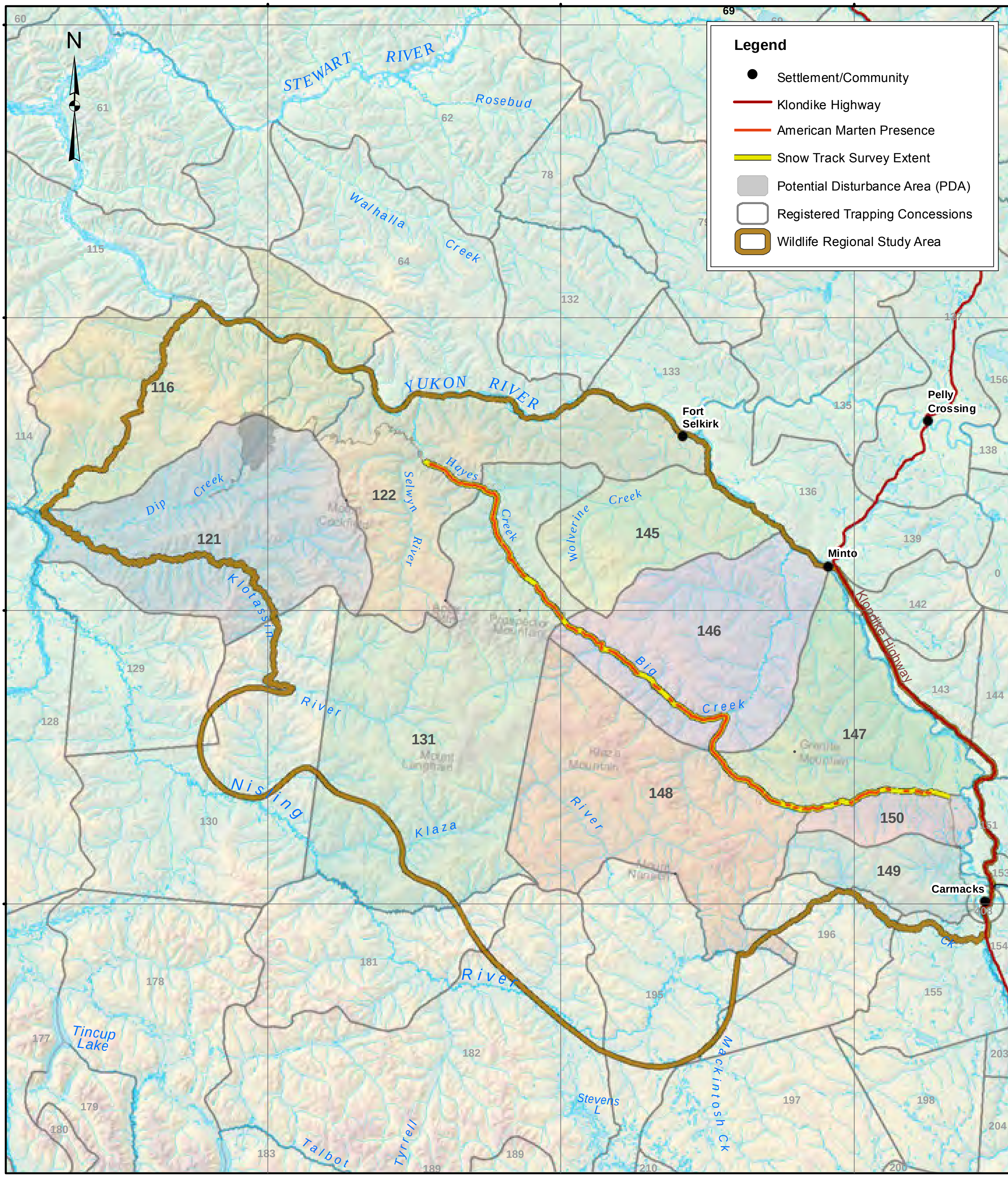
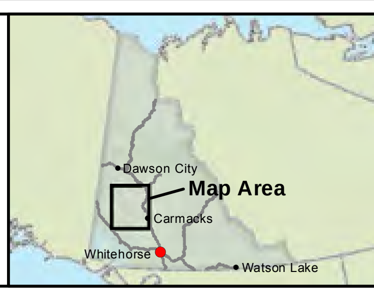


1:250,000 Topographic Spatial Data, National Road Network, Ecoregions; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. 2013.

2012 – 2013 snow tracking surveys (EDI).

Wildlife Key Areas, Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca



American marten detections during the snow tracking surveys

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	11.4

0 5 10 15 20 25 30
kilometres

Map scale 1:900,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

EDI

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12 COLLARED PIKA

Within Canada, the collared pika is limited to alpine areas in BC, NT, and Yukon. In November 2011, collared pika was federally listed under SARA as Special Concern (COSEWIC 2011b). The main threat for the species is believed to be habitat alteration due to climate change (COSEWIC 2011b). Collared pika has not been assessed within the Yukon. Studies of pika in the Yukon have found recent population declines which have been attributed to climatic variability such as lower winter snow depths (less insulation), freeze-thaw events, freezing rain, and late-winter snowfall (Morrison and Hik 2007, 2008).

The collared pika is primarily found on talus alpine slopes, interspersed with meadows or forest patches (Morrison and Hik 2008). Pikas spend the summer months collecting forbs and grasses to store them in a haypile cache for winter (Smith and Johnston 2008). Pikas typically live in small sub-populations in a single alpine or sub-alpine valley (Morrison and Hik 2007).

Species-specific baseline studies for pika were conducted in the summer of 2013 at four monitoring points near the proposed mine site (Figure 12.1). Viewing at each point was conducted for one hour by two biologists using binoculars. No pika activity was detected during these surveys; however, 11 pikas (9 observations: two groups of two pika, seven lone pika) were incidentally observed during bird and vegetation baseline work near the proposed mine site. Pikas were observed primarily in alpine habitats where they were located in small boulder fields (felsenmeer) on moderately steep slopes, adjacent to areas of herbaceous alpine vegetation (Photo 4; Figure 12.1).

12.1 COLLARED PIKA HABITAT SUITABILITY MODEL

In consideration of the naturally fragmented and geographically limited area of pika habitat, simplified habitat suitability modelling was conducted within the LSA. Habitat suitability indices (HSI) were assigned to habitat variables based on a review of literature (Nagorsen 2005; Morrison and Hik 2007; COSEWIC 2011) and comparing the proportion of pika observations to the proportion of available suitable habitat.

Based on the information provided in literature, two variables were initially selected to qualify pika habitat: bioclimate zone (e.g., alpine) and proximity to boulder fields (i.e., felsenmeer); however, the bioclimate zone data had to be excluded as its resolution was too poor (90 m) for the scale of the analysis. Consequently, only the proximity to boulder fields (felsenmeer) could be used. This variable was assigned an index value of either 0 or 1 (shown in parenthesis) to reflect whether areas are suitable (1) or unsuitable (0) pika habitat. The final variable, with index value ratings, is:

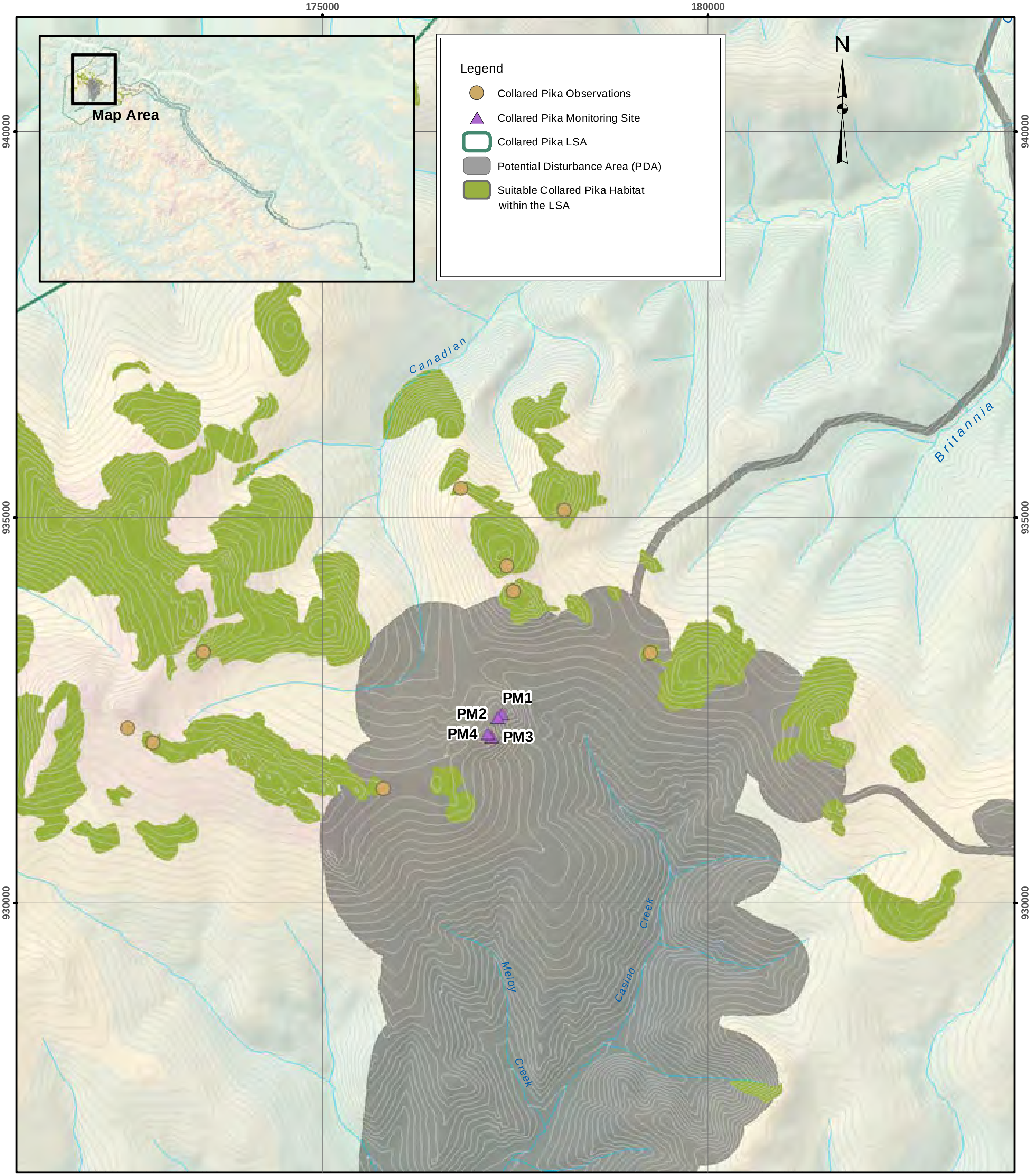
- Proximity to felsenmeer:
    - Areas within 10 m of felsenmeer (1)
    - Areas beyond 10 m from felsenmeer (0)

Observations of pika 2013 baseline surveys were used to validate the findings by examining the relative proportion of pika in suitable and unsuitable habitat (Figure 12.1). All but one of the nine pika observations fell within the model's suitable habitat output.

Table 12.1 Availability of suitable and unsuitable pika habitat within the LSA.

Habitat	Baseline area (km²)	% of total available
Suitable	31	3.5
Unsuitable	855	96.5

Photo 4. Typical habitat where pika were located near the Casino Mine Site.



1:250,000 Topographic Spatial Data, National Road Network, Ecoregions; courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Potential Disturbance Area (PDA) provided by Knight Piesold Ltd. 2013.

Collared pika observations collected by EDI (2012-2013) and AECOM (2010). Habitat suitability model produced by EDI, 2013.

Digital Elevation Models (30 m and 90 m) provided by Yukon Government - Geomatics Yukon; online Corporate Spatial Warehouse. www.geomaticsyukon.ca

Collared pika observations and suitable habitat near the proposed Casino Mine Site

Drawn:	Checked:	Date:	Figure:
MP/LG	MAS	16/10/2013	12.1

0 500 1,000 1,500 2,000
metres

Map scale 1:70,000 (printed at 8.5x11)
North American Datum 1983 CSRS Yukon Albers

CASINO COPPER AND GOLD

EDI

Path: J:\Yukon\Projects\2013\13_Y_0045_CMC_CasinoEA\Mapping\450_Wildlife\Baseline_Sept2013\450_Fig_12_1_PikaObs.mxd

13 AMPHIBIANS

Only four species of amphibians are known to occur in the Yukon: wood frog (*Lithobates sylvaticus*), western toad (*Anaxyrus boreas*), Columbia spotted frog (*Rana luteiventris*), and boreal chorus frog (*Pseudacris maculate*). The only species expected to occur in the RSA is the wood frog. The range of the latter three species extends north only into the southeast corner of the Yukon (Government of Yukon 2013e).

The wood frog is the most widespread amphibian species that occurs in the Yukon, with its range extending from the BC border north to Old Crow Flats. The wood frog occupies a variety of habitats, including habitats located away from water. Breeding occurs in clear shallow ponds from late April through June (Government of Yukon 2013e). The wood frog is assumed to occur throughout the RSA in the appropriate habitats. Although wood frog habitat is limited in the Project area, suitable habitat does occur.

No amphibian surveys were conducted as part of the Casino baseline surveys. However, both tadpoles and adult frogs were observed along the Freegold Road near Big Creek, during the rare plants survey conducted in 2012.

14 MINERAL LICKS

Mineral licks used by moose are typically located in moist, muddy areas and are often identified by the presence of a worn trail or concentrated tracks in an area (Rea et al. 2004). Mineral licks not only provide mineral nutrients and water to moose, but also aid in digestion (by consuming soil) and are known as social gathering areas (Rea et al. 2004). During baseline studies, two mineral licks were identified — one near Dip Creek in the northern part of the RSA (west of the mine site) and one near Hayes Creek. Once located, remote motion sensing cameras were established at each site on 20 and 21 June 2013 to quantify and qualify suspected use of these areas.

The majority of observations at both licks were of moose, including lone cows and bulls, as well as cow/calf groups. The Hayes Creek mineral lick only recorded moose on camera; however, the camera was only active for 11 days due to constant triggering by moose (Photo 5). Based on these camera observations, it appeared that a few individual moose, one cow in particular, regularly visited the Hayes Creek lick, remaining in the area for one to 55 minutes.

The Dip Creek mineral lick recorded observations of moose, wolves (Photo 6), grizzly bears, one black bear, and one lynx. The camera was active for 66 days, and recorded an estimated 111 separate visits by wildlife. Thirteen individual moose (or moose groups) were recorded at this site including two bulls, eight cows, and three cow/calf groups (Photo 7). Two observations of grizzly bears were recorded on 11 July 2013 and 5 August 2013 (Photo 8). Based on these photos, it appeared to be the same individual.

Photo 5. **Bull moose feeding at the Hayes Creek mineral lick.**

Photo 6. **Wolf walking through the Dip Creek mineral lick.**

Photo 7. **Cow moose with two calves at the Dip Creek mineral lick.**

Photo 8. **Grizzly bear walking through the Dip Creek mineral lick.**

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