Gladstone Lakes
Terrestrial Environment Baseline Studies

2009 and 2010 Mammal Surveys

(Photo: L. Turney)

Prepared for:

Yukon Energy Corporation
and
AECOM Canada Ltd.

Prepared by:

Anne MacLeod, B.Sc., R.P.Bio.
Sialia Biological Consulting
Smithers, BC

and

Laurence Turney, B.Sc., R.P.Bio.

ARDEA BIOLOGICAL CONSULTING
Smithers, BC

May 2011

Executive Summary

Yukon Energy Corporation (YEC) has engaged AECOM Canada Ltd. to assist with the study of several key energy enhancement projects as identified in YEC's 20-Year Resource Plan, including the Gladstone Diversion Concept. Baseline environmental studies for the Gladstone Concept commenced in the late summer of 2009 and continued through 2010. The 2009 and 2010 baseline work on terrestrial and aquatic mammals consisted of aerial surveys, reconnaissance-level ground-based surveys, Wildlife Habitat Assessment plots, investigation and documentation of mineral licks and collection of incidental observations within the Gladstone Lakes Study Area. During winter and spring surveys, biologists also documented late winter and spring snow and ice conditions in the study area.

Baseline surveys for aquatic and terrestrial mammals within the Gladstone Lakes Study Area documented 22 terrestrial and aquatic mammal species. Of these, the wood bison, woodland caribou, collared pika, grizzly bear, and wolverine are listed as species of conservation concern within the Yukon and/or Canada (Cannings and Jung 2010, COSEWIC 2010).

Four ungulate species were found within the Gladstone Lakes Study Area. Dall's sheep are prevalent throughout the area, particularly on the upper portions of south and south-east facing slopes on the north side of the valley and the alpine habitats above these slopes. The upper slopes provide critical escape terrain for sheep, while the mid slopes and the alpine areas above these slopes provide foraging opportunities. Wood bison appear to use habitats throughout the Study Area; however, evidence of bison was much more concentrated within the Isaac drainage than in the Gladstone drainage, primarily in wetland and mid-valley grassland terraces. Moose numbers appear to be relatively low in the study area, with most observations of animals and sign associated with willow-dominated habitats along the valley bottoms. Woodland caribou were observed in several areas within the study area although only in limited numbers. High value caribou habitat was found to be extensive in many portions of the study area, consisting of forested and alpine terrestrial lichen areas.

Several large and mid-sized carnivores were found within the Gladstone Lakes Study Area. Grizzly bear and evidence of grizzly bear was noted several times throughout the field surveys; in contrast, black bear was only detected twice. Several observations of bear sign were made that could not be identified to species, but were likely grizzly bear. High and moderately-high value habitats for bears were noted including wetlands, habitats with a high density of small mammals (e.g. arctic ground squirrel colonies) and areas with a significant amount of berry-producing shrubs. At least one wolf pack is present within the Gladstone Lakes Study Area: aerial surveys located an active wolf den above Gladstone Creek with three or four pups and four adult wolves. Three other wolf dens were located during field surveys; however, none of these were active during the survey period. Wolverine tracks were noted in several areas during the winter and early spring aerial surveys within alpine areas above Gladstone Lake D and upper Gladstone creek. Lynx were noted a few times during the field surveys, generally associated with areas showing higher snowshoe hare densities; and coyote was detected twice in the study area.

Beaver, muskrat and northern river otter were all detected during field work. River otter was only detected once in Isaac Lake A, muskrat seem to be limited to a few areas, and beaver appear relatively common. Muskrat push-ups were found on Gladstone Creek just downstream of the outlet of Gladstone Lake D, Isaac Lake D, and Isaac Lake E. Observations of beaver, beaver dams and lodges, and other beaver sign were found throughout the study area. A total of 19 beaver lodges were identified within lake, stream and wetland habitats throughout the study area. Nearly all of the Gladstone and Isaac Lakes have at least one beaver lodge present, and both Gladstone and Isaac Creek have beaver dams and lodges present along them.

Several small mammal species were detected within the study area. Arctic ground squirrels appear common throughout the study area and colonies were located in a wide variety of habitats ranging from valley bottom to alpine including grassy slopes, shrub-dominated sites, deciduous forests and even alpine tundra. Collared pika were only noted a couple of times during the field surveys; in both cases, the animals were heard calling from boulder fields or talus slopes at upper and mid elevations. Other small mammals observed within the study area included hoary marmot, bushy-tailed woodrat, least chipmunk, red squirrel, snowshoe hare, porcupine and vole sp.

Incidental observations of terrestrial invertebrates identified eight species of land snails, ten butterfly species, three damselfly species, four species of dragonflies and three bee species during the field work in July. None of the species are of conservation concern or being tracked by the Yukon CDC (COSEWIC 2010, YT CDC 2011).

Four mineral licks were located in the Gladstone Lakes Study Area during the 2009 and 2010 field surveys: one above Gladstone Creek downstream of the Gladstone Lakes, one above Gladstone Lake B, one above Gladstone Lake A, and one along the mid to lower sections of Isaac Creek. All four of these licks are situated on the north side of the Gladstone and Isaac valleys and are at relatively low elevations. Soil samples for analysis were obtained and motion-detecting cameras were set up at the Gladstone Lake A, Gladstone Lake B, and Isaac Creek mineral licks. The soil samples were analyzed for trace metal content, while the motion-detecting cameras were used to aid in understanding the amount of use the licks received and the species using the licks. Results of the trace metal analysis indicate that calcium and sodium concentrations are much higher in the mineral lick soils than control soils. Based on the results of the motion-detection cameras, Dall's sheep were the main species using the Gladstone Lake A and B licks, while the Isaac Creek lick had a wider variety of species captured on the cameras.

A dedicated effort to locate wildlife trails within the study area identified an extensive trail system along the valley sidewalls, which are currently used by the guide-outfitters as well as wildlife.

Suggested Citation:

Macleod, A. and L. Turney. 2011. Gladstone Lakes Terrestrial Baseline Studies: 2009 and 2010 Mammal Surveys. Unpublished report prepared for AECOM Canada Ltd. and Yukon Energy Corporation by Ardea Biological Consulting Ltd., Smithers, BC. 23 pp. + appendices.

Acknowledgements

This work was made possible with the support of the AECOM Whitehorse staff; Forest Pearson, Kathleen Woods and Chad Davey; who supported our broad program of terrestrial studies within AECOM and with Yukon Energy Corporation.

We would also like to thank Paul Rosset of Horizon Helicopters Ltd., who provided excellent flying for our work. Our work in Gladstone would not have been possible without the camp and logistic support of Joel MacFabe and Jonathan Kolot, who made coming home for dinner something to really look forward to. We would also like to thank Annika Joe from the Champagne and Aishihik First Nation (CAFN) and Jasmine Sheldon from the Kluane First Nation (KFN) who helped us in the field.

Disclaimer

This report has been prepared by the authors under the direction of Ardea Biological Consulting Ltd. (Ardea) for Yukon Energy Corporation and AECOM Canada Ltd. (the Clients) to provide baseline ecological information for the Gladstone Diversion Concept. The information contained in this report have been obtained and prepared in accordance with generally accepted biological survey standards and is intended for the exclusive use of the Clients. The information contained in this report is dependent on the conditions at the time and any recommendations or conclusions are based on the author's best judgement at the time of preparation. The Clients acknowledge that ecological conditions can change over time and that the conclusions and recommendations outlined in this report are time sensitive.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. The authors and Ardea accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Table of Contents

List of Figures

List of Tables

INTRODUCTION

Yukon Energy Corporation (YEC) has engaged AECOM Canada Ltd. (AECOM) to assist with the study of several key energy enhancement projects as identified in YEC's 20-Year Resource Plan. One of the studies is the Gladstone Diversion Concept, which has been identified as one of the most attractive schemes for enhancing energy capability at the Aishihik power generation facility. This concept would support additional generation of hydroelectric energy through the installation of a diversion structure at the outlet of the western-most of the Gladstone Lakes. Water from the Gladstone Lakes system would be diverted east into Isaac Creek and into the Sekulmun-Aishihik Lake system. This diverted water would allow for the production of an additional 18 GWh/yr, or more, of clean electricity annually at the existing Aishihik hydro facility.

Ardea Biological Consulting Ltd. (Ardea) was contracted by AECOM to complete terrestrial baseline studies within the Gladstone and Isaac systems. As part of the terrestrial baseline environment studies, terrestrial and aquatic mammal surveys were initiated in late summer of 2009 and included aerial, boat, and ground-based surveys. In the late winter and through the spring and early summer of 2010, additional surveys were conducted for aquatic and terrestrial mammals using a combination of aerial, boat-based and ground-based survey techniques. The main purpose of this work was to determine the presence of aquatic and terrestrial mammal species and identify critical habitats used by mammals within the study area. Surveys were carried out by Frank Doyle (Wildlife Dynamics Consulting), Laurence Turney (Ardea), Anne Macleod (Sialia Biological Consulting), Lis Rach (TerraNiche Environmental Solutions) and Anne-Marie Roberts (A. Roberts Ecological Consulting). Observations of invertebrate species such as land snails and insects were noted by the above as well as by Patrick Williston (Gentian Botanical Research).

This report focuses on the methodology and results of the 2009 and 2010 surveys for terrestrial and aquatic mammals in the Gladstone Lakes Study Area.

STUDY AREA

The Gladstone Lakes Study Area is located in southwest Yukon, just east of Kluane Lake and west of Sekulmun and Aishihik Lakes in the Ruby Ranges of the Kluane Plateau. The area is approximately 170 km northwest of Whitehorse and 50 kilometres northeast of Haines Junction. The study area is located within the generally east-west valleys of the Gladstone and Isaac drainages. The watershed divide exists closer to Sekulmun Lake, with Gladstone Creek flowing approximately 40 km west into Kluane Lake, and Isaac Creek flowing approximately 26 km east into Sekulmun Lake (see Figure 1).

The study area is located in the central portion of the Ruby Ranges Ecoregion (YEWG 2004) and is situated in the dry rain shadow area of the St. Elias Mountains. Precipitation is only 250 to 300 mm annually (YEWG 2004), with an average of 106 cm of snowfall (Environment Canada 2010), making the area one of the driest regions of the Yukon (YEWG 2004). Mean annual temperatures range from -3 to -7°C within the Ruby Ranges (YEWG 2004) with mean summer temperatures of 12.8°C and mean winter temperatures of -22°C (Environment Canada 2010). Vegetation is dominated by white spruce (*Picea glauca*) below treeline (at approximately 1,200 m), tall and medium shrubs dominated by willows (*Salix* sp.) and scrub birch (*Betula glandulosa*) in the subalpine (between 1,040 and 1,400 m), and alpine tundra with lichens and ground shrubs above 1,400 m (YEWG 2004).

The forests, wetlands and aquatic habitats of the upper reaches of Isaac Creek, Gladstone Creek, the lower portions of D-Prime Creek and all of the Gladstone Lakes were the focus of this study.

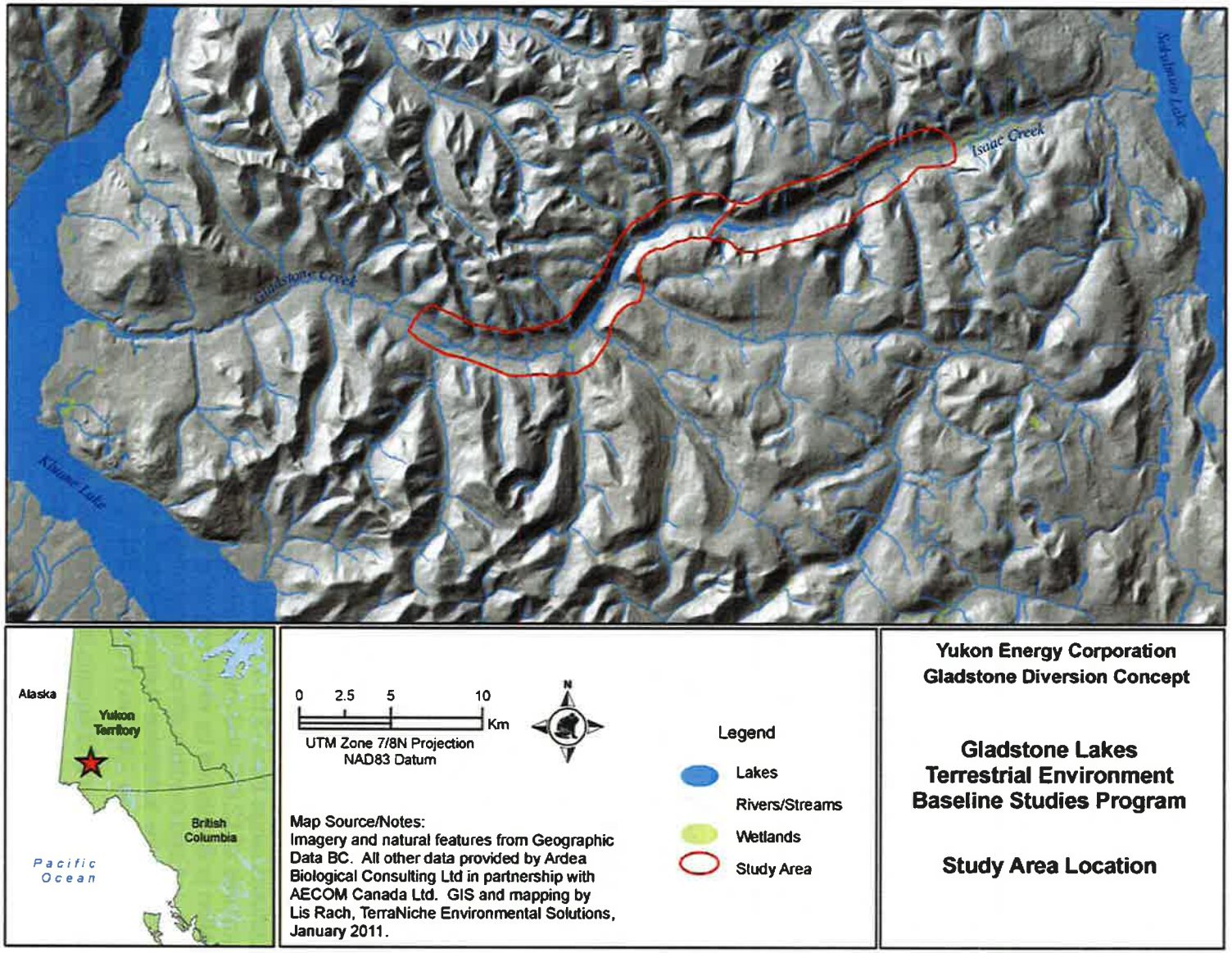


Figure 1. Gladstone Lakes Study Area location.

METHODS

The 2009 and 2010 baseline work on terrestrial and aquatic mammals consisted of aerial surveys for aquatic mammals, reconnaissance-level ground-based surveys, Wildlife Habitat Assessment plots, investigation and documentation of several mineral licks and collection of incidental observations within the Gladstone Lakes Study Area.

Aerial Surveys

Aerial surveys of the Gladstone Lakes Study Area were conducted using a R-44 helicopter following standards outlined by the BC Resource Inventory Committee for ungulates (RIC 2002) and for beaver and muskrat (RIC 1998b). Surveys were conducted in the fall of 2009, the late winter of 2010 and through to the summer of 2010 to assess aquatic and terrestrial mammal habitat use and populations. The helicopter was flown at speeds of 65 to 80 kph and a height of 60 to 100 m above the water. A minimum of two observers were present, along with the pilot to search for mammals on or adjacent to the lakes, ponds and streams. Whenever animals were observed, their location was marked with a GPS and information was collected on the species, number, age group, sex, activity and habitat type. Locations of dams, push-ups and lodges were also noted, with information recorded on if the dam or lodge was active.

Wildlife Habitat Assessments

Wildlife Habitat Assessment (WHA) plots consisted of 20 m diameter plots in which data were collected on evidence of use by wildlife, habitat suitability ratings for focal species, and information on some of the local habitat attributes (particularly tree and coarse woody debris layers). Plots were completed across the range of representative habitats as per the standards outlined in the *Field Manual for Describing Terrestrial Ecosystems* (MOELP and MOF 1998) and Wildlife Habitat Rating Standards (RIC 1999). Standardized wildlife habitat assessment forms (from the B.C. Provincial FS882 series) were used to record data. The WHA plots were generally completed in conjunction with vegetation plots for the terrestrial ecosystem mapping and additional information on the vegetation and ecosystems present are available from this source.

In 2009, the focal species selected for the habitat suitability rating portion of the WHA plots were arctic ground squirrel (*Spermophilus parryii*), moose (*Alces alces*), woodland caribou (*Rangifer tarandus caribou*), wood bison (*Bison bison*), Dall's sheep (*Ovis dalli dalli*), grizzly bear (*Ursus arctos*), and willow ptarmigan (*Lagopus lagopus*). Based on the findings of the 2009 field sessions, a few changes were made to data collected in the habitat suitability ratings portion of the 2010 WHA plots: the main change being that suitability data was collected for short-eared owl (*Asio flammeus*) rather than willow ptarmigan. Table 1 outlines the life requisites and the seasons that were assessed for each of the focal species.

Table 1. Species, life requisites and seasons for which suitability ratings were collected in the Gladstone Lake Gladstone Lakes Study Area.

Species Name	Latin Name	Life Requisites Assessed	Seasons Assessed	Comments
Arctic Ground Squirrel	*Spermophilus parryii*	Living (Feeding & Security/Thermal)	Growing	Collected in 2009 & 2010
Wood Bison	*Bison bison*	Living (Feeding & Security/Thermal)	Growing, Winter	Collected in 2009 & 2010.

Species Name	Latin Name	Life Requisites Assessed	Seasons Assessed	Comments
Woodland Caribou	*Rangifer tarandus caribou*	Living (Feeding & Security/Thermal)	Growing, Winter	2009: Only Winter season assessed. 2010: Winter & Growing seasons assessed.
Moose	*Alces alces*	Living (Feeding & Security/Thermal)	Growing, Winter	Collected in 2009 & 2010.
Dall's Sheep	*Ovis dalli dalli*	Living (Feeding & Security/Thermal)	Growing, Winter	Collected in 2009 & 2010.
Grizzly Bear	*Ursus arctos*	Living (Feeding & Security/Thermal)	Spring, Summer, Fall	Collected in 2009 & 2010.
Willow Ptarmigan	*Lagopus lagopus*	Living (Feeding & Breeding)	Summer, Winter	Only collected in 2009.
Short-eared Owl	*Asio flammeus*	Living (Feeding & Breeding)	Growing	Only collected in 2010.

Mineral Lick Investigations

Investigation of mineral licks in the Gladstone Lakes Study Area involved mapping and photographing the lick, and collecting soil samples from the lick and control areas that were then sent in for trace metals analysis. Additionally, at three of the licks, motion-detecting cameras were set up from late April to early July to document use of the licks.

Incidental Observations

Incidental observations consisted of wildlife observations made on an opportunistic basis whenever wildlife was observed in the course of other fieldwork or during travel between sites. For each observation, the species, number of animals, activity, location, age and sex (if known) were recorded.

Terrestrial Invertebrate Observations

Observations of terrestrial invertebrate species were also made on an opportunistic basis as the area has not been well sampled for these species as far as we could determine. Flying insects were sampled using a sweep net within wetland and upland areas, while terrestrial invertebrates were captured by hand. Identification of invertebrates was conducted using appropriate field guides and taxonomic keys. Land snails were identified by R. Forsyth, a leading expert in this field, who resides in Smithers.

RESULTS

Aerial Surveys

A total of seven flights were conducted within the Gladstone Lakes Study Area to document mammal distributions and habitat use (Table 2). Surveys obtained a variety of data and in many cases were conducted with multiple purposes, including acquiring waterfowl distribution and ice formation data. Of the seven surveys, one was completed during the fall of 2009, one in the late winter of 2010 and five during the spring and summer of 2010. The Aquatic and Terrestrial Mammal Assessment Locations maps located in Appendix A show a typical flight line for the aerial surveys within the Gladstone Lakes Study Area. Each of the flights is summarized below; Appendix B provides the full survey results.

Table 2. Aerial surveys of Gladstone Lakes Study Area in 2009 and 2010.

Survey Date	Observers	Start Time	End Time	Area Covered
Aug. 31, 2009	L. Turney, F. Doyle, A. Roberts	15:40	16:40	Gladstone Lakes, Isaac Lakes, Isaac Creek east to Aishihik Lake
Mar. 22, 2010	L. Turney, F. Doyle, M. Jim	07:05	12:10	Gladstone Creek, Gladstone Lakes, Isaac Lakes, Isaac Creek
Apr. 28, 2010	L. Turney, F. Doyle	09:30	16:00	Gladstone Creek, Gladstone Lakes, Isaac Lakes, Isaac Creek east to Aishihik, D-Prime to Kluane Lake Outflow
May 15, 2010	L. Turney, F. Doyle, A. Roberts	09:17	14:53	Gladstone Creek, Gladstone Lakes, Isaac Lakes, Isaac Creek East to Aishihik Lake, D-Prime to Kluane Lake Outflow
Jun. 4, 2010	L. Turney, L. Rach, A. Roberts	09:14	14:10	Gladstone Creek, Gladstone Lakes, Isaac Lakes, Isaac Creek, D-Prime
Jul. 6, 2010	L. Turney, F. Doyle, A. MacLeod	06:55	08:45	Gladstone Creek, Gladstone Lakes
Jul. 7, 2010	L. Turney, F. Doyle, A. MacLeod	09:10	10:30	Gladstone Creek, Gladstone Lakes, Isaac Lakes, Isaac Creek, D-Prime

The August 31, 2009 flight focussed on documenting aquatic and terrestrial mammal habitat use within the Gladstone Lakes Study Area. The only mammal noted during this survey was beaver. A total of 15 beaver lodges and numerous associated dams were located within lake, pond and stream habitats throughout the study area; several of the Gladstone and Isaac Lakes had more than one lodge present on them.

The March 22, 2010 flight consisted of a flight along the Gladstone Creek and Isaac Creek valley bottom, in addition to a pass along the ridge tops on either side of the valley (this was the only aerial survey which included a pass along the ridge tops) and looked at wildlife habitat use distributions and late winter conditions within the Gladstone Lakes Study Area. Two groups of bison (one with nine and another with ten individuals) were observed during the flight; both groups were observed in coniferous forest on mid-valley terraces above Isaac Creek. Bison tracks were noted on additional forested terraces, and a trail was found leading from the valley floor along Isaac Creek to alpine habitats on the south side of the valley. All observations of bison and bison sign were located within the Isaac drainage. Two moose were observed feeding on willows along a side-drainage of Isaac Creek and moose tracks were observed within a spruce forest along Gladstone Creek. A total of 178 Dall's sheep were observed within the Gladstone Lakes Study Area, in groups ranging in size from two to forty animals. The majority of these animals were observed in windswept alpine habitats or on south-facing slopes where snow levels were very low. No evidence of caribou was found during the aerial survey, and the mineral licks at Gladstone Lake A and Lake B showed no evidence of use. Wolverine tracks were noted in several locations along the survey including alpine habitats both north and south of the Gladstone Valley, and a set of tracks crossing Isaac Lake A; a wolverine was also sighted walking in forested habitats along Gladstone Creek. No other large carnivores were seen during the flight; however, wolf tracks were observed near the mineral lick on Gladstone Lake B, grizzly bear tracks were seen on the ice in the wetland between Gladstone Lake C and Lake D, and lynx tracks were noted in the Gladstone Creek valley in one of the few areas observed to have snowshoe hare tracks. The survey also found muskrat push-ups on each of the last two Isaac Lakes (four on Lake D and three on Lake E). In addition to the wildlife observations, the aerial

survey observed snowmobile tracks in alpine habitats south of Gladstone Lakes C and D and along Gladstone Creek to Kluane Lake.

The March survey also allowed documentation of late winter conditions within the Gladstone Lakes Study Area. The majority of the water bodies within the Gladstone and Isaac drainages were completely frozen over at this time, the only exceptions to this were a few small openings along the Gladstone and Isaac Creeks. The snowpack within the study area was less than one meter with large wind-swept areas that were nearly free of snow. In general, the deepest snowpack (up to one meter) was found on the north-facing slopes, while the south-facing slopes were almost bare. On the valley floor, tree and shrub habitats on level slopes were covered in approximately half a meter of snow. The snowpack did have a crust on it as smaller animals were able to stay on top but larger animals (e.g. ungulates) appeared to be breaking through this crust. Figure 2 shows the winter conditions observed during the March survey with a photo looking northeast across the Gladstone valley and Gladstone Lake A.

Figure 2. Late winter conditions in the Gladstone Lakes Study Area on March 22, 2010.

The April 28, 2010 flight focussed on documenting aquatic and terrestrial mammal habitat use and ice distributions within the main Gladstone Lakes Study Area, east to Aishihik Lake, and west to Kluane Lake. Numerous beaver lodges and beaver dams were documented during these surveys. Evidence of muskrat was found in three locations within the Gladstone and Isaac valleys: along Gladstone Creek between the outflow of Lake D and the confluence with D-Prime Creek (one push-up), Isaac Lake D (34 push-ups), and Isaac Lake E (five push-ups). A group of three bison was observed on grassy hillsides to the north of Isaac Lake B, and two moose were

observed foraging within a willow-dominated swamp along Isaac Creek between Isaac Lakes D and E. Two groups of caribou were noted within the Gladstone Lakes Study Area. A group of three animals was seen walking in a large wetland along Isaac Creek and a group of six caribou was observed feeding in an open Spruce-Scrub Birch forest between Gladstone Lakes A and B. We also documented three groups of Dall's sheep, each with three to five individuals. All three groups were located on steep slopes with warm aspects (ranging from southeast to southwest) and patchy vegetation. Wolverine tracks were noted in alpine habitat to the south of Gladstone Lake D, and bear tracks were noted near both Gladstone Lake C and Gladstone Lake D. The survey noted additional groups of bison, caribou and sheep outside of the main Gladstone Lakes Study Area. The details on these observations are available in Appendix B.

At the time of the April aerial survey, most of the snow had disappeared from the valley bottoms and the south and east-facing slopes. A thin layer of snow remained on north and west-facing slopes, in shaded and cool habitats on the valley bottoms and in some alpine areas. Water bodies within the Gladstone Lakes Study Area were still predominantly frozen with the exception of Gladstone Creek (both between the Gladstone Lakes and downstream of the lakes) which was 25-60% open.

The May 15, 2010 survey looked at aquatic and terrestrial mammals and the remaining ice distribution within the main Gladstone Lakes Study Area, east to Aishihik Lake, and west to Kluane Lake. The survey documented a total of 48 Dall's sheep, in groups ranging in size from three to fifteen animals. All sheep were observed on steep, south-facing slopes along the Gladstone and Isaac valleys. A wolf den was noted on a moraine along Gladstone Creek and a black bear was observed travelling along a forested slope above Isaac Creek near Sekulmun Lake. The survey also noted a porcupine near Isaac Lake E and several additional beaver dams and lodges within the Gladstone Lakes Study Area. Additional observations from outside the main Gladstone Lakes Study Area are available in Appendix B.

By the May survey, the snow was almost gone from the valley bottoms, although there was still some snow present on the north and west-facing slopes and in alpine areas. All of the lakes within the Gladstone Lakes Study Area were still mostly covered in ice, although the ice was melting quickly. Openings were present along many of the shorelines and in shallower waters and the remaining ice was very thin (< 10 cm). Several of the smaller ponds and wetlands within the Gladstone Lakes Study Area were free of ice and the streams were also opening up. Gladstone Creek was approximately 85% open and Isaac Creek was approximately 40% free of ice.

The aerial survey conducted on June 4, 2010 focussed on aquatic and terrestrial mammals within the main Gladstone Lakes Study Area west to Aishihik Lake. The survey noted a group of 24 sheep (lambs and ewes) departing from the mineral lick on Gladstone Lake A. It also noted a recently killed sheep carcass near the lick on Gladstone Lake B. At Isaac Lake D, a female caribou was observed in the standing in middle of the lake with a single black wolf laying on the hillside beside the lake. All other wildlife observations within the main Gladstone Lakes Study Area were related to beaver dams and lodges. The survey documented seven beaver dams along the mid and lower sections of Isaac Creek, only one of which appeared active. Several active dams and lodges were located closer to the Isaac Lakes. Outside of the Gladstone Lakes Study Area, biologists also noted a herd of 25 bison, including one collared animal, foraging in a meadow south of Sekulmun Lake. All creeks and lakes were ice-free at this time.

During the aerial surveys conducted on July 6-7, 2010, the only mammals noted during the survey were two wolves along Gladstone Creek near an active wolf den where one adult and three pups were observed. A single wolf was also noted approximately three kilometers east of the den site along Gladstone Creek.

Wildlife Habitat Assessments

Wildlife Habitat Assessment (WHA) plots were conducted in a variety of habitats throughout the Gladstone Lakes Study Area in both the 2009 and 2010 field sessions. A total of 73 plots were completed during the two years; 38 in 2009 and 35 in 2010. The Aquatic and Terrestrial Mammal Assessment Locations maps in Appendix A show the locations of the WHA plots. These surveys documented evidence of use by 19 different wildlife species including voles, arctic ground squirrel, red squirrel, collared pika, hoary marmot, snowshoe hare, porcupine, beaver, river otter, lynx, coyote, grey wolf, grizzly bear, moose, wood bison, Dall's sheep, and woodland caribou. Habitat suitability ratings collected during these surveys identified high and moderately high value habitats for most of the species rated. Table 3 describes some of these habitats for the identified mammals. Further details from the WHA findings are summarized below in the Discussion section along with the results of the other surveys.

Table 3. High and Moderate-High value habitats identified during WHA plots for selected mammal species.

Species Name	Habitats Identified as High or Moderately-High Value
Arctic Ground Squirrel	High and moderately-high value habitats for arctic ground squirrel were identified throughout the Gladstone Lakes Study Area within relatively dry habitats from alpine to valley bottom including grasslands, deciduous forests, shrub habitats and others.
Wood Bison	The majority of the high and moderately-high value bison habitats were located within the Isaac drainage. These habitats were generally graminoid-dominated, and included grassy hillsides and terraces as well as wetland habitats.
Woodland Caribou	High and moderately-high value habitats identified for caribou generally had a significant component of terrestrial lichens and included open Spruce-Scrub Birch forests and dry shrub habitats along terraces within the Gladstone and Isaac valleys, and alpine plateaus above the valleys.
Moose	High and moderately-high value moose habitat identified within the Gladstone Lakes Study Area was generally restricted to willow-dominated habitats along the valley bottoms.
Dall's Sheep	All high and moderately-high value habitats identified for Dall's sheep were either on or in close proximity to steep slopes, generally with warm aspects. Most of these were located on the north side of the Gladstone and Isaac valleys.
Grizzly Bear	High and moderately-high value habitats identified for grizzly bear included a variety of habitat types including wetlands, habitats with a high density of small mammals (e.g. arctic ground squirrel colonies) and areas with a significant amount of berry-producing shrubs.

Mineral Lick Investigations

Four mineral licks were located in the Gladstone Lakes Study Area during the 2009 and 2010 field surveys. Two licks were found in 2009; one above Gladstone Lake A and one above Gladstone Lake B. In 2010, two additional licks were found; one along the mid to lower sections of Isaac Creek and another above the mid section of Gladstone Creek. All four of the mineral licks detected within the Gladstone Lakes Study Area are situated on the north side of the Gladstone and Isaac valleys and are at relatively low elevations. The location of each of these licks is displayed on the Aquatic and Terrestrial Mammal Assessment Locations maps located in Appendix A.

Soil samples were acquired from each of the licks and sent in for analysis of trace metals. The results of the soils analysis from the Gladstone Lake A Mineral Lick and Gladstone Lake B Mineral Lick are presented in Appendix C, while the results of the soil analysis from the Isaac

Creek Mineral Lick are still pending at the time of this report. No soil samples were obtained for the Gladstone Creek Mineral Lick. Preliminary analysis of the soils analysis from the Gladstone A and B licks has been completed, with additional analysis to be completed once the results from all licks have been received.

A total of four motion-detecting cameras were set up at the Gladstone Lake A Mineral Lick and Gladstone Lake B Mineral Lick from late April to early July; and at the Isaac Creek Mineral Lick from mid May to early July. The cameras were deployed to determine the species using the licks, the timing and the amount of use of the licks. Each camera recorded the date and time a photo was taken, the temperature at the time of the photo, the moon phase and on the Moultrie cameras, the barometric pressure. Analysis of this data is currently ongoing, although a summary of the data collected is outlined in Table 4. Based on the preliminary review of the photos, both Gladstone A and B Mineral Licks are used almost exclusively by Dall's sheep, while the Isaac Creek Mineral Lick has a more diverse use. The photos of the various species at the Isaac Creek Mineral Lick is likely due to its being adjacent to Isaac Creek and the camera being placed along an established wildlife trail, although all of the ungulates photographed there appeared to be using the lick.

Table 4. Summary of motion-detection camera data collected at three mineral licks in the Gladstone Lakes Study Area during the 2010 season.

Camera Type	Location	Start Date	End Date	# Photos Obtained	Species Observed
Moultrie M60	Gladstone A Mineral Lick	Apr. 28, 2010	Jun. 1, 2010	769	Arctic Ground Squirrel Dall's Sheep Gray Jay Black Bear
Reconyx P800	Gladstone A Mineral Lick	May 15, 2010	Jul. 8, 2010	8445	Arctic Ground Squirrel Dall's Sheep Gray Jay Human
Moultrie M60	Gladstone B Mineral Lick	Apr. 28, 2010	Jul. 7, 2010	294	Black-billed Magpie Dall's Sheep Grizzly Bear Wolf
Reconyx P800	Isaac Creek Mineral Lick	May 15, 2010	Jul. 7, 2010	1115	Black-billed Magpie Coyote Dall's Sheep Grizzly Bear Human Moose Porcupine Wolf Wood Bison Woodland Caribou

Incidental Observations

Numerous incidental observations were made during the 2009 and 2010 fieldwork. These observations documented the presence and habitat use of 16 different wildlife species including: voles, arctic ground squirrel, red squirrel, collared pika, bushy-tailed woodrat, snowshoe hare, porcupine, beaver, muskrat, lynx, grey wolf, grizzly bear, moose, wood bison, Dall's sheep, and woodland caribou. These observations are discussed below in the Discussion section.

Terrestrial Invertebrate Observations

A variety of terrestrial invertebrate species were identified within the Gladstone Lakes Study Area including eight land snails, ten butterflies, three damselflies, four dragonflies and three bee species (see Appendix D). Of the species observed, one damselfly and two dragonflies were not identifiable to species in the field, while one butterfly species is being reviewed by a species expert. The species were found in a range of habitats but were concentrated within the lower valley areas that were surveyed more intensively. More details on these observations are available in the short summary reports by Forsyth (2011) and Rach and Turney (2011).

DISCUSSION

The 2009 and 2010 field surveys within the Gladstone Lakes Study Area documented evidence of habitat use by 22 terrestrial and aquatic mammal species (see Table 5).

Table 5. Mammal species detected in the Gladstone Lakes Study Area in 2009 and 2010.

Common Name	Scientific Name	Common Name	Scientific Name
Arctic Ground Squirrel	*Spermophilus parryii*	Lynx	*Lynx canadensis*
Beaver	*Castor canadensis*	Moose	*Alces alces*
Black Bear	*Ursus americanus*	Muskrat	*Ondatra zibethicus*
Bushy-tailed Woodrat	*Neotoma cinerea*	Northern River Otter	*Lutra canadensis*
Collared Pika	*Ochotona collaris*	Porcupine	*Erethizon dorsatum*
Coyote	*Canis latrans*	Red Squirrel	*Tamiasciurus hudsonicus*
Dall's Sheep	*Ovis dalli dalli*	Snowshoe Hare	*Lepus americanus*
Grey Wolf	*Canis lupus*	Wolverine	*Gulo gulo*
Grizzly Bear	*Ursus arctos*	Wood Bison	*Bison bison*
Hoary Marmot	*Marmota caligata*	Woodland Caribou	*Rangifer tarandus caribou*
Least Chipmunk	*Tamias minimus*	Vole sp.	

Species of Concern

Of the species observed within the Gladstone Lakes Study Area, five are listed as species of conservation concern within the Yukon and/or Canada. Wood bison has been listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Threatened, while woodland caribou, grizzly bear and wolverine are listed as Species of Special Concern (COSEWIC 2010). No additional mammal species in the Yukon are currently listed as Candidate Species for assessment by COSEWIC (COSEWIC 2011). At the territorial level, species experts in the Yukon have ranked the wood bison as a Species at Risk, while woodland caribou, collared pika, grizzly bear, and wolverine are listed as Sensitive (Cannings and Jung 2010). A summary of the status of these species is provided in Table 6.

Ungulates

Dall's sheep are prevalent within the Gladstone Lakes Study Area (the winter survey counted 178 sheep within the study area), particularly on the upper portions of south and south-east facing slopes on the north side of the valley and the alpine areas above these slopes. The upper slopes provide critical escape terrain for sheep, while the mid slopes and alpine areas above these slopes provide foraging opportunities. In the winter, a critical time for all ungulate species, the south and south-east facing slopes are largely snow-free and allow the sheep access to food resources. Sheep were observed on other slopes within the Gladstone Lakes Study Area

including north-facing slopes in the summer, and slopes with north or west aspects which were exposed by the prevailing winds in the winter; however, the majority of the sheep observed were associated with south or south-east facing slopes. The Aquatic and Terrestrial Mammal Assessment Observations maps in Appendix A show areas were sheep observed during the winter aerial survey; Figure 3 displays a couple of photos of some of these areas. Dall's sheep appear to be one of the main species frequenting all four of the mineral licks located within the Gladstone Lakes Study Area.

Table 6. Status of Species of Conservation Concern within the Gladstone Lakes Study Area.

Species	COSEWIC Status[1]	Yukon Ranking[2]
Wood Bison	Threatened	At Risk
Woodland Caribou	Special Concern	Sensitive
Collared Pika	Not Assessed	Sensitive
Grizzly Bear	Special Concern	Sensitive
Wolverine	Special Concern	Sensitive

[1] COSEWIC (2010); [2] Cannings and Jung (2010)

Figure 3. Dall's sheep habitat in the Gladstone Lakes Study Area.

Wood bison and evidence of bison were recorded numerous times during the field surveys in the Gladstone Lakes Study Area. Aerial surveys observed groups of up to ten wood bison within the study area in both the late winter and early spring surveys. The motion-detection camera set up at the Isaac Creek Mineral Lick photographed bison at the lick several times in May and June 2010. And ground-based surveys found excrement, tracks, and hair throughout the study area. Although they appear to use habitats throughout the Gladstone Lakes Study Area, evidence of wood bison was much more concentrated within the Isaac drainage than in the Gladstone drainage (see the Aquatic and Terrestrial Mammal Assessment Observations maps in Appendix A). The majority of use was located within wetland and meadow habitats and the mid-valley terraces along Isaac Creek and the Isaac Lakes. These terraces are composed of a mixture of dry, coniferous forests interspersed with small wetlands and grassy slopes. In particular, the grassy slopes showed a high concentration of use by buffalo. Figure 4 shows some of the habitat used by bison within the Gladstone Lakes Study Area including a large wetland along Isaac Creek and the grassy slopes below the mid-valley terraces above Isaac Lake D.

Observations of moose and moose sign (e.g. tracks, pellets etc.) were limited within the Gladstone Lakes Study Area. Moose were documented during both the winter and summer seasons indicating a year-round presence, however, numbers appear to be relatively low. Most

of the observations were associated with extensive high value willow-dominated habitats along the valley bottoms, often in riparian areas. Figure 5 shows photos of moose habitat within the Gladstone Lakes Study Area.

Woodland caribou sign and animal observations were made in several areas within the Gladstone Lakes Study Area. The numbers using the area appears to be limited, however, based on the field assessments. Only a few observations of individuals or small groups of caribou were made during the aerial surveys, and ground-based surveys did not find evidence of high-levels of use. Although limited evidence of use was observed, extensive high and moderately-high value habitats were identified for caribou within the Gladstone Lakes Study Area. These habitats generally had a significant component of terrestrial lichens within the ground cover and included open Spruce-Scrub Birch forests and open Scrub Birch habitats along glacio-fluvial terraces within the Gladstone and Isaac drainages, and alpine areas above the valleys. Figure 6 shows some of the terrestrial lichen habitats used by caribou within the Gladstone Lakes Study Area. Maps in Appendix A show the location of all caribou observations made during the 2009 and 2010 field surveys.

Figure 4. Wood bison habitat in the Gladstone Lakes Study Area.

Figure 5. Moose habitat in the Gladstone Lakes Study Area.

Figure 6. Woodland caribou habitat in the Gladstone Lakes Study Area.

Carnivores

Grizzly bear and evidence of grizzly bear were noted several times throughout the field surveys. In 2009, a large male grizzly was observed foraging in low shrubs within the Gladstone Creek valley (see Figure 7). In 2010, a female grizzly and yearling cub were photographed at the Isaac Creek Mineral Lick, and a single grizzly bear was photographed at the Gladstone Lake B Mineral Lick. Additionally, grizzly tracks and other sign were noted in various habitats and along the trail system used by guide outfitters within the Gladstone Lakes Study Area (see the Aquatic and Terrestrial Mammal Assessment Observations maps in Appendix A). High and moderately-high value habitats identified for bears included wetlands, habitats with a high density of small mammals (e.g. arctic ground squirrel colonies) and areas with a significant amount of berry-producing shrubs.

Black bear were documented twice during field work within the study area. Once during an aerial survey, when an adult bear was observed travelling along a forested slope above Isaac Creek near Sekulmun Lake. Another observation was from the motion-detection cameras on Gladstone Lick A, where a black bear was photographed and then chewed on the camera. Several other observations of bear sign were made that could not be identified to species, but most of the bear observations within the Gladstone and Isaac Valleys were of grizzly bear.

Figure 7. Grizzly bear foraging (September 5, 2009) and tracks on the ice (March 22, 2010) in the Gladstone Creek drainage.

At least one wolf pack is present within the Gladstone Lakes Study Area. The field work in 2009 identified several potential dens sites along Gladstone Creek and the July 2010 surveys confirmed that one of these sites was active, with at least three pups at the site and four adult wolves observed nearby. Another potential wolf den was located above Isaac Creek, although this den was not observed to be active during field work in 2010 and it is not known whether it is used by the same wolf pack or if a second pack inhabits portions of the Gladstone Lakes Study Area. All four identified den sites are on the north side of the valley below high value Dall's sheep habitat and in close proximity to mineral licks. The remains of two sheep were identified at the active den site and a recent kill observed at the Gladstone Lake B Mineral Lick, indicate that the sheep are likely a significant food source for these animals. As well as the observations around the dens, wolves and wolf sign were noted in several other locations throughout the study area, including being photographed at the Gladstone Lake B Lick and the Isaac Creek Lick.

Wolverine tracks were noted in several areas during the winter and early spring aerial surveys, primarily within a number of alpine areas above Gladstone Lake D and upper Gladstone creek and crossing Isaac Lake A when tracks were easier to detect in the snow. A wolverine was also observed walking within forested habitat along Gladstone Creek. The Aquatic and Terrestrial Mammal Assessment Observations maps in Appendix A show the location of all wolverine observations within the Gladstone Lakes Study Area.

Lynx tracks were only noted a few times during the field surveys and these observations were generally tied to areas with higher numbers of snowshoe hare. Coyote scat was detected once in the Gladstone Lakes Study Area and one individual was photographed by the motion-detection camera at the Isaac Creek Mineral Lick.

Aquatic Mammals

Beaver, muskrat and northern river otter were all detected within the Gladstone Lakes Study Area. River otter was only detected once during the field surveys when a group of four otters was observed swimming in Isaac Lake A in September 2009). Muskrat were only observed in a few areas, while beaver appear relatively common within the study area.

One of the key objectives of the early spring aerial surveys was to document the presence of muskrat within the Gladstone Lakes Study Area through the location of push-ups. Push-ups are mounds of vegetation that appear on the ice where muskrats have made a small area under the snow for resting and feeding in the winter. The surveys located three water bodies within the Gladstone Lakes Study Area that contained push-ups: Gladstone Creek just downstream of the outlet of Gladstone Lake D, Isaac Lake D and Isaac Lake E (see the Aquatic and Terrestrial Mammal Assessment Observations maps in Appendix A). Muskrat tracks and scat were also noted several times during various field surveys. Figure 8 shows some photos of Isaac Lake E, one of the areas in which muskrat were documented.

Observations of beaver, beaver dams and lodges, as well as other beaver sign were found throughout the Gladstone Lakes Study Area. A total of 19 beaver lodges were identified within the lake, pond, stream and wetland habitats within the Gladstone and Isaac drainages (see the Aquatic and Terrestrial Mammal Assessment Observations maps in Appendix A). Twelve of the lodges were identified as active, four were inactive during field visits and the status of the remaining three lodges was not able to be determined. Except for Isaac Lake B and C, the remainder of the lakes within the Gladstone Lake Study Area have at least one beaver lodge present, and many have more than one. Both Gladstone and Isaac Creek have beaver dams and lodges present along them, although many of these structures do not appear to be maintained. Many dams on Isaac Creek do not appear active and have been breached by the creek. Figure 9 shows some of the beaver habitat present within the study area.

Figure 8. Muskrat habitat in the Gladstone Lakes Study Area at Isaac Lake E.

Figure 9. Beaver habitat in the Gladstone Lakes Study Area at Gladstone Lake B and Isaac Creek.

Small and Medium-sized Mammals

Evidence of Arctic ground squirrels was common throughout the Gladstone Lakes Study Area and they are likely a key prey species for many of the raptor and mammalian predators. Colonies were located in a wide variety of habitats ranging from valley bottom to alpine and included grassy slopes, shrub-dominated sites, deciduous forests and even sub-alpine tundra. Although they varied significantly in structure, the colonies were generally located on sites with drier soils and some grasses and herbaceous plants present. Figure 10 shows some of the habitat types in which arctic ground squirrel colonies were located. The photo on the right outlines habitats where colonies were found, including the grassy knolls in the foreground, the shrub and forested habitats between knolls and on the steeper, more scarcely vegetated slopes in the background.

Collared pika were only noted twice during the field surveys, and in both cases the animals were heard calling from boulder fields or talus slopes at upper and mid elevations. The Aquatic and Terrestrial Mammal Assessment Observations maps located in Appendix A shows the locations of all pika detections.

Figure 10. Arctic ground squirrel habitat within the Gladstone Lakes Study Area.

Other small and medium-sized mammals observed within the Gladstone Lakes Study Area included hoary marmot, bushy-tailed woodrat, least chipmunk, red squirrel, snowshoe hare, porcupine and vole sp.. Hoary marmots were detected twice in sub-alpine habitats above the Gladstone valley, while the least chipmunk was only detected once near the Gladstone Lake B Mineral Lick. A bushy-tailed woodrat was also only observed once, when a juvenile woodrat was found by a fisheries crew in the stomach of a trout caught in Gladstone Lake A. Evidence of woodrat (packrat) dens were noted on various rock faces by their urea wash throughout the study area. Red squirrel and snowshoe hare were all detected several times throughout the field surveys, mostly in forested or shrub habitats along the valley bottom or on mid-valley terraces. Neither of these species appeared to be abundant within the Gladstone Lakes Study Area. Porcupine were detected nine times with the motion-detection camera at the Isaac Creek Lick and there were many trees that exhibited porcupine feeding damage as well as it appeared that porcupines were occupying the wolf dens sites at times based on the amount of scat and hair/quills present.

Wildlife Features

Mineral Licks

The Gladstone Lake A Mineral Lick is located at the base of the north wall of the Gladstone Valley at an elevation of 1180 m approximately half-way along Gladstone Lake A (Figure 11). The lick area is somewhat dome-shaped and appears to be a remnant from glacial deposition. There are five main sites within the lick area from which animals appear to be accessing minerals (Figure). Soil samples were taken at four of these sites from the layer that the

Figure 11. Location of Gladstone Lake A Mineral Lick site.

Figure 12. Photos of the Gladstone Lake A Mineral Lick and Dall's sheep at the site.

Figure 12 (cont'd). Photos of the Gladstone Lake A Mineral Lick and Dall's sheep at the site.

animals have excavated. Controls were also acquired at these same sites from soil layers above the dug-out areas and two additional controls were sampled above and beside the lick area. Preliminary analysis of the trace minerals results (see Appendix C) indicates that the lick soils contain higher levels of many trace minerals as compared to both the in-lick and outside controls. For example, the lick soils contain roughly twice as much calcium and sodium as the control soils. Photos acquired from the motion-detecting camera at this site indicate that the lick is used almost exclusively by Dall's sheep, with groups of 20+ animals observed at the site.

The Gladstone Lake B Mineral Lick sits at the base of the north wall of the Gladstone Valley just off the lake at an elevation of approximately 1187 m (Figure 13). There are eight main sites within the lick area from which animals appear to be accessing minerals. Soil samples were obtained from four of these sites to analyse. At each lick site, two soil samples types were collected, one from the target layer and a control sample from the soils closer to the surface which did not appear to be utilized by the animals. Preliminary analysis of the trace metals data (see Appendix C) reveals that the lick soils have approximately three times more calcium than the controls, 1.4 times more potassium, and over 2.5 times more sodium and strontium than the controls. As with the Gladstone Lake A Mineral Lick, motion-detecting camera at the Gladstone Lake B Mineral Lick was used almost exclusively by Dall's sheep (Figure 14).

Figure 13. Location of the Gladstone Lake B Mineral Lick site.

Figure 14. Photos of the Gladstone Lake B Mineral Lick and Dall's sheep at the site.

The Isaac Creek Mineral Lick is on the north side of Isaac Creek at an elevation of approximately 1070 m, where erosion from the creek has exposed the mineral soils. The formation of the lick appears to be similar to the Gladstone Lake A and B Mineral Licks in that glacial deposits have created a dome-shaped lobe of fine textured soils (Figure 15). Based on the motion-detection camera images, the Isaac Creek Mineral Lick appears to be frequented by a more diverse array of species than the two Gladstone Lakes licks (Figure 16). This is likely due to the site being adjacent to Isaac Creek, which appears to be used as a travel route. The camera captured bison, caribou, moose and Dall's sheep licking at the lick soils, and photographed grizzly bear, wolf, porcupine and a coyote moving along the wildlife trail beside the lick.

Figure 15. Location of the Isaac Creek Mineral Lick site.

Figure 16. Photos of wildlife species photographed at the Isaac Creek Mineral Lick site.

The Gladstone Creek Mineral Lick is situated on the slope of a small bench to the north of Gladstone creek. The lower sections of the lick are at approximately 1063 m, while the upper extent of the lick is at about 1084 m. The lick contains numerous sites where the animals appear to be accessing the minerals and the entire lick area is approximately 110 m across and 50 m wide (Figure 17). Numerous fresh tracks from Dall's sheep were noted at the lick when it was first located on July 4, 2010, and we noted that one of the lower lick sites appeared to have been at least temporarily taken over by a porcupine as a den.

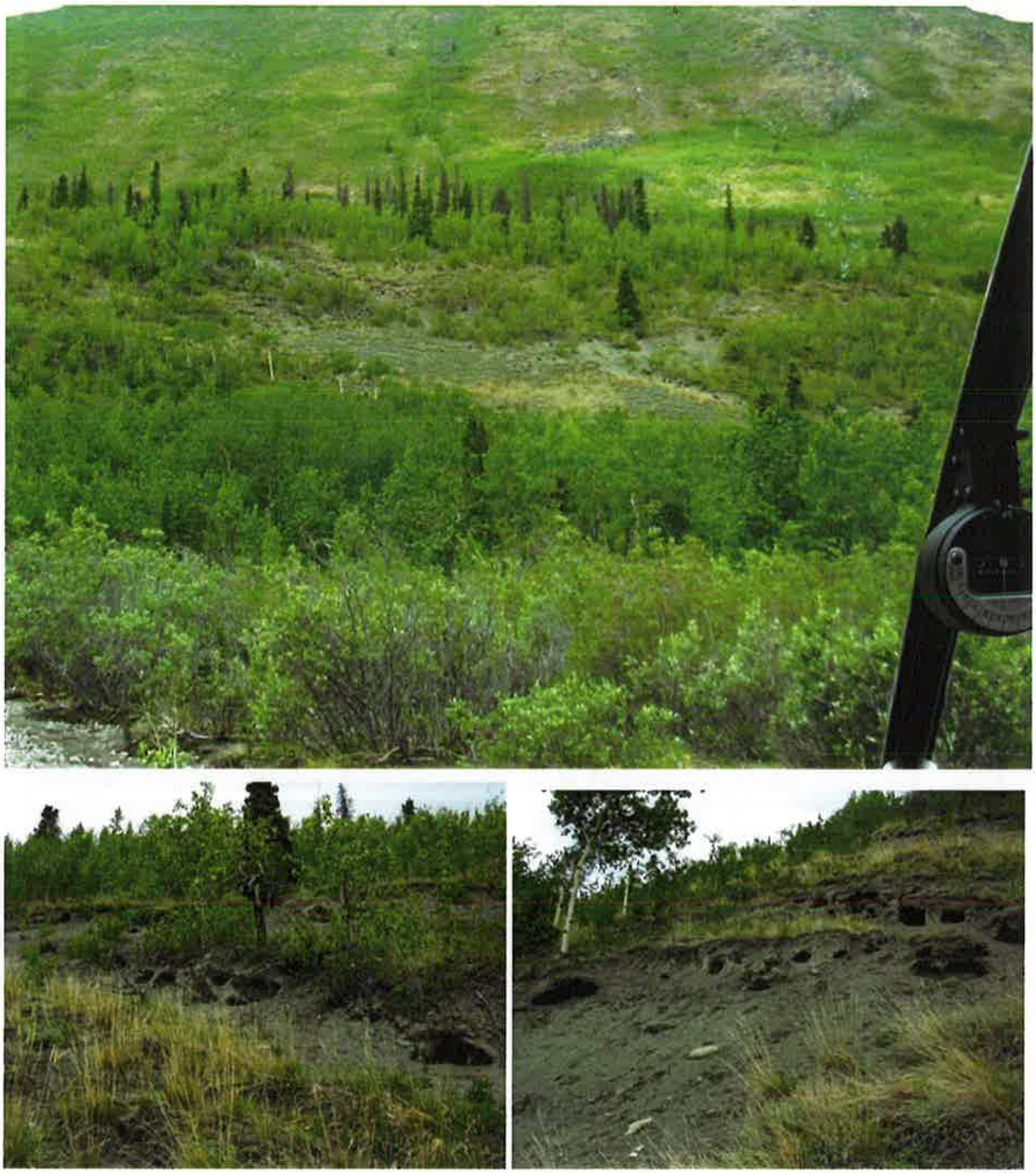


Figure 17. Photos of the Gladstone Creek Mineral Lick site.

Wildlife Trails

Due to the nature of the proposed Gladstone Diversion Concept, we made a dedicated effort to locate any wildlife trails crossing between the north and south valley walls of the Gladstone and Isaac drainages as well as identifying any trails running along the valley sidewalls. Based on both ground and aerial surveys, no significant trails crossing the valley were located, although there were several trails that run parallel to the valley along the valley sidewalls. The most extensive trail system in the drainages are the trails used by the guide-outfitters, which generally

run along the north side of the Isaac Valley and the south side of the Gladstone Valley with offshoots into side drainages and up into the alpine. Wildlife sign observed along the trails indicates that numerous wildlife species also use this trail system to move through the valleys. Discussions with the Human Environment team regarding the historic use of this trail by First Nations have been initiated to provide additional information on wildlife use observed by First Nations.

Terrestrial Invertebrates

The observations of terrestrial invertebrates within the Gladstone Lakes Study Area are provided for information and documentation purposes only as our objectives were to document terrestrial and aquatic mammal use rather than a comprehensive survey of terrestrial invertebrates. None of the invertebrates observed in the study area are listed by COSEWIC (2010) or being tracked by the Yukon Conservation Data Centre (YT CDC 2011).

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Baseline environmental studies on aquatic and terrestrial mammals were conducted within the Gladstone Lakes Study Area in 2009 and 2010, and included aerial surveys, reconnaissance-level ground-based surveys, Wildlife Habitat Assessment plots, investigation and documentation of mineral licks, and collection of incidental observations. These surveys documented 22 terrestrial and aquatic mammal species within the study area, including five species of conservation concern within the Yukon and/or Canada.

Four species of ungulates were found within the Gladstone Lakes Study Area. Dall's sheep are prevalent throughout the area, particularly on the south and south-east facing slopes on the north side of the valley, and the alpine habitats above these slopes. Wood bison appear to use habitats throughout the study area; however, use is mostly concentrated within the Isaac drainage, particularly, within drier wetland habitats and the mid-valley terraces along Isaac Creek and the Isaac Lakes. Moose and woodland caribou are present throughout the study area in relatively low numbers. Moose observations were generally associated with extensive willow-dominated habitats along the valley bottoms, while caribou habitat generally included a significant component of terrestrial lichens.

Several large and mid-sized carnivores were found within the Gladstone Lakes Study Area. Grizzly bear and grey wolf were both documented several times during field surveys in the area and appear to be relatively common. At least three different grizzly bears were seen or photographed within the survey area, and several observations of tracks, hair and other sign were documented. Observations of wolves and wolf sign were also made numerous times throughout the survey period; one wolf pack was documented within the study area, and it is possible that one or more additional wolf packs also use portions of the study area. Additionally, wolverine and evidence of wolverine was noted several times throughout the study area in habitats ranging from valley bottom to alpine plateau. Black bear, lynx and coyote were also recorded within the study area; however, observations relating to these species were less common.

Several species of small and mid-sized aquatic and terrestrial mammals were detected within the Gladstone Lakes Study Area including beaver, muskrat, northern river otter, arctic ground squirrel, collared pika, hoary marmot, bushy-tailed woodrat, least chipmunk, red squirrel, snowshoe hare, porcupine and vole sp.. Beaver appear common throughout the area and beaver dams and lodges are present on most of the water bodies within the study area. Arctic

ground squirrels are also relatively abundant with colonies found in a wide variety of habitats throughout the study area

Field surveys within the Gladstone Lakes Study Area also located and surveyed four mineral licks: one above Gladstone Creek downstream of the Gladstone Lakes, one above Gladstone Lake B, one above Gladstone Lake A, and one along the mid to lower sections of Isaac Creek.

Recommendations

Further work is recommended in several areas to gain a better understanding of habitat use by terrestrial and aquatic mammals within the Gladstone Lakes Study Area. These include:

- Further analysis of mineral lick soils within the valley once the trace metals analysis results have been received, as well as, further analysis of the photos acquired through motion-detection cameras at three of the licks.
- A second winter aerial survey looking at winter habitat use by wildlife within the Gladstone Lakes Study Area.
- Confirmation of the status of all beaver lodges within the Gladstone Lakes Study Area (active versus inactive).

REFERENCES

Cannings, S.G. and T.S. Jung. 2010. Vertebrates of conservation concern in the Yukon: 2010 status ranking. Available at: http://www.environmentyukon.gov.yk.ca/wildlifebiodiversity/documents/cdc_vertebrate_status.pdf. (Accessed January 2011).

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2010. Canadian wildlife species at risk. Committee on the Status of Endangered Wildlife in Canada. Available at: http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.cfm (Accessed January 2011).

Committee on the Status of Endangered Wildlife in Canada. (COSEWIC). 2011. Candidate wildlife species. Available at: http://www.cosewic.gc.ca/eng/sct3/index_e.cfm (Accessed March 2011).

Environmental Canada. 2010. National Climate Data and Information Archive - Environment Canada. Available at http://climate.weatheroffice.gc.ca (Accessed December 2010).

Forsyth, R. 2011. Identification of land snails from the Yukon Territory and Atlin Lake, British Columbia. Unpublished report. 6 pp. + appendix.

Ministry of Environment, Lands and Parks and Ministry of Forests (MOELP and MOF). 1998. Field manual for describing terrestrial ecosystems. Land Management Handbook 25. Ministry of Environment and Ministry of Forests, Prov. of BC, Victoria, BC.

Rach, L. and L. Turney. 2011. Terrestrial insects identified from the Gladstone and Isaac watersheds, Yukon Territory. Unpublished report. 11 pp.

Resource Inventory Committee (RIC). 1999. British Columbia wildlife habitat rating standards - Version 2.0. BC Ministry of Environment, Lands and Parks. Victoria, BC. 97 pp.

Resources Inventory Committee (RIC). 1998a. Ground-based inventory methods for selected ungulates: moose, elk and deer. Standards for Components of British Columbia's Biodiversity No. 33. Version 2.0. BC Ministry of Environment, Lands and Parks. Victoria, BC. 53 pp.

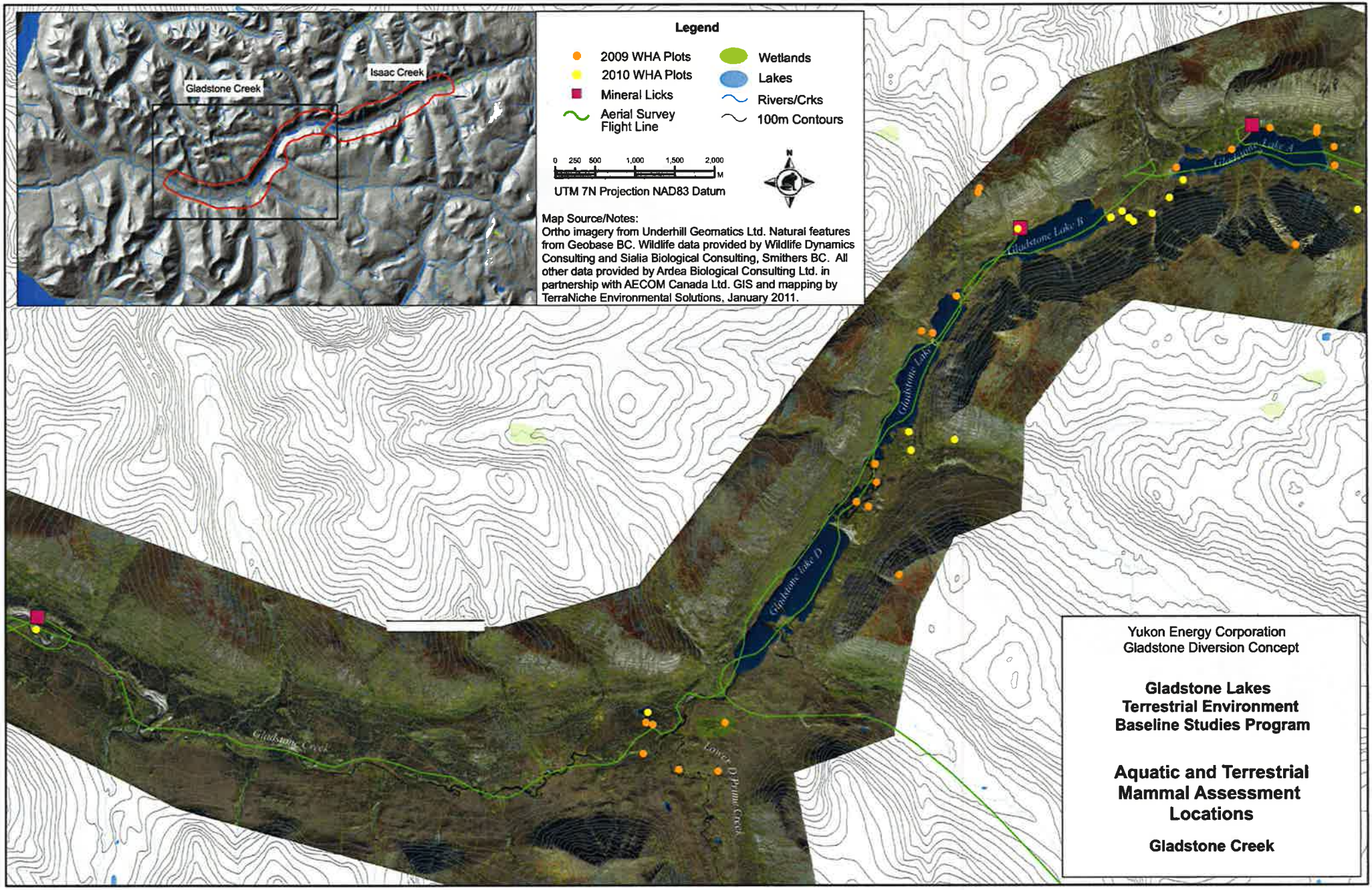
Resources Inventory Committee (RIC). 1998b. Inventory methods for beaver and muskrat. Standards for Components of British Columbia's Biodiversity No. 22. Version 2.0. BC Ministry of Environment, Lands and Parks. Victoria, BC. 33 pp.

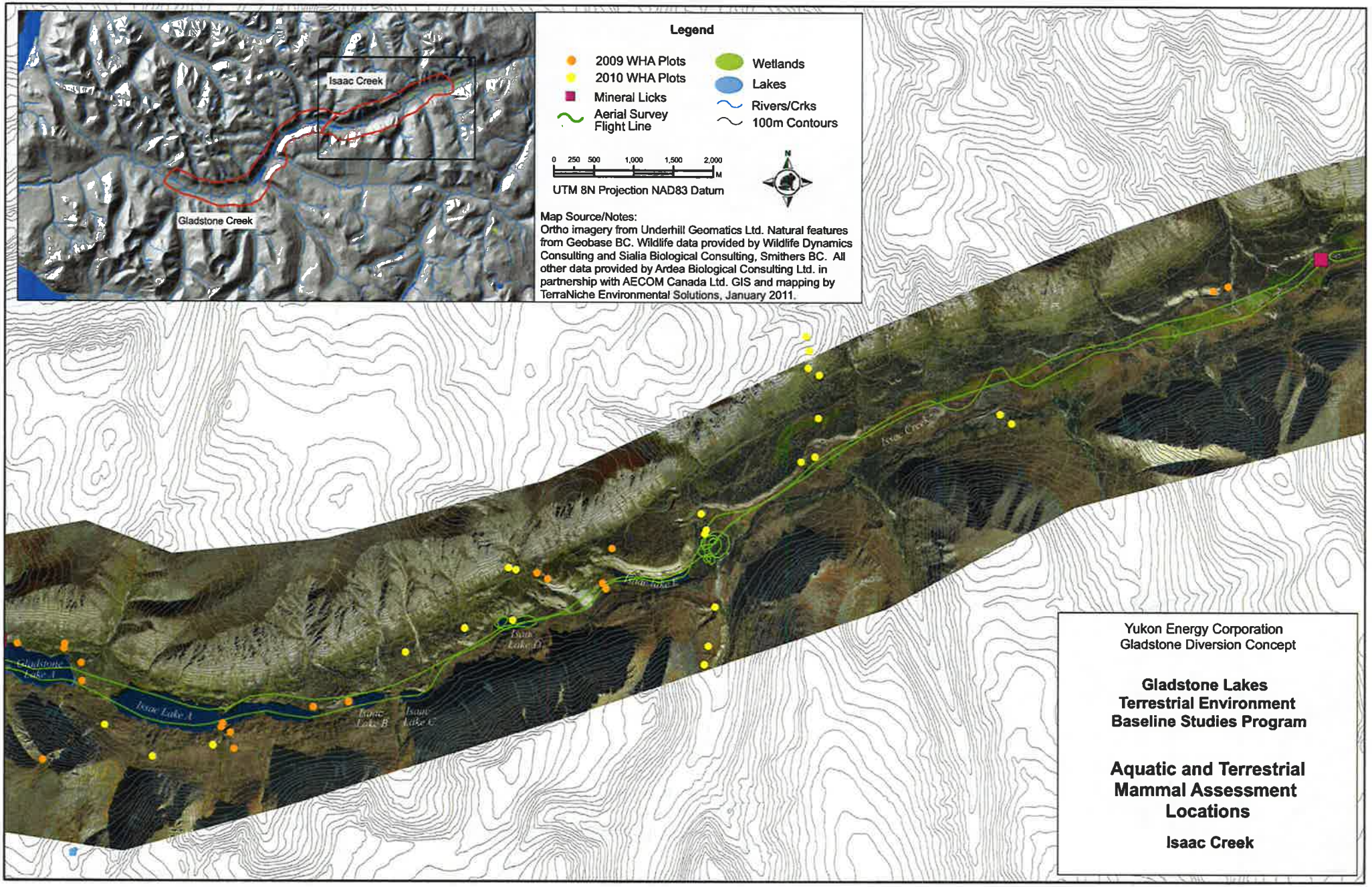
Resources Inventory Committee (RIC). 2002. Aerial-based inventory methods for selected ungulates: bison, mountain goat, mountain sheep, moose, elk, deer and caribou. Standards for Components of British Columbia's Biodiversity No. 32. Version 2.0. BC Ministry of Sustainable Resource Management. Victoria, BC. 91 pp.

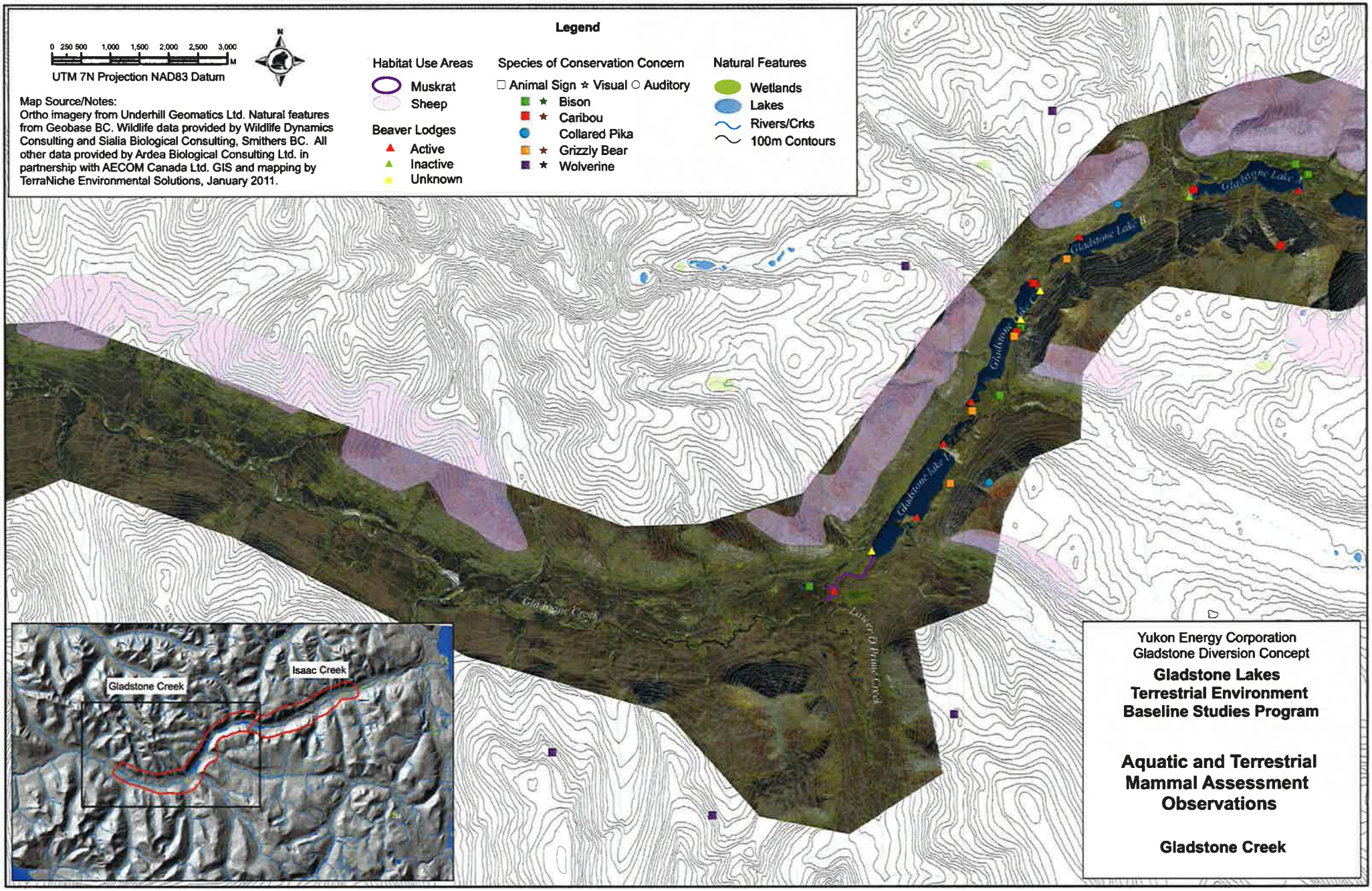
Yukon Ecoregions Working Group (YEWG). 2004. Ruby Ranges. In: Ecoregions of the Yukon Territory: Biophysical properties of Yukon landscapes, C.A.S. Smith, J.C. Meikle and C.F. Roots (eds.), Agriculture and Agri-Food Canada, PARC Technical Bulletin No. 04-01, Summerland, British Columbia, p. 179-186.

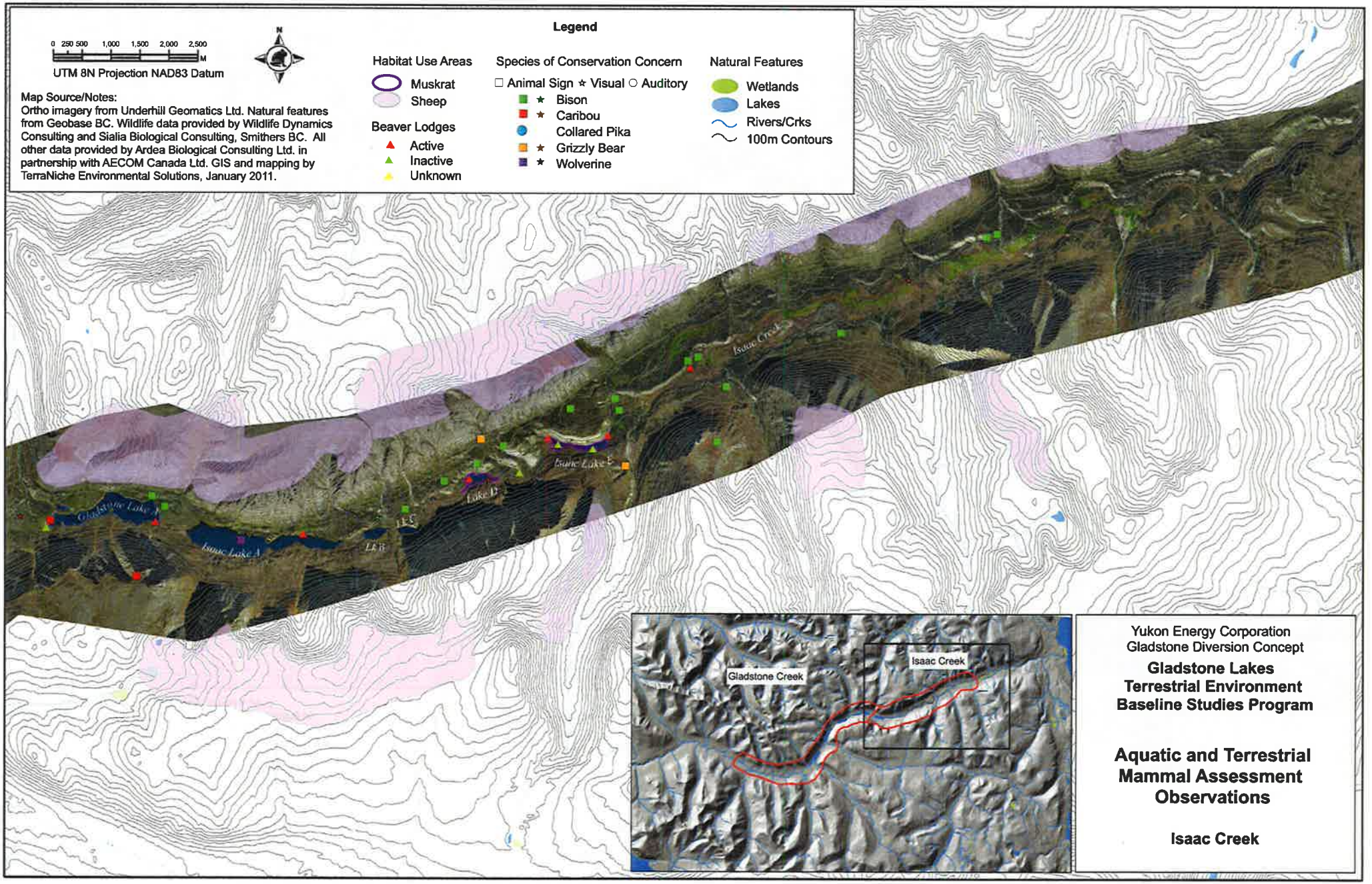
Yukon Conservation Data Centre (YT CDC). 2011. Invertebrate tracking list. Unpublished Excel spreadsheet prepared by the Yukon Conservation Data Centre (YCDC_Invert_TrackList_Apr23011.xls.)

APPENDIX A: REPORT MAPS.


Gladstone Creek
Isaac Creek
Legend
2009 WHA Plots
2010 WHA Plots
Mineral Licks
Aerial Survey Flight Line
Wetlands
Lakes
Rivers/Crks
100m Contours
0 250 500 1,000 1,500 2,000 M
N
UTM 7N Projection NAD83 Datum
Map Source/Notes:
Ortho imagery from Underhill Geomatics Ltd. Natural features from Geobase BC. Wildlife data provided by Wildlife Dynamics Consulting and Sialia Biological Consulting, Smithers BC. All other data provided by Ardea Biological Consulting Ltd. in partnership with AECOM Canada Ltd. GIS and mapping by TerraNiche Environmental Solutions, January 2011.
Gladstone Lake B
Gladstone Lake C
Gladstone Lake D
Gladstone Creek
Lower D Pup
Yukon Energy Corporation
Gladstone Diversion Concept
Gladstone Lakes
Terrestrial Environment
Baseline Studies Program
Aquatic and Terrestrial
Mammal Assessment
Locations
Gladstone Creek


Isaac Creek
Gladstone Creek
Legend
2009 WHA Plots
2010 WHA Plots
Mineral Licks
Aerial Survey Flight Line
Wetlands
Lakes
Rivers/Crks
100m Contours
0 250 500 1,000 1,500 2,000 M
UTM 8N Projection NAD83 Datum
N
Map Source/Notes:
Ortho imagery from Underhill Geomatics Ltd. Natural features from Geobase BC. Wildlife data provided by Wildlife Dynamics Consulting and Sialia Biological Consulting, Smithers BC. All other data provided by Ardea Biological Consulting Ltd. in partnership with AECOM Canada Ltd. GIS and mapping by TerraNiche Environmental Solutions, January 2011.
Isaac Lake A
Isaac Lake B
Isaac Lake C
Isaac Lake D
Isaac Creek
Yukon Energy Corporation
Gladstone Diversion Concept
Gladstone Lakes
Terrestrial Environment
Baseline Studies Program
Aquatic and Terrestrial
Mammal Assessment
Locations
Isaac Creek


0 250 500 1,000 1,500 2,000 2,500 3,000 M
UTM 7N Projection NAD83 Datum
N
Map Source/Notes:
Ortho imagery from Underhill Geomatics Ltd. Natural features from Geobase BC. Wildlife data provided by Wildlife Dynamics Consulting and Sialia Biological Consulting, Smithers BC. All other data provided by Ardea Biological Consulting Ltd. in partnership with AECOM Canada Ltd. GIS and mapping by TerraNiche Environmental Solutions, January 2011.
Legend
Habitat Use Areas
Muskrat
Sheep
Beaver Lodges
Active
Inactive
Unknown
Species of Conservation Concern
Animal Sign ☆ Visual ○ Auditory
Bison
Caribou
Collared Pika
Grizzly Bear
Wolverine
Natural Features
Wetlands
Lakes
Rivers/Crks
100m Contours
Gladstone Lake A
Gladstone Lake B
Gladstone Lake C
Gladstone Lake D
Gladstone Creek
Lower D Pothole Creek
Gladstone Creek
Isaac Creek
Yukon Energy Corporation
Gladstone Diversion Concept
Gladstone Lakes
Terrestrial Environment
Baseline Studies Program
Aquatic and Terrestrial
Mammal Assessment
Observations
Gladstone Creek


0 250 500 1,000 1,500 2,000 2,500
M
UTM 8N Projection NAD83 Datum
N
Map Source/Notes:
Ortho imagery from Underhill Geomatics Ltd. Natural features from Geobase BC. Wildlife data provided by Wildlife Dynamics Consulting and Sialia Biological Consulting, Smithers BC. All other data provided by Ardea Biological Consulting Ltd. in partnership with AECOM Canada Ltd. GIS and mapping by TerraNiche Environmental Solutions, January 2011.
Legend
Habitat Use Areas
Muskrat
Sheep
Beaver Lodges
Active
Inactive
Unknown
Species of Conservation Concern
Animal Sign ☆ Visual ○ Auditory
Bison
Caribou
Collared Pika
Grizzly Bear
Wolverine
Natural Features
Wetlands
Lakes
Rivers/Crks
100m Contours
Isaac Creek
Isaac Lake B
Lake D
Gladstone Lake A
Isaac Lake A
Lake E
Lake B
Gladstone Creek
Isaac Creek
Yukon Energy Corporation
Gladstone Diversion Concept
Gladstone Lakes
Terrestrial Environment
Baseline Studies Program
Aquatic and Terrestrial
Mammal Assessment
Observations
Isaac Creek

APPENDIX B: TERRESTRIAL AND AQUATIC MAMMAL OBSERVATIONS FROM 2009-2010 AERIAL SURVEYS IN THE GLADSTONE LAKES STUDY AREA.

Survey Date	Waypoint	Species	Observation Type	Activity Type	Number	General Area	Habitat	Comments
31/08/2009	251	Beaver	Sign	Lodge	2	Gladstone Lake D	Large Lake	2 lodges joined on lake
31/08/2009	254	Beaver	Sign	Lodge\ Dam	1, 1	Gladstone Lake D	Large Lake	Old lodge and dam near outflow
31/08/2009	260	Beaver	Visual	Swimming	1	Between Gladstone C and D	Slow Stream	
31/08/2009	262a	Beaver	Visual	Swimming	1	Between Gladstone C and D	Small Lake	Swimming with building material
31/08/2009	262b-d	Beaver	Sign	Lodge\ Dam	1, 2	Between Gladstone C and D	Small Lake	2 active dams and an active lodge near outflow of Lake C
31/08/2009	268	Beaver	Sign	Lodge	1	Gladstone Lake C	Small Lake	Lodge on lake edge
31/08/2009	271a	Beaver	Visual	Swimming	1	Gladstone Lake C	Small Lake	
31/08/2009	271b	Beaver	Sign	Lodge	1	Gladstone Lake C	Small Lake	
31/08/2009	272	Beaver	Sign	Lodge\ Dam	1, 1	Gladstone Lake C	Slow Stream	Small dam and lodge on creek
31/08/2009	273	Beaver	Sign	Lodge	1	Gladstone Lake B	Small Lake	On edge of Gladstone B
31/08/2009	286	Beaver	Sign	Lodge	1	Isaac Lake A	Large Lake	
31/08/2009	288	Beaver	Sign	Lodge	1	Isaac Lake D	Pond	
31/08/2009	289	Beaver	Sign	Lodge	1	Between Isaac Lake D and E	Fast Stream	Old lodge - Dry
31/08/2009	290a	Beaver	Sign	Lodge\ Dam	1, 1	Isaac Lake E	Pond	
31/08/2009	291	Beaver	Sign	Lodge	1	Isaac Lake E	Pond	
31/08/2009	292	Beaver	Sign	Dam	3	Isaac Lake E	Pond	Series of 3 dams in narrow portion of lake
31/08/2009	293	Beaver	Sign	Lodge	1	Isaac Lake E	Pond	Old lodge on side of lake
31/08/2009	294a	Beaver	Sign	Lodge\Dam	1, 1	Isaac Lake E	Pond/Slow Stream	Active
31/08/2009	295b	Beaver	Sign	Lodge	1	Isaac Creek	Pond	Active lodge in small pond along creek.
22/03/2010	08	Wolverine	Sign	Tracks	2	On ridge top south of Gladstone Creek	Alpine Unvegetated	<1m snow

Survey Date	Waypoint	Species	Observation Type	Activity Type	Number	General Area	Habitat	Comments
22/03/2010	09	Wolverine	Sign	Tracks	1	On ridge top south of Gladstone Creek	Alpine Unvegetated	
22/03/2010	10	Wolverine	Sign	Tracks	1	On ridge top south of Gladstone Creek and east of D-Prime.	Alpine Unvegetated	
22/03/2010	11	Snow Machine	Sign	Tracks	2	On ridge top south of Gladstone D.	Shrub-Carr	Snowmachine tracks
22/03/2010	12	Dall's Sheep	Sign	Tracks		On south-facing slope south of Gladstone D.	Alpine Unvegetated	mod-abundant tracks
22/03/2010	13	Dall's Sheep	Visual	Travelling, walking	13	On south-facing slope south of Gladstone D.	Alpine Tundra	mixed flock ewes and lambs
22/03/2010	14	Snow Machine	Sign	Tracks	2	On ridge top south of Gladstone C.	Shrub-Carr	Snowmachine tracks
22/03/2010	15	Dall's Sheep	Sign	Tracks		On ridge top south of Gladstone C.	Alpine Unvegetated	
22/03/2010	16	Dall's Sheep	Visual	Travelling, walking	4	On ridge top south of Gladstone C.	Alpine Tundra	
22/03/2010	17	Dall's Sheep	Visual	Travelling, walking	3	On ridge top south of Gladstone A and Isaac Lake (quite a ways away).	Alpine Tundra	
22/03/2010	17	Dall's Sheep	Sign	Tracks		On ridge top south of Gladstone A and Isaac Lake (quite a ways away).	Alpine Tundra	
22/03/2010	18	Dall's Sheep	Sign	Tracks		On ridge top south of Isaac Lake B.	Alpine Tundra	
22/03/2010	19	Unspecified Ungulate	Sign	Traveling on a path		On ridge top south of Isaac Lake D.	Alpine Tundra	Summer trails
22/03/2010	20	Dall's Sheep	Visual	Travelling, walking	9	On ridge top south of Isaac Lake E.	Alpine Unvegetated	
22/03/2010	21	Bison	Sign	Tracks	1	On ridge south of Isaac Creek.	Alpine Tundra	
22/03/2010	22	Bison	Sign	Tracks		On ridge south of Isaac Creek.	Subalpine Shrub/Grassland	Trail from south side mountain top to Isaac valley floor, several animals
22/03/2010	23	Dall's Sheep	Visual	Travelling, walking	7	On ridge south of Isaac Creek.	Alpine Unvegetated	

Survey Date	Waypoint	Species	Observation Type	Activity Type	Number	General Area	Habitat	Comments
22/03/2010	23	Dall's Sheep	Sign	Tracks		On ridge south of Isaac Creek.	Alpine Unvegetated	
22/03/2010	24	Dall's Sheep	Sign	Tracks		On ridge south of Isaac Creek.	Alpine Tundra	tracks abundant
22/03/2010	25	Moose	Visual	Feeding	2	South of Isaac Creek in valley of a tributary stream.	Subalpine Shrub/Grassland	South valley feeding on willows
22/03/2010	26	Dall's Sheep	Visual	Travelling, walking	2	On ridge south of Isaac Creek.	Alpine Unvegetated	South facing slope into Isaac
22/03/2010	27	Unspecified Ungulate	Sign	Tracks		North side of valley, above Isaac Creek.	Alpine Tundra	Tracks abundant from summer
22/03/2010	28	Dall's Sheep	Visual	Travelling, walking	5	North side of valley, above Isaac Creek.	Alpine Unvegetated	
22/03/2010	29	Dall's Sheep	Visual	Travelling, walking	13	North side of valley, above Isaac Creek.	Alpine Tundra	ewes and lambs
22/03/2010	30	Dall's Sheep	Visual	Living	25	North side of valley, above Isaac Lake E.	Alpine Tundra	ewes, lambs and rams
22/03/2010	32	Dall's Sheep	Visual	Living	40	North side of valley, above Isaac Lake D.	Alpine Tundra	ewes, lambs and rams
22/03/2010	33	Dall's Sheep	Visual	Travelling, walking	3	North side of valley, above 1rst Isaac Lake.	Cliff	South facing mountain slope
22/03/2010	34	Dall's Sheep	Visual	Travelling, walking	3	North side of valley, above 1rst Isaac Lake.	Cliff	South facing mountain slope
22/03/2010	35	Dall's Sheep	Visual	Travelling, walking	17	North side of valley, above Gladstone A.	Alpine Tundra	South facing mountain slope
22/03/2010	36	Unspecified Ungulate	Sign	Tracks		North side of valley, above Gladstone B.	Alpine Tundra	Tracks abundant
22/03/2010	37	Wolverine	Sign	Tracks		North side of valley, above Gladstone B.	Alpine Tundra	
22/03/2010	38	Dall's Sheep	Visual	Travelling, walking	4	North side of valley, above Gladstone B.	Alpine Tundra	South facing mountain slope
22/03/2010	39	Dall's Sheep	Sign	Tracks		North side of valley, above Gladstone C.	Alpine Unvegetated	South facing mountain slope. Tracks abundant

Survey Date	Waypoint	Species	Observation Type	Activity Type	Number	General Area	Habitat	Comments
22/03/2010	40	Wolverine	Sign	Tracks		North side of valley, above Gladstone C.	Alpine Tundra	South facing mountain slope. Tracks abundant
22/03/2010	42	Dall's Sheep	Sign	Tracks		North side of valley, above Gladstone C.	Alpine Shrubland	South facing mountain slope. Tracks abundant
22/03/2010	43	Dall's Sheep	Sign	Tracks		North side of valley, above Gladstone D.	Alpine Tundra	South facing mountain slope
22/03/2010	44	Dall's Sheep	Sign	Tracks		North side of valley, above Gladstone D.	Alpine Tundra	South facing mountain slope
22/03/2010	45	Dall's Sheep	Visual	Travelling, walking	10	North side of valley, on ridge opposite D-Prime.	Alpine Shrubland	
22/03/2010	46	Dall's Sheep	Visual	Travelling, walking	20	North side of valley, on ridge opposite D-Prime.	Alpine Unvegetated	
22/03/2010	49	Grey Wolf	Sign	Den	1	Valley floor - along Gladstone Creek.	Moraine	Wolf den
22/03/2010	50	Grey Wolf	Sign	Den	1	Valley floor - along Gladstone Creek.	Moraine	Wolf den
22/03/2010	51	Moose	Sign	Tracks		Valley floor - along Gladstone Creek.	Spruce - Scrub Birch Forested	Valley Floor Covered in Moose Tracks
22/03/2010	51	Wolverine	Visual	Travelling, walking		Valley floor - along Gladstone Creek.	Spruce - Scrub Birch Forested	
22/03/2010	52	Snowshoe Hare	Sign	Tracks		Valley floor - along Gladstone Creek.	Subalpine Shrub/Grassland	One of the few areas with hare tracks
22/03/2010	52	Lynx	Sign	Tracks	1	Valley floor - along Gladstone Creek.	Subalpine Shrub/Grassland	Lynx tracks in valley floor
22/03/2010	55	Grizzly Bear	Sign Sign	Tracks	1	Valley floor - between Gladstone Lake C and D.	Wetland	Gladstone valley
22/03/2010	56	Grey Wolf	Sign	Tracks		Valley floor - mineral lick on Gladstone B.	Small Lake	Beside Mineral Lick
22/03/2010	56	Unspecified Ungulate	Feature	Mineral Lick		Valley floor - mineral lick on Gladstone B.	Trembling Aspen Copse	Mineral Lick # 2 No sign of use
22/03/2010	57	Unspecified Ungulate	Feature	Mineral Lick		Valley floor - mineral lick on Gladstone A.	Trembling Aspen Copse	Mineral Lick # 1 No sign of use
22/03/2010	58	Wolverine	Sign	Tracks	1	Valley floor - 1st Isaac Lake.	Large Lake	Crossing lake

Survey Date	Waypoint	Species	Observation Type	Activity Type	Number	General Area	Habitat	Comments
22/03/2010	59	Bison	Sign	Tracks		Valley floor - near middle Isaac Lake.	Boreal White Spruce - Lodgepole Pine	
22/03/2010	60	Muskrat	Sign	Muskrat Push-up	4	Valley floor - Isaac Lake D.	Pond	Push-ups
22/03/2010	61	Bison	Sign	Tracks		Valley floor - bench above last Isaac Lake (on north side).	Boreal White Spruce - Lodgepole Pine	Abundant trails and feed sites
22/03/2010	62	Muskrat	Sign	Muskrat Push-up	3	Valley floor - Isaac Lake E.	Pond	Last downstream Issac Lake
22/03/2010	63	Bison	Visual	Travelling, walking	10	Valley floor - north side of valley just down from Isaac Lake E.	Boreal White Spruce - Lodgepole Pine	Yellow/tan radio collar
22/03/2010	65	Bison	Visual	Travelling, walking	9	Valley floor - along Isaac Creek.	Boreal White Spruce - Lodgepole Pine	
28/04/2010	120	Muskrat	Sign	Muskrat Push-up	21	Kluane	Large Lake	Sulpur Lake (Kluane)
28/04/2010	121	Muskrat	Sign	Muskrat Push-up	13	Kluane	Pond	Squirrel Camp Lake (Kluane)
28/04/2010	122	Bison	Sign	Travelling, walking	5	Kluane to Gladstone	Subalpine Grassland	LT Photo IMGP0643
28/04/2010	123	Dall's Sheep	Visual	Living	7	Kluane to Gladstone	Subalpine Shrub/Grassland	
28/04/2010	124	Unspecified Canid	Sign	Den	2	Kluane to Gladstone	Subalpine Grassland	Coyote or fox
28/04/2010	125	Bison	Visual	Travelling, walking	5	Kluane to Gladstone	Subalpine Grassland	LT Photo IMGP0646
28/04/2010	127	Arctic Ground Squirrel	Sign	Den	1	Kluane to Gladstone	Subalpine Grassland	
28/04/2010	129	Caribou	Visual	Travelling, walking	12	Kluane to Gladstone	Spruce - Scrub Birch Forested	Adjacent to Placer Mining

Survey Date	Waypoint	Species	Observation Type	Activity Type	Number	General Area	Habitat	Comments
28/04/2010	131	Wolverine	Sign	Tracks	1	Coming up creek that drains into middle of Gladstone D.	Alpine Tundra	LT Photo IMGP0657
28/04/2010	132	Muskrat	Sign	Muskrat Push-up		Gladstone Creek between Gladstone D and D-Prime.	Slow Perennial Stream	Upper Gladstone Creek
28/04/2010	137	Beaver	Sign	Dam	1	Between Gladstone B and C?	Wetland	
28/04/2010	138	Caribou	Visual	Feeding	6	Between Gladstone A and B.	Spruce - Scrub Birch Forested	
28/04/2010	139	Bison	Visual	Travelling, walking	3	Near 2nd Isaac Lake.	Subalpine Grassland	
28/04/2010	140	Muskrat	Sign	Muskrat Push-up	34	Isaac Lake D (2nd to last Isaac Lake).	Small Lake	
28/04/2010	141a	Beaver	Sign	Lodge	1	Isaac Lake D (2nd to last Isaac Lake).	Small Lake	
28/04/2010	141b	Beaver	Sign	Dam	1	Isaac Lake D (2nd to last Isaac Lake).	Small Lake	
28/04/2010	142	Moose	Visual	Feeding	2	Between Isaac Lake D and E	Shrub Swamp	
28/04/2010	143	Beaver	Sign	Dam	3	Last Isaac Lake (Lake E).	Small Lake	
28/04/2010	144	Muskrat	Sign	Muskrat Push-up	5	Last Isaac Lake (Lake E).	Small Lake	
28/04/2010	145	Beaver	Sign	Lodge	1	Isaac Creek valley	Pond	
28/04/2010	146	Caribou	Visual	Travelling, walking	3	Isaac Creek valley	Wetland	
28/04/2010	148a	Unspecified Ungulate	Feature	Mineral Lick	1	Isaac Creek valley	Cutbank	Mineral Lick # 3 Isaac Crk, LT Photo IMGP-0674-0677
28/04/2010	148b	Dall's Sheep	Visual	Travelling, walking	3	On ridge north of Isaac Creek	Alpine Unvegetated	Observed above Lick approx. 800m NW
28/04/2010	150a	Unspecified Ungulate	Feature	Mineral Lick	1	Gladstone Lake B	Trembling Aspen Copse	Mineral Lick # 2 Gladstone
28/04/2010	152	Unspecified Bear	Sign	Excreting	1	Gladstone Lake C.	Large Lake	Likely Grizzly

Survey Date	Waypoint	Species	Observation Type	Activity Type	Number	General Area	Habitat	Comments
28/04/2010	154a	Dall's Sheep	Visual	Travelling, walking	5	Ridge to north of Gladstone Lake D.	Alpine Unvegetated	
28/04/2010	154b	Unspecified Bear	Sign	Tracks	1	Gladstone Lake D.	Small Lake	Likely Grizzly
28/04/2010	158	Dall's Sheep	Visual	Travelling, walking	5	Ridge to north east of Gladstone Creek.	Alpine Unvegetated	
28/04/2010	159	Dall's Sheep	Sign	Carcass	2	Gladstone Creek valley.	Boreal White Spruce - Lodgepole Pine	Skulls Near Wolf Den (~ 100 m)
28/04/2010	162	Dall's Sheep	Visual	Travelling, walking	16	Kluane	Trembling Aspen Copse	LT Photo IMGP0726
28/04/2010	163	Dall's Sheep	Visual	Travelling, walking	82	Kluane	Subalpine Grassland	Mix of ewes, lambs and rams, LT Photo IMGP0730-0734
15/05/2010	267	Black Bear	Visual	Travelling, walking	1	Isaac Creek - getting close to Aishihik	Boreal White Spruce - Trembling Aspen	South facing slope above Isaac
15/05/2010	268	Unspecified Ungulate	Feature	Mineral Lick	1	Isaac Creek	Cutbank	Mineral Lick #3 Isaac Crk.
15/05/2010	269c	Dall's Sheep	Visual	Feeding	5	Isaac Creek	Alpine Unvegetated	Slope above Isaac lick S. Facing
15/05/2010	272a	Porcupine	Visual	Travelling, walking	1	Above Isaac Lake E	Subalpine Grassland	
15/05/2010	277	Beaver	Sign	Lodge	1	Isaac Lake A	Large Lake	
15/05/2010	278	Dall's Sheep	Visual	Feeding	3	North of Isaac Lake A and Gladstone Lake A	Alpine Unvegetated	Steep S. Facing slope
15/05/2010	279a	Dall's Sheep	Visual	Feeding	4	North of Gladstone Lake A.	Alpine Unvegetated	Steep S. Facing slope
15/05/2010	280	Unspecified Ungulate	Feature	Mineral Lick	1	Gladstone Lake A	Trembling Aspen Copse	Mineral Lick #1
15/05/2010	282a	Unspecified Ungulate	Feature	Mineral Lick	1	Gladstone Lake B	Trembling Aspen Copse	Mineral Lick #2
15/05/2010	282c	Dall's Sheep	Visual	Travelling, walking	7	North of Gladstone Lake B	Alpine Unvegetated	Steep S. Facing slope, may have been heading to Lick

Survey Date	Waypoint	Species	Observation Type	Activity Type	Number	General Area	Habitat	Comments
15/05/2010	288b	Beaver	Sign	Lodge	1	Gladstone Lake D	Large Lake	
15/05/2010	289b	Beaver	Sign	Lodge	1	Gladstone Creek - upstream of confluence with D-Prime.	Slow Perennial Stream	
15/05/2010	290a	Dall's Sheep	Visual	Feeding	7	Southeast of Gladstone D	Alpine Unvegetated	Steep Sf slope
15/05/2010	290b	Dall's Sheep	Visual	Feeding	7	Southeast of Gladstone D	Alpine Unvegetated	Steep Sf slope
15/05/2010	296	Moose	Visual	Travelling, walking	1	Kluane	Wetland	Kluane
15/05/2010	298	Caribou	Visual	Travelling, walking	1	Kluane	Beach	Kluane
15/05/2010	304	Dall's Sheep	Visual	Feeding	15	North of Gladstone Creek	Alpine Shrubland	S. Facing slope above Gladstone
15/05/2010	305	Grey Wolf	Sign	Den	1	Gladstone Creek valley	Moraine	
4/06/2010	315	Bison	Visual	Feeding	25	South of Sekulmun Lake	Meadow	Meadow, 1 Yellow Collar, LT Photos IMGP0994-0997
4/06/2010	319	Beaver	Sign	Dam	1	Isaac Creek	Slow Perennial Stream	
4/06/2010	320	Beaver	Sign	Dam	1	Isaac Creek	Fast Perennial Stream	Old dam (broken)
4/06/2010	321	Beaver	Sign	Dam	1	Isaac Creek	Fast Perennial Stream	Old dam (broken)
4/06/2010	326	Beaver	Sign	Dam	1	Isaac Creek	Fast Perennial Stream	Old dam (broken)
4/06/2010	327	Beaver	Sign	Dam	1	Isaac Creek	Slow Perennial Stream	Active dam
4/06/2010	328	Beaver	Sign	Dam	1	Isaac Creek	Fast Perennial Stream	Abandoned dam
4/06/2010	336	Beaver	Sign	Dam	1	Isaac Creek	Fast Perennial Stream	Old Dam
4/06/2010	338a	Beaver	Sign	Dam	1	Isaac Creek	Slow Perennial Stream	5 Active beaver dams in complex
4/06/2010	338b	Beaver	Sign	Dam	1	Isaac Creek	Slow Perennial Stream	5 Active beaver dams in complex
4/06/2010	338c	Beaver	Sign	Dam	1	Isaac Creek	Slow Perennial Stream	5 Active beaver dams in complex
4/06/2010	338d	Beaver	Sign	Dam	1	Isaac Creek	Slow Perennial Stream	5 Active beaver dams in complex
4/06/2010	338e	Beaver	Sign	Dam	1	Isaac Creek	Slow Perennial Stream	5 Active beaver dams in complex
4/06/2010	338g	Beaver	Sign	Lodge	1	Isaac Creek	Pond	Active lodge

Survey Date	Waypoint	Species	Observation Type	Activity Type	Number	General Area	Habitat	Comments
4/06/2010	340a	Beaver	Sign	Dam	1	Isaac Creek - at outflow of Isaac Lake E	Slow Perennial Stream	4 Active beaver dams in complex
4/06/2010	340b	Beaver	Sign	Dam	1	Isaac Creek - at outflow of Isaac Lake E	Slow Perennial Stream	4 Active beaver dams in complex
4/06/2010	340c	Beaver	Sign	Dam	1	Isaac Creek - at outflow of Isaac Lake E	Slow Perennial Stream	4 Active beaver dams in complex
4/06/2010	340d	Beaver	Sign	Dam	1	Isaac Creek - at outflow of Isaac Lake E	Slow Perennial Stream	4 Active beaver dams in complex
4/06/2010	340e	Beaver	Sign	Lodge	1	Isaac Creek - at outflow of Isaac Lake E	Slow Perennial Stream	Active lodge
4/06/2010	344	Beaver	Sign	Dam	1	Isaac Lake D	Pond	Active dam
4/06/2010	345a	Caribou	Visual	Fleeing	1	Isaac Lake D	Pond	Caribou was in lake fleeing from wolf. LT Photo IMGP1015-1016
4/06/2010	345b	Grey Wolf	Visual	Hunting	1	Above Isaac Lake D	Subalpine Grassland	Wolf was black in colour; hunting a female caribou
4/06/2010	345c	Beaver	Sign	Lodge	1	Isaac Lake D	Pond	Active Lodge
4/06/2010	359a	Dall's Sheep	Visual	Travelling, walking	24	Above Gladstone Lake A	Talus	Leaving Lick #1, LT Photo IMGP1019-1020
4/06/2010	366a	Dall's Sheep	Sign	Carcass	1	Along Gladstone Lake B	Subalpine Shrub/Grassland	Sheep kill site - appeared to be Juvenile
6/07/2010	31a	Grey Wolf	Visual	Travelling, walking	1	Gladstone Creek	Gravel Bar	Edge of Gladstone Creek
6/07/2010	33	Grey Wolf	Visual	Travelling, swimming	2	Gladstone Creek	Fast Perennial Stream	Crossing Gladstone Creek
6/07/2010	34a	Grey Wolf	Visual	Living	4	Gladstone Creek	Subalpine Grassland	3 pups at den site with adult
6/07/2010	34a	Grey Wolf	Sign	Den	1	Gladstone Creek	Subalpine Grassland	Den site with pups

APPENDIX C: TRACE METALS ANALYSIS RESULTS FOR SOILS FROM GLADSTONE LAKE A MINERAL LICK AND GLADSTONE LAKE B MINERAL LICK.

Sample ID	Site A1 - Sample 1	Site A1 - Sample 2	Site A2 - Sample 1	Site A2 - Sample 2	Site A3 - Sample 1	Site A3 - Sample 2	Site A4 - Sample 1	Site A4 - Sample 2	Site A5 - Sample 1	Site A6 - Sample 1	Site B1 - Sample 1	Site B1 - Sample 2	Site B2 - Sample 1	Site B2 - Sample 3	Site B3 - Sample 1	Site B3 - Sample 2	Site B4 - Sample 1	Site B4 - Sample 2
Sample Type	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Outside Control	Outside Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control
pH	8.9	8.3	8.9	7	9	7.6	8.8	8.2	8.2	7.5	8.5	8.2	9.5	8.3	9	8	8.4	7.7
Conductivity (mS/cm)	451	199	355	86.1	224	94.3	291	140	83.3	105	320	107	509	422	387	302	413	76.8
Available SO_4 (mg/g)	55	10.4	39	3	20	4.3	26	8.8	1.8	1.5	54	9.3	64	80	87	51	107	3.7
Ag (mg/g)	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Al (mg/g)	14800	10900	14300	13800	13600	12500	11300	11800	8070	8540	24300	12800	13400	12500	18500	15400	15900	20000
As (mg/g)	41	37	32	33	30	31	28	29	34	69	22	31	32	34	51	32	43	30
B (mg/g)	11	10	11	10	10	10	10	10	9	9	11	11	12	11	14	12	13	15
Ba (mg/g)	250	173	277	210	252	187	152	171	119	75	224	119	133	122	263	168	168	105
Be (mg/g)	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Ca (mg/g)	6690	4380	6600	3820	8800	3790	11100	4260	4320	3030	28400	4470	15000	11200	6970	5810	30300	5010
Cd (mg/g)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1	0.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Co (mg/g)	11	8	11	10	10	9	8	9	6	5	19	9	11	11	15	12	11	13
Cr (mg/g)	42	29	42	38	39	34	29	32	10	17	15	20	22	22	58	38	31	32
Cu (mg/g)	21	17	21	21	20	16	17	16	11	11	23	14	21	25	37	19	25	20
Fe (mg/g)	23600	19000	22700	22100	21500	20200	18600	19600	18000	16900	21100	20000	21300	20800	27200	23100	24300	28800
Hg (mg/g)	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
K (mg/g)	7740	5430	6890	6330	6660	5720	5320	5640	2910	3420	8340	4440	5170	4840	7780	4330	4130	4420
Mg (mg/g)	7970	5740	8060	7090	7640	6430	6020	6180	3440	3760	14200	6510	8020	7590	10700	7730	9580	9780
Mn (mg/g)	336	279	324	334	307	292	252	272	366	242	208	298	311	315	354	339	400	363
Mo (mg/g)	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4

Sample ID	Site A1 - Sample 1	Site A1 - Sample 2	Site A2 - Sample 1	Site A2 - Sample 2	Site A3 - Sample 1	Site A3 - Sample 2	Site A4 - Sample 1	Site A4 - Sample 2	Site A5 - Sample 1	Site A6 - Sample 1	Site B1 - Sample 1	Site B1 - Sample 2	Site B2 - Sample 1	Site B2 - Sample 3	Site B3 - Sample 1	Site B3 - Sample 2	Site B4 - Sample 1	Site B4 - Sample 2
Sample Type	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Outside Control	Outside Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control	Lick Soils	In-Lick Control
Na (mg/g)	318	155	342	181	303	175	232	161	91	95	938	232	697	366	609	230	444	154
Ni (mg/g)	22	15	21	20	21	17	17	17	8	9	10	12	13	14	34	25	19	20
P (mg/g)	1240	937	1470	1210	1340	1190	952	1020	459	518	481	703	992	997	1120	710	1210	1060
Pb (mg/g)	6	6	< 5	6	5	< 5	5	< 5	8	8	9	9	9	9	8	8	15	16
Sb (mg/g)	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Se (mg/g)	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Sn (mg/g)	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Sr (mg/g)	25	18	28	18	29	17	27	17	19	13	175	39	73	47	47	33	95	35
Ti (mg/g)	1660	1150	1640	1420	1520	1310	1190	1290	935	800	2690	1240	1200	1140	1640	1120	1240	1390
V (mg/g)	66	47	65	60	61	54	46	50	21	26	60	43	52	50	89	56	58	67
Zn (mg/g)	69	62	63	66	60	58	55	56	104	76	47	64	66	64	75	65	78	81
Zr (mg/g)	2	1	1	1	1	1	2	1	2	2	2	2	2	2	2	2	2	3

APPENDIX D: SUMMARY OF TERRESTRIAL INVERTEBRATE OBSERVATIONS WITHIN THE GLADSTONE LAKES STUDY AREA.

Common Name	Species Name		Common Name	Species Name
Land Snails			**Butterflies**	
Mellow Column	*Columella columella*		Grizzled Skipper	*Pyrgus centaureae*
Striate Disc	*Discus shimekii*		Silvery Blue	*Glaugopsyche lygdamus*
Brown Hive	*Euconulus fulvus*		Freija Fritillary	*Bolaria freija*
Striate Ambersnail	*Novisuccinea strigata*		Chryxus Arctic [1]	*Oeneis chryxus*
Crestless Column	*Pupilla hebes*		White-veined Arctic	*Oeneis bore*
Crested Vertigo	*Vertigo cristata*		Common Ringlet	*Coenonympha tullia*
Cross Vertigo	*Vertigo modesta*		Western White	*Pontia occidentalis*
Unknown Vertigo	*Vertigo* sp.		Arctic White	*Pieris angelika*
Damselflies			Clouded Sulphur	*Colias philodice*
Subarctic Bluet	*Coenagrion interrogatum*		Old World Swallowtail	*Papilio machaon*
Taiga Bluet	*Coenagrion resolutum*		**Bees**	
Unknown Bluet	*Enallagma* sp.		Arctic Bumblebee	*Bombus polaris*
Dragonflies			White-tailed Bumblebee	*Bombus lucorum*
Spiny Baskettail	*Epitheca spinegera*		Carpenter Bee	*Xylocopa sp.*
Unknown Emerald	*Somatochlora* sp.			
Unknown Whiteface	*Leucorrhinia* sp.			
Sedge Darner	*Aeshna juncea*			

[1] Identification to be confirmed.