Kensington Gold Project
2006 Annual Report

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February 2007

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2. Kensington Terrestrial Wildlife Monitoring Annual Report Slate Lakes Basin, February 2007, Kate Savage, Juneau, AK

3. 2006 Northern Goshawk Survey – Kensington Mine Site, February 2007, Kate Savage, Juneau, AK

4. Kensington Gold Project – Transportation Policy Audit Review, February 9, 2007, HDR, Bellevue, WA

5. TSF Ecological Monitoring: Upper Slate Lake Dolly Varden Survey, October 2006, Liz Flory, Juneau, AK

6. Berners Bay Herring Research – 2005 and 2006 Research Report (Draft), February 2007, ADFG, Juneau, AK

References

1. Coeur Alaska, Inc., 2006, Kensington Gold Project NPDES Permit AK-005057-1 Annual Water Quality Monitoring Summary Volume 1: Aquatic Resource Surveys 2006.
2. Coeur Alaska, Inc., 2006, Kensington Gold Project NPDES Permit AK-005057-1 Annual Water Quality Monitoring Summary 2006 Volume 2: Water Quality Data.

Introduction

The Kensington Gold Project is owned and operated by Coeur Alaska, Inc. (Coeur) a wholly owned subsidiary of Coeur d'Alene Mines, Inc. The project is located on the western and southern flanks of Lions Head Mountain; between Berners Bay and Lynn Canal; and in the drainages of Johnson, Sherman, and Slate Creeks (Attachment 1). Coeur Alaska has prepared this annual report to comply with requirements of the U.S. Forest Service (USFS) Plan of Operations (POO) for the Kensington Gold Project.

The Kensington Gold Project received authorization under the POO on June 13, 2005. The Final Supplemental Environmental Impact Statement, U.S. Forest Service Record of Decision and all necessary major permits were issued prior to year end 2005. Coeur Alaska issued construction contracts and ground breaking was initiated during July 2005.

Section 1.0 contains a synopsis of the activities conducted at the Kensington Gold Project during calendar year 2006, and Section 2.0 contains projections of activities planned for calendar year 2007. Section 3.0 is a project water balance projection.

No mining occurred during 2006. Construction concentrated on surface access and facilities at Slate Creek Cove, the Lower Slate Lake tailing facility, the Johnson Creek facilities site, and the Jualin Access Road. In August, 2006 an injunction against further development of the Lower Slate Lake tailings facility was received and all work on that facility was suspended with the exception of minor sediment control measures that were necessary to stabilize the area from potential erosion.

Project personnel on site are a mix of Coeur Alaska employees and contractors. As of December 2006, Coeur Alaska employed 403 personnel between the Juneau office, Johnson Creek camp and Comet Beach camp.

Construction activities and operations have been consistent with the approved POO. No gold production occurred during calendar year 2006.

Summary of 2006 Activities

1.1 Public Safety

Public access to the project site is managed as defined in the established Public Access Control Plan. Public access to the site must be controlled to ensure the safety of the public. During the construction and operational phases of the Project, hazards such as truck traffic, blasting, barge and tug operations, clearing operations, and earthwork could result in physical harm to unauthorized visitors.

During 2006, personnel accessed the site via rotary wing aircraft and to a lesser extent by fixed wing float plane. One of the air transporters had an incident that occurred in July

2006 in which three employees were injured during an especially hard landing caused by limited visibility in Berners Bay. Agency inspections and other public like personnel generally access the site by fixed winged aircraft.

1.2 Construction Activities

Site construction continued throughout 2006 with the exception of the work on the tailings treatment facility. An injunction was received in August which led to the suspension of construction activities associated with the continued development of the tails facility. Ongoing surface work in this area is limited to measures taken to stabilize and protect water quality from potential erosion of exposed areas that were under construction.

Approximately 400 individuals were employment at the site during 2006. The demographics of the employees was defined as:

- 57 Alaska Natives;
- 124 Local (Juneau) Hire; and
- 223 Alaska Hire.

Topsoil and growth media salvaged during 2006 construction activities included slash, stumps, duff, A-horizon soil, organic illuviated soils, and other suitable mineral soil. Approximately 119,000 cubic yards of salvaged soil were placed in stockpiles.

Timber was cut and removed along the main Jualin Access Road (Parcel #13), Tailings Facility Access Road (Parcel # 23), Part of Tailings Pipeline Road (Parcel #27), Tailings Facility Access Road (Parcel # 22), and all the Parcels around the lake (Parcels #24,25,26,28) except for the Western Interception Ditch (Parcel #35) and the Tailings Topsoil Stockpile (Parcel#36).

1.2.1 Storm Water Controls

Construction operations on both the Jualin and Comet sides of the Kensington Gold Project were conducted in compliance with storm water pollution prevention plan requirements. Both temporary construction Best Management Practices (BMPs) and permanent sediment pond BMPs were utilized to control excess sediment production from disturbed areas that otherwise might enter waters of the state. A full accounting of storm water controls can be found in Appendix 4F of the USFS POO, entitled: Storm Water Pollution Prevention Plan (SWPPP) for the Kensington Gold Project.

Sediment ponds and silt fences were maintained, existing check dams were maintained, new check dams were constructed in road ditches, and diversion channels were cut as necessary to redirect flow to treatment BMPs. Designs for these construction BMPs are discussed in the SWPPP. Most operational (long-term) sediment ponds were constructed during 2005, and all were constructed as designed in the SWPPP Addendum B, entitled Sediment Pond Design Kensington Gold Mine – Jualin Area Borough of Juneau, Alaska,

January 26, 2006. Minor pre-settling sumps were installed in 2006 to aid in the removal of the coarse fraction of sediment entrained in stormwater flow. Two addendums regarding updates to the SWPPP were submitted during 2005 and three updates were also submitted to the state, the USFS, and EPA during 2006.

The nature of construction BMPs is transitory; i.e., they change in response to site conditions and the rapidly evolving ground conditions encountered during construction. Therefore, designs are dependent on site conditions, which may change day by day. However, as construction elements are completed, operational BMP sediment ponds can be developed, which discretely demonstrate compliance with the SWPPP as amended.

In addition to SWPPP monitoring and inspections, site receiving water monitoring was also conducted in compliance with the current site NPDES permit to help document compliance with state water quality standards. Receiving water sampling data are discussed below under NPDES monitoring (section 1.9.1).

1.2.2 Corps of Engineers Wetland Disturbance

An annual summary of wetland areas impacted and reclaimed is a requirement of the Corps of Engineers (COE) 404 fill permit. Wetland areas impacted are tallied in Table 2-1. Overall, total wetland disturbance as of year end 2006, including soil excavation or fill placement was 62.3 acres.

1.2.3 Access Corridors

Road improvements during 2006 were an ongoing priority of project construction. A major improvement to the project in 2006 included constructing an improved alignment to the Jualin access road which was an ADOT project. The maintenance of stormwater BMPs along the access corridors was a major ongoing task for 2006.

During 2006, Alaska Department of Transportation (ADOT) personnel were present at the Jualin site to advance the design and construction of upgrades to the main access road leading from Slate Creek Cove to the main process area.

Safety berms and improved surface drainage were added to the Kensington 850 Level Portal access road.

1.3 Mine Operations

1.3.1 Ore Production

Mill operations had not commenced during the reporting period, and no ore was produced.

1.3.2 Waste Rock Production

Mine development continued underground from the 850 Level portal and produced 178,000 bank cubic yards of waste rock, which were hauled outside and stored on the Kensington Waste Rock Storage Facility (Parcel #4). Construction of the New Jualin Drift commenced as of August 2006 and as a result of that activity approximately 37,000 cubic yards of development rock was placed on the Jualin Development Rock Storage Facility. These numbers assume 10% overbreak and 50% swell factor.

1.3.3 Dust Suppression Activities

Construction activities were initiated on July, 2005 and were ongoing through year end 2006. During this period the project's climate was exceptionally wet and very limited road watering via water wagon was required.

1.4 Mill Operations

Activities continued on the mill foundation bench and included the construction of surface buildings and facilities for the eventual milling of ore from the underground.

1.4.1 Gold Production

No gold or gold equivalent was produced during the reporting period.

1.4.2 Tailing Production

As the mill complex was in the early stages of construction, the project was not operational during 2006, therefore, no tailing was produced.

1.5 Solid/Hazardous Waste Generation and Transport

Solid waste was generated from the Comet and Jualin sides of the Kensington Gold Project, including: incinerator ash, construction debris, worn cable, and broken equipment. This material was managed in accordance with the approved ADEC Solid Waste Management Permit. Coeur Alaska managed the Comet side operations from which approximately 49,820 pounds of solid waste, including 3,200 pounds of incinerator ash, were shipped to Juneau. These materials were then transported to disposal facilities or otherwise managed according to controlling regulations and permits (Table 2).

Camp and construction operations on the Jualin side of the Kensington project are managed by contractors in the same general manner as those from Comet. That is, domestic wastes were incinerated and the ash and other solid waste was containerized and returned to Juneau for proper management.

TCLP aqueous solution extraction results for incinerator ash samples collected on August 22, 2005 for the Comet Camp incinerator show only barium and/or cadmium were high enough for the laboratory to measure their concentrations. Of four samples measured, all show barium from 0.18 to 0.46 mg/L (average 0.34) and cadmium between non-detect

and 0.11 mg/L (average 0.057). These values are orders of magnitude below characteristic levels for hazardous waste (barium = 100, cadmium = 1.0 mg/L).

Hazardous waste, including Universal waste, generated at the site could include:

- Lead/acid batteries
- Rolled roofing
- Lamps
- Dry cell batteries
- Computer backup power supplies

Universal wastes (batteries, lamps, mercury switches) need not be manifested. Therefore, in no month was more than 100 kg of hazardous waste generated, accumulated, or transported to Juneau for disposal.

1.6 Tailings Storage Facility

During 2006, construction was initiated on the Tailings Storage Facility (TSF). This initial work was suspended due to an injunction being issued, which resulted in the ACOE suspending their approval to proceed with the development of this facility. Work completed prior to the issuance of the injunction include the development of a coffer dam at the main outlet to Lower Slate Lake and the construction of a diversion dam at the outlet of Upper Slate Lake.

1.7 Compliance

For the year 2006, there were no Notice of Violations issued to Coeur Alaska. All reporting was completed as required. One component of these plans is the reporting of hydrocarbon spills. Spills that occurred during 2006 were all very small, yet each release was taken very seriously and all site resources were utilized, as appropriate, occurrence. A total of twelve incidents were reportable during 2006 (Table 3).

1.8 Reclamation

No concurrent reclamation was performed in 2006. Interim stabilization of some construction areas and topsoil stockpiles was performed as a BMP under the approved SWPPP plan.

1.8.1 Revegetation Test Plots

Revegetation test plots will be installed at the Tailings Storage Facility (TSF) following construction of the Phase I dam and flooding of the reservoir. As construction of the dam and TSF had not been initiated in 2006 these test plots were not installed during the reporting period.

1.9 Monitoring

1.9.1 NPDES

Results of the extensive monitoring program contained in the Kensington Gold Project NPDES permit AK-005057-1 is compiled in the NPDES Annual Water Quality Monitoring Summary Volume 1: Aquatic Resource Surveys 2006, and Volume 2: Water Quality Data (Coeur, 2006a). This report was submitted to the US Forest Service, Juneau under separate cover.

1.9.2 Fresh Water

Fresh water monitoring requirements are contained within the USFS POO. Monitoring performed for the NPDES permit and summarized in the Kensington Gold Project NPDES Permit AK-005057-1 Annual Water Quality Monitoring Summary 2006 Volume 2. Water Quality Data are inclusive of requirements under the USFS POO. This report was submitted to the US Forest Service, Juneau and EPA, Seattle under separate cover, as the NPDES 2006 Annual Report.

1.9.3 Water Usage

Under requirements of the ADNR water rights, certain water usage and stream flow submittals are prepared. Some of these filings are made monthly while others are submitted quarterly. These reports are available at ADNR's offices, Juneau.

1.9.4 Aquatic Resource Surveys

The USFS POO references aquatic resource surveys, which are to include:

- Annual photographs of stream habitat types.
- Fish surveys and minnow trapping in Upper Slate Lake.
- Salmon escapement surveys in Sherman, Slate, and Johnson Creeks.

Annual photographs of stream habitat types are included in the Kensington Gold Project NPDES Permit AK-005057-1 Annual Water Quality Monitoring Summary Volume 1: Aquatic Resource Surveys 2006.

Salmon escapement surveys were performed in 2006 on Sherman, Slate, and Johnson Creeks. Tabulations of these data are presented in the Kensington Gold Project NPDES Permit AK-005057-1 Annual Water Quality Monitoring Summary Volume 1: Aquatic Resource Surveys 2006.

1.9.5 Marine

The U.S. Forest Service Plan of Operations Appendix 4.d. contains a marine monitoring program for Berners Bay. Requirements of this monitoring plan have been contracted to various agencies that are responsible to implement and report on portions of the plan (Table 5).

Monitoring of mammals within the Bay was completed during 2006 by select flight personnel traveling to and from the mine site over Berners Bay. Flight co-pilots are observing and recording marine mammal sightings on maps and submitting those observations to the Juneau Coeur office for compilation. Field data sheets were faxed to Aleria Jensen at NMFS, Juneau in the spring of 2006 (Table 4).

1.9.6 Air

During the period, quarterly Facility Operating Reports, including fuel use summaries, were submitted to the Fairbanks office of ADEC Air Permits Program (610 University Avenue) in compliance with ADEC air quality permits. These reports are not reproduced here, but can be found in the offices of ADEC, Fairbanks.

1.9.7 Archeology

Surface disturbance activities within historic areas were completed during 2005. Several Archeological reviews were conducted by the Walking Dog Consulting during 2006. These reviews were to confirm that clearance for archeological survey had been completed. These reviews included the following Parcels in Kensington's Plan Of Operations: Parcels #10, 20, 21, and 23.

1.9.8 Tailing Storage Facility Ecological Monitoring Plan

Dolly Varden spawing activities were document as a planning exercise for ultimate closure of the tailing storage facility. This study is included in Attachment 5.

1.9.9 Berners Bay Transportation Plan

Marine vessel transport was between Juneau or Adlersheim Lodge and Slate Cove or Comet Beach. Heavy equipment and supplies were transported via barge or landing craft and were received at Slate Cove or Comet Beach. Marine waters around all marine facilities discussed above were open to public access.

It is a requirement of the Berners Bay Transportation Policy, Mitigation, and BMP Plan to collect information on company marine vessel encounters with special fish, marine mammals, and important bird species during the eulachon spawning season in Berners Bay. During 2006, no ferry service occurred in Berners Bay.

Monitoring in Berners Bay included herring and hydrocarbon studies conducted by ADFG and NOAA respectively. The ADFG herring draft report is included as Attachment 6. Coeur Alaska has not been issued a report concerning the hydrocarbon studies from NOAA staff.

As required in the transportation plan, Coeur Alaska commissioned an independent third-party audit, the results of which are included as Attachment 4.

1.9.10 Waste Rock, Borrow Source, and Tails Material

Waste rock and tailing sampling for acid base accounting (ABA) is a requirement of the POO. A draft mine waste sampling plan is being submitted to the USFS in response to underground development in 2006.

No tails were generated during 2006. Future quarterly sampling of tailing for acid base accounting will commence following project commissioning and commercial production.

1.9.11 Construction/Excavation Dewatering (Non-Stormwater)

Groundwater intercepted during excavation and construction of the New Jualin Tunnel is captured, treated, and discharged to either a land application area or through site sedimentation ponds – as appropriate. Discharge is authorized and managed under ADEC general permit 2004DB0101 and the stormwater Construction General Permit AKR10000.

During the reporting period, the New Jualin Tunnel excavation commenced, followed by the consequent interception and management of groundwater. A land application area was prepared of roughly six acres extent to disperse this water. A system of industrial drip lines was installed wherein drip emitters were placed on a four foot center grid system. Drip application is preferred to spray application in this case. Advantages include:

- Lower pressures can be employed as compared to other systems
- Clogging of spray heads is avoided
- Pressure equalization is achieved through a simple internal system
- Water can be more uniformly applied
- Esthetically, there is no visual water spray

In compliance with the general permit authorization, local baseline groundwater data were collected to establish background conditions. Monitoring of shallow wells around the land application area and upstream and downstream in Johnson Creek continued during discharge application to help detect potential impacts to Johnson Creek.

1.9.12 Tailing Storage Facility Monitoring

Project construction is currently underway, therefore no water balance measurements area available. Upon project commissioning and startup, data will be captured on the overall mine/mill/TSF water balance to verify projected water usage, conservation, and discharges. These data will help confirm projected water production, allowable discharge quantities ("net precipitation"), water use, and efficient recycle. Coeur Alaska is presently collecting additional baseline information, which will be of use in water balance preparation.

1.9.13 Wildlife

1.9.13.1 ADFG Goat Monitoring

Mountain goat monitoring in the Lions Head Mountain area associated with the Kensington Gold Project has been conducted intermittently since the late 1980's, in part to help determine potential future mine impacts on this population. An updated ADFG goat study is included with this report as Attachment 1.

1.9.13.2 Goshawk and Wildlife Observations

A condition of the USFS POO is to collect observations of raptor and heron presence in the Kensington Gold Project area. Observations made during 2006 are captured in two separate reports issued by Kate Savage. These reports are included as Attachments 2 and 3 in this annual report.

1.10 Avalanche Safety Plan

Coeur Alaska implemented an avalanche hazard awareness and mitigation safety plan, during the 2006/07 winter season. A qualified professional firm was retained to:

- Identify and quantify the snow avalanche safety hazard
- Prepare recommendations on managing that hazard
- Train employees and contractors in pertinent requirements of the resulting safety plan
- Prepare daily hazard forecasts and perform potential avalanche control activities

Because of the nature of construction, risk avoidance cannot be accomplished in all cases. Therefore, an active avalanche risk mitigation program was initiated. This involves use of explosives to initiate controlled release of smaller avalanches so as to reduce the risk of naturally triggered larger and more destructive avalanches.

During 2006, no active control work was required or performed. During the 2006 reporting period,

- Areas of avalanche risk were placarded
- Crews were informed of avalanche hazards and the appropriate responses to those hazards
- Daily risk forecasts were prepared and communicated to crews, based on site weather and snow condition data
- Avalanche rescue equipment was procured and located on-site
- Crews were trained in their roll in avalanche rescue operations and the use of the rescue equipment – as appropriate

During the reporting period, construction activities were not curtailed as a result of identified avalanche hazards. No personnel were caught or injured in avalanches, nor were any facilities or material negatively impacted.

1.11 Dam Safety Oversight Status

The dam safety approval to construct was issued in March 2006, and construction was initiated and continued until August when an injunction against further development of the tailings facility was issued. Work at Lower Slate Lake was restricted to erosion control measures while the injunction was in effect for the remainder of the year.

Projected Activities for 2007

Key Issues and Permitting Activities

The Kensington Gold Project was under construction during the reporting period and will continue in this status during much if not all of 2007. The timetable for completion is uncertain at this time due to the ongoing injunction of the project. Once the injunction is lifted continued construction activities may vary from conditions projected during initial permitting, it is likely that modifications to approved permits, plans, leases, and other authorizations may be requested. These modifications cannot be anticipated prior to actually encountering changed conditions in the field. It is anticipated any such potential changes or modifications will be relatively minor in scope.

2.1 Public Safety

No changes to the Public Access Control Plan are contemplated for 2007.

2.2 Mine Operations

Continued underground mine construction and development will be the primary focus of 2007 activities. Mine development and exploration activities will require ore excavation, in which case the ore will be stockpiled on surface or underground as future mill feed.

2.3 Mill Operations

Mill commissioning and start-up are anticipated in October 2007, if the current injunction is lifted by the spring of 2007.

2.4 Tailings Storage Facility

The TSF Phase I dam will be under construction in 2007, pending a favorable and timely decision from the court. The TSF will begin receiving tailings with mill commissioning and startup, currently scheduled for October 2007, again, pending a timely suspension of the current injunction.

2.5 Access Corridors

Most access road and corridor upgrades were completed in 2006. In 2007 we anticipate the construction of the Tailings Pipeline Access Road.

2.6 Reclamation

No significant reclamation activities are anticipated to occur in 2007. Temporary stabilization activities; such as maintaining interim covers on the topsoil stockpiles, will be continued throughout 2007.

2.7 Proposed Modifications to Monitoring Plans for 2006

Modifications to the anadromous fish population inventories in Sherman, Slate, and Johnson Creek will likely be formulated and proposed to the appropriate agencies. No specific modifications of this plan are proposed in this annual report.

2.8 Bonding

The Kensington Gold Project is currently bonded, including the tailings storage facility, as described in the 2005 FSEIS and USFS Record of Decision. Bonding activities have been coordinated with US Forest Service as needed with each revision.

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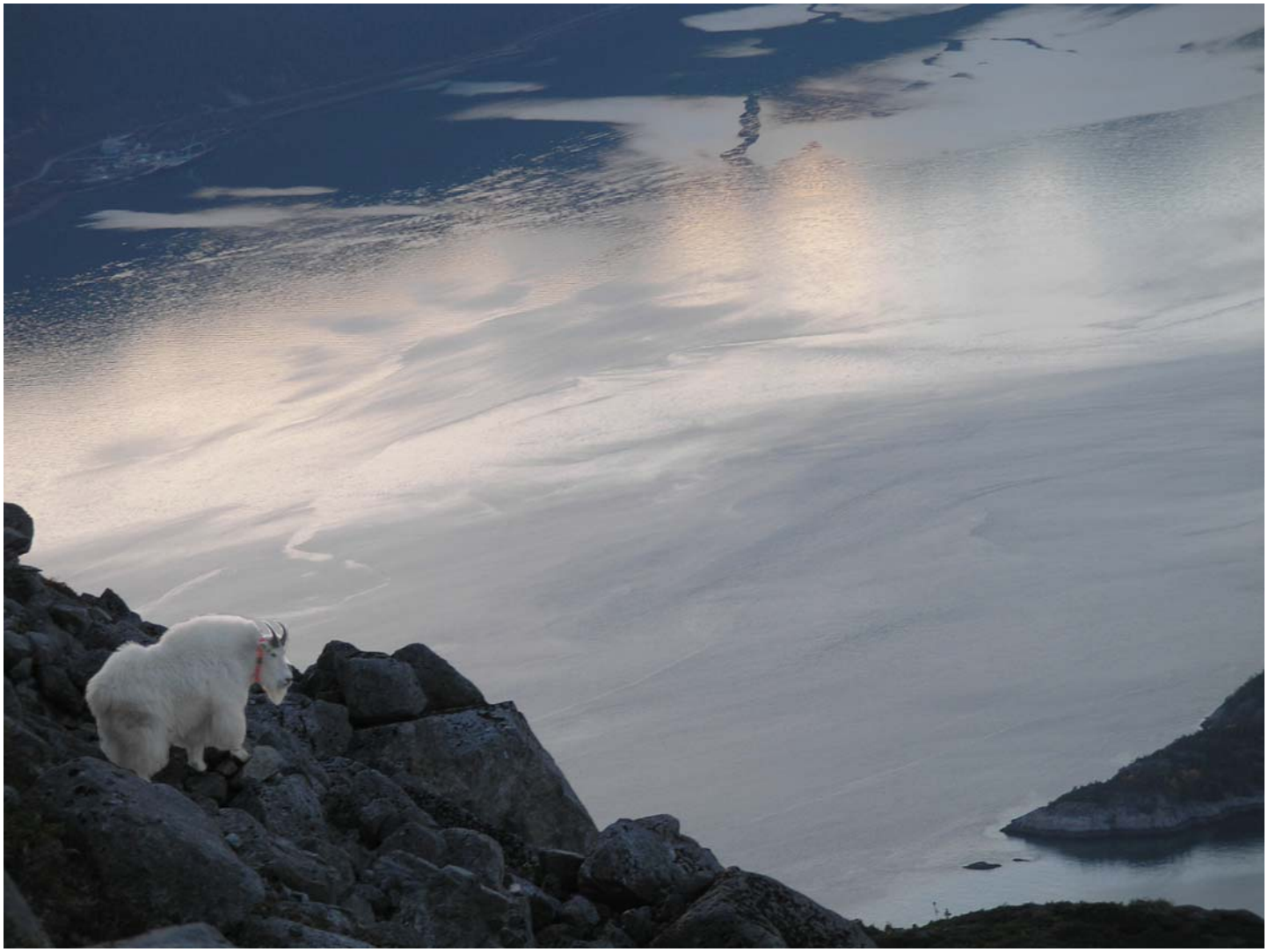
Attachment 1

Mountain Goat Assessment - ADFG

Wildlife Research Annual Progress Report

Mountain Goat Assessment and Monitoring along the Juneau Access Road Corridor and near the Kensington Mine, Southeast Alaska.

Kevin S. White, Neil L. Barten and Doug Larsen



Alaska Department of Fish and Game
Division of Wildlife Conservation

November 2006

Mountain Goat Assessment and Monitoring along the Juneau Access Road Corridor and near the Kensington Mine, Southeast Alaska.

Kevin S. White, Neil L. Barten and Doug Larsen

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Annual Progress Report

August 2006

This report contains preliminary data and should not be cited without permission of the authors.

ACKNOWLEDGEMENTS

This project was funded by the State of Alaska Department of Transportation and Public Facilities and Coeur Alaska. Reuben Yost (SOA, DOT/PF) and Carl Schrader (SOA/DNR) coordinated project funding. John Crouse, Eran Hood, Steve Lewis, Karin McCoy, Jeff Nichols, Dale Rabe, Chad Rice, Ryan Scott and Jamie Womble assisted in field and/or office work. Fixed-wing survey flights were conducted by Lynn Bennett (LAB), Jacques Norvell (Tal Air) and Pat Valkenburg. Helicopter support was provided by Rey Madrid and Mitch Horton (Temsco Helicopters) as well as Chuck Schroth (Fjord Flying Service). Coordination of ground work activities was provided by Frank Bergstrom and Al Gillan (Coeur Alaska) and Coastal Helicopters.

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Cover photo by Kevin White. Mountain Goat #LG-15 standing near his capture site on the northwest slope of Mt. Villard, overlooking Lynn Canal.

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INTRODUCTION

This annual progress report was prepared to meet the reporting requirements for State of Alaska Department of Transportation and Public Facilities and Coeur Alaska. Funding for this project was made available in September 2005 and this report summarizes activities completed by July 31, 2006.

Background

Coeur Alaska has recently re-initiated development activities at the Kensington mine site, located a short distance northwest of Berners Bay. In addition, the Department of Transportation and Public Facilities is planning to construct an all-season highway between Echo Cove and the Katzehin River (ca. 51 miles in length). Among the wildlife species potentially affected by mine development and road construction activities are mountain goats (*Oreamnos americanus*). A small-scale study of mountain goats conducted in the vicinity of the Kensington mine by Robus and Carney (1995) showed that goats moved seasonally from high alpine elevations in the summer and fall to low, timbered elevations during winter months. One of the main objectives of the Robus and Carney (1995) study was to assess the impacts of the mine development activities on habitat use, movement patterns and, ultimately, productivity of mountain goats. However, since the mine never became operational these objectives could not be achieved, and by 1995 goat monitoring in the area wound down and eventually ended. Now, however, the mine is in the process of re-opening and the Alaska Department of Fish and Game maintains that many of the same concerns that prompted the Robus and Carney (1995) study are still valid and need to be addressed. In addition, large-scale plans for development of the Juneau Access road raise new, potentially more substantial, concerns regarding not just the enlarged “footprint” of industrial development activities in eastern Lynn Canal, but also the cumulative impacts of both development projects.

The affects of mining and road development activities on local mountain goat populations in the vicinity of the Kensington mine and eastern Lynn Canal are not well known or understood at this time. However, studies conducted elsewhere indicate that mountain goats can be negatively impacted by industrial development activities. Such effects include temporary range abandonment, alteration of foraging behavior and population decline (Chadwick 1973, Foster and Rahs 1983, Joslin 1986, Cote and Festa-Bianchet 2003). Consequently, information about the distribution of mountain goats proximate to the mine and road development corridor is needed to determine the extent to which populations may be affected by associated industrial activities. Information collected by Robus and Carney (1995), in the vicinity of Kensington mine, as well as Schoen and Kirchhoff (1982), near Echo Cove, suggest that spatial overlap between mountain goats and the proposed industrial activity will be most pronounced when goats are over-wintering in low-elevation habitats. In addition, it is not clear where goats spend non-winter months and, by extension, the spatial extent to which development activities are thereby translated across the landscape.

In response to the above concerns, the Alaska Department of Fish and Game, with funding provided by the Department of Transportation and Public Facilities and Coeur Alaska, has initiated monitoring and assessment activities to determine possible impacts of road construction and mine development on mountain goats and identify potential mitigation measures, to the extent needed. Assessment and monitoring work includes collection of vital rate, habitat use and movement data from a sample of radio-marked mountain goats in addition to conducting annual aerial population abundance and productivity surveys. These efforts are aimed at providing the Alaska Department of Fish and Game with information necessary to appropriately manage mountain goats in the proposed areas of development.

STUDY OBJECTIVES

This research is designed to investigate the spatial relationships, vital rates and abundance of mountain goats in the Berners Bay and upper Lynn Canal area. The specific objectives are as follows:

1) Determine seasonal movement patterns of mountain goats in the area of the Kensington mine and Juneau Access road corridor;

2) Characterize mountain goat habitat selection patterns and the extent of spatial overlap with areas impacted by Kensington mine and Juneau Access road corridor development activities;

3) Estimate reproductive success and survival of mountain goats in areas near the Kensington mine and Juneau Access road corridor; and

4) Estimate mountain goat population abundance and composition in areas near the Kensington mine and Juneau Access road corridor.

STUDY AREA

Mountain goats were studied in a ca. 600 km^2 area located in a mainland coastal mountain range east of Lynn Canal, a post-glacial fiord located near Haines in southeastern Alaska (Figure 1). The study area is oriented along a north-south axis and bordered in the south by Berners Bay (58.76N, 135.00W) and by Dayebas Creek (59.29N, 135. 35W) in the north. Within this area, three separate study sites were delineated based on the actual or expected extent of industrial activity occurring in or near each locality (Figure 1).

An additional study area located east of Berners Bay was established in spring 2006. This area was not originally included in the study design however recent information about road construction timelines resulted in a re-evaluation of the efficacy conducting research activities in this area. Research efforts in this area will be limited in scope and low intensity sampling in this area is intended to provide managers with baseline information needed to evaluate impacts associated with specific road construction activities (i.e gravel stock-piling and crushing). Additional ADFG funding was allocated to partially offset costs associated with research activities in this area.

Elevation within the study areas range from 6300 feet to sea level. This area is an active glacial terrain underlain by late cretaceous-paleocene granodiorite and tonalite geologic formations (Gehrels 2000). Specifically, it is a geologically young, dynamic and unstable landscape that harbors a matrix of perennial snowfields and small glaciers at high elevations (i.e. above 4000 feet) and rugged, broken terrain that descends to a rocky, tidewater coastline. The northern part of the area is bisected by the Katzehin river, a moderate volume (ca. 1500 c/fs; USGS, unpublished data) glacial river system that is fed by a tributary of the Juneau Icefield.

The maritime climate in this area is characterized by cool, wet summers and relatively, warm snowy winters. Annual precipitation at sea-level averages 55 inches and winter temperatures are rarely less than 5º F and average 30º F (Haines, AK; National Weather Service, Juneau, AK, unpublished data). Elevations at 2600' typically receive ca. 250 inches of snowfall, annually (Eaglecrest Ski Area, Juneau, AK, unpublished data). Predominant vegetative communities occurring at low-moderate elevations (<1500') include Sitka spruce (*Picea sitchensis*)-western hemlock (*Tsuga heterophylla*) coniferous forest, mixed-conifer muskeg and deciduous riparian forests. Mountain hemlock (*Tsuga mertensiana*) dominated 'krummholtz" forest comprises a subalpine, timberline band occupying elevations between 1500-2500 feet. Alpine plant communities are composed of a mosaic of relatively dry ericaceous heathlands, moist meadows dominated by grasses and forbs and wet fens. Avalanche chutes are common in the study area, bisect all plant community types and often terminate at sea-level.

METHODS

Mountain Goat Capture

Mountain goats were captured using standard helicopter darting techniques and immobilized by injecting 3.0/2.7mg of carfentanil citrate (males/females, respectively; Taylor 2000) via projectile syringe fired from a Palmer dart gun (Cap-Chur, Douglasville, GA). During handling, all animals were carefully examined and monitored following standard veterinary procedures (Taylor 2000) and routine biological samples and morphological data collected. Following handling procedures, the effects of the immobilizing agent was reversed with 100mg of naltrexone hydrochloride per 1mg of carfentanil citrate (Taylor 2000). All capture procedures were approved by the State of Alaska Animal Care and Use Committee.

GPS Location Data

Telonics TGW-3590 GPS radio-collars (Telonics, Inc., Mesa, AZ) were deployed on all animals captured. Radio-collars were programmed to collect GPS location data at 6-hour intervals (collar lifetime: 2.5 years). During each location attempt, ancillary data about collar activity (i.e. percent of 1-second switch transitions calculated over a 15 minute period following each GPS fix attempt) and temperature (degrees C) were simultaneously collected. Complete data-sets for each individual were remotely downloaded (via fixed-wing aircraft) at 8-week intervals. Location data were post-processed and filtered for "impossible" points and 2D locations with PDOP (i.e. position dilution of precision) values greater than 10, following D'Eon et al. (2002) and D'Eon and Delparte (2005).

Habitat Selection and Movement Patterns

Comprehensive analyses of mountain goat habitat use and movement patterns will not be conducted until all GPS location information is collected (i.e. 2009). Nevertheless, preliminary analyses focused on describing altitudinal distribution patterns of mountain goats between September 28, 2005-July 25, 2006 were conducted. These analyses summarize daily average and upper and lower altitudinal extremes for GPS-collared mountain goats. The proportion of GPS locations within different altitudinal categories was also summarized.

Additional analyses were conducted to evaluate seasonal differences in sex-specific patterns of terrain use and movement patterns using a sub-set of the existing GPS location data (i.e. encompassing the period between September 28, 2005-February 10, 2006). These analyses served as the basis for a paper presented at the 15th Biennial Symposium of the Northern Wild Sheep and Goat Council in Kananaskis, Alberta on April 6, 2006 (see Appendix 1).

Reproduction and Survival

Kidding rates and mountain goat survival were determined by monitoring individual study animals during monthly surveys using fixed-wing aircraft (Heliocourier, Cessna 210) equipped for radio-telemetry tracking. During surveys, radio-collared adult female mountain goats were monitored to determine whether they gave birth to kids and, if so, how long they survived. Monitoring kid production and survival was only possible during the non-winter months when animals could be reliably observed in open habitats. Mortality of individual mountain goats was determined by detecting radio-frequency pulse rate changes during monthly monitoring surveys. In cases where mortality pulse rates were detected, efforts were made to investigate sites as soon as possible via helicopter. To the extent possible, all mortalities were thoroughly investigated to ascertain the cause of death and relevant biological samples collected.

Population Abundance and Composition Estimation

Aerial Surveys-Population abundance and composition surveys were conducted using fixed-wing aircraft (i.e. Piper PA-18, Heliocourier) in late-summer and fall 2005 (August and October). Because capture efforts began late in the season (due to funding constraints) and few collars had been deployed at the time of aerial surveys it was not possible to estimate mountain goat sightability (i.e. the probability of seeing mountain goats on a given survey) or population abundance using mark-resight techniques, as planned. Nevertheless, aerial surveys were

conducted in order to obtain estimates of minimum population size and composition (i.e. % kids in the population).

Ground Surveys-Evaluation of ground-based techniques for estimating mountain goat population size and composition was conducted in a small portion of the Lions Head study area (i.e. 13.2 km^2) . Previous research has concluded that aerial surveys are often inadequate for providing accurate estimates of the proportion of adult males and females, as well as, sub-adults during aerial surveys (Cote and Festa-Bianchet 2003); only the proportion of adults and kids in a population can be reliably estimated. As a result, ground-based survey techniques were tested to evaluate whether this method might serve as a reliable tool for classifying individuals of separate sex and age classes during survey efforts.

RESULTS AND DISCUSSION

Mountain Goat Capture

Mountain goat helicopter capture activities summarized in this report were conducted during five days in late-fall 2005 and seven days in summer-fall 2006. Overall, 64 mountain goats (36 males, 28 females) were captured over 12 days of effort (Figure 1, Table 1). Captures were attempted during periods when mountain goats were distributed at high elevations, snow accumulation was minimal (less than 2 feet) and weather conditions were favorable (i.e. high flight ceiling and moderate wind speed). Additionally, captures were scheduled to avoid periods within 8 weeks of parturition in order to avoid unnecessary disturbance adult females and associated neonates. As a result of these constraints, opportunities to capture mountain goats were fairly limited. However, no animals died during capture or handling procedures and evidence of kid abandonment was not observed in cases where adult females with associated kids were captured.

During handling procedures standard biological specimens were collected and morphological measures taken. Specific biological samples collected from study animals included: whole blood (4mL), blood serum (8mL), ear tissue, hair and fecal pellets. Whole blood, serum and fecal pellet sub-samples were sent to Dr. Kimberlee Beckmen (ADFG, Fairbanks, AK) for disease screening. All remaining samples have been archived at Alaska Department of Fish and Game facilities in Douglas, AK. Mountain goat morphological data are summarized in Table 2.

GPS Location Data

Telonics TGW-3590 GPS radio-collars were deployed on all mountain goats captured. However, performance of GPS radio-collars (as of July 26, 2006) was evaluated for only 22 individuals since 41 collars were deployed after the most recent scheduled GPS data download flight. Overall, the remote GPS data collection system used in this study worked as expected. We did not encounter any problems with GPS collar performance nor did problems occur with remote data download attempts. This high level of success was achieved despite occasionally poor weather conditions and, in some cases, substantial download distances between aircraft and mountain goats (i.e. up to 3 miles).

Overall, 20,016 GPS locations were acquired from 22 radio-collared mountain goats between September 26, 2005-July 25, 2006. Locations were subsequently filtered to remove impossible locations (i.e. those in salt water; n = 130), 2-D locations with PDOP values greater than 10 (n = 598). This standard data filtering routine was used to reduce positional bias in GPS location bias (D'Eon et al. 2002, D'Eon and Delparte 2005). In addition, locations collected during the 2-day period following capture were also removed from the data set (n = 175). Overall, GPS fix success was moderately high and remarkably consistent between individual animals (mean±SE : 83±1%; n = 22)(Table 2).

Habitat Use and Movement Patterns

Preliminary analyses indicated that female mountain goats used steeper, more rugged terrain in locations closer to cliffs (i.e. slopes greater than 40º) than males during winter (Appendix 1). However, males and females did not differ with respect to their altitudinal distribution during this period (Appendix 1). In general, both males

and females exhibited distinct seasonal movements from high elevation summer ranges and lower elevation winter ranges (Figures 2 & 3). Altitudinal shifts to low elevations were likely related to snow accumulation patterns at high elevations and were initiated during late-September and persisted through mid-November (Figure 2). The highest proportion of use of low elevation habitats occurred between early-January through late-April (Figure 4). The winter of 2005/2006 was atypically mild and warm storm systems originating in tropical regions resulted in significant snow ablation events at high elevations during early-winter (particularly during November 17-25, 2005). Mountain goat altitudinal distribution exhibited substantial variation during these periods presumably in response to associated snow depth fluctuations within individual home ranges.

Mountain goat seasonal movement patterns and home range sizes differed between males and females. In particular, males moved more widely across the landscape and used larger home ranges during the rut (i.e. October 19-November 23) than females (Appendix 1). However, during the fall and post-rut, or winter, period movement rates and home range sizes did not differ between males and females (Appendix 1). Presumably, these differences are linked to variation in behavioral strategies used by males and females to maximize reproductive success and survival.

Survival and Reproduction

Mountain goats were monitored monthly during fixed-wing aerial telemetry flights. Of the 23 animals monitored between October 15, 2005-August 7, 2006, five animals died of various causes. Three animals (2 males and 1 female) died of natural causes during mid-late winter. All three animals were among the oldest monitored and probable causes of death included: a fall from a cliff, avalanche and starvation. One male mountain goat died from a certain unnatural cause involving entanglement in mining debris. An additional female died from injuries relating to a fall (i.e. compound fracture of right femur) approximately two days after it was captured. The preliminary natural mortality rate reported here (i.e. 14.2%) is similar to that documented for mountain goats elsewhere in southeast Alaska (Smith 1986).

Preliminary estimates of adult female kidding rates and kid survival to ca. 2.5-months of age were based on monitoring of 10 females from May 30-August 7, 2006. Of the 10 females monitored, 9 were seen with kids following parturition (ca. May 15); no cases of twins were recorded. The single female that did not have a kid was in the youngest age class monitored (i.e. 4.5 years old). By early-August, two previously parturitient females had lost their kids. Overall, these preliminary estimates of kidding rates and kid survival appear to be high however small sample sizes limit inference from these data.

Population Abundance and Composition

Aerial Surveys-Overall, five fixed-wing aerial surveys were conducted in fall 2005 (Lions Head, n = 2, Sinclair Mountain, n = 2, Mount Villard, n = 1); surveys were not attempted in the East Berners study area in 2005 (Table 3, Appendix 2). Survey opportunities were limited in 2005 as a result of weather conditions, mountain goat capture activities and funding constraints. Consequently, it was not possible to conduct three replicate surveys in each area as planned. In addition, mountain goat sightability estimation data were not collected because of the small number of radio-collared goats at the time of survey flights. Due to these constraints, interpretation of aerial survey data is limited. Specifically, population abundance data represent the minimum number of animals present in survey areas (Table 3). Thus, estimates of actual population size and variance are unknown at this time. Nevertheless, estimates of population composition (i.e. % kids in the population) are likely to be reliable given the fairly large number of goats seen and classified (as adults or kids) on surveys (Table 3). Yet, due to limited survey replication it is not possible to statistically compare differences in population composition between study areas.

Ground-based Surveys-On June 26, 2006, a ground-based survey was conducted on the north side of Lions Head Mountain. Observers (n = 2) used binoculars and spotting scopes (8X and 25X, respectively) to survey sub-alpine and alpine terrain along a 3.8 kilometer route that enabled survey of a 13.2 km^2 area (Appendix 2).

During this survey it was possible to accurately identify adult males and females, sub-adults and kids with a high degree of confidence. Identification of male and female sub-adults and kids was not possible however with more time and favorable weather conditions it is likely sex-specific identification of sub-adults would be possible. Overall, 15 mountain goats were observed during this survey (Table 4).

On July 2, 2006, a helicopter (Hughes 500) survey was conducted in the ground count area (observers, n = 4) to provide information about possible limitations of ground-based surveys. Ground-based surveys may result in biased estimates of actual abundance because observers are not able to survey areas quickly and unintentional disturbance of goats could result in movement of animals in or out of sampling areas. Helicopter surveys are capable of (nearly) simultaneously surveying small areas, thus alleviating problems mentioned above. In this preliminary assessment, results relating to the total number of adults and kids seen during the helicopter survey were very similar to those derived from ground-based survey efforts (Table 4). However, it was not possible to conduct sex-specific classifications of individuals via helicopter without causing an unacceptable level of disturbance. Overall, these preliminary results indicate that ground-based surveys represent a potentially important means for acquiring detailed population composition data and should be used to complement broad-scale aerial survey efforts.

FUTURE WORK

Study animals will continue to be monitored monthly to assess reproductive status and survival. Additionally, at 8-week intervals GPS data will be downloaded from each animal during aerial surveys. These data will be post-processed and integrated the existing GPS location database. Three replicate aerial surveys will be conducted in early-fall 2006, weather permitting, in order to estimate mountain goat sightability, population abundance and composition. Results of these efforts will be summarized and submitted as an annual research progress report on September 1, 2007.

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FIGURES

Figure 1. Location of mountain goat study areas and sites where individual animals were captured (n = 64). Local landmarks and the Juneau Access Road alignment are also referenced.

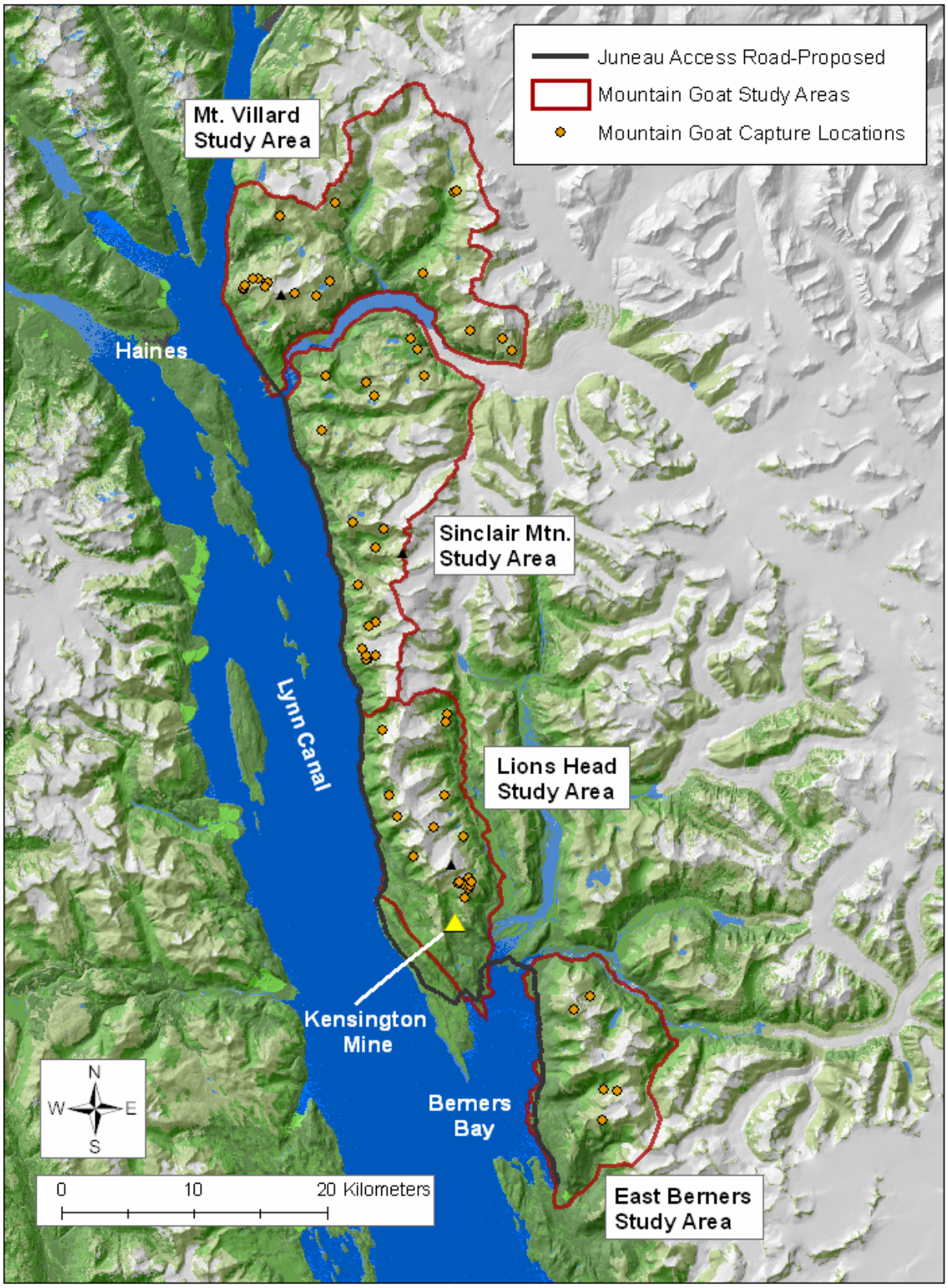


Figure 2. Average daily elevation (±1 SE) of GPS-collared mountain goats (n = 11 males, 11 females) between September 27, 2005-July 25, 2006. Summaries are compiled from daily mean values for individual animals. Maximum and minimum daily elevation trend lines were derived using 7-day moving averages.

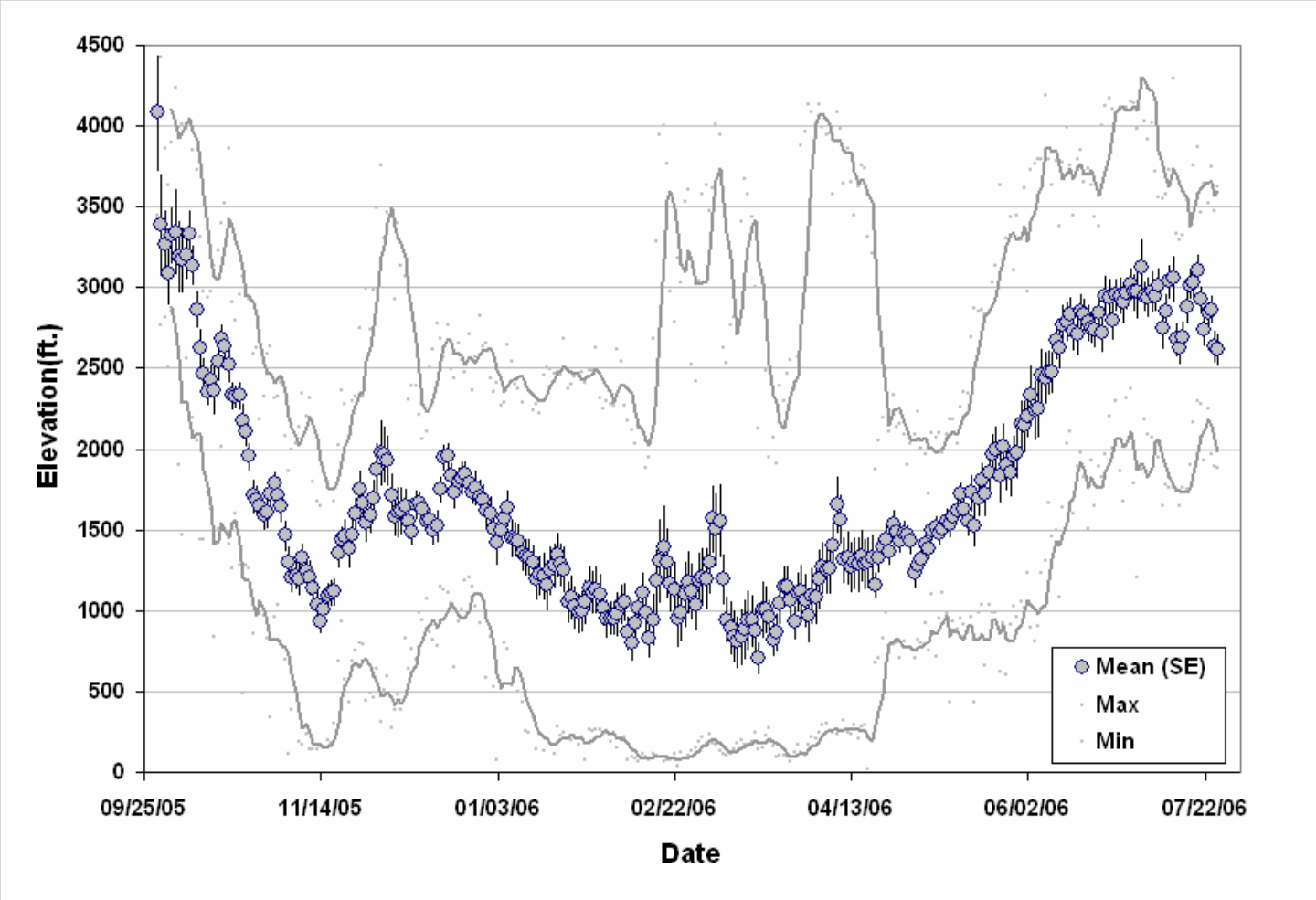
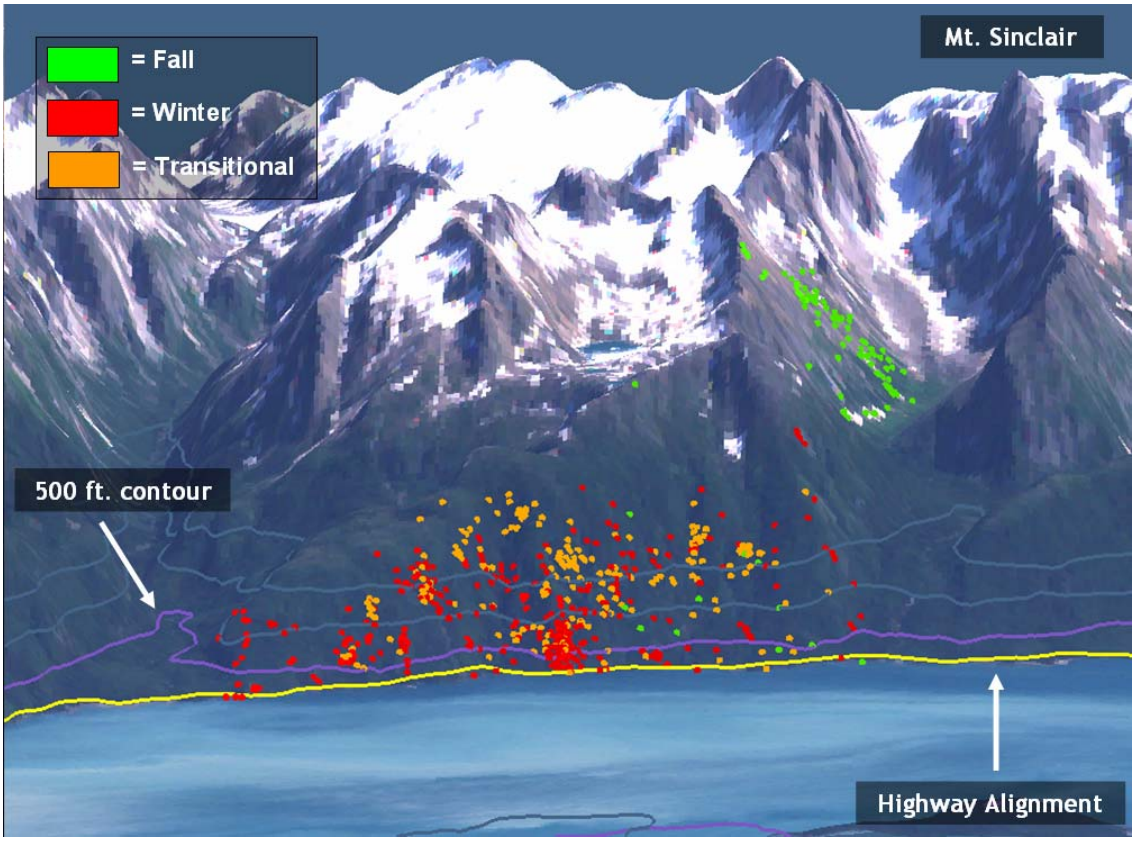


Figure 3. Maps depicting seasonal distribution and movement patterns for a representative adult female mountain goat (LG-04) that over-wintered near the eastern shore of Lynn Canal near Sinclair Mountain (September 27, 2005-May 30, 2006). The Juneau Access Highway alignment is illustrated in yellow.



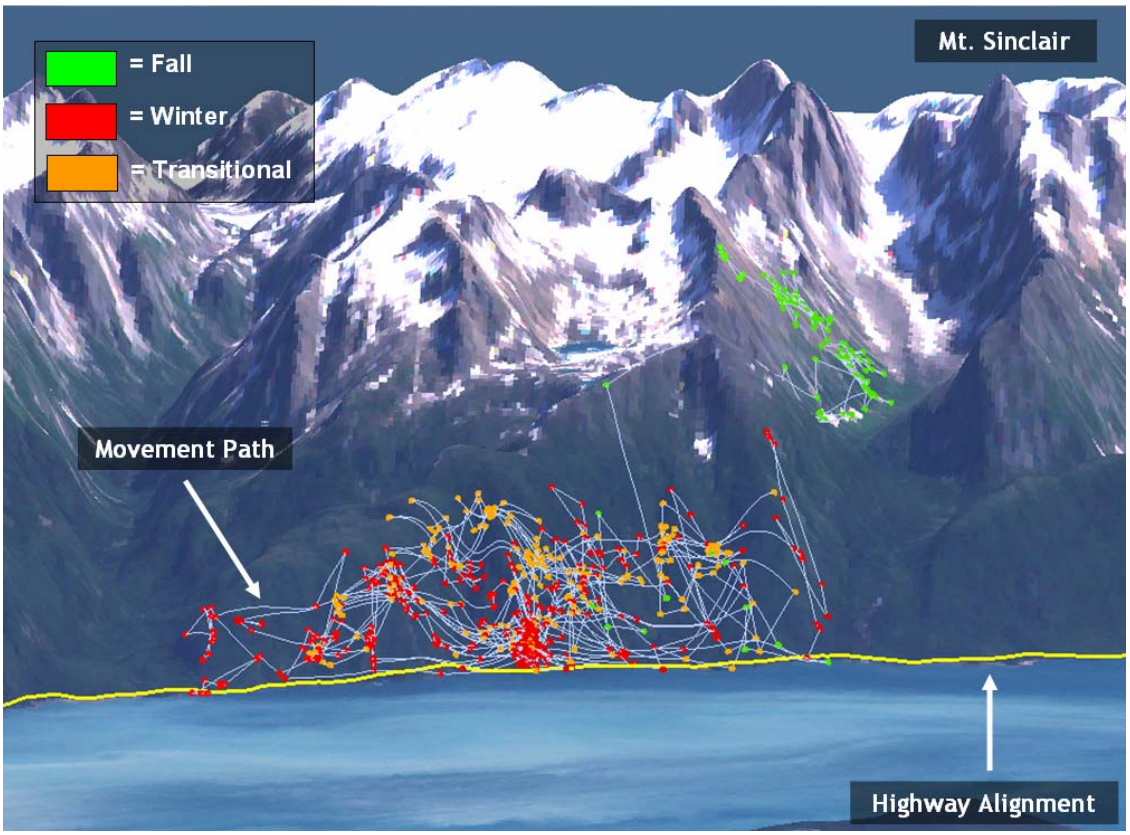
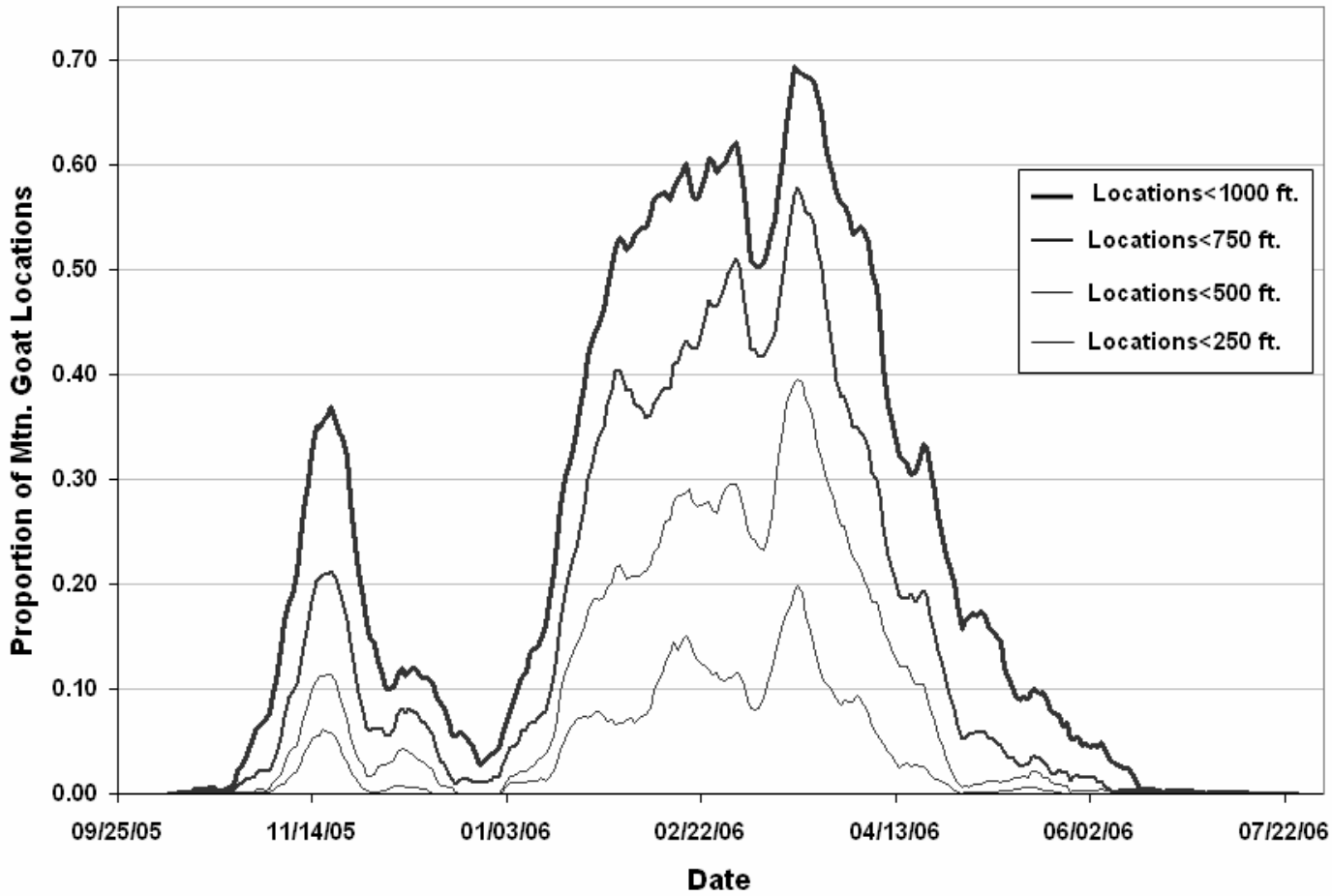


Figure 4. Proportion of mountain goat GPS locations (n = 19,113 locations) located in different elevation categories (September 27, 2005-July 25, 2006).



TABLES

Table 1. Summary of sex, age class and survival information for GPS-collared mountain goats. GPS-collar performance data is summarized for the period between September 28, 2005-October 13, 2006.

					GPS Fix Attempts[1]				
Mtn Goat ID	Study Area	Capture Date	Sex	Est. Age	Total Fixes	Successful Fixes	% 2D Fixes	% 3D Fixes	Comments
LG-01	Mt. Sinclair	09/26/05	M	9.5	812	695	41.9	43.7	Died: 4/17/06
LG-02	Mt. Sinclair	09/26/05	F	10.5	809	573	50.9	19.9	Died: 4/16/06
LG-03	Mt. Sinclair	09/26/05	F	6.5	1208	1077	46.0	43.1	
LG-04	Mt. Sinclair	09/26/05	F	6.5	1207	989	48.9	33.1	
LG-05	Mt. Sinclair	09/26/05	M	8.5	1207	971	50.1	30.3	
LG-06	Lions Head	10/02/05	M	7.5	524	426	34.0	47.3	Died: 2/10/06
LG-07	Lions Head	10/02/05	M	2.5	1184	960	48.3	32.8	
LG-08	Lions Head	10/02/05	F	4.5	1184	962	45.9	35.4	
LG-09	Lions Head	10/02/05	F	9.5	1183	967	50.5	31.2	
LG-10	Mt. Sinclair	10/03/05	F	6.5	1180	943	49.4	30.5	
LG-11	Mt. Sinclair	10/0305	M	8.5	1179	967	44.4	37.6	
LG-12	Mt. Villard	10/03/05	F	7.5	1180	971	45.8	36.5	
LG-13[2]	Mt. Villard	10/03/05	F	8.5	--	--	--	--	Died: 10/06/05
LG-14	Mt. Villard	10/03/05	F	4.5	1180	987	47.5	36.2	
LG-15	Mt. Villard	10/03/05	M	5.5	1179	998	47.1	37.6	
LG-16	Mt. Sinclair	10/14/05	M	4.5	1136	971	51.1	34.3	
LG-17	Mt. Villard	10/14/05	F	6.5	1136	966	49.7	35.3	
LG-18	Mt. Villard	10/14/05	M	3.5	1135	959	49.3	35.2	
LG-19	Lions Head	10/15/05	M	5.5	1017	852	50.2	33.5	Died: 6/26/06
LG-20	Lions Head	10/15/05	M	8.5	1132	936	45.9	36.7	
LG-21	Lions Head	10/15/05	F	4.5	1132	919	50.1	31.1	
LG-22	Lions Head	10/15/05	F	8.5	1132	986	40.9	46.2	
LG-23	Lions Head	10/15/05	M	9.5	1132	941	47.4	35.7	
LG-24[3]	Lions Head	07/28/06	M	2.5	--	--	--	--	
LG-25	Lions Head	07/28/06	F	5.5	--	--	--	--	
LG-26	Lions Head	07/28/06	M	5.5	--	--	--	--	
LG-27	Lions Head	07/28/06	M	9.5	--	--	--	--	
LG-28	Lions Head	07/28/06	M	7.5	--	--	--	--	
LG-29	Mt. Sinclair	07/28/06	F	6.5	--	--	--	--	
LG-30	Mt. Sinclair	07/28/06	F	7.5	--	--	--	--	
LG-31	East Berners	07/28/06	M	11.5	--	--	--	--	
LG-32	East Berners	07/28/06	F	3.5	--	--	--	--	
LG-33	East Berners	07/29/06	M	8.5	--	--	--	--	
LG-34	East Berners	07/29/06	M	5.5	--	--	--	--	
LG-35	East Berners	07/29/06	F	4.5	--	--	--	--	
LG-36	Lions Head	07/29/06	M	5.5	--	--	--	--	
LG-37	Lions Head	07/29/06	M	3.5	--	--	--	--	
LG-38	Lions Head	07/29/06	F	3.5	--	--	--	--	

[1]GPS location data summarized as of 7/25/06

[2]LG-13 died before adequate GPS location data could be collected

[3]LG-24 to LG-38 were deployed with GPS collars following the last scheduled GPS download flight

Table 1. Continued.

Mtn Goat ID	Study Area	Capture Date	Sex	Est. Age	GPS Fix Attempts[1] Total Fixes	Successful Fixes	% 2D Fixes	% 3D Fixes	Comments
LG-39	Mt. Sinclair	08/29/06	F	9.5	--	--	--	--	
LG-40	Mt. Sinclair	08/29/06	M	7.5	--	--	--	--	
LG-41	Mt. Sinclair	08/29/06	F	4.5	--	--	--	--	
LG-42	Mt. Villard	08/29/06	F	2.5	--	--	--	--	
LG-43	Mt. Villard	08/29/06	F	3.5	--	--	--	--	
LG-44	Mt. Villard	08/29/06	M	11.5	--	--	--	--	
LG-45	Mt. Sinclair	09/25/06	F	5.5	--	--	--	--	
LG-46	Mt. Villard	09/25/06	M	7.5	--	--	--	--	
LG-47	Mt. Villard	09/25/06	M	10.5	--	--	--	--	
LG-48	Mt. Villard	09/25/06	M	11.5	--	--	--	--	
LG-49	Mt. Villard	09/25/06	M	5.5	--	--	--	--	
LG-50	Lions Head	10/07/06	M	7.5	--	--	--	--	
LG-51	Mt. Sinclair	10/07/06	F	1.5	--	--	--	--	
LG-52	Mt. Sinclair	10/07/06	F	2.5	--	--	--	--	
LG-53	Lions Head	10/07/06	M	2.5	--	--	--	--	
LG-54	Mt. Villard	10/12/06	M	6.5	--	--	--	--	
LG-55	Mt. Villard	10/12/06	F	11.5	--	--	--	--	
LG-56	Mt. Villard	10/12/06	M	8.5	--	--	--	--	
LG-57	Mt. Villard	10/12/06	F	7.5	--	--	--	--	
LG-58	Mt. Villard	10/12/06	M	3.5	--	--	--	--	
LG-59	Mt. Villard	10/12/06	F	4.5	--	--	--	--	
LG-60	Mt. Sinclair	10/13/06	M	4.5	--	--	--	--	
LG-61	Mt. Sinclair	10/13/06	M	9.5	--	--	--	--	
LG-62	Mt. Sinclair	10/13/06	M	9.5	--	--	--	--	
LG-63	Mt. Sinclair	10/13/06	M	9.5	--	--	--	--	
LG-64	Mt. Sinclair	10/13/06	M	3.5	--	--	--	--	

[1]GPS location data summarized as of 7/25/06

[2]LG-13 died before adequate GPS location data could be collected

[3]LG-24 to LG-64 were deployed with GPS collars following the last scheduled GPS download flight

Table 2. Summary of selected morphological data collected for mountain goats captured between September 27-October 15, 2005.

	Females			Males		
	mean	SE	n	mean	SE	n
Est. Age	6.0	0.5	28	7.0	0.5	36
Weight (lbs.)	176.3	4.6	22	280.2	9.6	32
Body Length (cm)	159.0	2.2	26	179.3	2.2	36
Girth (cm)	106.2	1.3	26	126.9	1.6	36
Neck (cm)	42.1	0.5	24	49.9	0.6	36
Hind Foot (cm)	22.7	0.2	25	25.0	0.2	33
Horn Length (in)	8 10/16	3/16	26	9	2/16	36
Horn Circumference (in)	4 1/16	1/16	26	5 4/16	1/16	36

Table 3. Summary of mountain goat aerial survey data collected during August-October 2005. Totals represent the number of animals seen on surveys not actual population estimates.

Study Area	Date	Survey Time (min)	Area Surveyed (km^2)	Adults	Kids	Total	% Kids	Goats/km^2	Temp (F)	Weather	Aircraft	# of Observers
Lions Head	8/11/2005	35	55.8	35	5	40	12.5	0.72	70	Clear	PA-18	2
Lions Head	10/3/2005	57	77.7	55	8	65	12.3	0.84	45	Clear	Heliocouirer	3
Sinclair Mtn.	8/11/2005	77	111.5	77	17	94	18.1	0.84	70	Clear	PA-18	2
Sinclair Mtn.	10/3/2005	93	111.5	159	30	189	15.9	1.69	45	Clear	Heliocouirer	3
Mt. Villard	8/12/2005	85	133.3	23	4	27	14.8	0.20	68	Clear	PA-18	2

Table 4. Summary of mountain goat survey data collected during ground-based and helicopter surveys on June 26 & July 2, 2006. Totals represent the number of animals seen on surveys not actual population estimates.

Study Area	Survey Type	Date	Area Surveyed (km^2)	Survey Time (min)	Adults Males	Adults Females	Unk.	Subadults	Kids	Total	% Kids	Goats/km^2	Temp (F)	Weather	# of Observers
Lions Head	Ground	6/26/2006	13.2	181	3	5	--	2	5	15	33.3	1.13	60	Cloudy	2
Lions Head	Helicopter	7/2/2006	9.5	11	--	--	10	--	6	16	37.5	1.68	65	Clear	4

APPENDIX 1.

Proceedings of the 15th Biennial Symposium of the Northern Wild Sheep and Goat Council, 15:000-000. (In Review)

SEASONAL AND SEX-SPECIFIC VARIATION IN TERRAIN USE AND MOVEMENT PATTERNS OF MOUNTAIN GOATS IN SOUTHEASTERN ALASKA: PRELIMINARY FINDINGS

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Abstract: Fundamental differences in fitness requirements between male and female individuals result in sex-linked ecological variation within many species of large mammals. Determining the extent to which sex-specific requirements alter behavioral strategies and subsequent spatial use patterns has important implications for conservation and management of species such as mountain goats (*Oreamnos americanus*). In this study, location data were collected from 22 GPS radio-collared mountain goats (11 males, 11 females) during September 2005-February 2006. These data were integrated with terrain data layers in a GIS framework to address questions about sex-specific variation in movement patterns and terrain use across a 600 km^2 study area located in northern Southeast Alaska. Male mountain goats exhibited greater rates of movement than females during the rut but not during fall or winter. As a result, male home ranges were significantly larger than females during this period. Both males and females moved to lower elevations with the onset of winter but did not differ with respect to altitudinal distribution. Following the rut, the period when sexual aggregation occurs, females used areas in which slope was steeper, distance to escape terrain was less and terrain ruggedness was greater than areas used by males. Overall, these preliminary findings detail differences in terrain and spatial use patterns between male and female mountain goats and suggest that vulnerability to anthropogenic disturbance factors may be sex-specific.

INTRODUCTION:
Elucidating patterns of resource use and movement play an important role in our understanding of the ecology and conservation of many species. While many factors may influence variation in these fundamental ecological characteristics, the sex of individuals in a population represents one variable of principal interest (Clutton-Brock et al. 1982, Main et al. 1996). This is particularly evident among polygynous ruminants that display pronounced sex-specific contrasts in morphology, social behavior and life history strategies (Clutton-Brock et al. 1982). These patterns arise because natural selection acts on males and females in disparate ways as a result of fundamental differences in their reproductive characteristics (Darwin 1871).

Mountain goats provide an interesting example for evaluating sex-mediated differences in patterns of resource use and movement as a result of sexual body size dimorphism, social organization and narrow constraints on habitat use requirements (Côté and Festa-Bianchet 2003). Adult male mountain goats are 40-60% larger than females (Houston et al. 1989). As a result, males are expected to experience greater nutritional requirements but may also be less prone to predation. In addition, energetic resources required for successful reproduction are partitioned differently between males and females. In particular, polygynous males do not participate in rearing of young and maximize reproductive success by utilizing behavioral strategies that optimize their ability to mate with many high quality females during a limited 4-6 week rutting season (Brandborg 1955, Geist 1964). Females, on the other hand, maximize their reproductive success by selectively breeding with a single high quality male (Brandborg 1955) and, perhaps more importantly, optimizing foraging and habitat use decisions that enable acquisition of adequate nutritional resources required for survival and successful rearing of young (Cote 2001); a period that may span at least 10 months (Chadwick 1977).

Largely unique among North American ungulates, mountain goats exhibit distinct morphological adaptations that enable them to live in steep, rugged mountain environments characterized by extreme climate conditions. It is widely recognized that the preferential for use of such habitat types is primarily linked to the avoidance of predation (Schaller 1979, Smith 1983, Fox and Streveler 1986). At smaller spatial scales, these environments are composed of a mosaic of forage-rich alpine meadows and barren cliffs that provide escape terrain. Because of this juxtaposition of habitat types, mountain goats likely face trade-offs between utilizing forage-rich but relatively dangerous alpine meadows and forage-poor but safe cliff habitats. Such sex-specific trade-offs in habitat use have been documented in other mountain ungulate species (Bleich et al. 1997) and provide a framework for interpreting resource use patterns in mountain goats.

In this paper two principal research questions were addressed: (1) do adult male and female mountain goat home range and movement patterns differ during and outside of the rut?, and (2) do adult male and female mountain goats differ in their use of “safe” terrain features during periods outside of the breeding season?

STUDY AREA:
Mountain goats were studied in a 600 km^2 study area located in a mainland coastal mountain range east of Lynn Canal, a post-glacial fiord located near Haines in southeastern Alaska (Figure 1). The study area is oriented along a north-south axis and bordered in the south by Berners Bay (58.76N, 135.00W) and by Dayebas Creek (59.29N, 135. 35W) in the north (Figure 1). Elevations range from 6300 feet to sea level. This area is an active glacial terrain underlain by late cretaceous-paleocene granodiorite and tonalite geologic

formations (Gehrels 2000). Specifically, it is a geologically young, dynamic and unstable landscape that harbors a matrix of perennial snowfields and small glaciers at high elevations (i.e. above 4000 feet) and rugged, broken terrain that descends to a rocky, tidewater coastline. The northern part of the study area is bisected by the Katzehin river, a moderate volume (ca. 1500 c/fs; USGS, unpublished data) glacial river system that is fed by a tributary of the Juneau Icefield.

The maritime climate in this area is characterized by cool, wet summers and relatively, warm snowy winters. Annual precipitation at sea-level averages 55 inches and winter temperatures are rarely less than 5º F and average 30º F (Haines, AK; National Weather Service, Juneau, AK, unpublished data). Elevations at 2600' typically receive ca. 250 inches of snowfall, annually (Eaglecrest Ski Area, Juneau, AK, unpublished data). Predominant vegetative communities occurring at low-moderate elevations (<1500') include Sitka spruce (*Picea sitchensis*)-western hemlock (*Tsuga heterophylla*) coniferous forest, mixed-conifer muskeg and deciduous riparian forests. Mountain hemlock (*Tsuga mertensiana*) dominated 'krummholtz" forest comprises a subalpine, timberline band occupying elevations between 1500-2500 feet. Alpine plant communities are composed of a mosaic of relatively dry ericaceous heathlands, moist meadows dominated by grasses and forbs and wet fens. Avalanche chutes are common in the study area, bisect all plant community types and often terminate at sea-level.

METHODS:

Mountain Goat Captures-

During September-October 2005, we captured 22 adult mountain goats (11 male, 11 female) using standard helicopter darting techniques (Taylor 2000). Mountain goats were immobilized by injecting 3.0/2.7mg of carfentanil citrate (males/females, respectively) via projectile syringe fired from a Palmer dart gun (Cap-Chur, Douglasville, GA). During handling, all animals were carefully examined and monitored following standard veterinary procedures (Taylor 2000) and routine biological samples and morphological measures collected. Following handling procedures, the effects of the immobilizing agent was reversed with 100mg of naltrexone hydrochloride per 1mg of carfentanil citrate (Taylor 2000). All capture procedures were approved by the State of Alaska Animal Care and Use Committee.

GPS Radio-collaring-

Telonics TGW-3590 GPS radio-collars (Telonics, Inc., Mesa, AZ) were deployed on all animals captured. Radio-collars were programmed to collect GPS location data at 6-hour intervals. During each location attempt ancillary data about collar activity (i.e. percent of 1-second switch transitions calculated over a 15 minute period following each GPS fix attempt) was simultaneously collected. Complete data-sets for each individual were remotely downloaded (via fixed-wing aircraft) at 8-week intervals. Location data were post-processed and filtered for "impossible" points and 2D locations with PDOP (i.e. position dilution of precision) values greater than 10, following D'Eon et al. (2002) and D'Eon and Delparte (2005).

Defining Seasonality-

Seasons were defined by using remotely collected activity sensor data a as proxy for defining behaviorally mediated changes in seasonal activity patterns. Specifically, GPS collars were deployed with mercury tip switches programmed to record the proportion of 1-second switch transitions that occurred over a 15 minute period coordinated with GPS location attempts (ie. 6-hour intervals). Previous research on comparable species has documented reliable linkages between actual animal behavior and remotely collected activity switch data (Coulombe et al. 2006). As a result, I assumed that the proportion of switch transitions was positively correlated with animal activity. Thus, distinct changes in activity patterns were used to define biologically relevant seasons for mountain goats.

GIS Analyses-

Mountain goat GPS location data were integrated into a GIS (ArcView 3.2, ArcGIS 9, ESRI, Redlands, CA) in order to derive spatial attribute information for each data point. Digital elevation models (30-m resolution; NASA 2004) were used to estimate elevation (m), slope (degrees), distance (m) to slopes greater than 40 degrees (hereafter "distance to cliffs") and standard deviation of elevation within a 60m radius of point locations (hereafter "topographic roughness"). Distance moved between successive locations was calculated at different time steps (1-day and 5-day intervals). Fixed-kernel home ranges (95% isopleths) were calculated using the least-squares cross validation (LCSV) technique to parameterize the smoothing function (Seaman and Powell 1999, Seaman et al. 1999). Both movement distance and home range area were calculated using surface area rather than planimetric area functions (following Jenness 2004). This approach enabled more precise estimates of space use parameters; planimetric area calculations tended to underestimate actual space use by 20.3%, on average (K. White, unpublished).

Statistical Analyses-

To compare seasonal and inter-sexual differences in male and female home range sizes I used analysis of variance (ANOVA) and Tukey HSD pair-wise comparisons (Zar 1999). To evaluate seasonal and sex-specific differences in movement distances (1-day and 5-day intervals), elevation, slope, distance to cliffs and topographic roughness, daily mean values were estimated for each sex category. Confidence intervals (±95%) were calculated using individual animal mean values pooled across each biologically relevant season in order to determine whether sex-specific differences occurred between parameter estimates (Steel and Torrie 1980). This analysis employed a variable estimation procedure that differs from explicit hypothesis testing approaches; however, this approach was used because it provided a more descriptive assessment of variability in male-female differences at short time intervals.

RESULTS

Mountain Goat Capture and GPS Data Acquisition-

During September 27-October 15, 2005, 22 adult mountain goats (11 male, 11 female) were captured and deployed with GPS radio-collars. Subsequently, complete GPS location data sets (including successful and unsuccessful fixes) were remotely downloaded (via fixed-wing aircraft) from all study animals. Between September 27, 2005-February 10, 2006 a total of 8576 GPS locations (mean ± SE = 389 ± 4 locations/animal) were acquired and used in subsequent analyses, following data filtering routines (see methods).

Defining Seasons:

As defined by the proportion of switch transitions, male and female mountain goat activity patterns were similar except between October 18-November 23, 2005 (Figure 2). During this period male activity patterns were significantly less than females. Based on observations reported by Geist (1964), that males are less active than females during the rut, I assumed that this period of reduced male activity coincided with the rut. The period between September 27-October 18 was defined as fall while the period between November 23, 2005-February 10, 2006 was defined as winter (Figure 2).

Movement Rates and Home Range Size Differences-

Movement rates for males and females were similar during fall and winter; however, rates significantly deviated during the rut. Specifically, movement rates were significantly greater for males than females, particularly when analyzed over 5-day time intervals (figure 3, 4). During the shorter, 1-day time step movement rate overlap between males and females was evident for brief periods but overall was greater for males despite greater variability in estimates at this time scale (Figure 5).

Significant differences were detected in seasonal home range estimates for males and females ($r^2 = 0.32$, $F_{5,52} = 12.71$, $P < 0.001$; Figure 6, 7). Specifically, males used larger home ranges than females during the rut; however, home range estimates did not differ by sex during other seasons.

Terrain Use Comparisons-

Altitudinal distribution did not differ between males and females during the period of study (Figure 8). Yet, an overall decline in mean elevation of all goats occurred with the onset on winter conditions at high elevations, though variability was evident in this relationship and coincided with the occurrence of an abnormally warm, late-season storm system (i.e. November 17-25, 2005).

Overall, we estimated that mean differences in slope, distance to cliffs and terrain ruggedness were significantly different between males and females during the post-rut, winter period (Figure 9-11). Specifically, our findings indicate that females used steeper slopes that were more rugged and closer to cliffs than males. No differences were detected in terrain use comparisons between males and females during the breeding aggregation period, or rut.

Discussion:

Adult male and female mountain goats are faced with differential selection pressure as a consequence of variation in morphology and associated life history strategies. By comparing behavioral differences between males and females during the breeding season it is possible characterize mechanisms that males and females employ to maximize chances for increasing their individual fitness.

Similar to previous research in southeast Alaska (Schoen and Kirchhoff 1982, Smith and Raedeke 1982), male and female mountain goats in this study exhibited substantial differences in movement rates and home range sizes. Males moved widely across the landscape during the breeding season, presumably in search of receptive females, while females used relatively small areas and moved less. These differences in space use and movement patterns suggest males exhibit behavioral strategies during the rut that enable increased chances to successfully breed with as many females as possible. Females, on the other hand, exhibit space use strategies that encompass relatively small areas that, possibly, maximize chances of discovery by high quality males during the breeding season.

Since body size of males is substantially larger than females, females may be potentially more vulnerable to attacks by large mammalian predators (Curio 1976). Additionally, females are also more likely to be associated with related young or sub-adults, than males; a factor that further predisposes them to increased predation-risk. Findings from this study, consistent with previous mountain goat research in southeast Alaska (Schoen and Kirchhoff 1982), suggest females use safe terrain features to a greater extent than males. This pattern was specifically evident during the post-rut period when females used steeper more rugged terrain in areas closer to cliffs than did males. While largely consistent with expectations associated with predation-mediated habitat-use trade-offs, the documented affinity for use of steep, rugged terrain by females in this study may also be due to lower snow depths in these habitat types during winter (Fox 1983).

In coastal mountain regions mountain goats typically migrate from high elevation summer ranges to lower elevation, forested winter ranges (Herbert and Turnbull 1977, Fox et al. 1987). However, whether males and females maintain similar altitudinal distributions during winter in southeast Alaska is less clear (Schoen and Kirchhoff 1982, Smith 1986). In this study we documented sex-independent altitudinal migrations by mountain goats that coincided with the onset of the first winter storms. Overall, 80% of all winter locations were at elevations less than 2000' above sea-level. These findings represent an interesting contrast to those of

Hundertmark et al. (1983) which documented mountain goats inhabiting an upper tributary of the Chilkat river valley, approximately 35 miles north, wintered primarily in windswept, high elevation habitats. Consequently, it appears that over-wintering strategies of mountain goats can vary over relatively small spatial scales and are unlikely to be related to differences in the composition of males and females in each population.

The extent to which the sexes segregate or employ different strategies for utilizing resources in their environment and avoiding mortality have important implications for conservation and management of species. For instance, differences in sex-specific movement patterns during the rut are likely to result in increased vulnerability of males to hunting pressure as a consequence of their increased movement and visibility during this period. Disparities in visibility of males relative to females may also alter the likelihood of observing animals during routine population monitoring surveys. Thus, acquisition of information about sex-specific variability in habitat use and movement patterns may offer potential for resolving certain key challenges associated with management and conservation of mountain goats.

AKNOWLEDGEMENTS:

Neil Barten, John Crouse, Doug Larsen, Steve Lewis, Karin McCoy, Dale Rabe and Chad Rice assisted in field and/or office work. Grey Pendleton provided statistical advice. Fixed-wing survey flights were conducted by Lynn Bennett (LAB) and Jacques Norvell (Tal Air). Helicopter support was provided by Rey Madrid and Mitch Horton (Temsco Helicopters). This project was funded by the State of Alaska Department of Transportation and Public Facilities and Coeur Alaska. Reuben Yost (SOA, DOT/PF) and Carl Schrader (SOA/DNR) coordinated project funding.

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TABLES AND FIGURES:

Figure 1. General location of 600 km^2 mountain goat study area, located between Juneau and Haines along the east side of Lynn Canal, AK.

Figure 2. Radio-collar activity patterns for male and female mountain goats between Sept. 27, 2005-Feb. 10, 2006. Activity data were derived from tip-switch sensors located on Telonics TGW-350 GPS radio-collars attached to mountain goats. Data are summarized as daily mean values ± 95% confidence intervals.

Figure 3. Example of differences in 1-day interval movement patterns for 2 representative radio-collared male and female mountain goats during the rut (Oct. 18- Nov. 23, 2005).

Figure 4. Distance moved (feet/meters) at 5-day intervals by male and female mountain goats between Sept. 27, 2005-Feb. 10, 2006. Data are summarized as 5-day mean distances ± 95% confidence intervals.

Figure 5. Distance moved (feet/meters) at 1-day intervals by male and female mountain goats between Sept. 27, 2005-Feb. 10, 2006. Data are summarized as daily mean distances ± 95% confidence intervals.

Figure 6. Example of differences in 95% fixed kernel home range sizes for 2 radio-collared male and female mountain goats during the rut (Oct. 18-Nov. 23, 2005).

Figure 7. Home range sizes (95% fixed kernel) for male and female mountain goats during different seasons. Data reported as seasonal mean values ± SE.

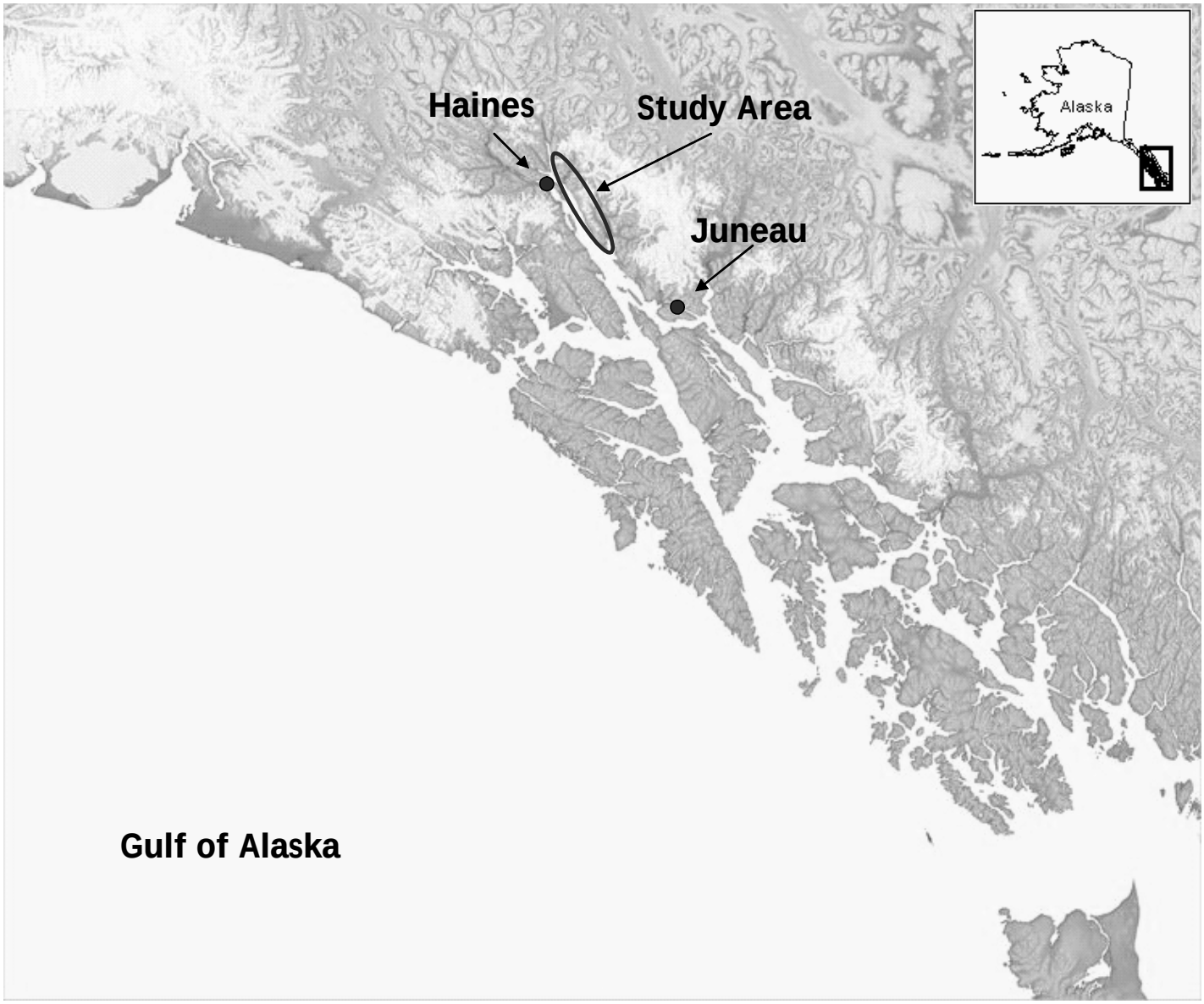
Figure 8. Mean daily elevation (feet/meters) for male and female mountain goats between Sept. 27, 2005-Feb. 10, 2006. Data are summarized as daily mean values ± 95% confidence intervals.

Figure 9. Mean daily slope (%) used by male and female and mountain goats between Sept. 27, 2005-Feb. 10, 2006. Data are summarized as daily mean values ± 95% confidence intervals.

Figure 10. Mean daily distance to cliffs (i.e. 40º slope) for male and female mountain goats between Sept. 27, 2005-Feb. 10, 2006. Data are summarized as daily mean values ± 95% confidence intervals.

Figure 11. Mean daily terrain ruggedness used by male and female mountain goats between Sept. 27, 2005-Feb. 10, 2006. Data are summarized as daily mean values ± 95% confidence intervals.

Figure 1.



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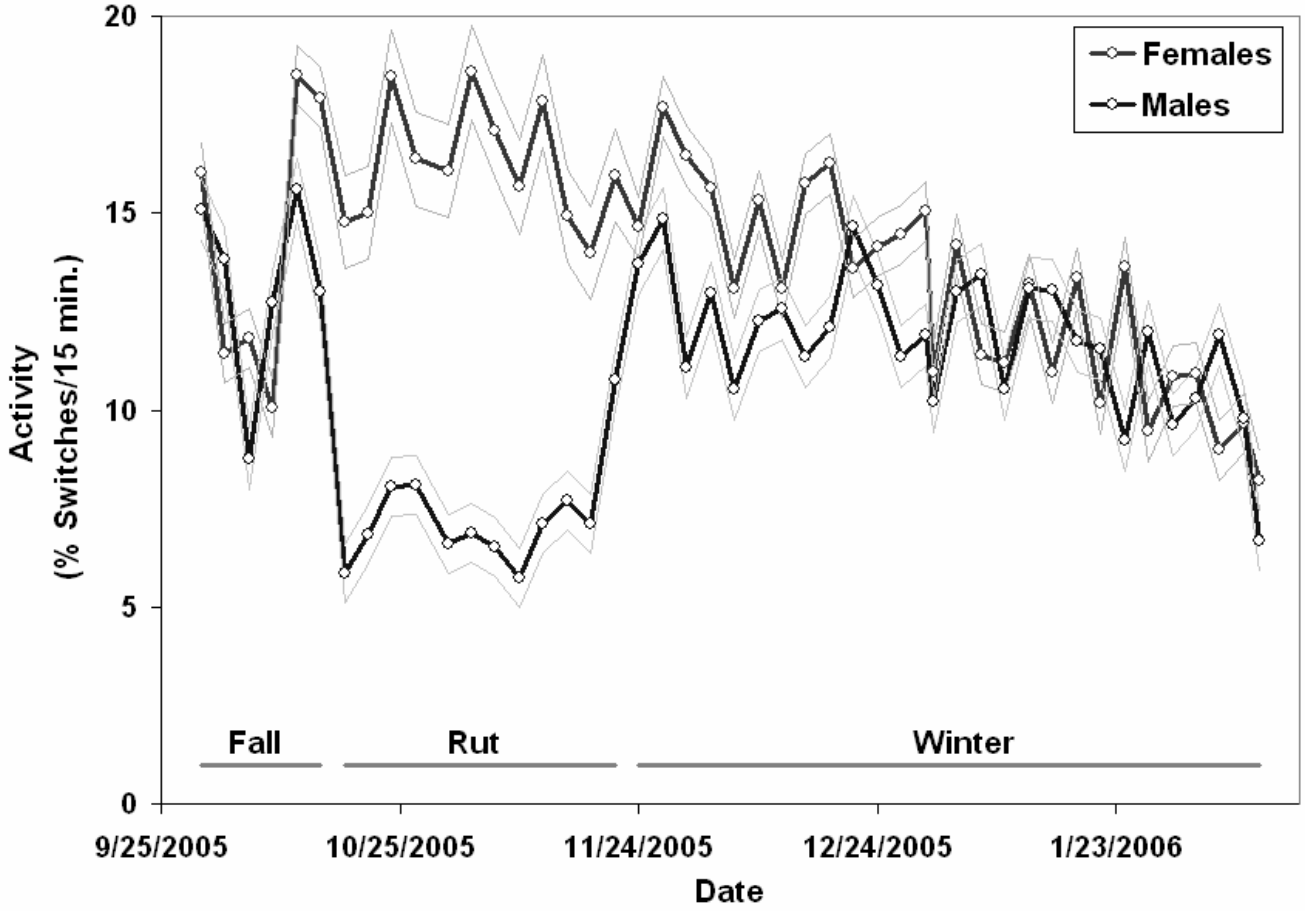

Females
Males
Activity
(% Switches/15 min.)
20
15
10
5
0
Fall
Rut
Winter
9/25/2005
10/25/2005
11/24/2005
12/24/2005
1/23/2006
Date

Figure 3.

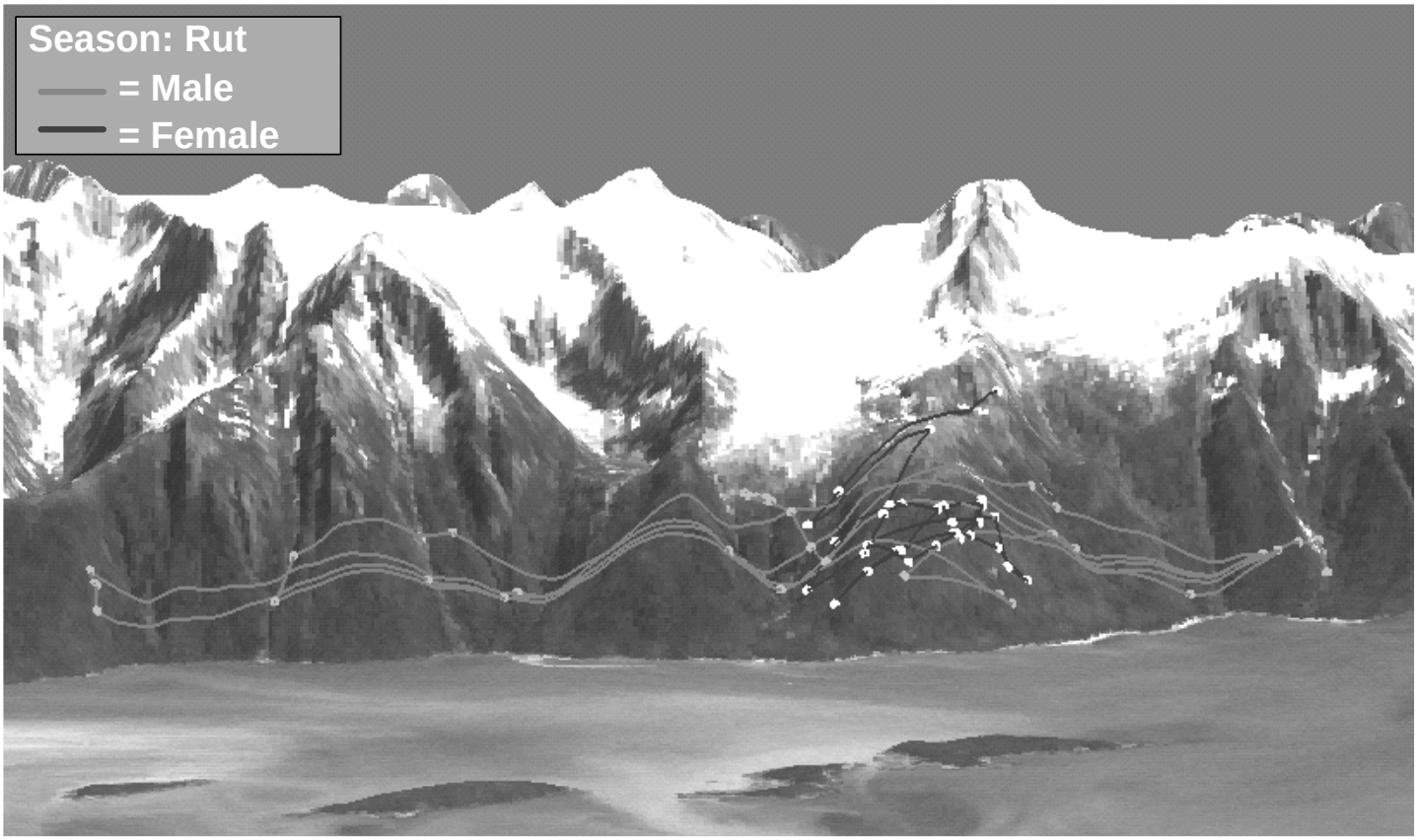
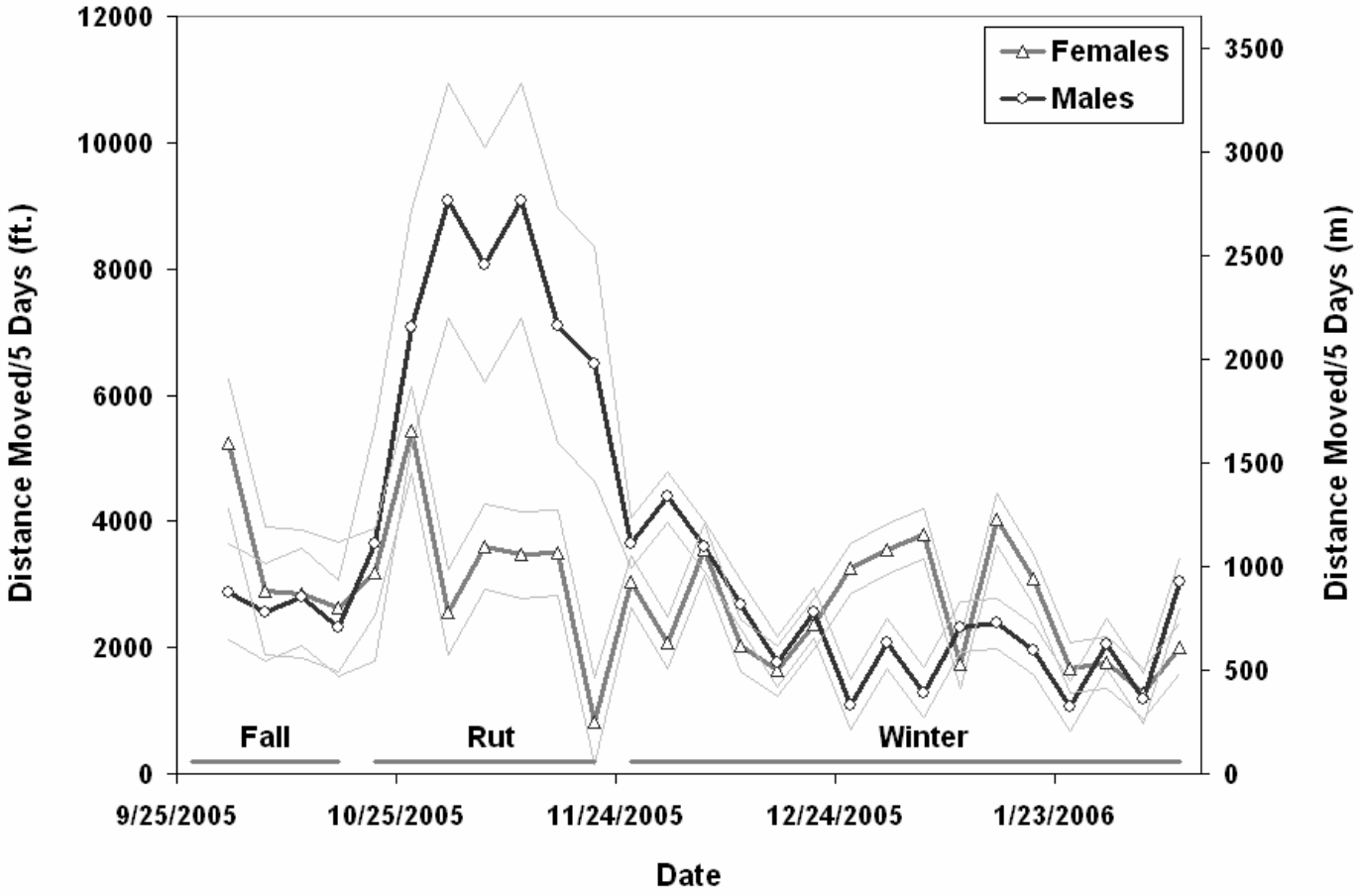


Figure 4


Females
Males
Distance Moved/5 Days (ft.)
Distance Moved/5 Days (m)
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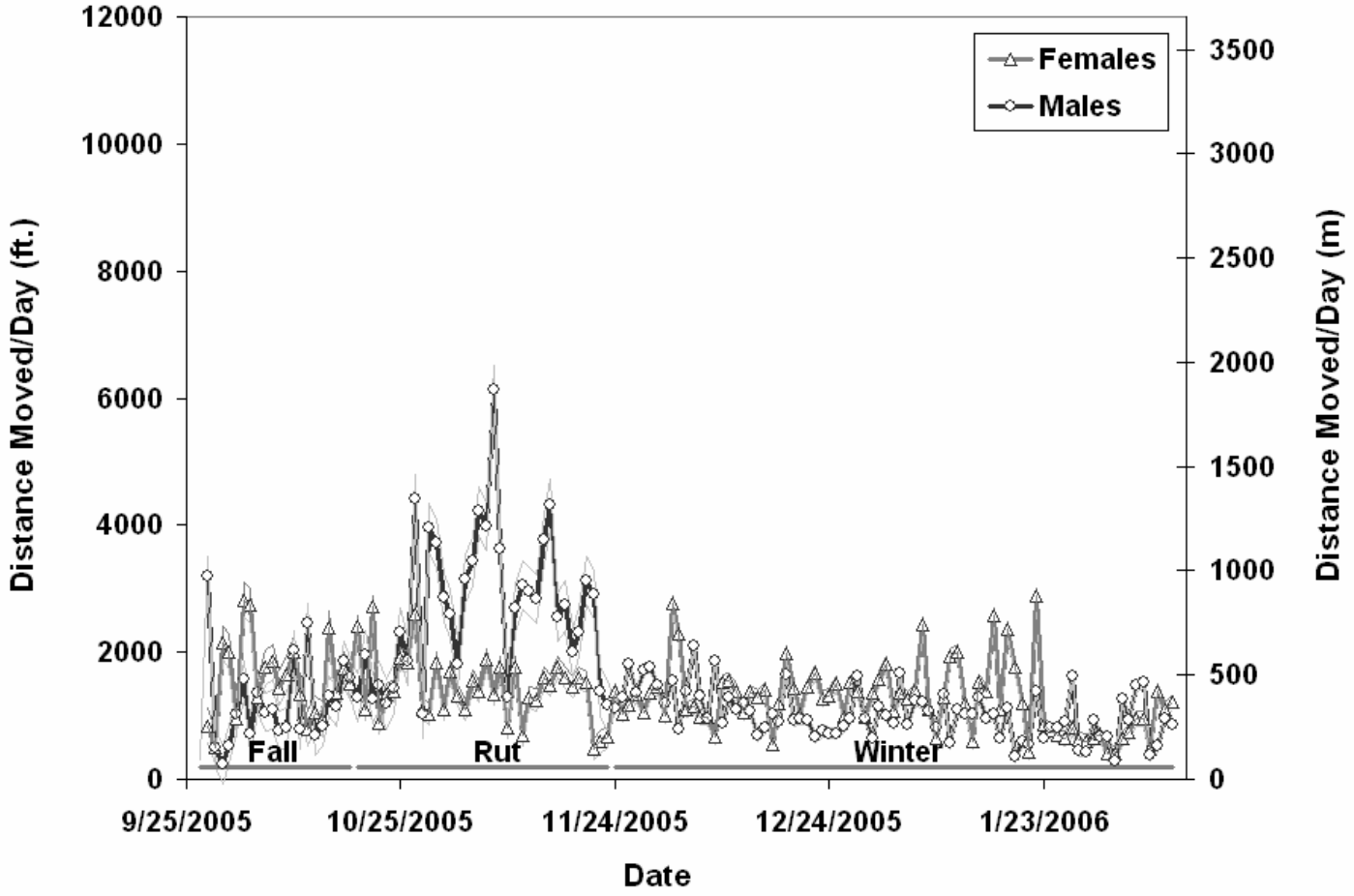
10000
8000
6000
4000
2000
0
3500
3000
2500
2000
1500
1000
500
0
Fall
Rut
Winter
9/25/2005
10/25/2005
11/24/2005
12/24/2005
1/23/2006
Date

Figure 5.


Females
Males
Distance Moved/Day (ft.)
Distance Moved/Day (m)
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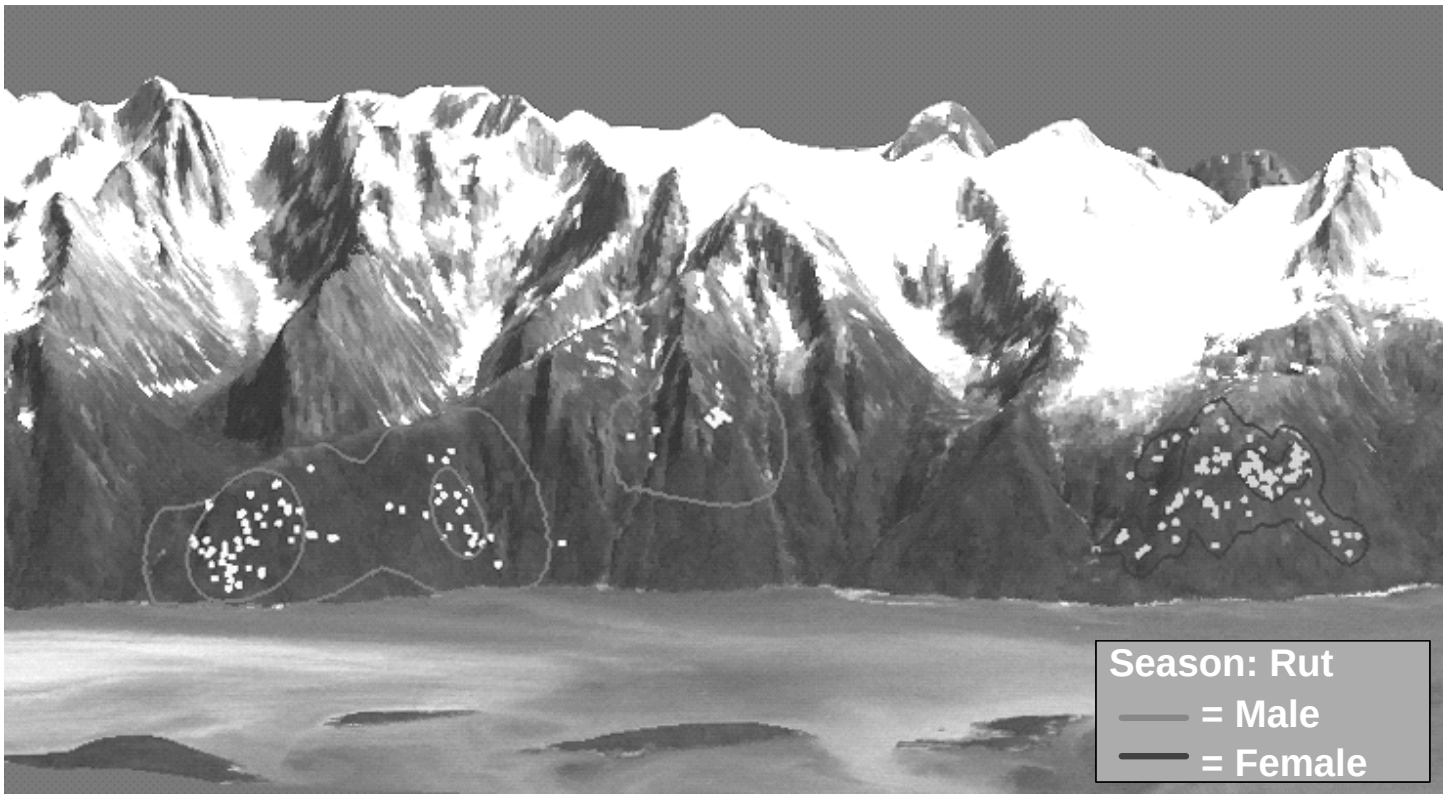
10000
8000
6000
4000
2000
0
3500
3000
2500
2000
1500
1000
500
0
Fall
Rut
Winter
9/25/2005
10/25/2005
11/24/2005
12/24/2005
1/23/2006
Date

Figure 6.



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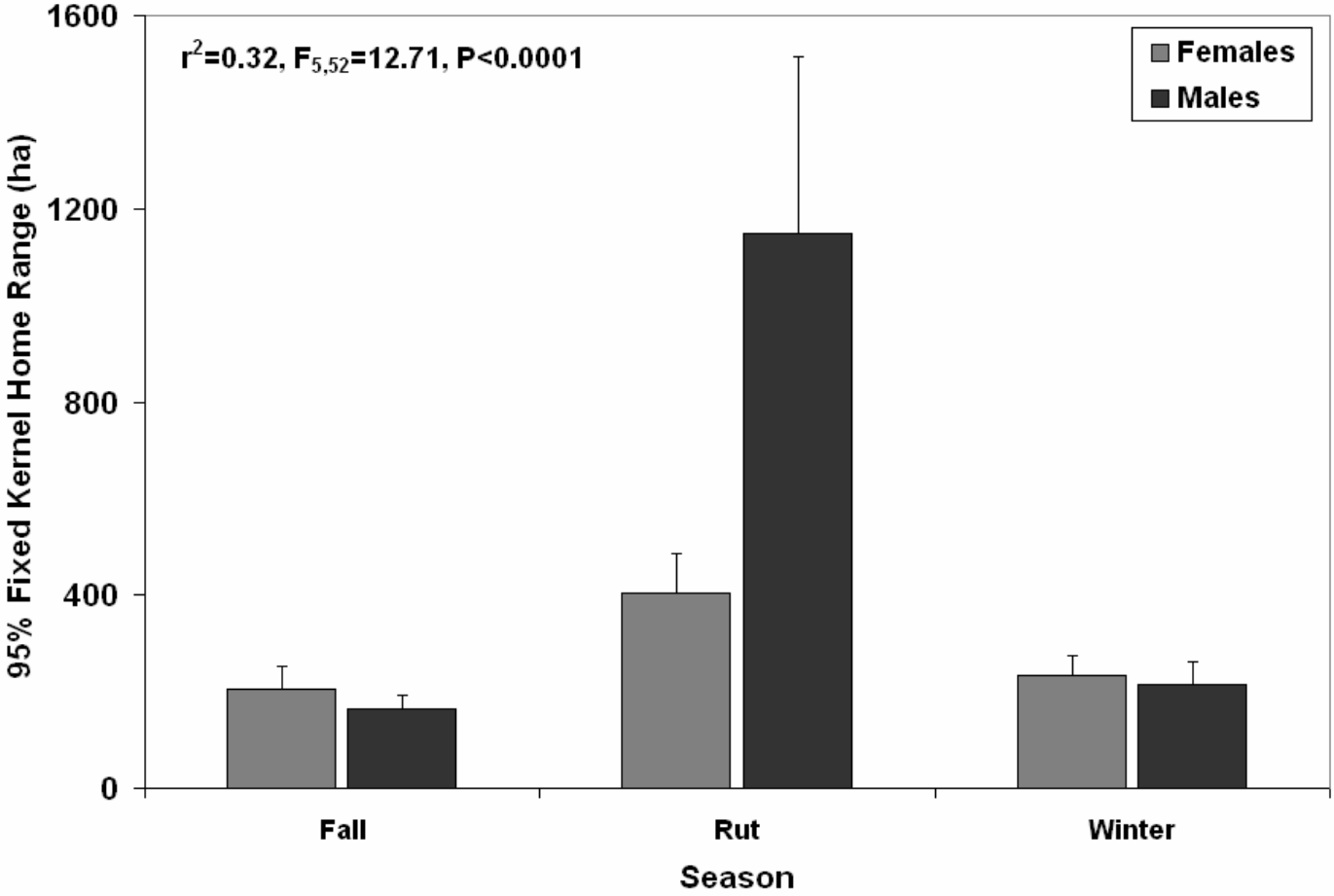

1600
1200
800
400
0
95% Fixed Kernel Home Range (ha)
r2=0.32, F5,52=12.71, P<0.0001
Females
Males
Fall
Rut
Winter
Season

Figure 8.

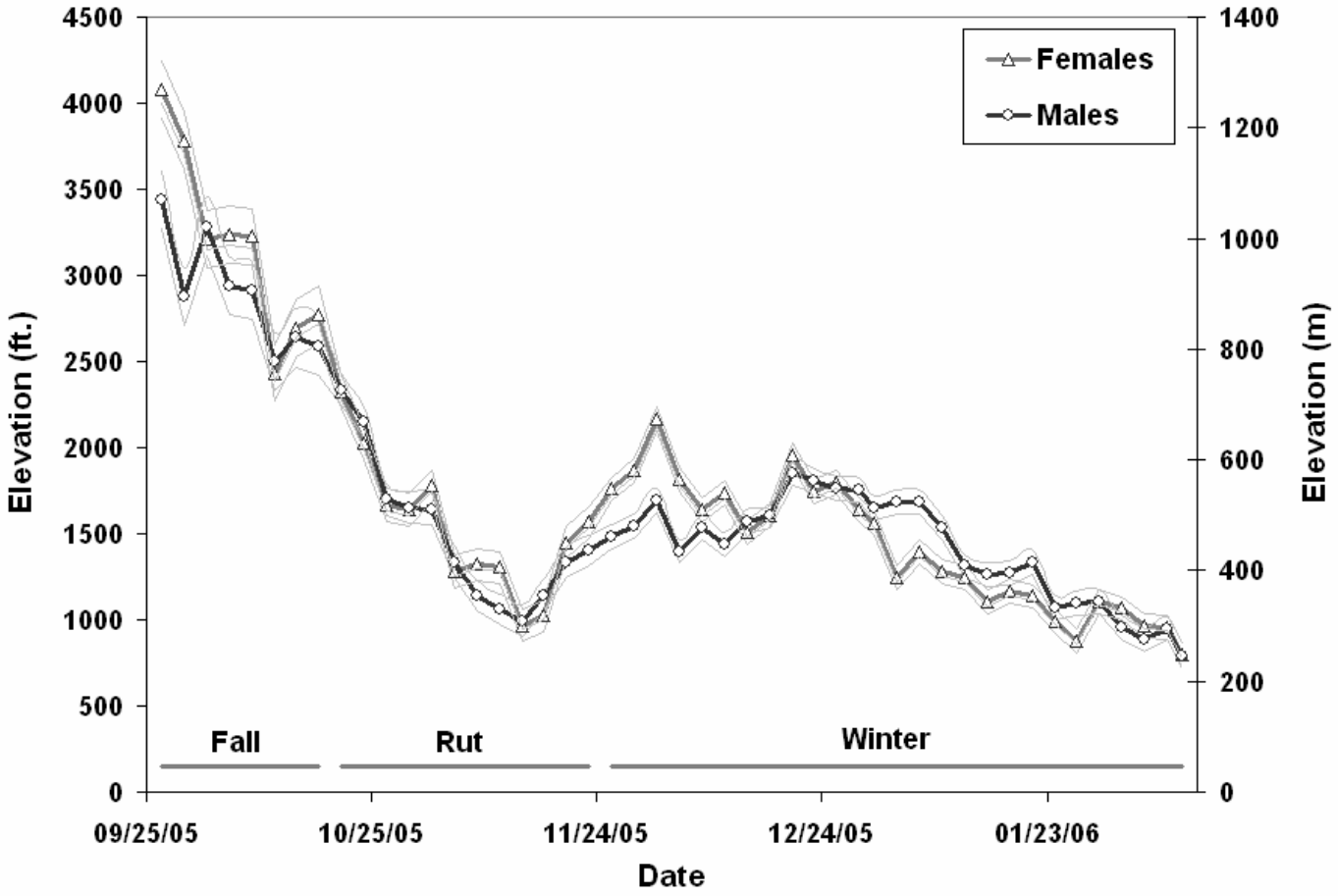

Females
Males
Fall
Rut
Winter
Elevation (ft.)
Elevation (m)
Date
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1400
1200
1000
800
600
400
200
0
09/25/05
10/25/05
11/24/05
12/24/05
01/23/06

Figure 9.

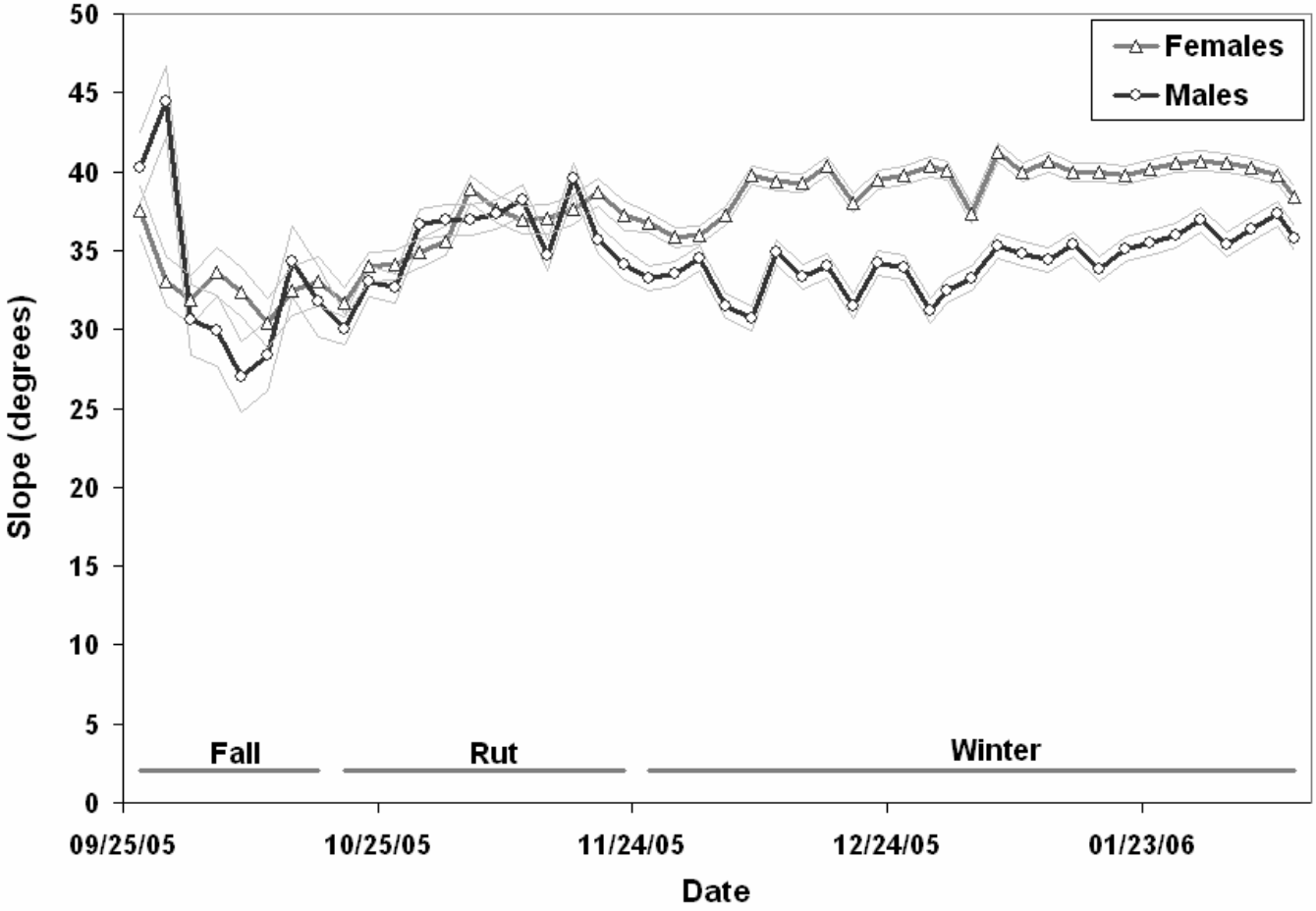

Females
Males
Slope (degrees)
50
45
40
35
30
25
20
15
10
5
0
Fall
Rut
Winter
09/25/05
10/25/05
11/24/05
12/24/05
01/23/06
Date

Figure 10.

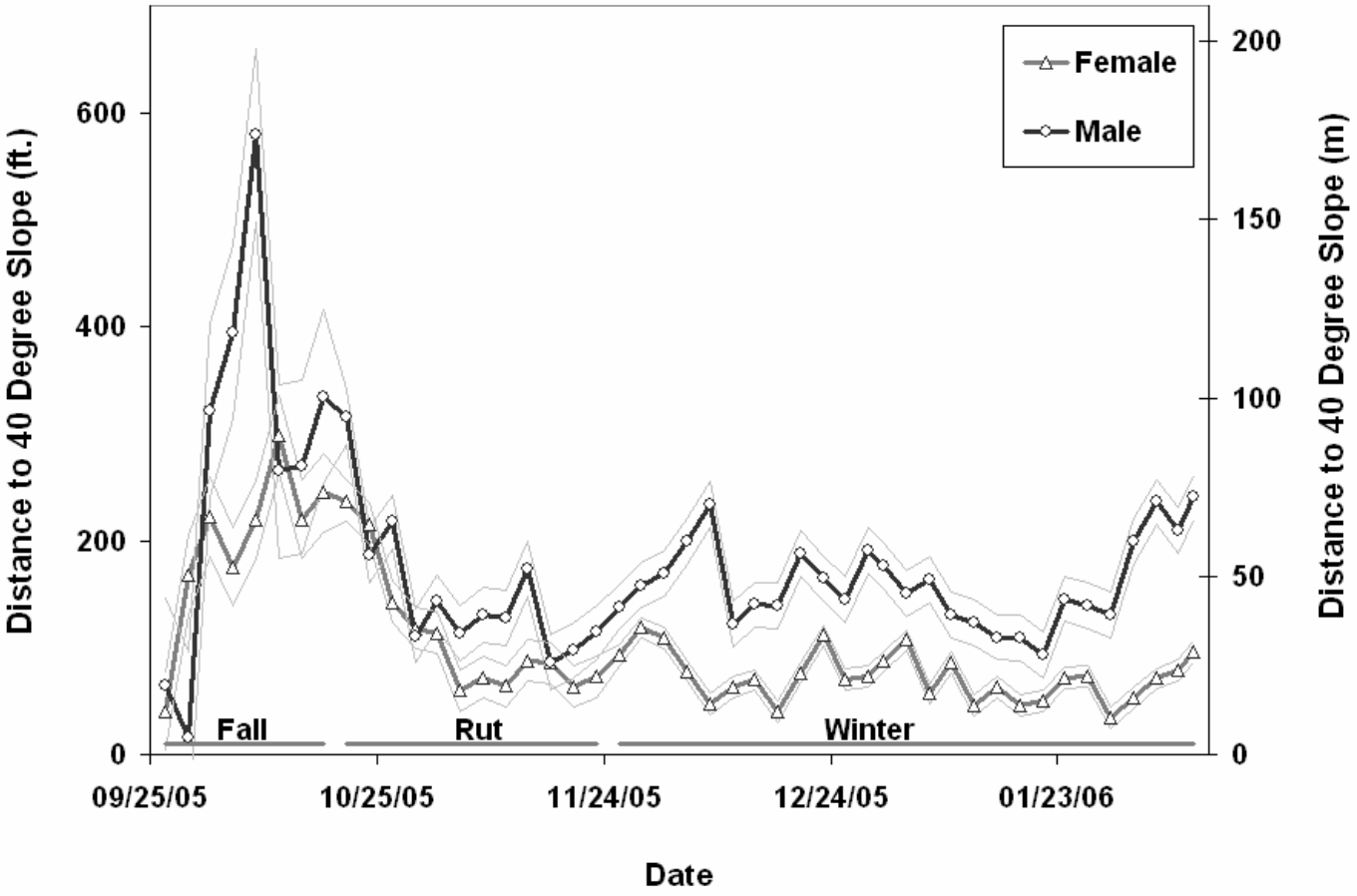
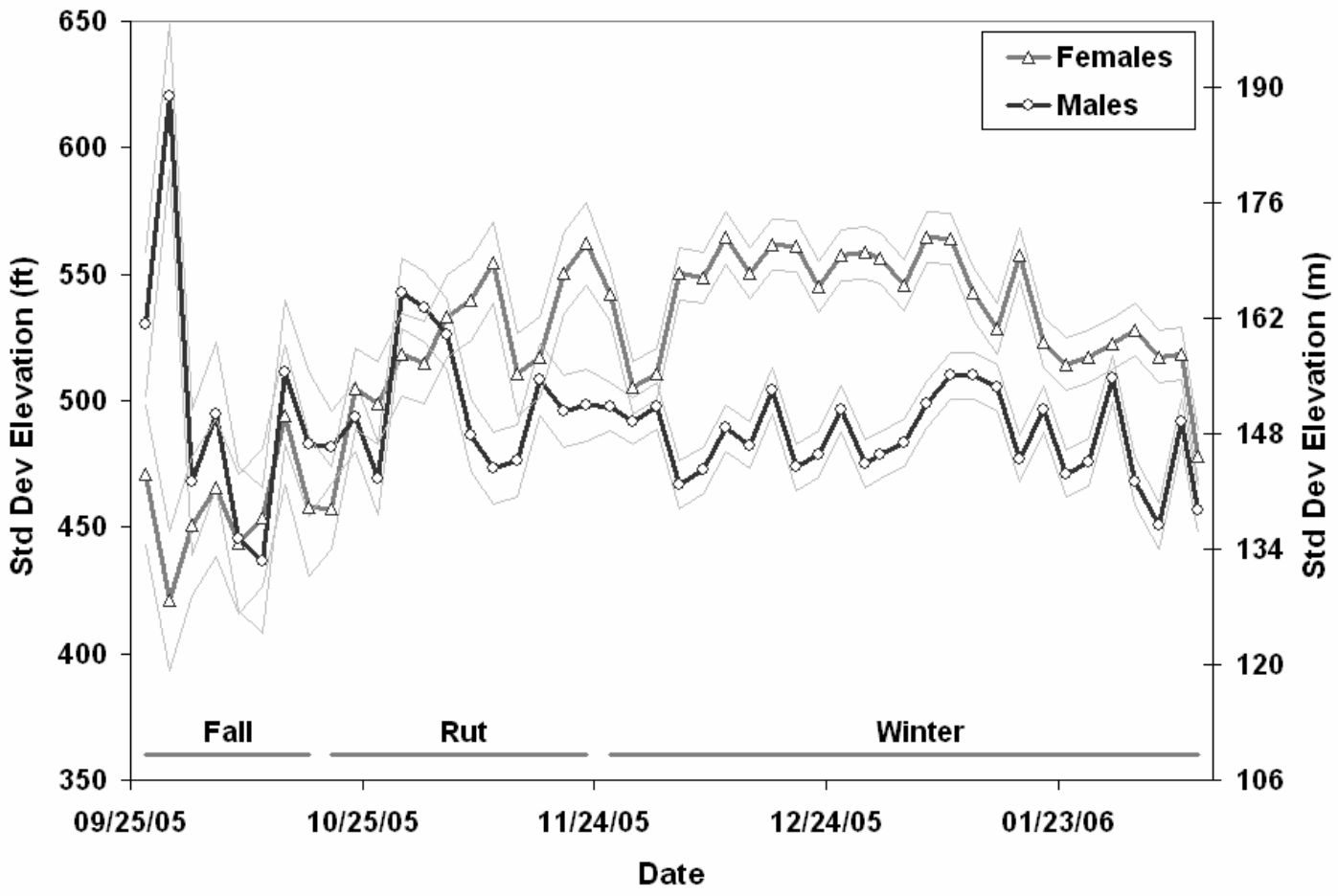
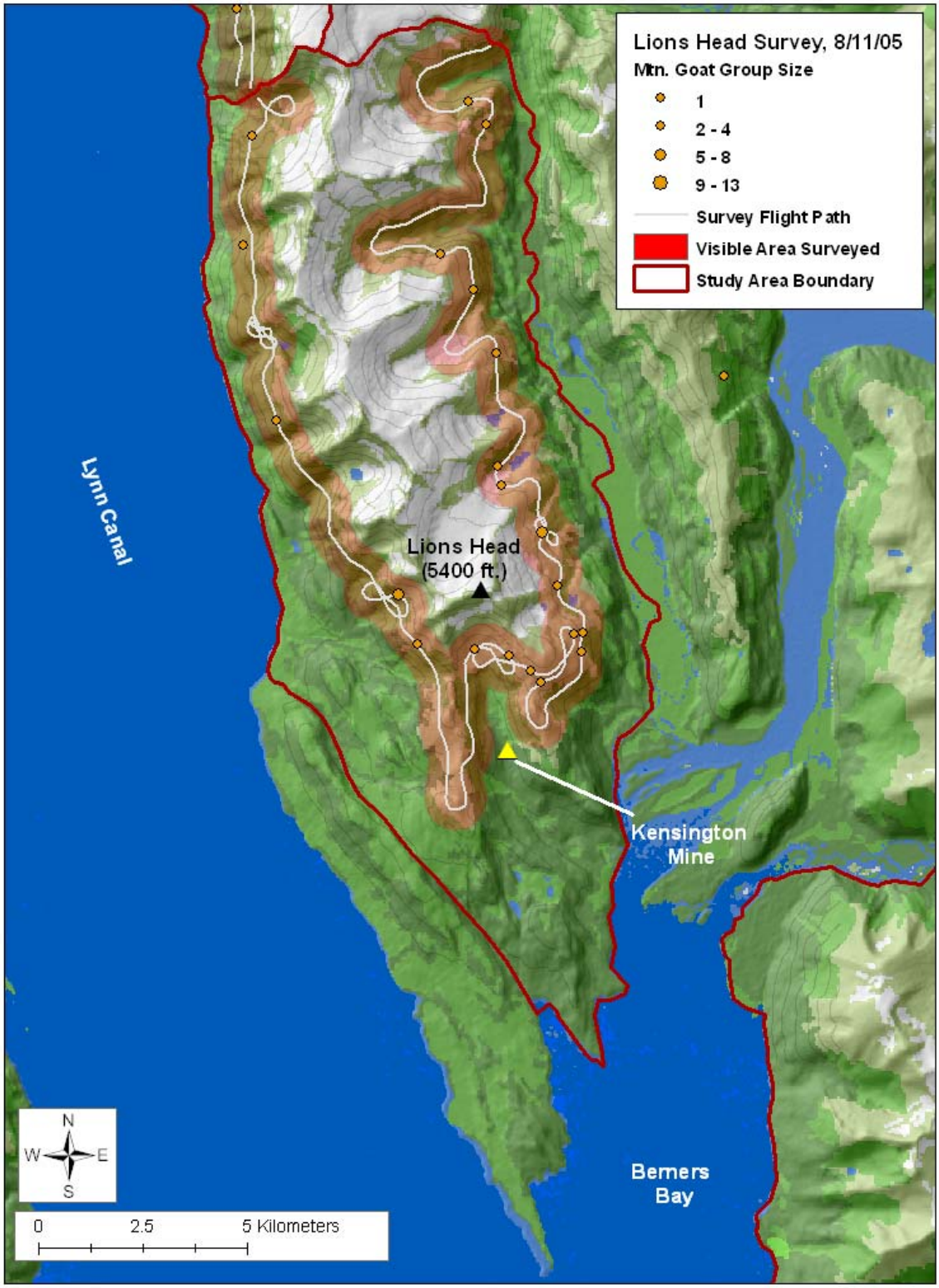

Female
Male
Distance to 40 Degree Slope (ft.)
Distance to 40 Degree Slope (m)
0
200
400
600
0
50
100
150
200
Fall
Rut
Winter
09/25/05
10/25/05
11/24/05
12/24/05
01/23/06
Date

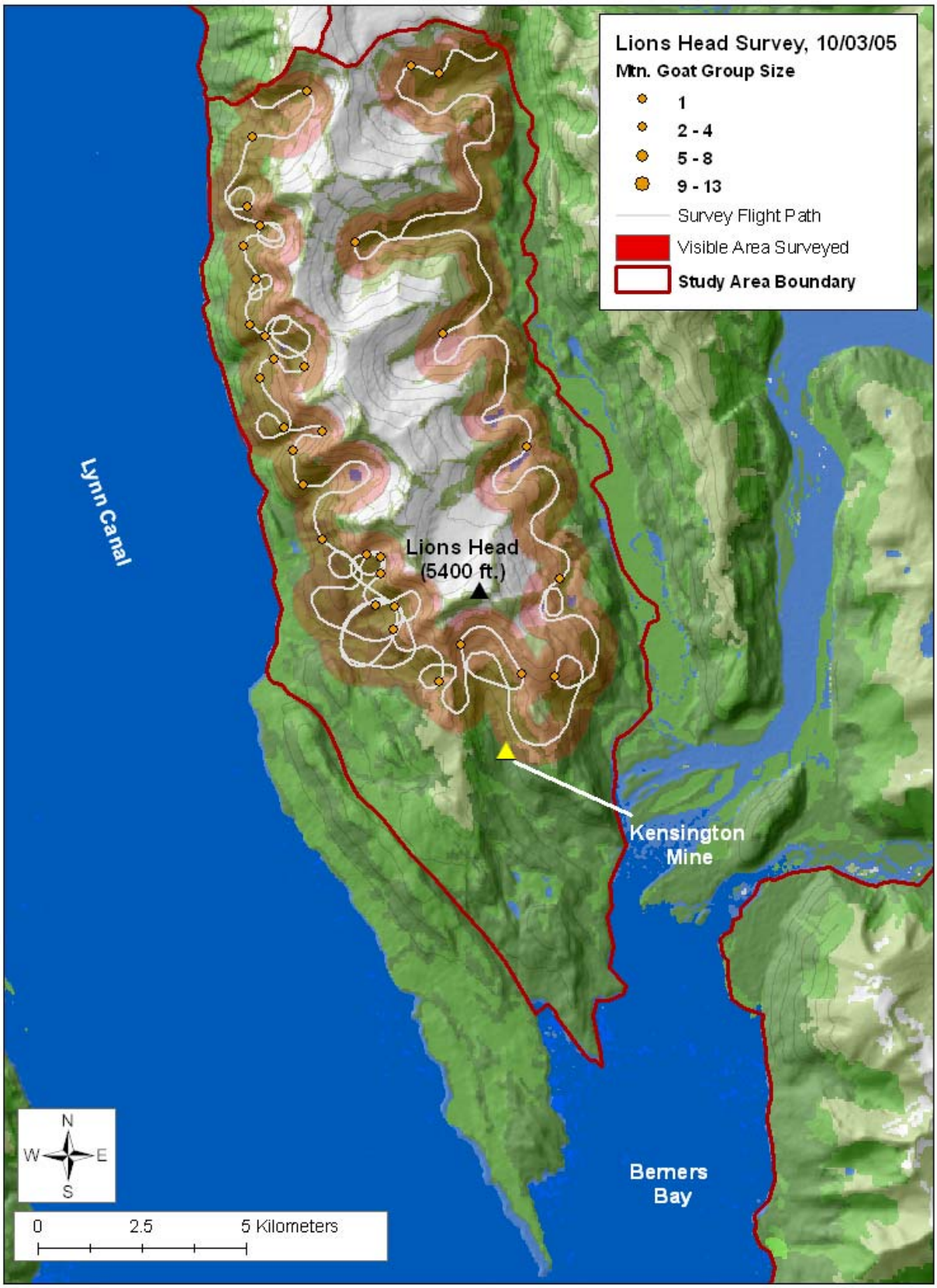
Figure 11.

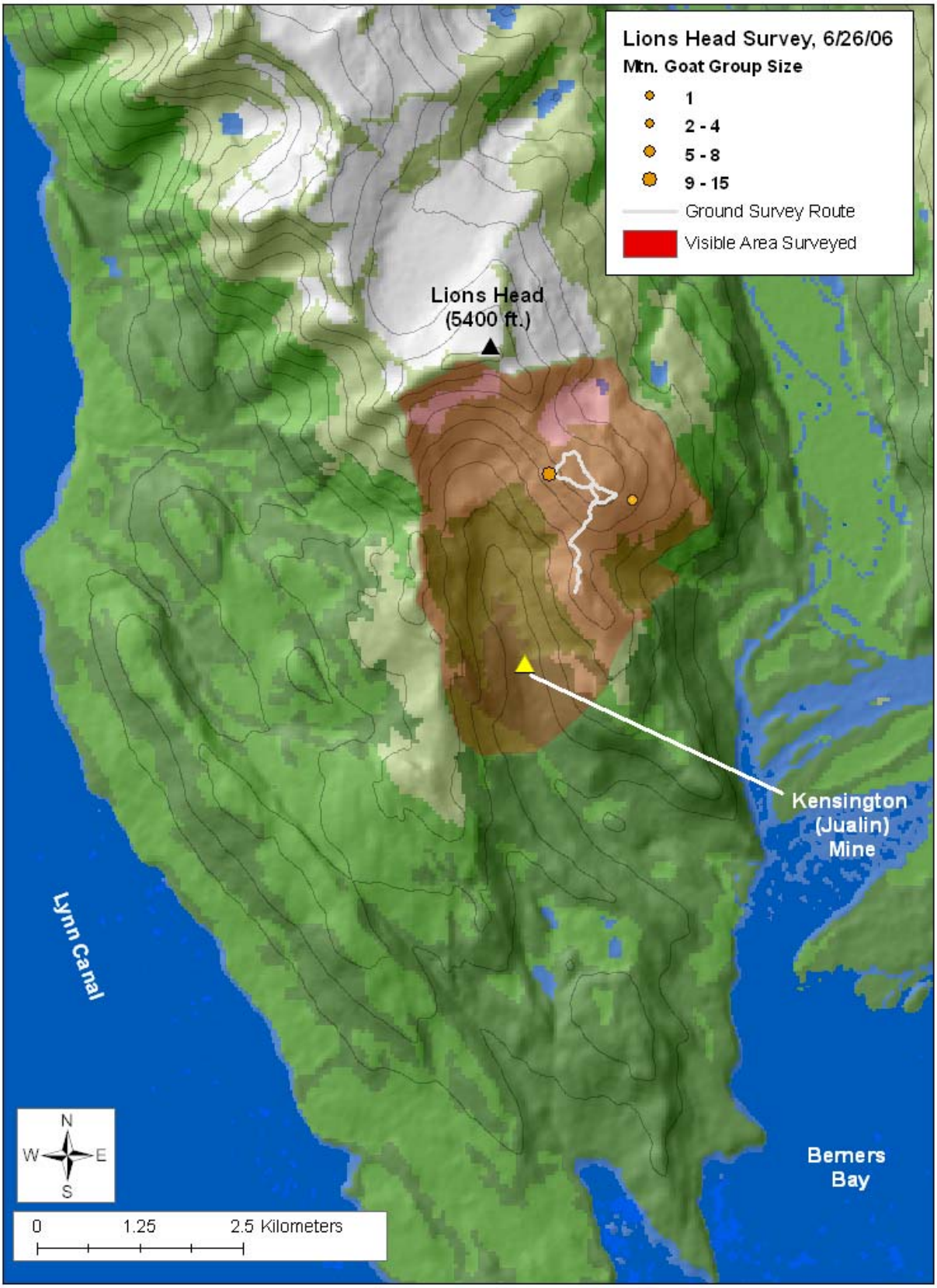

Females
Males
Std Dev Elevation (ft)
Std Dev Elevation (m)
650
600
550
500
450
400
350
190
176
162
148
134
120
106
Fall
Rut
Winter
09/25/05
10/25/05
11/24/05
12/24/05
01/23/06
Date

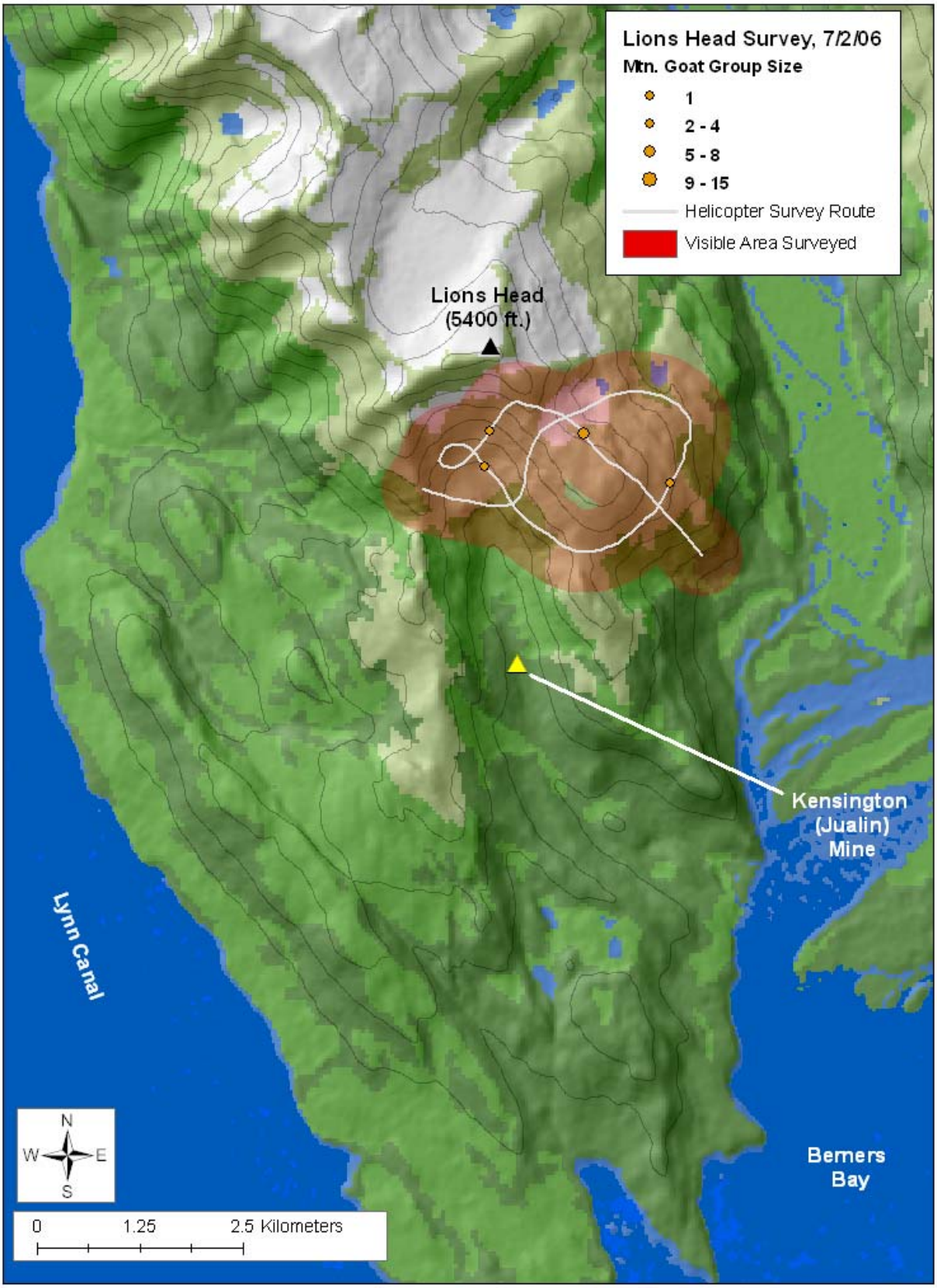
Appendix 2.

Geographical summary of mountain goat aerial survey activities conducted between August 11, 2005-July 2, 2006. Maps describe survey routes, estimated visible area surveyed and location of mountain goat groups recorded.




Lions Head Survey, 10/03/05
Mtn. Goat Group Size
1
2 - 4
5 - 8
9 - 13
Survey Flight Path
Visible Area Surveyed
Study Area Boundary
Lynn Canal
Lions Head
(5400 ft.)
Kensington
Mine
Berners
Bay
N
W
E
S
0
2.5
5 Kilometers


Lions Head Survey, 6/26/06
Mtn. Goat Group Size
1
2 - 4
5 - 8
9 - 15
Ground Survey Route
Visible Area Surveyed
Lions Head
(5400 ft.)
Kensington
(Jualin)
Mine
Lynn Canal
Berners
Bay
N
W
E
S
0
1.25
2.5 Kilometers


Lions Head Survey, 7/2/06
Mtn. Goat Group Size
1
2 - 4
5 - 8
9 - 15
Helicopter Survey Route
Visible Area Surveyed
Lions Head
(5400 ft.)
Kensington
(Jualin)
Mine
Lynn Canal
Berners
Bay
N
W
E
S
0
1.25
2.5 Kilometers

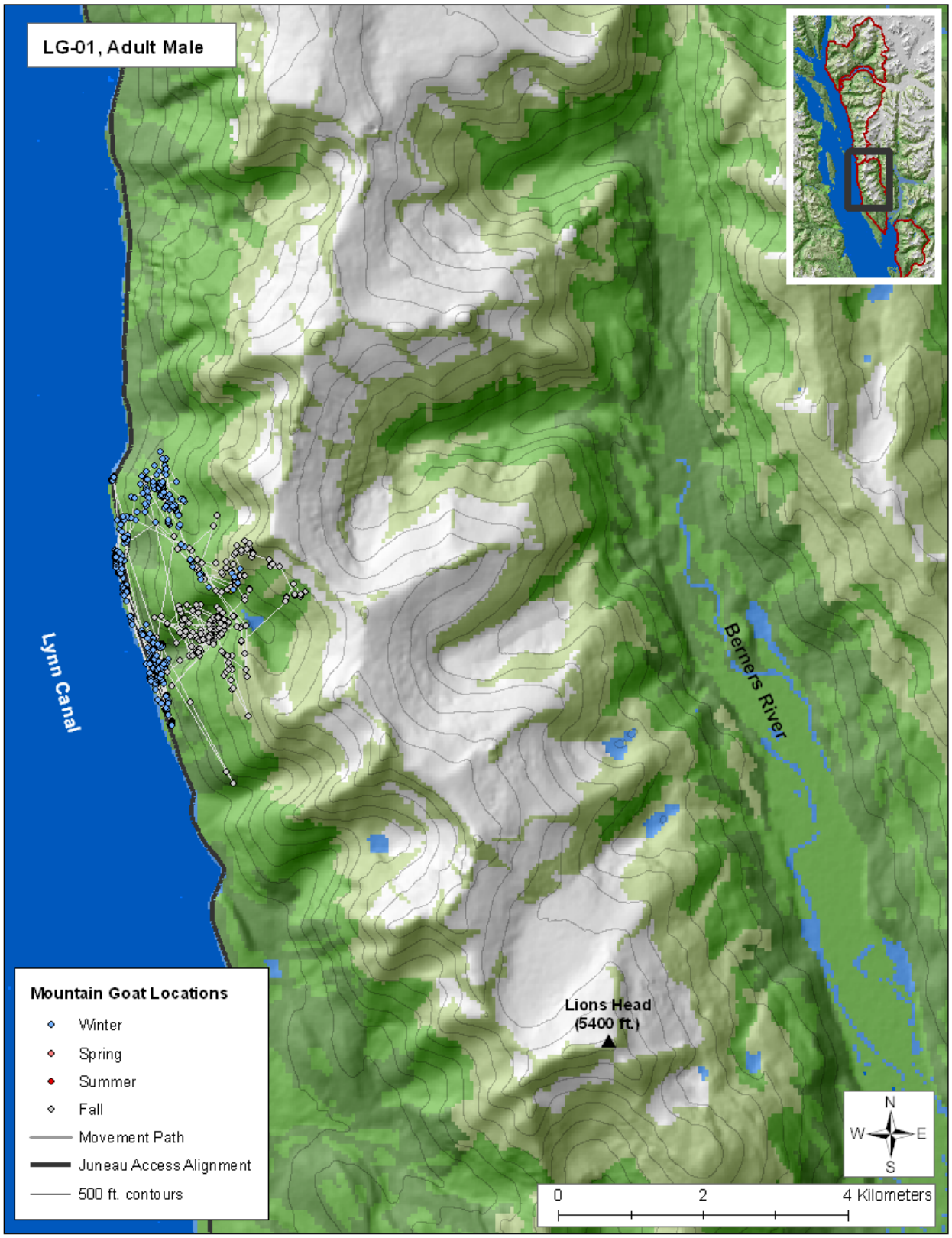
Katzehin River
Lynn Canal
Sinclair Mtn.
(6300 ft.)
Sinclair Mtn. Survey, 8/11/05
Mtn. Goat Group Size
1
2 - 3
4 - 8
9 - 13
Survey Flight Path
Visible Area Surveyed
Study Area Boundary
N
W
E
S
0
2
4 Kilometers

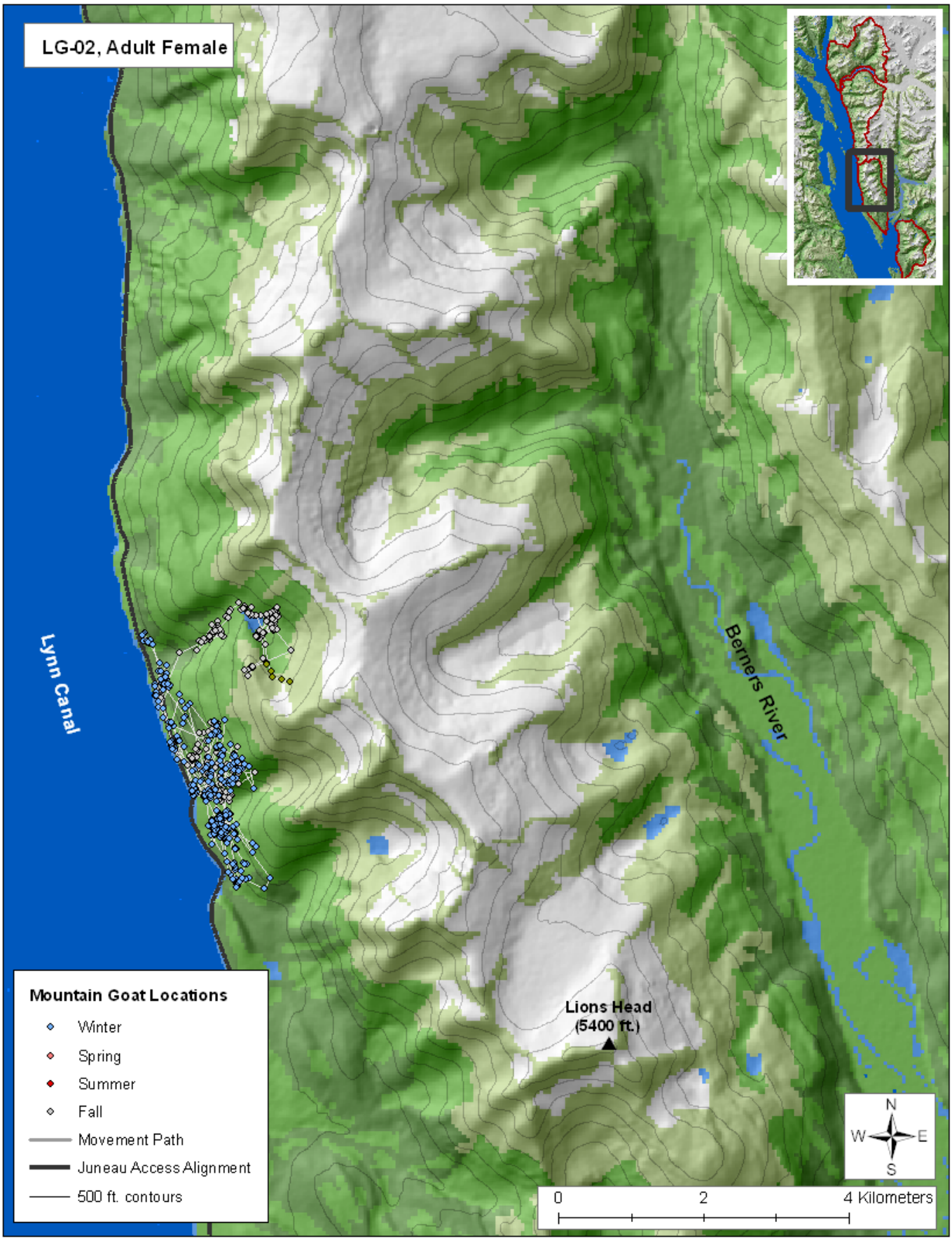
Katzehin River
Lynn Canal
Sinclair Mtn.
(6300 ft.)
Sinclair Mtn. Survey, 10/03/05
Mtn. Goat Group Size
1
2 - 3
4 - 6
7 - 12
Approx. Visible Area Surveyed
Study Area Boundary
N
W
E
S
0
2
4 Kilometers

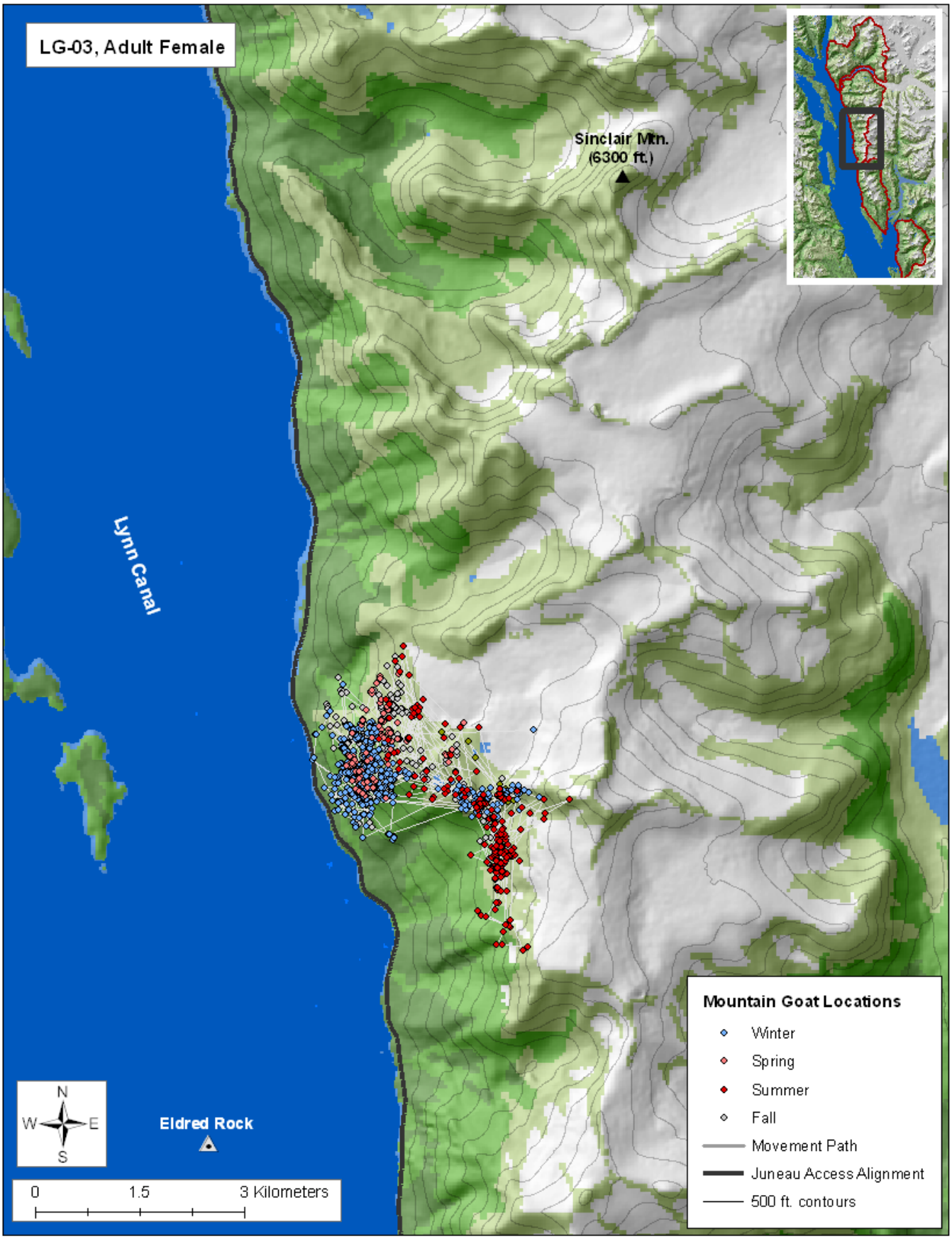
Mt. Villard
(4990 ft.)
Katzehin River
Lynn Canal
Mt. Villard Survey, 8/12/05
Mtn. Goat Group Size
1
2 - 3
4 - 8
9 - 13
Survey Flight Path
Visible Area Surveyed
Study Area Boundary
N
W
E
S
0
2
4 Kilometers

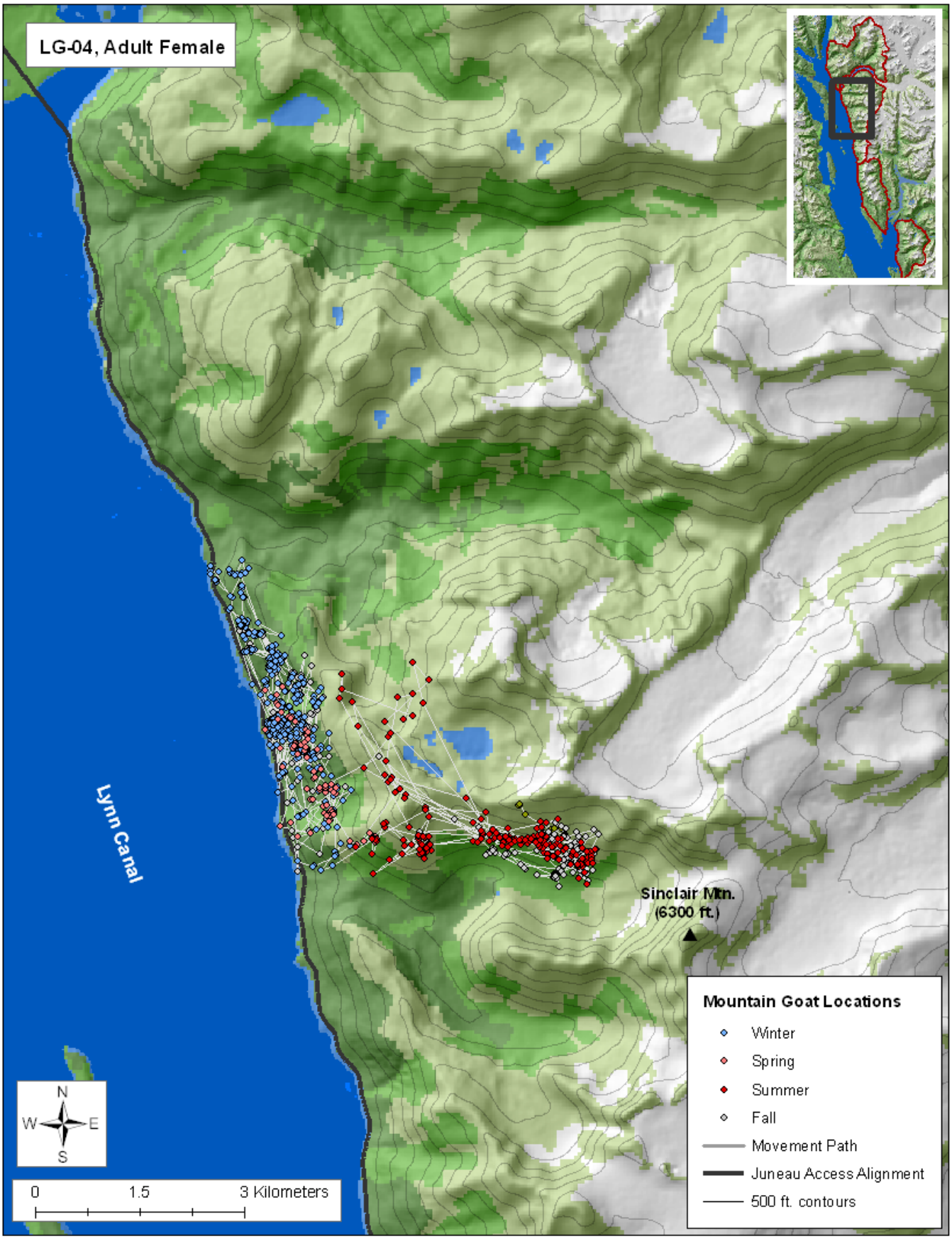
Appendix 3.

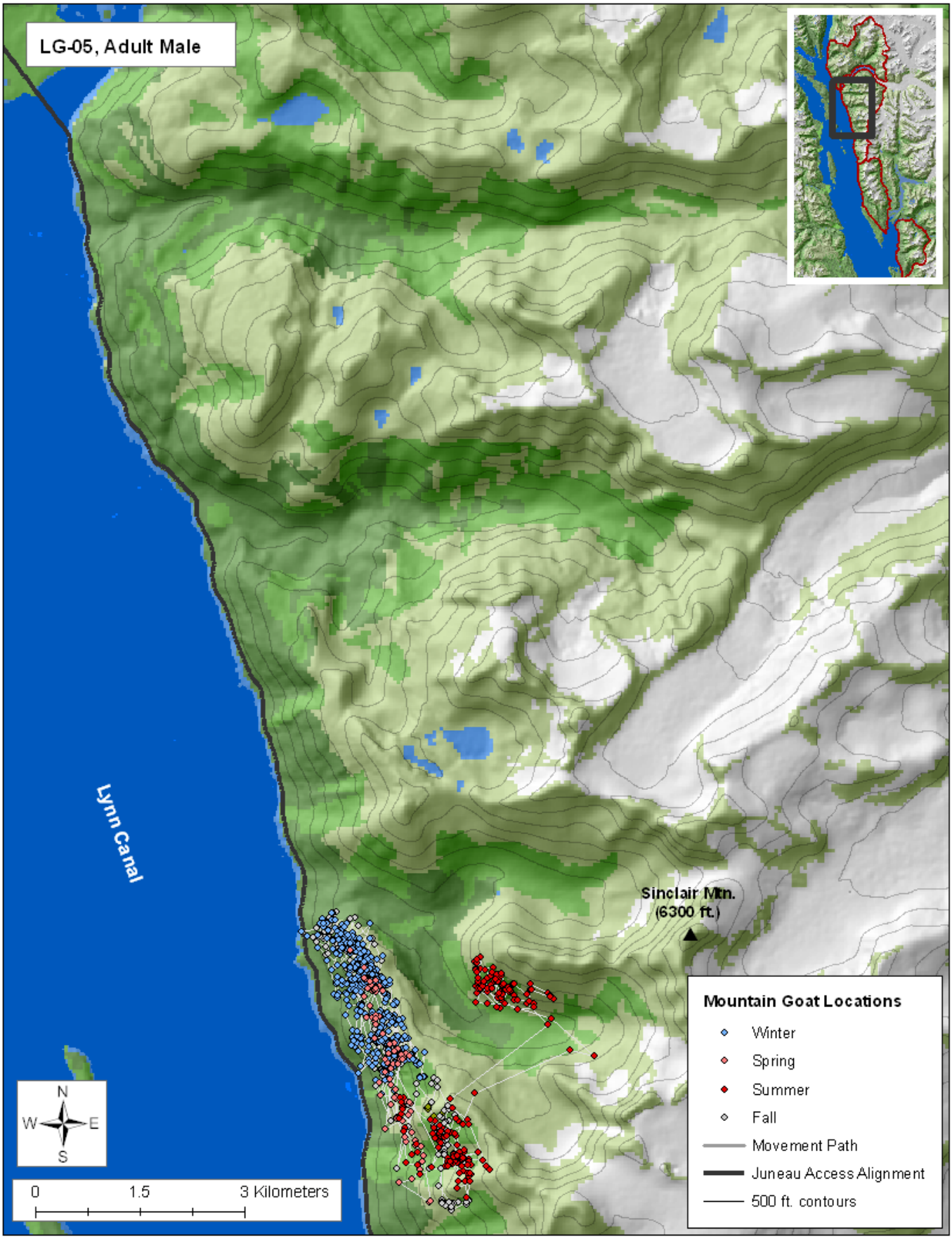
Geographical description of GPS-collared mountain goat distribution between September 28, 2005-July 25, 2006. Maps illustrate all GPS locations collected for each of the 22 individual mountain goats captured before July 25, 2006.

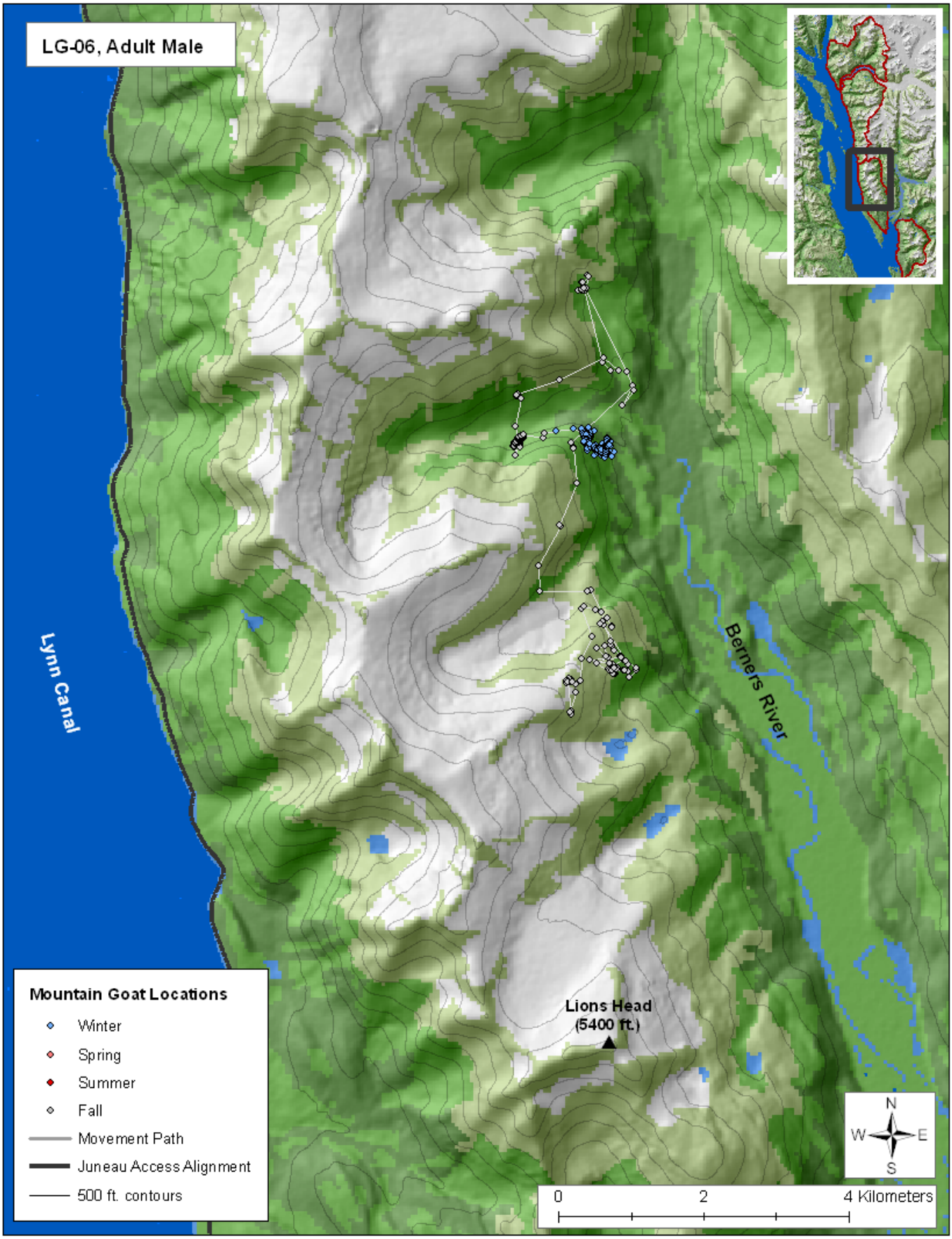


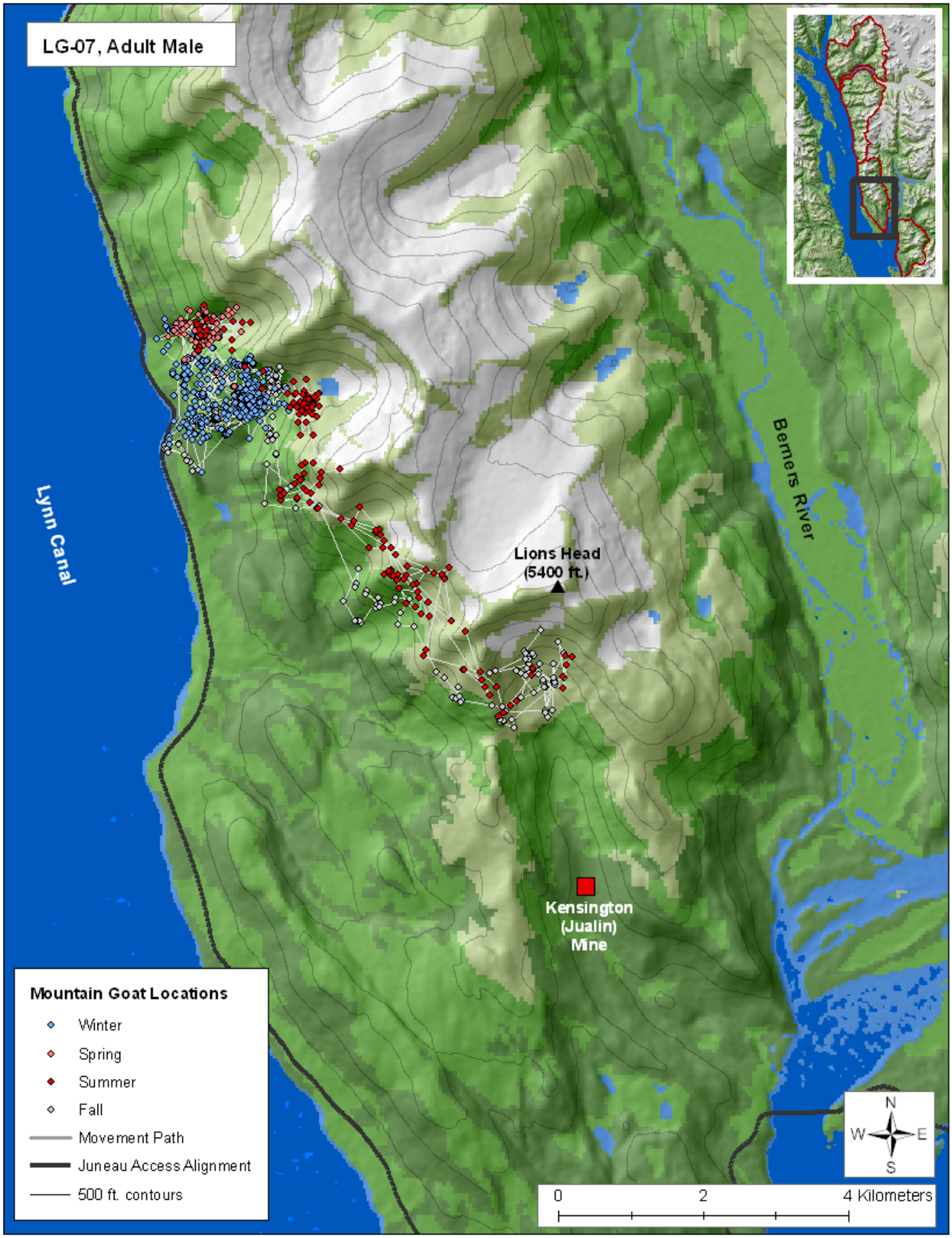

LG-02, Adult Female
Lynn Canal
Berners River
Lions Head
(5400 ft.)
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers

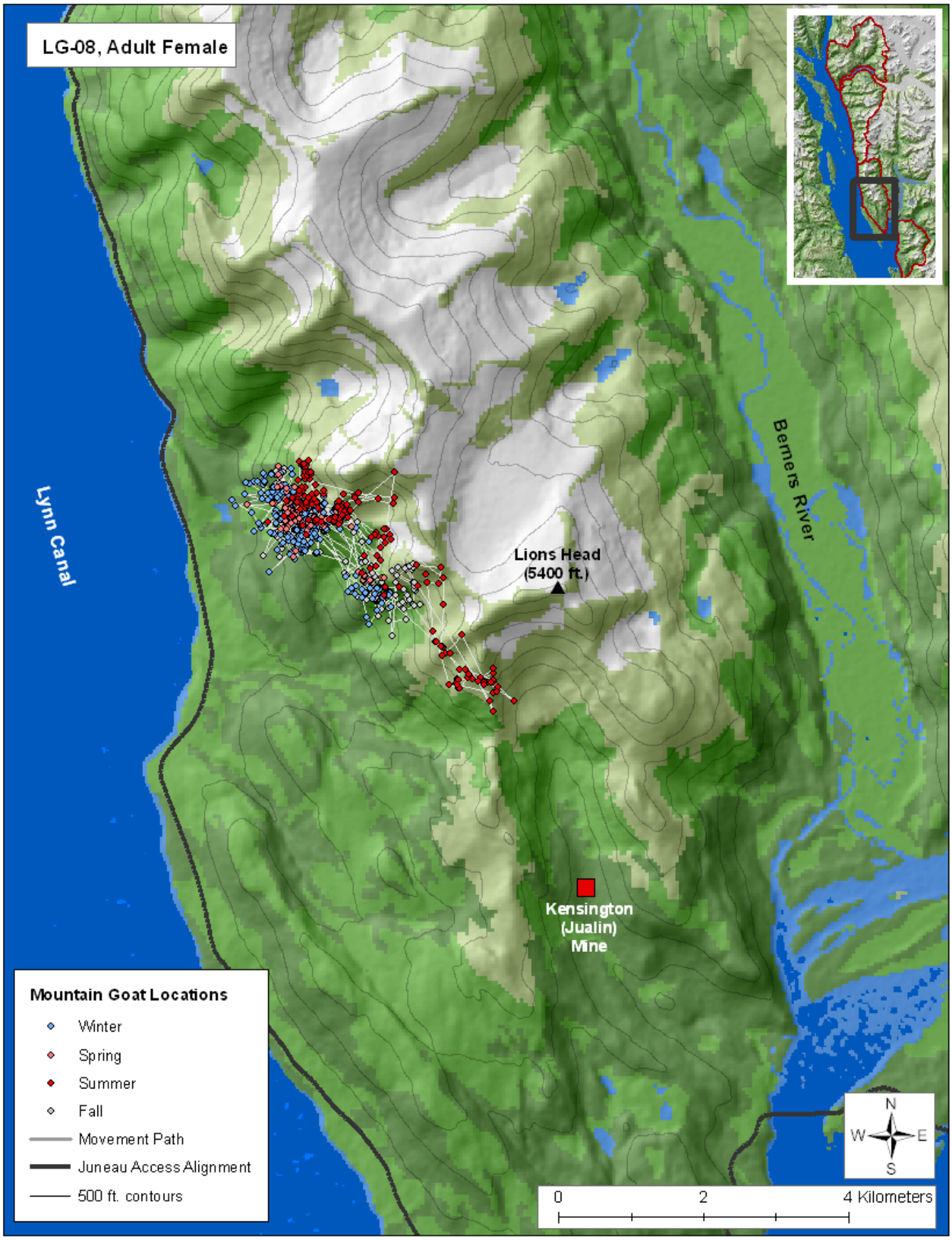

LG-03, Adult Female
Sinclair Mtn.
(6300 ft.)
Lynn Canal
Eldred Rock
N
W
E
S
0
1.5
3 Kilometers
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours

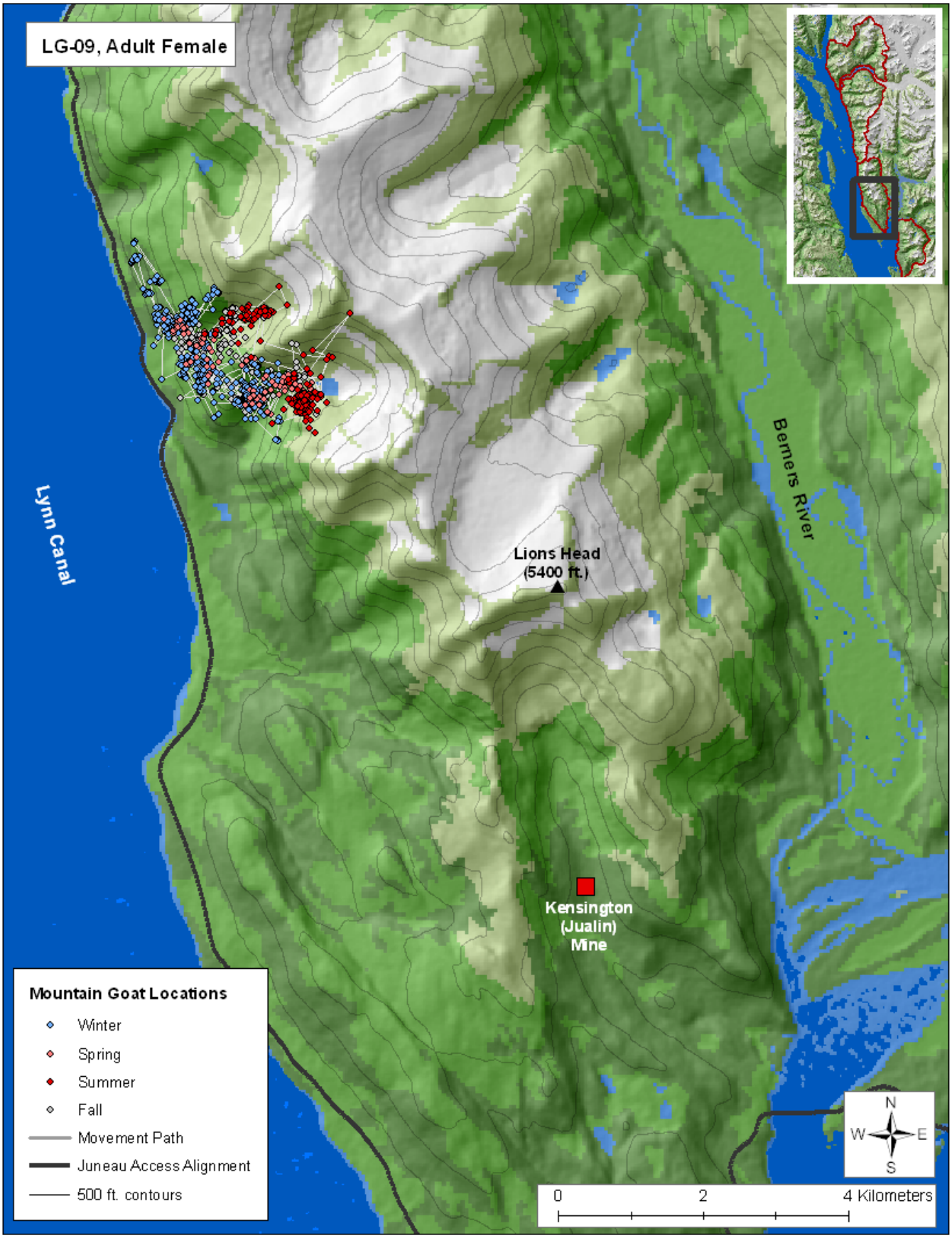

LG-04, Adult Female
Lynn Canal
Sinclair Mtn.
(6300 ft.)
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
1.5
3 Kilometers

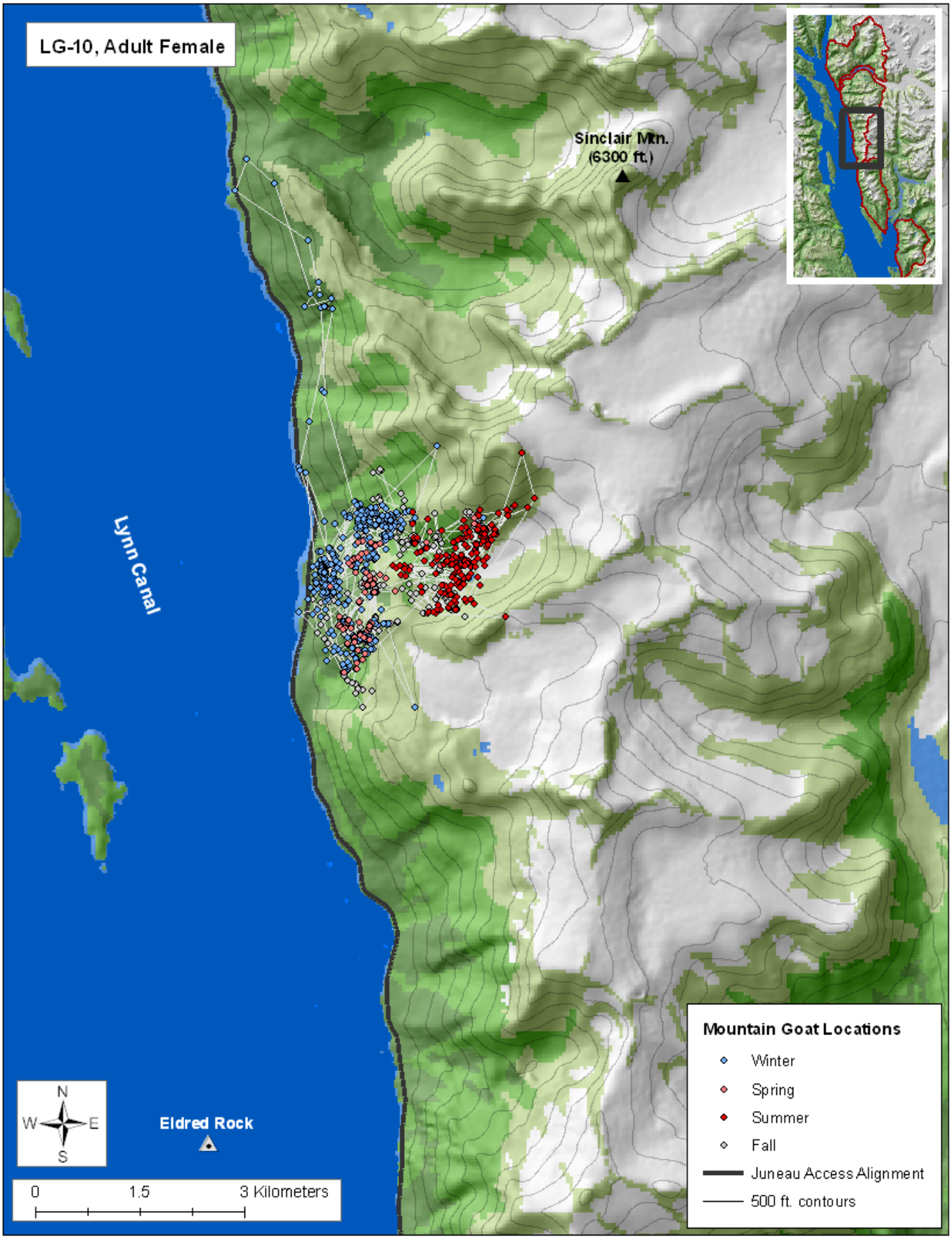

LG-05, Adult Male
Lynn Canal
Sinclair Mtn.
(6300 ft.)
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
1.5
3 Kilometers

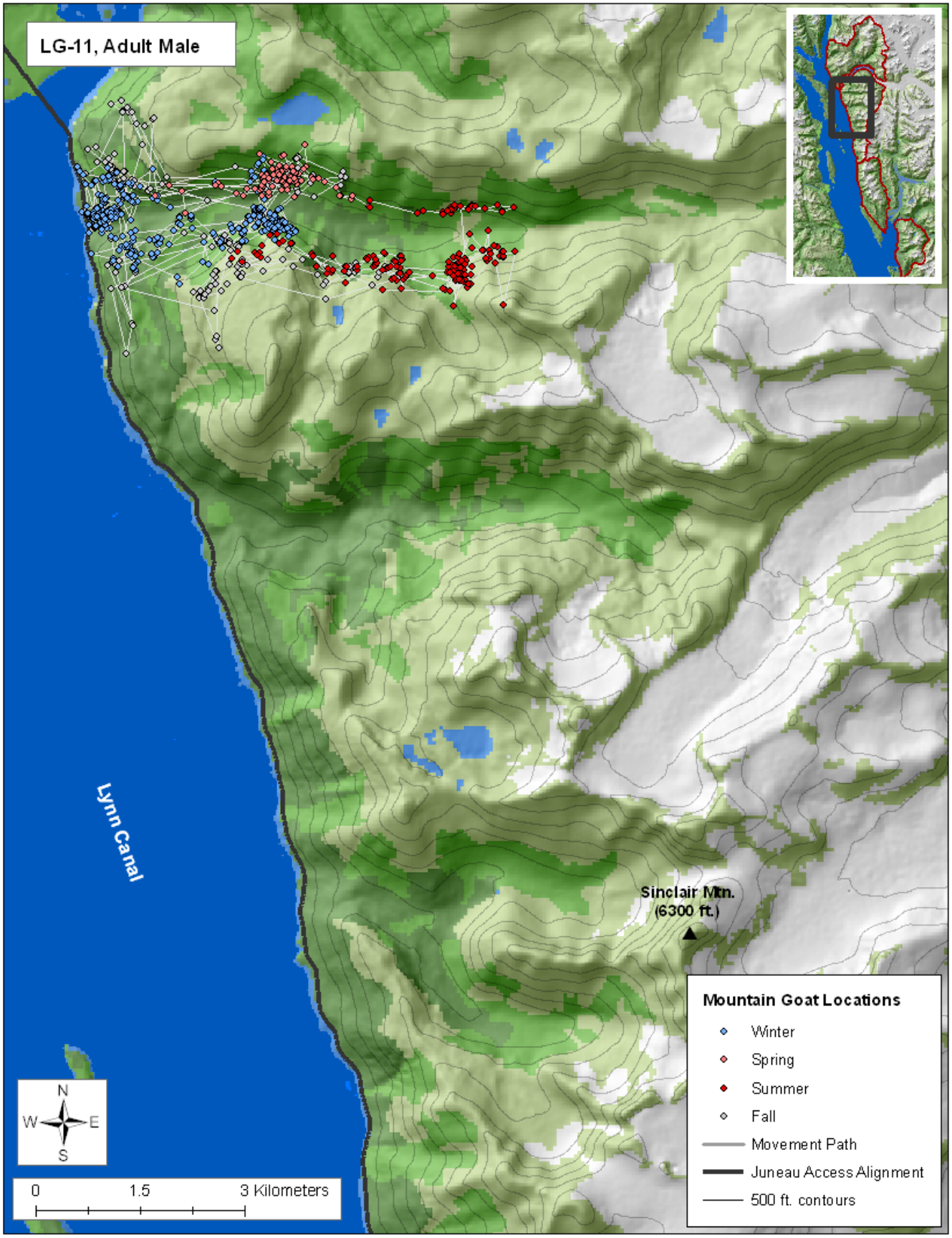

LG-06, Adult Male
Lynn Canal
Berners River
Lions Head
(5400 ft.)
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers

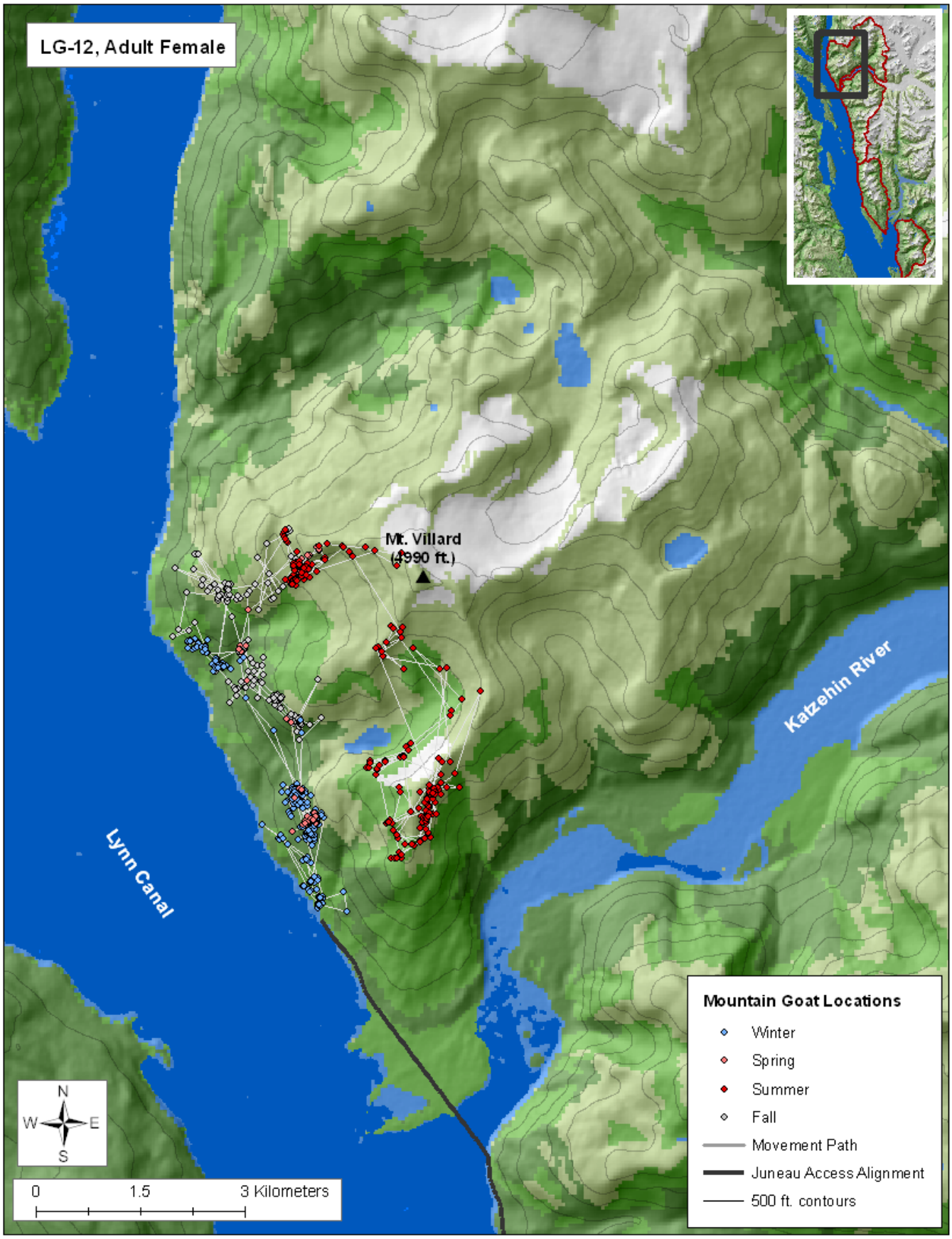

LG-07, Adult Male
Lynn Canal
Berners River
Lions Head
(5400 ft.)
Kensington
(Jualin)
Mine
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers

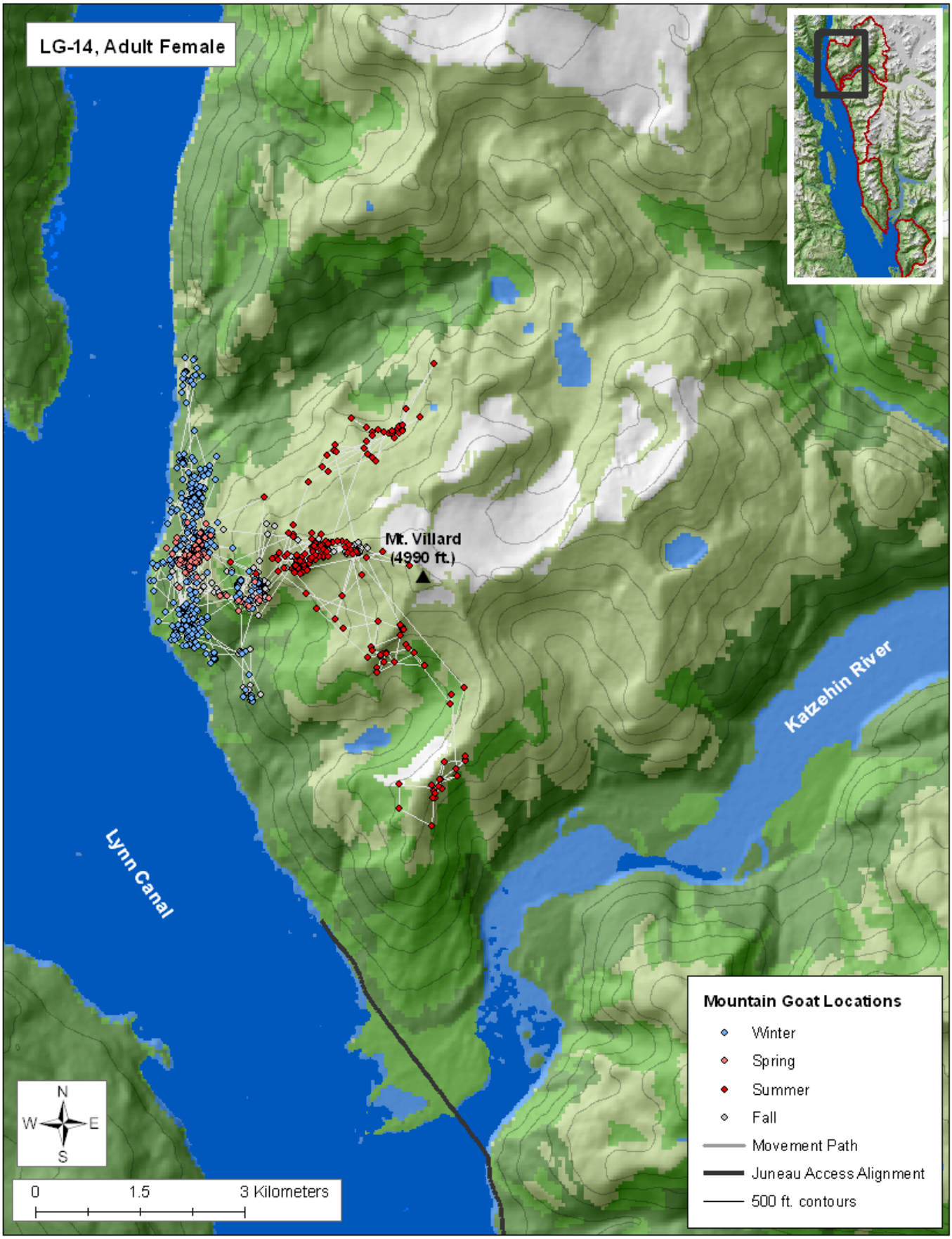

LG-08, Adult Female
Lynn Canal
Berners River
Lions Head
(5400 ft.)
Kensington
(Jualin)
Mine
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers

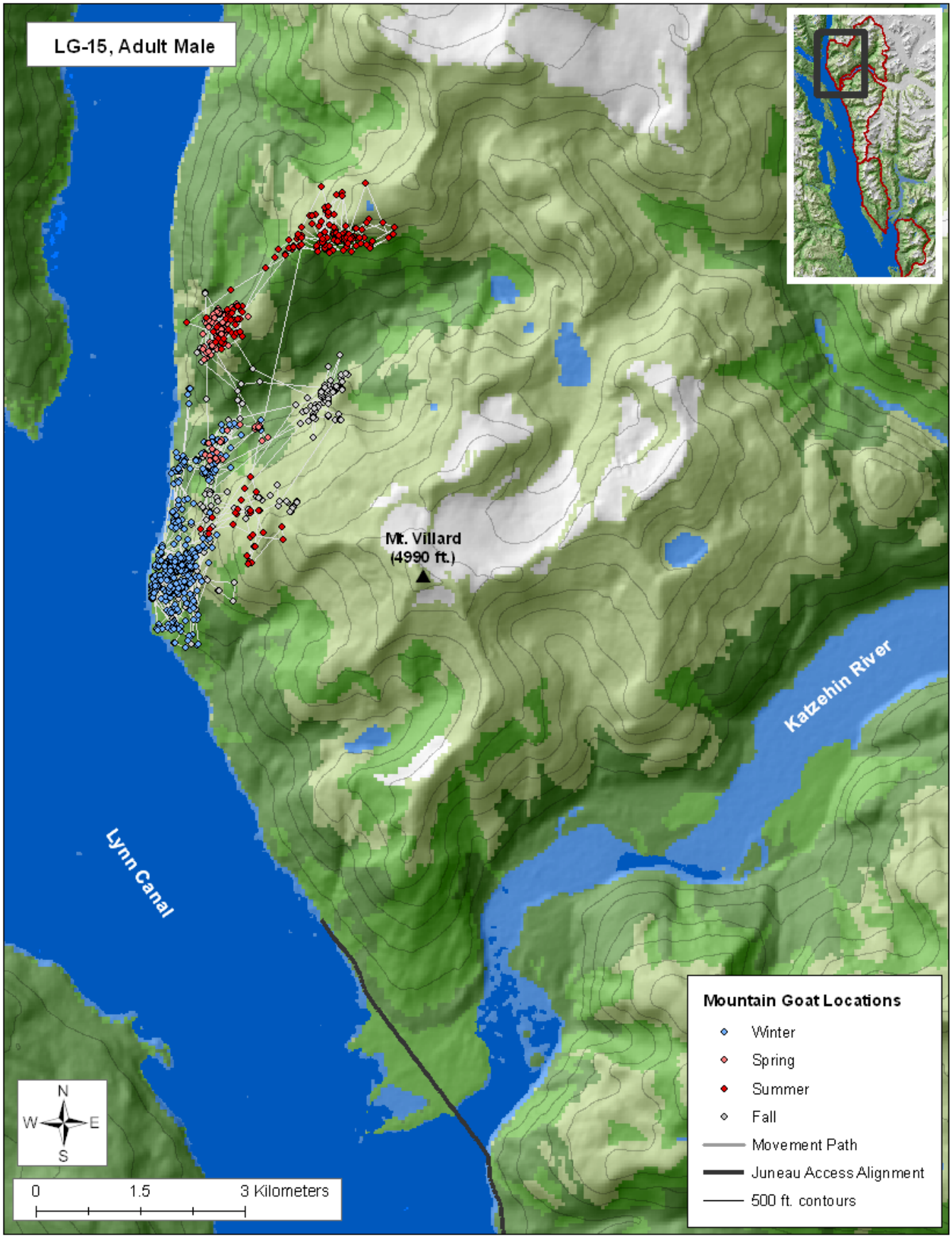

LG-09, Adult Female
Lynn Canal
Berners River
Lions Head
(5400 ft.)
Kensington
(Jualin)
Mine
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers

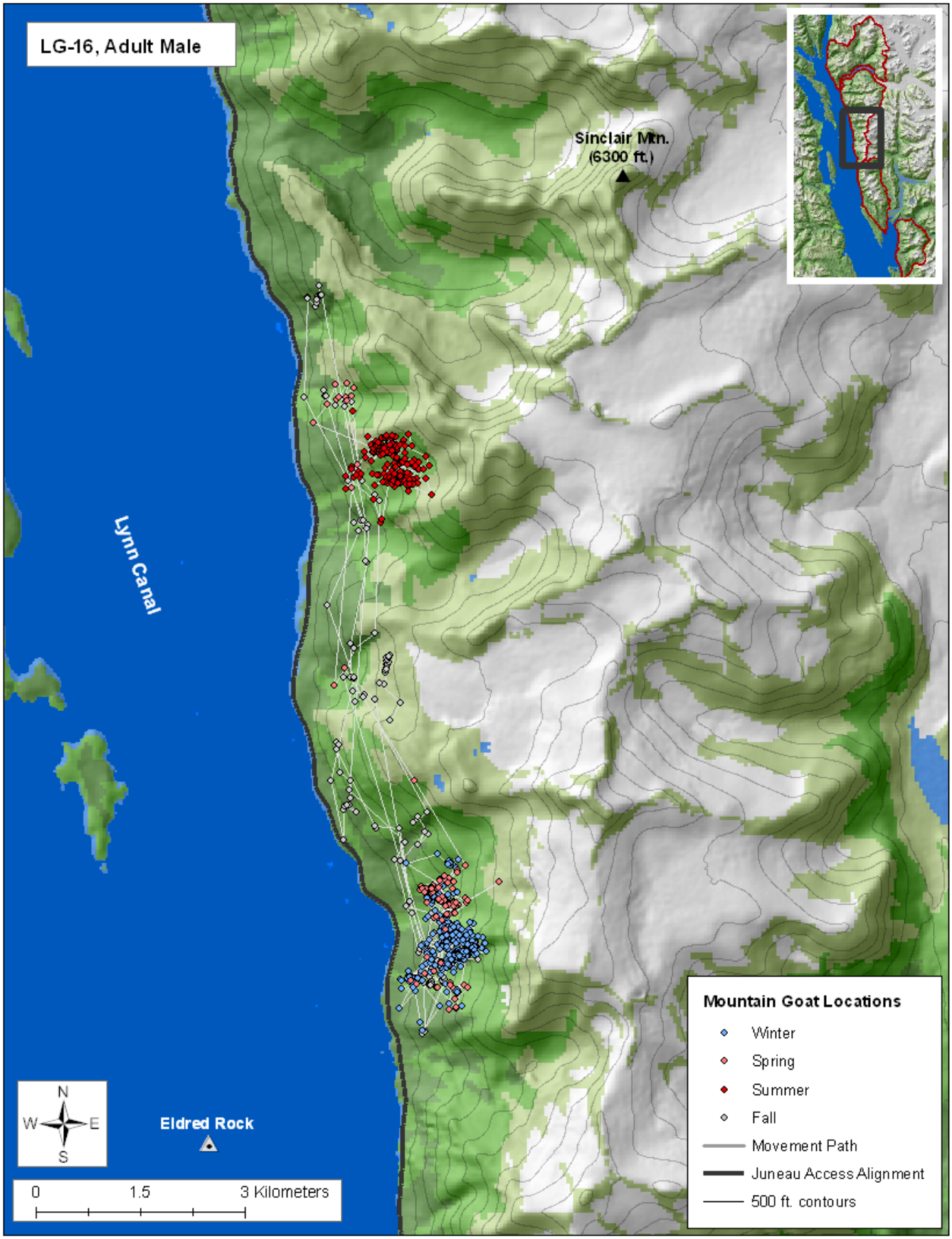

LG-10, Adult Female
Sinclair Mtn.
(6300 ft.)
Lynn Canal
Eldred Rock
N
W
E
S
0
1.5
3 Kilometers
Mountain Goat Locations
Winter
Spring
Summer
Fall
Juneau Access Alignment
500 ft. contours

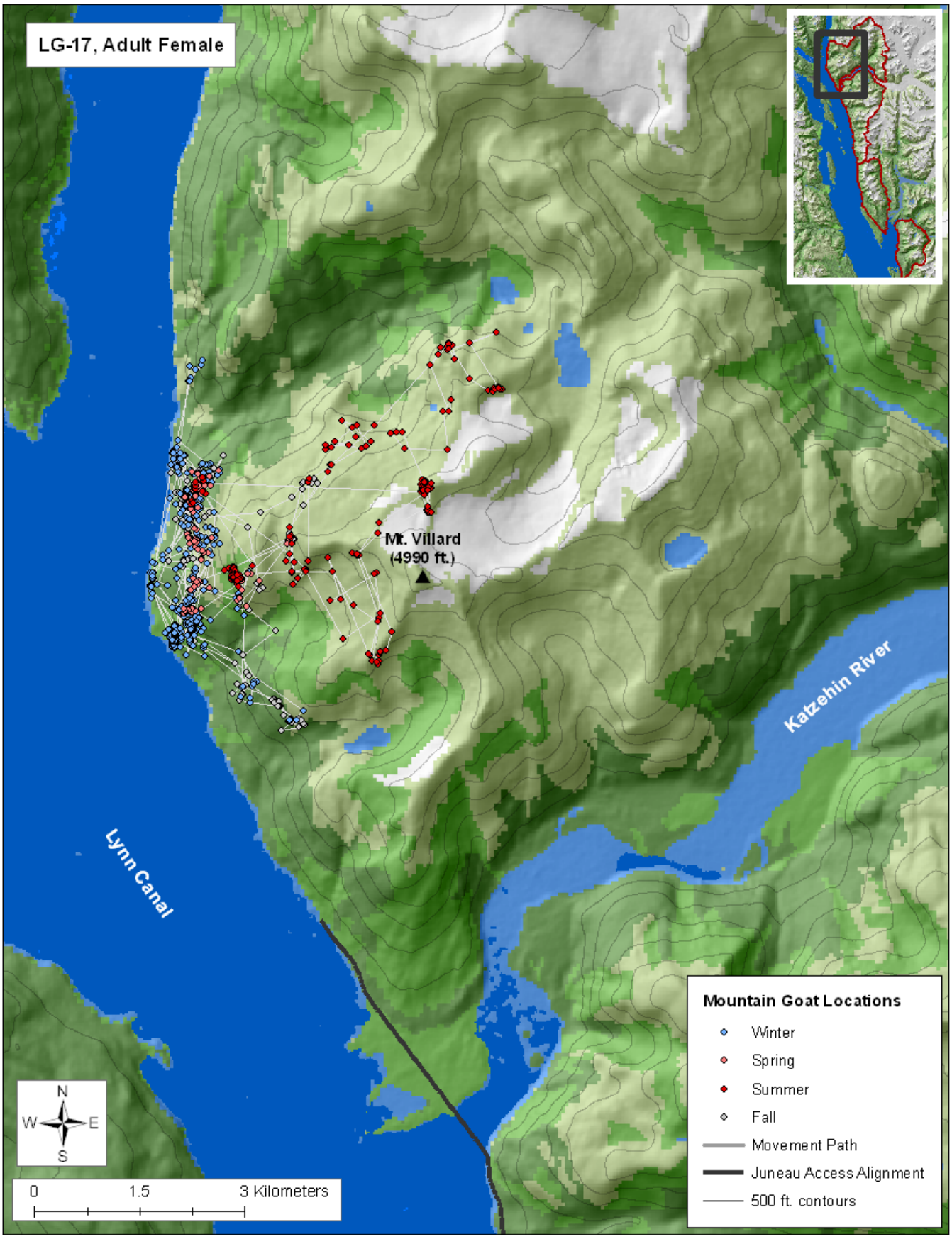

LG-11, Adult Male
Lynn Canal
Sinclair Mtn.
(6300 ft.)
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
1.5
3 Kilometers

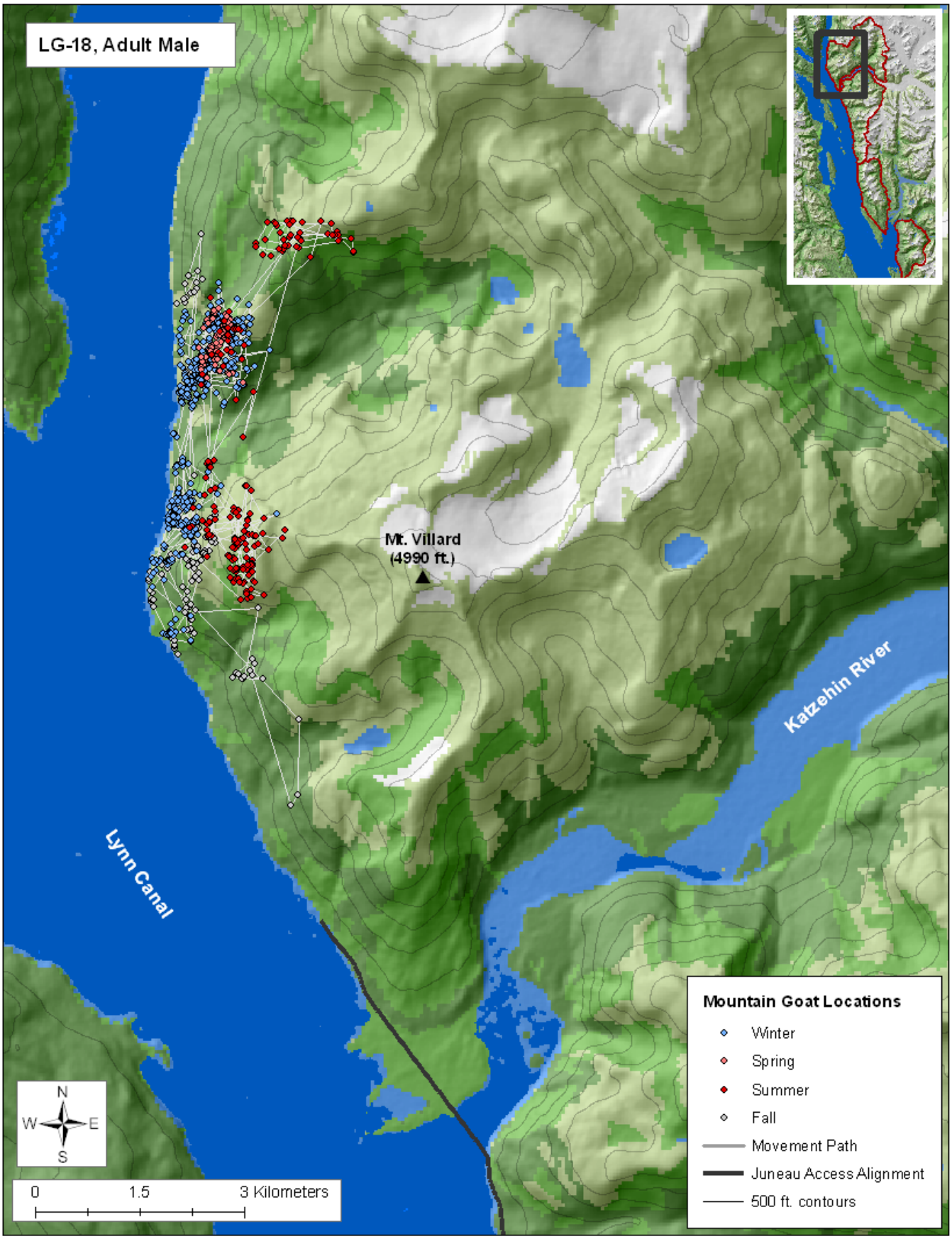

LG-12, Adult Female
Mt. Villard
(4990 ft.)
Katzehin River
Lynn Canal
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
1.5
3 Kilometers

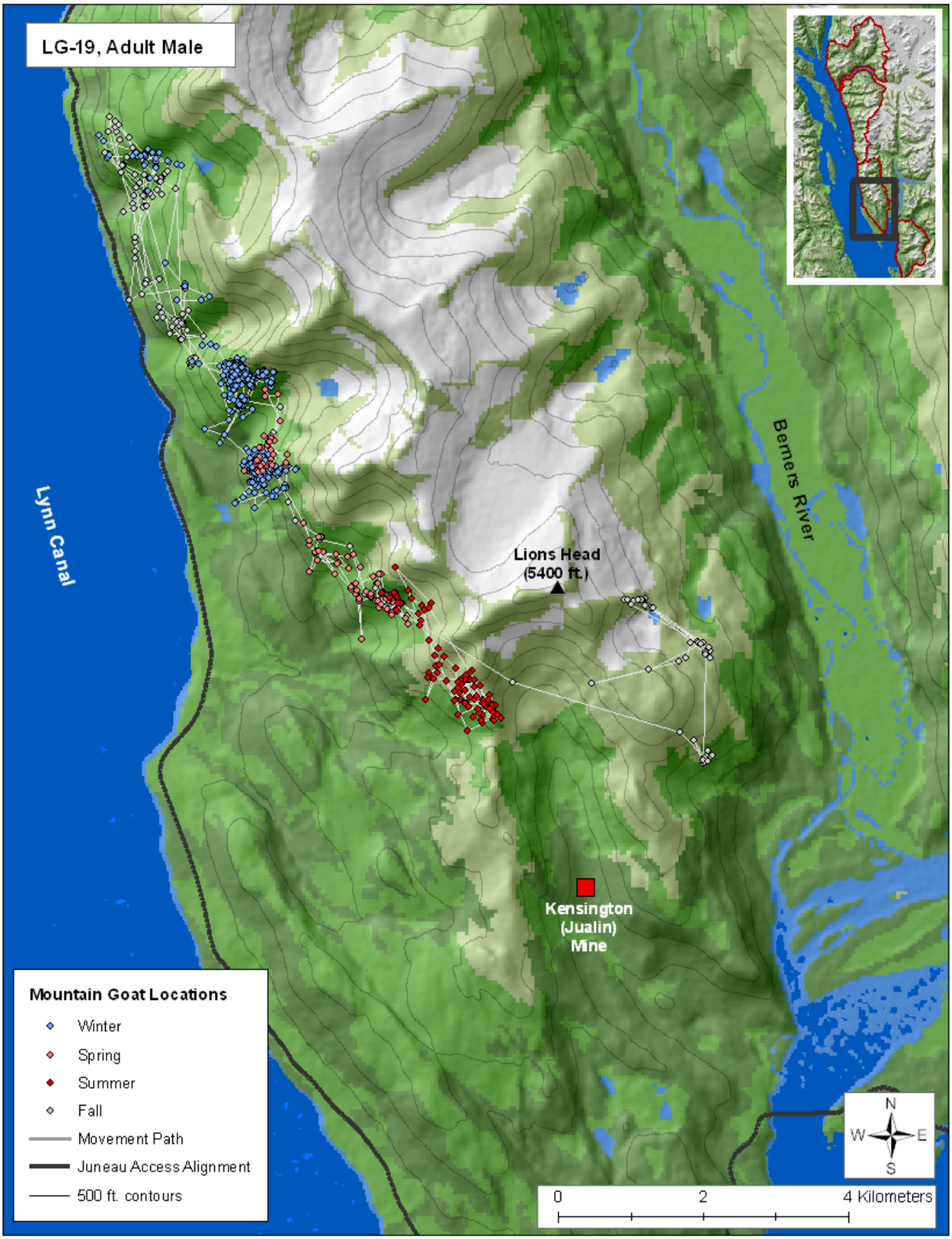

LG-14, Adult Female
Mt. Villard
(4990 ft.)
Katzehin River
Lynn Canal
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
1.5
3 Kilometers

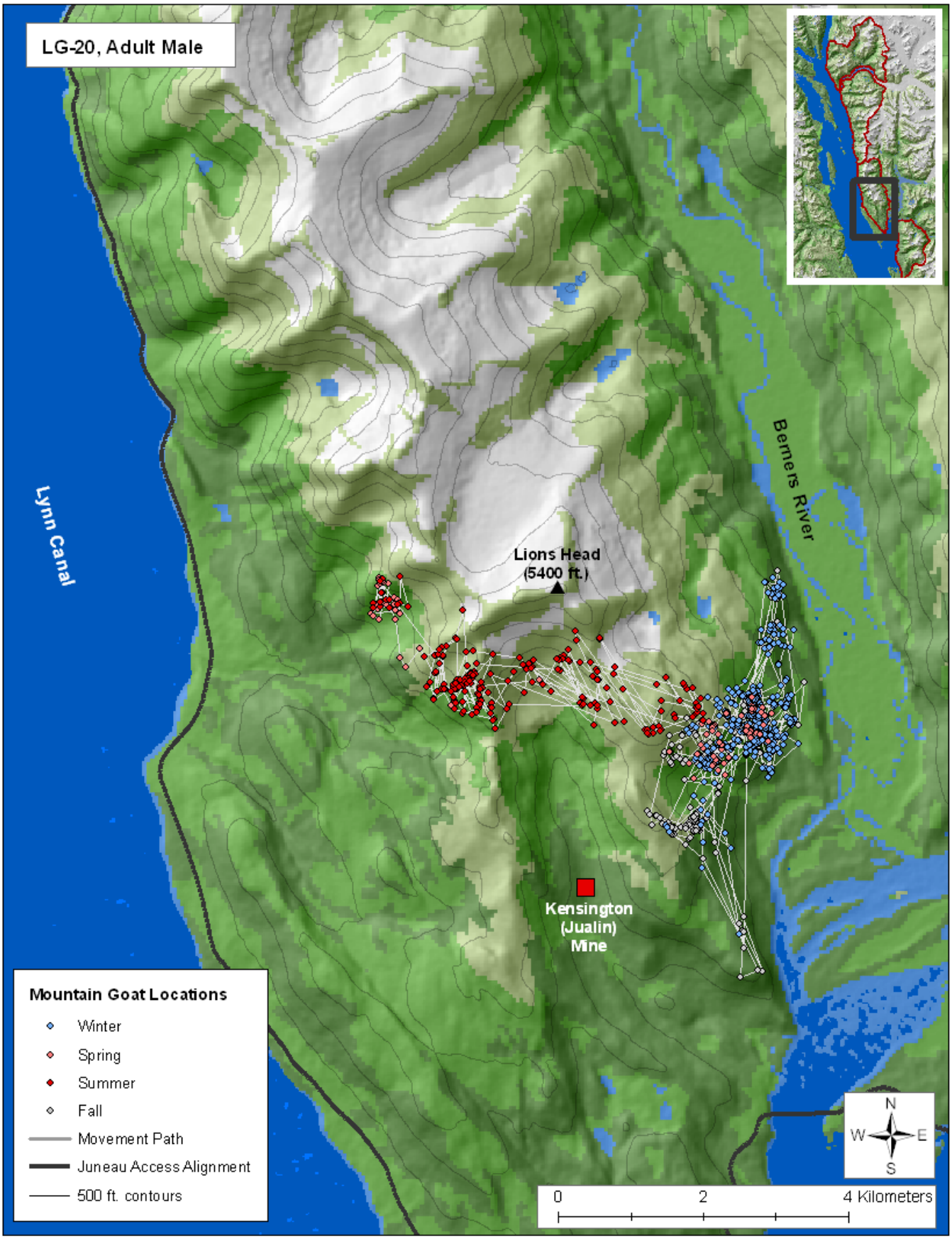

LG-15, Adult Male
Mt. Villard
(4990 ft.)
Katzehin River
Lynn Canal
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
1.5
3 Kilometers

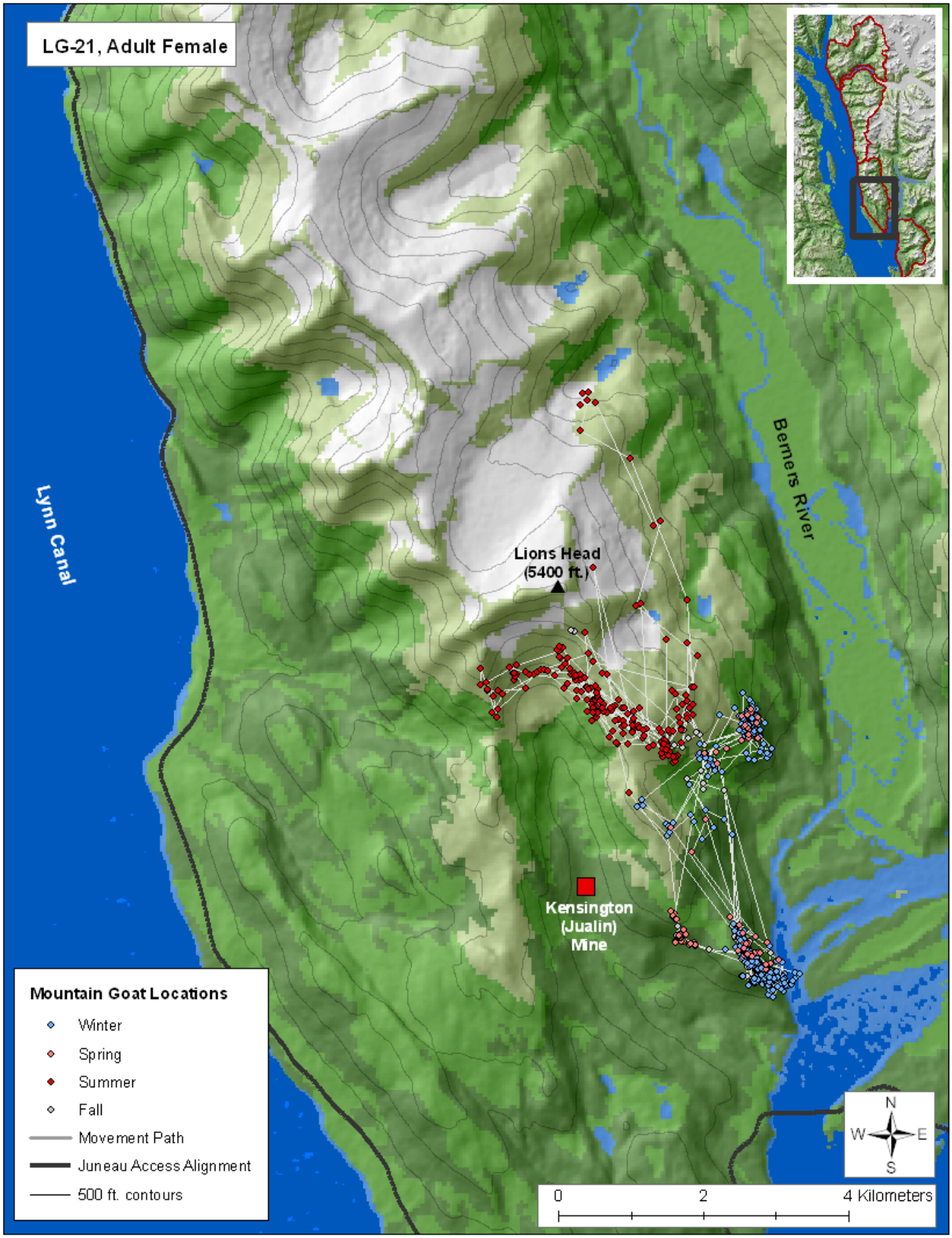

LG-16, Adult Male
Sinclair Mtn.
(6300 ft.)
Lynn Canal
Eldred Rock
N
W
E
S
0
1.5
3 Kilometers
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours

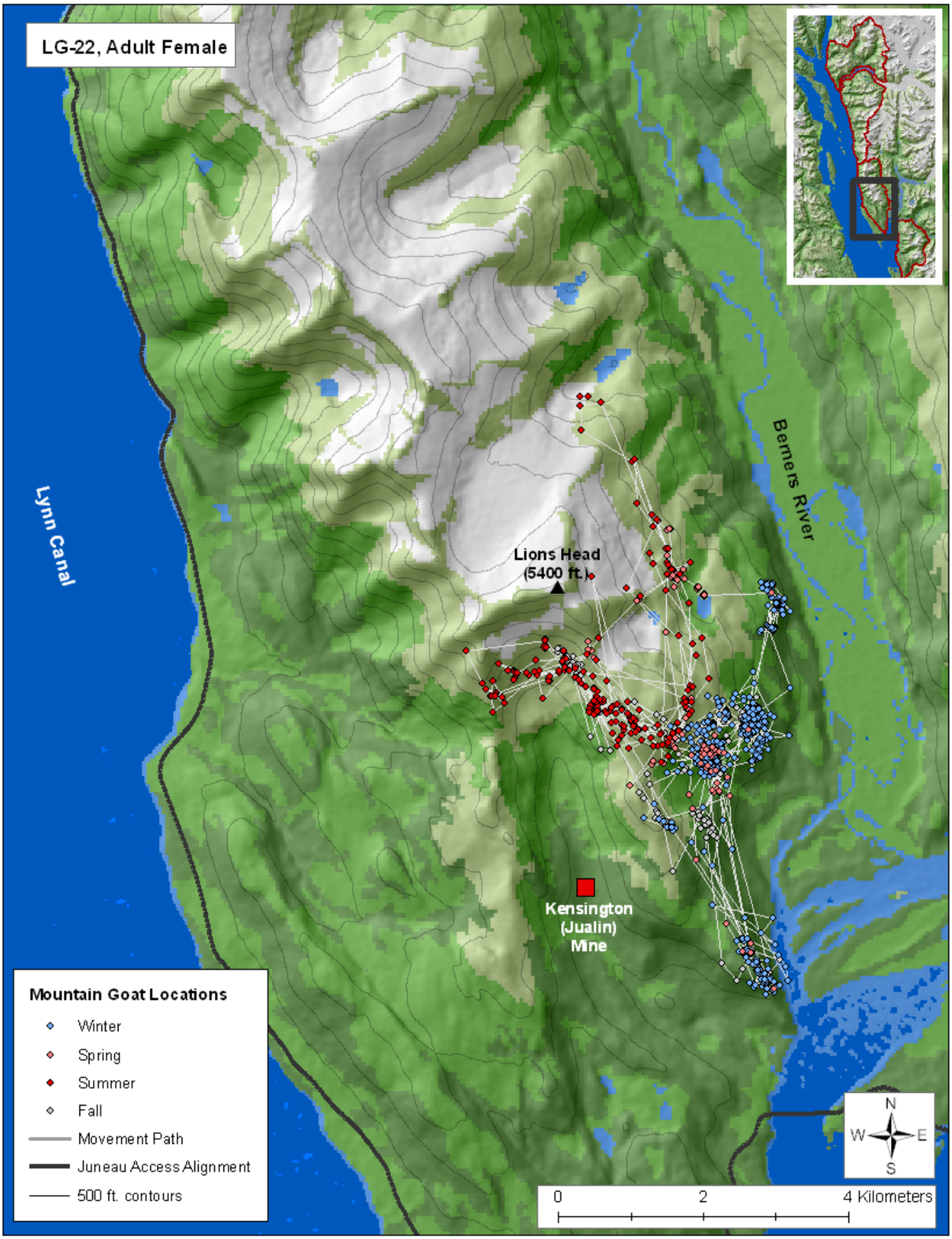

LG-17, Adult Female
Mt. Villard
(4990 ft.)
Katzehin River
Lynn Canal
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
1.5
3 Kilometers

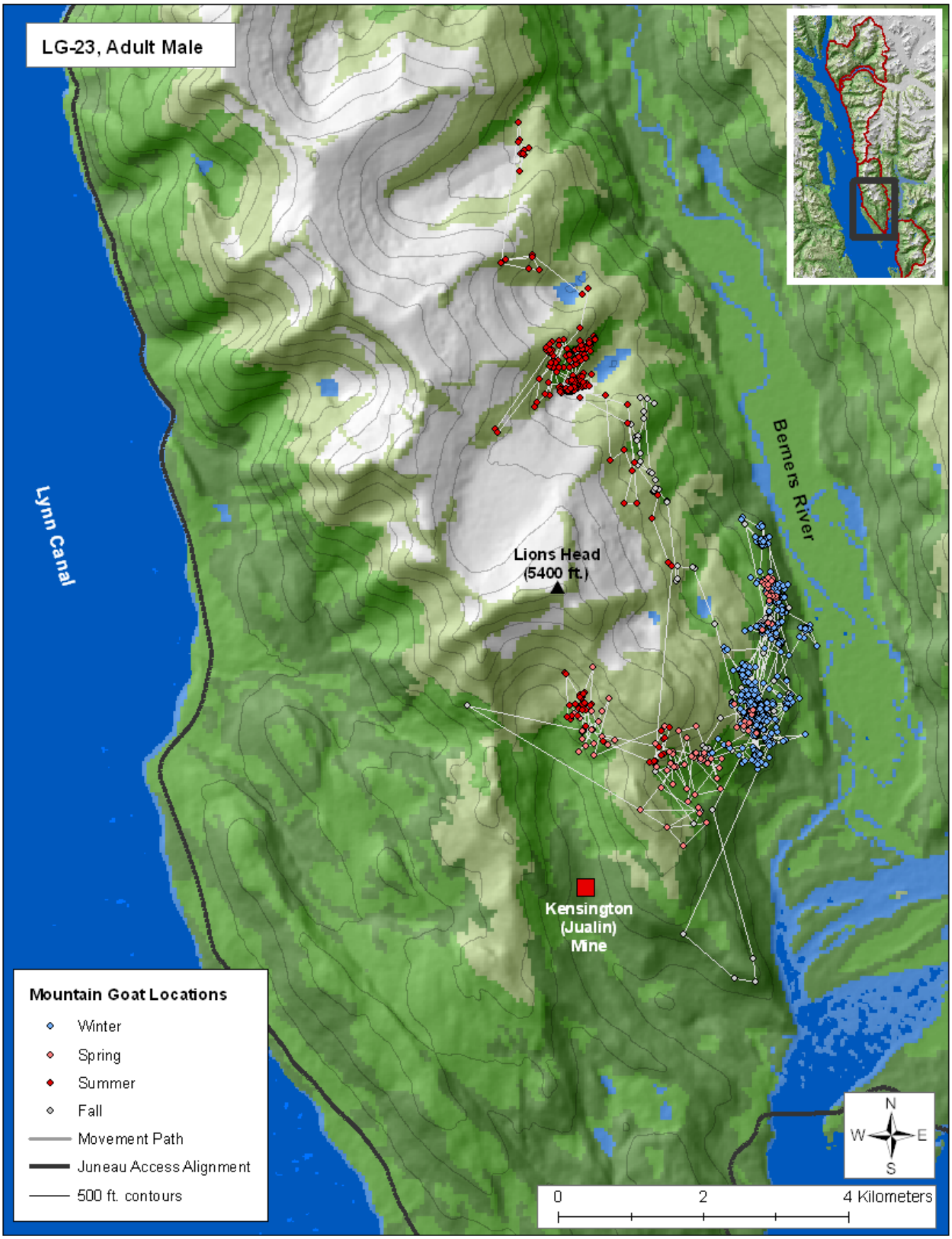

LG-18, Adult Male
Mt. Villard
(4990 ft.)
Katzehin River
Lynn Canal
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
1.5
3 Kilometers


LG-19, Adult Male
Lynn Canal
Berners River
Lions Head
(5400 ft.)
Kensington
(Jualin)
Mine
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers


LG-20, Adult Male
Lynn Canal
Berners River
Lions Head
(5400 ft.)
Kensington
(Jualin)
Mine
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers


LG-21, Adult Female
Lynn Canal
Lions Head
(5400 ft.)
Berners River
Kensington
(Jualin)
Mine
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers


LG-22, Adult Female
Lynn Canal
Berners River
Lions Head
(5400 ft.)
Kensington
(Jualin)
Mine
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers


LG-23, Adult Male
Lynn Canal
Berners River
Lions Head
(5400 ft.)
Kensington
(Jualin)
Mine
Mountain Goat Locations
Winter
Spring
Summer
Fall
Movement Path
Juneau Access Alignment
500 ft. contours
N
W
E
S
0
2
4 Kilometers

Attachment 2

Wildlife Monitoring Report - 2006

Kensington Terrestrial Wildlife Monitoring Annual Report Slate Lakes Basin, 2006

Coeur Alaska
3031 Clinton Drive
Suite 202
Juneau, Alaska 99801

Prepared for Coeur by K. Savage
Submitted January 24, 2007

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Introduction

Coeur Alaska's Kensington Project is an underground gold mine, located approximately 45 air miles north of Juneau, Alaska. The Jualin site of the project is located in a valley east of Comet and includes the Slate Lakes basin, an area approximately 1 mile north of Berner's Bay. Within the Slate Lakes basin are Lower and Upper Slate Lakes and the Spectacle Lake complex, which encompasses the upper and lower sections of Spectacle Lake and Fat Rat Lake, as well as associated environs (Fig. 1). When the mine begins production, the Jualin site will include a camp, mill, tailings storage facility (TSF) and associated infrastructure. Tailings will be processed at the mill and subsequently conveyed as slurry through a pipeline to the Lower Slate Lake TSF in the Slate Lakes basin. A dam built at the southern end of Lower Slate Lake will eventually increase the area of Lower Slate Lake from 20 acres to 56 acres. The project also involves the construction of both roads and limited facilities through and within the Slate Lakes basin. Because activities associated with construction and operation of the project may possibly effect wildlife and habitats within the area, a terrestrial wildlife monitoring plan has been incorporated into the *Kensington Gold Project Final Plan of Operations*, dated May 6, 2005, the *Kensington Project Lower Slate Lake Tailings Storage Facility Ecological Monitoring Plan*, dated May 6, 2005, and the *Kensington Gold Mine Berners Bay Transportation Mitigation and Best Management Practices Plan*, dated August 2005, in accordance with federal, state and local agency permit requirements. This plan, as described in *The Kensington Project Terrestrial Wildlife Monitoring Plan*, dated June 19, 2006, was designed to ensure that environmental impacts to wildlife resources in the project area are mitigated during both construction and operation and that the reclamation process includes a plan to support and encourage use by local wildlife species.

The goals of the 2006-2007 Terrestrial Wildlife Monitoring Plan include the following:

- Collect data and other information that can be used to shape a standardized protocol for subsequent year's studies and long-term monitoring. The survey techniques as defined in the *The Kensington Project Terrestrial Wildlife Monitoring Plan* (2006) would be used as preliminary guidelines and modified accordingly. This would ultimately include:

  1. Gathering information on specific wildlife species and habitats that could be affected by increased activity at the project site.

  2. Identifying specific locations where concentrations of wildlife would be expected to be observed because of specific resources present (e.g., stream mouth marshes, wetlands, bird nesting/feeding areas, large mammal crossing areas, etc.).

3. Determining the temporal and spatial use of the different vegetation types within the target area by wildlife species.

4. Determining and instituting mitigative measures to support wildlife species during construction and operations.

- Determine the optimum frequency of monitoring relative to season and the intensity of wildlife activity.
- Supplement the regional resource knowledge available with site-specific data for the study area of interest.

Survey Area and Methods

Survey Area:

Topography and Vegetation

The survey area covered by the wildlife monitoring project lies within the confines of the Slate Lake basin, an area of approximately 2 sq. km, ranging in elevation from 200 m at the mouth of Lower Slate Lake to 300 m atop the ridge to the west of Lower Slate Lake. Water bodies within the basin include Lower and Upper Slate Lakes to the west and the Spectacle Lakes complex to the east. Though both Lower and Upper Slate Lake have steep western slopes, each lake has a specific topography. Lower Slate Lake has a moderately inclined slope leading to a ridge to the east and the upper and lower drainages are only mildly sloping. The area around Upper Slate Lake is fairly flat in the northern and southern sections with a mild slope to the east. Spectacle Lake is also a fairly flat region with mildly elevated patches throughout.

Prior to construction, terrestrial vegetation types around Upper and Lower Slate Lake were fairly similar and included mixed spruce and predominantly hemlock forest to the west of both lakes and to the southeast of Lower Slate Lake, some lake shore wetland, grass/sedge meadow and patchy bog/ muskeg to the north and east. As of August 2006, the periphery of Lower Slate Lake had been clear-cut and a road system constructed around the lake. The immediate vicinity of Upper Slate Lake has not been impacted by the project. The vegetation structure around the Spectacle Lake complex mainly includes sphagnum bogs and sedge fens with brushy, scrub forest in elevated areas. A road constructed to the far north of Spectacle Lake connects the TSF to the Spur Road. All of the lakes contained various species of aquatic vegetation, though not in high volume. Spectacle Lake contains the greatest concentration of aquatic vegetation, mainly in the three sloughs and also in Fat Rat Lake.

Methods:

The primary goal for the fall 2006 wildlife monitoring was to begin establishing a long-term workable protocol to assess the wildlife species present in the fall and then working towards assessing the reason for their presence. The initial survey methodology was based upon *The Kensington Project Terrestrial Wildlife Monitoring Plan*, dated June 19, 2006, which included:

1. A standardized schedule for fixed scan wildlife observations conducted from a field camp set in an elevated location as well as along an established route, which also included specific sites for dawn and dusk surveys. Observations would be made on a regular basis from spring through fall, and intermittently through the remainder of the year. Results from the first year of monitoring would be used to determine the frequency of monitoring in following years relative to seasonal intensity of wildlife activity.

2. The collection of data including field records of all observed wildlife species and indices, with photographs/video footage/sample collection at times as an adjunct to recorded data. Data collection would also include information concerning human activities in the area.
3. Particular animal species would be of special interest if they are located at any area of the project site, including herons, waterfowl and raptors such as eagles and goshawks.
4. Regarding the presence of goshawks, a follow up to the 2000 ABR survey as well as a repeat of the 2004 Tetra Tech limited survey would be conducted by trained personnel in June/ July 2006 using standard broadcast calling protocols.
5. Cross-training of associated personnel by the field biologist as necessary.

An initial reconnaissance was made by the field biologistand a technician on June 14, 2006, which covered the southern, western and northern periphery of Lower Slate Lake and the entire periphery of the Spectacle Lake complex. The terrain and vegetation around the lakes was assessed at this time as well as the presence and location of any wildlife indices. On August 22, the two day surveys started on a weekly schedule and continued until Dec. 8. By Dec. 8, sufficient information had been collected to fulfill, modify and/or increase the scope of *The Kensington Project Terrestrial Wildlife Monitoring Plan* as follows:

1. Modifications to the proposed field camp and dawn and dusk surveys.

   The dawn and dusk surveys were incorporated into the plan to allow for monitoring, mainly for the presence of waterfowl and crepuscular species, during periods of no human activity. The field camp was proposed as a means to access the area for the dawn and dusk surveys prior to the construction of a Slate Lakes basin road system. By August of 2006, the road system around the lakes was in place and a field camp was unnecessary. The road system was used to access the lakes and by August 23, the optimum sites for dawn and dusk observations had been determined. Sites were chosen to provide the greatest vantage point and included the upper road east of Lower Slate Lake, the grassy meadow immediately south of Upper Slate Lake and the sparsely forested, western knoll between the upper and lower portions of Spectacle Lake. Because of bear activity in the immediate area, dawn/dusk surveys of the Spectacle Lakes were eventually performed via kayak. No increase in wildlife activity was noted on the dawn and dusk surveys. This lack of increase, coupled with the onset of limited daylight hours, lead to the discontinuation of the dawn and dusk surveys in early November.
2. Modifications and additions to suggested techniques for wildlife observations and data collection.

   The original plan called for fixed scans along an established route. Scans were included on all routes of the fall survey. At Lower Slate Lake, the entire lake up to the edge of the clear-cut was easily visible from almost any aspect. At Upper Slate Lake, scans for waterfowl in particular were made from both the southern meadow and the edge of the eastern muskeg. Viewing locations were optimum in the Spectacle Lakes area from the western edge on Lower Spectacle Lake, the southern tip of lower Spectacle Lake, which also afforded a good view of the adjacent southern slough, and

the northern tip of upper Spectacle Lake. By August 22, a workable route was established around each of the lakes, with the presence and location of wildlife and/or indices noted along each route. However, because of topographical issues as well as time constraints, both primary and secondary routes were established to cover the greatest area. The primary routes were standard in the survey and secondary routes incorporated if time allowed. A pilot set of transects was then set around the Spectacle Lake route, which showed the greatest evidence of wildlife activity, to determine if the magnitude of change in indices warranted increasing the frequency of surveys. Based on the results of the pilot study, it was determined that weekly observations were sufficient at that time. In order to more systematically document and quantify the presence, location and change in frequency of observed indices, a series of transects and grids was put into place. By the end of October, 21 50 x 2 m strip transects had been placed in a stratified, nonrandomized pattern in open bogs/ muskeg around the lakes. In addition, two 20 m^2 grids were set on the north and south ends of Spectacle Lake in areas with suspected high wildlife activity. As of October 20, three trail monitors (Bushnell Trail Sentry, Model 11-9300) had also been placed in strategic locations at each of the lakes.

Data collected included weather conditions and visibility, noise levels as well as any source of potential man-made disturbance, route, any noted environmental changes and observations of wildlife species and/or indices. When mammalian species were present, data included time of day, GPS location, approximate morphometrics and behavior (e.g. browsing, traversing etc.). Indices included perennial sign such as game trails, presence of dens or middens, scratching posts and stripped bark as well as ephemeral sign such as tracks, scat, browsing or digs, bedding activity. Data on location, direction of tracks (followed when possible), and scat composition were recorded, samples collected when necessary and photographs taken to document observations. Data also included anecdotal information. Introductions were made to Coeur personnel associated with work in Slate Lake basin, who were informed of the project intent, including species of particular interest, and regularly questioned on sightings of any wildlife species that may have occurred throughout the week.

3. Monitoring of avian species

Avian species of particular interest included herons, waterfowl and raptors such as eagles and goshawks. A survey for the presence of the Queen Charlotte Northern Goshawk was conducted in April and June (refer to the *2006 Northern Goshawk Survey, Jualin Mine Site*, dated November 7, 2006). Sightings and/or songs/calls of any avian species that occurred during the surveys were recorded, including information on location, number, gender (when possible) and behavior. Because Spectacle Lake in particular showed substantial sign of goose activity, seven 1 m circular grids were set in areas with greatest concentration of feathers and scat.

4. On going training of field personnel

Each survey was conducted by the field biologist as well as one of four technicians, who were trained on site to ensure that observations and data collection was as standardized and unbiased as possible.

Survey Results

Wildlife Species Present in the Slate Lakes Basin, Fall 2006

Species richness and location of sightings are summarized below.

Large Mammals:

Black Bear (*Ursus americanus*)

No bears were sighted at either Lower or Upper Spectacle Lake. Five sightings of black bear were made at Spectacle Lakes. Two of the sightings involved bears that were traversing the area (B1, B5) with the remaining three actively foraging through either blueberry bushes (B3, B4) or in the grassy edge of the slough south of lower Spectacle Lake (B2). A simultaneous sighting of two of the bears was made along the slough south of lower Spectacle Lake (B1 and B2).In Lower Slate Lake, bear scat was predominantly located in the grassy meadow north of the lake, which was cleared by August, and the bench immediately below a major wildlife trail along the northwestern portion of the lake. In Upper Slate Lake, bear scat was mainly found in the grassy meadow at the northeastern corner of the lake. Bear indices were plentiful in all areas of Spectacle Lake and included tracks, scat and digs Wildlife grid #1, located in the grassy meadow south of the lower Spectacle slough, contained a large number of bear scat (4 piles/ 300m^2 as of August 23, increasing to 6 piles/300m^2 by October 26) though no digs were found in the grid. Wildlife grid #2, located at the northern tip of upper Spectacle Lake, increased from 2 to 3 piles/ 300m^2 between August 23 and October 26 with 19 separate digs. Composition of bear scat varied between what appeared to be roots and blueberry with one pile containing ungulate hair.

Moose (*Alces alces*)

Aside from the cow moose photographed by a trail monitor, all moose sightings were strictly anecdotal, with information provided by Coeur personnel. On September 21, a moose was sighted moving from Slate Creek, along the road and into the forest east of Lower Slate Lakes. Tracks from this particular animal were later identified by survey personnel and partially followed up the ridge. On October 9, a bull and a cow were observed moving into the brush of the southeastern Upper Slate Lake muskeg and on Nov. 1, a bull moose was observed crossing the road west of Spectacle Lake into the Upper Slate Lake muskeg. Tracks of the former animal were verified in the muskeg, but tracks of the latter animal were probably obscured by snow which had fallen since the sighting. The cow photographed by the trail monitor on October 29 was located west of lower Spectacle Lake. Moose indices in the form of tracks, scat, browse and bedding sites were present at all the lakes, with the greatest concentration focused around Upper Slate Lake and Spectacle Lake. In Lower Slate Lake, the predominant area where moose scat and tracks were located included the grassy meadow north of the lake, along the edge

of the lake and along the bench immediately below a major wildlife trail along the northwestern portion of the lake. In Upper Slate Lake, most indices were found at the southern tip of the lake and in the eastern muskeg. At Spectacle Lake, moose sign was consistently located around lower Spectacle Lake, with the exception of tracks and bedding sites found to the west of upper Spectacle Lake on Dec. 8.

Coyote (*Canis latrans*)

Anecdotal coyote sightings were made on October 7 and 18, with the latter sighting verified by photograph. Canid scat was found north of upper Spectacle Lake on October 12.

Mountain Goat (*Oreamnos americanus*)

Refer to *Mountain Goat Assessment and Monitoring along the Juneau Access Road Corridor and near the Kensington Mine,* ADF&G, Wildlife Research Annual Progress Report, August 2006.

Small Mammals:

Porcupine (*Erithizon dorsatum*)
Pine Marten (*Martes americana*)
Short-tailed Weasel (*Mustela erminea*)
Mink (*Mustela vison*)
Red Squirrel (*Sciuris vulgaris*)
Deer Mouse (*Peromyscus maniculatus*)

The only small mammal sightings were of red squirrels and a porcupine found between Lower Slate Lake and Spectacle Lake on June 1. However, indices were plentiful around all of the lakes. Perennial sign such as den sites, gnawed branches and stripped bark were mainly found in the forested areas around Upper and Lower Slate Lake. Historic beaver activity was noted around Spectacle Lake in the form of unoccupied dams and logging. Though a set of mink tracks was located at the edge of Lower Slate Lake in June, ephemeral sign in the form of tracks was most apparent with the advent of snow in early November. Both porcupine and marten tracks were found crossing open space around Spectacle Lake and marten tracks were plentiful in the slash piles surrounding of Lower Slate Lake. However, the vast majority of tracks were found in the forests surrounding Lower and Upper Slate Lake as well as in and around the brush of Spectacle Lake and included porcupine, squirrel, short-tailed weasel, marten and deer mice.

Avian Species

The avian species identified through direct sightings or indirectly through songs or calls included both resident and migratory wading birds, nonpasserine land birds, passerines, raptors and waterfowl. Regarding species of particular interest, a heron was possibly present at Lower Spectacle Lake, though the sighting was unverified and further information not available. Aside from a Northern Pygmy owl heard in the distance, eagles were the only raptor species observed and then noted strictly in flight. Waterfowl

included a variety of migratory ducks and a single Canada Goose. With the exception of the solitary goose, which was observed swimming and grazing along the edge of Lower Spectacle Lake, and a single unidentified duck in the waters of northern Upper Slate Lake, all of the waterfowl activity was focused in Spectacle Lake. Most of this activity was concentrated in both the northern and southern sloughs of lower Spectacle Lake. Lesser activity was noted in the eastern slough of upper Spectacle Lake and one unidentified duck was seen in Fat Rat Lake,. None of the waterfowl were ever seen on the shore; they were only observed feeding and swimming in the water. There was substantial evidence of past goose activity primarily along the shore of Spectacle Lake. Within the seven circular grids scattered along the edge of Spectacle Lake, the number of scat piles ranged from 7 – 81 and the feather count ranged from 2 – 42, though no change was noted throughout the fall and no geese observed around or in Spectacle Lake.

Optimum Frequency of Monitoring Relative to Season and Wildlife Activity

One of the goals of the fall 2006 survey was to determine the optimum frequency of monitoring relative to season and wildlife activity levels. The pilot study along the Spectacle Lake route showed insufficient change in observed indices to warrant increasing the frequency of surveys. The use of trail monitors, (which will increase in number from 3 to 6 in 2007) as well as observations by Coeur personnel on site, also proved a useful adjunct to monitoring during interim periods.

Regarding the intensity of wildlife activity, the number of actual sightings of wildlife varied substantially between the lakes. Sightings at Spectacle Lake peaked in August/September and declined through the remainder of the fall, though this pattern reflected species specificity. With hibernation and migration as seasonal patterns, black bear and waterfowl were understandably absent in late fall. Spectacle Lake moose, however, were sighted by either the trail monitor or ancillary personnel throughout the fall. Very few sightings of any species were made at either Lower Slate Lake or Upper Slate Lake.

Wildlife indices were also used to indirectly indicate wildlife presence. However, in detecting seasonal wildlife activity indices were useful only when it was unequivocal that they were recent. This was possible both with data collected from the transects and grids set around the lakes and also with the advent of snow by Nov. 1. Regarding the transects and grids, no new bear activity was noted after Oct. 12. Moose activity, mainly in Upper Slate Lake and Spectacle Lake was apparent through the final fall survey on Dec. 8. With the advent of snow in early November, small mammal activity became apparent around all of the lakes and also continued through Dec. 8.

Based on the seasonal wildlife activity as noted above, it was determined that the monitoring in the fall of 2007 should continue as weekly surveys through November.

Wildlife Activity and Movement

Observations of wildlife and indices provided an initial list of animals present in the fall as well as some tentative insight into how these animals are using the area.

Regarding large mammal activity, it was apparent through the presence of digs and scat, especially around Spectacle Lake, that bears use the area extensively. In the fall, black bears were observed actively browsing on blueberry bushes around Spectacle Lake. Bear scat was also found along both Upper and Lower Slate Lake. Moose, on the other hand, mainly seem to pass through the area. One principal route appeared to start from the lower eastern reaches of Spectacle Lake and then either cross over the eastern ridge of Lower Slate Lake heading south or moving north, crossing the road and passing through the eastern meadow of Upper Slate Lake On the initial reconnaissance around the Lower Slate Lake on June 14, two major game trails, neither of which appeared to be related to human activity, were found along the northwestern portion of Lower Slate Lake, leading from an upper grassy meadow to a bench dominated by skunk cabbage. Both bear and moose scat were present along this bench. Below this bench at the north end of the lake was a grassy meadow where bear scat and moose tracks were also located No large mammal activity was detected along these game trails in the fall, either with a trail monitor or along the transect.

Small mammal presence was abundant, primarily where there was sufficient cover as in forested or brushy areas. Regarding the project impact, a set of mink tracks was noted in the muddy southern bank of Lower Slate Lake during the initial reconnaissance on June 14. Accessing the edge of Lower Slate Lake to look for more tracks near the water's edge was not possible in the fall, either on foot or by boat, which was attempted on October 12. No mink tracks were found in the snow around the lake, though snow conditions sometimes made the species identification of track sets impossible. The only other tracks seen around the immediate periphery of Lower Slate Lake were those of pine marten.

Based on the abundance of scat and feathers found around the periphery of Spectacle Lake, it was apparent that the majority of waterfowl activity occurred prior to the fall survey. Lynn Canal is a major migratory corridor for waterfowl and all species observed during the fall were migratory, feeding and resting before moving on

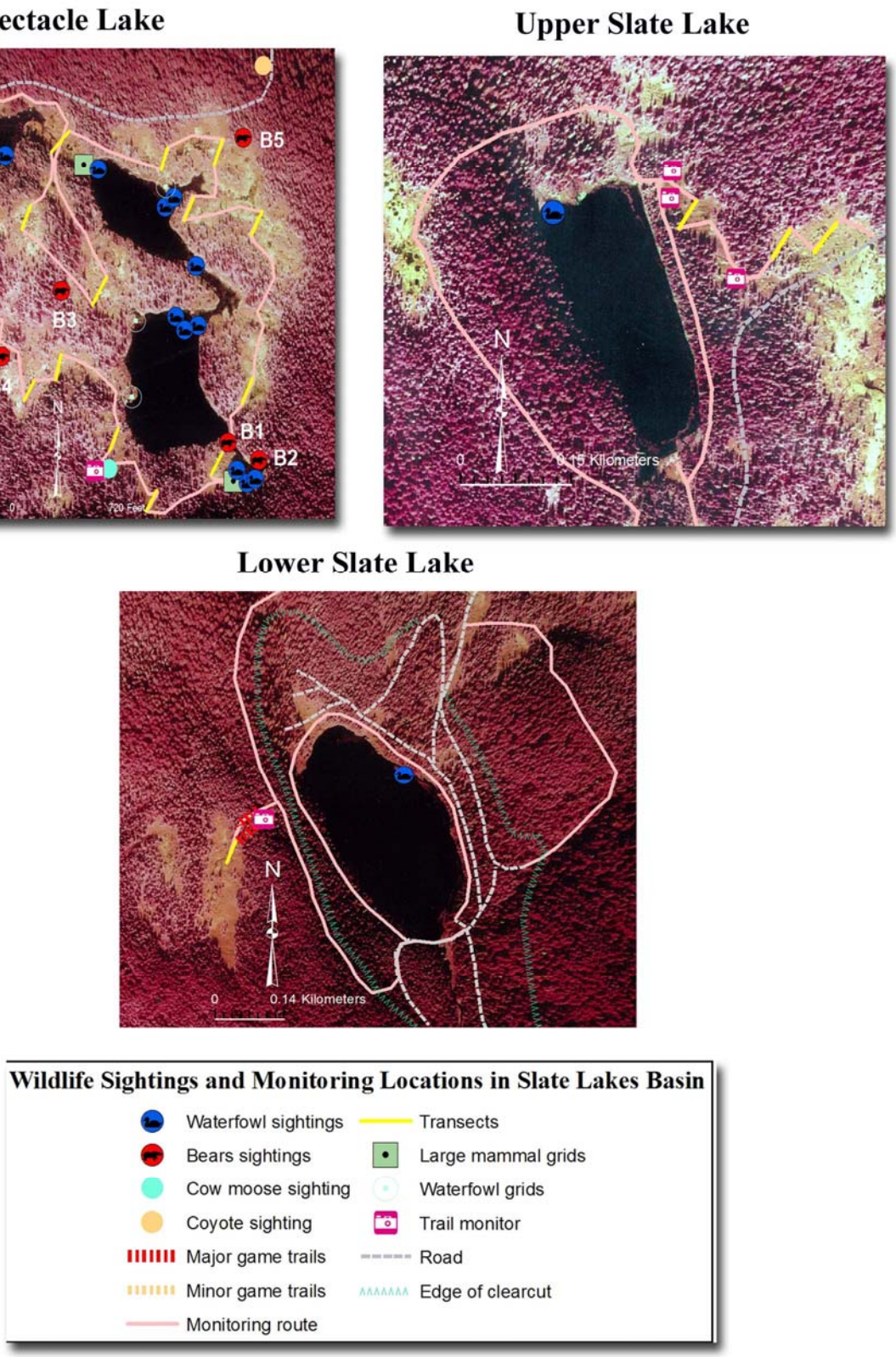
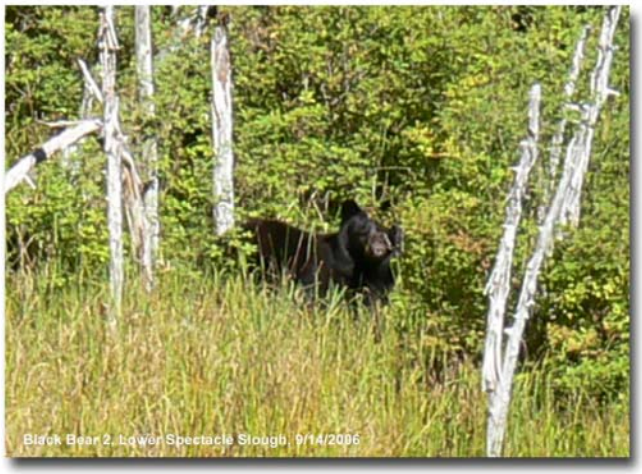


Figure 1. Wildlife Sightings and Monitoring Locations in Slate Lakes Basin



Black bear (B2), Spectacle Lake, 9/14/2006

Coyote, 10/18/2006
(Photo courtesy of G. Stout)

Ring-necked Ducks,
Spectacle Lake, 9/14/2006

Cow moose from Trail Monitor,
Spectacle Lake, 11/2/2006

Bohemian Waxwing,
Spectacle Lake, 11/9/2006

Greater Scaups,
Spectacle Lake, 9/22/2006

Figure 2. Examples of Wildlife Sightings in Slate Lake Basin

Summary

Either through direct observation or indirectly through the use of indices, the presence of 10 species of mammals and 20 avian species were documented during the 2006 survey. Though most animal sightings and evidence were around the Spectacle Lake complex, indices of wildlife species were observed throughout the area. Most of the sightings occurred between September and October, though applied mainly to bear and waterfowl. Signs of moose activity, resident birds and small mammals were apparent throughout the survey.

Appendix 1 Slate Lake Basin Wildlife Sightings, Fall 2006 – Refer to Figs. 1 and 2

DATE	WATERFOWL SIGHTINGS	TIME	LOCATION	PHOTO?	Anecdotal or verified?
8/22/2006	1 F mallard	Dusk	E Upper Spect	N	V
8/30/2006	1 Canada Goose	Dawn	L Slate	N	V
9/7/2006	pair white-winged scoters	Day	E Upper Spect	N	V
9/14/2006	6 Ring-necked ducks	Day	E Lower Spect - Confluence	Y	V
9/15/2006	1 M mallard	Dawn	E Upper Spect	Y	V
9/21/2006	1 brown headed duck - F greater scaup?	Dusk	Upper Spect. Confluence	N	V
	1 M, 2 F ducks. M with dark head, light to moderately dark breast to tail	Dusk	L Spect. Slough	N	V
9/22/2006	Flock of greater scaup and ring-necked ducks. 9 - 11/ 3 M, 8 F	Day	L Spect Confluence	Y	V
9/28/2006	1 unid. sp.	Dusk	L. Spect. Slough	N	V
9/29/2006	1 unid. sp.	Dawn	N Upper Spect.	Y	V
10/24/2006	Heron?	Day	LSL	N	A
10/26/2006	Unidentified duck - brown with white head patch	1100	USL	N	A

DATE	MISC. BIRD SIGHTINGS/CALLS	TIME	LOCATION	PHOTO?	S/C/B
8/23/2006	Pair of least sandpipers	Day	S Slough	N	S
8/30/2006	Kingfisher	Dawn	L Slate	N	S
9/14/2006	Stellars Jay	Day	N edge of upper Spect.	Y	B
9/21/2006	Eagle	Day	Flying over L Slate	N	S
	Small light colored shore bird - sp?	Day	In mud along L Slate periphery	N	S
	Winter wren, Savannah sparrow	Day	NE L Slate in grasses	N	S
	N pygmy owl	Dusk	W of Upper Spect	N	C
9/22/2006	Winter wren,common raven, c.b. chickadee	Dawn	LSL/USL	N	C
9/28/2006	c.b. chickadee, juncos, Stellar's ravens, eagle	Day	LSL, Spect	N	B
10/4/2006	Belted kingfisher, chickadee	Day	USL	N	C

Appendix 1 - continued

10/5/2006	2 - 4 Varied thrush	Day	Spect.	N	B
10/11/2006	Chickadees, Stellars	Dusk	Spect.	N	B
10/12/2006	Chickadees, Stellars	Dawn	LSL	N	B
	Common raven	Dawn	USL	N	B
	Flock of 5 - 6 Pine grosbeak	Day	Spect.- in trees W between Tr. 6 and 7	N	B
11/2/2006	sapsucker	Day	W LSL	N	S
11/9/2006	Flock of 4-5 Bohemian waxwings	Day	SP- E of Tr. 5	Y	B

DATE	SIGHTINGS - BEARS	TIME	LOCATION	PHOTO?	Anecdotal or verified?
9/14/2006	2 black bears, B1 & 2	Day	N & E Lower Spect. Slough	Y	V
9/14/2006	1 back bear (same as above?) B3	Dusk	W of penninsula between upper and lower Spect.	N	V
9/22/2006	black bear B4	Day	W of lower Spectacle,SW of grid 4	N	V
10/2/2006	black bear B5	A1630	NE of upper Spect.	Y	A

DATE	SIGHTINGS - OTHER MAMMALS	TIME	LOCATION	PHOTO?	Anecdotal or verified?
9/21/2006	M moose M1	Dawn	SE Lower Slate	N	A
10/7/2006	gray colored wolf-coyote C1	A1630	W of road near Pit 7	N	A
10/9/2006	2 moose - 1 bull and cow(?) M2&3	dusk	muskeg W of USL, N of road	N	A
10/18/2006	coyote C2	1400	just N of pit 7, W along road	Y	A
11/1/2006	bull moose	1800	crossed road from Spectacle to USL muskeg	N	A
11/2/2006	Cow moose	0530	W of lower Spectacle	Y	V

Appendix 2

AVIAN SPECIES IDENTIFIED
SLATE LAKES BASIN, FALL 2006

WATERFOWL

1. White-winged Scoter (*Melanitta fusca*)
2. Greater Scaup (*Aytha marila*)
3. Mallard (An*as platyrhynchos*)
4. Canada Goose (*Branta canadensis*)
5. Ring-necked Duck (*Aythya collaris*)

OTHER

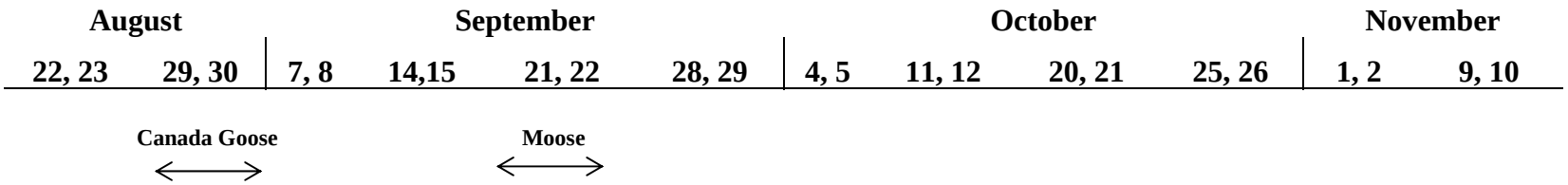
1. Belted Kingfisher (*Ceryle alcyon*) – Common, B
2. Steller's Jay (*Cyanocitta stelleri*) – Common, B
3. Bald Eagle (*Haliaeetus leucocephalus*) – Common, B
4. Common Raven (*Corvus corax*) – Common, B
5. Chestnut-backed Chickadee (*Poecile rufescens*) – Common, B
6. Dark-eyed Junco (*Junco hyemalis*) – Common, B
7. Winter Wren (*Troglodytes troglodytes*) – C/S
8. Savannah Sparrow (*Passerculus sandwichesis*) - B
9. Northern Pygmy Owl (*Glaucidium gnoma*) – C/S
10. Varied Thrush (*Ixoreus naevius*) - B
11. Pine Grosbeak (*Pinicola enucleator*) - S
12. Northwestern Crow (*Corvus caurinus*) - B
13. Red-breasted Sapsucker (*Sphyrapicus rubber*) - B
14. Bohemian Waxwing (*Bombycilla garrulous*) - B
15. Least Sandpiper (*Calidris minutilla*) - S

Common = multiple sightings through season
S = identified through sighting
C/S = identified through call or song

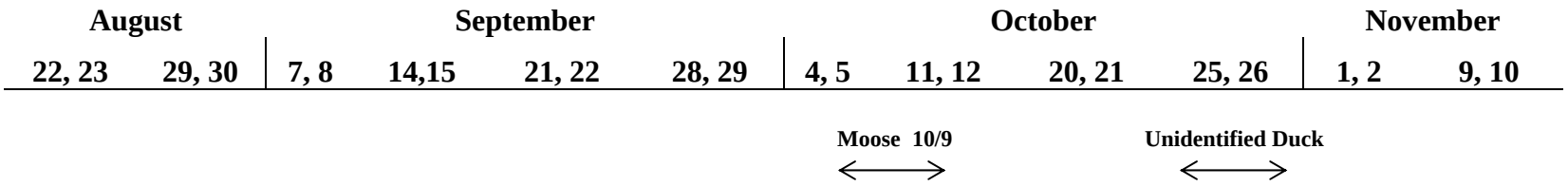
Appendix 3

MONTHLY WATERFOWL AND LARGE MAMMAL SIGHTINGS
SLATE LAKES BASIN, FALL 2006

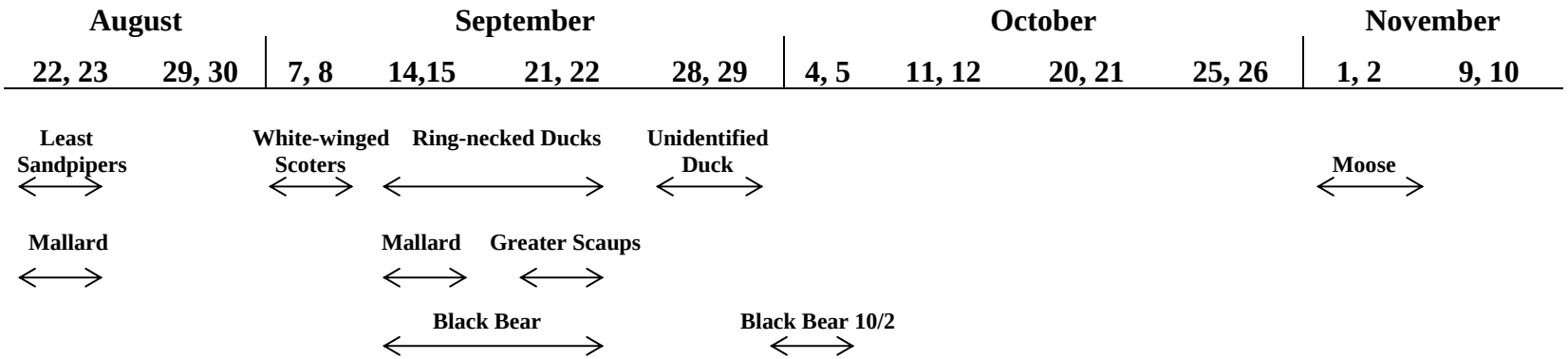
Lower Slate Lake



Upper Slate Lake



Spectacle Lakes



Attachment 3

Goshawk Monitoring Report – 2006

2006 NORTHERN GOSHAWK SURVEY
JUALIN MINE SITE

Coeur Alaska
3031 Clinton Drive
Suite 202
Juneau, Alaska 99801

Prepared for Coeur by K. Savage
November 7, 2006

2006 Northern Goshawk Survey
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Introduction

Coeur Alaska's Kensington Gold Mine Project is currently under construction approximately 45 air miles north of Juneau, Alaska. The Jualin site of the mine project is located north of Berner's Bay and will eventually include a mill, camp and tailings storage facility (TSF). Mine tailings will be transported from the mill via pipeline along the pipeline access route to the TSF at Lower Slate Lake (Figure 1). Phases of the construction plan include limited timber clearing within the Tongass National Forest for the establishment of roads and structures. As timber harvesting has proved to be a principal threat to nesting habitat of the Northern Goshawk (*Accipiter gentilis*) (Squires and Reynolds 1997), annual goshawk surveys have been incorporated into the Kensington Plan of Operations in accordance with the US Forest Service (USFS) and the US Fish and Wildlife Service (USFWS).

The goal of the 2006 Northern Goshawk Survey at the Jualin mine site was to determine the potential presence of breeding and/or nesting Queen Charlotte Goshawks in 2 unsurveyed and 2 previously surveyed locations.

Background

An initial survey for Northern Goshawks was conducted on July 8 -11, 2000 by ABR, Inc. The survey area encompassed the Jualin mine site, the Slate Lakes basin and followed the existing road system from the mine site to the eastern point of Slate Creek Cove. Sampling station design and broadcast protocol were conducted in accordance with Kennedy and Stahlecker (1993) and included broadcasting "wailing" calls at 300m intervals to elicit potential goshawk response and determine nesting sites. On July 9, an active nest with two 3 to 4 week old young was identified approximately 150 m west of the road leading from Slate Creek Cove to the Jualin mine site (Fig 1). On July 10, an adult goshawk was observed flying over the forest near the camp. The bird did not respond to broadcast calls and it was speculated that it may have been one of the nesting pair.

On June 8, 2004, personnel from USFS, USFWS, ADF&G, and Tetra Tech FW, Inc. attempted to relocate the 2000 nest site using GPS coordinates provided by ABR. No sign of the nest or nesting material was found, though a large downed Sitka spruce tree was noted within 100 feet of the GPS coordinates. The team also conducted a broadcast survey in the vicinity of the nest site as well as along the first 3.5 miles of the existing road from Slate Creek Cove to the Jualin camp, which encompassed the nest site. Standard "wailing" broadcast protocols were followed, with calling stations approximately 250 m apart. No response was detected. It was surmised that the goshawks were not using the immediate area around the nest site, though additional surveying was recommended.

Survey Area and Methods

The 2006 Northern Goshawk Survey protocol followed guidelines from Woodbridge and Hargis (2005) with techniques timed to follow goshawk breeding biology

The survey, conducted on the Jualin side of the Kensington Mine Project, focused on 4 distinct areas which included:

1. The area of the nest found in 2000 by ABR, Inc.,
2. The Spur Road, both pre and post construction,
3. The upper mill road adjacent to Snowslide Gulch and
4. The pipeline access route from the southern edge of Snowslide Gulch to the point adjoining the Spur Road.

Dawn acoustical, valley watch and limited search surveys were performed on the proposed Spur Road prior to construction in April and broadcast surveys per Kennedy and Stahlecker (1993) were performed at all sites in June. The weather was good for all surveys. Biologists included Kate Savage and Liz Flory with Gwen Bayluss from the USFS also participating in the dawn acoustical, valley watch and search surveys done pre-construction on the Spur Road.

The Spur Road, approximately 0.75 miles long with a single switchback halfway up the hillside, connects the main road to an upper area containing the pipeline access route and the Slate Lakes basin. In April 2006, the proposed road had been surveyed, staked and flagged, with road construction scheduled for May 2006. In order to determine any Northern Goshawk presence in the area, dawn acoustical surveys, nest search surveys and valley watches were completed on April 19, 20, 25 – 27, 2006. Habitat suitability was also assessed during this time. The dawn surveys included arriving at the first surveyor's flag approximately 1/2 hour before dawn, then following the flagged survey markers to the eventual intersection with the pipeline access route. Listening stations were conducted at approximately 150 m intervals with 5 - 10 minutes of listening as well as making note of the vegetation structure. A search for nests or signs of nesting activity was done continuously along the route. Valley watches were conducted on April 25 – 27. The location for the valley watches was near the gravel pit west of

the main road, which overlooks the project area and affords an excellent view of the forest canopy .

On June 27, 2006, broadcast surveys were conducted in all four areas (Fig 1). Playback recordings of adult female alarm calls were broadcast at maximum volume with call stations approximately 250 meters apart. Broadcasts were started facing the direction of travel, with 10 seconds of recorded calls followed by 30 seconds of listening and observing. This procedure was then repeated at 60° and 180° from the direction of travel and conducted twice at each station. The broadcast survey for the nest active in 2000 was initiated at the original nest location, followed a relatively circular route through the woods west of the site, to and along the road. Although the goshawk noted flying over the forest near the camp in the 2000 survey was considered as one of the nesting pair, broadcasts were repeated in the area along the upper mill road just to ensure no nests were in the area. Broadcasts were then made along the pipeline access route, starting from the timbered area south of Snowslide Gulch and continuing to the intersection with the Spur Road. The post-construction survey of the Spur Road consisted of broadcasts along the entire section of road.

Survey Results

Goshawk presence was not detected at any of the four surveyed areas. All bird calls heard in the acoustical surveys were identifiable, except for one call, which was recorded and later identified by Gwen Bayluss (USFS) as a variant call of a red-breasted sapsucker (*Sphyrapicus ruber*). No goshawks were noted during the valley watch surveys and no goshawk response was detected during the follow up broadcast surveys.

References

Crocker-Bedford, D and B. Chaney. 1986. Characteristics of goshawk nesting stands. In. R.L. Glinski et al., editors. Southwest Raptor Management Symposium and Workshop: 210 – 217.

Kennedy, P.L. and D. W. Stahlecker. 1993. Responsiveness of nesting northern goshawks to taped broadcast of 3 conspecific calls. Journal of Wildlife Management 57: 249-257.

Woodbridge, B. and C. D. Hargis. 2005. Northern goshawk inventory and monitoring technical guide. USDA Forest Service, Washington Office.

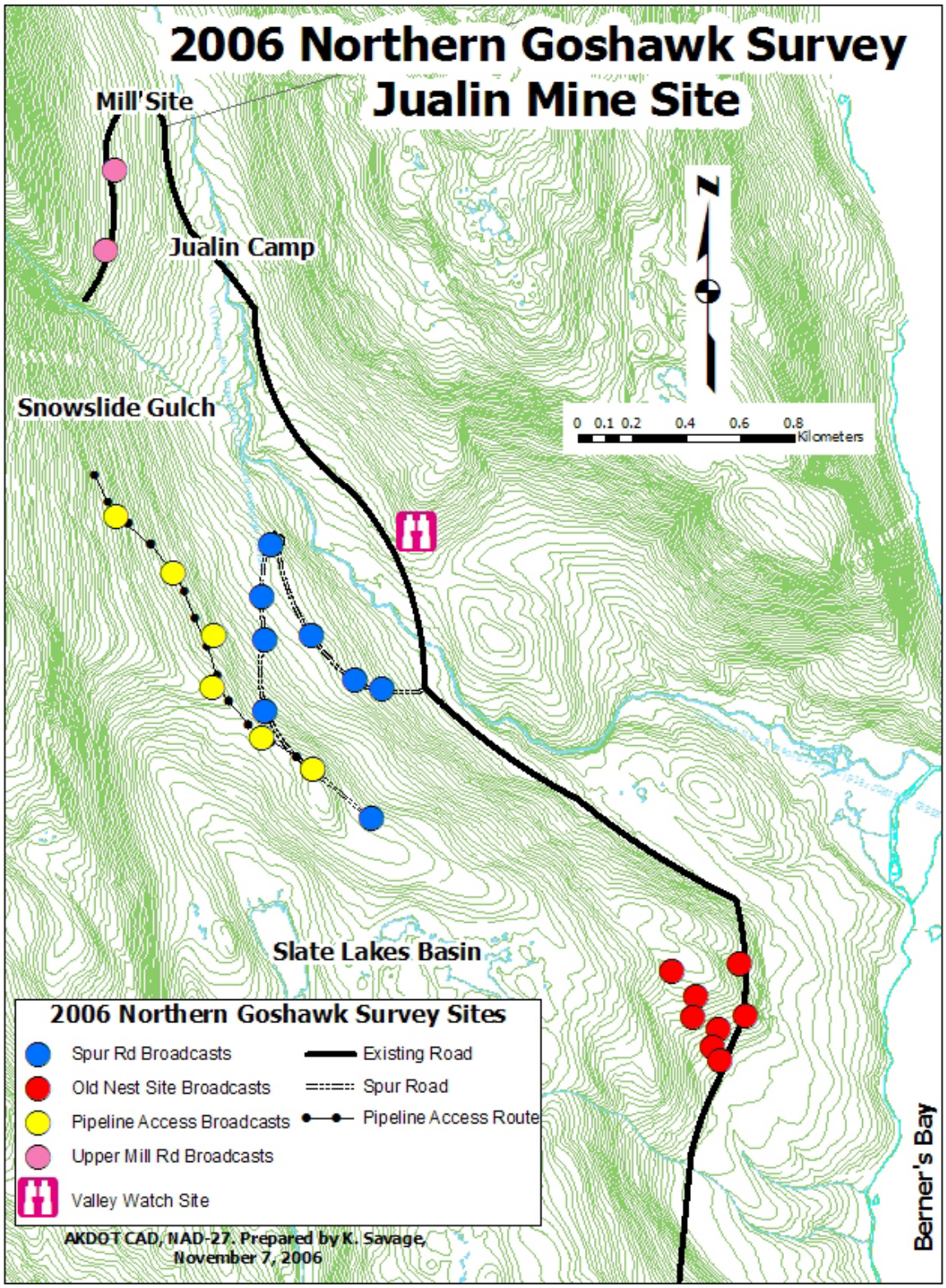


Figure 1. 2006 Northern Goshawk Survey Sites

Figure 2. Open meadow along pipeline access route.

Figure 3. Trees and understory surrounding 2000 nest site.

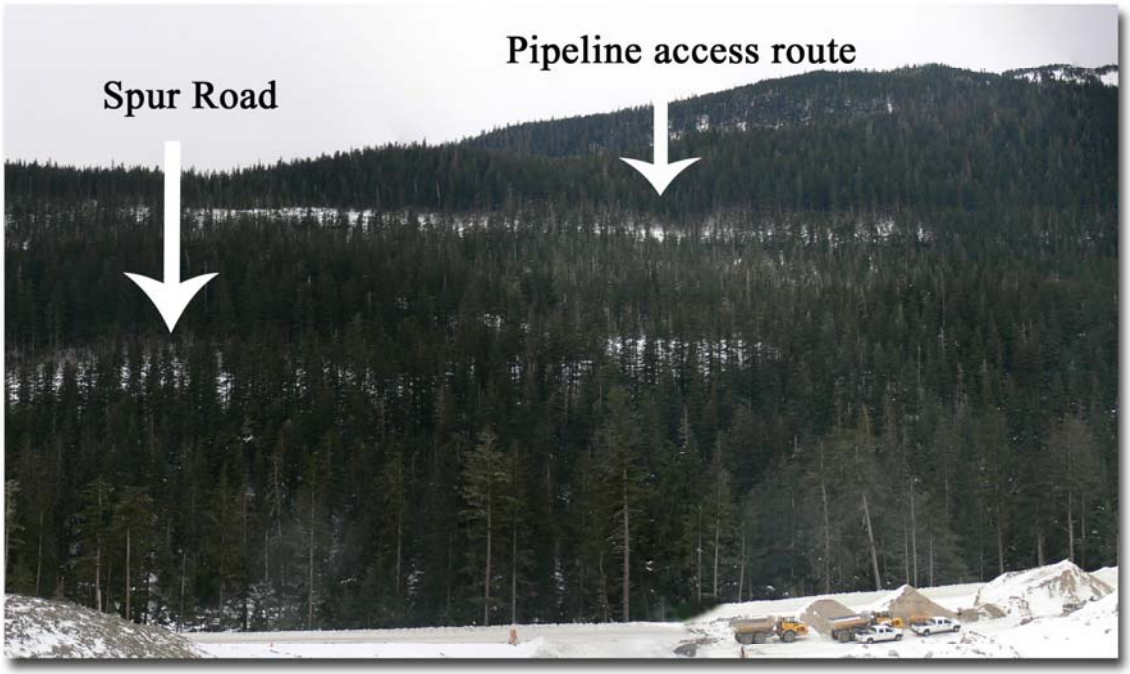


Figure 4. View of Spur Road and pipeline access route from valley watch position.

Attachment 4

Transportation Policy Audit Report - 2006

Transmitted via E-mail

February 9, 2007

Mr. Luke Russell
V.P. Environmental Services
Coeur Alaska, Inc.
3031 Clinton Drive, Suite 202
Juneau, AK 99801

Subject: Kensington Gold Project – Transportation Policy Audit Review
Audit Report

Dear Mr. Russell,

HDR is pleased to provide you with this Draft Audit Report for the Transportation Policy Audit Review for the Kensington Gold Project. This Draft Audit Report presents the initial findings of the audit and is provided for your review and comment.

Introduction

HDR was contracted by Coeur Alaska to perform a third-party review (the "audit") of the Transportation Policy for the Kensington Gold Project. The purpose of the audit is to ascertain the basis for the currently established monitoring programs. Specifically, the relationship between environmental risks and target monitoring indices will be evaluated to develop an understanding of the objectives and goals of the monitoring, enable an opinion on the appropriateness of the current monitoring, and evaluate the ability of the monitoring data to detect a change in the baseline environment potentially resulting from transportation operations.

Methodology

The audit was conducted by Bill Blaylock, HDR, during the week of November 27-30 in Juneau, Alaska. Material reviewed during the audit included existing plans and documents (described below). Interviews were conducted with Coeur Alaska staff, and staff with Alaska Department of Fish and Game (ADFG) Juneau, and National Oceanic and Atmospheric Administration (NOAA) staff from the Auke Bay Lab who were currently involved in ongoing monitoring associated with the Kensington Gold Project. Meeting minutes from interviews with ADFG and NOAA staff are attached to this draft report.

Background Information Review

The following documents were reviewed:

- Berners Bay Transportation Policy, Mitigation and Best Management Practices Plan
- NMFS Biological Opinion on the Kensington Gold Project
- Spill Response Plan (Slate Cove Dock Facility)
- Storm Water Pollution Prevention Plan
- Plan of Operations, and
- Federal and State Permits.

Interviews Conducted

Interviews were conducted with the following individuals:

Crellin Scott - Coeur Alaska
Randy MacGillivray – Coeur d'Alene Mines
David Harris – ADFG
Dave Barto – ADFG
Mark Pritchett – ADFG
Jeep Rice – NOAA
Adam Moles – NOAA
Larry Holland - NOAA

Initial Findings

Summary of Information Reviewed

- Berners Bay Transportation Policy, Mitigation and Best Management Practices Plan. This document describes Coeur Alaska's best management practices (BMPs) and monitoring commitments related to construction and operation of the marine facilities and subsequent worker/material marine transportation practices. The BMPs are intended to limit impacts during construction by identifying critical time periods for sensitive marine resources and avoiding in water work during those periods. Operational BMPs have the goal of limiting potential hydrocarbon pollution and avoiding congregations of marine mammal populations during transportation activities.

  This document includes a number of goals and associated standard operating procedures (SOPs). During the audit, each goal and its associated SOP were reviewed to determine whether they applied to baseline conditions, construction, or operation and what additional documents (such as permits or plans related to the project) contained reference to the goals.

- NMFS Biological Opinion on the Kensington Gold Project (March 18, 2005). The NMFS Biological Opinion (BO) found that the Plan of Operations for the project is not likely to jeopardize the continued existence of Steller sea lion or humpback whale populations in the wild or destroy or adversely modify designated critical habitat found in proximity to the project area. The BO concluded that the project may impact individual animals of these two species and identified 16 separate conservation recommendations to minimize any such adverse effects (NMFS BO Section 8.0).

- Spill Response Plan (Slate Cove Dock Facility). The Spill Response Plan covered construction and operation at the Slate Cove Dock Facility. It did not include coverage of the Cascade Point facility. This Cascade Point facility is to be privately constructed and operated by Goldbelt. Based on interviews with Coeur Alaska staff during this audit, it is understood that the intention of Coeur Alaska to include the requirement to develop a site specific Spill Response Plan for the Cascade Point facility as part of the contract terms between Coeur Alaska and Goldbelt.

- Storm Water Pollution Prevention Plan (SWPPP). The SWPPP covered construction and operation at the Slate Cove Dock Facility. It did not include coverage of the Cascade Point facility. This Cascade Point facility is to be privately constructed and operated by Goldbelt. Based on interviews with Coeur Alaska staff during this audit, it is understood that the intention of Coeur Alaska to include the requirement to develop a site specific SWPPP for the Cascade Point facility as part of the contract terms between Coeur Alaska and Goldbelt.

- Plan of Operations. The Plan of Operations was reviewed for information specific to the marine facilities and marine transportation policy. Specific areas of interest for the audit included methods or practices described in the Plan of Operations dealing with solid waste generation and disposal, sanitary wastes, fuel delivery and storage. Monitoring activities during construction and operation were reviewed in the areas of stormwater, marine resources, and spill prevention and response.

- Federal and State Permits. The US Army Corps of Engineers 404 permit and State of Alaska DNR Tidelands lease for Slate Creek Cove and Cascade Point were reviewed. Conditions within these permits, as well as all other permits received to date or pending, have been summarized by Coeur Alaska in a document entitled "Overview: Environmental Permits (April 13, 2006)". Based on interviews with Coeur Alaska staff, one purpose of the Overview: Environmental Permits is to provide a reference source to staff, contractors, vendors, and agency personnel for all the environmental compliance requirements of construction and operation of the project, including the marine facilities and associated transportation.

Summary of Persons Interviewed

Meetings were held with personnel from Alaska Department of Fish and Game and NOAA National Marine Fisheries Service and who are involved in several ongoing monitoring activities. A summary of the meeting minutes from those meetings is included as Attachment 1 (ADFG) and Attachment 2 (NOAA) to this Draft Report.

ADFG is currently conducting 3 types of monitoring associated with the Kensington project marine facilities and transportation: aerial herring spawning surveys, dive transects documenting herring biomass, and dive surveys of habitat types at Cascade Point. Aerial herring spawning surveys have been conducted in SE Alaska since 1972. Berners Bay has not been surveyed annually over this period, but past and current data indicate that the herring stock has contracted and relocated from Berners Bay to Point Bridget in recent years and that no spawning at Cascade Point has occurred over the last several years. Data compilation, interpretation, and reporting is carried out according to standardize ADFG practices for all

aerial spawning surveys in SE Alaska and reporting of the Berners Bay results would be a subset of the overall annual reports produced by ADFG.

The ADFG dive surveys to quantify herring biomass have been conducted in SE Alaska using consistent methods since 1976, Berners Bay dive surveys have completed for the last 3 years. Initial results for Berners Bay resulted in a spawning biomass estimate ranging from 300-700 tons. The threshold for a commercial fishery opening is 5,000 tons.

ADFG monitoring of herring habitat at the site of the proposed Cascade Point Breakwater was developed in 2005 with subsequent dive surveys conducted in 2005 and 2006. A draft report of existing conditions is recently completed and this baseline will be compared with future colonization. ADFG staff indicated that there are ongoing studies to better understand the distribution trends of herring spawning and the potential of an engineered breakwater to enhance or affect the potential for spawning habitat.

NOAA staff is currently conducting hydrocarbon monitoring. The monitoring objective is to determine and document baseline levels of PAHs prior to initiation of regular operations at the marine facilities followed by collection of samples at specified intervals during operation. Should increasing PAH signals be documented in the future, another consideration would be to delineate what concentrations of bioavailable PAHs would cause chronic exposure to what species. A plastic membrane device is used as a passive sampler; materials on the plastic membrane sequester the bioavailable PAH dissolved in the water column. Three years of baseline sampling have been completed to date (2004-2006) comprising 10 sites with 2 samples/site. Control sites outside Berners Bay are included in the sampling plan.

Assessment of the Efficacy of the Current and Future Monitoring

Both the aerial and dive herring surveys being conducted by ADFG are consistent with surveys carried out throughout SE Alaska by ADFG, with a period of record using similar methods of greater than 30 years. A change in herring spawning abundance and location in the Berners Bay region has been observed in past surveys. On-the-ground dive surveys in the vicinity of Point Bridget and Cascade Point indicate that there is not a shortage of suitable herring spawning habitat. The factor or factors leading to observed variability in herring spawning distribution are unknown. Nevertheless, the surveys being conducted provide a pre-construction baseline of data that can be used for comparison with post construction surveys as an indicator of general conditions in the area. This type of data, being highly variable, will be difficult to use for any cause-effect type of assessments. For example, further decline in distribution or abundance of herring spawning or biomass deposition in the Berners Bay region may or may not be directly linked to construction or operation of the marine facilities.

The ADFG dive surveys at Cascade Point are intended to document both (1) disturbance of benthic habitat from placement of material for breakwater/dock construction and (2) document increases in hard substrate habitat (breakwater material), its colonization by algae and potential suitability as herring spawning habitat. The methods employed will produce quantifiable results and appear to directly address the goal of this sampling. Based on the data reviewed during this audit, there appears to be adequate pre-construction baseline information upon which to base a comparison with post-construction surveys.

The PAH monitoring being conducted by NOAA is a cost-effective method to provide an indication of the presence of hydrocarbons in the vicinity of the marine facilities. For example, monitoring at Slate Creek Cove picked up a spike of hydrocarbon compounds in the water column in the vicinity of the dock construction that was linked to the presence of treated wood compounds. Upon removal of this material, the hydrocarbon concentrations decreased and were returning to levels typical of ambient as of the last data interpretation. This demonstrates the effectiveness of these in-situ monitoring methods versus grab sampling at discrete points in time.

Ability of the Current and Future Monitoring to Differentiate Potential Transportation-related Impacts from Natural Environmental Variability

In the absence of a major transportation accident, such as a major fuel spill in a known herring spawning area, it is likely that the aerial and dive herring surveys would not provide data that would differentiate transportation related impacts from natural environmental variability. Rather, as indicated above, they are valuable as indicators of general conditions in the project area in relation to overall herring presence throughout SE Alaska. For example, ADFG staff related during the audit interview that herring spawning has been absent from the Cascade Point area recently, while occurring in the past, and to their knowledge there has been no noticeable change in the quality or quantity of suitable herring spawning habitat.

The dive surveys to document existing subtidal habitat and monitor suitability of new habitat created during breakwater and dock construction at Cascade Point will quantify changes that are transportation related.

The PAH monitoring should be able to differentiate potential transportation related impacts from natural variability. It is somewhat unclear how the cause-effect relationship will be established in the absence of known events (such as an accidental spill) or how follow-up analysis would occur. It is recommended that these contingencies be discussed as an adaptive management strategy so that a process is identified to respond to such questions.

Recommendations for Adaptive Management Strategies to Guide Future Efforts

It is our recommendation that Coeur Alaska discuss adaptive management strategies as a regular discussion topic with the resource agencies, especially as this may relate to changes not linked to Coeur Alaska activities. This would include developing a framework to respond to environmental monitoring data that indicates a negative trend in environmental values. It would be desirable to identify a process to be used to determine the appropriate course of action to take in such an event. As an example, data from the PAH monitoring being conducted by NOAA may show a hydrocarbon concentration at some point in the future that is clearly outside documented background. There may be no direct link to any known incident however, such as an accidental fuel spill. What would be the process to determine if additional monitoring or sampling is required to further investigate such an occurrence? Our recommendation is to consider such events ahead of time and specify a process for follow-up resolution. Such factors as magnitude, frequency of occurrence (one-time vs. repeated), seasonality (presence of sensitive receptors) should all be considered.

It is also recommended that current and future monitoring be evaluated for data quality and usefulness in either providing baseline information for a better understanding of the marine resources under consideration or in the data's ability to document any environmental effects of construction and operation of the marine facilities. Based on our previous professional experience, marine biological and water quality data can be extremely variable. As adaptive management strategies are discussed and developed, the intended use of the data should be considered.

Conclusions and Recommendations

- Commitments to best management practices and marine resource monitoring related to the marine transportation policy that were described in the Plan of Operations, and identified as conditions in any number of environmental permits for the project have been carried forward by Coeur Alaska For construction of the Slate Creek Cove marine facilities.
- Similar commitments related to construction of the Cascade Point marine facilities have been made and are to be incorporated into the contract terms between Coeur Alaska and Goldbelt based on interviews with Coeur Alaska staff. It is recommended that Coeur Alaska provide documentation for future reference that this has occurred once the contracts are finalized.
- It is recommended that statistical analysis of monitoring data be a consideration in developing ongoing and future monitoring in order to ensure that the data being collected will provide the information desired, in a cost-effective manner. This process could be incorporated into any ongoing adaptive management discussions.
- It is recommended that Coeur Alaska implement a system of compiling and archiving documentation for BMP and monitoring commitments which would facilitate compliance reporting once the project begins operation. This would include such items as employee training logs, vessel captain observation reports, copies of design specifications and as-built drawings, agreements with consultants or vendors, and photo documentation of construction practices or procedures for significant construction events.
- It is recommended that Coeur Alaska consider working with the resource agencies to develop an adaptive management strategy that addresses the process to follow in the event of unforeseen events or monitoring data that point to a potential environmental problem without a clear link to project construction or operation.
- All entities or organization conducting monitoring for the project, public or private, should provide data reports in a timely manner so that adaptive management decisions, if needed, can be applied as soon as practicable.
- Coeur Alaska should consider incorporating field verification of BMPs into future audits in order to improve documentation of results.

Sincerely,

William M. Blaylock
Vice President

Attachments

Attachment 1 – Minutes from Meeting with ADFG

Meeting Minutes

for the

Kensington Gold Project
(ADFG) Berners Bay Monitoring Review

Date: November 27th, 2006 **Time:** 3:00 pm
Location: Coeur Alaska Offices - Mendenhall Mall

Scope: The intent of the meeting is focused on providing a third-party reviewer with the objectives and initial results of the Berners Bay herring monitoring program as initiated by ADFG staff.

Participants:

David Harris – ADFG
Dave Barto – ADFG
Mark Pritchett - ADFG
Crellin Scott – Coeur Alaska
Bill Blaylock – HDR
Randy MacGillivray – Coeur d'Alene Mines (by telephone)

Introductions:

Mark Pritchett: Dive surveys herring spawn deposition region wide surveys on post spawn. In the past (1982) included Berners Bay.

Dave Barto: Cascade point herring habitat May 2005, July 2006 baseline surveys completed. No spawning at Cascade Point in the past two years, Lynn Canal herring stocks declined, (Lynn Canal Herring stock spawns historically from Auke Bay to Berners Bay, no commercial fishery has occurred on this stock since 1982).

David Harris: Assistant Manager Commercial Fisheries – Berners Bay has not rebounded. Conducts aerial surveys with Kevin Monagle.

Bill Blaylock: Peer reviewer with HDR responsible for the Transportation Plan audit. History with Kensington Project baseline data collection for marine baseline studies focused on Comet Beach side. Also participated in site-specific criteria for Kensington. Experienced in monitoring plan development and review.

Crellin Scott: Environmental Manager with Coeur Alaska for the Kensington Gold Project.

Herring Aerial Monitoring Program Review:

1. *Development of the aerial program: objectives and goals*
    a. Initiated approximately in 1972.
    b. Stock has contracted/relocated from Berners Bay to Point Bridget in recent years.
    c. Not known why smaller spawning groups and/or relocation of spawning takes place.
    d. Anecdotal evidence at Craig and Tenakee of construction effects to spawning density.
    e. No spawning at Cascade Point over the last several years.
    f. Aerial survey monitoring to aid in establishing construction windows and aid in the identification of areas to dive for the determination of a negative or positive effect to spawning habitat with the construction of the Cascade Point Breakwater.
    g. Applicability of biomass data may not be applicable to the mitigation program was questioned.
    h. Reporting of Berners Bay results would be a subset of the overall annual reports produced by ADFG.

2. *Monitoring protocols*
    a. Identification of a spawn by aerial survey would result in a dive survey.
    b. Discussion of random transect requirements.
    c. Marine monitoring plan produced and discussed.
    d. Discussion of the monitoring plan as a component of the Transportation Plan.
    e. Aerial surveys are 'more' focused on Berners Bay with the funding from Coeur Alaska than they may otherwise be.
    f. Flights are once a week initially, schools of herring are seen on the beach.
    g. Once herring are observed, daily flights occur.

3. *Initial results*
    a. Results shown on maps.
    b. 1.4 nautical miles last year, 4 nautical miles shown this year.
    c. Spawning within Berners Bay, but not close to Cascade Point in recent years.
    d. The potential of a 6-7 year cycle was discussed.
    e. Herring spawning habitat is still present at Cascade Point.
    f. Reference to the Sitka breakwater USFW and ADFG studies which suggested that the breakwater extended spawning habitat.
    g. A review of the construction materials used in the Sitka breakwater could be beneficial for the construction at Cascade Point. ADFG to supply papers to Coeur Alaska.

4. *Anticipated or planned changes to the program*

a. No changes anticipated.
b. It was mentioned that the helicopter commuting may aid in identification of spawns within Berners Bay.

Lynn Canal Biomass Transect Studies:

5. *Development of the program: objectives and goals*
   a. No additional cost for conducting diving surveys
   b. Dive surveys have been conducted in SE Alaska using this methodology since 1976.
   c. Biomass dive surveys completed in Berners Bay (Lynn Canal stock) for the last 3 years. Data does exist.
   d. Biomass studies supplement the aerial survey data.

6. *Monitoring protocols*
   a. Established protocols exist and are adhered to.
   b. Transect squares are used for biomass estimates.
   c. Age-Weight-Length (AWL) data is collected as conditions allow. In 2006 severe weather prevented landing the float plane to collect samples. Also, resources are not sufficient to mobilize a research vessel for winter sampling; such samples have been collected in the recent past as opportunity presented itself. As of now, there is no guarantee that AWL samples will be collected in 2007.
   d. Age structure-classes data is obtained during the aerial surveys, herring are sampled from the float plane.
   e. Survival is not likely to be calculated for the Lynn Canal spawning stock in the immediate future. The modeling required to calculate survivability takes at least a 10 year (or longer) time series of spawn deposition; ADF&G only have the most recent three years of survey data to do this modeling.
7. Initial baseline results
   a. 4-5 hundreds of tons are estimated (ranges from 300-700 tons/spawning biomass) and is considered a small weight for a stock.
   b. 5,000 ton threshold is needed for a fishery.

8. Anticipated or planned changes to the program
   a. No anticipated changes
   b. ADFG would like Coeur to clarify data needs from the work that is being completed, ADFG would like Coeur to clarify data needs from the work that is being completed, e.g., annual reports, final reports, content requirements.

Cascade Point Herring Habitat Breakwater Monitoring Program:

9. *Development of the program: objectives and goals*
   a. Early April 2005 – Project Plan exists.

b. Comments on the plan were requested from DNR, NMFS and USFWS. Comments received from USFWS and incorporated
c. Transect developed inside and outside of the planned footprint for the breakwater to compare pre-construction vs. post construction habitat potential.
d. Construction schedule for the breakwater has not been finalized.

10. Monitoring protocols

a. 5 transects in 2005 with photographs taken.
b. 4 transects completed in 2006 focusing on areas between the 2005 survey.
c. Survey transects were run from shore to a depth of 45 feet, therefore the length of the transects varies.
d. Presence and absence of vegetation noted.
e. Video documentation was completed on one of the transects.

11. Initial baseline results

a. A draft of the pre-construction survey results has been completed.
b. Figures 1, through 6 were reviewed.
c. Color coding on photos represents vegetation and substrate types
d. The extent of each habitat/vegetation type will be completed.
e. This baseline will be compared against future colonization.

12. Anticipated or planned changes to the program

a. Potential to combine older Lynn Canal herring dive survey habitat data into a GIS compilation.
b. More transects would be beneficial to increase the density of the study.
c. Potential funding may be available at ADNR.

Use of the data

It was discussed that these are ongoing studies to better understand the distribution trends of herring spawning and the potential of an engineered breakwater to enhance or affect the potential for spawning habitat.

It was also discussed that these reports will need to be presented to the Berners Bay working group in February 2007.

Draft reports were shared with Coeur Alaska for the audit.

Meeting ended at 5:00 pm

Attachment 2 – Minutes from Meeting with NOAA

Meeting Minutes

for the

Kensington Gold Project
(NOAA) Berners Bay Monitoring Review

Date: November 28th, 2006 **Time:** 2:30 p.m.
Location: Coeur Alaska Offices 3031 Clinton Drive, Suite 202

Scope: The intent of the meeting is focused on providing a third-party reviewer with the objectives and initial results of the Berners Bay hydrocarbon monitoring programs as initiated by NOAA staff.

Introductions

Jeep Rice – NOAA with Auke Bay Lab

Adam Moles – NOAA with Auke Bay Lab

Larry Holland – Auke Bay Lab Chemist with NOAA

Crellin Scott – Environmental Manager of the Kensington Gold Project for Coeur Alaska

Bill Blaylock – Independent auditor with a background in the development of biological monitoring programs, including past experience with the Kensington Gold Project. Bill is a biologist and employed as the Manager of the Environmental Division with HDR.

Randy MacGillivray (on telephone) – Coeur d'Alene Mines

Hydrocarbon Monitoring Program

1. **Development of the program: objectives and goals**
    d. Currently in the baseline data collection mode
    e. The objective of the program is to determine and document baseline levels of PAHs vs. levels monitored in several year intervals following the baseline studies.
    f. Another consideration, if increasing PAH signals are documented in the future, would be to delineate what concentrations of bioavailable PAHs would cause chronic exposure to what species.

2. **Monitoring protocols**
    g. Passive polyethylene membrane device sampler used.

h. Caution should be used when using plastic membrane values to 'back-calculate' hydrocarbon concentration in the water – no absolute factor.
i. No lipid used in the ABL adaptation of the membrane device.
j. Three years of baseline sampling so far.
k. 10 sites with 2 devices at each site per year (2004, 2005, 2006) plus field and lab blanks.
l. 4 water, 4 sediment and 4 tissue sites were also collected in 2004 & 2005, 5 sediment, 5 tissue and 4 water during the 2006 sampling year.
m. Plastic membrane sampling in spring and summer, sediment, tissue and water spring or summer only.
n. Control sites were used outside of the Bay.
o. Sites are placed at approximately +1.8 meter tideline (about mid-tide).
p. Tissue sampling of mussels adjacent to the membrane sampling sites.
q. Special precautions and techniques needed for sample collection to avoid false positive results.
r. Potential contamination from the boat used as transportation from site to site is controlled for by identifying a "clean" individual for all sample handling (i.e. no contact with fuel, motors, etc.) and field blanks.
s. Samplers are deployed in the spring & summer (typically April 10th – May 10th and July 10th - August 10th).
t. PAHs are the focus of the monitoring, organochlorines, other organic pollutants and inorganics are outside the analytical capability or focus of this study.
u. Gas chromatography/mass spectrometry (GC/MS) is the analytical method used to determine the PAH concentrations.
v. Sampling occurs in other sites i.e. Auke Lake, Prince William Sound
w. These devices are sequestering the bio-available PAH dissolved in the water column.

3. Initial results

x. 2004 results were all near or below detection limits
y. The first observation for this study that clearly shows an elevated TPAH signal was in the 2005 July sampling period and corresponds to the installation of the floating dock at the mine road terminus. Installation was after the April sampling period and before the July samples were deployed.
z. No indication of PAH in mussels, sediment, or water at Slate Creek Cove in 2005
aa. Characterization of the creosote signature was completed by sampling material from a creosote pole.
bb. Once the creosote dock was replaced with a steel dock the measurements returned to slightly elevated levels.
cc. Report for 2005 is in the final draft stage.

4. Anticipated schedule or planned changes to the program

dd. In 2006 additional plastic membranes were deployed at the head of Slate Creek Cove due to the signal observed in 2005.

ee. The potential for a sampling point submerged and tethered to the dock in Slate Creek Cove may mitigate against false positives from airborne particulate emanating from the generator located on shore near the dock.

ff. The need for official (NOAA) signatures to the MOU is reported to be an outstanding item and is affecting the transfer of funding and data.

gg. The potential for notification of anomalous results may allow Coeur Alaska to review practices immediately.

hh. The sampling schedule is not completely set, but it is felt that a few more years going into the production phase and then sample once ever few years or so. A review of the best sampling schedule going forward is warranted.

ii. A consideration of the potential for effects from the road project should be considered.

Meeting ended at approximately 4:00 pm

Attachment 5

Upper Slate Lake Dolly Varden Survey – 2006

TSF Ecological Monitoring: Upper Slate Dolly Varden 2006

Introduction

This report summarizes monitoring conducted in accordance with the Ecological Monitoring Plan for the TSF during 2006 concerning Dolly Varden migration in Mid-Lake Slate Creek and Dolly Varden spawner surveys at Upper Slate Lake.

Dolly Varden Migration

The Ecological Monitoring Plan for the TSF states that "*Dolly Varden in Mid-Lake Slate Creek will be captured and released below the TSF dam from the beginning of construction of the TSF until confirmation that suitable conditions for Dolly Varden are present in the TSF. These Dolly Varden will be measured for length, weighed, searched for abnormalities, and scanned for tags from baseline studies. By relocating migrants, subtleties of timing and life stage relating to downstream movement will be preserved. The information that will be gained on numbers, seasonality, and sizes of Dolly Varden migrants will be directly applicable to the final plan for reintroduction of Dolly Varden to the TSF.*"

Methods

During the summer of 2006, preparation of the TSF involved diversion of part of Mid-Lake Slate Creek, around Lower Slate Lake to the creek below (Figure 1). On August 23, 2006, five minnow traps, baited with disinfected salmon eggs were set in the remaining section of Mid-Lake Slate Creek for 30 minutes. Fish captured were anesthetized with a solution of MS222 (Tricane-methane Sulphonate), measured to the nearest 1mm and weighed to the nearest 0.1g. Fish were examined for any abnormalities and tags from baseline studies. After being allowed to recover from the anestitic, fish were released downstream of the TSF. Five traps were set in the same location on August 31, 2006. After measurement, these fish were released at their trap site near Upper Slate Lake.

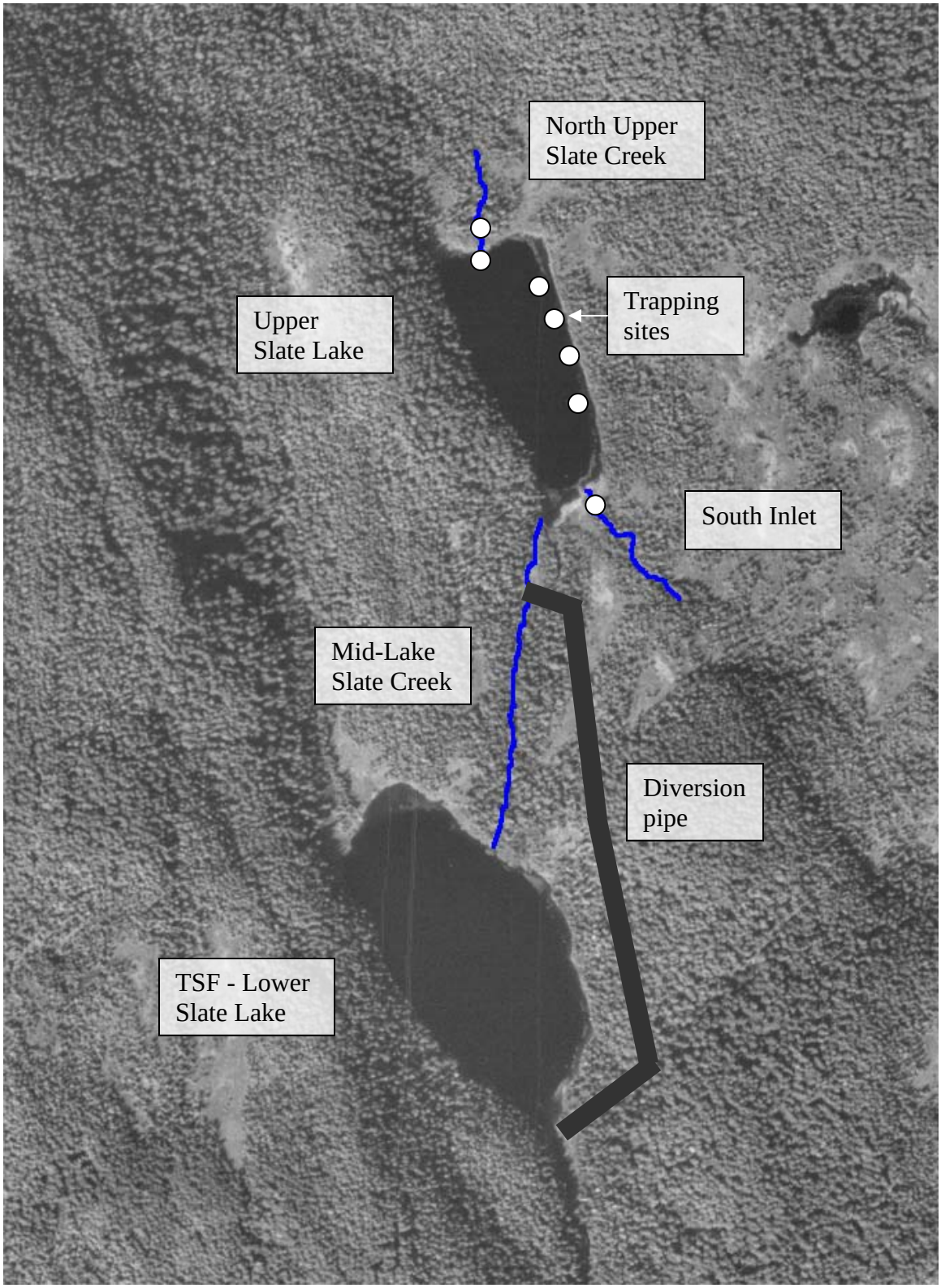
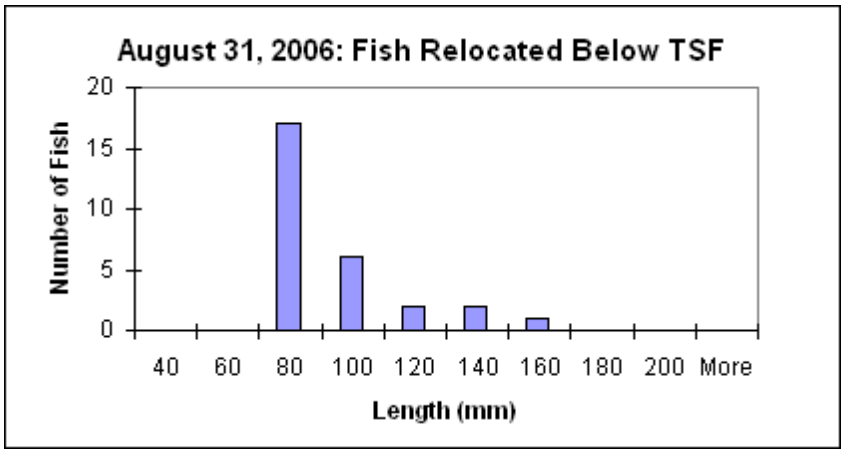


Figure 1: Upper Slate Aerial View. Mid-Lake Slate Creek is now diverted around the TSF through a pipe. Trapping sites for spawner surveys are shown by white circles.



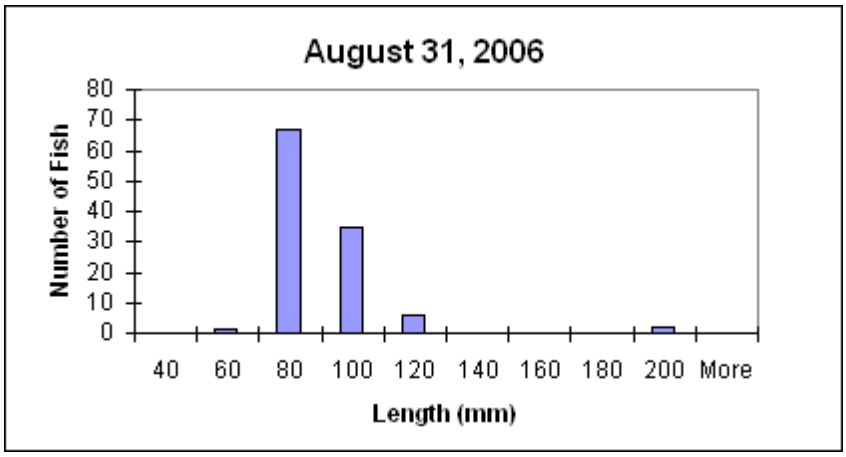


Figure 2: Length-Frequency Histograms of fish captured in Mid-Lake Slate Creek in August 2006.

Results

The size distribution of captured fish is shown in Figure 2. Lengths and weights are given in Appendix 1. 28 fish were captured on August 23 and relocated to Slate Creek downstream from the proposed TSF. 111 fish were captured on August 31 and returned to the location of capture. It seems unlikely that very large numbers of Dolly Varden migrate from Upper Slate Lake to lower Slate Creek annually, therefore only a total of 28 fish were relocated. The second trap survey provided data on sizes of fish available for final reclamation.

Dolly Varden Spawner Surveys

Potential Dolly Varden spawning habitat occurs in North Upper Slate Creek and along the eastern shore of Upper Slate Lake (Figure 1). Spawner surveys were conducted during October and November 2006 to gain an understanding of the variability in recruitment of Dolly Varden to the Slate Creek basin from the Upper Slate area in accordance with the Ecological Monitoring Plan for the TSF. The plan states that surveys will be conducted from July through September, however, Dolly Varden in South-East Alaska are known to spawn in late Fall (Armstrong 1965, Armstrong & Morrow 1980, Blackett 1973, Heiser 1966) therefore surveys were adapted accordingly.

Methods

The eastern shore of Upper Slate Lake and North Upper Slate Creek, were examined for redds on October 4, 2006. Dark-colored tannins in the water prevented observation of the lake and streambed. Future surveys were therefore conducted by setting minnow traps near likely spawning areas, namely gravel beds at the mouth of small streams running into the east shore of Upper Slate Lake and the North Inlet Creek (Figurse 1, 2). Some minnow traps were modified to have larger entrance holes to allow larger fish (which are more likely to be spawning) to enter the traps. Traps were set on October, 11 and 20 and 25 and November 9, and left to soak overnight. Captured fish were removed and measured and note made of any spawning coloration or milt production (Figures 4, 5). The surveys ceased after November 9 owing to the diminishing number of spawners found and ice and snow cover on the lake (Figure 6).

Results

The size distribution of fish captured is shown in Figure 7. Lengths and weights of fish are presented in Appendix 2. The size range for spawning fish and the percentage of fish captured with spawning colors changed over the course of the surveys. On October 12 only 11% of fish captured showed signs of spawning despite a wide range of sizes being captured (Table 1) and the smallest fish with spawning colors was 207 mm, 58.2g. In mid to late October, up to 38% of fish had signs of spawning and the smallest fish with spawning color was 135mm, 39.5g. By November, only a few of the largest fish (240-250 and 91.5-116g) showed signs of spawning. Fish showed signs of milt only on the first 2 surveys (October 12 and 20).

Figure 3: North end of Upper Slate Lake.

Figure 4: Mature Dolly Varden showing red spots around spawning time.

Figure 5: Dolly Varden with spawning coloration.

Figure 6: In November, holes had to be cut through 5 inches of ice to set traps.

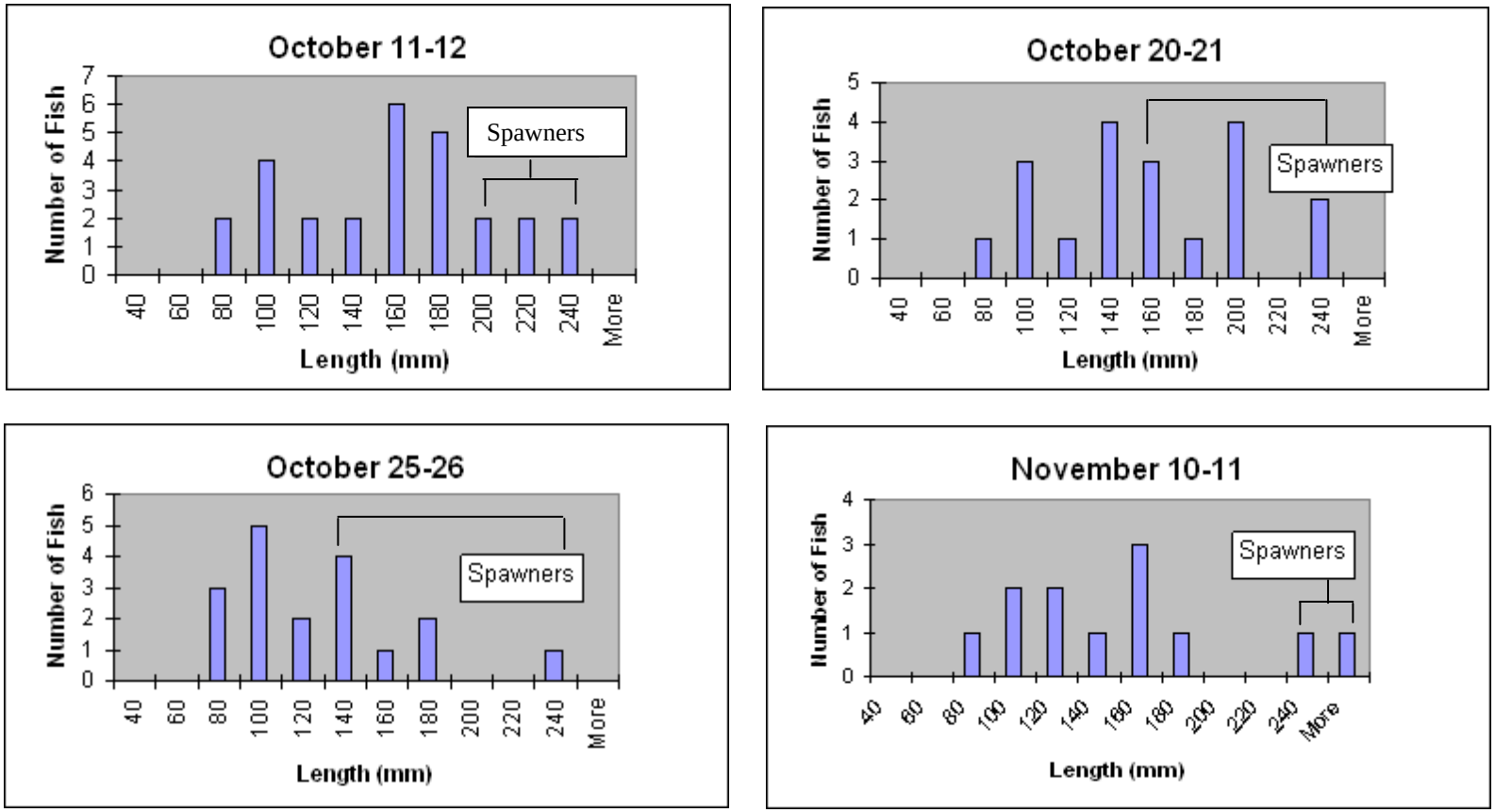


Figure 7: Length-Frequency Histograms of fish captured during spawning surveys. The size range of fish with spawning Colors was greatest in mid to late October.

Table 1: Percentage of catch with spawning sign.

Date	% spawners
12-Oct	11.1
21-Oct	31.6
26-Oct	38.5
10-Nov	16.7

References:

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Heiser, D.W. 1966. Age and Growth of Anadromous Dolly Vardn Char Salvelinus malma in Eva Creek, Baranof Island, Southeastern Alaska. Research Report No. 5. ADFG, Juneau, Alaska.29pp.

Appendix 1: Dollys Captured in Mid-Lake Slate Creek, August 23, 2006.

	Length (mm)	Weight (g)
1	145	24.5
2	108	10.2
3	125	16.2
4	82	4.5
5	79	4.1
6	78	3.6
7	122	16.5
8	80	4.5
9	75	3.6
10	80	4.5
11	90	6.3
12	78	3.8
13	65	1.9
14	69	3
15	80	4.1
16	74	3.2
17	97	7.5
18	76	3.9
19	92	5.7
20	82	5.3
21	80	4.4
22	105	8.7
23	90	5.6
24	66	2.3
25	78	4.2
26	80	3.9
27	65	2.1
28	63	1.5

Appendix 1 cont: Dollys Captured in Mid-Lake Slate Creek, August 31, 2006.

	Length (mm)	Weight (g)		Length (mm)	Weight (g)
1	80	4.1	56	66	2.4
2	71	3	57	78	3.7
3	87	5	58	71	3.3
4	80	4.4	59	118	14.3
5	90	5.9	60	84	5.3
6	73	3.4	61	86	5.7
7	95	6.5	62	71	2.9
8	86	5.5	63	82	4.6
9	87	5.5	64	79	4.2
10	77	3.9	65	75	3.8
11	83	4.8	66	80	4
12	80	4.3	67	67	2.8
13	67	2.5	68	77	4
14	83	4.9	69	82	4.7
15	89	5.7	70	88	5.5
16	99	9.1	71	65	2.5
17	97	6.7	72	78	4.5
18	91	5.9	73	78	3.6
19	73	3.4	74	77	4.3
20	198	78.2	75	81	5.1
21	79	4.1	76	96	7.5
22	78	3.8	77	110	13
23	79	4	78	105	10.2
24	70	2.8	79	90	6.1
25	79	4.1	80	69	3.1
26	80	4.3	81	91	6.8
27	79	4	82	92	7.9
28	71	3.3	83	60	1.9
29	75	3.6	84	74	3.9
30	80	4.3	85	85	5.8
31	188	53.7	86	71	3
32	76	3.9	87	87	6.2
33	80	4.7	88	83	5.4
34	76	4	89	63	2.2
35	69	2.8	90	95	7.6
36	78	4	91	80	4.3
37	80	4	92	69	2.9
38	87	6.2	93	107	11.3
39	80	4.6	94	64	2.2
40	70	3.1	95	76	3.9
41	75	3.1	96	81	4.2
42	78	4	97	107	11
43	64	2.2	98	65	2.5
44	67	2.3	99	84	5.1
45	77	3.9	100	67	2.6
46	83	4.8	101	75	3.5
47	79	4.3	102	78	3.9
48	74	3.6	103	86	5.3
49	97	7.2	104	74	3.7
50	74	3.1	105	92	7.3
51	75	3.6	106	115	13.6
52	83	4.6	107	77	4.3
53	81	3.7	108	86	6.1
54	67	2.6	109	77	3.7
55	70	3	110	71	3.2
56			111	74	3.6

Appendix 2: Lengths, Weights and Spawning Sign of Fish Captured During Spawner Surveys 2006.

10/11/07

Length	Weight	Spawning sign
158	27.2	
195	49.1	
162	34.3	
183	44.2	
213	69.9	
82	4.5	
238	86.5	orange belly, milty
207	58.2	orange spots, milty
99	6.5	
118	12.4	
162	32.9	
124	14	
101	8.4	
75	3.2	
142	24	
149	25.2	
172	37.8	
150	27.5	
122	16.3	
149	25.9	
159	28.6	
161	29.1	
163	30.6	
93	8.4	
81	4.8	
79	5.5	
230	89.9	orange spots, milty

Appendix 2 cont.

10/20/06

Length	Weight	Spawning sign
77	3.4	
123	15.4	
160	27.9	
181	42.7	orange spots
230	77.7	orange spots, eggs visible
91	6.2	
125	14.1	
129	15.9	
143	22.2	
140	20.9	
86	5.4	
120	13.4	
199	53.5	orange spots, no milt or eggs sign
222	72.5	
192	48.2	orange spots, no milt
194	46.5	
82	5.7	
171	44.2	orange spots
154	29.4	milty, not much color

10/25/06

Length	Weight	Spawning Sign
168	41.5	orange, eggs showing
86	5.4	
111	12.2	
125	13.9	
95	6.7	
90	6.1	
109	9.4	
133	18	
136	17.5	
162	28.3	orange spots, no milt
158	31.5	orange spots, no milt
225	94.3	red spots, orange belly
135	39.5	red spots, no milt
84	4.8	
79	4.8	
86	5.4	
78	3.8	
78	4.3	

Appendix 2 cont.

11/10/06

Length	Weight	Spawning Sign
100	7	
89	5.3	
101	8	
142	22.1	
145	21.9	
80	5.1	
240	91.5	orange/red spots
163	29.9	
118	11.7	
124	14.1	
250	116	orange/red spots
154	25.8	

Attachment 6

Berners Bay Herring Research – 2005-2006

Regional Information Report No. #RYY-XX

Berners Bay Herring Research

2005 and 2006 Research Report

by

Marc Pritchett

Sherri Dressel

and

Kevin Monagle

February 2007

Alaska Department of Fish and Game **Division of Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, Special Publications and the Division of Commercial Fisheries Regional Reports. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$log_{2,}$ etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

REGIONAL INFORMANTION REPORT NO. #RYY-XX

BERNERS BAY HERRING RESEARCH

2005 AND 2006 RESEARCH REPORT

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Division of Commercial Fisheries
Publishing Office Address

February 2007

This investigation was partially financed by Coeur Alaska.

The Regional Information Report Series was established in 1987 and was redefined in 2006 to meet the Division of Commercial Fisheries regional need for publishing and archiving information such as project operational plans, area management plans, budgetary information, staff comments and opinions to Board of Fisheries proposals, interim or preliminary data and grant agency reports, special meeting or minor workshop results and other regional information not generally reported elsewhere. Reports in this series may contain raw data and preliminary results. Reports in this series receive varying degrees of regional, biometric and editorial review; information in this series may be subsequently finalized and published in a different department reporting series or in the formal literature. Please contact the author or the Division of Commercial Fisheries if in doubt of the level of review or preliminary nature of the data reported. Regional Information Reports are available through the Alaska State Library and on the Internet at: http://www.sf.adfg.ak.us/statewide/divreprots/htlm/intersearch.cfm.

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This document should be cited as:
Pritchett, M., S. Dressel, K. Monagle . 2007. Berners Bay Herring Research, 2005 and 2006 Research Report. Alaska Department of Fish and Game, Regional Report Series No. #RYY-XX, Douglas Alaska.

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ABSTRACT

Lynn Canal aerial and skiff surveys were used to document herring spawn locations in 2005 and 2006. Spawn deposition dive surveys were used to estimate spawning biomass. Results of these surveys indicate the Lynn Canal herring spawning population remains below threshold. As a result, Lynn Canal herring were not opened to commercial harvest in 2005 or 2006 and will not be opened in 2007. The 2005 and 2006 herring spawn occurred mostly outside of Berners Bay, unlike the 1999-2004 spawn that occurred along the eastern shore of Berners Bay.

Key words: Lynn Canal, Berners Bay, herring, Southeast Alaska, stock assessment

INTRODUCTION

Prior to 1983 the Lynn Canal herring stock was one of the larger stocks in Southeast Alaska supporting several commercial fisheries including a sac roe fishery, bait pound fishery, and a winter food and bait fishery. This stock declined in 1982 and has remained at low levels. The reason for the decline is not clear, however potential contributing factors include: over fishing, habitat degradation or disturbance in Auke Bay, water pollution, geographic shifting of spawning aggregations, and population growth of major predators such as sea lions. If the long-term decline was solely the result of over fishing, it is expected that this stock should have recovered during the 20-year period since commercial exploitation has ceased. In other areas in Southeast Alaska, such as Hoonah Sound, herring stocks have grown from low levels to relatively high levels over a span of a few years.

The established spawning biomass threshold level for this stock is 5,000 tons. This means that before a herring fishery may be considered for the Lynn Canal spawning stock, a forecast of spawning biomass must meet or exceed 5,000 tons. Based on shoreline miles of spawn, it is estimated that the stock biomass has varied between 100 and 2,500 tons over the last 20 years. No commercial harvest has occurred in the Juneau area since the 1981-82 season.

From 1953 to 1981 Lynn Canal herring spawned from Auke Bay to Point Sherman including Berners Bay and Cascade Point. The documented spawn for the Lynn Canal herring stock during this period ranged from 6 to 28 nmi, averaging approximately 12 nmi. While significant spawning occurred in the vicinity of Auke Bay prior to 1981, there has been very limited spawning in Auke Bay in recent years. Recently, spawning activity for the entire Lynn Canal herring stock is centered between Bridget Cove and the east shoreline of Berners Bay. Since 1982 the documented spawn has ranged from 0.5 to 9 nautical miles, averaging only 3.7 nautical miles. ADF&G records since 1971 document herring spawn between Echo Cove and the Berners Bay flats in most years, with few exceptions. The consistent herring spawn along this shoreline for the last 20 years is indicative of its importance to this stock. Pacific herring have been documented to spawn at Cascade Point as early as April 18 and as late as May 24.

Because Cascade Point and adjacent areas of Berners Bay are within primary spawning grounds for the depressed Lynn Canal herring stock, development of a marine facility here could have an impact on this herring resource. Increased disturbance from vessel traffic, transient lighting, increased turbidity and sedimentation, and increased petroleum hydrocarbons in the water from

oil or gas spills are all concerns. Additionally, because herring spawn on inter tidal and sub tidal kelp, the project may directly affect spawning success if it reduces kelp abundance or variety.

The Alaska Department of Fish and game conducts aerial, skiff, and scuba dive surveys to monitor the Lynn Canal spawning stock. Aerial and skiff surveys have been conduced since 1970 to identify the dates and extent (miles of spawn along shoreline) of herring spawn. A 2004 dive survey provided the first estimate of spawning biomass escapement by the department for the Lynn Canal area since a 1984 dive survey and a 1992 hydroacoustic estimate. Using dive surveys, the department estimates the total number of herring eggs in the Lynn Canal spawning grounds and converts this to an estimate of spawning population biomass through use of a fecundity relationship and weight-at-age data. Monitoring of the Lynn Canal spawning stock through aerial, skiff, and spawn deposition scuba dive surveys continued in 2005 and 2006 as reported here.

MATERIALS AND METHODS

A series of aerial and skiff surveys are used to record spawning activities during the spring spawning period to document spawn timing and estimate the nautical miles of beach that received herring spawn. During the spring of 2005, all aerial surveys were flown in a Piper PA-18 Supercub aircraft on floats with a department contracted pilot. In 2005 there were 14 aerial surveys and one skiff survey conducted for the Lynn Canal area between April 22 and May 27 (Appendix A). During the spring of 2006, all aerial surveys were flown in a Cubcrafters CC-18 supercub aircraft on floats with a department contracted pilot. In 2006 there were 13 aerial surveys conducted for the Lynn Canal area between April 11 and May 16 (Appendix B).

As in 2004, scuba dive surveys were used in 2005 and 2006 to estimate the total number of herring eggs in the Lynn Canal spawning grounds. Scuba dive line transect surveys were used to estimate egg densities along shoreline segments identified with herring spawn from aerial and skiff surveys. Two-person SCUBA teams swam along line transects and recorded visual estimates of the number of eggs within a 0.10 m^2 sampling quadrat placed on the bottom at 5 m intervals along the transects. Depth, substrate, and vegetation type were recorded along with the visual estimate of egg abundance at each 5 m interval. Because the quadrats (i.e. samples) were spaced equidistant along transects, the record of the number of quadrats along a transect was also used to compute transect length.

Starting points for dive transects were located randomly along the shore in areas where aerial or skiff surveys indicated probable spawn deposition. Transects were oriented perpendicular to the shoreline. Transects extended from intertidal to either a maximum of 15 m (50 fsw) of depth or until no further egg deposition was observed. Transects extended above the waterline as far as egg deposition occurred. Dives were limited to 15 m because deeper dives severely limit total bottom time for SCUBA divers and pose safety risks when conducted repetitively over several days. Normally, little if any herring egg deposition occurs deeper than 15 m.

Since visual estimates rather than actual counts of eggs within the sampling quadrat are recorded, measurement error occurs. To minimize the influence of measurement error on final estimates of total egg deposition, diver-specific correction coefficients are used to adjust estimates of egg density. Correction coefficients are calculated by visually estimating the number of eggs within a sampling quadrat and then collecting all of the eggs within the quadrat for later enumeration. To collect the eggs, divers either remove them from the substrate (e.g. rock) or collect the vegetation (e.g., kelp) for later removal of the eggs. Correction samples were collected from several southeast Alaska spawning areas in 2005 and 2006 but not from Lynn Canal. Collected samples were combined and used to adjust all southeast Alaskan herring stock estimates, including Lynn Canal. Detailed procedures for determining egg densities from collected samples are discussed in the 1993 Annual Report, RIR IJ93-19.

Total egg deposition for a Lynn Canal (t) is estimated as:

$$t = a\,\overline{d} \tag{1}$$

where a is the estimated total area (m^2) on which eggs have been deposited and $\overline{d}$ is the estimated mean density of eggs (eggs/m^2). The total area on which eggs have been deposited (a) is estimated as:

$$a = l\overline{w} \tag{2}$$

where l is the total meters of shoreline receiving spawn (determined from aerial and skiff surveys) and $\overline{w}$ is the mean length of transects in meters. The mean density of eggs/m^2 ($\overline{d}$) is estimated as:

$$\overline{d} = 10 \cdot \left[\frac{\sum_h \sum_j \sum_k v_{hjk}\, c_{hk}}{\sum_h m_h} \right] \tag{3}$$

where v_{hj} is the visual estimate of egg numbers by diver h, quadrat j, on kelp type k. The c_{hk} term refers to a diver-specific, kelp-specific correction factor to adjust visual estimates made by diver h on kelp type k, and m_h is the number of quadrats visually estimated by diver h. Divers visually estimate egg density within 0.1 m^2 quadrats. Multiplying by 10 expands the mean density from a 0.1 m^2 to a 1.0 m^2 unit basis. Diver-specific, kelp-specific correction factors (c_{hk}) are estimated as:

$$c_k = \frac{\bar{r}_{hk}}{\bar{v}_{hk}} \tag{4}$$

where $\bar{v}_{hk}$ is the mean visual estimate of egg numbers for diver *h* on kelp type *k* and $\bar{r}_{hk}$ is the mean laboratory count of egg samples collected from quadrats visually estimated by diver *h* on kelp type *k*.

The total number of eggs per spawning area is a key element used in estimating herring spawning biomass. The Lynn Canal estimate of spawning biomass (tons) is calculated using the total number of eggs estimated in the Lynn Canal spawning grounds, weight-at-age from Lynn Canal age, weight and length (AWL) sampling, and a linear weight-to-fecundity relationship estimated with 1996 data from fecundity sampling in Seymour Canal. The weight-to-fecundity relationship was estimated as:

$$f(g) = -1573.3 + 222.4 \cdot g \tag{5}$$

where *f(g)* is the fecundity (total number of eggs deposited) of a fish of weight *g*. The total biomass (b) was estimated for Lynn Canal as:

$$b = \frac{\left[\dfrac{\left(\dfrac{t}{L}\right) * 2}{f(\bar{w})}\right] \cdot \bar{w}}{907180} \tag{6}$$

where *t* is the total egg deposition for Lynn Canal, $\bar{w}$ is the mean weight of all Lynn Canal AWL samples, *L* is the egg loss correction factor (0.9) that accounts for an estimated 10% egg mortality between the time eggs are deposited and spawn deposition surveys are conducted, and $f(\bar{w})$ is the fecundity of a fish of weight $\bar{w}$.

RESULTS AND DISCUSSION

Aerial surveys documented a total of 1.4 nmi of spawn in Berners Bay in 2005 (Figure 1, Appendix A). Aerial surveys documented a total of 3.9 nmi of spawn in Berners Bay in 2006 (Figure 2, Appendix B). In Berners Bay all 2006 spawning was documented west of Cowee Creek. In Lynn Canal no 2006 spawn was observed south of Bridget Cove. Figure 3 documents herring spawn recorded in the Berners Bay area from 1999 through 2004 where the majority of the spawning occurred on the eastern shore of Berners Bay. In 2005 and 2006 no spawn was

documented along the eastern Berners Bay shore but was observed along the Point Bridget shoreline and in Lynn Canal.

The 2004, 2005, and 2006 dive surveys were the first spawning biomass escapement estimates completed by the department in the Lynn Canal area since a 1984 dive survey and a 1992 hydroacoustic estimate. Estimates in years without dive or hydroacoustic surveys have been approximated based on observed nautical miles of shoreline and average historical biomass per linear nautical mile. In 2005, the spawn deposition survey was conducted on May 18 with the completion of seven[1] randomly selected transects. The average transect length was 54 meters with an average density of 190,692 eggs per square meter. The estimated 2005 spawning biomass was 318 tons (Table 1). In 2006, the spawn deposition dive survey was conducted on May 26 with the completion of eight randomly placed transects. The average transect length was 58 m with an average density of 141,408 eggs per square meter. The estimated 2006 spawning biomass was 712 tons (Table 1). The 2006 spawning biomass estimate was similar to the 719 ton herring spawning escapement estimate for 2004.

The Lynn Canal spawning stock is currently below the 5,000 ton threshold and will likely remain closed to commercial harvest in the foreseeable future. In the future, and as resources permit, the department intends to document herring spawning locations in the Juneau area with aerial and skiff surveys and to conduct dive assessment surveys in Lynn Canal and Berners Bay.

[1] A total of eight transects were placed but transect #3 was not surveyed due to increasing weather conditions and concerns for diver safety.

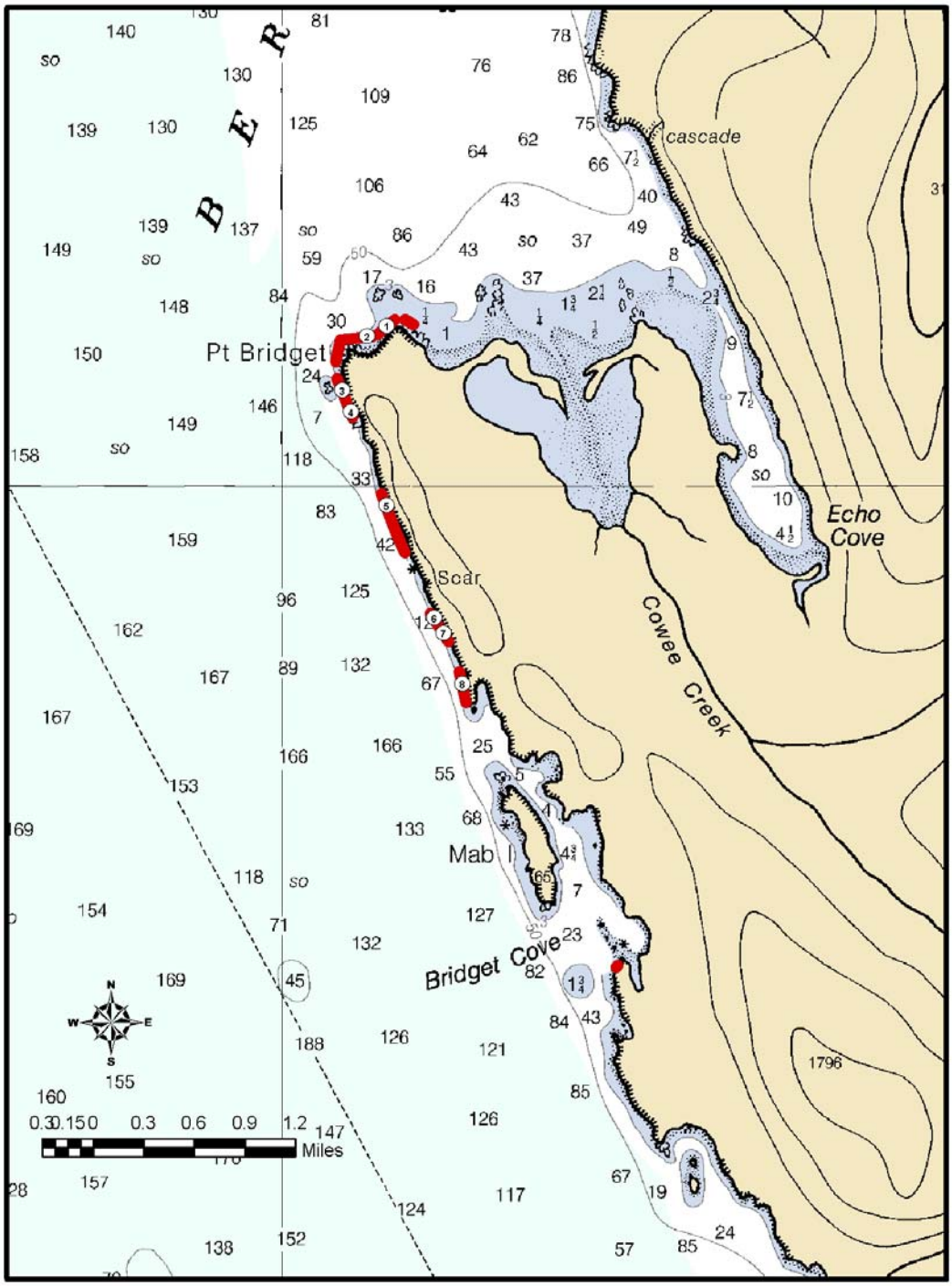

Figure 1.–Berners Bay 2005 herring spawn shoreline (broad, dark line parallel to shore) and transect locations (numbers 1 – 8).

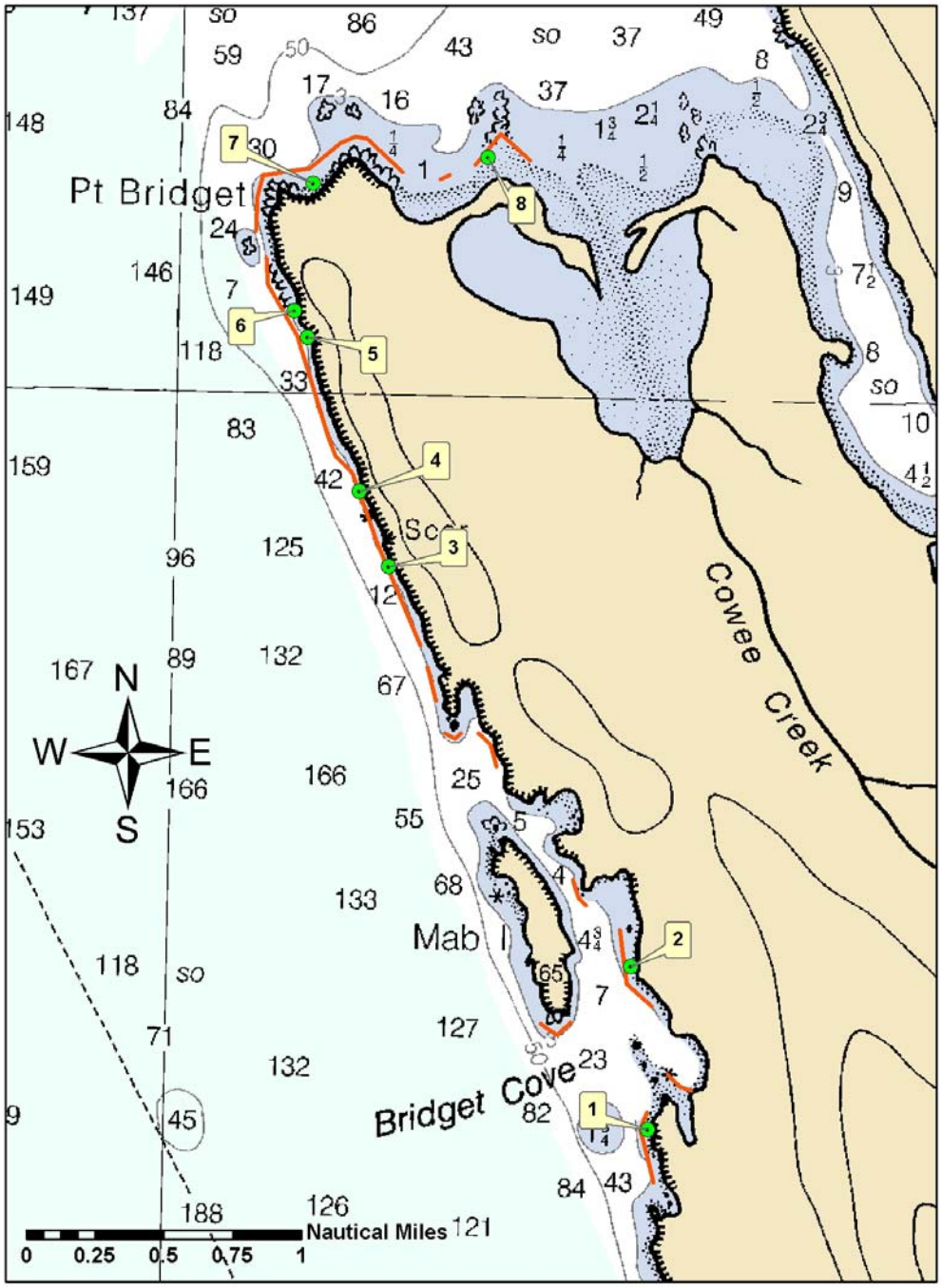

Figure 2.–Berners Bay and Lynn Canal 2006 herring spawn shoreline (broad, dark line parallel to shore) and transect locations (numbers 1-8).

Figure 3.–Berners Bay and Lynn Canal 1999 - 2004 herring spawn.

Table 1.–Historic Lynn Canal commercial harvest and nautical miles of spawn.

Season	Total quota (tons)	Total Harvest (tons)	Pound catch (tons)	Seine catch (tons)	Gillnet catch (tons)	Date of first spawn	Major spawning dates	Nautical miles of spawn	Spawning escapement
1952-53								8.2	
1953-54								9.4	
1954-55								12.2	
1955-56								10.0	
1956-57								28.1	
1957-58								24.1	
1958-59								10.8	
1959-60		156	156			5/1	5/1-5/15	12.9	
1960-61		22	22						
1961-62		354	354						
1962-63		101	101						
1963-64		195	195						
1964-65		200	200						
1965-66		109	109						
1966-67		100	100						
1967-68		475	475						
1968-69		600	0	600					
1969-70	750	240	240				5/2-5/4	11.5	
1970-71	750	654	654						
1971-72	950	524	431	93		5/2	5/6-10	8.5	
1972-73	950	350	49	301			4/25	10.6	
1973-74	620	396	73	319	4		4/27	13.2	
1974-75	620	644	88	556	2		5/5	10.9	
1975-76	870	631	74	433	124		4/27	15.9	
1976-77	995	926	0	709	217		5/3	9.7	
1977-78	820	966	0	603	363		4/24	8.0	
1978-79	120	7	11	0			4/18	5.7	
1979-80	720	976	0	976			5/8	9.8	
1980-81	845	777	2	775			4/30	9.2	
1981-82	400	551	0	551			spotty	2.5	
1982-83							5/1	6.0	
1983-84							4/24	2.6	
1984-85							4/29	5.1	
1985-86							5/2	5.0	
1986-87							5/4	2.5	
1987-88							4/30-5/3	7.0	
1988-89							24-Apr	5.0	
1989-90							26-Apr	3.0	
1990-91							4/30-5/4	2.5	
1991-92							27-Apr	4.0	
1992-93							5/4-5/6	3.2	
1993-94							4/27-5/8	4.3	

Table 1 continued.

Season	Total quota (tons)	Total Harvest (tons)	Pound catch (tons)	Seine catch (tons)	Gillnet catch (tons)	Date of first spawn	Major spawning dates	Nautical miles of spawn	Spawning escapement
1994-95							5/10-5/24	0.95	
1995-96						4/29	5/1	2.9	
1996-97						5/1	5/5	2.2	
1997-98						5/13		0.49	
1998-99								6.0	
1999-00						5/4	5/10-5/10	3.3	
2000-01						5/5	5/5-5/6	4.0	
2001-02						5/29	5/29	3.0	
2002-03						4/30	4/30 - 5/2	2.2	
2003-04						5/4	5/4 – 5/9	5.1	719
2004-05						5/10	5/11 – 5/12	1.4	318
2005-06						5/12	5/13 - 5/14	3.9	712

APPENDIX A

Appendix A.– Lynn Canal and Berners Bay 2005 Herring Survey Flight Log.

Total miles of spawn:	1.4
Spawning dates:	5/10 - 5/17
Peak spawning:	5/11 - 5/12

4/22	No spawn or herring observed. No evidence of eulachon up the Berners and Lace. 15 sea lions, w/ 5 in Berners Bay
5/3	No spawn observed. Fair sized school in Bridget Cove, no predators.
5/5	No spawn observed. Many schools, Auke Bay, Indian Cove, Lena Cove, Tee Harbor, Bridget Cove, Pt Bridget and along east BB. Few predators.
5/7	No spawn observed. More schools in same places, with herring lining the beach along the east shore of BB. Few predators.
5/9	No spawn observed. Additional schools in Fritz Cove, lining beach near Outer Point. Few predators, no sea lions at Benjamin Is. Many birds between Echo Cove and Pt. Bridget - possible spawn yesterday?
5/10	~0.5 nm spawn at Pt Bridget. Numerous small schools, Auke Bay, Tee Harbor, Bridget Cove and Berners Bay. 80-100 sea lions, one whale.
5/11	Scattered spot spawns from Bridget Cove to Pt. Bridget. Small schools in Smugglers Cove, Indian Cove, Tee Harbor, Sunshine Cove, Echo Cove.
5/12	40 yards active spawn at Bridget Cove, two light spots S of and one at Pt. Bridget. Small schools in Auke and Berners Bay. Few predators.
5/13	Very light spawn S of Pt Bridget. Small schools Fritz Cove, Auke Bay, Auke Nu, Auke Rec, Tee Harbor, Good sized school inside Mab Island
5/16	Spot spawns on W Mab Is. Large schools in Auke Bay, Auke Nu, and Tee Harbor. 50 harbor seal at Slate Point, otherwise few predators.
5/17	Skiff survey. Very small spot spawn E Mab Is. No spawn observed on entire E coast of BB
5/23	No spawn observed. Herring lining the beach at Auke Cape, good schools in N Tee Harbor, small schools in Berners Bay. 70 sea lions on Benjamin Is.
5/24	No spawn observed. Good school on beach near Cascade Pt. Small schools in Auke Bay, Pt Louisa, Lena Cove, Tee Harbor. Sea lions hauled out at Benjamin Is.
5/27	No spawn observed. Schools in Auke Bay, Indian Cove, Tee Harbor. Few predators.

APPENDIX B

Appendix B. Lynn Canal and Berners Bay 2006 Herring Survey Flight Log.

Total miles of spawn: 3.9

Spawning dates: 5/12 – 5/15

Peak spawning: 5/13 – 5/14

4/11: 6 sea lions between Pt Bridget and the flats, gulls and scattered eagles as though some eulachon may have been in the area – nothing obvious. Many sea lions at Benjamin Is.

4/18: Quiet, very few predators – 18 sea lions in Berners Bay. A good sea lion show at Benjamin Is, with two orcas in stealth mode approaching.

4/21: Lynn Canal was very quiet, with one small school of herring observed in the Auke Bay area. Very few predators were observed along the shoreline between Auke Bay and Mab Island. Berners Bay was very quiet as well with a half dozen sea lion observed spread out in singles and pairs. One whale was observed in the southeast portion of the bay. No herring were observed.

4/25: The Lynn Canal shoreline was very quiet, with only a couple of sea lions observed near Pt. Lena and Mab Island. More than 100 sea lions were observed at the Benjamin Island haulout. Large concentrations of scoters were observed near Eagle River and Mab Island. Berners Bay was quiet with very few sea lions and no whales observed. No herring or herring spawn was observed.

4/28: No herring, spawn, or predators, except a good show at Benjamin Is. on the Lynn Canal shore. A few sea lions near Pt Bridget and Cascade Point, 10 seal ions actively feeding near the head of the bay. Many dead eulachon observed on the flats. Many birds and eagles feeding on the Lace and Antler Rivers.

5/3: No herring or spawn. Only about 30 sea lions at the Benjamin Is haulout. Two whales at Pt Bridget. Many seal feeding at the mouth of Berners River. Lots of eagles and seabirds about 5 miles up Lace River, and about 2 miles up Antler River.

5/7: No spawn, small school off Pt Louisa. 250 sea lions at Benjamin, and 2 in Berners Bay

5/10: No spawn, one school in the Auke Bay ferry terminal area. Approximately 200 sea lions observed at Benjamin Is. 33 sea lion and 2 whales observed from Mab Is to Point Bridget.

5/12 0.33 miles of active spawn observed between Bridget Cove and Cowee Creek. Three whales and 20-30 sea lions in the Mab Is Bridget Cove area.

5/13: 2.4 miles active spawn observed in the Pt Bridget area between Mab Is and Cowee Creek. Schools staging in Bridget Cove. A large school observed in Tee Harbor.

5/14: 3 miles of active spawn observed in same area. More intense in the Mab Is area. Herring in N Tee Harbor broken into four schools

5/15: Two spots S Bridget and Mab Island. Benjamin haulout half full of sea lions. Schools in shallow in N Tee Harbor.

5/16: No herring or spawn observed.

5/22: No herring or spawn observed.