Wildlife Research Annual Progress Report

Mountain Goat Movement Patterns and Population Monitoring in the Haines-Skagway area.

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Alaska Department of Fish and Game
Division of Wildlife Conservation

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Cover photo: Nanny-kid group (n = 11), near Tukgahgo Mountain, Takshanuk Ridge, April 2011.

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INTRODUCTION

The effects of summer and winter commercial helicopter tourism on mountain goat populations is an issue of significant conservation concern (Hurley 2004). Mountain goats are sensitive to helicopter overflights and such activities have well documented effects on mountain goat behavior (Cote 1996, Hurley 2004, Goldstein et al. 2005). Disturbance caused by industrial activities is ecologically comparable to predation-risk (Frid 2002) and outcomes of disturbance may not only alter behavior but also habitat selection, reproduction and survival; though the latter topics have not been definitively investigated in scientific studies.

The Haines-Skagway area has experienced substantial growth in commercial helicopter tourism activities in the last 20 years. Helicopter tourism in summer is largely based out of Skagway while winter helicopter recreation has grown over the past decade in Haines. Management and the apparent impacts of these helicopter activities differ in character. During summer (May 15-Sept 25), helicopter tours originating in Skagway travel along pre-defined routes and land at one of 7 pre-approved landing sites (Figure 1). During winter (Feb 1-April 30), helicopter skiing operations originate out of, at least, 3 different locations in the Chilkat valley and travel to several different landing sites and ski across a broad area of designated terrain (Figure 1). Summer helicopter activities are permitted by the Bureau of Land Management (BLM), while winter helicopter landings are permitted by the BLM and the Haines Borough.

The impact of helicopter tourism activities on local mountain goat populations is not understood but may include alteration of behavior, movement patterns and, ultimately, reproduction and survival (Hurley 2004). During summer, disturbance of adult females and neonates during the kidding season is considered an important conservation concern. During winter, disturbance of mountain goats is likely to have negative effects on animals that are nutritionally stressed at the end of the long northern winter period. Consequently, disturbance during both seasons, while different in character, has the potential to negatively alter local populations if not regulated appropriately.

In response to the above concerns, the Alaska Department of Fish and Game (ADFG) and the BLM have initiated cooperative mountain goat population monitoring activities intended to identify key summer and winter habitats, estimate reproductive and survival rates, and monitor population composition and abundance. Research activities include collection of movement and vital rate data on a sample of radio-marked mountain goats in addition to implementation of annual aerial population abundance and productivity surveys. These efforts are aimed at providing ADFG, BLM and local stakeholder groups with information necessary to appropriately manage and conserve mountain goats in the vicinity of helicopter tourism areas.

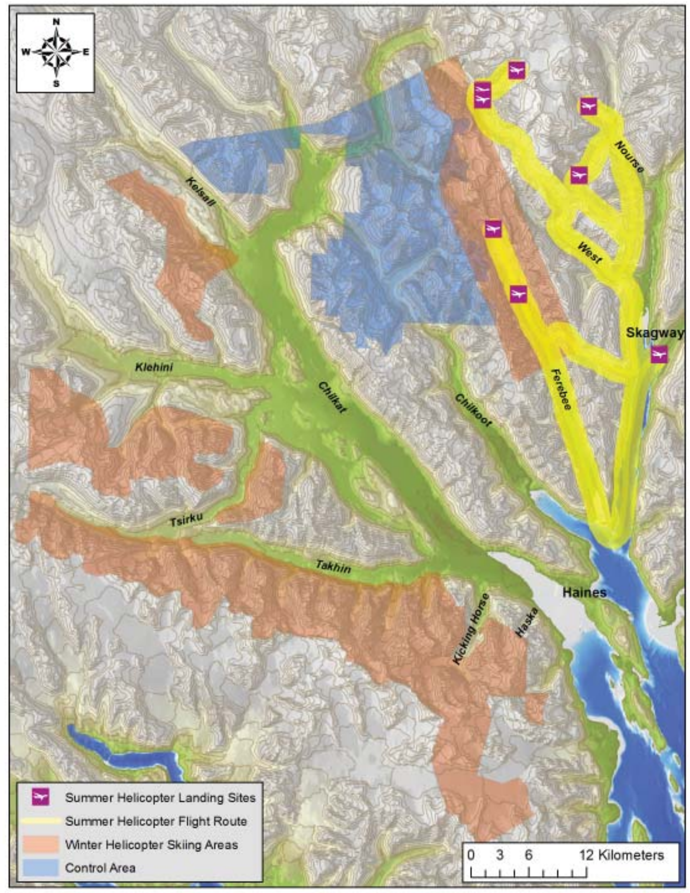

Figure 1: Map of the Haines-Skagway study area. Summer and winter commercial helicopter use areas are described.

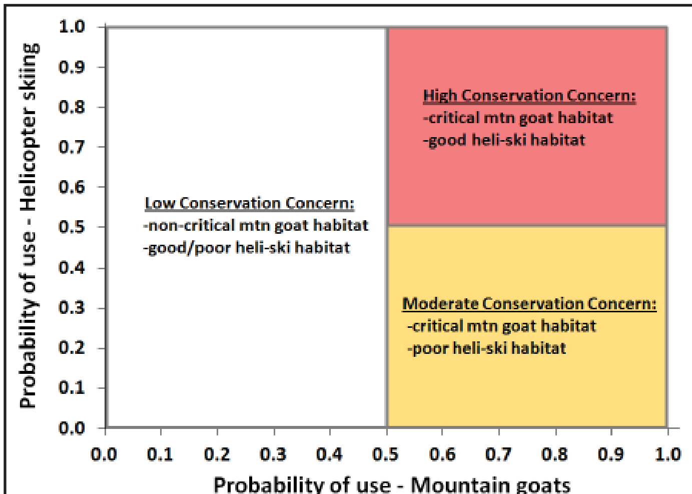

Figure 2: Diagram describing the conceptual framework used to manage helicopter skiing in mountain goat habitat (adapted from Nielsen et al. 2006). The probability of use by mountain goats and helicopter skiing will be estimated using resource selection function (RSF) models reliant on GPS location data (from mountain goats and helicopters) and GIS data layers. This framework provides a data-based tool for prioritizing management efforts and reducing conflicts between mountain goats and helicopter skiing activities.

The three primary objectives of the proposed research project include:

Objectives:

1) Characterize habitat selection patterns of mountain goats and helicopter tourism (Figure 2);

2) Assess reproductive success and survival of mountain goats;

3) Estimate and monitor mountain goat population abundance and composition.

STUDY AREA

Field research activities were concentrated in ca. 1100 km^2 area located in the vicinity of the communities of Haines and Skagway, Alaska (Figure 1). This configuration of the study area is intended to enable collection of field data across an array of locally distinctive habitat complexes inhabited by mountain goats (Figures 3 and 4) and within areas where helicopter tourism activities do and do not occur (Figure 1). In addition, since mountain goats are capable of making routine annual movements of 10-15 km (and dispersal movements exceeding 30 km) it was considered necessary to delineate a study area large enough to encompass the area used by mountain goats potentially affected by tourism activities.

Figure 3: Photo taken in late-April of upper Summit creek in the Porcupine area. This area is a popular helicopter skiing area. Incidentially, a radio-marked female mountain goat (KG-22) died in the avalanche chute visible at the bottom of the photograph.

Figure 4: Looking south down the Ferebee river valley towards Lynn Canal. Summer helicopter tourism occurs on the glacier in the foreground, and winter heli-skiing on the alpine ridges.

Figure 5: ADFG wildlife technician, Jeff Jemison, and an 7-yr old male mountain goat (KG-17) captured in the upper Chilkat Valley, August 2010. This animal weighed 370 lbs. and was the second largest handled during the capture operation.

METHODS

Mountain Goat Capture

Mountain goats were captured using standard helicopter darting techniques and immobilized by injecting 3.0 - 2.4mg of carfentanil citrate, depending on sex and time of year (Taylor 2000, White and Barten 2010), 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 (Figure 5). 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 and TGW-4500 GPS radio-collars (Telonics, Inc., Mesa, AZ) were deployed on all animals captured (Figure 5). In addition, lightweight Telonics MOD-400 VHF radio-collars were also simultaneously deployed on each animal (Figure 5) to enable longer-term monitoring opportunities (collar lifespan: ~6 years, May 2016). GPS radio-collars were programmed to collect location data at 6-hour intervals (collar lifetime: 3-4 years for TGW-3590 and TGW-4500, respectively). 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. For Telonics TGW-3590 collars (n = 5), GPS location data-sets will be remotely downloaded (via fixed-wing aircraft) 3-4 times per year (pre-programmed download "windows" occur twice every 8 weeks). Telonics TGW-4500 radio-collars store all GPS data "on-board" and will not be downloaded until collars automatically release on 6/15/2014. Location data will be 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).

Climate and Snow Monitoring

To characterize general climate conditions in the Haines-Skagway area data were acquired from the National Weather Service, which currently maintains weather stations in four local areas of interest. Also, in order to characterize spatial variation in snow depth, snow monitoring devices were deployed in the Chilkat valley at one location during November 2010 and 5 locations during October 2011. Low-cost snow depth monitoring devices were constructed using commercially available components. Specifically, ibutton temperature sensors were vertically attached to 6 ft. tall PVC conduit at 12 in. intervals (Figure 6). Each sensor was deployed at a standard elevation (1100-1500 ft) in an area free of canopy cover along a spatial gradient between the coast and the Canadian border (Figure 7). The sensor data will be manually downloaded at 1-2 year intervals. Data will be interpreted based on the expectation that temperatures sensors under the snow pack will exhibit less daily variation than those above the snow pack and thereby enable determination of the snow depth based on the incremental configuration of sensors on the snow pole. Ultimately, data are expected to provide a metric of snow depth profiles at specific sites and enable understanding of how snow depth varies spatially across a coastal-interior climate gradient and also between years at specific localities.

Figure 6: Photograph of a ibutton snow depth measuring device in early-November 2010 prior to snow accumulation, 13-Mile area, Takshanuk Ridge, AK.

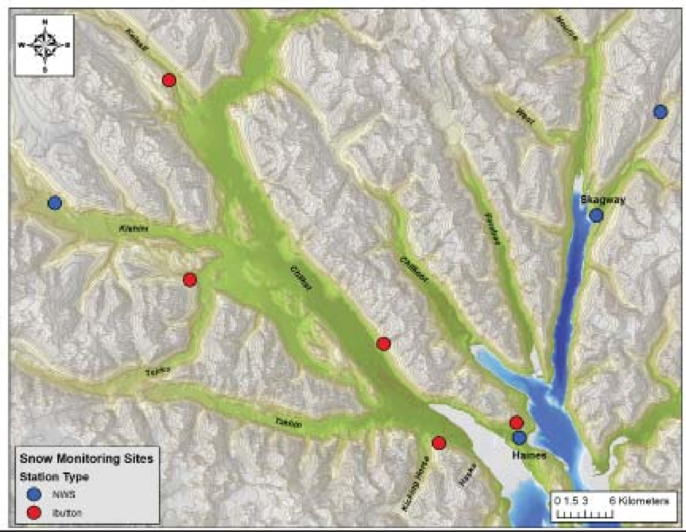

Figure 7: Location of snow monitoring sites in the Haines-Skagway area. The red dots depict the location of ibutton snow sensors; the blue dots depict the location of NWS weather stations.

Movement Patterns and Habitat Use

In order to gather a basic understanding of mountain goat wintering strategies, a preliminary analyses of elevational distribution patterns, activity and movement patterns were conducted using of a sub-set of GPS radio-marked mountain goats. Specifically, mean daily elevation was calculated for each animal for which data was available and examined to ascertain the range of elevations used by given animals during the winter period. Otherwise, complete analyses of GPS location data to characterize movement patterns and habitat use of mountain goats will not be conducted until data have been downloaded for GPS collars (i.e. 2014).

Reproduction and Survival

Kidding rates and subsequent survival will be estimated by monitoring individual study animals during surveys using fixed-wing aircraft (Piper PA-18 Super Cub) 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 can be reliably observed in open habitats. We will assume that kids did not survive winter if they were not seen with their mothers the following spring. Cases in which kid status assessments were equivocal will be filtered from the data set and not used for subsequent estimates of kid survival.

Mortality of individual radio-collared mountain goats will be determined by evaluating activity sensor data embedded in GPS location data and/or by detecting radio-frequency pulse rate changes during routine monitoring surveys. In cases where mortalities are detected, efforts were made to investigate sites as soon as possible via ground, helicopter or boat. To the extent possible, all mortalities were thoroughly investigated to ascertain the cause of death and relevant biological samples collected. Annual survival of radio-collared animals will be estimated using the Kaplan-Meier methodology (Pollock et al. 1989). This procedure allows for staggered entry and exit of newly captured or deceased animals, respectively.

Population Abundance and Composition Estimation

Aerial Surveys.—Population abundance and composition surveys were conducted using fixed-wing aircraft. Aerial surveys were typically conducted when conditions met the following requirements: 1) flight ceiling above 5000 feet ASL, 2) wind speed less than 20 knots, 3) sea-level temperature less than 65 degrees F. Surveys were typically flown along established flight paths between 2500-3500 feet ASL and followed geographic contours. Flight speeds varied between 60-70 knots. During surveys, the pilot and experienced observers enumerated and classified all mountain goats seen as either adults (includes adults and sub-adults) or kids. In addition, each mountain group observed was checked (via 14X image stabilizing binoculars) to determine whether GPS-collared animals were present. Flight conditions, terrain complexity and animal behavior often complicated efforts to determine whether observed mountain goats were collared. As a result, the number of adults for which collar presence could be ascertained with a high degree of confidence was also recorded for each group observed. Further, for each collared animal seen or not seen during surveys data were collected to characterize behavioral and habitat conditions expected a priori to influence sighting probabilities.

Estimating the probability of observing mountain goats on a given survey (i.e. sightability) is critical for deriving population size estimates for focal areas. This is typically achieved by comparing the number of marked animals in an area to the number of marked animals actually seen (or re-sighted) during a survey. This fairly simple procedure can be complicated when its not always possible to assess whether observed animals are marked. This situation occurs on mountain goat surveys and requires additional refinement of standard mark-resight population estimators. New analytical methods appropriate for estimating mountain goat population size in this study are currently being developed (G. Pendleton, ADFG, unpublished).

Results and Discussion:

Mountain Goat Capture and Handling

Capture Activities.—Mountain goats were captured during three days in August 2010 and three days in September-October 2011. Overall, 33 animals (13 females and 20 males) were captured using standard helicopter darting

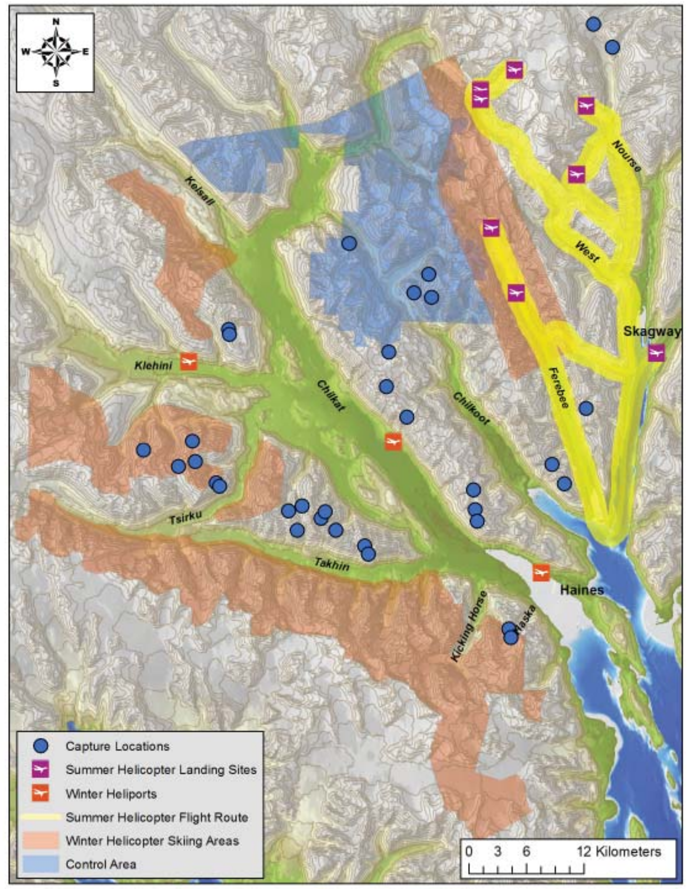

Figure 8: Location of mountain goat capture sites in the Haines-Skagway area, August-September 2010-11. Key geographic localities and helicopter management zones are also identified.

methods (Table 1, Figure 8). Each animal was deployed with a Telonics TGW-3590 (n = 21) or TGW-4500 (n = 12) GPS radio-collar and a lightweight Telonics MOD-400 VHF radio-collar (370g). Double-collaring animals was conducted to extend to period of time individual animals could be monitored (lifespan, GPS: 3-4 years, VHF: 6 years), thereby increasing the long-term opportunity to gather mountain goat survival and reproduction data and reducing the frequency in which mountain goats must be captured. Overall, the combined weight of radio-collars attached to animals comprises 1.2% of average male body weight and 2.0% of average female body weight and is well within the ethical standards for instrument deployment on free-ranging wildlife.

Helicopter captures were attempted during periods when mountain goats were distributed at high elevations 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 of adult females and associated neonates. Captures were attempted in areas where mountain goat access to dangerously steep terrain was limited. As a result of these constraints, opportunities to capture mountain goats were fairly limited. While we were able to meet our sample size objectives during

Table 1: Characteristics of mountain goats (n = 33) captured in the Haines-Skagway area, August-September 2010-2011.

ID	Capture Date	Area	Sex	Age	Kid	Mass (lbs.)	Horn Length (in.)[1]	Horn Circ. (in.)[1]	Status
KG001	8/4/10	Takshanuk	F	8	1	184	9 9/16	4 3/16	Alive
KG002	8/4/10	Takshanuk	M	6	--	385	9 14/16	5 7/16	Died
KG003	8/4/10	Takshanuk	F	6	0	211	9 13/16	4 6/16	Alive
KG004	8/4/10	Takshanuk	M	5	--	284	9 11/16	5 14/16	Alive
KG005	8/4/10	Takshanuk	F	13	1	187	9 10/16	4 4/16*	Alive
KG006	8/4/10	Takshanuk	F	14	0	147	8 15/16	3 12/16	Died
KG007	8/4/10	Four Winds	F	6	1	135	8 5/16	4 1/16	Alive
KG008	8/4/10	Takhin	M	5	--	345	8 5/16*	5 12/16	Alive
KG009	8/13/10	Ferebee	M	11	--	305	8 1/16*	5 2/16	Died
KG010	8/13/10	Ferebee	M	5	--	283	8 11/16	5 9/16	Alive
KG011	8/13/10	Nourse	M	6	--	255	9 10/16	5 8/16	Alive
KG012	8/13/10	Nourse	M	12	--	289	8 9/16	5 8/16	Alive
KG013	8/13/10	Ferebee	M	9	--	289	9 7/16	5 10/16	Died
KG014	8/13/10	Chilkoot	M	11	--	306	9 14/16	5 6/16	Died
KG015	8/13/10	Chilkoot	F	6	0	204	8 6/16	4 4/16	Alive
KG016	8/13/10	Chilkoot	F	6	1	180	8 4/16	4 4/16	Alive
KG017	8/14/10	Takhin	M	7	--	370	9 14/16	5 9/16	Alive
KG018	8/14/10	Takhin	M	6	--	325	8 8/16	5 14/16	Alive
KG019	8/14/10	Takhin	M	4	--	--	--	--	Alive
KG020	8/14/10	Porcupine	M	6	--	336	8 13/16	5 4/16	Alive
KG021	8/14/10	Porcupine	F	3	0	177	8 6/16	4 9/16	Alive
KG022	8/14/10	Porcupine	F	4	0	194	9	4 10/16	Died
KG023	8/14/10	Four Winds	F	11	1	185	9 12/16	4 1/16	Died
KG024	9/8/11	Haska	F	5	0	164	8 14/16	3 14/16	Alive
KG025	9/8/11	Haska	M	5	--	284	8 8/16	5 5/16	Alive
KG026	9/8/11	Takhin	M	4	--	251	9	5 6/16	Alive
KG027	9/8/11	Takhin	M	6	--	357	9 2/16	5 6/16	Alive
KG028	9/8/11	Takhin	M	7	--	341	9 4/16	5 3/16	Alive
KG029	9/8/11	Takhin	F	1	0	115	5 8/16	3 12/16	Alive
KG030	9/8/11	Porcupine	M	4	--	304	9 4/16	5 12/16	Alive
KG031	10/2/11	Takshanuk	M	4	--	281	8 6/16	5 5/16	Alive
KG032	10/2/11	Porcupine	M	6	--	346	9	5 5/16	Alive
KG033	10/2/11	Porcupine	F	8	1	256	10 5/16	4 5/16	Alive

[1]Horn dimensions reflect maximum length or basal diameter for the largest horn. Asterisk denotes the horn tip was broomed.

2010-2011, the distribution of collar deployments was less uniform than desired with a majority of collar deployments being concentrated on western side of the study area. This occurred because the density of animals in the Skagway area was less than expected and offered extremely limited capture opportunities, particularly in the West Creek-Nourse River areas.

Biological Sample Collection.—During handling procedures, standard biological specimens were collected and morphological measures recorded. Specific biological samples collected from study animals included: whole blood (4 mL), blood serum (8 mL), red blood cells (8mL), ear tissue, hair and fecal pellets. Whole blood, serum, red blood cells and fecal pellet sub-samples were either sent to Dr. Kimberlee Beckmen (ADFG, Fairbanks, AK) for disease screening, trace mineral analyses or archived at ADFG facilities in Douglas, AK.

Disease Testing.—In 2010, a subset of captured animals (n = 5) were tested for prevalence of respiratory bacteria associated with incidence of pneumonia (specifically *Pasteurella trehalosi* and *Mycoplasma ovipneumonia*). Its important to note that even if such bacteria are found in the upper respiratory tracts of animals sampled it does not necessarily mean that a given animal has pneumonia, only that the potential exists. In fact, it is not unusual for reasonably high proportions of animals in a population to have pneumonia associated bacteria and never show adverse effects, particularly if animals are subject to minimal stress (ie. nutritional limitation, severe winters, etc.). Overall, 3 of 5 animals sampled in the Haines-Skagway area tested positive for *Pasteurella sp.,* though none tested positive for *Mycoplasma ovipneumonia*. While sampling was limited, these results are comparable to those acquired from samples collected in 2010 from three other populations in southeast Alaska (Appendix 1). Until additional samples are collected, the overall findings must be considered preliminary.

Blood serum samples collected from captured animals were also tested for a suite of 15 different diseases relevant to ungulates (Appendix 2). Of particular interest was contagious ecthyma (CE), a viral disease previously documented among mountain goats in Haines and other areas of southeast Alaska. Common symptoms of CE include presence of grotesque lesions on the face, ears, and nose which can lead to death of animals, primarily those in young or old age classes; healthy adults commonly survive the disease. Of the 13 animals successfully tested for CE only one animal tested positive for CE-specific antibodies; a comparable prevalence relative to other southeast Alaska populations tested in 2010 (n = 4).

Trace Mineral Testing.—In 2010, whole blood and serum samples were analyzed to determine trace mineral concentration of 22 mountain goats in order to examine whether mineral deficiencies were prevalent in our study population. Preliminary results are summarized in Appendix 3.

Genetic Analyses.-Tissue samples from all mountain goats captured (and a majority of animals harvested via ADFG registration hunts) have been sent Aaron Shafer (University of Alberta) for inclusion in a broad-scale mountain goat population genetics analysis. Previous results from Shafer et al. (2010) indicate that substantial genetic structuring exists among mountain goats in southeast Alaska however broad-scale analyses suggest that animals within the Haines-Skagway study area are likely from the same genetic sub-population. In the future, additional analyses involving larger samples sizes may provide the opportunity to examine whether further structuring is evident within the study area.

Body mass.—Body mass was measured for 22 of the 23 animals captured. Interestingly, preliminary results indicate that body mass of mountain goats in the Haines-

Skagway area, particularly males, were substantially larger than mountain goats measured in other areas of southeast Alaska (White, unpublished). Overall, males weighed 322±7 lbs and females 189±8 lbs, on average. The largest male weighed 385 lbs. and the largest female weighed 256 lbs; both of these animals represent the largest mountain goats, in their respective sex classes, weighed in southeast Alaska since 2005 (n = 225, K. White, unpublished). The underlying cause of large body size of mountain goats in the Haines-Skagway area is not currently understood but leading hypotheses include mechanisms related to genetic insularity and/or sexual selection.

Movement Patterns

GPS location data-We downloaded 20,668 GPS locations from 21 mountain goats between August 2010-October 2011 (Figure 9). Most data was derived from a sub-set of animals that were deployed with remotely downloadable collars. Thus, the existing data does not incorporate location data from all animals captured.

Activity and movement patterns-Mountain goat exhibit distinct seasonal variation in activity and movement patterns (as indexed via GPS collar activity sensors). Specifically, activity and movement rates are highest during the growing season (June-August) and reduced significantly during the lean months of winter (October-April) when deep snow is prevalent on mountain goat winter range and animals must conserve energetic resources in order to survive the long winter period (Figure 10 and 11). Within this general framework, shorter duration patterns of activity variation are evident such that during the rut males reduce activity substantially, relative to females (Figure 10). And, dur-

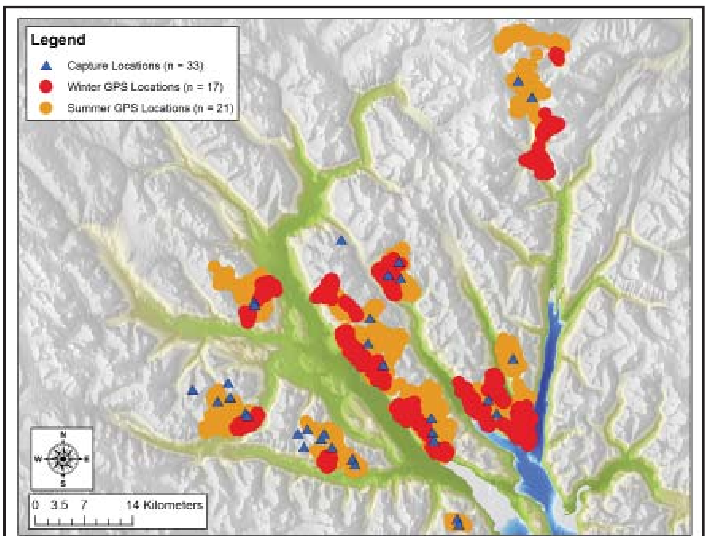

Figure 9: GPS location data collected from a subset of radio-marked animals, 2010-2011. Orange circles depict summer loactions and red dots depict winter locations; capture location are shown for reference. Locations do not describe the actual distribution of all mountain goats in the area, only the selected animals that were radio-marked.

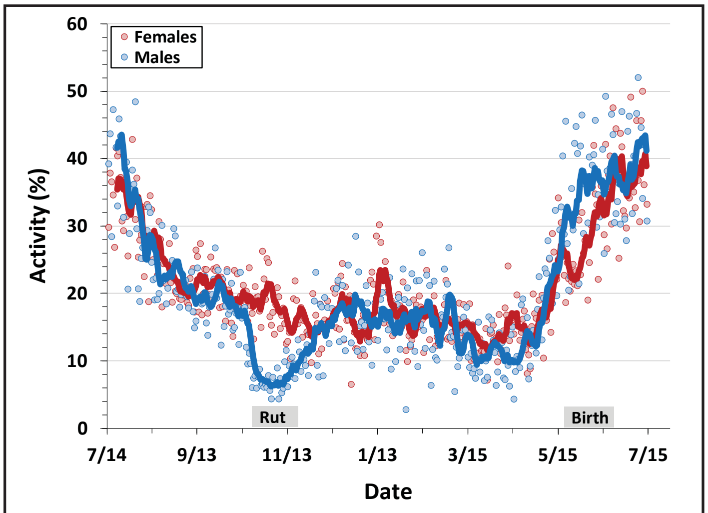

Figure 10: Sex-specific patterns in seasonal activity (as indexed via tip-switch activity sensors on GPS radio-collars) for 19 mountain goats monitored during 2010-2011.

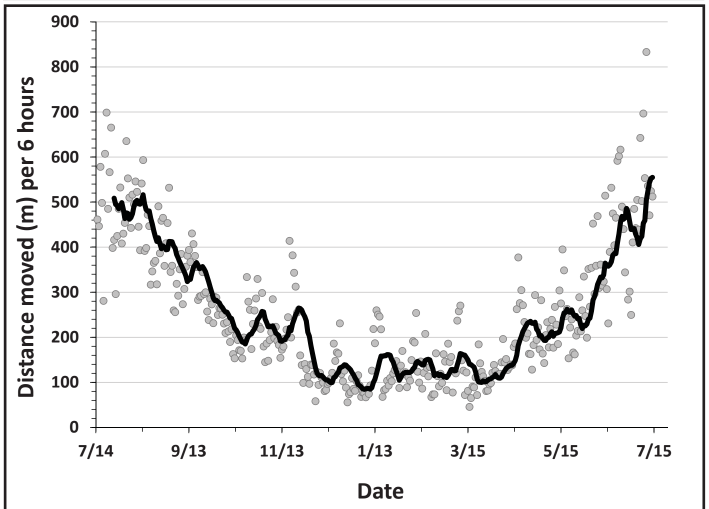

Figure 11: Average distance moved per 6-hour period for 21 GPS radio-marked mountain goats, August 2010-October 2011. Note the substantial decrease in movement rates during the winter period.

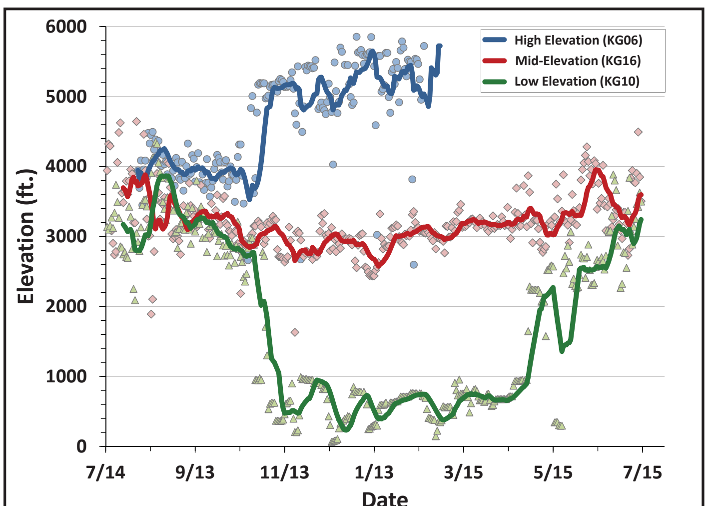

Figure 12: Seasonal elevational profile, derived from 6-hr interval GPS radio-collar location data, for a migratory mountain goat using low-, mid- and high elevation wintering strategies, 2010-2011.

ing the parturition period, females reduce activity periods markedly, relative to males (Figure 10).

Wintering strategies-Herbert and Turnbull (1977) first documented the occurrence of variation in over-wintering strategies in mountain goat populations. Specifically, they documented that coastal populations generally winter at low elevations, whereas interior populations tended to winter at high (sub-alpine or alpine) elevations. Preliminary analyses of elevational distribution data indicate that mountain goats in the Haines-Skagway area use multiple strategies, presumably in response to geography and local climate variation. Specifically, animals close to the coast tended to winter at low elevations (Figure 12), whereas animals furthest from the coast tended to winter at high elevations (Figure 12); animals at moderate distances from coastal maritime influence tended to winter at intermediate elevations (Figure 12). Overall, further refinement of our understanding of geographic variation in wintering strategies (via additional data collection efforts) will be crucial for evaluating the potential for spatial overlap of mountain goats and helicopter skiing activities during winter.

Reproduction and Survival

Reproduction-In order to estimate reproductive productivity, we monitored radio-marked adult females to determine whether they had kids at heel. In 2010, our estimates were based on surveys beginning in August and thus likely represent an underestimate of kid production. However, in 2011

Table 2: Proportion of radio-marked adult female mountain goats seen with a kid at heel in the Haines-Skagway area and, for comparison, in Lynn Canal, 2005-2011.

Year	Kids	AdF	Prop	SE
Haines-Skagway				
2010	5	10	0.50	0.16
2011	8	10	0.80	0.13
Total	13	20	0.65	0.11
Lynn Canal				
2005	8	12	0.67	0.14
2006	16	25	0.64	0.10
2007	20	32	0.63	0.09
2008	19	33	0.58	0.09
2009	15	25	0.60	0.10
2010	18	26	0.69	0.09
2011	15	21	0.71	0.10
Total	111	174	0.64	0.04

surveys were conducted during the parturition period and are expected to closely approximate actual parturition rates. Overall, we determined that 65% of marked females had kids at heel during 2010-2011(Table 2). This baseline estimate is similar to the longer-term estimates calculated for the nearby Lynn Canal study area (Table 2). Of the five kids observed in August 2010, three survived until May 2011.

Survival-We estimated survival of 23 mountain goats monitored between August 2010-May 2011. Our estimates did

Table 3: Mountain goat survival estimates, and associated winter climate data, for radio-marked mountain goats in the Haines-Skagway study area and, for comparison, the Lynn Canal study area. Sample sizes in the Haines-Skagway area are small and estimates should be interpreted with caution.

	Males				Females				Total				Haines: Snow Depth	Haines: Snowfall	Eaglecrest: Snow Depth	Eaglecrest: Snowfall
	At Risk	Died	$\hat{S}$	SE	At Risk	Died	$\hat{S}$	SE	At Risk	Died	$\hat{S}$	SE	Mean (in)	Total (in)	Mean (in)	Total (in)
Haines-Skagway																
2010/2011	11.6	4	0.69	0.13	9.2	3	0.70	0.14	20.8	7	0.70	0.10	4	90	34	168
All years	11.6	4	0.69	0.13	9.2	3	0.70	0.14	20.8	7	0.70	0.10	4	90	34	168
Lynn Canal																
2005/2006	9.6	2	0.79	0.13	10.0	1	0.90	0.09	19.6	3	0.85	0.08	6	114	15	122
2006/2007	25.4	11	0.57	0.10	22.1	4	0.82	0.08	47.5	15	0.68	0.07	46	309	60	381
2007/2008	26.5	6	0.79	0.07	20.8	3	0.88	0.07	47.3	9	0.83	0.05	24	208	45	285
2008/2009	24.2	10	0.66	0.09	21.4	6	0.73	0.09	45.6	16	0.69	0.06	18	240	44	235
2009/2010	25.1	4	0.86	0.07	22.3	4	0.85	0.07	47.4	8	0.85	0.05	18	202	28	166
2010/2011	24.3	3	0.88	0.06	23.2	2	0.91	0.06	47.5	5	0.90	0.04	4	90	34	168
All years	133.3	37	0.76	0.03	117.8	21	0.84	0.03	251.2	58	0.79	0.02	19	194	38	226

At Risk = average number of animals monitored per month (per time period)

Snow Depth, Mean = calculated as daily mean between Nov 1-April 30

Eaglecrest, Elevation = 1200 ft.

not include fates of animals during June-July 2010 (prior to initial captures) and thus do not span an entire biological year. Nonetheless, since mortality rates are typically low during these months (White et al. 2011) our estimates are expected to be similar to actual annual survival. Overall, we determined that 70±10% of animals survived; male and female survival did not differ (Table 3). All mortalities occurred during winter (Dec-April). Four of the 7 animals that died were found in avalanche debris, while the remainder died of unknown causes. While avalanche related mortality is not an uncommon cause of death for mountain goats, the proportion of animals that died via avalanche in the winter of 2010/2011 is uncharacteristically high, relative to findings from a companion study in Lynn Canal (2005-2011; White 2011). Overall, estimated survival in the Haines-Skagway area was relatively low, especially considering winter conditions (i.e. snowfall and snow depth) were relatively mild. Estimated survival in the Haines-Skagway study area was 20% lower than estimates in the nearby Lynn canal study area in 2010/2011 (Table 3). Nonetheless, it is important to recognize that our sample size for the Haines-Skagway area is small for the purposes of estimating survival, and chance events (such as avalanches) may result in our estimates not being representative of the local populations as a whole. Clearly, additional monitoring of an increased sample of marked mountain goats over multiple years will increase our ability to accurately characterize baseline survival rates for this population.

Scavenging-During investigation of mountain goat mortality sites occurrence of scavenging activity was recorded. In one instance (LG23), a remote camera was set-up near a female that was buried in an avalanche chute enabling a unique opportunity to photo-document scavenging activity on a mountain goat carcass. In this case, three species of carnivores were observed at the carcass (coyote, brown bear and black bear). At one point, both a black bear and a brown bear were simultaneously at the carcass site (Figure 13). Carnivore evidence observed at other mortality sites included wolverine, wolf and marten; wolverine being the most common.

Population Abundance and Composition Estimation

Aerial surveys were conducted in 10 distinct survey areas during 3 days in September 2010 (n = 7 areas) and 4 days in September 2011 (n = 10 areas; Appendix 4 and 5). During each survey, mark-resight protocols were followed in order to estimate sighting probability and population size. Results of mark-resight surveys indicated that approximately 65% of mountain goats were seen over the course of all surveys (2010-2011 combined: marked = 52, sighted = 34); however substantial variation existed between surveys. Utilization of mark-resight and other survey covariate information will be used to estimate population size for each survey following statistical methods currently being developed (White and Pendleton 2010, G. Pendleton, unpublished) and are expected to be completed in winter 2011/2012.

Figure 13: Image taken from a remote camera depicting black and brown bear scavenging activity in avalanche debris, upper Chilkat Valley. The brown bear is feeding/digging at the location of LG23, an adut female that died in the avalanche a few months prior.

Examination of preliminary population composition data (i.e. % kids in the surveyed population) indicate that most survey areas have moderate-high levels of kid productivity (i.e. 13-25% kids), relative to other areas surveyed in southeast Alaska. However, the area between the Ferebee and Nourse glaciers (Halutu, Yeatman and Nourse-West survey areas) were characterized by very low proportions of kids (Appendix 5). During 2011, the only year we were able to conduct a complete survey of all three areas, only 4.1% of the 96 animals seen were classified as kids. It is currently unclear whether such findings are representative of longer-term patterns for this area. Nonetheless, continued monitoring of this area in addition to compilation and analyses of historical survey data will be important for determining whether this area is typically characterized by very low productivity.

Future Work/Recommendations:

Radio-marked mountain goats will continue to be monitored to determine survival and reproductive status during regularly scheduled aerial surveys. In the event radio-marked animals die, mortalities will be investigated as soon a practicable. In addition, for the subset of animals marked with TGW-3700 collars, GPS location data will be downloaded during aerial surveys at 2-4 month intervals; acquired data will be integrated into the existing GPS location database. Funding permitting, during August/September 2012, 6-8 additional GPS radio-collars will be deployed via helicopter capture methods. Annual fall aerial population estimation and composition surveys will be conducted in September/October 2012. An annual project progress report will be prepared and submitted by December 31, 2012.

Longer-term goals of the project (i.e. to be accomplished once GPS radio-collar deployments are completed) will involve using GPS location data from radio-marked mountain goats combined with remote sensing GIS data layers to develop resource selection function (RSF) models for the summer and winter periods. Such models will represent data-based tools for predicting areas most important for mountain goats across the study area. Ultimately, mountain goat RSF models can be integrated with spatially explicit helicopter tourism activity information to quantitatively examine if or where areas of conservation concern occur (i.e. Figure 1). The best mechanism for accurately characterizing helicopter activity involves standardized collection of GPS locations during helicopter flights (i.e. via handheld GPS units) to develop remote-sensing models comparable to mountain goat RSF models. The Haines Borough has recently implemented a program focused on gathering GPS location data from helicopter skiing operators. Continued collection of such data will play a critical role in the ability to implement an objective, data-based framework for examining putative conservation concerns related to helicopter tourism and local mountain goat populations. Ultimately, completion of this project objective will represent the single most important product of research activities and will provide resource managers and stakeholders with a much needed tool for making defensible and appropriate policy decisions.

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Appendix 1: Incidence of respiratory bacteria documented in mountain goats in the Haines-Skagway ("Klukwan") study area (n = 5), 2010. Results are also provided for three other populations in southeast Alaska in 2010, for comparison.

Area	Lynn Canal	Klukwan	Baranof	Cleveland	All Areas
Pasteurella trehalosi	0	2	5	2	9
Pasteurella sp.	0	1	0	0	1
Pasteurella sp.*	0	0	0	2	2
Total Pasturella	0	3	5	3	11
Arcanobacterium pyogenes	1	1	0	1	2
Mannheimia haemolytica	1	0	0	0	0
Moraxella sp.	1	1	0	0	1
Staphylococcus aureus	0	0	1	1	2
Mycoplasma (culture)	0	0	0	--	0
Mycoplasma ovipneumonia (PCR)	0	0	0	0	0
n (tested)	5	5	5	5	20

Notes:

Pasturella sp. = not identifiable to species

Pasteurella sp.* = organism most like P. trehalosi but looks different than other P. trehalosi (grows on MacConkey agar)

Total Pasturella = # of animals with some form of Pasturella (CG012 had 2 forms)

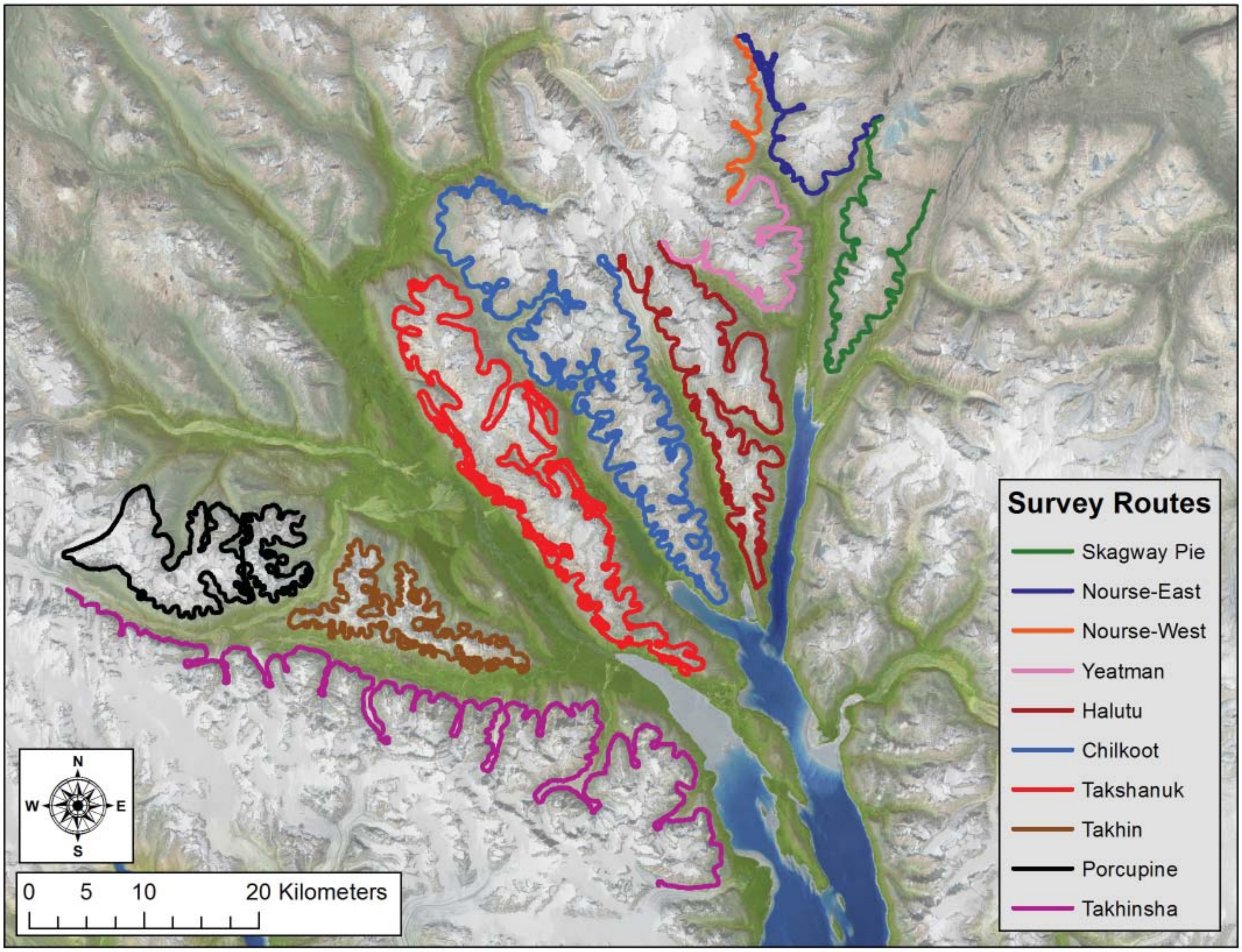
Appendix 2: Incidence of disease prevalence of mountain goats in the Haines-Skagway study area, 2010. Results are also provided for three other populations in southeast Alaska in 2010, for comparison.

	Baranof			Cleveland			Haines			Berners			Kakuhan			Villard			Total		
Disease	n	Positive	Prop	n	Positive	Prop	n	Positive	Prop	n	Positive	Prop	n	Positive	Prop	n	Positive	Prop	n	Positive	Prop
Contagious Ecthyma	12	1	0.08	10	1	0.10	13	1	0.08	20	1	0.05	23	0	0.00	22	0	0.00	100	4	0.04
Chlamydia	11	0	0.00	12	0	0.00	22	0	0.00	27	0	0.00	29	0	0.00	30	1	0.03	131	1	0.01
Q Fever	12	0	0.00	11	0	0.00	22	0	0.00	29	0	0.00	30	0	0.00	30	1	0.03	134	1	0.01
Bluetongue	10	0	0.00	10	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	9	0	0.00	60	0	0.00
Bovine respiratory synctial virus (BRSV)	10	0	0.00	9	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	8	0	0.00	58	0	0.00
Infectious bovine rhinotrachetis (IBR)	10	0	0.00	9	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	8	0	0.00	58	0	0.00
Parainfluenza-3 (PI-3)	10	0	0.00	9	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	8	0	0.00	58	0	0.00
Epizootic hemorrhagic disease (EHD)	10	0	0.00	9	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	8	0	0.00	58	0	0.00
Caprinae arthritis encephalitis (CAE)	10	0	0.00	9	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	8	0	0.00	58	0	0.00
Malignant cataharral fever-ovine (MCF)	10	0	0.00	9	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	8	0	0.00	58	0	0.00
Leptospirosis cannicola	10	0	0.00	9	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	8	0	0.00	58	0	0.00
Leptospirosis grippo	10	0	0.00	9	0	0.00	10	1	0.10	10	0	0.00	11	0	0.00	8	1	0.13	58	2	0.03
Leptospirosis hardjo	10	0	0.00	9	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	8	0	0.00	58	0	0.00
Leptospirosis ictero	10	0	0.00	9	0	0.00	10	3	0.30	10	2	0.20	11	1	0.09	8	2	0.25	58	8	0.14
Leptospirosis pomona	10	0	0.00	9	0	0.00	10	0	0.00	10	0	0.00	11	0	0.00	8	0	0.00	58	0	0.00

Appendix 3: Trace mineral concentration documented for mountain goats in the Haines-Skagway study area, 2010. Results are also provided for three other populations in southeast Alaska in 2010, for comparison.

	Se			Fe			Cu			Zn			Mo			Mn		
Area	Mean	n	SE	Mean	n	SE	Mean	n	SE	Mean	n	SE	Mean	n	SE	Mean	n	SE
Baranof	0.37	12	0.01	1.95	12	0.11	1.10	12	0.06	0.76	12	0.05	<0.05	12	0.00	<0.006	12	0.00
Cleveland	0.26	5	0.01	1.71	5	0.09	0.81	5	0.03	0.70	5	0.04	<0.05	5	0.00	<0.006	5	0.00
Grandchild	0.27	2	0.08	2.86	2	0.03	1.07	2	0.05	0.77	2	0.06	<0.05	2	0.00	<0.006	2	0.00
Kakuhan	0.19	6	0.04	1.98	6	0.12	1.04	6	0.05	0.61	6	0.03	<0.05	6	0.00	<0.006	6	0.00
Haines	0.30	22	0.03	2.27	21	0.07	1.07	21	0.07	0.78	21	0.05	<0.05	21	0.00	<0.006	21	0.00
Total	0.30	47	0.02	2.11	46	0.06	1.04	46	0.04	0.74	46	0.03	<0.05	46	0.00	<0.006	46	0.00

Appendix 4: Mountain goat aerial survey routes, Haines-Skagway, AK, 2010-2011



Appendix 5: Mountain goat aerial survey results, Haines-Skagway, AK, 2010-2011.

Study Area	Year	Date	Adults	Kids	Total	% Kids	Temp	Wind	Weather	Marked	Seen	Sighting Probability
Takhinsha	2011	9/26/11	56	8	64	12.5%	27	10-15	Mostly Clear	2	1	0.50
Takhin Ridge	2010	9/10/10	94	29	123	23.6%	42-50	0-10	High Overcast	4	3	0.75
Takhin Ridge	2011	9/12/11	54	14	64	21.9%	46	5-10	Mostly Clear	8	2	0.25
Takhin Ridge	2011	9/26/11	92	27	119	22.7%	32	5-15	High Overcast	8	6	0.75
Porcupine	2010	9/10/10	71	19	90	21.1%	43-45	0-10	High Overcast	3	1	0.33
Porcupine	2011	9/12/11	68	31	99	31.3%	50	5	High Overcast	3	3	1.00
Porcupine	2011	9/26/11	87	26	113	23.0%	36	10-15	High Overcast	3	1	0.33
Takshanuk	2010	9/8/10	311	73	384	19.0%	50	5	High Overcast	6	5	0.83
Takshanuk	2011	9/27/11	275	90	365	24.7%	35	0-10	High Overcast	4	3	0.75
Chilkoot	2010	9/22/10	144	41	185	22.2%	35	5-15	High Overcast	5	3	0.60
Chilkoot[1]	2011	9/25/11	172	34	206	16.5%	34-37	5-10	Mostly Clear	2	2	1.00
Halutu Ridge	2011	9/25/11	59	3	62	4.8%	34-37	5-10	Mostly Clear	1	1	1.00
Halutu Ridge[2]	2010	9/22/10	22	8	30	26.7%	35	5-15	High Overcast	1	1	1.00
Yeatman	2011	9/25/11	14	0	14	0.0%	34-37	5-10	Mostly Clear	0	--	--
Nourse-West	2010	9/22/10	14	0	14	0.0%	39	5-15	High Overcast	0	--	--
Nourse-West	2011	9/25/11	19	1	20	5.0%	34-37	5-10	Low Overcast	0	--	--
Nourse-East[3]	2010	9/22/10	13	3	16	18.8%	39	5-15	High Overcast	1	1	1.00
Nourse-East	2011	9/25/11	32	5	37	13.5%	34-37	5-10	Low Overcast	1	1	1.00
Skagway Pie	2011	9/25/11	27	4	31	12.9%	34	5-10	Low Overcast	0	--	--

[1]new area added north of Klukwah (19 adults, 3 kids in this new area)

[2]incomplete survey, only to Burro Creek

[3]did not survey Saussure Glacier (accounted for 5 adults, 0 kids in 2011).