Wildlife Research Annual Progress Report

Mountain Goat Movement Patterns and Population Monitoring on Baranof Island

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Alaska Department of Fish and Game Division of Wildlife Conservation

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Mountain Goat Movement Patterns and Population Monitoring on Baranof Island

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INTRODUCTION

The City and Borough of Sitka is planning to conduct hydroelectric development activities on central Baranof Island, specifically in the vicinity of Blue and Takatz lakes. Among the key wildlife species potentially affected by this development project are mountain goats (City and Borough of Sitka Electric Department 2010). Specifically, mountain goat populations are expected to be sensitive to hydroelectric project activities associated with inundation of lakeshore winter habitat, construction activities, increased human access and cumulative effects of dual projects in both the Blue and Takatz lake watersheds.

In response to the above concerns, the City and Borough of Sitka (CBS) and the Alaska Department of Fish and Game (ADFG) have initiated cooperative mountain goat population monitoring activities to determine possible impacts of hydroelectric development on mountain goats and identify potential mitigative measures, to the extent feasible. 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 the ADFG and local stakeholder groups with information necessary to appropriately manage mountain goats in the vicinity of proposed development activities and beyond. The three objectives of the proposed assessment and monitoring work include:

Objectives:

1) Characterize seasonal movement and habitat selection patterns of mountain goats on central Baranof Island.

2) Assess reproductive success and survival of mountain goats on central Baranof Island.

3) Estimate and monitor mountain goat population abundance and composition on central Baranof Island.

Study Area:

Field research activities were concentrated in ca. 1360 km^2 area surrounding the Blue and Takatz lake hydroelectric project sites (Figure 1). This configuration was intended to enable collection of field data across an array of locally distinctive habitat complexes inhabited by mountain goats within the hydroelectric project areas (Figure 2). In addition, since mountain goats are capable of making routine annual movements of 10-15 km (and dispersal movements exceeding 35 km) it was considered necessary to delineate a study area large enough to encompass the area used by mountain goats potentially affected by development activities.

Figure 1: Map of the Baranof Island study area. The red shaded area depicts the study area boundary; the city of Sitka is shown for reference.

Figure 2: Photograph of upper Indian River/Katlian divide depicting the rugged character of the landscape on the western side of the mountain goat study area, November 2012 .

METHODS

Mountain Goat Capture

Mountain goats were captured using standard helicopter darting techniques and immobilized by injecting 2.4-3.0 mg 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 3). Following handling procedures, the effects of the immobilizing agent were reversed with 100 mg of naltrexone hydrochloride per 1 mg of carfentanil citrate (Taylor 2000). All capture procedures were approved by the State of Alaska Animal Care and Use Committee.

Figure 3: Sitka wildlife biologist, Kent Bovee, handling an adult male mountain goat (BG-20) in the upper Blue Lake watershed, Baranof Island, August 2012.

GPS Location Data

Telonics TGW-3590 and TGW-4500 GPS radio-collars (Telonics, Inc., Mesa, AZ) were deployed on all captured animals. In addition, lightweight Telonics MOD-400 VHF radio-collars were also simultaneously deployed on each animal to enable longer-term monitoring opportunities (collar lifespan: ~6 years). 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 = 9), GPS location data-sets were remotely downloaded (via fixed-wing aircraft) 2-3 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 in June 2014 and annually thereafter (depending on deployment date). 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).

Movement Patterns and Habitat Use

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 from all GPS collars (i.e., 2015).

Preliminary analyses of GPS location data downloaded from 9 TGW-3590 radio-collars was conducted to examine seasonal movement patterns and elevational migration. Specifically, we summarized the average elevation (ft.) per day in order to determine when elevational migrations occurred and the average elevation used during the summer and winter periods. We also estimated the average distance moved during a 6-hr period and examined how movement distances varied seasonally (using the Geospatial Modeling Environment software; http://www.spatialecology.com/gme/).

Reproduction and Survival

Kidding rates and subsequent survival was 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 could be reliably observed in open habitats. We assumed 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 were filtered from the data set and not used for subsequent estimates of kid survival.

Mortality of individual radio-collared mountain goats was 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 were 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 was 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

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 ancillary data were collected to characterize behavioral and habitat conditions expected, a priori, to influence sighting probabilities.

Preliminary estimates of mountain goat population size were calculated using standard Lincoln-Peterson mark-resight methods. In the future, estimates will be revised using more complex models (see White and Pendleton 2012). The entire study area was subdivided into geographically discrete survey areas (Appendix 1) in order to gain insight into patterns of spatial variability. However, preliminary population estimates were based on adjusting raw counts in accordance with the sighting probability (i.e., the ratio of the number of marked animals seen vs. present in the study area) estimates for the entire study area. This approach was used because the number of marked animals in any given survey area was too small for accurate estimates, and we did not feel that survey conditions during the day of survey varied markedly between survey areas.

Results and Discussion:

Mountain Goat Capture and Handling

Capture Activities.—Mountain goats were captured during four days in August-September 2010-2012. Overall, 24 animals (6 females and 18 males) were captured using standard helicopter darting methods (Figure 4, Appendix 2). Each animal was deployed with a Telonics TGW-3590 (n = 9) or TGW-4500 (n = 15) GPS radio-collar and a lightweight Telonics MOD-400 VHF radio-collar (370g). Double-collaring animals was conducted to extend the

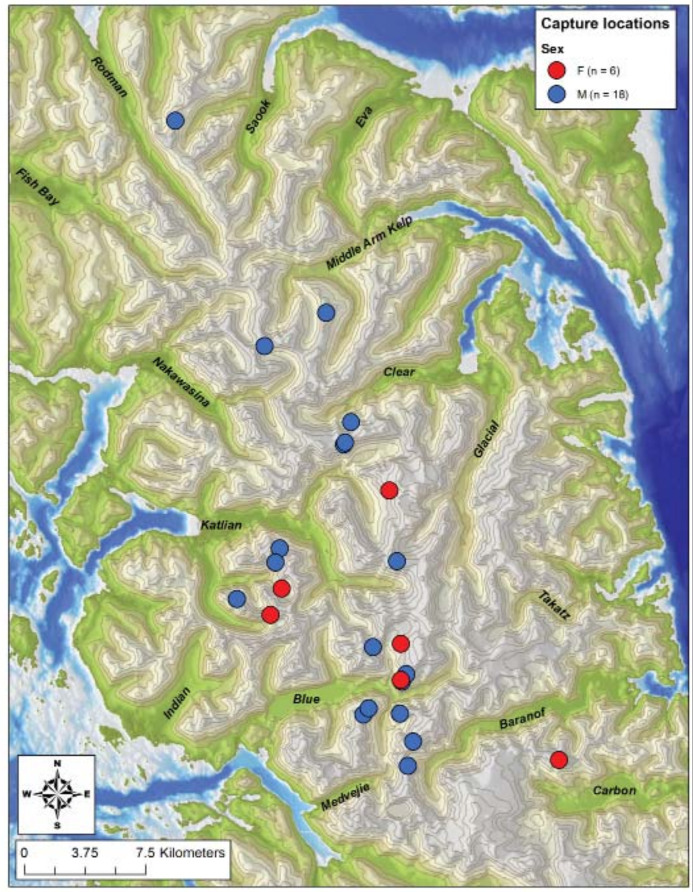

Figure 4: Location of mountain goat capture sites in central Baranof Island, September 2010-2012 (n = 24). Sex of animals captured and key geographic localities are identified.

time period 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 had to 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 annual sample size objectives, the difficulty of capturing mountain goats (due to terrain ruggedness and animal abundance and distribution) exceeds that of other areas in southeastern Alaska where mountain goats have been captured in recent years (i.e., Lynn Canal, Haines/Skagway, Cleveland Peninsula). Consequently, the distribution of collar deployments was less uniform than desired, with a majority of collar deployments being concentrated on the central and western side of the study area. Nonetheless, given seasonal movement patterns, capture locations are not necessarily a reliable indicator of the annual distribution of individual animals. Thus, the possibility remains that the apparent bias, described above, may not persist over time.

Helicopter capture activities during August 2012 afforded an opportunistic observation of a Sitka black-tailed deer with a rare color morph (Figure 5). This male deer was observed in association with two other male deer in alpine habitat, and within 1 km of a pair of male mountain goats. The grey pelage was comparable in appearance to light phase black bears (commonly referred to as "glacier" bears) and did not appear to be a true albino. This color morph has also been reported among Sitka black-tailed deer on Admiralty (n = 2) and Chichagof islands (n =1). However, since systematic surveys or archival of anecdotal records do not currently exist, it is possible that light colored Sitka black-tailed deer also occur elsewhere in comparable frequency.

Figure 5: Photo of a "glacier" phase Sitka black-tailed deer encountered during mountain goat capture activities on Baranof Island, September 2012.

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 and trace mineral analyses, or archived at ADFG facilities in Douglas, AK.

Disease Testing.—Blood serum samples collected from captured animals were also tested for a suite of 15 different diseases relevant to ungulates (Appendix 3). Of particular interest was contagious ecthyma (CE), a viral disease previously documented among mountain goats in Juneau, Haines and other areas of southeastern 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 18 animals successfully tested for CE, only one animal tested positive for CE-specific antibodies; a comparable prevalence relative to other southeastern Alaska populations tested in 2005-2011 (Appendix 3). Otherwise, antibody prevalence of the remaining diseases tested for was virtually absent and indicates a general lack of disease exposure among Baranof mountain goats; yet, it is important to recognize that such conditions likewise suggest a high level of vulnerability should such diseases become prevalent in the future (i.e., due to a lack of a previous immune response). The general lack of positive antibody responses for the suite of diseases examined was also typical of the other southeastern Alaska populations tested.

Trace Mineral Testing.—In 2010-2011, whole blood and serum samples were analyzed to determine trace mineral concentration of 19 mountain goats in order to examine whether mineral deficiencies were prevalent in our study population (Appendix 4). Unfortunately, baseline mineral concentration values for healthy mountain goats are limited and constrain our ability to compare observed values in our study population to established standards. Nonetheless, Selenium (Se) and Copper (Cu) deficiencies have been studied in northern ungulates (Fielder 1986, O'Hara et al. 2001) and the mountain goats sampled did not appear to have concentrations below reported deficiency thresholds for both of these minerals (i.e., Se > 0.05, Cu >0.8). In comparison to other southeastern Alaska populations, Baranof mountain goats appear to have comparable or higher values for the minerals tested, suggesting that equal or higher levels of mineral resources were available for animals in the Baranof population, relative to elsewhere.

Population Genetics.—Tissue samples from all mountain goats captured (and a majority of animals harvested via ADFG registration hunts) were sent to Aaron Shafer (University of Alberta) for inclusion in a broad-scale mountain goat population genetics analysis. Results from this study (Shafer et al. 2010) indicate that substantial genetic structuring exists among mountain goats in southeastern Alaska. Interestingly, analyses suggest that mountain goats on Baranof Island are derived from two separate source populations (Shafer et al. 2010, Shafer et al. 2011). One source population consists of animals translocated from Tracy Arm in 1923 (Paul 2009). The other source population consists of animals originating from a population endemic to Baranof Island, putatively occurring on Baranof Island prior to the 1923 translocation and persisting in a coastal refugia during the last ice age (unbeknownst to contemporary historians). The conservation implications associated with the presence of two distinct genetic lineages (one introduced and one endemic) on Baranof Island are provocative.

Future analyses will focus on examining the spatial distribution of each lineage and determining the extent of overlap (relying primarily on data from harvested animals). Further, genotyping animals captured during this study will enable assignment to the appropriate genetic lineages and make possible more discrete linkages between genetic identity to spatial distribution (via GPS collar location data) and, potentially, vital rates. To accomplish the latter objectives, additional sample collection efforts have resulted in archival of 156 mountain goat samples (102 males, 54 females) from Baranof Island during 2003-2012. As of August 2012, laboratory analyses have been completed and further statistical analyses of genetic data are planned for the future.

GPS Data and Movement Patterns

GPS location data were successfully downloaded during aerial surveys from all nine animals deployed with remotely downloadable collars (i.e., TGW-3590) and one animal that was deployed with a "store-on-board" GPS collar (that died in May 2011). Overall, 17,704 GPS locations (n = 10 animals) have been downloaded and archived.

Preliminary analyses were conducted to examine seasonal patterns in altitudinal distribution and movement. Specifically, mountain goats on Baranof Island conducted seasonal altitudinal migrations between high elevation summer range (ca. 3000-3400 ft) and lower elevation forested winter range (ca. 1200-1500 ft.; Figure 6), a pattern typical of mountain goat populations elsewhere in southeastern Alaska. Fall migration to lower elevation appears to coincide with the onset of snow accumulation at high elevation and typically occurs during October-November. In spring, movements to high elevation occur during May and coincide with snow ablation and the kidding season. Interannual variation in altitudinal fall migrations was evident and migration appeared to commence later in 2010 than in 2011; the latter year was characterized by more early-season snowfall.

Mountain goat movement rates also varied seasonally (Figure 7). Specifically, movement patterns were 5-6 times greater during the summer, as compared to winter. Within this context, male mountain goats increased movement rates substantially during the breeding season, presumably in order to maximize encounter rates with receptive females. Females, on the other hand, had relatively low

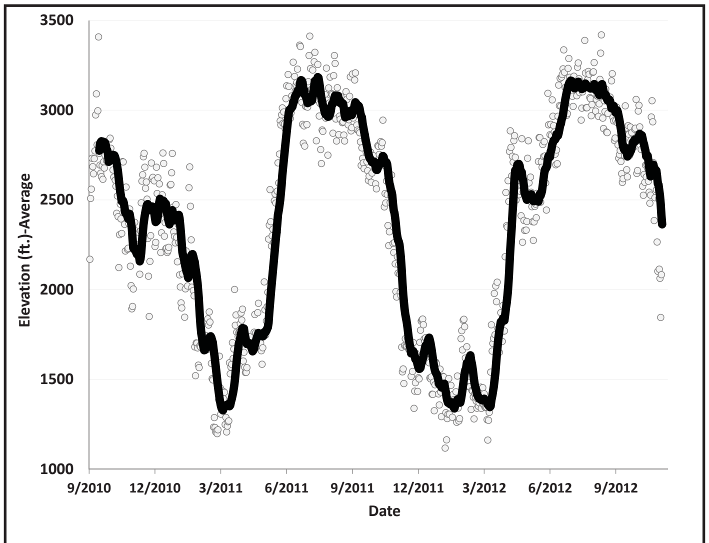

Figure 6: Altitudinal distribution on GPS radio-marked mountain goats (n = 9) between 2010-2012 on Baranof Island. Data are reported as average daily elevation, pooled across all animals.

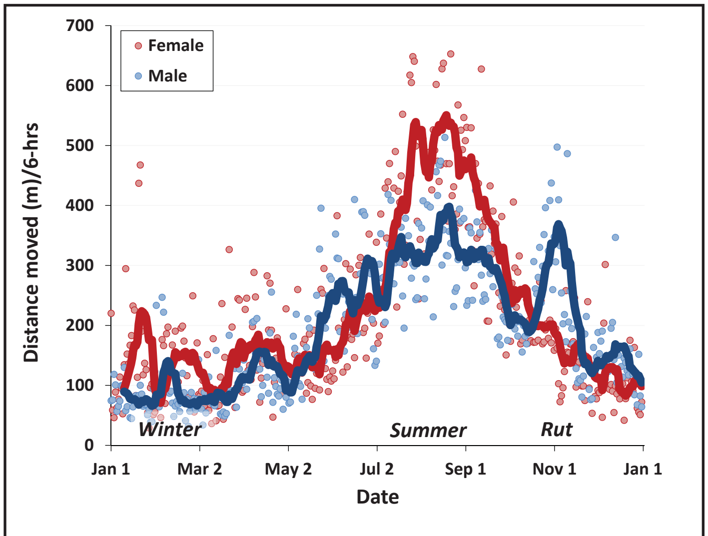

Figure 7: Relationship between daily movement rate and time of year for male and female GPS radio-marked mountain goats (n = 9) on Baranof Island. Data are pooled among years.

movement rates. Limited movement would result in female distribution being spatially predictable and thereby increasing the likelihood of being encountered by more widely-ranging males during the breeding season.

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 and 2012 surveys were conducted during the late-parturition period and are expected to more closely approximate actual parturition rates. Overall, we determined that 80% of marked females had kids at heel during 2010-2012 (Table 1). This baseline estimate is higher than longer-term estimates calculated for mountain goats on the mainland (Table

Table 1: Proportion of radio-marked adult female mountain goats seen with a kid at heel in the Baranof Island study area and, for comparison, Haines-Skagway and Lynn Canal areas, 2005-2012.

Area	Year	Kids	AdF	Prop	SE
Baranof					
	2010	4	4	1.00	0.00
	2011	5	6	0.83	0.15
	2012	3	5	0.60	0.22
	Total	12	15	0.80	0.10
Haines-Skagway					
	2010	5	10	0.50	0.16
	2011	8	10	0.80	0.13
	2012	6	9	0.67	0.16
	Total	19	29	0.66	0.09
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
	2012	8	14	0.57	0.13
	Total	119	188	0.63	0.04

1); however, sample sizes are small and estimates should be considered preliminary until more data is gathered in future years.

Survival-We estimated survival for 19 mountain goats monitored between August 2010-May 2012 (Table 2). Our estimates for 2010 did not include fates of animals during June-August 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 97±3% of animals survived (Table 2). Only one animal died during the monitoring period; an old male that died during late-winter (May 2011) which was either killed or scavenged by a brown bear. Overall, estimated survival in the Baranof population was relatively high, but comparable to estimated survival in the Lynn Canal and Haines-Skagway populations during the equivalent time period. Winter snowfall, an important determinant of mountain goat survival, tends to be substantially lower in the Sitka area, due to the strong maritime influence, relative to the mainland and may account for higher survival rates. Alternatively, mountain goat survival may normally be high on Baranof, relative to mainland populations, due to the absence of wolves. Nonetheless, it is important to recognize that our sample size for the Baranof population is very small for the purposes of estimating survival, and chance events 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.

Population Abundance and Composition Estimation

Systematic aerial surveys were conducted in the study area each year between 2010-2012. However, mark-resight surveys were conducted only in 2011 and 2012 (Appendix 5); mark-resight surveys enable estimation of sighting probability and population size.

Sighting probabilities tended to be lower in 2012 as compared to 2011 (Table 3, Appendix 5), but sample sizes were relatively small, resulting in a lack of statistical differences between years. Sighting probabilities observed during aerial surveys on Baranof Island were similar to sighting probabilities estimated during simultaneous studies conducted in Lynn Canal and the Haines-Skagway area (Table 3). Overall, we estimated that between 52-67% of mountain goats were seen during surveys on Baranof Island in 2011-2012. Preliminary analysis of environmental factors influencing the sighting probability of individual mountain goats during aerial surveys were summarized in White and Pendleton (2012).

Survey results were categorized based on watershed basin delineations to provide insight relative to spatial variation in abundance and kid production across the study area. In general, mountain goat abundance was higher on the west side of the island, relative to the east side (Appendix 1). However, within this context, areas on the west side of the island that were in close proximity to human access tended to have reduced abundance; though formal statistical analyses (including reference to historical survey data) are needed to confirm this preliminary assessment. The study area-wide estimate of mountain goat abundance was 38% lower in 2012 as compared to 2011. Likewise, the proportion of kids in the population was substantially lower in 2012 (10.2%) as compared to 2011 (17.9%). While these preliminary results appear to suggest a marked population decline between 2011 and 2012, is it important to interpret these results with caution until further population monitoring data is collected in subsequent years. In addition, further statistical analysis is need to calculate the precision

Table 2: Mountain goat survival estimates, and associated winter climate data, for radio-marked mountain goats in the Baranof Island study area and, for comparison, Cleveland Peninsula, Haines-Skagway and Lynn Canal areas. Sample sizes in the Baranof Island, Cleveland Peninsula and Haines-Skagway area are small and estimates should be interpreted with caution.

	Males				Females				Total			
	At Risk	Died	Ŝ	SE	At Risk	Died	Ŝ	SE	At Risk	Died	Ŝ	SE
Baranof Island												
2010/2011	6.0	1	0.88	0.11	3.0	0	1.00	0.00	9.0	1	0.92	0.08
2011/2012	10.8	0	1.00	0.00	5.5	0	1.00	0.00	16.3	0	1.00	0.00
All years	16.8	1	0.95	0.05	8.5	0	1.00	0.00	25.3	1	0.97	0.03
Cleveland Pen.												
2009/2010	5.0	0	1.00	0.00	2.0	0	1.00	0.00	7.0	0	1.00	0.00
2010/2011	5.8	2	0.67	0.16	5.0	0	1.00	0.00	10.8	2	0.83	0.10
2011/2012	4.0	2	0.50	0.18	6.0	0	1.00	0.00	10.0	2	0.80	0.11
All years	13.5	4	0.73	0.10	12.5	0	1.00	0.00	26.0	4	0.86	0.06
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
2011/2012	13.2	2	0.87	0.09	9.0	1	0.90	0.09	22.2	3	0.88	0.06
All years	22.8	6	0.79	0.08	16.7	4	0.80	0.09	39.5	10	0.79	0.06
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
2006/2007	25.4	11	0.57	0.10	22.1	4	0.82	0.08	47.5	15	0.68	0.07
2007/2008	26.5	6	0.79	0.07	20.8	3	0.88	0.07	47.3	9	0.83	0.05
2008/2009	24.2	10	0.66	0.09	21.4	6	0.73	0.09	45.6	16	0.69	0.06
2009/2010	25.1	4	0.86	0.07	22.3	4	0.85	0.07	47.4	8	0.85	0.05
2010/2011	24.3	3	0.88	0.06	23.2	2	0.91	0.06	47.5	5	0.90	0.04
2011/2012	17.9	6	0.72	0.10	15.3	3	0.85	0.08	33.2	9	0.77	0.07
All years	150.7	43	0.75	0.03	132.5	24	0.83	0.03	283.2	67	0.79	0.02

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

Table 3: Summary of sighting probabilities detected during mountain goat aerial surveys conducted in 4 seperate study areas during 2010-2012 in southeastern Alaska.

Area	Seen	Total	Prop. seen	SE
Baranof				
2010	--	--	--	--
2011	12	18	0.67	0.11
2012	11	21	0.52	0.11
Total	23	39	0.59	0.08
Cleveland Pen				
2010	--	--	--	--
2011	--	--	--	--
2012	3	16	0.19	0.10
Total	3	16	0.19	0.10
Haines-Skagway				
2010	14	20	0.70	0.10
2011	20	32	0.63	0.09
2012	8	18	0.44	0.12
Total	42	70	0.60	0.06
Lynn Canal				
2010	39	73	0.53	0.06
2011	19	28	0.68	0.09
2012	21	32	0.66	0.08
Total	79	133	0.59	0.04
Overall total	215	383	0.56	0.03

of annual estimates (sensu White and Pendleton 2012) and determine whether statistically significant differences have occurred between years of study. Regardless, these preliminary results suggest that management of the population should remain conservative.

It is not yet firmly understood why population abundance and the proportion of kids in the population may have declined over the past year. However, possible factors contributing to the observed pattern include winter severity and the effects of chronic harvest of female mountain goats. Sitka reported substantially less winter snowfall during the winter of 2010/2011 (12.7 inches) than in the winter of 2011/2012 (77.4 inches). While the amount of snowfall reported in Sitka is substantially less than other mainland sites, the differences between years may account for increased energetic costs and reduced reproduction and survival during 2012, relative to 2011. However, the high survival estimates documented in 2012 are not consistent with this interpretation; yet sample sizes were small and may not be representative of the population as a whole. In addition, the summer of 2012 was also characterized by unusually cool temperatures and significantly delayed melt of the snowpack at high elevations and may have affected nutritional condition and reproductive success. With regard to harvest effects, the western side of the study area has experienced high mountain goat harvest, in general, but of specific concern has been the relatively high proportion of female mountain goats in the harvest. Harvest of female mountain goats can have a disproportionate effect on mountain goat population growth rates, relative to harvest of males (Hamel et al. 2006). The long-term effects of overharvest on mountain goat populations can result in an altered population age structure which is particularly relevant to mountain goats given the late age at first reproduction and, generally, low reproductive rates. Consequently, the reduced proportion of mountain goat kids in the population could be due to the combined effects of deleterious weather conditions and harvest-induced alteration of the population age structure and reduction of number of sexually mature females in the population. Additional field data is needed to examine these hypotheses.

Future Work/Recommendations:

Original project planning called for radio-marking and monitoring 30 mountain goats over a 5 year period in order to acquire scientifically defensible field data for management applications. To date, 56% of the funding required to implement the project, as described above, has been secured (approximately equal contributions have been made by the City of Sitka and ADFG). Additional contributions have been received from the U.S. Forest Service for the population estimation and aerial survey sighting probability component of the study. Prospects for additional funding from existing or other funding sources is uncertain. Consequently, planned project activities scheduled for 2013 are likely to be scaled back to fit with available funds, unless additional funding is secured.

Continued efforts will be made to monitor fates of marked animals opportunistically from the ground or air. Specific efforts will be made to remotely download TGW-3590 GPS collars (n = 9) and ascertain reproductive success of radio-marked female mountain goats (n = 6) in spring 2012; over-winter mortalities will be investigated from the ground, as applicable. During June 2013, 5 TGW-3590 GPS radio-collars are scheduled to automatically release from mountain goats and will be recovered from the field with helicopter support. During August/September 2013, no more than 6 additional GPS radio-collars will be deployed via helicopter capture methods, contingent on sufficient funding. Annual fall aerial population estimation and composition surveys will be conducted in September/October 2013. Finally, an annual project progress report will be prepared and submitted by December 31, 2013.

Acknowledgements

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Project Publications:

White, K. S., P. Mooney and K. Bovee. 2011. Mountain goat movement patterns and population monitoring on Baranof Island. Wildlife Research Annual Progress Report. Alaska Department of Fish and Game, Division of Wildlife Conservation, Douglas, AK.

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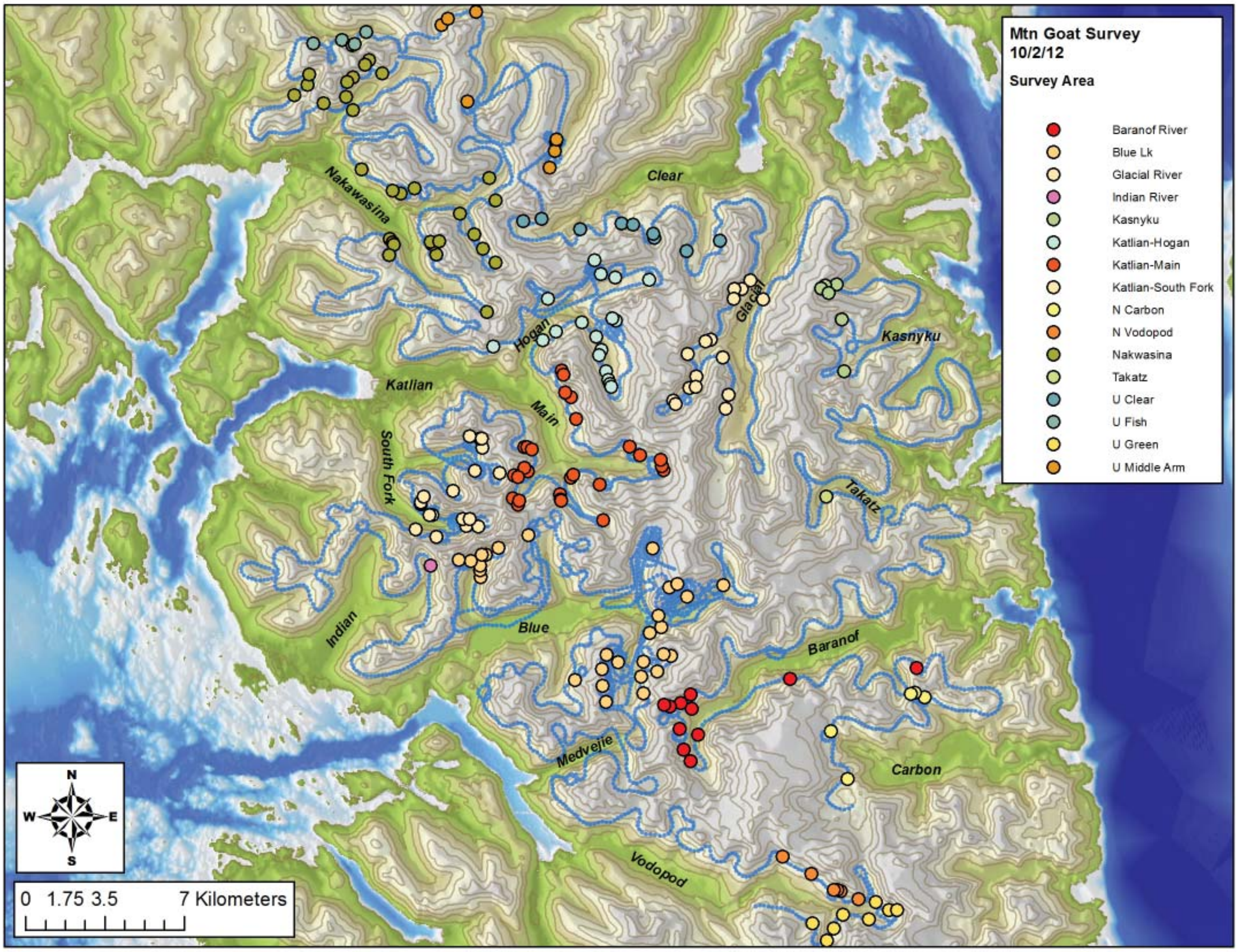
Appendix 1. Map depicting the route (i.e., light blue line) of the mountain goat aerial survey conducted in 2012 in the Baranof Island study area. The locations of each mountain goat group observed are color coded based on specific watershed-based geographic areas; survey results are reported in Appendix 5.



Appendix 2: Characteristics of mountain goats (n = 24) captured on central Baranof Island, 2010-2012. "Status" denotes fate as of November 9, 2012.

Mtn Goat ID	Date	Sex	Est. Age	Kid at Heel	Weight (lbs.)	Horns[1]		GPS Collar Type	Status	Location
						Total Length	Basal Circum.			
BG01	9/7/10	M	3	--	--	--	--	TGW-3590	Alive	Blue Lk
BG02	9/7/10	M	1	--	134	7 1/16	4 11/16	TGW-3590	Alive	Blue Lk
BG03	9/7/10	F	6	1	196	7 3/16	3 9/16	TGW-3590	Alive	Blue Lk
BG04	9/7/10	M	2	--	150	8	4 12/16	TGW-3590	Alive	Blue Lk
BG05	9/7/10	M	8	--	290	7 0/16*	4 14/16	TGW-3590	Alive	Baranof R Pass
BG06	9/7/10	F	5	1	163	7 14/16	3 14/16	TGW-4500	Alive	Katlian
BG07	9/7/10	M	1	--	119	6 2/16	4 5/16	TGW-4500	Alive	Katlian
BG08	9/12/10	F	9	1	201	10 2/16	3 12/16	TGW-4500	Alive	Carbon
BG09	9/12/10	M	4	--	--	8 13/16	5 1/16	TGW-4500	Alive	Baranof R Pass
BG10	9/12/10	M	8	--	306	8 10/16	4 14/16	TGW-4500	Died	Katlian
BG11	9/12/10	M	8	--	--	9 7/16	--	TGW-4500	Alive	Katlian
BG12	9/12/10	F	5	1	179	8 13/16	4	TGW-4500	Alive	Katlian
BG13	9/11/11	M	3	--	229	8 1/16	4 14/16	TGW-3590	Alive	Blue Lk
BG14	9/11/11	M	4	--	275	8 9/16	5 1/16	TGW-3590	Alive	Blue Lk
BG15	9/11/11	F	4	1	175	8 11/16	4	TGW-3590	Alive	Blue Lk
BG16	9/11/11	F	5	1	203	8	3 15/16	TGW-3590	Alive	Katlian
BG17	9/11/11	M	7	--	340	8 8/16	5 3/16	TGW-4500	Alive	Hogan Lk
BG18	9/11/11	M	3	--	209	8 1/16	5	TGW-4500	Died	Hogan Lk
BG19	9/11/11	M	7	--	322	7 14/16*	5	TGW-4500	Alive	Nakwasina
BG20	8/20/12	M	6	--	285	9 1/16	5 4/16	TGW-4500	Alive	Blue Lk
BG21	8/20/12	M	6	--	267	8 10/16	5 4/16	TGW-4500	Alive	Katlian
BG22	8/20/12	M	14	--	227	10 2/16	5 15/16	TGW-4500	Died	Clear R
BG23	8/20/12	M	6	--	324	9 15/16	5 2/16	TGW-4500	Alive	MF Kelp Arm Ck
BG24	8/20/12	M	5	--	259	9 8/16	5 2/16	TGW-4500	Alive	Saook

[1] **Horn dimensions reflect length or circumference of the largest horn; an asterisk denotes the horn tip was broomed.**

Appendix 3. Incidence of disease prevalence of mountain goats in the Baranof Island study area, 2010-2011. Results are also provided for three other populations in southeastern Alaska in 2005-2011, for comparison.

	Baranof			Cleveland			Haines			Berners			Kakuhan			Villard			Total		
Disease	n	Pos.	Prop	n	Pos.	Prop	n	Pos.	Prop	n	Pos.	Prop	n	Pos.	Prop	n	Pos.	Prop	n	Pos.	Prop
Contagious Ecthyma	18	1	0.06	10	1	0.10	19	1	0.05	20	1	0.05	41	3	0.07	24	0	0.00	132	7	0.05
Chlamydia	11	1	0.09	12	1	0.08	22	0	0.00	27	2	0.07	29	1	0.03	30	0	0.00	131	5	0.04
Q Fever	19	0	0.00	11	0	0.00	32	0	0.00	29	0	0.00	50	3	0.06	32	1	0.03	173	4	0.02
Bluetongue	17	0	0.00	10	0	0.00	20	0	0.00	20	0	0.00	17	0	0.00	18	0	0.00	102	0	0.00
Bovine respiratory synctial virus (BRSV)	17	0	0.00	10	0	0.00	20	0	0.00	21	0	0.00	17	0	0.00	16	0	0.00	101	0	0.00
Infectious bovine rhinotrachetis (IBR)	17	0	0.00	10	0	0.00	20	0	0.00	21	0	0.00	17	0	0.00	17	0	0.00	102	0	0.00
Parainfluenza-3 (PI-3)	17	0	0.00	10	0	0.00	20	0	0.00	21	0	0.00	17	0	0.00	17	0	0.00	102	0	0.00
Epizootic hemorrhagic disease (EHD)	17	0	0.00	9	0	0.00	20	0	0.00	21	0	0.00	17	0	0.00	17	0	0.00	101	0	0.00
Caprinae arthritis encephalitis (CAE)	17	0	0.00	9	0	0.00	20	0	0.00	21	0	0.00	17	0	0.00	16	0	0.00	100	0	0.00
Malignant cataharral fever-ovine (MCF)	17	0	0.00	9	0	0.00	20	0	0.00	21	0	0.00	17	0	0.00	16	0	0.00	100	0	0.00
Leptospirosis cannicola	17	0	0.00	9	0	0.00	20	0	0.00	21	0	0.00	17	0	0.00	17	0	0.00	101	0	0.00
Leptospirosis grippo	17	0	0.00	9	0	0.00	20	1	0.05	21	0	0.00	17	1	0.06	17	1	0.06	101	3	0.03
Leptospirosis hardjo	17	0	0.00	9	0	0.00	20	0	0.00	21	0	0.00	17	0	0.00	17	0	0.00	101	0	0.00
Leptospirosis ictero	17	0	0.00	9	0	0.00	20	3	0.15	21	2	0.10	17	3	0.18	17	3	0.18	101	11	0.11
Leptospirosis pomona	17	0	0.00	9	0	0.00	20	0	0.00	21	0	0.00	17	0	0.00	17	0	0.00	101	0	0.00

Positive titers: PI3>1:120, IBR> 1:64, BRSV >1:32, Leptospirosis sp.>1:100

Appendix 4. Trace mineral concentration (ppm) documented for mountain goats in the Baranof Island study area, 2010-2011. Results are also provided for three other populations in southeastern 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	0.34	19	0.01	1.81	19	0.09	1.09	19	0.04	0.80	19	0.04	<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	0.18	10	0.02	1.67	10	0.15	0.92	10	0.07	0.69	10	0.04	<0.05	6	0.00	<0.006	6	0.00
Haines	0.28	32	0.03	2.03	30	0.09	1.07	30	0.05	0.79	30	0.04	<0.05	21	0.00	<0.006	21	0.00
Total	0.28	68	0.02	1.91	66	0.06	1.03	66	0.03	0.77	66	0.02	<0.05	46	0.00	<0.006	46	0.00

Appendix 5. Summary of mountain goat aerial survey results, conducted from a fixed-wing aircraft (Piper Cub) during 2011 and 2012. Results for “adults”, “kids” and “total” represent the number of animals seen (i.e., not corrected for sighting probabilities) in specific watersheds on central Baranof Island, AK. The “estimated total” represents the estimated number of total animals in each survey area after accounting for year-specific aerial survey sighting probabilities (i.e., the proportion of marked animals seen during the study area-wide survey, by year).

Area	Date	Adults	Kids	Total	% Kids	Sighting Prob	Est. Total	CI
N Vodopod	9/25/11	21	2	23	8.7	0.67	34	7
	10/2/12	8	0	8	0.0	0.52	16	0
Medvejie	9/25/11	0	0	0	0.0	--	--	--
	10/2/12	0	0	0	0.0	--	--	--
Blue Lake	9/25/11	63	16	79	20.3	0.67	116	31
	10/2/12	42	5	47	10.6	0.52	87	28
Indian River	9/25/11	3	1	4	25.0	--	--	--
	10/2/12	3	1	4	25.0	--	--	--
Katlian-South Fork	9/25/11	36	6	42	14.3	0.67	62	15
	10/2/12	38	4	42	9.5	0.52	78	25
Katlian-Main	9/25/11	58	10	68	14.7	0.67	100	27
	10/2/12	48	4	52	7.7	0.52	96	31
Katlian-Hogan	9/25/11	66	21	87	24.1	0.67	128	35
	10/2/12	34	6	40	15.0	0.52	74	23
Nakwasina (partial)*	9/25/11	81	14	95	14.7	0.67	139	38
	10/2/12	46	7	53	13.2	0.52	98	32
Glacial River	9/25/11	40	13	53	24.5	0.67	78	20
	10/2/12	18	3	21	14.3	0.52	39	10
Kasnyku	9/25/11	7	0	7	0.0	--	--	--
	10/2/12	12	0	12	0.0	--	--	--
Takatz	9/25/11	5	2	7	28.6	--	--	--
	10/2/12	1	0	1	0.0	--	--	--
Baranof River	9/25/11	23	3	26	11.5	0.67	38	8
	10/2/12	13	0	13	0.0	0.52	25	4
N Carbon	9/25/11	2	1	3	33.3	--	--	--
	10/2/12	9	1	10	10.0	--	--	--
Total	9/25/11	403	88	491	17.9	0.67	722	210
	10/2/12	272	31	303	10.2	0.52	556	200
% change		-32.5	-64.8	-38.3			-22.9	

*Nakwasina (partial) = Slaughter Ridge, Rosenburg Lk and W Annahootz not surveyed in 2011 (in 2012 those areas accounted for 11 Adults and 3 kids)