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

December 2011

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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 Fish and Game and the City of Sitka. Dean Orbison (Sitka), Rod Flynn (ADFG), Sandy O'Brien (ADFG), David Thomsen (ADFG) and Brian Logan (USFS) coordinated project funding. Jeff Jemison, Holley Dennison, Kevin Johnson, Jon Martin and Tyler Orbison provided assistance with field or related activities. Mark Pakila, Pat Valkenburg, Mark Hackett and Craig Walters provided fixed-wing air charter services. Mitch Horton (Temsco Helicopters) provided unparallelled helicopter capture services.

Cover photo: Photograph of a 3-year old male mountain goat captured in September 2011 in the Blue Lake watershed (Photo by Phil Mooney).

Contents

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 Alaska Department of Fish and Game 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. 500 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 30 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 Blue and Takatz Lake sites are specifically identified in addition to the nearby city of Sitka.

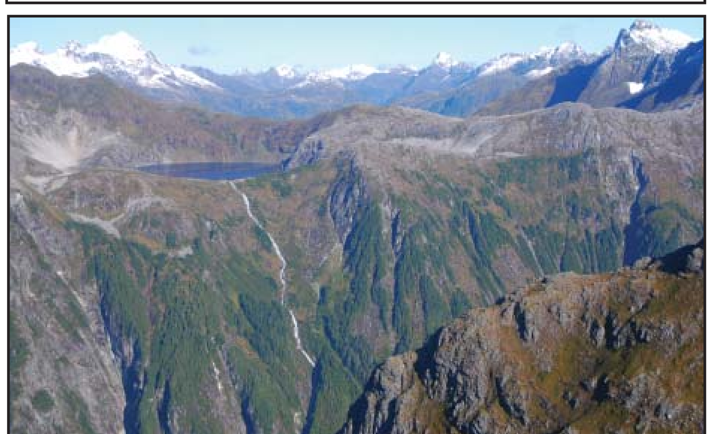
Figure 2: Image of Bear Lake taken from the southern section of the study area (looking north) depicting the diversity of habitat types and ruggedness of the terrain.

METHODS

Mountain Goat Capture

Mountain goats were captured using standard helicopter darting techniques (Figure 3a)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 3b). Following handling procedures, the effects of the immobilizing agent were 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.

Figure 3a: ADFG wildlife biologist, Kevin White, and Temsco helicopter pilot, Mitch Horton, prepare to dart a mountain goat from a helicopter on central Baranof Island, September 2011.

Figure 3b: Temsco helicopter pilot, Mitch Horton, and ADFG wildlife biologist, Phil Mooney, handle an immobilized 7-year old male mountain goat on central Baranof Island, September 2011.

GPS Location Data

Telonics TGW-3590 and TGW-4500 GPS radio-collars (Telonics, Inc., Mesa, AZ) were deployed on most animals captured. 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, 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).

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 for GPS collars (ie. 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 will be 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 two days in September 2010 and one day in September 2011. Overall, 19 animals (6 females and 13 males) were captured using standard helicopter darting methods (Table 1, Figure 4). Each animal was deployed with a Telonics TGW-3590 (n = 9) or TGW-4500 (n = 10) GPS radio-collar and a lightweight Telonics MOD-400 VHF radio-collar (370g). Double-collaring animals was conducted to extend to 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 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

Table 1: Characteristics of mountain goats (n = 19) captured on central Baranof island, September 2010-11.

						Horns[1]			
ID	Date	Sex	Est. Age	Kid at Heel	Weight (lbs.)	Total Length	Basal Circum.	GPS Collar Type	Status
BG001	9/7/10	M	3	--	--	--	--	GPS-SST	Alive
BG002	9/7/10	M	1	--	134	7 1/16	4 11/16	GPS-SST	Alive
BG003	9/7/10	F	6	1	196	7 3/16	3 9/16	GPS-SST	Alive
BG004	9/7/10	M	2	--	150	8	4 12/16	GPS-SST	Alive
BG005	9/7/10	M	8	--	290	7 0/16*	4 14/16	GPS-SST	Alive
BG006	9/7/10	F	5	1	163	7 14/16	3 14/16	GPS-SOB	Alive
BG007	9/7/10	M	1	--	119	6 2/16	4 5/16	GPS-SOB	Alive
BG008	9/12/10	F	9	1	201	10 2/16	3 12/16	GPS-SOB	Alive
BG009	9/12/10	M	4	--	--	8 13/16	5 1/16	GPS-SOB	Alive
BG010	9/12/10	M	8	--	306	8 10/16	4 14/16	GPS-SOB	Died
BG011	9/12/10	M	8	--	--	9 7/16	--	GPS-SOB	Alive
BG012	9/12/10	F	5	1	179	8 13/16	4	GPS-SOB	Alive
BG013	9/11/11	M	3	--	229	8 1/16	4 14/16	GPS-SST	Alive
BG014	9/11/11	M	4	--	275	8 9/16	5 1/16	GPS-SST	Alive
BG015	9/11/11	F	4	1	175	8 11/16	4	GPS-SST	Alive
BG016	9/11/11	F	5	1	203	8	3 15/16	GPS-SST	Alive
BG017	9/11/11	M	7	--	340	8 8/16	5 3/16	GPS-SOB	Alive
BG018	9/11/11	M	3	--	209	8 1/16	5	GPS-SOB	Alive
BG019	9/11/11	M	7	--	322	7 14/16*	5	GPS-SOB	Alive

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

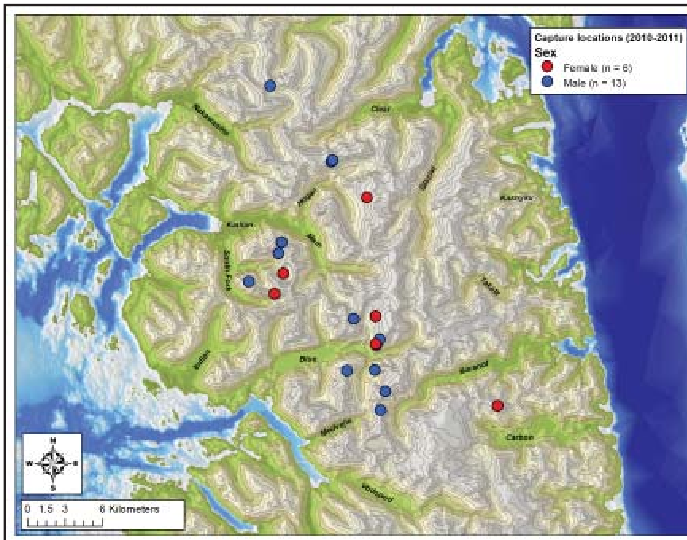

Figure 4: Location of mountain goat capture sites in central Baranof island, September 2010-2011 (n = 19). Sex of animals captured and key geographic localities are identified.

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 for 2010 and 2011 within the allotted helicopter time budgeted, 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 (ie. 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.

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.—Blood serum samples collected from captured animals were also tested for a suite of 15 different diseases relevant to ungulates (Appendix 1). 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 2.

Tissue samples from all mountain goats captured (and a majority of animals harvested via ADFG registration hunts) have been 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 southeast 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 (see 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

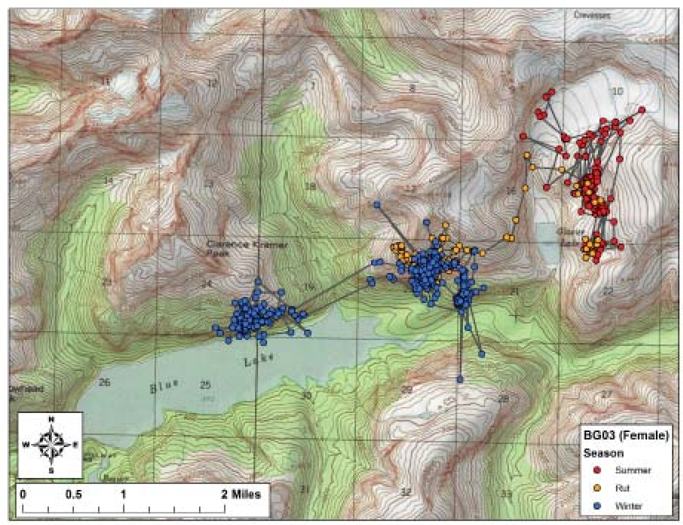

Figure 5: Map of GPS location data downloaded from an adult female mountain goat between Sept. 2010-April 2011, Baranof Island, AK. Locations are color coded based on season.

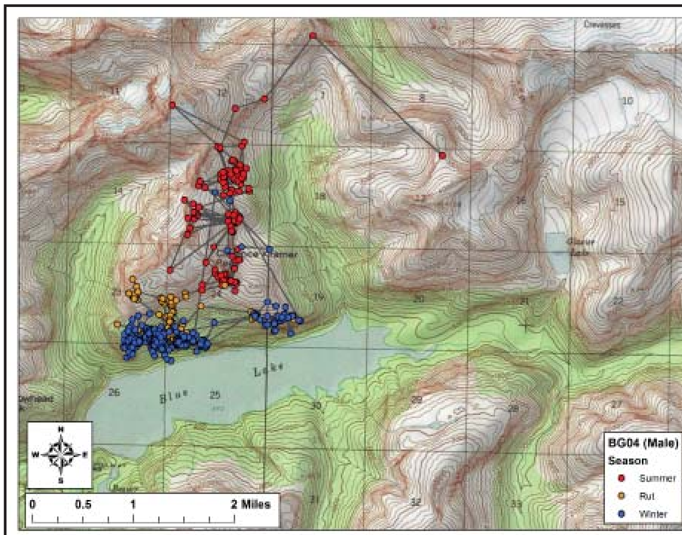

Figure 6: Map of GPS location data downloaded from an adult male mountain goat between Sept. 2010-April 2011, Baranof Island, AK. Locations are color coded based on season.

data from harvested animals). In addition, animals captured during this study will be genotyped and assigned to the appropriate genetic lineage in order to more discretely link genetic identity to spatial distribution (via GPS collar location data) and, also, vital rates.

GPS Data and Movement Patterns

GPS location data were successfully downloaded from all five animals deployed with remotely downloadable collars in 2010 and one animal that was deployed with a "store-on-board" GPS collar (that died in May 2011). Preliminary analyses of the data indicate that, similar to other goat populations in coastal Alaska, the marked animals conduct seasonal migrations from high elevation summer ranges to low elevation winter ranges (Figure 5 and 6). More detailed analyses of the data will be conducted when GPS radio-collar deployments are completed at the conclusion of the study.

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 surveys were conducted during the late-parturition period and are expected to more closely approximate actual parturition rates. Overall, we determined that 90% of marked females had kids at heel during 2010-2011(Table 2). This baseline estimate is higher than longer-term estimates calculated for mountain goats on the mainland (Table 2), however sample sizes are very small and estimates should be considered preliminary until more data is gathered in future years.

Table 2: 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, 2005-2011.

	Year	Kids	AdF	Prop	SE
Baranof					
	2010	4	4	1.00	0.00
	2011	5	6	0.83	0.15
	Total	9	10	0.90	0.09
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

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

	Males				Females				Total			
	At Risk	Died	$\hat{S}$	SE	At Risk	Died	$\hat{S}$	SE	At Risk	Died	$\hat{S}$	SE
Baranof												
2010/2011	6.0	1	0.88	0.11	3.0	0	1.00	0.00	9.0	1	0.92	0.08
All years	6.0	1	0.88	0.11	3.0	0	1.00	0.00	9.0	1	0.92	0.08
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
All years	11.6	4	0.69	0.13	9.2	3	0.70	0.14	20.8	7	0.70	0.10
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
All years	133.3	37	0.76	0.03	117.8	21	0.84	0.03	251.2	58	0.79	0.02

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

Survival-We estimated survival for 12 mountain goats monitored between August 2010-May 2011. Our estimates 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 92±8% of animals survived (Table 3). Only one animal died during the monitoring period; a 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 population for 2010/11. The winter of 2010/11 was relatively mild and the observed survival rate may be related to lower than average snowfall (see White et al. 2011). 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

One aerial survey of the study area was conducted over two days in mid-September 2010 and two surveys were conducted during August 2011 and September 2011. During the September 2011 survey, mark-resight protocols were followed in order to estimate sighting probability and population size (Table 4 and 5). During the September 2011 aerial survey (fixed-wing) 12 of the 18 radio-marked mountain goats were seen resulting in a 0.67 sighting probability (above average relative to previous surveys conducted on the mainland, White and Pendleton 2010)(Table 4). Overall, 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 (Table 5, Figure 7). 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; however formal statistical analyses (including reference to historical survey data) are needed to confirm this preliminary assessment. Mountain goat kids comprised 18.4% of the surveyed animals across the study area; a proportion comparable to mainland populations (White and Barten 2010). Nonetheless,

Table 4. Summary of mountain goat sighting probabilities estimated during a fixed-wing aerial survey conducted on September 25, 2011, Baranof Island, AK.

Area	Marked	Seen	Sighting Prob
Blue Lake	7	5	0.71
Katlian	7	4	0.57
Nakwasina	1	1	1.00
N Carbon	1	0	0.00
Baranof River	2	2	1.00
Total	18	12	0.67

Table 5. Summary of mountain goat aerial survey results, conducted from a fixed-wing aircraft (Piper Cub) on September 25, 2011. Results represent the number of animals seen (i.e. not corrected for sighting probabilities) in specific watersheds on central Baranof Island, AK.

Area	Adults	Kids	Total	% Kids
N Vodopod	21	2	23	8.7
Medvejie	0	0	0	0.0
Blue Lake	63	16	79	20.3
Indian River	3	1	4	25.0
Katlian-South Fork	36	6	42	14.3
Katlian-Main	58	10	68	14.7
Katlian-Hogan	66	21	87	24.1
Nakwasina (partial)*	81	14	95	14.7
N Carbon	2	1	3	33.3
Glacial River	40	13	53	24.5
Kasnyku	7	0	7	0.0
Takatz	5	2	7	28.6
Baranof River	23	3	26	11.5
U Clear (partial)*	14	4	18	22.2
U Middle Arm (partial)*	3	2	5	40.0
Grand Total	422	95	517	18.4

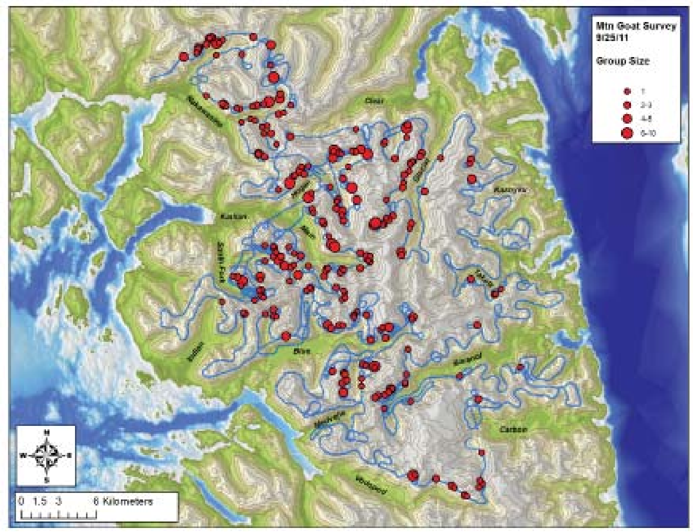

Figure 7. Map depicting locations of mountain goat groups (red dots) and the survey route (blue line) followed during the fixed-wing aerial survey conducted on September 25, 2011 on central Baranof Island, AK.

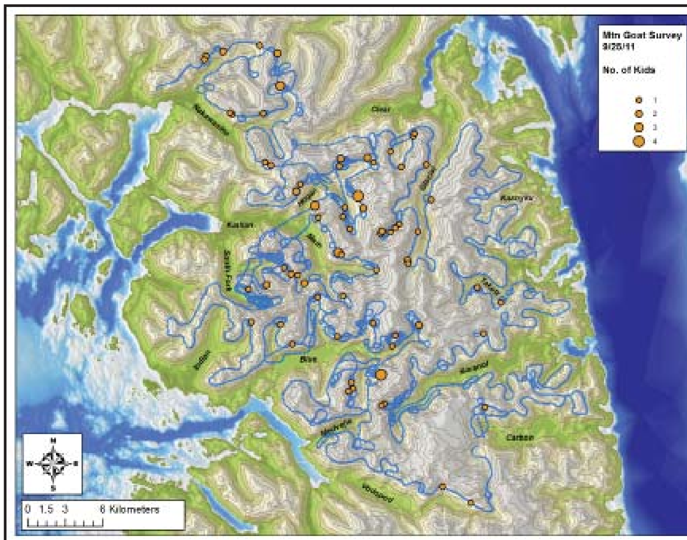

Figure 8.Map depicting locations of mountain goat kids (orange dots) and the survey route (blue line) followed during the fixed-wing aerial survey conducted on September 25, 2011 on central Baranof Island, AK.

substantial spatial variation in kid production was evident across the study area (Table 5, Figure 8).

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 USFS 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 2012 are likely to be scaled back to fit with existing funds available, unless additional funding is secured.

Overall, 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 August/September 2012, no more than 6 additional GPS radio-collars may be deployed via helicopter capture methods, contingent on funding constraints. Annual fall aerial population estimation and composition surveys will be conducted in September/October 2012. Finally, an annual project progress report will be prepared and submitted by December 31, 2012.

Project Publications:

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Appendix 1: Incidence of disease prevalence of mountain goats in the Baranof Island 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 2: Trace mineral concentration documented for mountain goats in the Baranof Island 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