Wildlife Research Annual Progress Report

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

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

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Cover photo: Mountain goat #LG-71 leaping across a small alpine stream in the upper Katzehin river valley, August 2007. (Kevin White)

Contents

INTRODUCTION

This annual progress report was prepared to meet the reporting requirements for State of Alaska Department of Transportation and Public Facilities and Coeur Alaska. Funding for this project was made available in September 2005 and this report summarizes activities completed by July 31, 2007.

Background

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

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

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

STUDY OBJECTIVES

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

1) Determine seasonal movement patterns of

mountain goats in areas near the Kensington mine and Juneau Access road corridor;

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

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

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

STUDY AREA

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

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

Elevation within the study areas range from 6300 feet to sea level. This area is an active glacial terrain underlain by late cretaceous-paleocene granodiorite and tonalite geologic formations (Gehrels 2000).

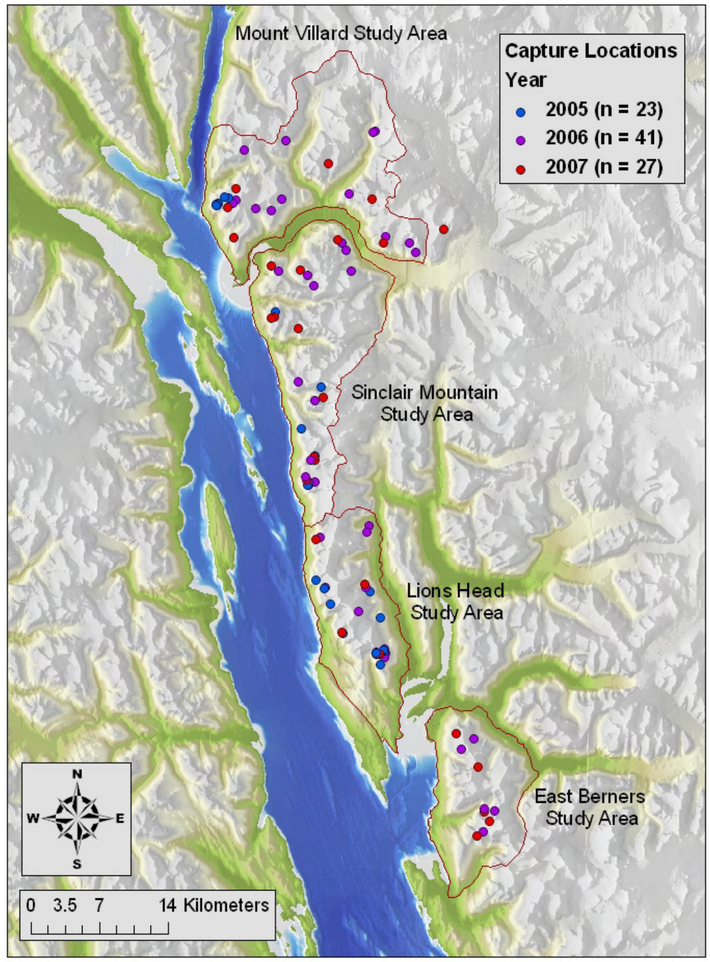

Figure 1. Mountain goat capture locations, Lynn Canal, 2005-2007. Study areas are labeled and delineated in red.

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

The maritime climate in this area is characterized by cool, wet summers and relatively warm snowy winters. Annual precipitation at sea-level averages 55 inches and winter temperatures are rarely less than 5º F and average 30º F (Haines, AK; National Weather Service, Juneau, AK, unpublished data). Elevations at 2600' typically receive ca. 250 inches of snowfall, annually (Eaglecrest Ski Area, Juneau, AK, unpublished data). Predominant vegetative communities occurring at low-moderate elevations (<1500') include Sitka spruce (*Picea sitchensis*)-

western hemlock (*Tsuga heterophylla*) coniferous forest, mixed-conifer muskeg and deciduous riparian forests. Mountain hemlock (*Tsuga mertensiana*) dominated 'krummholtz" forest comprises a subalpine, timberline band occupying elevations between 1500-2500 feet. Alpine plant communities are composed of a mosaic of relatively dry ericaceous heathlands, moist meadows dominated by grasses and forbs and wet fens. Avalanche chutes are common in the study area, bisect all plant community types and often terminate at sea-level.

METHODS

Mountain Goat Capture

Mountain goats were captured using standard helicopter darting techniques and immobilized by injecting 3.0-2.55mg of carfentanil citrate, depending on sex and time of year (Taylor 2000), via projectile syringe fired from a Palmer dart gun (Cap-Chur, Douglasville, GA). During handling, all animals were carefully examined and monitored following standard veterinary procedures (Taylor 2000) and routine biological samples and morphological data collected. Following handling procedures, the effects of the immobilizing agent was reversed with 100mg of naltrexone hydrochloride per 1mg of carfentanil citrate (Taylor 2000). All capture procedures were approved by the State of Alaska Animal Care and Use Committee.

GPS Location Data

Telonics TGW-3590 GPS radio-collars (Telonics, Inc., Mesa, AZ) were deployed on most animals captured (seven Telonics MOD-500 VHF radio-collars were deployed on an experimental basis). GPS radio-collars were programmed to collect location data at 6-hour intervals (collar lifetime: 2 years). During each location attempt, ancillary data about collar activity (i.e. percent of 1-second switch transitions calculated over a 15 minute period following each GPS fix attempt) and temperature (degrees C) were simultaneously collected. Complete data-sets for each individual were remotely downloaded (via fixed-wing aircraft) at 8-week intervals. Location data were post-processed and filtered for "impossible" points and 2D locations with PDOP (i.e. position dilution of precision) values greater than 10, following D'Eon et al. (2002) and D'Eon and Delparte (2005).

Habitat Selection and Movement Patterns

Altitudinal Distribution.—Annual variation in mountain goat altitudinal distribution was characterized by estimating daily average altitude for 18 mountain goats for which multi-year data were available. In addition, duration of time spent on winter ranges was calculated, for both male and female mountain goats, during the winters of 2005-2006 and 2006-2007.

In general, comprehensive analyses of mountain goat habitat use and movement patterns will not be conducted until all GPS location information is collected (i.e. 2009). Nevertheless, preliminary analyses focused on describing sex specific variation in terrain use, and movement patterns were conducted using a subset of the data (White, in press) during the previous reporting period (White et al. 2006).

Winter Severity and Snow Modeling Data Collection

Winter distribution of mountain goats is strongly influenced by snow depth and distribution. Since patterns of snow accumulation vary at both small and large spatial scales it is often necessary to collect site-specific field data in order to accurately characterize these relationships within focal areas. Unfortunately, standardized snow depth monitoring information is extremely limited within the study area and additional information is needed in order to properly characterize spatial patterns of snow accumulation and, ultimately, mountain goat winter distribution. Consequently, we initiated field efforts designed to create a snow depth database in order to generate spatially explicit snow depth models within the study area.

Standardized field surveys were conducted in order to estimate patterns of snow depth as it related to habitat type (i.e. forested/non-forested), altitude, and slope aspect. These preliminary efforts focused on four sites located in different mountain goat winter ranges. During surveys snow depth was measured at geo-referenced locations along an altitudinal gradient (beginning at sea level). Snow measurements were replicated at each sampling location (n = 5) and associated covariate information was collected. Sampling locations were spaced at regular (100-200m) intervals, depending upon terrain complexity. Steep (>35 degrees), exposed slopes were, generally, not sampled due to safety considerations. In addition, daily climate information for reference weather stations was acquired from the National Weather Service (Haines and the Mendenhall Valley) and Coeur Alaska (Jualin Camp).

Reproduction and Survival

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

Population Abundance and Composition Estimation

Aerial Surveys.—Population abundance and composition surveys were conducted using fixed-wing aircraft (i.e. Heliocourier) and helicopter (Hughes 500) during August-October 2006. Original project planning required flying 3 replicate surveys in the Lions Head, Sinclair and Villard study areas. Additional funding provided by the Alaska Department of Fish and Game provided the opportunity to fly surveys in the East Berners area and additional replicate surveys in the three focal study areas. 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 two 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 8X 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 or not. 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.

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 or not. 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. As a result, mountain goat survey data were summarized in this report to include estimates of population composition and the minimum number of mountain goats seen on surveys (i.e. the number observed) but not the estimated actual number of mountain goats in focal areas.

Ground Surveys.—Evaluation of ground-based techniques for estimating mountain goat population size and composition were conducted in a small portion of the Lions Head study area (i.e. 13.2 km^2) in June 2006 and in the Mt. Villard area during June 2007. Previous research has concluded that aerial surveys are often inadequate for providing accurate estimates of the proportion of adult males and females, as well as sub-adults during aerial surveys (Cote and Festa-Bianchet 2003); only the proportion of adults and kids in a population can be reliably estimated. As a result, ground-based survey techniques were tested to evaluate whether this method might serve as a reliable tool for classifying individuals of separate sex and age classes during survey efforts.

Additional field efforts involved collection of GPS-collar activity sensor validation data. In these cases, individual study animals were observed during pre-programmed activity sensor evaluation periods (i.e. 15 minute intervals following fix initiation events). During observation periods, detailed behavioral data were collected using focal animal sampling procedures (Altman 1974).

RESULTS AND DISCUSSION

Mountain Goat Capture and Handling

Capture Activities.—Mountain goats were captured over 5 days between July 29-August 11, 2007. Overall, 27 animals were captured using standard helicopter darting methods. Nineteen animals were deployed with Telonics TGW-3590 GPS radio-collars and seven were deployed with Telonics MOD-500 VHF radio-collars. We deployed VHF radio-collars on a subset of captured mountain goats because battery life-span is significantly longer (radio-collar battery life span: VHF = 8 years, GPS = 2 years). The extended life span of VHF radio-collars will enable collection of supplementary mountain goat survival and reproduction data and reduce the frequency in which mountain goats must be captured.

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. Nevertheless, given the fairly large area of study and decent summer weather conditions, it was typically possible to capture approximately six mountain goats per day of effort.

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), ear tissue, hair and fecal pellets. Whole blood, serum and fecal pellet sub-samples were sent to Dr. Kimberlee Beckmen (ADFG, Fairbanks, AK) for disease screening. In addition, tissue sub-samples were sent Dr. Steeve Cote (University of Laval, Quebec) for inclusion in a broad-scale mountain goat population genetics analysis. Fecal sub-samples were sent to the Wildlife Habitat Nutrition Lab (Washington State University, Pullman, WA) for microhistological analysis to determine diet composition of mountain goats. All remaining samples have been archived at Alaska Department of Fish and Game facilities in Douglas, AK.

*Mountain Goat Body Mass.—*Data relating to morphological characteristics of mountain goats were collected for all animals, when practicable. Preliminary analysis of age- and sex-specific body mass were conducted. Body mass data were standardized following Cote et al. (1998) to control for the effects of capture date on body mass and allow for comparisons with other studies. Overall, adult (i.e. 4+ years of age) male mountain goats were heavier and appeared to sustain a longer

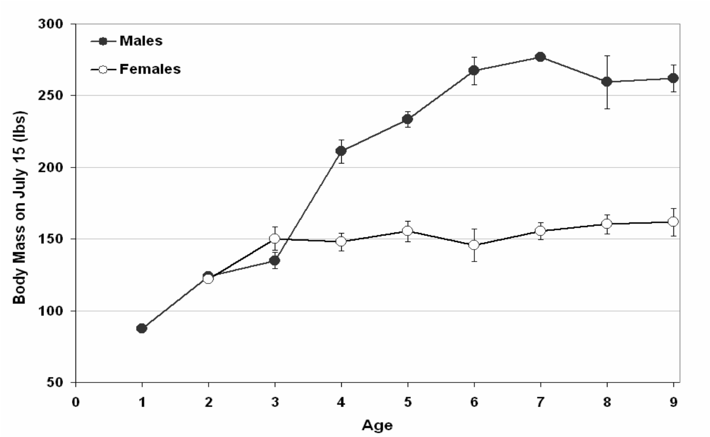

Figure 2. Sex and age specific body mass of mountain goats, 2005-2007 (females, n = 34; males, n = 46).

Table 1. Average body of mass adult (<5 years old) male and female mountain goats. Weight estimates are standardized and represent predicted weights in mid-summer (i.e. July 15). Regression equations used to standardize weights to July 15 for Lynn Canal mountain goats were: males, $y = 0.62x + 242.91$, $r^2 = 0.27$; females, $y = 0.39x + 149.28$, $r^2 = 0.35$.

	Adult Males			Adult Females			
Area	Mean (lbs.)	SD	n	Mean (lbs.)	SD	n	Source
Lynn Canal, AK	259	31.91	33	156	17.81	25	This Study
Caw Ridge, AB	216	18.35	36	156	--	--	Festa-Bianchet and Cote 2007
Olympic Mountains, WA	246	--	9	136	--	40	Houston et al. 1989

period of mass gain than females (Figure 2). In comparison to other studies, mountain goats in Lynn Canal were within the normal range of values reported. While adult males tended to be heavier, the degree of sexual dimorphism tended to be intermediate and adult females were of similar body mass as compared to other populations (Table 1). Statistical analyses of population comparisons is limited due to incomplete data in the literature.

GPS Location Data

GPS System Performance.—The performance of GPS radio-collars (as of 8/21/07) has been evaluated for 79 collars deployed since the beginning of the study. In general, the remote GPS data collection system used in this study worked as expected. We did not encounter any problems with GPS collar performance, nor did significant problems occur with remote data download attempts. This high level of success was achieved despite occasionally poor weather conditions and, in some cases, substantial download distances between aircraft and mountain goats (i.e. up to 3 miles). However, several pre-programmed bi-monthly GPS data download periods were missed due to weather conditions. Nevertheless, it was always possibly to download missed GPS data on subsequent surveys.

Collar Retrieval.—Of the 24 animals that died, nearly all (n = 23) collars were retrieved from the field and GPS data downloaded from the collar. One collar was not located in the field due to an unknown VHF transmitter failure, however, all GPS data collected had been previously downloaded by this time. Fifteen GPS collars deployed in fall 2005 had been pre-programmed to automatically release on August 15, 2007. Twelve of these collars were

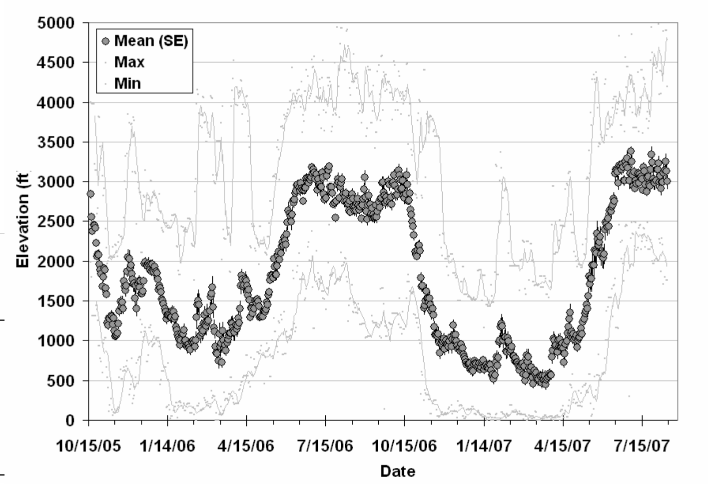

Figure 3. Altitudinal distribution of mountain goats, Lynn Canal, AK, 2005-2007. Data were summarized only for mountain goats for which data were available during 2005-

retrieved from the field on August 23, 2007 and subsequently downloaded. These data revealed every collar released on the exact day they were programmed to do so. This differs with results obtained in brown bear studies where collars can take up to a few weeks to release (Rod Flynn, Alaska Department of Fish and Game, personal communication).

Habitat Use and Movement Patterns

Altitudinal Distribution.—During the high snow winter of 2006-2007, mountain goats, on average, wintered at lower elevations (females, mean = 840 ft; males, mean = 782 ft) than during the moderate winter of 2005-2006 (females, mean = 1493 ft; males = 1303 ft; Figure 3). Nonetheless, the duration of time mountain goats spent in wintering areas was similar between years (2005-2006, mean = 193 days; 2006-2007, mean = 179 days), though tended to be longer for males (mean duration = 197 days) than females (mean duration = 175 days).

Winter Severity and Snow Modeling

Snow Surveys.—Four field-based snow surveys were conducted during April 3-20, 2007 in the Echo Cove (n = 1) and northern Lynn Canal (n = 3) areas. Preliminary analyses of these data quantified the degree to which snow depth differs with increasing elevation between forested and non-forested sites (Figure 4). Specifically, we determined that snow depth increased about 1 foot for every 400 feet in elevation gain. Further, snow depth was, on

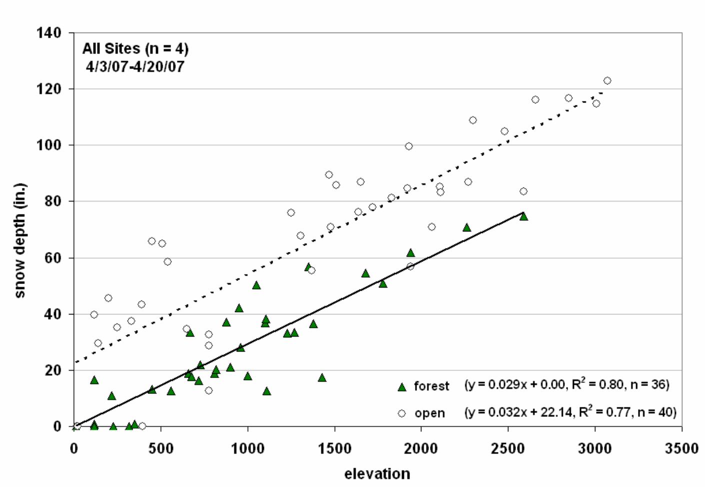

Figure 4. Relationship between snow depth, elevation and forest cover. Based on data collected at four sites in upper Lynn Canal, AK during April 3-21, 2007.

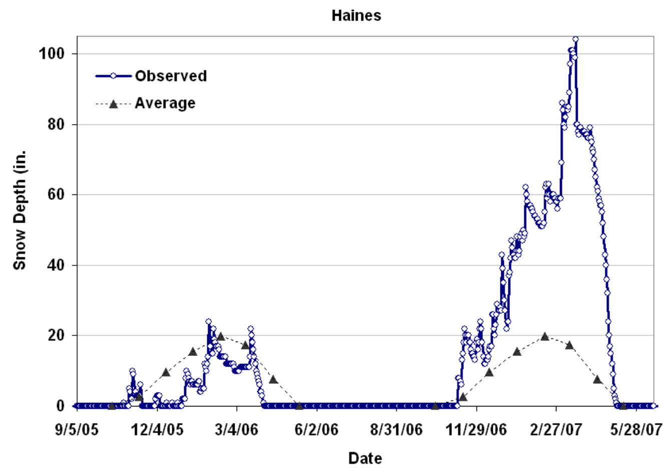

Figure 5. Daily snow depth (inches) recorded at the NWS weather station in Haines, AK, 2005-2007. Average daily snow depth is depicted by the black dashed line.

average, about 22 inches deeper in open sites as compared to forested sites.

Climate Data.—Daily climate data were archived from the National Weather Service and Coeur Alaska databases to characterize broader scale climate patterns. Mean daily snow depth and snowfall data were summarized from data collected at the Juneau Forecast Office (Mendenhall Valley), Haines and Jualin Camp (snowfall data only). Mean snow depth during the winter of 2006/2007 in Haines and the Mendenhall Valley was the highest on record. In Haines, snow depth during late-winter was as much as five times higher than the long-term average, however, the overall winter mean snow depth was not as extreme (Figure 5). Snow depth in the Mendenhall Valley was substantially lower than in Haines, though still up to 2-3 times higher than normal during extended periods (Figure 6). In general, snowfall patterns exhibited a bi-modal distribution when compared across time. Specifically, these data indicated that snowfall peaked during November-January and March; only moderate amounts of snowfall were recorded during February (Figure 7). Snow depth data collected in the Mendenhall Valley documented an approximate 6 week period of minimal or negative snow accumulation during January-February 2007, a period during which snow depth approximated average. However, in Haines snow depth consistently increased during the entire winter and a significant melting event was not evident in mid-winter. These data corroborate long-term climate

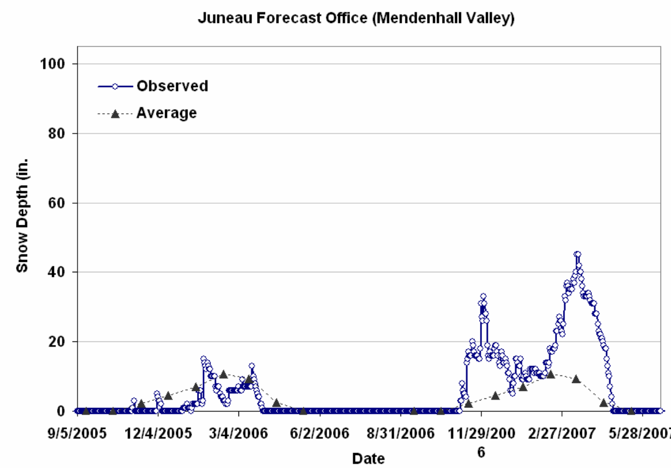

Figure 6. Daily snow depth (inches) recorded at the NWS weather station in Mendenhall Valley, AK, 2005-2007. Average daily snow depth is depicted by the black dashed line.

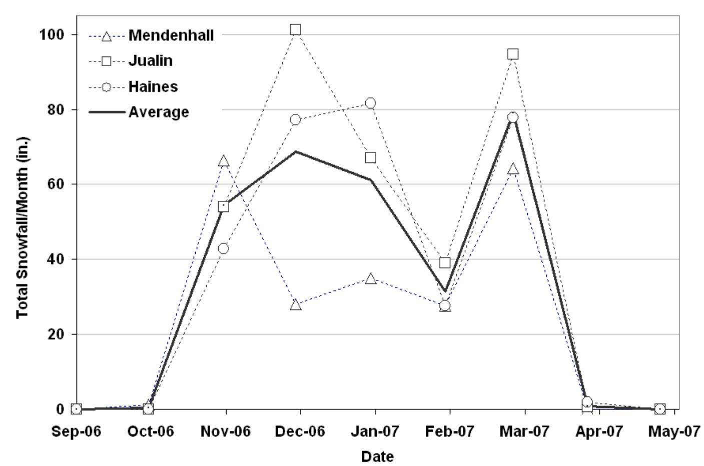

Figure 7. Daily snowfall/month inches) recorded in Mendenhall Valley, Jualin Camp and Haines AK, 2006-2007. Average daily snowfall depth is depicted by the solid black line.

Table 2. Estimates of annual survival for adult male and female mountain goats, 2005-2007, Lynn Canal, AK. Estimates independent of gender and year are also provided.

	Males				Females				Total			
Year	At Risk	Died	Survival	SE	At Risk	Died	Survival	SE	At Risk	Died	Survival	SE
2005/2006	11	2	0.82	0.12	11	1	0.91	0.09	22	3	0.86	0.07
2006/2007	33	11	0.67	0.08	25	4	0.84	0.07	58	15	0.74	0.06
Both years	44	13	0.70	0.07	36	5	0.86	0.06	80	18	0.78	0.05

trends which indicate that Haines is typically colder in winter than the Juneau area where winter precipitation is less likely to fall as snow than in Haines.

Survival and Reproduction

Survival.—Mountain goats were monitored monthly during fixed-wing aerial telemetry flights. Of the 58 animals monitored during 2006/2007 (i.e. 5/20/2006– 5/19/2007), 15 animals died of various causes. Overall, preliminary survival estimates were 12% lower in 2006/2007 than in 2005/2006 (Table 2). In general, survival of females was higher than males (Table 2) and older animals were more likely to die than younger animals (Table 3). Most mortality occurred during late winter (February-May), however, two adult males died during October-November, a period coinciding with the rut (Figure 8). The preliminary estimates of survival reported for 2006/2007 are lower than has been documented elsewhere (Smith 1986, Festa-Bianchet and Cote 2007), however, survival estimates for 2005/2006 are similar to previous studies (Table 3). Given that winter snowfall accumulation during

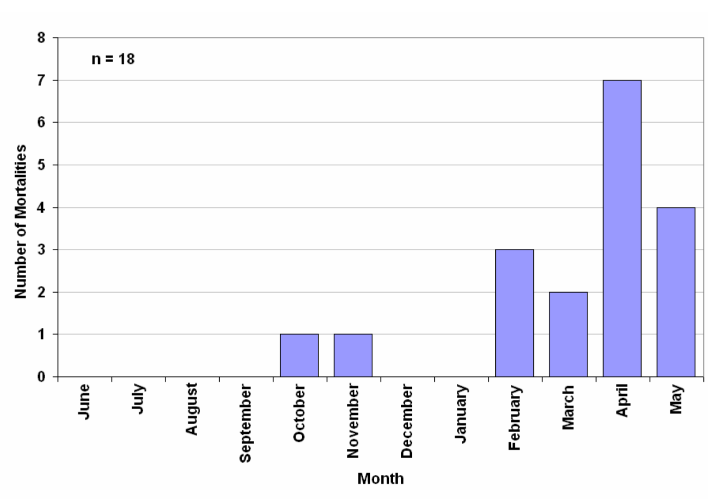

Figure 8. Season distribution of mountain goat mortality, 2005-2007, Lynn Canal, AK.

Table 3. Comparison of mountain goat sex- and age-specific annual survival among three populations, for which data exist, in North America.

	Females		Males		Both Sexes		
Population	2-8 Years	9+ Years	2-8 Years	9+ Years	2-8 Years	9+ Years	Source
Lynn Canal, AK	0.90 (30)	0.60 (5)	0.83 (30)	0.43 (14)	0.87 (60)	0.47 (19)	This Study
Ketchikan, AK	--	--	--	--	0.95 (152)	0.68 (25)	Smith 1986
Caw Ridge, AB	0.94 (303)	0.84 (85)	0.78 (161)	0.71 (17)	0.89 (464)	0.81 (102)	Cote and Festa-Bianchet 2003

2006/2007 was the highest on record, severe winter conditions likely played a key role on increased mortality of mountain goats during this period.

Kid Recruitment.—Kid recruitment of radio-marked female mountain goats was estimated by determining the percentage of radio-marked females seen with kids during May-June aerial telemetry surveys (n = 3). Since each radio-marked female was not observed daily during the kidding period, it was not possible to determine if kids were born and subsequently died prior to, or between, surveys. As such, estimates of kid recruitment reported here are presumably lower than the actual percentage of females that gave birth. Nevertheless, our estimates of kid recruitment in summer (57-64%; Table 4) were similar to estimates of kidding rates reported elsewhere (Festa-Bianchet and Cote 2007). Past studies have documented late age at first reproduction for mountain goats, as compared to other ungulates (Festa-Bianchet and Cote 2007, Galliard et al. 2000). Consistent with these findings, we did not document any cases where females less

Table 4. Proportion of radio-marked adult female mountain goats associated with kids during summer, 2005-2007, Lynn Canal, AK. These data represent an early season measure of kid recruitment rather than and estimate of the actual proportion of kids born.

	Proportion of Females with Kids		
Year	Mean	SE	n
2005/2006	0.60	0.15	10
2006/2007	0.64	0.10	25
2007/2008	0.57	0.11	21
All Years	0.61	0.07	56

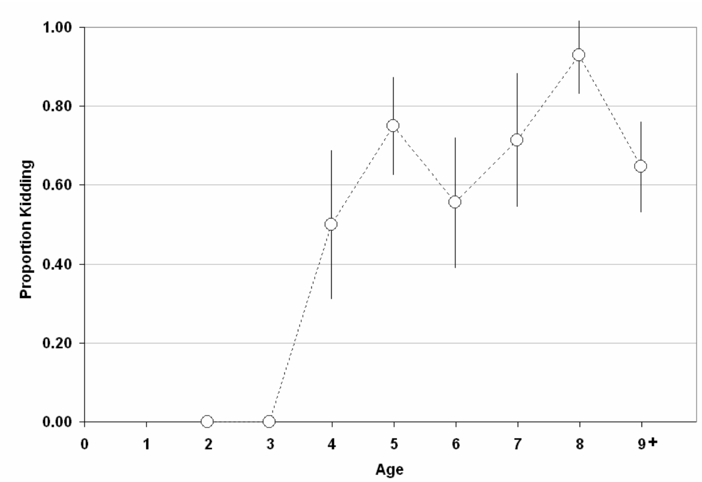

Figure 9. Age-specific mountain goat kid recruitment (as of June 15), 2005-2007, Lynn Canal, AK.

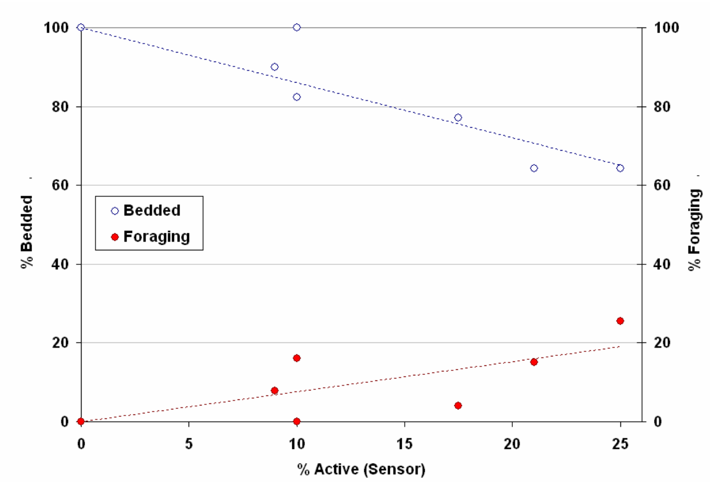

Figure 10. Relationship between radio-collar activity sensor output and actual mountain goat foraging and bedding activity summarize over 15 minute periods. Data were collected from three adult female mountain goats, April 21-24, 2007, Lynn Canal, AK.

than four years of age were associated with kids in summer. Overall, kid recruitment varied with female age (range = 50-93%) such that younger and older females were generally less likely to have a kid at heel than prime-aged females (i.e. 5-8 years old; Figure 9). We did not observe cases of kid abandonment when females with kids were captured, as determined via post-capture aerial telemetry surveys.

Population Abundance and Composition

Aerial Surveys.—Overall, 13 fixed-wing and 3 helicopter surveys were conducted in August-October 2006 (Lions Head, n = 4, Sinclair Mountain, n = 4, Mount Villard, n = 5, East Berners, n = 3; Appendix 1). Five surveys were attempted but not completed in entirety. Incomplete surveys provide meaningful data but are not, at this point, directly comparable to other surveys. Of the complete surveys flown (n = 8), substantial variation was observed in the minimum number of mountain goats observed and the proportion of kids (Appendix 1). These findings underscore the value of conducting replicate surveys in each area.

The proportion of mountain goats for which the presence or absence of a collar could be ascertained was highly variable and primarily depended upon weather conditions and aircraft type. In general, collar status assessments varied between 79-92% during helicopter surveys, and 16-63% during fixed-wing surveys (considering only complete surveys in the three focal study areas). Estimates of mountain goat sightability will be performed following development of additional analytical methodology.

Ground-based Surveys.—Ground based surveys were conducted in the Mount Villard and upper Dayebas Creek area during June 21-25, 2007 in order to estimate age and sex composition of mountain goats in this area. Overall, 54 individual mountain goats were classified, of which 1 was an adult male, 16 adult females, 12 subadults, 16 kids and 9 adults of unknown sex. In some cases, it was not possible to identify sex status for all animals due to large distances (i.e. <3 kilometers) between observers and animals. Of the animals observed, 5 were radio-collared (females, n = 4; males, n = 1). Of the 14 adult female-kid dyads, 2 were accompanied by twins.

Detailed behavioral data was collected for three GPS radio-collared adult females in order to validate data collected by activity sensors imbedded in radio-collars. The activity sensor data calculates the percent of mercury tip-switch transitions over a 15 minute period commencing at pre-programmed times linked to GPS location acquisition attempts. Seven data collection trials were conducted in which actual animal behavior over a continuous 15 minute period was collected and later compared to activity sensor data (downloaded remotely from GPS collars). While sample sizes are limited, preliminary analyses suggest the percent of activity tip-switch transitions negatively correlated with percent of time animals are bedded and positively correlated with the percent of time foraging (Figure 10). Continued data collection is necessary before reliable conclusions can be made regarding these data, however, preliminary results are encouraging.

FUTURE WORK

Study animals will continue to be monitored monthly to assess reproductive status and survival. Additionally, at 8-week intervals GPS data will be downloaded from each animal during aerial surveys. These data will be post-processed and integrated with the existing GPS location database. Three replicate aerial surveys will be conducted in early-fall 2007, weather permitting, in order to estimate mountain goat sightability, population abundance and composition. Results of these efforts will be summarized and submitted as an annual research progress report on September 1, 2008.

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Appendix 1. Summary of mountain goat population abundance and composition survey data, 2006, Lynn Canal, AK.

Study Area	Date	AST	Survey Time (min)	Area Surveyed (km^2)	Adults	Kids	Total	% Kids	Goats/ min	Goats/ km^2	km^2/ min	Temp	Weather	Wind (knots)	Aircraft	# of Observers
East Berners[b]	8/28/2006	1244-1326	42	49.3	86	42	128	32.8	3.05	2.60	1.17	40-50	Mostly Clear	0-10	Heliocourier	3
East Berners[a]	9/3/2006	1550-1637	47	66.8	83	21	104	20.2	2.21	1.56	1.42	51	Partly Cloudy	0-10	Heliocourier	2
East Berners	10/3/2006	1325-1406	41	67.5	70	22	92	23.9	2.24	1.36	1.65	35-40	High Overcast	5-15	Heliocourier	3
Lions Head	8/28/2006	1339-1426	47	65.2	49	9	58	15.5	1.23	0.89	1.39	40-50	Mostly Clear	0-10	Heliocourier	3
Lions Head[a]	9/3/2006	1652-1739	47	65.2	54	11	65	16.9	1.38	1.00	1.39	51	Partly Cloudy	0-10	Heliocourier	2
Lions Head[a]	10/2/2006	1133-1213, 1424-1440	57	65.1	92	13	105	12.4	1.84	1.61	1.14	26-31	Mostly Cloudy	5-15	Heliocourier	3
Lions Head	10/16/2006	1123-1235	62	64.9	91	23	114	20.2	1.84	1.76	1.05	35-42	Mostly Clear	10-25	Hughes 500	3
Sinclair Mtn.[b2]	8/28/2006	1426-1530	64	97.6	86	21	107	19.6	1.67	1.10	1.53	40-50	Mostly Clear	0-10	Heliocourier	3
Sinclair Mtn.[a]	9/2/2006	1605-1739	94	119.7	128	31	159	19.5	1.69	1.33	1.27	50-56	High Overcast	0-10	Heliocourier	4
Sinclair Mtn.	9/23/2006	1526-1717	111	131.6	153	22	182	12.1	1.64	1.38	1.19	40-42	High Overcast	0-10	Heliocourier	3
Sinclair Mtn.	10/16/2006	1235-1311, 1402-1415, 1506-1638	141	124.1	227	41	268	15.3	1.90	2.16	0.88	35-42	Mostly Clear	10-25	Hughes 500	3
Mt. Villard	9/2/2006	1741-1912	91	137.8	102	23	125	18.4	1.37	0.91	1.51	50-56	High Overcast	0-10	Heliocourier	4
Mt. Villard[b3]	9/23/2006	1723-1831	68	96.4	90	12	102	11.8	1.50	1.06	1.42	40-42	High Overcast	0-10	Heliocourier	3
Mt. Villard[b4]	10/1/2006	1222-1240	18	21.5	41	12	53	22.6	2.94	2.46	1.20	31	Mostly Cloudy	5-15	Heliocourier	3
Mt. Villard	10/2/2006	1230-1355	85	130.7	165	28	193	14.5	2.27	1.48	1.54	26-31	Mostly Cloudy	5-15	Heliocourier	3
Mt. Villard[b5]	10/17/2006	1012-1117	65	83.7	145	29	174	16.7	2.68	2.08	1.29	35-31	High Overcast	0-10	Hughes 500	3

[a] poor GPS reception during portions of survey, estimated part or all of survey route
[b1] not complete survey: Davies Ck.-Antler Lk. only
[b2] not complete survey: to Katz lk. only
[b3] not complete survey: Meade Gl.-Katz Flats only
[b4] not complete survey: Dayebas Ck. only
[b5] not complete survey: N Meade Gl to NW fork Katzehin