Wildlife Research Annual Progress Report

Mountain goat population monitoring and movement patterns near the Kensington Mine, Alaska

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Alaska Department of Fish and Game — Division of Wildlife Conservation

Cover Photo: An adult female mountain goat (LG-175), August 2015 ©2015 ADF&G/photo by Kevin White.

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Contents

INTRODUCTION

This report was prepared to meet the annual reporting requirements for Coeur Alaska, Inc.. Funding for this project was made available in September 2005 and this report summarizes activities completed by December 30, 2015.

Background

In 2005, Coeur Alaska, Inc. re-initiated development activities at the Kensington mine site, located a short distance northwest of Berners Bay. In addition, the Alaska Department of Transportation and Public Facilities (ADOT/PF) proposed construction an all-season highway between Echo Cove and the Katzehin River. In the context of these proposed industrial development activities, mountain goats were identified as an important wildlife species likely to be affected by mine development and road construction activities.

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, the mine never became operational, thus these objectives could not be achieved, and by 1995 goat monitoring in the area wound down and eventually ended. In 2005, when the mine development activities were re-initiated, the Alaska Department of Fish and Game (ADFG) maintained that many of the same concerns that prompted the Robus and Carney (1995) study were still valid and needed to be addressed. In addition, large-scale plans for development of the Juneau Access road raised new and potentially more substantial concerns regarding not only the enlarged "footprint" of industrial development activities in eastern Lynn Canal, but also the cumulative impacts of both development projects on wildlife resources.

The potential effects of mining and road development activities on local mountain goat populations in the vicinity of the Kensington mine and eastern Lynn Canal have potentially important ramifications for management and conservation of the species in the area. 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, Cote et al. 2013). Consequently, information about the distribution of mountain goats proximate to the mine and road development corridor is critical for determining 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 response to the above concerns, ADFG, with operational funding provided by ADOT/PF, Federal Highway Administration (FHWA) and Coeur Alaska, Inc., 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 included 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 ADFG with information necessary to appropriately manage mountain goats in the proposed areas of development.

Implementation of field objectives were initiated in 2005 and consisted of a 5-year monitoring program (2005-2011) jointly funded by ADOT/PF, FHWA, Coeur Alaska, Inc. and ADFG. Beginning in 2007, the ADFG committed additional annual funding for a complementary aerial survey technique development project within and adjacent to the project area. In 2009, the USDA-Forest Service (Tongass National Forest) also began contributing funding to further support aerial survey technique development data collection efforts. And, in 2010, Coeur Alaska, Inc. resumed funding of mountain goat monitoring near the Kensington Mine and adjacent areas (as per the Kensington Plan of Operations, USFS 2005). In 2012, the project components funded by ADOT/PF and associated with the Juneau Access project were completed (see White et al. 2012). Currently, mountain goat monitoring activities are focused on the area surrounding the Kensington mine and north to the Katzehin river, an area considerably smaller than the original Juneau Access/Kensington joint study area.

STUDY OBJECTIVES

Research efforts were designed to investigate the spatial relationships, vital rates, and abundance of mountain goats near the Kensington Mine and upper Lynn Canal. The research objectives were to:

1) determine seasonal movement patterns of mountain goats;

2) characterize mountain goat habitat selection patterns;

3) estimate reproductive success and survival of mountain goats; and

4) estimate mountain goat population abundance and composition.

STUDY AREA

Mountain goats were studied in a ca. 491 km^2 area located in a mainland coastal mountain range east of Lynn Canal, a marine fjord located between Juneau and Haines in southeastern Alaska (Figure 1). The study area was located in the Kakuhan Range and oriented along a north-south axis and bordered in the south by Berners Bay (58.76N, 135.00W) and the Katzehin River (59.27N, 135.14W) in the north. The Kensington Mine, a hard rock gold mine, is located at the southern end of the study area, immediately south of Lions Head mountain in the Johnson, Slate and Sherman creek watersheds. A majority of above ground mining activity occurs in four principal locations situated between 200–300 meters in elevation. The overall mine "footprint" comprises 56.6 km^2 of patented claims; a significant amount of activity is at low elevation (<300 m) and underground. This study occurred during both construction and production phases of the mine and possible sources of disturbance to mountain goats in the vicinity included blasting, heavy equipment operation, helicopter operation, and vehicle traffic.

Elevation within the study area ranges from sea level to 2070 m. This area is an active glacial terrain underlain by late cretaceous-paleocene granodiorite and tonalite geologic formations (Stowell 2006). 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. >1200 m) and rugged, broken terrain that descends to a rocky, tidewater coastline. The northern boundary of the area is defined by the Katzehin River, a moderate volume (ca. 1500 cfs; USGS, unpublished data) glacial river system that is fed by the Meade Glacier, a branch 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 1.4 m and winter temperatures are rarely less than -15° C and average -1° C (Haines, AK; National Weather Service, Juneau, AK, unpublished data). Elevations at 790 m typically receive ca. 6.3 m of snowfall, annually (Eaglecrest Ski Area, Juneau, AK, unpublished data). Predominant vegetative communities occurring at low-moderate elevations (<460 m) 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 ~460–760 meters. Alpine plant communities are

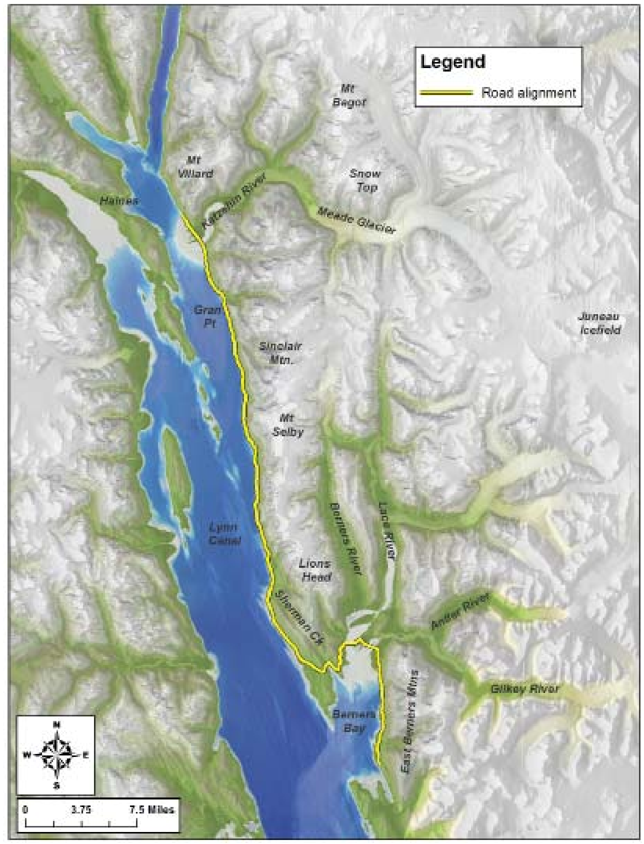

Figure 1: Map of the Lynn Canal and Berners Bay area. Local place names referenced in this report are identified. Mountain goats were studied in this area during 2005-2015.

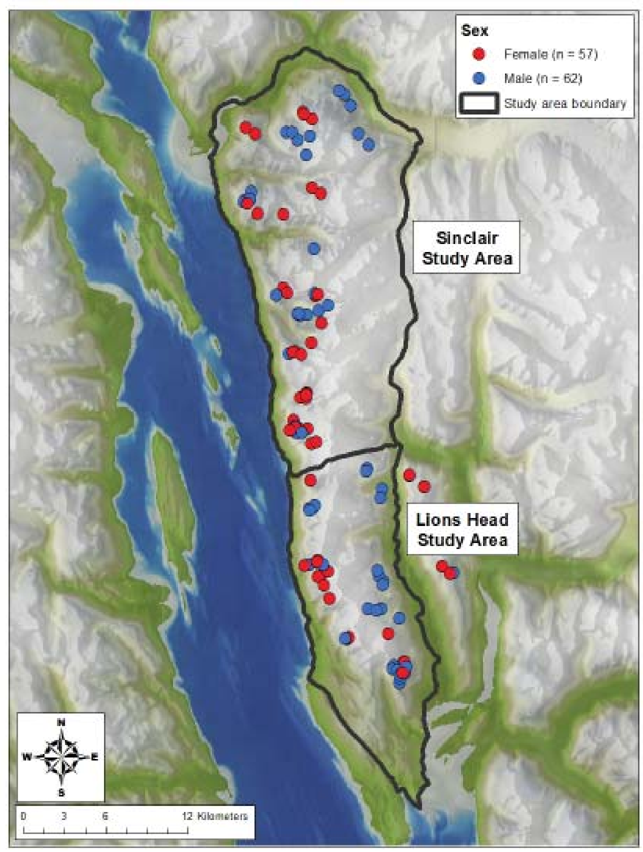

Figure 2: Locations of mountain goats captured and subsequently monitored in the Lynn Canal study area, 2005-2015.

composed of a mosaic of relatively dry ericaceous heathlands and moist meadows dominated by sedges, forbs and wet fens. Avalanche chutes are common in the study area and 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 - 2.4 mg 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 (Figure 3). 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.

Figure 3: ADFG wildlife research technician, Yasaman Shakeri, handling an immobilized male mountain goat (LG-178) captured in Lynn Canal, south of Mt. Sinclair, August 2015.

GPS Location Data

Telonics TGW-3590 or TGW-4590 GPS radio-collars (Telonics, Inc., Mesa, AZ) were deployed on most animals captured. Telonics MOD-500 VHF radio-collars were been deployed on a subset (n = 23) of animals to enable longer-term monitoring opportunities. During 2009-2015, animals were simultaneously marked with GPS and lightweight (Telonics MOD-410) VHF radio-collars (370 g). Double-collaring animals was conducted to extend the period of time individual animals could be monitored (lifespan, GPS: 3 years, VHF: 6 years), thereby increasing the long-term opportunity to gather mountain goat survival and reproduction data and reducing the frequency that mountain goats must be captured. The combined weight of radio-collars attached to animals comprise 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.

GPS radio-collars were programmed to collect location data at 6-hour intervals (collar lifetime: 2-3 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, and/or manually downloaded. 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).

Resource Selection and Movement Patterns

Diet Composition.—Fresh fecal pellets were collected from live-captured animals during the summer-fall period (late-July to mid-October). Fecal pellet samples were also collected opportunistically during winter reconnaissance and snow surveys. Samples were sent to Washington State University (Wildlife Habitat Analysis Lab, Pullman, WA) for dietary analyses. Specifically, microhistological analyses of plant cell fragments in pellet samples were conducted to provide an estimate of diet composition for individual mountain goats and a composite winter sample. Results of these analyses were reported in White et al. (2012).

Activity, Movement Patterns and Resource Selection.—Analyses of mountain goat GPS location data (i.e. data collected during 2005-2011) to characterize activity, movement and resource selection patterns were summarized in White (2006), Shafer et al. (2012) and White et al. (2012). More recently, White and Gregovich (2016) assessed relationships between mountain goat resource selection and proximity to mine development. Additional analyses will be conducted in the future to update previous analyses as new data are collected.

Snow and Winter Severity Monitoring.—
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, in 2006 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 efforts focused on four sites located in different mountain goat winter ranges in 2007 but consistent annual monitoring was conducted at only one site located on Echo Ridge, near Davies Creek. 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 (100-200 m) 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 COOP Weather Station).

Reproduction and Survival

Kidding rates and subsequent survival were estimated by monitoring individual study animals during monthly surveys using fixed-wing aircraft (usually a Piper PA-18 Super Cub) equipped for radio-telemetry tracking or via ground-based observations. During surveys, radio-collared adult female mountain goats were observed (typically using 14X image stabilizing binoculars) to determine whether they gave birth to kids and, if so, how long individual kids 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 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

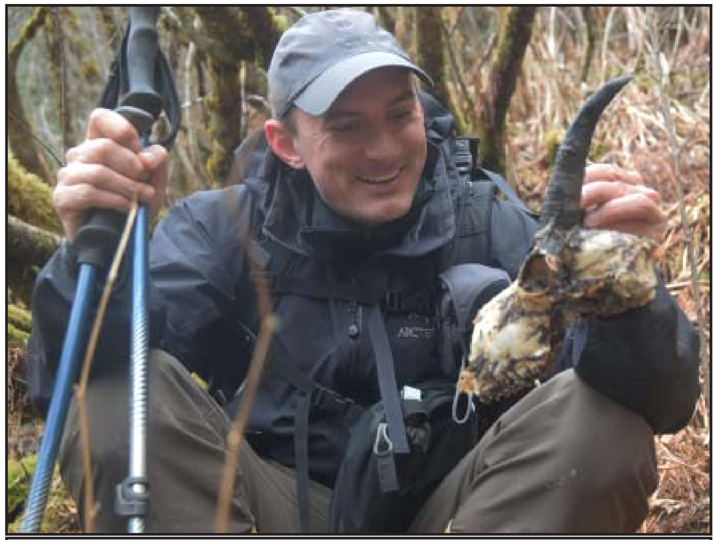

Figure 4: ADFG volunteer (and USCG dentist), Brooks Horan, examining dental health of an adult female mountain goat (LG-130), Davies Creek, March 2015. The animal was diagnosed with peridontal disease though cause of death was unknown.

biological samples collected (Figure 4). We determined date of mortalities via examination of activity sensor data logged on GPS radio-collars. Annual survival of radio-collared animals was estimated using the Kaplan-Meier procedure (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 (Helicourier and PA-18 Super Cub) and helicopter (Hughes 500) during August-October, 2005-2011. 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 radio-collared animals were present.

Evaluation of Population Trends.—In order to assess how mountain goat abundance changed over space and time we delineated nine geographically distinct survey areas and summarized the maximum number of mountain goats seen in each area, by year (Appendix 4). The number of animals seen during aerial surveys is a commonly used metric of mountain goat population abundance; termed the “minimum count”. Since the quantity does not account animals “missed” during surveys, the minimum count underestimates actual population size (i.e. by 35-50%). Nonetheless, provided survey conditions do not vary across time in a biased way, minimum count data can provide meaningful inference about population trends (though reduced precision is expected, relative to actual population estimates). To assess population trends, we used simple linear regression to fit equations and determine proportional change in minimum counts over time, for each area. In addition, we determined the amount of summer range habitat in each area (km^2; based on RSF models in White and Gregovich 2016) in order to covert minimum counts to density; a standardized quantity useful for geographic comparisons and inference.

Sightability Data Collection.—During aerial surveys, data were simultaneously collected to evaluate individual- and survey-level "sightability". For accomplishing survey-level objectives, we enumerated the number of radio-collared animals seen during surveys and compared this value to the total number of radio-collared animals present in the area surveyed. To gather individual-based "sightability" data, we characterized behavioral, environmental and climatic conditions for each radio-collared animal seen and not seen (i.e. missed) during surveys. In cases where radio-collared animals were missed, it was necessary to back-track and use radio-telemetry techniques to locate animals and gather associated covariate information. Since observers had general knowledge of where specific individual radio-collared animals were likely to be found (i.e. ridge systems, canyon complexes, etc.), it was typically possible to locate missed animals within 5-15 minutes after an area was originally surveyed. In most cases, it was possible to completely characterize behavioral and site conditions with minimal apparent bias, however in some cases this was not possible (i.e. animals not seen in forested habitats, steep ravines, turbulent canyons) and incomplete covariate information was collected resulting in missing data.

RESULTS AND DISCUSSION

Mountain Goat Capture and Handling

Capture Activities.—During August 2015, 6 animals were captured in the Lions Head-Mt. Sinclair areas. All animals were simultaneously marked with GPS (TGW-4590) and lightweight VHF (Telonics MOD-410) radio-collars. Since 2005, 118 mountain goats have been radio-marked in the Lions Head and Sinclair Mountain study areas; GPS location data has been compiled for 79 animals within this area. Currently, 22 animals are marked in these two areas; all other previously deployed collars have either remotely released or animals have died. Annual capture activities are important for maintaining adequate sample sizes and compensating for natural or scheduled collar losses. 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 could be reasonably contained. 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), red blood cells (8 mL), 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 and trace mineral screening or archived at ADFG facilities in Douglas, AK. During 2010, nasal and pharyngeal swab samples were collected from 5 animals to index prevalence of respiratory bacteria.

Genetic Analyses.—Tissue samples from all mountain goats captured between 2005-2011 have been genotyped by Aaron Shafer (University of Alberta, Edmonton, AB). (Sample collected during 2012-2014 have been archived for future analyses). These data have been analyzed and included in continent-wide analyses of mountain goat population genetics (Shafer et al. 2010). Shafer et al. (2010) indicated that substantial genetic structuring exists among mountain goats in southeastern Alaska (and across the western North American range of the species). More recent analyses indicated that three genetically distinct mountain goat populations occur in our study area [east Berners mountains, Kakuhan range (including Lions Head and Sinclair Mountain), and Mt. Villard]; population boundaries generally coincide with our specific study area boundaries (Shafer et al. 2012). These findings indicate that gene flow between our study areas (with the exception of the Lion Head and Sinclair study areas, which are genetically indistinct) is limited. Additional analyses examined the extent to which mountain goat habitat selection characteristics and landscape configuration are linked to genetic relatedness across the study area (Shafer et al. 2012). Results from this analyses indicated that small- (i.e. distance to cliffs, heat load) and large-scale (i.e. river valleys and marine waterways) landscape features are key determinants of mountain goat gene flow across our study area (Shafer et al. 2012).

Disease Surveillance.—In 2010, a subset of captured animals (n = 5) were tested (Washington Animal Disease Diagnostic Laboratory, Pullman, WA) for prevalence of respiratory bacteria associated with incidence of pneumonia (specifically *Pasteurella trehalosi* and *Mycoplasma ovipneumonia*). Results of these analyses were summarized in White et al. (2012).

During 2005-2013, blood serum samples collected from captured animals have been tested each year 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 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 54 animals successfully tested for CE in the Lions Head and Mt Sinclair areas, three animals (6%) tested positive for CE-specific antibodies; a level of prevalence comparable to other southeastern Alaska populations tested.

Trace Mineral Testing.—In 2010-2014, whole blood and serum samples were analyzed to determine trace mineral concentration for 31 mountain goats in order to examine whether mineral deficiencies were prevalent in our study population (Appendix 2a). While experimental data is limited to assess deficiency threshold values for Selenium, a trace mineral that can influence pregnancy, values less than 0.10 ppm are generally considered low. In the Lion Head/Sinclair study areas 32% of animals had blood Selenium values below this threshold (Appendix 2b); a high proportion of deficiencies relative to other mountain goat research study areas in southeastern Alaska. Presumably, deficiencies are related to site productivity and geologic substrate and can provide some level of insight relative to inherent productivity of mountain goat summer range in this area.

GPS Location Data

GPS System Performance.—The performance of GPS radio-collars (Telonics TGW-3590) was evaluated for 124 collars deployed since the beginning of the study (see White et al. 2012). In general, the remote GPS data collection system used in this study worked as expected. Specifically, we did not encounter any significant problems with GPS collar performance, nor did any notable 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 possible to download missed GPS data on subsequent surveys.

Winter Severity and Snow Modeling

Snow Surveys.—Field-based snow surveys were conducted within 5 days of April 1 during 2007-2008, 2010-2015 on Echo Ridge. Analyses of these data quantified the degree to which snow depth differs with increasing elevation between forested and non-forested sites (White et al. 2012). Overall, these data quantify the extent to which snow depth varied relative to elevation and habitat type (i.e. open vs. forest). Specifically, snow depth was 30-40 inches deeper in open relative to forested habitats, on average. Further, snow depth increased 2.3-2.7 inches per 100 foot gain in elevation, on average (White et al. 2012). Impor-

Table 1: Proportion of radio-marked adult female mountain goats observed with kids at heel during parturition in the Lynn Canal study area, 2005-2015. Data are also presented from other study areas, for comparative purposes.

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
	2013	5	10	0.50	0.16
	2014	9	12	0.75	0.13
	2015	7	14	0.50	0.13
	Total	33	51	0.65	0.07
Haines-Skagway					
	2010	5	10	0.50	0.16
	2011	8	10	0.80	0.13
	2012	8	11	0.73	0.13
	2013	10	12	0.83	0.11
	2014	10	17	0.59	0.12
	2015	14	18	0.78	0.10
	Total	55	78	0.71	0.05
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	18	27	0.67	0.09
	2012	9	15	0.60	0.13
	2013	9	13	0.69	0.13
	2014	8	14	0.57	0.13
	2015	15	17	0.88	0.08
	Total	155	239	0.65	0.03

Table 2: Estimates of mountain goat survival for different sex classes during 2005-2014, Lynn Canal, AK. Data are also presented from other study areas, for comparative purposes.

	Males				Females				Total			
	At Risk	Died	Ŝ	SE	At Risk	Died	Ŝ	SE	At Risk	Died	Ŝ	SE
Baranof Island												
2010/2011	8.0	1	0.88	0.11	4.0	0	1.00	0.00	12.0	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
2012/2013	15.0	3	0.82	0.09	6.0	0	1.00	0.00	21.0	3	0.87	0.07
2013/2014	15.8	3	0.82	0.09	9.3	0	1.00	0.00	25.1	3	0.89	0.06
2014/2015	15.2	3	0.82	0.09	11.3	1	0.92	0.08	26.4	4	0.86	0.06
All years	62.7	10	0.85	0.04	35.1	1	0.97	0.03	97.8	11	0.89	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
2012/2013	1.6	1	0.50	0.35	6.0	0	1.00	0.00	7.6	1	0.88	0.12
2013/2014	1.0	0	1.00	0.00	5.5	1	0.83	0.15	6.5	1	0.86	0.13
2014/2015	--	--	--	--	--	--	--	--	--	--	--	--
All years	16.1	5	0.72	0.09	24.0	1	0.96	0.04	40.1	6	0.86	0.10
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
2012/2013	16.3	2	0.89	0.07	10.3	1	0.91	0.08	26.6	3	0.90	0.06
2013/2014	20.2	2	0.91	0.06	10.9	1	0.92	0.08	31.1	3	0.91	0.05
2014/2015	18.7	2	0.89	0.07	14.3	2	0.85	0.08	32.9	4	0.88	0.05
All years	77.9	12	0.86	0.04	52.2	8	0.86	0.04	130.1	20	0.86	0.03
Lynn Canal												
2005/2006	9.6	2	0.82	0.12	10.0	1	0.91	0.09	19.6	3	0.86	0.07
2006/2007	25.4	11	0.67	0.08	22.1	4	0.84	0.07	47.5	15	0.74	0.05
2007/2008	26.6	7	0.77	0.08	20.8	4	0.83	0.08	47.3	11	0.80	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
2012/2013	16.8	8	0.59	0.10	13.6	7	0.60	0.11	30.4	15	0.59	0.07
2013/2014	11.3	3	0.75	0.13	10.9	2	0.83	0.11	22.3	5	0.79	0.08
2014/2015	8.8	5	0.57	0.14	12.8	1	0.93	0.07	21.6	6	0.76	0.08
All years	187.7	59	0.72	0.03	169.8	34	0.81	0.03	357.4	93	0.77	0.02

At Risk = average number of animals monitored per month (per time period) tantly, these data provide quantitative information about winter severity in areas representative of where mountain goats in our study area are wintering. Such data will be able to be used as covariates in future analyses of survival, reproduction and resource selection.

Climate Data.—Daily climate data were archived from the National Weather Service database to characterize broader scale climate patterns. Mean daily snow depth and snowfall data were summarized from data collected at the National Weather Service station in Haines, AK (Appendix 3). Mean snowfall in Haines during the study period (2005-2015) was 119% of the long-term normal (i.e. 1950-2015). Overall, snowfall in Haines during 6 of the 10 winters of the study was above normal (including 5 of the 10 highest snowfall winters on record; 39 years of data). The winter of 2014/2015 was exceptionally mild (54 inches of total snowfall, or 34% of normal).

Reproduction and Survival

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 (Table 1). 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 production reported here are presumably lower than the actual percentage of females that gave birth. Nevertheless, our estimates of kid production were similar to estimates of kidding rates reported elsewhere (Festa-Bianchet and Cote 2007).

Annual estimates of kid production in Lynn Canal ranged from 57-88% between 2005-2015 (Table 1). During 2015, 88% of radio-marked females (n = 17) had a kid at heel; the highest estimate yet for the population (Table 1). As described above, the winter of 2014/2015 was exceptionally mild and may have contributed to the observed increase in reproduction.

Survival.—Mountain goats were monitored monthly during fixed-wing aerial telemetry flights and/or via GPS-telemetry. During 2014/2015 biological year, 6 radio-marked animals died. Two animals died in an avalanches and the remaining four animals died of unknown causes. Overall, 76±8% of animals survived during 2014/2015. Winter snowfall amounts during 2014/2015 was 34% of normal (see Winter Severity and Snow Modeling section above). The observed overall survival rate was lower than might be expected during a mild winter (i.e. White et al. 2011) and was largely attributed to low male survival (57±14%). Female survival (93±7%) was above average and more consistent with expectations related to winter severity effects on mountain goat survival.

Table 3: Population-level aerial survey sighting probabilities, based on surveys conducted between 2010-2014 in Lynn Canal and other areas 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
2013	16	22	0.73	0.09
2014	18	25	0.72	0.09
2015	16	21	0.76	0.09
Total	73	107	0.68	0.05
Cleveland Pen				
2010	--	--	--	--
2011	--	--	--	--
2012	3	16	0.19	0.10
2013	10	21	0.48	0.11
2014	2	5	0.40	0.22
2015	--	--	--	--
Total	15	42	0.36	0.07
Haines-Skagway				
2010	14	20	0.70	0.10
2011	20	32	0.63	0.09
2012	9	19	0.47	0.11
2013	24	31	0.77	0.08
2014	23	34	0.68	0.08
2015	20	27	0.74	0.08
Total	110	163	0.67	0.04
Lynn Canal				
2010	39	73	0.53	0.06
2011	19	28	0.68	0.09
2012	21	32	0.66	0.08
2013	13	22	0.59	0.10
2014	15	26	0.58	0.10
2015	7	20	0.35	0.11
Total	114	201	0.57	0.03
Overall total	312	513	0.61	0.02

Population Abundance and Composition

Aerial Surveys.—During September 2015, we conducted three aerial surveys in the Lions Head and Sinclair Mountain study areas and the Berners-Lace ridge area (Appendix 4). The Berners-Lace ridge was surveyed because seasonal movement (albeit limited) by male mountain goats has been documented from the Lions Head study area to this site in past years.

Evaluation of Population Trends.— Geographic and temporal trends were calculated for eight survey areas within the Lions Head and Sinclair study areas, and Berners-Lace ridge (Appendix 4, 5a-c). Analyses included annual minimum count data (i.e. total number of mountain goats seen during in each area during aerial surveys standardized by area - i.e. density/km^2) collected during 2005-2015.

Minimum count densities declined substantially in most areas since 2005/2006 (Table 4). In the Lions Head area, the strongest decline occurred in the Kensington survey area (i.e. -11% per year) however declines were also evident in the neighboring Met (-7% per year) and West Berners (-3% per year) areas; Berners-Lace Ridge appeared stable. In the more northerly Sinclair study area, mountain goat populations exhibited even stronger declines (Table 4). The peripheral, low density populations adjacent to the icefield appeared stable (but should be interpreted cautiously due to very low total number of animals seen in each areas). Minimum count densities also varied substantially among areas with the highest initial densities occurring on the south and west side of the Kakuhan range (i.e. Kensington, Met, Yeldagalga and S Katzehin). Areas on the east side of the Kakuhan Range, generally had lower densities (and closer proximity to icefields and glaciers).

The general decline in mountain goat populations coincided with succession of severe winters between 2006-2014; total annual snowfall in Haines was greater than average in 6 of the 8 winters during this period (Appendix 3). Winter snowfall can exert strong negative effects of mountain goat survival (White et al. 2011) by increasing energetic costs of locomotion and burial of food resources. It is not immediately clear why declines appear to be strongest in the northwestern Kakuhan Range (i.e. Yeldagalga, South Katzehin and Katzehin Lake) and Kensington survey areas. It is possible that snow depths are greater in the northwestern areas; an observation supported by anecdotal information. The northwestern survey areas also had the highest initial minimum count densities and may have been closer to nutritional carrying capacity (and thus more vulnerable to population declines) prior to the severe winters. In the Kensington area, declines appeared stronger than in surrounding areas suggesting that factors other than local variation in winter conditions were important. Recent analyses suggested that mountain goat avoidance of winter range habitats within 1.8 km of Kensington Mine developments has reduced the functional winter range carrying capacity by 42% in the local area (White and Gregovich 2016). Thus, mine related disturbance may have indirectly exacerbated the effects of severe winters in the local mountain goat population. Nonetheless, the analyses and interpretation of these data should be considered preliminary.

Trends estimated from minimum count data are subject to greater variation than those derived from actual population estimates. For example, the proportion of collared

Table 4: Estimated change in minimum count densities, based on mountain goats observed during aerial surveys during 2005-2015, Lynn Canal, Alaska.

Area	Slope (change/yr)	r^2	Density (count/km^2) Mean	Max	Min	Area (km^2)	# years
Lions Head							
W Berners	-0.03	0.13	0.6	1.1	0.3	22.0	11
Kensington	-0.11	0.38	1.3	2.7	0.5	19.9	11
Met	-0.07	0.17	3.1	4.0	2.5	15.4	10
Sinclair							
Yeldagalga	-0.26	0.64	2.5	4.5	0.9	25.1	10
S Katzehin	-0.20	0.76	1.5	2.7	0.6	41.6	10
Katzehin Lk	-0.14	0.90	0.6	1.5	0.1	21.2	10
Icefield							
S Meade	-0.01	0.02	0.5	1.2	0.2	18.2	10
U Lace	0.01	0.03	0.4	0.7	0.1	16.9	10
BL Ridge	-0.01	0.02	0.7	1.2	0.3	30.0	8

mountain goats seen on surveys in 2015 was significantly lower than previous years and may have muted evidence of population recoveries (Table 3). Future analyses involving actual population estimates (that explicitly incorporate variation survey conditions and sighting probabilities) and more sophisticated trend analyses are expected to be more robust and provide greater analytical resolution and, possibly, result in different or more nuanced inference.

Sightability Modeling and Population Estimates.—During all surveys, data were collected for purposes of developing individual-based and population-level sighting probability models (exceptions occurred when surveys were conducted prior to marking). In addition, complementary aerial surveys were conducted in areas outside of the study area (Haines, Baranof Island) where mountain goats were marked as part of independent studies (Table 3). Collection of data in other areas enabled acquisition of additional sightability data resulting in opportunity to more accurately parameterize sightability models; however, a majority of the data used to develop models was collected in the Lynn Canal/Berners Bay study areas. Efforts to develop and validate mountain goat sightability models are ongoing. Once models are completed all existing mountain goat aerial survey data will be used to derive population estimates and update analyses of population trends.

FUTURE WORK

The mountain goat population monitoring and assessment work in the vicinity of the Kensington Mine is planned to continue during the operational phase on mining operations (the current funding agreement between ADFG and Coeur Alaska, Inc. continues through 2018 but is expected to be renewed by Coeur Alaska, Inc. thereafter). The project area for ongoing mine-related monitoring work encompasses the area between Slate cove and the Katzehin River (i.e. the “Lions Head” and “Sinclair” study areas). In this area study animals (2016, n = 22) will continue to be monitored monthly to assess reproductive status and survival. Mortalities will be investigated during April - October, or as conditions allow. GPS location data will be downloaded from radio-collars following field recovery efforts; GPS radio collars automatically release 3 years after capture/deployment (or at the time or mortality). GPS data will be post-processed and appended to the existing GPS location database. During late-summer, 6-8 mountain goats will be captured to ensure scientifically defensible sample sizes are maintained. Three replicate aerial surveys will be conducted in early-fall 2016, weather permitting, in order to estimate mountain goat sightability, population abundance and composition. During 2016-2017, efforts will continue to develop mountain goat aerial survey sightability models and, ultimately, derive population estimates. Results of project activities will be summarized and submitted to Coeur Alaska, Inc. and associated stakeholders as an annual research project report in spring 2017.

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Appendix 1: Incidence of disease prevalence of mountain goats in the Lions Head, Sinclair, Villard and East Berners study areas, 2010-2013. Results are also provided for three other populations in southeastern Alaska in 2010-2013, for comparison. (Kakuhan includes the Lions Head and Sinclair study areas combined).

	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	30	1	0.03	10	1	0.10	32	3	0.09	20	1	0.05	54	3	0.06	24	0	0.00	170	9	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	26	0	0.00	11	0	0.00	40	0	0.00	29	0	0.00	55	3	0.05	32	1	0.03	193	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 2a: Trace mineral concentration documented for mountain goats in the Lions Head and Sinclair study areas, 2010-2013. Results are also provided for three other populations in southeastern Alaska in 2010-2014, for comparison. (Kakuhan includes the Lions Head and Sinclair study areas combined).

	Se			Mo			Mn			Fe			Cu			Zn		
Area	mean	SE	n	mean	SE	n	mean	SE	n	mean	SE	n	mean	SE	n	mean	SE	n
Baranof	0.31	0.01	36	0.05	0.00	36	0.006	0.000	36	1.64	0.07	36	1.07	0.02	36	0.81	0.03	36
Cleveland	0.26	0.01	5	0.05	0.00	5	0.006	0.000	5	1.71	0.09	5	0.81	0.03	5	0.70	0.04	5
Kakuhan	0.17	0.02	31	0.05	0.00	31	0.006	0.000	31	1.58	0.09	31	1.01	0.05	31	0.81	0.03	31
Haines	0.24	0.02	52	0.05	0.00	51	0.006	0.000	51	1.82	0.07	51	1.06	0.03	51	0.83	0.03	51
Average	0.24	0.01	126	0.05	0.00	125	0.006	0.000	125	1.72	0.04	125	1.04	0.02	125	0.82	0.02	125

Appendix 2b: Selenium concentration for mountain goats in the Lions Head and Sinclair study areas, 2010-2013. Results are also provided for three other populations in southeastern Alaska in 2010-2014, for comparison. (Kakuhan includes the Lions Head and Sinclair study areas combined).

Selenium (ppm)

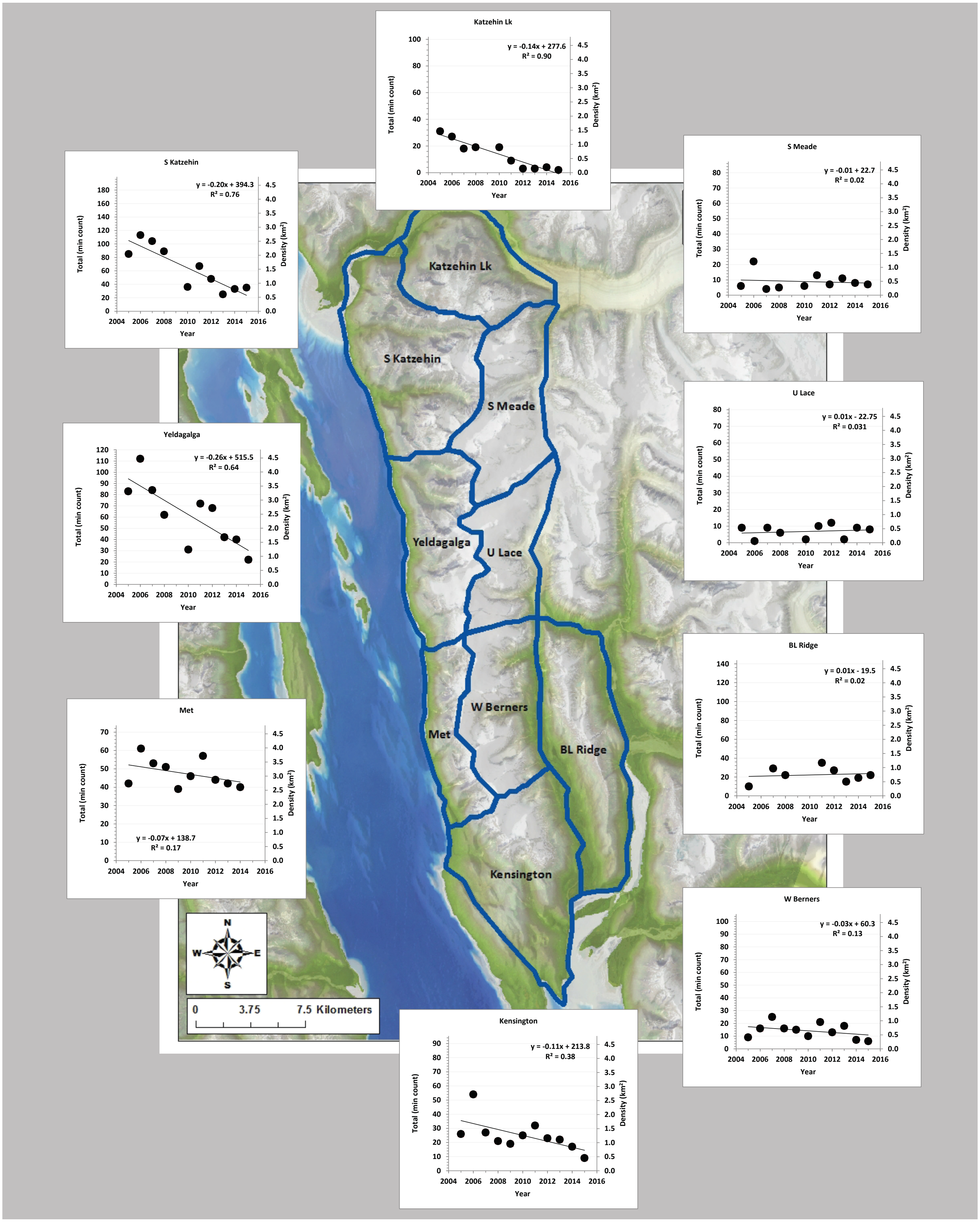
Area	mean	SE	n	Min	Max	# < 0.10	Prop < 0.10
Baranof	0.31	0.01	36	0.19	0.41	0	0.00
Cleveland	0.26	0.01	5	0.22	0.29	0	0.00
Kakuhan	0.17	0.02	31	0.05	0.37	10	0.32
Haines	0.24	0.02	52	0.03	0.73	9	0.17
Average	0.24	0.01	126	0.03	0.73	19	0.15

Appendix 3: Monthly snowfall (in.) recorded at the NWS weather station in Haines, AK between 2005-2015.

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total	% of normal
2005/2006	0	30	9	40	22	16	0	0	118	74%
2006/2007	0	42	78	81	28	78	3	0	309	195%
2007/2008	0	6	56	78	41	31	3	0	214	135%
2008/2009	22	24	56	62	45	43	9	0	261	165%
2009/2010	0	48	19	68	8	59	0	0	202	128%
2010/2011	0	24	25	19	20	3	3	0	93	59%
2011/2012	0	126	40	121	20	56	0	0	363	230%
2012/2013	4	20	41	21	23	10	14	1	133	84%
2013/2014	0	20	92	22	23	35	1	0	192	122%
2014/2015	0	0	5	14	18	16	0	0	53	34%
Average, Study period	3	31	42	52	24	32	3	0	187	119%
Average, Long-term[1]	3	22	38	39	29	21	4	0	157	100%

[1]Haines Airport (1950-1955, 1973-1998) and Haines COOP NWS Station (1999-2014)

Appendix 4: Mountain goat aerial survey areas in the Kakuhan Range (Lions Head, Sinclair and Berners-Lace Ridge study areas). Each area was surveyed by fixed- and/or rotor-wing aircraft during August-October, 2005-2015. Estimated change in minimum count densities, based on mountain goats observed during aerial surveys, are provided in described in associated figures.



Appendix 5a: Summary of mountain goat population composition and minimum count data collected during aerial surveys on the Lions Head study area (and associated survey areas), 2005-2015. These data do not account for differences in mountain goat sighting probabilities that occur between surveys/years. As a result, the number of mountain goats recorded represent the minimum number of animals in each survey area during a given year.

Study Area	Survey Area	Year	Adults	Kids	Total	Density	Prop. kids	Groups	# of surveys	Area (km^2)
Lions Head	W Berners	2005	9	0	9	0.4	0.00	5	2	22.0
Lions Head	W Berners	2006	16	2	16	0.7	0.13	14	4	22.0
Lions Head	W Berners	2007	18	7	25	1.1	0.28	13	4	22.0
Lions Head	W Berners	2008	15	1	16	0.7	0.06	8	2	22.0
Lions Head	W Berners	2009	12	3	15	0.7	0.20	7	1	22.0
Lions Head	W Berners	2010	9	1	10	0.5	0.10	8	2	22.0
Lions Head	W Berners	2011	17	4	21	1.0	0.19	14	1	22.0
Lions Head	W Berners	2012	11	2	13	0.6	0.15	9	1	22.0
Lions Head	W Berners	2013	16	2	18	0.8	0.11	13	1	22.0
Lions Head	W Berners	2014	6	1	7	0.3	0.14	6	1	22.0
Lions Head	W Berners	2015	5	1	6	0.3	0.17	4	1	22.0
Lions Head	Kensington	2005	21	5	26	1.3	0.19	13	2	19.9
Lions Head	Kensington	2006	48	8	54	2.7	0.15	35	4	19.9
Lions Head	Kensington	2007	24	4	27	1.4	0.15	14	4	19.9
Lions Head	Kensington	2008	17	4	21	1.1	0.19	12	2	19.9
Lions Head	Kensington	2009	15	5	19	1.0	0.26	11	2	19.9
Lions Head	Kensington	2010	18	7	25	1.3	0.28	11	2	19.9
Lions Head	Kensington	2011	25	7	32	1.6	0.22	16	1	19.9
Lions Head	Kensington	2012	20	3	23	1.2	0.13	13	1	19.9
Lions Head	Kensington	2013	17	5	22	1.1	0.23	14	1	19.9
Lions Head	Kensington	2014	16	1	17	0.9	0.06	12	1	19.9
Lions Head	Kensington	2015	7	2	9	0.5	0.22	6	1	19.9
Lions Head	Met	2005	35	7	42	2.7	0.17	20	2	15.4
Lions Head	Met	2006	47	14	61	4.0	0.23	30	5	15.4
Lions Head	Met	2007	48	5	53	3.5	0.09	32	4	15.4
Lions Head	Met	2008	39	13	51	3.3	0.25	26	2	15.4
Lions Head	Met	2009	30	9	39	2.5	0.23	13	2	15.4
Lions Head	Met	2010	32	14	46	3.0	0.30	23	2	15.4
Lions Head	Met	2011	42	15	57	3.7	0.26	24	1	15.4
Lions Head	Met	2012	37	7	44	2.9	0.16	26	1	15.4
Lions Head	Met	2013	31	11	42	2.7	0.26	21	1	15.4
Lions Head	Met	2014	30	10	40	2.6	0.25	22	1	15.4
Lions Head	Met	2015	--	--	--	--	--	--	0	15.4

Appendix 5b: Summary of mountain goat population composition and minimum count data collected during aerial surveys on the Mt. Sinclair study area (and associated survey areas), 2005-2015. These data do not account for differences in mountain goat sighting probabilities that occur between surveys/years. As a result, the number of mountain goats recorded represent the minimum number of animals in each survey area during a given year.

Study Area	Survey Area	Year	Adults	Kids	Total	Density	Prop. kids	Groups	# of surveys	Area (km^2)
Sinclair	Yeldagalga	2005	67	16	83	3.3	0.19	25	2	25.1
Sinclair	Yeldagalga	2006	95	22	112	4.5	0.20	57	6	25.1
Sinclair	Yeldagalga	2007	69	15	84	3.4	0.18	38	3	25.1
Sinclair	Yeldagalga	2008	50	12	62	2.5	0.19	27	2	25.1
Sinclair	Yeldagalga	2009	--	--	--	--	--	--	0	25.1
Sinclair	Yeldagalga	2010	25	9	31	1.2	0.29	19	2	25.1
Sinclair	Yeldagalga	2011	57	15	72	2.9	0.21	24	1	25.1
Sinclair	Yeldagalga	2012	59	9	68	2.7	0.13	23	1	25.1
Sinclair	Yeldagalga	2013	34	8	42	1.7	0.19	20	1	25.1
Sinclair	Yeldagalga	2014	31	9	40	1.6	0.23	23	1	25.1
Sinclair	Yeldagalga	2015	15	7	22	0.9	0.32	10	1	25.1
Sinclair	S Katzehin	2005	72	13	85	2.0	0.15	37	2	41.6
Sinclair	S Katzehin	2006	94	19	113	2.7	0.17	51	4	41.6
Sinclair	S Katzehin	2007	84	20	104	2.5	0.19	45	3	41.6
Sinclair	S Katzehin	2008	70	19	89	2.1	0.21	42	2	41.6
Sinclair	S Katzehin	2009	--	--	--	--	--	--	0	41.6
Sinclair	S Katzehin	2010	29	7	36	0.9	0.19	22	2	41.6
Sinclair	S Katzehin	2011	53	14	67	1.6	0.21	36	1	41.6
Sinclair	S Katzehin	2012	42	6	48	1.2	0.13	24	1	41.6
Sinclair	S Katzehin	2013	21	4	25	0.6	0.16	15	1	41.6
Sinclair	S Katzehin	2014	27	6	33	0.8	0.18	20	1	41.6
Sinclair	S Katzehin	2015	27	8	35	0.8	0.23	20	1	41.6
Sinclair	Katzehin Lk	2005	23	8	31	1.5	0.26	9	2	21.2
Sinclair	Katzehin Lk	2006	25	3	27	1.3	0.11	17	4	21.2
Sinclair	Katzehin Lk	2007	16	2	18	0.8	0.11	10	3	21.2
Sinclair	Katzehin Lk	2008	15	4	19	0.9	0.21	11	2	21.2
Sinclair	Katzehin Lk	2009	--	--	--	--	--	--	0	21.2
Sinclair	Katzehin Lk	2010	14	5	19	0.9	0.26	9	2	21.2
Sinclair	Katzehin Lk	2011	7	2	9	0.4	0.22	6	1	21.2
Sinclair	Katzehin Lk	2012	3	0	3	0.1	0.00	2	1	21.2
Sinclair	Katzehin Lk	2013	2	1	3	0.1	0.33	2	1	21.2
Sinclair	Katzehin Lk	2014	3	1	4	0.2	0.25	2	1	21.2
Sinclair	Katzehin Lk	2015	2	0	2	0.1	0.00	1	1	21.2

Appendix 5c: Summary of mountain goat population composition and minimum count data collected during aerial surveys on the Meade Icefield and Berners-Lace Ridge study areas (and associated survey areas), 2005-2015. These data do not account for differences in mountain goat sighting probabilities that occur between surveys/years. As a result, the number of mountain goats recorded represent the minimum number of animals in each survey area during a given year.

Study Area	Survey Area	Year	Adults	Kids	Total	Density	Prop. kids	Groups	# of surveys	Area (km^2)
Icefield	U Lace	2005	9	0	9	0.5	0.00	6	1	16.9
Icefield	U Lace	2006	1	0	1	0.1	0.00	1	1	16.9
Icefield	U Lace	2007	8	1	9	0.5	0.11	6	1	16.9
Icefield	U Lace	2008	6	1	6	0.4	0.17	4	2	16.9
Icefield	U Lace	2009	--	--	--	--	--	--	0	16.9
Icefield	U Lace	2010	2	1	2	0.1	0.50	1	2	16.9
Icefield	U Lace	2011	6	4	10	0.6	0.40	3	1	16.9
Icefield	U Lace	2012	9	3	12	0.7	0.25	5	1	16.9
Icefield	U Lace	2013	2	0	2	0.1	0.00	2	1	16.9
Icefield	U Lace	2014	6	3	9	0.5	0.33	2	1	16.9
Icefield	U Lace	2015	7	1	8	0.5	0.13	5	1	16.9
Icefield	S Meade	2005	6	1	6	0.3	0.17	2	2	18.2
Icefield	S Meade	2006	19	3	22	1.2	0.14	16	2	18.2
Icefield	S Meade	2007	3	1	4	0.2	0.25	3	1	18.2
Icefield	S Meade	2008	5	1	5	0.3	0.20	3	2	18.2
Icefield	S Meade	2009	--	--	--	--	--	--	0	18.2
Icefield	S Meade	2010	4	2	6	0.3	0.33	4	2	18.2
Icefield	S Meade	2011	10	3	13	0.7	0.23	9	1	18.2
Icefield	S Meade	2012	7	0	7	0.4	0.00	6	1	18.2
Icefield	S Meade	2013	10	1	11	0.6	0.09	7	1	18.2
Icefield	S Meade	2014	5	3	8	0.4	0.38	5	1	18.2
Icefield	S Meade	2015	5	2	7	0.4	0.29	4	1	18.2
BL Ridge	BL Ridge	2005	10	0	10	0.3	0.00	10	1	30.0
BL Ridge	BL Ridge	2006	--	--	--	--	--	--	0	30.0
BL Ridge	BL Ridge	2007	25	4	29	1.0	0.14	14	1	30.0
BL Ridge	BL Ridge	2008	19	3	22	0.7	0.14	13	1	30.0
BL Ridge	BL Ridge	2009	--	--	--	--	--	--	0	30.0
BL Ridge	BL Ridge	2010	--	--	--	--	--	--	0	30.0
BL Ridge	BL Ridge	2011	26	9	35	1.2	0.26	17	2	30.0
BL Ridge	BL Ridge	2012	24	3	27	0.9	0.11	13	1	30.0
BL Ridge	BL Ridge	2013	13	2	15	0.5	0.13	11	1	30.0
BL Ridge	BL Ridge	2014	16	3	19	0.6	0.16	13	1	30.0
BL Ridge	BL Ridge	2015	18	4	22	0.7	0.18	16	1	30.0