Wildlife Research Annual Progress Report

Mountain Goat Population Monitoring and Survey Technique Development

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Cover photo: Photo of an adult male mountain goat climbing in very steep, rocky terrain near the Mendenhall Glacier, AK (K. White).

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INTRODUCTION

This annual progress report was prepared to meet the reporting requirements for United States Forest Service. In 2009, the USFS provided funding to support mountain goat aerial survey technique development and population monitoring field activities. Prior to 2009, ADFG has been conducting research on this and other topics as part of an independent study funded by ADFG, AKDOT/PF and Coeur Alaska (see White and Barten 2009). This report summarizes activities associated with the 2009 USFS contract that have been completed by December 31, 2009 (but also includes relevant survey technique development research conducted prior to 2009).

Background

Monitoring the abundance and productivity of mountain goat populations is critical for evaluating the effects of forest management practices including timber harvest, helicopter tourism and mining activities. Mountain goats are designated a management indicator species under Forest Service policy yet actual monitoring has, historically, been very limited. Aside from routine surveys conducted by ADFG in high use hunting areas, long-term, consistent monitoring data is absent; especially in areas where intensive helicopter tourism is prevalent. Compounding this problem are complexities associated with estimating actual population size from raw survey data. A common approach for calculating actual population size involves developing mark-resight or logistic regression based "sightability" models. Such models can then be used to calculate actual population size by statistically accounting for sources of environmental and survey bias recorded in routine surveys. Unfortunately, such models have not been developed for mountain goats in southeast Alaska and, as a result, the ability to accurately monitor mountain goat populations is limited. This study aims to develop mountain goat "sightability" models to address this important limitation of monitoring efforts.

STUDY OBJECTIVES

This research is designed to investigate sources of mountain goat aerial survey bias (ie. behavioral, environmental and climatic) in order to develop statistical and field techniques needed to accurately estimate mountain goat population size during routine monitoring surveys. The specific objectives are as follows:

1) estimate individual mountain goat sighting probabilities under a range of different conditions (ie. to determine which habitat conditions/circumstances result in the highest/lowest chance of seeing goats), and

2) estimate population sightability estimates for a given survey under a given set of conditions (ie. proportion of animals seen during a survey)

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. 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.

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

Study Design Overview

Beginning in 2005, the Alaska Department of Fish and Game (with funding from ADOT/PF and Coeur Alaska) initiated a broad-based mountain goat ecology study in the Lynn Canal area (See White and Barten 2009). A key aspect of this project involved deploying radio-collars on mountain goats to address multiple study objectives (i.e. habitat selection, movement patterns, vital rates, popu-

lation estimation). The deployment of radio-collars on mountain goats in this area provided an additional opportunity to conduct research relating to mountain goat aerial survey technique development. As such, the focus of this specific project has been to gather field data to develop statistical models and field protocols that can be used in a management context to monitor mountain goat populations in the future throughout southeast Alaska. The basis of these efforts involves conducting routine aerial surveys in areas inhabited by radio-marked mountain goats and, subsequently, gathering site specific information about factors that influence the probability of sighting mountain goats on a given survey and/or under certain circumstances. While funding for this project specifically involves gathering data from radio-marked animals collected during aerial surveys, information is also provided about activities associated with deployment of radio-collars (that was funded from other sources, as described above).

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, White and Barten 2009), 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. All animals were equipped with red or orange-colored GPS (Telonics TGW-3590) or VHF radio-collars (Telonics MOD-500; Figure 1). 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.

Aerial Survey Technique Development Data Collection

Aerial Surveys.—Population abundance and composition surveys were conducted using fixed-wing aircraft (Helio-courier and PA-18 "Super Cub") and helicopter (Hughes 500) during August-October 2006-2009. 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.

Figure 1: Post-capture photograph of LG124 (5-year old male), north of Lions Head, illustrating use of shaded, subalpine habitats (ie. elev.: 2850 ft.) during warm days in early-August 2009.

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 (ie. missed) during surveys. In cases where radio-collared animals were missed, it was necessary to backtrack 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 (ie. 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 (ie. 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.—Mountain goats were captured during August-October in 2005-2009. Overall, 137 animals (62 females and 75 males) were captured using standard helicopter darting methods. Due to programmed GPS-collar self-release or natural mortality, by the fall 2009 aerial survey season 53 animals were deployed with radio-collars.

Aerial Survey Technique Development Data

Collection

Aerial Surveys.—Overall, 7 aerial surveys were conducted in August-October 2009. During six of these surveys, data were collected for purposes of developing individual-based sighting probability models. One survey was conducted in the Mendenhall-Herbert Glacier area (on 8/20/09) to gather baseline population monitoring information in a high-use helicopter tourism zone, an area where radio-collared goats were not present. Of the six surveys conducted in areas inhabited by radio-collared animals, two surveys encompassed an area large enough to estimate survey-level sightability; the remaining surveys enabled collection of individual-based sightability data only.

Individual-based Sightability Data Collection.-During 2009, habitat and behavioral covariate data were collected for 60 marked mountain goat observations during aerial surveys. These data were paired with records of whether animals were either seen or not seen during routine surveys in order to compile a database suitable for determining factors related to mountain goat survey sighting probability. Overall, data has been collected during 147 "sightability trials" involving marked mountain goats have been conducted between 2007-2009.

Table 1. Observed values of categorical covariates in 147 observations of mountain goat sightability in Lynn Canal, AK

Variable	Category	*n*	%[a]	*n* missing
Behavior	Bedded	35	29	27
	Feeding	10	8	
	Running	2	2	
	Standing	31	26	
	Walking	42	35	
Landform	Mid-Slope	85	62	10
	Ravine	32	23	
	Ridge	20	15	
Slope	Gentle	12	9	12
	Moderate	48	36	
	Steep	46	34	
	Very Steep	29		
Terrain	Smooth	19	14	11
	Broken	80	59	
	Very Broken	37	27	
Habitat	Meadow	27	19	6
	Rocky	75	53	
	Snow	16	11	
	Forest	14	10	
	Thicket	9	6	
Lighting	Sun	28	19	3
	Shade	11	8	
	High Overcast	97	67	
	Low Overcast	8	6	
Aircraft	Cub	119	81	0
	Heliocourier	4	3	
	Helicopter	24	16	

[a] % of nonmissing values

Table 2. Categorical covariate summary for mountain goat sightability trials in Lynn Canal, AK, including proportion of animals seen under each sub-category.

Variable	Category	Seen	Missed	Total	Proportion Seen
Behavior	Bedded	28	7	35	0.80
	Feeding	7	3	10	0.70
	Running	2	0	2	1.00
	Standing	21	10	31	0.68
	Walking	28	14	42	0.67
Landform	Mid-Slope	60	25	85	0.71
	Ravine	12	20	32	0.38
	Ridge	14	6	20	0.70
Slope	Gentle	8	4	12	0.67
	Moderate	36	12	48	0.75
	Steep	33	13	46	0.72
	Very Steep	9	20	29	0.31
Terrain	Smooth	18	1	19	0.95
	Broken	55	25	80	0.69
	Very Broken	13	24	37	0.35
Habitat	Meadow	24	3	27	0.89
	Rocky	53	22	75	0.71
	Snow	2	14	16	0.13
	Forest	5	9	14	0.36
	Thicket	2	7	9	0.22
Lighting	Sun	21	7	28	0.75
	Shade	7	4	11	0.64
	High Overcast	55	42	97	0.57
	Low Overcast	4	4	8	0.50

Table 3. Summary of mean (SE) values and sample sizes for continuous coraviates involving mountain goats that were either seen and missed during sightability trials in Lynn Canal, AK

	Seen			Missed		
	mean	SE	n	mean	SE	n
Group Size	3.2	0.5	90	2.0	0.2	38
Canopy Cover (%)	7.5	4.3	23	22.6	6.9	33
Distance to Terrain Obstruction (m)	17.9	3.5	23	10.3	2.4	24
Distance from Track	356.2	37.1	31	334.0	62.1	15
Aircraft Speed (km/hr)	110.8	4.0	19	120.3	3.6	12

Preliminary summaries of individual sightability data were conducted separately for continuous and categorical covariates. These data provide information about the extent to which sampling has varied within each category (Table 1). In some cases, data were missing due to aerial survey constraints or animal behavior (Table 1), however such cases were, generally, uncommon. Data were also summarized to compare the proportion of cases in which animals were seen for each category in order to gain insight into which conditions are most likely to effect individual sightability (Table 2). In addition, the mean values for continuous vari-

ables were compared for animals that were seen and those missed during surveys (Table 3). Since sample sizes are limited for many categories and not yet adequate for formal analyses, it is not appropriate to draw process-oriented conclusions from these data summaries. Nonetheless, these preliminary summaries provide meaningful information about sampling intensity and variability that are useful for planning future field efforts.

Population-level Sightability Data Collection.-Two aerial surveys were conducted that provided adequate data for estimating population-level sightability. On 8/12/09, the east side of Lynn Canal was surveyed between Lions Head and Yeldagalga Creek. During this survey 10 of the 15 (66.7%) of the radio-collared animals inhabiting this area were seen. On 10/3/09, a larger area including east Berners Bay, Berners River and the Katzehin river watershed was surveyed. During this survey 12 of 37 (32.4%) radio-collared animals were seen. Overall, the differences in the proportion of marked animals seen on these surveys is likely due to difficult spotting conditions observed on the latter survey as a result of fresh snow at elevations above 2500-3000 feet. Nonetheless, while sightability conditions appear to be extremely low for this survey substantial value is gained by gathering data when conditions are sub-optimal in order to ensure that data collected over the course of the study span a realistic continuum of conditions likely to be observed during future routine monitoring surveys.

FUTURE WORK/RECOMMENDATIONS

Individual- and population-level sightability data sets are not yet adequate for formal statistical analyses and additional data collection efforts are needed. Currently, 49 mountain goats are deployed with radio-collars in the Lynn Canal area. In September 2009, 7 VHF radio-collars were deployed on mountain goats on the lower Cleveland Peninsula (plans call for additional deployment of 5 collars in this area in 2010). In addition, planning is underway to initiate another radio-collar deployment (i.e. 15-20) in the Thomas Bay area, near Petersburg, in summer 2010. Overall, a significant opportunity exists to continue mountain goat aerial survey technique data collection efforts in multiple areas throughout southeast Alaska. However, the extent to which additional data collection efforts will occur is unknown at this time and dependent on additional funding.

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