

Wildlife Research Annual Progress Report

## **Mountain Goat Population Monitoring and Survey Technique Development**



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Alaska Department of Fish and Game  
Division of Wildlife Conservation

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Cover photo: Photograph of a radio-marked adult male mountain goat in the Sawmill Creek watershed, Berners Bay, 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, ADOT/PF and Coeur Alaska (see White and Barten 2009). This report summarizes activities associated with the USFS contract that have been completed by December 31, 2010 (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 AND 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 (White and Barten 2010). Later, in 2009, ADFG initiated a small-scale research project on the lower Cleveland Peninsula, north of Ketchikan (White et al. 2010). And, in 2010, ADFG initiated additional research projects in the Haines/Skagway area (funded by ADFG and BLM; White 2010) and on central Baranof island (funded by ADFG and City of Sitka; White et al. 2010). A key aspect of each of these projects has involved deployment radio-collars on mountain goats to address various study objectives (i.e. habitat selection, movement patterns, vital rates, population estimation). The deployment of radio-collars on mountain goats in these areas 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).

## Study Area

Mountain goats were studied 4 separate study areas in southeastern Alaska (Figure 1), as described above. In general, the overall area has a maritime climate that is characterized by cool, wet summers and relatively warm snowy winters. Annual precipitation at sea-level averages 55-155 inches and winter temperatures are rarely less than 5° F and average 30-35° F. Elevations at 2600' can 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.

## Mountain Goat Capture

Mountain goats were captured using standard helicopter darting techniques and immobilized by injecting 3.0 - 2.4mg 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) and/or VHF radio-collars (Telonics MOD-500, MOD-410; Figure 2). 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



Figure 2: Photograph of an 8-yr old male mountain goat and ADFG wildlife biologist, Phil Mooney, after radio-collar attachment and just prior to chemical reversal, Katlian watershed, Baranof island, September 2010.

*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 2006-2010. 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.

*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 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 (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 2005-2010. Overall, 201 animals (91 females and 110 males) were captured using standard helicopter darting methods. Due to programmed GPS-collar self-release or natural mortality, by the fall 2010 aerial survey season 95 animals were deployed with radio-collars in 4 separate study areas (Figure 1).

### Aerial Survey Technique Development Data Collection

*Aerial Survey Training Manual.*—An aerial survey training manual was produced in order to ensure that moderately complicated aerial survey protocols could be consistently implemented by different observers. The manual focuses on describing specific field protocols, illustrating each habitat classification type and providing test cases to enable prospective observers to test their proficiency and calibrate their responses to other observers (Figure 3). The manual is intended to be a working document and will be revised in the future as additional images and materials become available.

*Aerial Surveys.*—Overall, 12 aerial surveys were conducted during September 2009 (Table 1). During all of these surveys, data were collected for purposes of developing individual-based and population-level sighting probability models. Aerial surveys were conducted in three of the four study areas; surveys were not conducted on the Cleveland Peninsula in 2010.

*Individual-based Sightability Data Collection.*—During 2010, habitat and behavioral covariate data were collected for 98 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 246 “sightability trials” involving marked mountain goats have been conducted between 2007-2010.

Preliminary analyses of individual sightability data (through 2009) were summarized in White and Pendleton

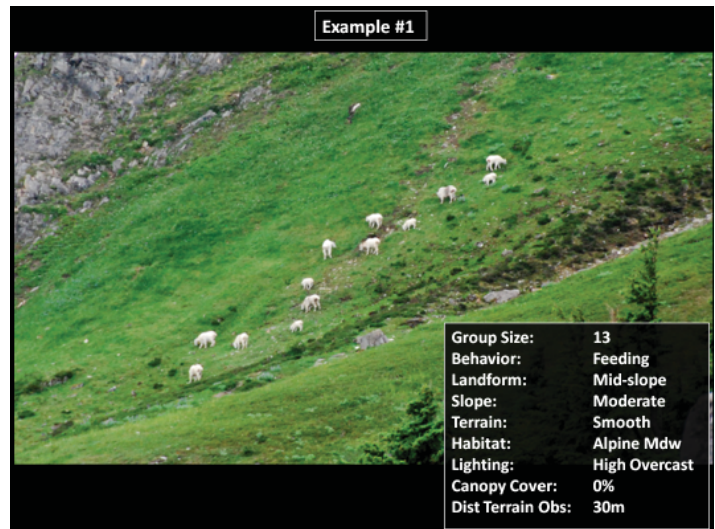


Figure 3: Example taken from the aerial survey technique manual. This figure depicts a scenario likely to be encountered during an aerial survey and provides the correct classification of biological and environmental covariates. Such scenarios enable observers to practice characterizing field settings prior to conducting aerial surveys.

Table 1: Summary of mountain goat aerial surveys conducted in 2010 in order to gather data needed to develop sighting probability models. Preliminary sighting probability estimates are provided for each survey in addition to sample size of marked animals and survey conditions.

Study Area	Date	Temp	Weather	Wind	Collars Seen	Total Collars	Sighting Prob
<b><u>Lynn Canal</u></b>							
East Berners	9/11/2010	51	Clear	0	5	10	0.50
East Berners	9/22/2010	42	Mostly Clear	0-10N	6	10	0.60
Lions Head	9/6/2010	44-48	Mostly Clear	15N	7	11	0.64
Lions Head	9/21/2010	36-42	Clear	0-5S	7	11	0.64
Sinclair Mtn.	9/6/2010	44-48	Mostly Clear	15N	6	10	0.60
Sinclair Mtn.	9/21/2010	36-42	Clear	0-5S	4	10	0.40
Mt. Villard	9/12/2010	41-48	Clear	20	4	11	0.36
<b><u>Haines/Skagway</u></b>							
Porcupine	9/16/2010	43-45	High Overcast	0-10	1	3	0.33
Takhin	9/16/2010	50	High Overcast	0-10	3	4	0.75
Takshanuk	9/8/2010	50	High Overcast	5	5	6	0.83
Chilkoot/Nourse	9/22/2010	35-39	Mostly Clear	0-15	5	7	0.71
<b><u>Baranof</u></b>							
Central Baranof	9/21/2010	--	Clear	--	6	12	0.50
<b><u>Cleveland Peninsula</u></b>							
Lower Cleveland	No Survey Conducted				--	--	--
<b>Total</b>					<b>59</b>	<b>105</b>	<b>0.56</b>

(2009). More comprehensive data analyses are planned but will not be conducted until data collection efforts for this project are completed.

*Population-level Sightability Data Collection and Analyses.*—Twelve aerial surveys were conducted that provided adequate data for estimating population-level sight-

ability. Overall, survey-level sighting probability estimates ranged between 0.33-0.83, however sample sizes were generally small for meaningful comparisons between individual surveys. Nonetheless, the mean sighting probability among all surveys combined was 0.56, which likely provides a more reasonable estimate of mountain goat sighting probabilities during routine aerial surveys.

During 2010, substantial progress was made relative to developing population-level sighting probability models (Pendleton and White 2010). Specifically, data collected between 2007-2009 were used to estimate detectability as a function of survey-specific predictor variables in a Bayesian analytical framework. An advantage of this statistical approach is that it is able to explicitly use data collected over multiple surveys, for a specific area, to improve estimates of survey detectability and, by extension, population size and precision for each subsequent survey. Ultimately, once models are developed, population size can be estimated for future surveys regardless of whether there is a sample of marked individuals but further refinement of detectability models requires a marked sample of animals. Currently, preliminary models have been developed and used to provide population estimates for a specific “case study” area (ie. Lions Head survey route). As expected, the population estimates using the Bayesian approach provide a markedly higher level of precision as compared to conventional methods (ie. Lincoln-Peterson mark-resight). Overall, the Bayesian method for estimating mountain goat population size is expected to offer a promising solution to traditional challenges associated estimating and monitoring mountain goat population size over time.

## FUTURE WORK/RECOMMENDATIONS

Individual- and population-level sightability data sets are not yet adequate for complete statistical analyses and additional data collection efforts are needed. Currently, 95 mountain goats are deployed with radio-collars in four study areas throughout southeastern Alaska. Additional radio-collar deployment efforts are planned for late-summer 2010 and will occur in the Lynn Canal and Baranof island study areas. Overall, a significant opportunity exists to continue mountain goat aerial survey technique data collection efforts in multiple areas throughout southeast Alaska. Currently, funding is available to maintain the current level of survey effort during 2011. In addition, during 2011, efforts will continue to further develop and refine statistical methods for analyzing mountain goat aerial survey data.

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