

Bighorn Sheep Assessment and Monitoring in the Peninsular Ranges of Southern California

Proposed Start and Completion Date:

Funding requested in this proposal to support population assessment and monitoring activities in the Peninsular Ranges will be expended between 1 July 2012 and 30 June 2013. However, field monitoring and data collection will likely extend through fall 2017 based on expected operational life of Very High Frequency (VHF) and Global Positioning System (GPS) equipment to be deployed on bighorn sheep.

Executive Summary and Statement of Need

Despite recent increases in population size, the Peninsular Ranges bighorn sheep population remains extremely vulnerable to predation, demographic and environmental stochasticity, habitat loss and fragmentation, disease, and human disturbance. A scientifically credible population assessment and monitoring program designed to determine and track population status, distribution, habitat use, recruitment and survival rates, and mortality factors has been in place since 1992. Continued implementation of this program remains crucial to the development and refinement of management and recovery strategies and achieving established recovery objectives.

Introduction

Peninsular bighorn sheep (*Ovis canadensis cremnobates*) were originally listed as a distinct subspecies but has recently been recognized as a distinct population segment of *Ovis canadensis nelsoni*. Due to habitat loss, habitat degradation and fragmentation, urban and commercial development, disease, predation and insufficient lamb recruitment, peninsular bighorn sheep were listed by the state as threatened in 1971 and then federally listed as endangered in 1998 (California Wildlife Action Plan 2007). The Peninsular Ranges encompass over one million acres from the San Jacinto Mountains near Palm Springs south to the Jacumba Mountains at the United States border with Mexico. The northern portion of the range is bordered by the cities of Palm Springs, Cathedral City, Rancho Mirage, Palm Desert, Indian Wells and La Quinta. The remainder of the range lies within the unincorporated portions of Riverside, San Diego, and Imperial counties and is bordered by agricultural or undeveloped lands. Nine recovery regions have been designated within the Peninsular Ranges to facilitate bighorn sheep recovery. These regions from north to south are: the San Jacinto Mountains, northern Santa Rosa Mountains, central Santa Rosa Mountains, southern Santa Rosa Mountains, Coyote Canyon, northern San Ysidro Mountains, southern San Ysidro Mountains, Vallecito Mountains and Carrizo Canyon.

To facilitate recovery, the Department of Fish and Game (DFG) developed and implemented a long-term population assessment and monitoring program in 1992 for bighorn sheep in the Peninsular Mountain Ranges. This program relies on range-wide population assessment and telemetry monitoring of radio-collared (marked) bighorn sheep to determine and track population status, distribution, habitat use, recruitment, survival, and mortality. As designed, the program is consistent with recommended monitoring strategies outlined in the "Recovery Plan for Bighorn Sheep in the Peninsular

Ranges, California” developed by the U.S. Fish and Wildlife Service (USFWS) in 2000 (U.S. Fish and Wildlife Service, 2000).

Due to the Peninsular Range’s ruggedness and large geographic size fixed-wing aircraft support is required to effectively monitor radio-collared bighorn sheep. Additionally, chronic funding shortages to support field personnel, equipment and helicopter flight time remain an obstacle to full implementation of the monitoring program. Continued monitoring at or above the current level of effort is crucial to the development and refinement of management and recovery strategies and achieving established recovery objectives. Without adequate funding and skilled expertise specifically dedicated to bighorn sheep assessment, monitoring, data collection and analysis, it is unlikely that recovery objectives identified in the USFWS Recovery Plan can be met.

Objectives

Monitoring objectives for bighorn sheep in the Peninsular Ranges include:

- Monitor population status, dynamics, and trends (Recovery Plan Section II.D.2.1) so that the success of recovery efforts can be evaluated.
- Monitor population abundance (Recovery Plan Section II.D.2.1.1) to generate estimates of abundance for individual recovery regions as well as for the entire population.
- Monitor distribution (Recovery Plan Section II.D.2.1.2) to track changes in the number and distribution of ewe groups and determine if augmentation or reintroductions are necessary and where.
- Monitor recruitment (Recovery Plan Section II.D.2.1.3) to determine lamb production so results can be compared among recovery regions, years and management strategies.
- Maintain and restore habitat connectivity (Recovery Plan Section II.D.1.1.3.5)
- Reduce mortality rates (Recovery Plan Section II.D.1.3)
- Research habitat use/selection and dispersal behavior (Recovery Plan Section II.D.2.6)
- Research disease and preventative measures (Recovery Plan Section II.D.2.8)

Methods and Analysis

Conservation of bighorn sheep in the Peninsular Ranges requires, at a minimum an understanding of population structure and dynamics, habitat use, behavior and mortality factors. To gain this understanding long-term monitoring is required. The monitoring program established by DFG for the peninsular ranges bighorn sheep population relies on marking individual bighorn sheep with VHF radio-collars, GPS attachment pods, colored ear tags, and/or colored marker collars. Helicopter mark-resight surveys and ground and aerial telemetry are the primary monitoring methods employed in the Peninsular Ranges.

Bighorn sheep will be captured, examined, and fitted with VHF/GPS collars and ear tags during fall 2012 for the purpose of mark-resight population estimation and demographic monitoring. A hand held net-gun fired from a helicopter will be used as the primary means of entrapment to provide for dispersal of radio-collared sheep throughout the capture area. Captured sheep will be fitted with a color coded VHF radio-collar (MOD 500, Telonics, Inc., Mesa AZ, USA). Additionally, all VHF radio-collars will be fitted with a stand alone, solar or battery powered downloadable GPS unit (Quantum 4000 Enhanced GPS Pod, Telemetry Solutions, Concord CA, USA). Capture operations will strictly adhered to animal and human safety, medical considerations, helicopter netting, and animal transportation guidelines described in the Department’s Wildlife Investigation

Laboratory Wildlife Restraint Handbook (2010). Capture guidelines are further described in the federal recovery plan.

VHF radio-collars will be monitored daily by DFG personnel for the week immediately following capture. Subsequent ground monitoring will be conducted two to three times per week for detection of mortality signals, to obtain visual observations and to record general locations and movements. Ground monitoring will be attempted at least once per month in areas where terrain ruggedness or remoteness makes obtaining visual observations and/or locations difficult. Fixed-wing telemetry monitoring will be conducted by DFG three to four times per month for detection of mortality signals, recording locations, and to obtain GPS fix location downloads.

All VHF radio-collars fitted to sheep will be equipped with a four-hour mortality delay (MS-6 Mortality Option, Telonics, Inc., Mesa AZ, USA). This mortality feature is critical to allow investigation of cause-specific mortality. Survivorship of radio-collared bighorn sheep will be monitored at least bi-weekly throughout the range. However, based on terrain ruggedness and remoteness mortality monitoring of some bighorn sheep may be limited to scheduled aerial telemetry flights. All detected mortalities will be investigated promptly so that the cause of mortality can be determined and cause-specific mortality rates can be calculated. A standardized mortality investigation protocol and reporting form have previously been developed and will be used. To the extent feasible, fresh carcasses or tissue samples will be collected and submitted to the California Animal Health and Food Safety Laboratory in San Bernardino, California for pathological examination. Analysis of survivorship and cause-specific mortality data will be conducted such that comparisons can be made among recovery regions, years and management strategies.

Depending on type of GPS pod deployed (solar or battery) and specific monitoring needs, GPS fix locations may be recorded anywhere from once per day to once per hour. GPS units will be programmed so fix locations and resulting data analysis will minimally yield information on seasonal habitat use and selection, movement patterns, and mortality locations. GPS point locations will be downloaded from the ground but may periodically be downloaded via fixed-wing aircraft during regular scheduled telemetry monitoring flights. Bighorn sheep movements and home range will be determined using the Animal Movement extension and the Home Range extension for ArcView (Environmental Systems Research Institute, Redlands, California, USA). ArcGIS may be used to analyze VHF/GPS location data along with variables that may influence resource selection patterns of bighorn sheep such as distance to escape terrain, distance to perennial water, elevation, distance to brush edge and terrain steepness. One of two modeling procedures, standard distance choice (DC) or modified discrete choice (MDC) developed for GPS fix data will be employed to account for missing location fixes.

Aerial helicopter surveys will be used to derive mark-resight population abundance estimates using individually marked (radiocollared and ear tagged) female bighorn sheep. Since 2000 DFG has followed aerial survey protocols developed for monitoring population abundance as outlined in Appendix E of the federal recovery plan. Accurate population estimates using mark-resight methodology requires that approximately 30% of female bighorn in a given recovery region be marked (USFWS 2000). Colored radio-collars and ear tags in various combinations will be used to allow marked bighorn sheep to be individually identified. Population estimates with confidence intervals (95 percent) will be generated using Chapman's (1951) modification of the Peterson estimator (Seber 1982). Female (yearlings and adults) and female and male (yearlings and adults) abundance estimates will be calculated for each of the nine recovery regions, as well as

for the entire range. Simultaneous double-count methodology will also be employed to estimate the number of bighorn sheep groups missed and to generate an additional estimate of the minimum number of bighorn sheep present within the surveyed areas (Graham and Bell 1989).

Products (and estimated dates of completion)

Numerous reports and publications have been created as products of previous Peninsular Ranges' capture, survey, and monitoring projects (see References). These products have helped guide population assessment and monitoring activities as well as the overall recovery program.

Results of all capture and radio-collaring operations will be reported by DFG in a detailed post-capture report. Reports will be forwarded to cooperating state and federal agencies and non-governmental organizations involved in the Peninsular Ranges bighorn sheep recovery effort. Results will also be described in the DFG annual recovery activities report to the USFWS. Information contained in these reports will include:

- Dates and locations of capture operations
- Purpose for captures and funding sources
- Participating personnel and assignments
- Number, age and sex of sheep captured per recovery region
- Types of collars fitted and use of ear tags
- Processing locations and types of biological samples collected
- Health of captured sheep, capture related injuries and/or mortalities
- Post-capture monitoring plans, monitoring frequency and reporting timeframes
- Table summary of sheep captured including date, location, sex, and age

Results of range-wide population abundance surveys will be reported by DFG in a report titled "Results of bighorn sheep helicopter survey in the Peninsular Ranges". When finalized, reports will be forwarded to cooperating state and federal agencies and non-governmental organizations involved in the Peninsular Ranges bighorn sheep recovery effort. These reports will detail:

- Dates of survey, sources of funding, and participants
- Areas surveyed, data collected, and data collection methods
- Individual recovery region and range-wide summary of bighorn sheep observed
- Individual recovery region and range-wide helicopter (flight) hours and catch per unit effort (CPUE)
- Individual recovery region and range-wide summary of marked bighorn sheep present, marked bighorn sheep observed, and percent marked bighorn sheep observed
- Individual and range-wide population ratios, including lambs per adult ewe, lambs per yearling and adult ewe, yearlings (male and female) per adult ewe, adult ram per adult ewe, and yearling and adult ram per yearling and adult ewe observed
- Individual recovery region and overall female (yearlings and adults) abundance estimates
- Individual recovery region and overall female and male (yearlings and adult males and females) abundance estimates
- Simultaneous double count estimation of total number of bighorn sheep present in survey polygons
- Total range-wide population abundance estimate

Collaborators

- U.S. Fish and Wildlife Service
- California Department of Parks and Recreation
- Bighorn Institute

References

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Budget

<u>ITEM DESCRIPTION</u>	<u>QUANTITY</u>	<u>UNIT COST</u>	<u>TOTAL</u>
Telemetry Solutions Quantum 4000 GPS with D Cell	4	\$1,255.00	\$5,020.00
Telemetry Solutions Quantum 4000 GPS	6	\$1,255.00	\$7,530.00
Telemetry Solutions Remote Download Option	10	\$ 730.00	\$7,300.00
Telemetry Solutions Solar Option	6	\$ 295.00	\$1,770.00
Tax @ 8.5%			\$1,891.75
Shipping			\$ 75.00
		SUBTOTAL:	\$23,586.75
Telonics Inc., MOD 500 VHF Transmitter for Females	10	\$310.00	\$3,100.00
Telonics Inc., MOD 500 VHF Transmitter for Males	10	\$330.00	\$3,300.00
Shipping			\$ 75.00
		SUBTOTAL:	\$6,475.00
DFG Air Services - Aerial Monitoring (3 flights/month @4.0 hours/flight) (\$1,968.00/month @12 months)		\$164.00/hour	\$1,968.00
		SUBTOTAL:	\$23,616.00
		GRAND TOTAL:	<u>\$53,677.75</u>