Understanding Distribution, Movement Patterns and Seasonal Home Ranges of Bodie Hills Pronghorn

Proposed Start and Completion Date: January 1, 2013 –June 30, 2015

Executive Summary

The Bodie Hills pronghorn (*Antilocapra americana*) herd is an interstate herd that winters in Mineral and Lyon Counties, NV, and summers primarily within the Bodie Hills, Mono County, CA. The herd is not hunted in California; however, the Nevada Department of Wildlife (NDOW) annually issues a small number of buck only tags. To date, no telemetry studies have been conducted and little baseline information exists regarding the current distribution, movement patterns, and seasonal home ranges of the Bodie Hills herd.

Several proposed public land use issues, including mining and wind energy proposals, OHV use, and military maneuvers on the winter range, have created concern within the Inland Deserts Region regarding the long-term sustainability of the Bodie Hills herd. Additionally, conifer encroachment throughout the herd range threatens connectivity between seasonal ranges, and cheat grass (*Bromus tectorum*) invasion has increased the risk of catastrophic wildfire. Road construction, agriculture conversion, and range management practices, including livestock fencing and water management, have potential to further fragment this small population.

The proposed study will employ the use GPS collars with real-time tracking to delineate migration routes between the winter range in western NV and summer range in Bodie Hills, CA. Potential bottlenecks that threaten these migration routes, including both physical and anthropogenic barriers, will be identified and the functional connectivity of these migration routes will be assessed. All seasonal ranges, including summer and winter core areas, transition ranges and early summer fawning habitats will be delineated. Patterns of spatial use within all seasonal core areas will be ascertained. Annual survival rates and cause-specific mortality among adult female radio-collared pronghorn will be calculated.

Information from this study will aid land use planners and public and private stakeholders when making decisions regarding the impacts of proposed and existing land-use practices on the Bodie Hills herd. Moreover, this study will indirectly benefit other wildlife species of the sagebrush steppe, including greater sage grouse (*Centrocersus urophasianus*) and mule deer (*Odocoileus hemionus*), that require connectivity to move between seasonal core habitats located across state boundaries.

Statement of Need

The Bodie Hills pronghorn herd, also referred to as the Bodie-Wassuk interstate herd, winters in Mineral and Lyon Counties, NV, and summers primarily within the Bodie Hills, Mono County, CA. The herd was originally established in 1946 when 32 animals

obtained from Lassen County were reintroduced into an area north of Mono Lake (CDFG 1987). Currently, the Bodie Hills herd is estimated to comprise ≤150 animals and the population trend is regarded as stable (NDOW 2010, CDFG 2012). According to NDOW, the impact of long-term drought on winter range forage production is one plausible factor limiting this population.

Many studies have previously documented seasonal migration and home range use by pronghorn in North America (Kitchen 1974, Canon 1993, Bates 2000, Sawyer et al. 2005, Jacques et al. 2009). However, to my knowledge, only one study of pronghorn has been conducted in eastern California since the early 1980's (CDFG 2012), and no telemetry studies have been conducted to ascertain current distribution, movement patterns, and seasonal home ranges of the Bodie Hills herd (Jason Salisbury, NDOW pers. comm.). According to Sawyer et al. (2005) and Jacques et al. (2009a), knowledge of seasonal movements and home ranges is critical for determining the impacts of proposed land use projects and other human activities on pronghorn populations. Information from this project is needed to assist land use planners and public and private stakeholders when making decisions regarding the potential impacts of proposed projects and management activities on the Bodie Hills herd.

Several recent public land use proposals, including mining and wind energy proposals, have created concern within the Inland Deserts Region regarding the long-term sustainability of the Bodie Hills herd. Increased OHV use associated with public recreation and military training maneuvers have introduced year-round disturbance threats to winter range areas in Nevada and the Bodie Hills. Road construction, agriculture conversion, and range management practices, including livestock fencing and water management, also have potential to further fragment this small population. Additionally, conifer encroachment throughout the herd range threatens connectivity between seasonal ranges, and cheat grass (*Bromus tectorum*) invasion has increased the risk of catastrophic wildfire.

Pinyon-juniper forest encroachment into sagebrush steppe habitat on the north flank of the Bodie Hills threatens connectivity between seasonal ranges and may constrain winter range availability (Jason Salisbury, NDOW, pers. comm.). Throughout the Intermountain West and the Great Basin, displacement of native shrub cover and associated wildlife species by pinyon-juniper woodland and cheatgrass invasion are of paramount concern (Tausch and West 1988, Wisdom et al. 2003). Schaefer et al. (2003) documented a 500 percent increase in juniper cover from 1957 to 1988 in northeastern California and concluded that shrub dependent wildlife species appear to have been affected by this change. Yoakum (1980) concluded that juniper was suboptimal habitat for pronghorn. This study is needed to inform habitat management decisions designed to maintain linkage habitat by reducing conifer encroachment and the risk of cheat grass invasion on public lands occupied by the Bodie Hills herd.

Wild horse and livestock competition in conjunction with prolonged drought conditions may threaten the availability of forage, water and fawn hiding cover for the Bodie Hills herd (Jason Salisbury, NDOW, pers. comm.). Researchers in Utah concluded that apart

from inter-annual variation in precipitation, grazing pressure was the most significant factor affecting the availability of fawn hiding cover (Warnecke and Brummer 2006). These authors also suggested that the impacts of drought on fawn hiding cover and recruitment can be ameliorated through management practices that maintain habitat quality and reduce interspecific competition.

Jacques et al. (2007) suggested that a pronghorn population decline in western South Dakota was associated with reduced habitat quality resulting from drought conditions. Similarly, NDOW (2010) speculated that extended drought conditions on the Nevada winter range may be the primary factor limiting the Bodie Hills herd. From 1981-2010, annual population estimates for the Bodie Hills herd averaged 162 pronghorn (range = 135-202) (Jason Salisbury, NDOW, pers. comm.). This relatively stable population trend suggests that the herd winter range in Nevada may be at carrying capacity (Jason Salisbury, NDOW, pers. comm.). However, if this were the case, then higher adult female mortality during late-winter and early spring would be expected (White and Treanor 2002). This study will monitor survival of radio-collared adult females to determine if resource limitations are occurring on the winter range.

In light of Bodie herd's small population size, concern has been raised over population persistence. Populations that drop below minimal viable levels experience lower fawn survival, lower fertility rates and are more vulnerable to extirpation from catastrophic events, such as disease and severe winters (White and Treanor 2002). This study does not propose to monitor fawn survivorship through radio-telemetry, or conduct a population viability analysis. However, the information collected here can be used to identify factors that may contribute to the risk of extinction, including migration bottlenecks, winter range crowding, and water distribution. Depending on the results of this investigation, future work on the Bodie herd might focus on evaluating fawn survivorship and the quality of fawning habitats. Additional work might also focus on comparative genetics analyses to evaluate inbreeding, genetic uniqueness, and identifying potential source populations for possible future translocation.

The impacts of livestock and right-of-way fencing on the seasonal distribution and migratory movements of the Bodie Hills herd are currently unknown (Jason Salisbury, NDOW, pers. comm.). However, cattle exclusion fences surrounding the two NDOW guzzlers located on the winter range currently preclude use by pronghorn (Jason Salisbury, NDOW, pers. comm.). Fences can impact seasonal pronghorn movements (Boccadori and Garrott 2002, Sievers 2004, Sheldon, 2006) and reduce carrying capacity by fragmenting the landscape and excluding animals from important habitat use areas (Boone and Hobbs 2004, Sheldon 2006). This study will examine the impact that fences, roads and other anthropogenic barriers have on the migration and seasonal distribution of the Bodie Hills herd.

Introduction

The Bodie Hills pronghorn herd is the only pronghorn herd residing in Mono County, California. The herd is known to summer in the Bodie Hills, Mono County, CA;

however, the extent of the summer range is not well defined (Figure 1). During the summer months, animals are routinely observed by Department staff to the north of Bodie State Park, primarily in vicinity of Bodie Mountain and near the Geiger Grade. Additionally, numerous observations of pronghorn to the south of State Highway 270 in the vicinity of Mt. Biedeman have been reported in recent years (CDFG, Mono Unit files). Winter range for the Bodie Hills herd is located primarily in Lyon County, NV, on Nine-Mile Flat south of the East Walker River and Aldrich Grade on the north flank of the Wassuk Mountains (Figure 1) (Jason Salisbury, NDOE. pers. comm.). The locations of migration routes and transition range connecting winter and summer range core areas in Nevada and California have not been delineated.

Information regarding the historical range of the Bodie Hills herd was provided by Anderson (Status of Antelope in Mono County, 1960) and CDFG (Pronghorn Management Plan, Mono Herd, Management Unit 7, 1987). According to Anderson (1960), pronghorn were reintroduced into Mono County in the late 1940's in attempt to "bolster the remnants of California's aboriginal herd of nearly one-half million." During the winter of 1946-47, 32 pronghorn from Lassen County were transplanted in the area "just north of Mono Lake in Mono County" (Table 1). In the winter of 1949-50, a total of 143 pronghorn from Lassen County were released in Adobe Valley located approximately 15 miles west of Benton and 20 miles east of Mono Lake in Mono County.

In May 1952, the Inyo-Mono Antelope Committee, composed of DFG personnel, land-users, stockmen and sportsmen, was formed. The purpose of the committee was to evaluate the feasibility of future stocking of pronghorn in Mono County. The committee recommended that no further stocking of pronghorn in Mono County occur. However, on February 15, 1957, NDOW released "44 head of ear-tagged Yellowstone antelope 2 miles above Lewis Gold Mine on the East Walker River about 15 airline miles from the California line." Some of these ear-tagged animals became part of the interstate population because marked animals were observed on both sides of the boarder. Anderson (1960) noted that sighting records suggested that in general the population of pronghorn in Mono County appeared to have declined since the reintroductions. He attributed this decline primarily to poaching during the deer hunting season. Of the 44 pronghorn released by NDOW, "between 11 and 15 were killed illegally." Anderson (1960) also noted that fawn predation and forage, primarily a lack of grasses and forbs due to competition from livestock, could also have been limiting factors.

According to CDFG (1987), 43 pronghorn were reintroduced into Adobe Valley in March 1982. Subsequent reintroductions occurred in Hammil Valley in southeastern Mono County in February 1984 and 1985, when 24 and 50 animals were released, respectively (Table 1). In 1986, the Bureau of Land Management estimated that of the 117 pronghorn originally introduced into southeastern Mono County from 1982 to 1985, 61 were still occupying the area (CDFG 1987). Pronghorn have not been observed in southeastern Mono County south of Benton for many years now; however, a few pronghorn are occasionally observed during summer on the Department's River Springs Ecological Reserve in Adobe Valley. These animals are thought to be part of the Bodie Hills herd.

Table 1. Summary of Pronghorn Reintroductions into Mono County, CA and Lyon County, NV (1946-1985).

Date of Reintroduction	Location of Reintroduction	Number of Pronghorn Released	Source Population
Winter 1946-47	North of Mono Lake	32	Lassen, CA
Winter 1949-50	Adobe Valley	143	Lassen, CA
2/15/1957	East Walker River	44	Yellowstone, MT.
February 1984	Hammil Valley	24	?
February 1985	Hammil Valley	50	?
Total		293	

The Bodie herd has been hunted in Nevada under a buck-only harvest system since 1961, with occasional closures due to concerns regarding low buck: doe ratios. In California, the herd was hunted only in 1984 and 1985. In 1984, a total of 10 permits (5 buck, 5 doe) were issued with a hunter success of 100%. In 1985, a total of 5 buck permits were issued with a 100% hunter success (CDFG 1987). The pronghorn season in Mono County was closed in 1986 due to concerns regarding low buck: doe ratio and declining herd size.

In October 2010, NDOW issued 7 buck only tags for zones 202-204, which includes winter range occupied by the Bodie Hills herd. Of the 7 tags issued, 3 were returned prior to the season and 1 buck was harvested for a 25% success rate. Tags were likely returned because the majority of the herd was believed to be residing in California during the October hunt period. In January 2011, NDOW classified 62 pronghorn (35 does, 15 bucks and 12 fawns) on the winter range, yielding a buck: doe ratio of 43: 100 and fawn: doe of 34: 100. Since 1981, winter fawn: doe ratios have averaged 31: 100 (range = 15-62 fawns: 100 does) (Jason Salisbury, NDOW, pers. comm.). The modeled prehunt August population estimate for 2011 was 154 animals. Annual population estimates from 1981-2011 averaged 162 pronghorn (range = 135-202) suggesting a stable population trend (Jason Salisbury, NDOW, pers. comm.).

In 1987, the department prepared a herd management plan for the Mono pronghorn herd, (CDFG, 1987; Pronghorn Management Plan, Mono Herd, Management Unit 7). The plan identified potential landscape scale impacts in the California portion of the range that could negatively impact the Bodie Hills herd, as well as an adjacent reintroduced herd located in southeastern Mono County. Some of these factors included: forage competition from livestock, impacts from mining operations and potential energy developments, inadequately designed livestock fences, fire management practices and wild horse competition. Within the Nevada portion of the herd range, NDOW (1983) identified road construction, agriculture conversion, and range management practices, including livestock fencing and water management, as factors threatening to fragment the population.

With the exception of perhaps agricultural conversion, all land use concerns identified in

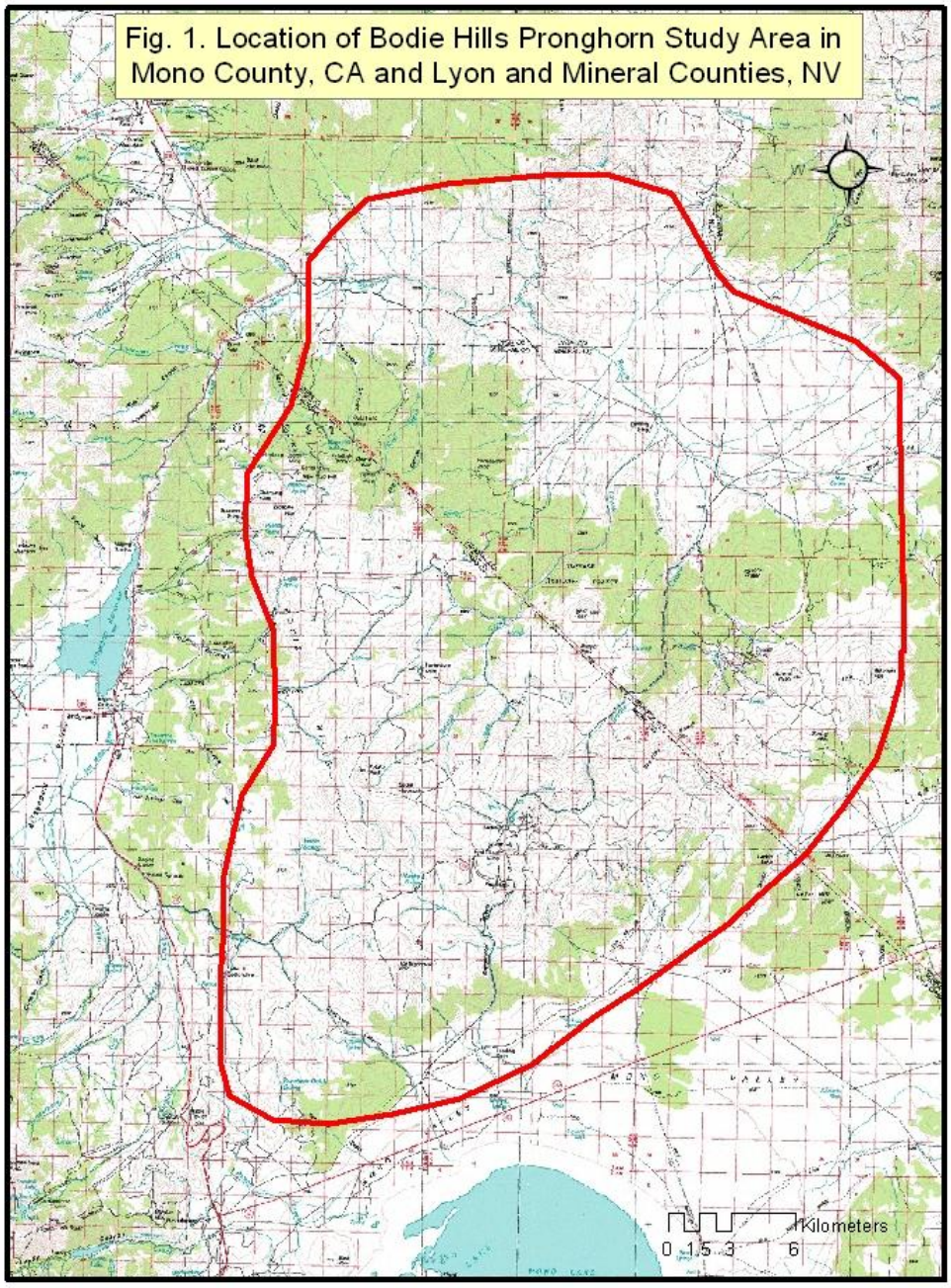
the 1987 Mono herd plan still remain valid today. Many of these impacts, such as fences, road construction, and mining disturbance have been ongoing, while other projects (e.g., energy expansion) have not yet be implemented. However, despite these ongoing impacts, the Bodie Hills herd has continued to persist, albeit at a relatively low level.

The 1987 management plan for the Mono population identified population and habitat management objectives for the Bodie Hills and Adobe Valley herds. Population objectives included: 1) maintaining a herd ratio of 45 bucks: 100 does and 50 kids: 100 does; 2) once a total herd size of 200 animals is obtained, maintaining herd ratios of 35 bucks: 100 does and 50 kids: 100 does; 3) continuing to closely monitor the southeast (Adobe Valley) population; 4) continuing to obtain composition counts and harvest information from NDOW on the Bodie Hills herd; and 5) reducing road access in the Bodie Hills through BLM road closures to discourage poaching. Habitat management goals in the 1987 plan included: 1) revising BLM allotment management plans to improve forage conditions for pronghorn by delaying the grazing season until July and reducing AUM's; 2) minimizing ongoing and future impacts from mining; 3) designing livestock fences to allow access by antelope; 4) allowing no surface occupancy of energy development sites within important kidding and forb production areas within the Bodie Hills and Adobe Valley herd areas; 5) maintaining wild horse AUM's at or below the present level of 98 horses in the Adobe Valley herd area; and 6) maintaining a no-let-burn policy for wildfires in the Adobe Valley area and implementing control burns in the Bodie Hills to stimulate forb production on selected sites. The 1987 plan also identified the need to make annual assessments of Herd Management Unit 7 and to complete major plan revisions at 5 year intervals if necessary.

To my knowledge, the 1987 plan for the Mono herd unit was never revised to include updated population, harvest and habitat management information. It appears that after the close of the California pronghorn season in Mono County in 1986, the department's participation in management of the Bodie herd decreased substantially. DFG file information for the Bodie Hills herd after about 1987 consisted primarily of annual herd composition reports from NDOW. These reports were no longer sent to the department after 1995. File information after 1995 is relegated to random observational reports of pronghorn in the Bodie Hills. This study will provide information that can be used to specifically update the Mono herd portion of the department's 2012 Pronghorn Status Report and Management Plan Update (CDFG 2012).

The Department of Fish and Game does not have a pronghorn season in Mono County. However, the Department is responsible for commenting on land-use projects that may potentially impact seasonal habitats occupied the herd. Because of its relatively small size (≤150 animals), the Bodie Hills herd may be especially vulnerable to natural and anthropogenic perturbations, such as pinyon-juniper encroachment, cheat grass invasion, agricultural conversion, large-scale mining operations, fences, roads, OHV use and water manipulations. Data produced from this study, including migration routes and seasonal range locations, can be incorporated into BLM Resource Management Plans, U. S. Forest Service Forest Plans, and County zoning and planning ordinances. Actions such as these will aid wildlife mangers in protecting important habitat areas for pronghorn and other

species that depend on sagebrush ecosystems for their survival.



Study Objectives

The objectives of this study are to:

1. Delineate specific travel routes between low elevation winter ranges in NV, and high elevation summer ranges in CA. Hypothesis: The Bodie Hills herd is migratory with distinct summer and winter ranges.
2. Delineate seasonal ranges, including summer and winter core areas, transition ranges early summer fawning habitats, water sources and factors influencing migration. Hypotheses: Pronghorn movements are closely tied to water; pronghorn are obligatory migrants.
3. Identify potential bottlenecks that threaten migratory routes, including anthropogenic and natural physical barriers, and assess the functional connectivity of these migration routes. Hypothesis: Anthropogenic and natural physical barriers currently restrict migration between seasonal ranges.
4. Ascertain patterns of spatial use (e.g., home range) within primary winter and summer core areas. Hypothesis: The functional size of the winter range is limited due to fragmentation from anthropogenic and natural physical barriers.
5. Determine survival rates and cause-specific mortality among adult female radio-collared pronghorn. Hypothesis: The winter range is at carrying capacity and adult female survival is low.
6. Provide formal publication of results in appropriate professional journals.

Methods

Capture and Marking. The proposed study will commence in mid-January 2013 with the capture of pronghorn on their Nevada winter range. All work will be performed with the cooperation and assistance of the Nevada Department of Wildlife. A pre-capture fixed-wing flight will be conducted in January 2013 to determine numbers and distribution of pronghorn. In mid-January 2013, a total of 10 female adult (≥18 months) pronghorn (approximately 12 percent of the estimated adult female population) will be captured on the winter range in Mineral and Lyon County, NV, using helicopter net-gunning techniques. An additional 10 adult females will be captured and fitted with GPS collars in mid-January 2014 to increase the sample size; no animals will be captured and collared in January 2015. Therefore, a total 20 adult females will be radio-marked during the study. Any collars from mortalities collected during the first year of the study will be redeployed in January 2014. Capture planning and procedures will strictly follow DFG Operations Manual 2487.8 Helicopter Air Operation Procedures and the requirements and procedures identified in DFG Departmental Bulletin 2010-07, Helicopter Flight Crew Operational Requirements/Procedures.

Animal safety and medical considerations listed on pages 3-1 and 9-1 through 9-3 of the CDFG Wildlife Restraint Handbook (Jessup et al. 2000) will be followed. Jacques et al. (2009b) reported moderate to high (15%) mortality to net-gunned captured pronghorn in South Dakota. They attributed this high mortality to long transport distances to central processing sites and unfavorable capture conditions, including unseasonably warm temperatures and lack of snow. As a result, these authors recommended that transport

distances should be minimized or eliminated and that captures should be conducted during favorable weather conditions. Jacques et al. (2009b) also recommended that in order to minimize risk of injury and capture myopathy, pursuit times should be limited to <5 minutes and animals should be processed at capture locations to reduce handling time.

Following the recommendations of Jacques et al. (2009b), chase times will be limited to <5 minutes and animals will be processed at capture locations to reduce risk of capture myopathy. If possible, we will attempt to capture pronghorn during early February when temperatures on the winter range are coldest and when the possibility of snow on the ground is greatest. Standard methods of animal restraint will incorporate hobbles and eye covers. Body temperature will be monitored and individuals will be released if body temperature exceeds 42° C (Jacques et al. 2009b). Standardized morphometric data and biological samples will be obtained from all animals handled during this operation. Animals will be aged based on incisor wear and replacement (Dow and Wright 1962). Blood samples will be drawn from each animal by jugular venipuncture and analyzed for disease and genetic information. Total handling time will be recorded for each animal.

Relocation of Collared Animals. Pronghorn will be fitted with GPS collars (NSG-LC1; North Star Science and Technology, LLC, King George, VA) providing real-time tracking. Collars will weigh approximately 720 g and will have an operational life of 12-14 months when collecting 6 GPS locations per day. All collars will be equipped with a VHF unit for conventional tracking and a drop-off mechanism for retrieval of the GPS collar.

Ground monitoring of radio-collared female pronghorn will be conducted 1-2 times weekly during seasonal migrations in effort to verify the locations of movement corridors in relation to natural physical and anthropogenic barriers (e.g., fences and roads), and document anthropogenic disturbances (e.g., military maneuvers, mining activities, traffic) on seasonal ranges. Ground monitoring will occur at least twice weekly during the winter and summer periods in effort to determine cause-specific mortality (Jacques et al. 2007), and identify the locations of fawning and fawn rearing habitats used by the Bodie Hills herd. Radio-collared animals will be tracked from the ground until they are observed using a hand-held antenna and receiver (Advanced Telemetry Systems, Isanti, MN); the locations of all individuals will be assigned UTM coordinates using a hand-held GPS. In addition, all observed pronghorn groups not containing radio-collared individuals will also be recorded in effort to further delineate seasonal distributions of the Bodie Hills herd. Following Byers (1997), adult males will be identified by horn length and neck band coloration. The size and composition of each pronghorn group will be recorded. A fixed-wing aircraft will be used to opportunistically locate failed GPS collars and any collars that need to be retrieved.

Movements and Home Range. Pronghorn seasonal movement and home range use data will be entered into ArcGIS® 10 (Environmental Systems Research Institute, Redlands, CA) and analyzed using the Home Range Tools Animal Extension (Rogers and Carr 1998). Migratory distances between summer and winter core areas will be determined and home range size will be estimated using adaptive kernel (ADK) methods (Worton

1989, Kie et al 1996). Differences in home range size between radio-collared individuals will be examined using parametric t-tests. All fence lines bisecting migration routes will be mapped, classified by type (e.g., 3-strand barbed wire) and evaluated for passability using criteria recommended by Autenrieth et al. (2006), where the bottom wire is a minimum of 41 cm above ground. Pronghorn distribution and movement patterns are closely tied to water availability (Sundstrom 1968, Beael and Smith 1970, Ockenfels et al. 1994). Therefore, all water sources within the herd range will be located, mapped and evaluated to determine if they are accessible to pronghorn and if they contain year-round water. Distances to the nearest water source from each relocation point will be calculated in ArcGIS® and analyzed by ANOVA to test for seasonal differences.

Habitat Preference. Data collected at each pronghorn GPS relocation site will be evaluated using BLM's 25 m Thermatic Mapper and high resolution imagery Quick Bird Imagery to determine dominate vegetation type, elevation, slope, and aspect. Pronghorn relocations will be compared with random sites to determine habitat preferences using Chi-square analysis (use vs. availability; alpha = 0.05) (Kilgore and Fairbanks, 1997). Random points will be ground-truthed to verify accuracy.

Cause-specific Mortality. Annual (June 1-May 31) survival rates of radio-collared adult female pronghorn will be calculated using the Kaplan-Meier (1958) method. Necropsies will be conducted in the field to determine cause of death. Following Beringer et al. (2006), deaths occurring at the time of capture and up until 26 days after capture will be classified as capture related.

Field work for the proposed project will end on May 30, 2015 with spring migration. The final report will be completed on June 30, 2015.

Required Products

- A 1-year progress report discussing preliminary results will be provided in January 2014.
- A final project completion report will be provided 3-months subsequent to project completion on June 30, 2015.
- Results of this study will be formally published in appropriate professional journals, such as JWM, Great Basin Naturalist and California Fish and Game.

Collaborators

- CDFG – Tim Taylor, Mono Unit Biologist
- Nevada Department of Wildlife – Jason Salisbury, Area 201-204 Biologist
- Bureau of Land Management, Bishop Field Office – Steve Nelson, Field Supervisor. BLM has verbally committed to purchasing either collars or airtime and providing field support.
- U.S. Forest Service – Humboldt Toyiabe National Forest, Bridgeport Ranger District

Program Planning

- A pre-project planning meeting involving essential CDFG project personnel and

interagency partners (NDOW, BLM, and USFS) will be conducted in September 2012 to discuss project goals and objectives, and January 2013 capture plans.

- An annual interagency meeting will be conducted in December 2013 to discuss preliminary findings from year 1, address any concerns from collaborators and discuss project needs and additional capture plans for January 2014.

Issues to be Resolved

- LMAC approval.
- Funding and personnel commitments from NDOW.

Personnel Requirements and Commitments from CDFG

- Unit Biologist – 20 to 50%
- 1 Scientific Aid – 100%
- WIL Staff –January 2013 capture for 10 pronghorn females – estimated 1 day of capture and 2 days of travel. January 2014 capture for a minimum 10 pronghorn females – estimated 1 day capture and 2 days travel.
- Helicopter and net-gun required for capture.
- Fixed-wing aircraft for pre-capture survey.

Budget Detail

Proposed Bodie Hills Pronghorn Budget

FY 12/13 (Jan 1-June 30, 2013) **Expenditure**	cost/hr	cost/collar	Number collars	Number months	Number hours/mo	Total
Helicopter Time (Jan 2013 capture)		$1,600.00	10			$16,000.00
Materials						
GPS collars (northstar NSG-LC1)		$2,500.00	10			$25,000.00
VHF transmitter on GPS		$350.00	10			$3,500.00
Sirtrack		$350.00	10			$3,500.00
Airtime (for 10 GPS collars through June 30, 2013)		$41.00	10	6		$2,460.00
Personnel						
Mono Unit Biologist				6	20	
Scientific Aid	$11.00			6	168	$11,100.00
Fixed-wing time (including precapture survey and telemetry**)**	$270.00				11	$2,970.00
Total FY12/13						**$64,530.00**

FY 13/14 (July 1, 2013-June 30, 2014) **Expenditure**	cost/hr	cost/collar	Number collars	Number months	Number hours/mo	Total
Helicopter Time (Jan 2014 capture)		$1,600.00	10			$16,000.00
Materials						
GPS collars (northstar NSG-LC1)		$2,500.00	10			$25,000.00
Sirtrack		$350.00	10			$3,500.00
Airtime (for 10 GPS collars through 3/2014 until battery failure)		$41.00	10	8		$3,280.00
Airtime (for 310GPS collars through 6/30/14 until battery failure)		$41.00	10	6		$2,460.00
Personnel						
Mono Unit Biologist				12	20	
Scientific Aid	$11.00			9	168	$16,700.00
Fixed-wing time	$270.00				11	$2,970.00
Total FY 13/14						**$66,910.00**

FY 14/15 (July 1, 2014-Jun 30, 2015) Expenditure	cost/hr	cost/collar	Number collars	Number months	Number hours/mo	Total
Airtime (for 3 GPS collars through 1/30/15 until battery failure)		$41.00	10	6		$2,460.00
Personnel						
Mono Unit Biologist				6	40	
Scientific Aid	$11.00			9	168	$16,700.00
Fixed-wing time	$270.00				20	$5,400.00
Total FY 14/15						**$24,560.00**
Total Project Cost						**$156,000.00**

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