Large Mammal Research Proposal

Investigating Factors that Limit Mule Deer Populations in Eastern Siskiyou County

Project Duration

January 2013 – December 2017

Executive Summary

Range-wide declines in mule deer populations have raised awareness and concern over the health and persistence of this socio-economically important species. The scarcity of information describing this ungulate in Siskiyou County has prevented a basic understanding of population dynamics, and prompted the need for a detailed investigation into underlying factors that may be limiting populations. Mule deer will be captured and monitored for 5 consecutive years to assess the causal mechanisms responsible for limiting population growth. Results from this project will enhance our understanding of density-dependent processes, ecological carrying capacity, and reproductive ecology that will improve management of this species across a wide geographic region. It will also impart information describing the ecological integrity and connectedness of wildlife habitats in the Southern Cascade Ecoregion, and provide the most comprehensive understanding of habitat use and private land conservation values for mule deer in Northern California.

Statement of Need

The mule deer of northern California is a high profile species where declining population trends and the failure to actively address this issue have led to public frustration and distrust. In 2009, helicopter surveys on 308 transect miles of winter range polygons counted 163 deer, with male deer representing < 3% of all deer observed and an overall density of 1.72 deer / mi^2. These survey results were used, in part, to justify a 50% reduction in tag allocations for the X-1 zone. In 2010, the Siskiyou County Board of Supervisors passed a resolution to actively encourage, develop, and help implement cooperative strategies and projects geared toward research, restoration, and sustainability of abundant, healthy deer herds in the County.

This project will provide new insights into the population dynamics of this species using analytical methods to unravel the details of population regulation and ecology. It will also provide information for using a science based approach in the habitat and population management of mule deer, while imparting fine scale ecological knowledge in a region where complicated biological, social, and economic issues present challenging circumstances in the conservation of natural resources.

Introduction

The 20th century eruption of western mule deer (*Odocoileus hemionus hemionus*) populations has been attributed to a period of excessive levels in livestock grazing followed by severe winter conditions where dramatic losses of native and non-native ungulates created an ecological opening for the vast expansion of woody plant species (Clements and Young 1997). The alterations of fire cycles that followed this period helped promote the establishment of fire intolerant shrub communities, allowing the remarkable enhancement and release of nutritional quality for shrub obligate herbivores (Caugley 1970, Clements and Young 1997, Peek et al. 2000). Mule deer populations peaked in northeastern California during the mid 1900's, followed by post-eruptive declines that today finds some populations estimated at <5% of historically high levels (Randal 1939, Salwasser 1979, CDFG 2007). Loft et al. (1998) pointed out that the greatest declines in California deer populations have occurred in northeastern California where fire, livestock grazing, and changing plant communities have had the greatest negative impacts. In Siskiyou County, mule deer populations have continued to decline in the 21st century (CDFG unpublished survey data), raising questions and concerns regarding their current management and and actions needed to conserve the species. This has prompted political representatives and the Northern Region Wildlife Program to intensify efforts into identifying the underlying causes that may be limiting mule deer in eastern Siskiyou County (Siskiyou County 2009).

One of the greatest obstacles in understanding the population dynamics of native ungulates is the scarcity of long-term field investigations (Bleich et al. 2006). On the adjacent Modoc Plateau, long-term patterns in the abundance of live shrubs were associated with declines in shrub-dependent wildlife populations (Schaefer et al. 2003), but the lack of detailed knowledge of the population dynamics of mule deer in this region has prevented understanding the role of nutrition in limiting these native herbivores. For 5 mule deer populations occupying the eastern Sierra Nevada Mountains, predation by mountain lions attributed >70% of winter range mortality, but lack of research describing the influences of predation, nutrition, and climate precluded knowing the ultimate influence of these variables on population growth (Bleich and Taylor 1998). This project proposes to address the controversial issue of mule deer declines through a scientific approach where the study of life history characteristics and demographic relationships will reveal the underlying causes that may be limiting populations.

Investigative Approach

Large herbivorous mammals are particularly suited for examinations of population dynamics because age-classes are readily identifiable, they are culturally important, and their spatial requirements provide a foundation for conservation programs (Gaillard et al.1998). Central to understanding the regulation of mule deer populations is the ability to sort out the influence of density dependence from environmental variation and measurement error (McCullough 1990). When considering how herbivorous mammals are regulated, the length of studies should be measured against the pace of natural processes, rather then accepting the constraints of funding cycles or graduate institutions (Strayer 1986). Understanding factors that limit mule deer populations require a time series approach where patterns in quantified aspects of nutrition, demography, and environmental conditions begin to reveal the causal mechanisms which directly influence population growth. This project proposes a 5 year investigation to examine patterns in population density, performance, fecundity, and resource availability so that the underlying causes that limit mule deer populations can be clarified. Moreover, global positioning systems (GPS) data from this project will be used to examine the reproductive strategies and behaviors of female deer, and provide the most comprehensive understanding of habitat ecology and private land conservation values for mule deer in Northern California.

Nutritional Ecology

The central question in exploring how mule deer populations are regulated is if the limitation of food resources is a predominant factor in limiting growth. Foraging efficiency is the difference between energy intake and energy expenditure and can be assessed through indices of condition. An animal's condition is the basis for most life history strategies as it is related to nearly every parameter of productivity and survival (Short 1981). Monteith et al. (2009) monitored long-term patterns in animal condition, environmental variables, and demographic rates to conclude that mule deer populations in the eastern Sierra Nevada are driven by bottom-up mechanisms, where nutritional quality ultimately determines response in survival and reproduction. Nutritional status is the best single measure of habitat quality, and provides a basis for predicting changes in growth rates and determining the carrying capacity of populations. Populations that have exceeded or are near carrying capacity become nutritionally stressed, and increasingly vulnerable to density dependent factors such as competition, predation, and disease. Only by comparing long-term patterns in nutrition with demographic and environmental variables will the underlying factors which limit mule deer populations begin to emerge.

Reproductive Phenology

The effects of male-only harvest strategies on mule deer in northern California are poorly understood. Such strategies can bias the population sex ratio toward females and reduce the mean age of males, which may consequently delay birth dates, reduce birth synchrony, delay body mass development, and alter offspring sex ratios (Milner et al. 2006). In most ungulate ecosystems reproductive periods are highly synchronistic, timed to maximize offspring survival by reducing predation risk while coinciding with seasonal differences in vegetation quality or availability. In harvested populations, a lower proportion of younger females will breed when sex ratios are heavily skewed towards females (Ginsberg & Milner-Gulland 1994; Solberg *et al*. 2002). Simulations have shown that reduced rates of pregnancy and male age structures occur when adult sex ratios are severely skewed towards females (Gruver et. al. 1984, Ginsberg et al.1994). In eastern Siskiyou County, aerial surveys in 2009 revealed an imbalanced population structure where males represented <4% of the total population, a potentially important observation when considering the effects of single gender harvest (CDFG unpublished survey data).

Male deer will increase mobility and extend home ranges during the rut to maximize breeding opportunities (Nelson and Mech 1981, Beir and McCullough 1990). Female movements during the rut are less fixed, and may fluctuate in response to the breeding environment (Hirth 1994). Holzenbeiin and Schwede (1989) reported that female white-tailed deer restrict movements to home range cores prior to the formation of tending bonds and participate passively in the breeding process making their locations more predictable to breeding males. However, females approaching estrus when lacking potential mates may shift to a search strategy where core areas or entire home ranges are abandoned (Labisky and Fritzen 1998).

A low abundance of breeding males may affect deer population dynamics negatively by causing decreased synchrony of breeding, increased mortality of offspring born outside the optimal birth season, reduced fecundity in females due to limitations in male availability, loss of viable female gametes due to protracted search time for males, and increased risk of mortality as females search for males outside familiar home ranges (Verme and Ozoga 1981, Gruver et al. 1984, Clutton-Brock et al. 1987, Ginsberg and Milner-Gulland 1994). It is unknown if these impacts may be more pronounced when populations occur at low densities or their distributions are increasingly fragmented. If females are dispersed, occupy heavy cover or broken ground, and use stealth behaviors to avoid predation, there may be severe limitations in the ability of males to gain access to or guard females (McCullough 1990). Accordingly, measures of female movement during rut may serve as an index to male breeding performance and abundance, and help clarify the effects of current harvest strategies on population dynamics.

Predator-Prey Relationships

On today's modern landscape predator-prey dynamics can be complicated to assess as human related impacts make these relationships difficult to quantify and interpret (Siskiyou County 2009). Although there are predator removal studies that show relief to prey populations, there are also studies that show little influence by predators in regulating their prey (Ballard et al. 2001). Indeed, in the Eastern Sierra Nevada, the longest study of predator-prey dynamics for mule deer in California found that populations were driven by bottom-up processes, where the condition of habitats and its influence on the nutritional status of deer were the driving force behind population regulation (Monteith et al. 2009). Unlike the eastern Sierra Nevada, in eastern Siskiyou County mule deer occur on ranges occupied by populations of wild horses and antelope, a potentially important consideration when evaluating predator-prey dynamics.

Bowyer (2005) contends that the need to understand mule deer and the carnivores that prey upon them is paramount to the effective conservation of biodiversity. Key to understanding the role of predators in ungulate ecosystems is knowledge of resource limitations and the balance between nutritional status and rates of predation. A failure to consider the ecological carrying capacity for mule deer can result in the misinterpretation of the role predators may play in these complex systems. This study will assess the details of nutrition, mortality, survival, and responses in demographic variables to environmental conditions to determine if predation is a potentially additive or compensatory form of mortality for mule deer.

Disease

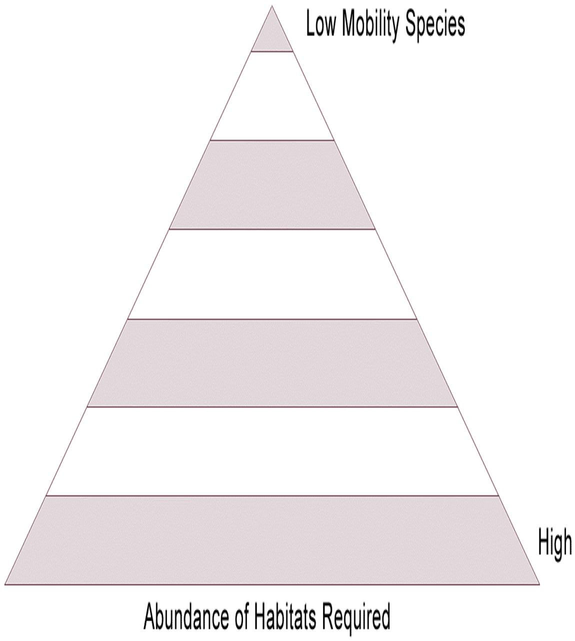
Limited information is available on health and disease of mule deer in eastern Siskiyou County. Deer populations that become nutritionally stressed by exceeding the ecological carrying capacity can be associated with higher rates of disease and mortality (Halls 1984). Even changing climatic conditions can influence the rates and emergence of disease in ungulates (Gould and Higgs 2009). Human related activities can also influence the disease status of deer such as the introduction of agricultural chemical compounds to wildlife habitats which can adversely affect the physiological processes of reproduction and immune responsiveness (USGS 1999). Surveillance of health-related parameters for mule deer in this study will provide base line knowledge useful in diagnosing disease, understanding physical condition, and revealing potential deficiencies in nutrition.

Habitat Use and Ecology

Little is known about the details of habitat-use or foraging ecology for mule deer in eastern Siskiyou County. This is important for understanding the effects of long-term habitat changes, as shifts in nutrient distributions can alter population performance and be substantially degraded even when habitats and forage supplies appear to be plentiful with no obvious signs of overbrowsing. This project will reveal the fine scale foraging behavior and habitat-use patterns for mule deer. It will provide insights into the use of nutritional resources, assist land managers in designing targeted approaches for improving the condition of habitats, and illuminate the interactions and influences of herbivorous competitors.

Conservation Planning and Foundation Species

Because it is difficult to monitor and manage every aspect of biodiversity, conservationists have used surrogate species as a shortcut to conservation problems. Unfortunately, terms such as umbrella, flagship, and indicator have been used loosely or interchangeably without specific definitions, causing confusion over their application and preventing acceptance as conservation tools (Simberloff 1998). For resource agencies with restrictive budgets and changing staffs to effectively and practically plan for the conservation of resources, a concept based on the principles of conservation biology is needed where broad-scale knowledge of an ecosystems function and structure provides a blueprint for preserving landscapes of high ecological value. If society is to accept the need for thresholds when assessing the cumulative effects to ecological systems, it is important that resource agencies present illustrated estimates of environmental risks, so they can be balanced against the economic gains of human disturbance (Caro and O’doherty 1998).



Large and highly mobile mammals include a suite of terrestrial species requiring the greatest availability of habitats to persist. The spatial requirements of these megafauna provide an ecological foundation in which the targeted preservation of habitats shared ultimately by multiple plant and animal species can be achieved.

Large herbivores such as mule deer exert a strong influence on community structure within the diverse range of habitats they occupy, making their persistence and health of high ecological concern. The chances of long-term survival for populations are slim unless they are linked to natural habitat corridors for dispersal and completion of life history needs. A landscape level approach which identifies the ecological requirements of mule deer is an essential conservation priority.

Using state-of-the-art GPS technology, this project will quantify landscape occupancy, dispersal, and temporal/spatial distributions. It will help prioritize the private land conservation values of this region, and impart baseline knowledge of ecosystem function for gauging future impacts from changing climatic conditions. The abundance of high resolution data generated by this project will provide a platform for launching model based conservation applications based on the spatial needs of mule deer, and exploring from a landscape perspective the links between occupancy, environmental characteristics, and population performance.

Primary Hypotheses

H_0 *Patterns in demography, nutrition, and environmental conditions are consistent with density dependent regulation or bottom-up processes.*

H_0 *Females do not play an active role in mate acquisition*.

Primary Objectives

1. Establish a reliable monitoring method for calculating deer densities on winter ranges.

2. Monitor annual patterns of survival, causes of mortality, and factors that influence survival for neonatal, juvenile, and adult female deer.

3. Monitor environmental variables including daily weather conditions and plant phenology on seasonal ranges.

4. Monitor nutritional condition and reproductive performance for adult female deer.

5. Measure the detailed movements of female deer during the pre-rut, rut, and post-rut phases of conception.

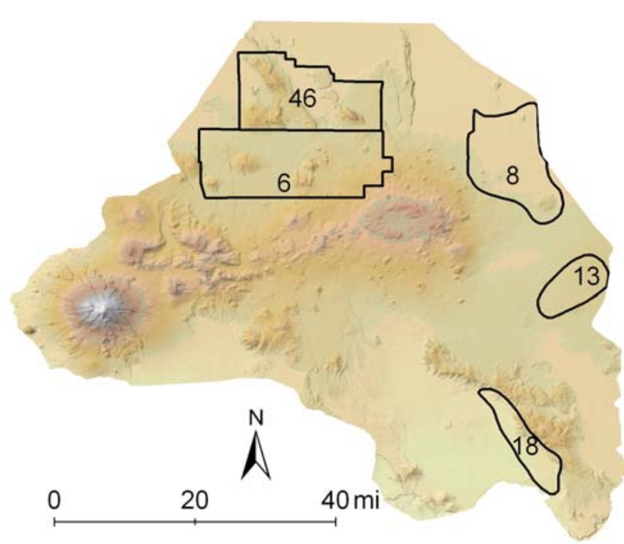
6. Identify the diet composition and seasonal changes in foraging strategies of deer.

7. Identify core reproductive areas, critical ranges, migration corridors, and temporal-spatial distributions for mule deer.

Methods

Study Area

X1 Zone and Study Area with Helicopter Polygons



The investigation will be conducted in the X1 portion of the McCloud Flat Deer Herd planning area (CDFG 1983). The McCloud Flat deer herd consists of several distinct winter ranges where migration to common summer ranges in the Mount Shasta, Medicine lake highlands, and McCloud Flat region have been documented (Ashcraft 1961). Winter range is composed of Great Basin habitats including sagebrush, bitterbrush, mahogany, and rabbitbrush, with western juniper and yellow pine woodlands scattered throughout. Summer range is considered the High Cascade Range and is generally characterized by ponderosa pine, montane fir/pine, and lodgepole-pine forests, with treeless alpine communities on Mount Shasta. Native ungulates occurring sympatrically with mule deer on these ranges include pronghorn antelope and elk, as well as large populations of non-native ungulates administered by the USFS including feral horses and cattle. A variety of predators occurring on these ranges include mountain lions, coyote, bobcat, and black bear. Recently, a transient gray wolf moved into this region from northeastern Oregon, but the establishment of this predator within these ranges has not been documented.

Animal Capture

Adult females will be captured on winter ranges using helicopter net-gunning from 2013 -2017. If required, additional techniques will be available including helicopter drive-netting, ground darting, clover trapping, or drop-nets. Net-gunned deer will be ferried to remote base camps and monitored for stress and temperature where an NSAID or sedative will be administered if temperatures exceed 105° or deer become highly agitated. If deer are free-range darted, a cyclohexamine and α_2 agonist cocktail will be used following guidelines established by the Wildlife Investigations Lab (WIL). Darting conducted at night will use transmitter darts to allow locating the deer post induction. Anesthetic drugs will be delivered via projectile syringe using combinations of Telazol® (tiletamine HCl and zolazepam; 4.4 mg/kg) and xylazine (2.2 mg/kg) or medetomidine HCl (0.1-0.2 mg/kg) and antagonized intramuscularly with tolazoline (2 mg/kg) or atipamezole (0.5 mg/kg).

The weights of all captured animals will be recorded with a scale, and an incisiform canine extracted for aging (Swift et al. 2002). Chest and neck girth circumference will be taken, blood, fecal, and ectoparasite samples collected, and prophylactic medications administered including antibiotics, vitamin E, and selenium. Iridium based GPS collars and a VHF mortality collar will be attached to each deer, and a vaginal implant transmitter (VIT) inserted using methods described by Bishop et al. (2007b). All telemetry collars will be colorized to distinguish individuals by year of capture.

Neonatal mule deer will be located during parturition by monitoring VITs and locations of collared females. Neonates will be captured between 2-10 days old by hand where the sex, approximate age (Brinkman et al. 2004), weights, and a GPS location recorded, and an expandable VHF collar attached (White et al. 1972, Bowyer et al. 2005). Microhabitat evaluations will be conducted for fawning sites and include measurements of vegetation, canopies, hiding cover, and photographs. Deer will be monitored for mortality either from the ground, by aerial survey, or by satellite transmissions, and immediately investigated for determining a cause of death (Wade and Bowns 1985, Kunkel and Mech 1994).

Population Monitoring

Reliable estimates of population density are an important parameter when assessing patterns in demographic variation. Aerial surveys are often relied upon for estimating ungulate populations due to the sampling of large numbers, the ability to survey broader geographic areas (e.g. surveys are not limited to areas near roads), and better visibility of surveyed animals (Bender et al. 2003). This project will use stratified aerial transects on winter range polygons to monitor deer densities using a combination of methods that may include distance sampling, density per transect, ratio estimation, double-count, and mark-recapture techniques. These surveys will also provide estimates of non-target ungulate populations including wild horses and elk, and an index of coyote populations, a potentially important consideration when assessing limiting factors for mule deer.

Population structure will be monitored with vehicle spotlight surveys during late fall for sex and age composition. Vehicle spot light surveys are less biased than daylight counts due to greater deer use of open habitats and less avoidance of the observer (McCullough 1993).

Demographic Rates

A population increases or decreases depending on the rates at which individuals are born, mature, reproduce, and die. Demographic vital rates can include measurements of fecundity (reproductive potential), survival, recruitment, and density, and can be directly influenced by physical condition. This study will assess several demographic parameters as indices of population performance and provide a framework for predicting if populations are regulated by resource limitation or factors independent of population density.

Table. 1. Population performance indicators and period or method of assessment.

Performance	***Assessment***
Age of first reproduction	Nutritional screening and cementum aging
Fetal rates	Nutritional screening
Pregnancy rates	Nutritional screening
Recruitment	Observing marked deer with young-at-heel and aerial surveys
Adult cohort specific survival	Cementum aging and GPS / VHF telemetry
Juvenile survival	VHF Telemetry
Condition (various indices)	In vitro and post mortem
Weights of adults and neonates	Captures and post mortem

Recruitment status will be determined periodically for each marked female beginning in August by locating with telemetry and observing the number of young-at-heel. Tracking annual differences in recruitment status for marked deer during the course of this study will be useful for assessing age class productivity, senescence, and reproductive performance. Aerial surveys in winter may also be used as an index of recruitment by determining adult-juvenile ratios.

Survivorship analysis will use the Kaplan-Meyer procedure to allow staggered entry and exit of marked individuals (Pollock et al. 1989). Survivorship of juveniles will be categorized by age (1-6 mos / 6-12 mos) and season (summer and winter). A matrix of age-class frequency data will be constructed for the doe cohorts >1 year of age to yield age-specific population survival rates and for assessing patterns in senescence and productivity.

Population rate of change

An understanding of the demographic machinery that produces changes in population size is essential for discerning the factors or processes that underlie the dynamics and regulation of populations (Dobson and Oli 2001). The relative importance of demographic variables to the population growth rate (λ) has substantial consequences when assessing limiting factors in deer populations. Knowledge of the sensitivity of populations to the host of growth dependent variables can help discern if populations are being regulated in a density dependent or independent manor. This project will monitor variables from a range of demographic, nutritional, and environmental parameters for constructing population models to help explain the complex interaction of regulation (Leslie 1945, Caswell 2006, Bishop 2007a).

Nutritional Status

Body condition of ungulates directly influences reproduction, survival, growth and decline, and is a central issue when investigating factors that regulate mule deer populations. Ultrasound represents the optimal approach for estimating body condition in live animals but several constraints may limit its widespread application: 1) portable ultrasound equipment is expensive, 2) formal training is required, and 3) logistics associated with the technique may hinder capture (Bishop et al. 2009). Other techniques utilizing live animals include serum thyroid hormone concentrations (STHC) which is one of the few serum variables that have shown promise as a condition index (Bahnak et al. 1981; Watkins et al. 1982, Cook et al. 2001*a*). Body condition score (BCS) is another technique using live animals that is inexpensive, but is subjective, requires standardization among investigators, and may lack the resolution necessary for comparing annual changes.

Post mortem techniques can provide direct reliable estimates of lipid reserves using marrow fat indices (Riney 1955) or physical condition ratings (Oliver 1997, Kistner 1980) but require sacrificing the animal (Taylor 1996, Schaefer 1999). This project will use an approach that combines live and post mortem methods to assess the nutritional status of deer, and for comparing and validating a standardized technique. Deer will be nutritionally screened during capture of live animals using STHC, body weight, and BCS indexes. Additionally, deer will be shot on winter ranges where blood will be immediately collected for STHC, carcasses weighed, physical condition and BCS ratings recorded, and kidney and femurs frozen for measurements of marrow fat. Deer collections will also provide the benefit of additional disease testing. Necropsy sampling protocols will be followed for all carcasses for testing of poisonous chemicals that may include rodenticides, pesticides, and insecticides. Tissues will also be provided for CWD testing as well as metagenomic studies**.**

Female Reproductive Behavior

Assessing the behavior of females during reproductive periods will utilize GPS data with home range and animal movement programming to analyze differences between the pre-rut, rut, and post-rut phases of conception. Conception periods determined from deer collected on winter ranges will be compared to dates previously described (Chattin1948) and used as a basis for categorizing location data into pre and post phases of conception.

Environmental Patterns

Climatic fluctuation can be an important influence on the population dynamics of mule deer. Variation in weather patterns can result in consequences for fitness of individuals born into cohorts characterized by conditions in preceding winters. Winter precipitation and temperature can be directly linked to the availability and quality of nutritional resources. It can affect the timing of movements for large migratory herbivores, and have consequences on survival and productivity. For this study, temperature and precipitation will be monitored daily for winter and summer ranges. Additionally, bitterbrush leader growth and utilization will be measured annually on winter and transition ranges. A climograph will help assess if relationships exist between the timing of forage availability, arrival of mule deer to ranges occupied by bitterbrush, and patterns in nutritional indices (Monteith et al. 2011).

Diet

The details of mule deer diet composition or quality is poorly understood in Siskiyou County and important for assessing environmental constraints such as interspecific competition, availability of resources, seasonal changes in foraging strategies, or relationships between native and non-native herbivores. By contrasting diet composition with temporal/spatial variation, understanding how deer populations cope with seasonal variations in food availability can be important when designing projects to benefit the nutritional availability for deer. Fecal samples will be collected at monthly intervals from locations of collared mule deer utilizing ground searches and satellite location information. Laboratory techniques will be used to identify plant species composition, and fecal nitrogen content as an index to diet quality (Osborn and Ginnett 2001).

Data Management

A web-based application for database management will be developed and maintained by the Northern Regions Environmental Resource Information Services. All data and meta-data associated with this project ranging from capture sheets for individual deer to satellite uploads for GPS data will be accessible by project employees. This will allow real-time knowledge of progress in meeting daily and annual goals and objectives.

Statistical Design

This project will require the use of sophisticated statistical modeling techniques to assess how nutritional status, reproductive rates, survival, mortality, environmental conditions, and other relevant variables interact in the process of population regulation. It will require development of priori model sets based on expectations of important variable relationships and use Akaike's information criterion to select among candidate models. This project is expected to involve a number of graduate students that will be preparing detailed study proposals for their research, including statistical designs for this project that will be submitted to LMAC for review.

Products

Annual progress reports will be submitted with preliminary evaluation of progress towards meeting objectives. Several scientific publications are expected on mule deer ecology, conservation, and factors limiting population growth.

Collaborators

NR Wildlife Programs
CDFG Wildlife Branch
Klamath National Forest
Six Rivers National Forest
CDFG Wildlife Investigation Lab
CDFG NR Environmental Resource Information Services
CDFG statistical methods analyst
University Researchers
Siskiyou County Board of Supervisors
CDFG Large Mammal Advisory Committee
Siskiyou County Fish and Game Advisory Committee
California Deer Association
Rocky Mountain Elk Foundation
Lava Bed-Butte Valley Resource Conservation District

Program Planning

The data requirements for this project will require weekly meetings and daily coordination between the project leader and staff in meeting goals and objectives. Project progress will be reviewed annually where adjustments in protocols may be updated. A generalized project timeline by year is provided in Appendix 1.

Issues to be Resolved

1. Acquire 3 project vehicles
2. Helicopter capture contracting
3. University laboratory contracting
4. University graduate student contracting
5. Preparation of capture plan
6. Preparation of collection plan
7. Preparation of fawn sight evaluation protocols.
8. Resolve issues related to staff firearm restrictions for deer collections.
9. Development of a trained project-specific volunteer network.

Required Products

Progress reports will be submitted annually in June that summarizes all capture and data collection results. A final report for this project is expected by June 2017. Pier reviewed publications resulting from this work are expected. Data from this project will be updated weekly to a web-based application and available from the Northern Region Environmental Resource Information Services.

Personnel Requirements and Commitments from CDFG Northern Region

Staff	Position	Function
Richard Callas	Senior Environmental Scientist Supervisor	Project supervision
Robert Schaefer	Siskiyou County Environmental Scientist	Project lead
Richard Shinn	Modoc County Environmental Scientist	Capture/collections
Brian Ehler	Lassen County Environmental Scientist	Capture/collections
Dave Lancaster	Humboldt County Environmental Scientist	Capture/collections
Scott Hill	Tehama County Environmental Scientist	Capture/collections
Pete Figura	Shasta County Environmental Scientist	Capture/collections
Scott Koller	Mendocino Environmental Scientist	Capture/collections
Brett Furnas	NR Environmental Scientist	Statistical and study design support
Ken Morefield	Research Analyst 2	Web base design and maintenance

All personnel with active participation in captures will attend the CDFG wildlife restraint class. CDFG veterinarians or biologists with advanced certification in wildlife immobilization will handle all chemical therapies during captures.

Primary Equipment Needs

3 Vehicles and expenses
3 Telemetry receivers and antennas
Portable weather stations
VITs
Expandable VHF fawn collars
Iridium lite GPS collars
VHF lite mortality collars
3 Laptop Computers

Misc Sampling Supplies
GPS units
Cameras
Spotting scopes/binoculars
Adult and neonate scales, fetal boards
Freezers

Personnel Requirements

All personnel with active participation in captures will attend the CDFG wildlife restraint class. CDFG veterinarians or biologists with advanced certification in wildlife immobilization will handle all chemical therapies during captures.

Budget Detail

	2013	2014	2015	2016	2017	Total
GPS/VHF Telemetry	$207,440	$207,440	$122,180	$122,180	$62,180	$721,420
Helicopter Capture and Survey	$84,000	$84,000	$84,000	$84,000	$84,000	$420,000
Personnel (University and Sci Aids)	$100,000	$100,000	$100,000	$100,000	$100,000	$500,000
Mics costs (expenses, per diem, supplies)	$50,000	$50,000	$50,000	$50,000	$50,000	$250,000
Fixed- Wing	$30,000	$30,000	$30,000	$30,000	$30,000	$150,000
Total Project Cost	$477,400	$477,400	$392,180	$392,180	$332,180	$2,041,420

**Heli and fix winged costs are estimates.*
**Costs associated with GPS collars vary depending on battery lives and replacement needs.*
**Per diem costs include WIL and HQ*

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Appendix 1. Project Timeline

Eastern Siskiyou Mule Deer Project
Year 1 - FY 2012-2013

	J	A	S	O	N	D	J	F	M	A	M	J
Develop and Finalize 2-Year Contract for Helicopter Capture and University Laboratory	X	X	X	X	X	X						
Develop and Finalize MOU with University Collaborators	X	X	X	X	X	X						
Student Draft Proposals Developed and Submitted to DFG (LMAC)	X	X	X	X	X	X	X					
Develop MOU's with Project Partners including Siskiyou County, USFS, and CDA	X	X	X	X	X	X	X					
Establish Housing for Field Crews	X	X	X	X								
Finalize Iridium Web Based Data Application	X	X	X	X	X	X	X					
Equipment Purchase	X	X	X	X	X	X	X					
Bring on Project Assistants					X	X						
Develop and Submit Capture and Collection Plans to HQ	X	X	X	X	X	X						
Capture 60 Adult Female Deer								X				
Collect 20 Female Deer								X	X			
Winter Range Helicopter Surveys									X			
Survey Recruitment Status of Marked Females (young-at-heel)												X
Conduct Fawning Site Evaluations												X
Collect Monthly Fecal Samples									X	X	X	X
Winter Range Shrub Measurements			X	X								
Monitor VIT Status									X	X	X	X
Fawn Capture									X	X	X	X
Spot Light Surveys					X	X						
Project Evaluation and Oversight Meeting											X	
Progress Report Completion											X	X

Appendix 1. Project Timeline

Siskiyou Mule Deer Project Timeline
Year 2 - FY 2013-2014

	J	A	S	O	N	D	J	F	M	A	M	J
Equipment Purchase		■	■	■	■	■	■					
Capture 60 Adult Female Deer								■				
Collect 20 Female Deer								■	■			
Winter Range Helicopter Surveys									■			
Survey Recruitment Status for Marked Females (young-at-heel)	■	■									■	■
Conduct Fawning Site Evaluations	■	■									■	■
Collect Fecal Samples	■	■	■	■	■	■	■	■	■	■	■	■
Winter Range Shrub Measurements			■	■								
Monitor VIT Status	■	■							■	■	■	■
Fawn Capture	■	■									■	■
Spot Light Deer Composition Surveys					■	■						
Project Evaluation and Oversight Meeting											■	
Progress Report Completion											■	■

Appendix 1. Project Timeline

Siskiyou Mule Deer Project Timeline
Year 3 - FY 2014-2015

	J	A	S	O	N	D	J	F	M	A	M	J
Develop and Finalize 2-year Contract for Helicopter Capture and University Laboratory	■	■	■	■	■	■						
Develop and Finalize MOU with University Collaborators	■	■	■	■	■	■						
Equipment Purchase	■	■	■	■	■	■	■					
Capture 60 Adult Female Deer								■				
Collect 20 Female Deer								■	■			
Winter Range Helicopter Surveys									■			
Survey Recruitment Status for Marked Females (young-at-heel)	■	■									■	■
Conduct Fawning Site Evaluations	■	■									■	■
Collect Fecal Samples	■	■	■	■	■	■	■	■	■	■	■	■
Winter Range Shrub Measurements			■	■								
Monitor VIT Status	■	■							■	■	■	■
Fawn Capture	■	■							■	■	■	■
Spot Light Deer Composition Surveys					■	■						
Project Evaluation and Oversight Meeting											■	
Progress Report Completion											■	■

Appendix 1. Project Timeline

Siskiyou Mule Deer Project Timeline
Year 4 - FY 2015- 2016

	J	A	S	O	N	D	J	F	M	A	M	J
Equipment Purchase		■	■	■	■	■	■					
Capture 60 Adult Female Deer								■				
Collect 20 Female Deer								■	■			
Winter Range Helicopter Surveys									■			
Survey Recruitment Status for Marked Females (young-at-heel)	■	■									■	■
Conduct Fawning Site Evaluations	■	■									■	■
Collect Fecal Samples	■	■	■	■	■	■	■	■	■	■	■	■
Winter Range Shrub Measurements			■	■								
Monitor VIT Status	■	■							■	■	■	■
Fawn Capture	■	■									■	■
Spot Light Deer Composition Surveys					■	■						
Project Evaluation and Oversight Meeting											■	
Progress Report Completion											■	■

Appendix 1. Project Timeline

Siskiyou Mule Deer Project Timeline
Year 5 - FY 2016-2017

	J	A	S	O	N	D	J	F	M	A	M	J
Develop and Finalize 1-year Contract for Helicopter Capture and University Laboratory	■	■	■	■	■	■						
Equipment Purchase	■	■	■	■	■	■	■					
Capture 60 Adult Female Deer								■				
Collect 20 Female Deer								■	■			
Winter Range Helicopter Surveys									■			
Survey Recruitment Status for Marked Females (young-at-heel)	■										■	■
Conduct Fawning Site Evaluations	■										■	■
Collect Fecal Samples	■	■	■	■	■	■	■	■	■	■	■	■
Winter Range Shrub Measurements			■	■								
Monitor VIT Status	■	■							■	■	■	■
Fawn Capture	■	■							■	■	■	■
Spot Light Deer Composition Surveys					■	■						
Project Evaluation and Oversight Meeting											■	
Completion Report											■	■