SUBGRANT VI PROJECT NARRATIVE

State: NEVADA
Grant #.: W-48 R-42
Grant Title: NEVADA WILDLIFE – GAME MANAGEMENT
Sub grant # and Title: VI – MULE DEER RESEARCH
Project Duration: July 1, 2010 – June 30, 2011
Report Due Date: September 28, 2011

INTRODUCTION

Mule deer (*Odocoileus hemionus*) populations have experienced declines throughout the western portions of their range (Carpenter 1998, Gill 2001), including Nevada. Mule deer have both aesthetic and economic value and generate high degree of public interest; as a result mangers are especially concerned with observed declines in their populations. Mule deer are the primary game species in Nevada (Wasley 2004) and not only provide recreational opportunities but generate revenue for management agencies through the sale of hunting tags (Heffelfinger and Messmer 2003). Moreover, mule deer are good indicator species of changes in habitat quality and ecosystem health; their biology is well known compared with other species of wildlife and they have sufficiently large home ranges to integrate spatial patterns across landscapes (Kie et al. 2003).

Many hypotheses have been proposed to explain the declines in populations of mule deer, and those hypotheses include competition with wild and domestic herbivores, predation, habitat fragmentation, habitat loss, and extreme weather events (Clements and Young 1997, Gill 2001). Reductions in quality of habitat resulting from habitat loss, particularly type conversion to cheat grass (*Bromus tectorum*) dominated ranges, or decadence of woody vegetation, likely has reduced the ecological carrying capacity (*K*; McCullough 1979) of their habitats so that ranges in Nevada support smaller populations of mule deer than in previous decades. Poor nutritional condition of individuals in populations close to *K*, has important ramifications for adult and juvenile survival, incidence of disease, age structure, and productivity of populations (McCullough 1979, Kie et al. 2003). Understanding the relationship of mule deer populations relative to carrying capacity will aid biologists in more effective management of mule deer populations, especially in determining whether harvest of females, improvement of habitats, or predator manipulation is warranted.

Migration is a basic response to adversity (Taylor and Taylor 1977), and migration may have evolved because individuals opportunistically exploited areas of higher quality or avoidance of inhospitable conditions (e.g. deep snow) during certain portions of the year (Nicholson et al. 1997). Migration also is risky; deer often are exploiting areas of higher risk during migratory movements such as unfamiliar habitats and may have higher risk of predation during migration than when occupying seasonal ranges (Nicholson et al. 1997). Mule deer in Nevada follow 3 primary strategies during the year, they may be obligate migrators (those that migrate annually regardless of environmental conditions), facultative migrators (those that migrate during specific environmental conditions, such as high snow levels), or residents (Nicholson et al. 1997). Indeed, Nicholson et al. (1997) observed that migratory females had higher rates of mortality during migration than their resident counterparts during years of low precipitation, although this relationship was reversed in years of normal precipitation. Impediments to migration including railroads, fences, highways, guardrails, canals, housing, and mining all impede migration routes, often many of those factors occur in a single route and resulted in fragmented and degraded habitat for mule deer (Wasley 2004). Mule deer are highly philopatric and unlikely to modify or alter migration routes to avoid impediments, which add additional hardships and risks to migratory individuals (Wasley 2004). Moreover, climate change likely affects tradeoffs associated with migratory behavior and may support one of the three strategies (obligate, facultative, or resident) over the others. How migration is linked with corridor use and population persistence or is affected by alteration or fragmentation of habitat has not been well studied and is currently not well understood (Simberloff et al. 1992, Beier and Noss 1998, Berger 2004).

The proposed project will measure body condition, survival, reproduction, health status, energetic costs, movement patterns, and habitat relationships of mule deer as well as interactions with other big game

species including competition and predation.

NEED

Nevada State Law has granted the Nevada Department of Wildlife (NDOW) the authority and responsibility to be the "steward" of Nevada's wildlife populations including all big game herds. Due to the relatively high public interest and demand in the recreational pursuit of big game (primarily hunting), it is imperative that NDOW take an active role in the conservation, management, and enhancement of Nevada's big game herds.

Mule deer populations are continuing to experience declines in Nevada and reasons for the declines are not well understood. Those declines also have ramifications to recreational opportunities and a corresponding loss of revenue to local economies that support sportsmen during scouting and hunting trips. NDOW uses population models to determine number of tags and quotas for mule deer in each game management unit and improvements in obtaining data on the nutritional condition of deer in populations in Nevada as well as improved data on survivorship will help to improve those population models and prevent overexploitation of those populations. In addition, knowledge of population densities relative to the carrying capacity of those populations, as indexed by nutritional condition, reproduction, and survivorship will aid NDOW in determining appropriate management activities for specific populations. Finally, improvements in understanding the effects of habitat fragmentation or habitat loss on mule deer populations will help managers to understand reasons for declines in mule deer populations, allow for appropriate management activities to prevent further declines of those populations, and to understand factors affecting survival and recruitment of juvenile mule deer.

Migratory behavior of mule deer and human induced modifications to habitats have resulted in potentially more risk and higher energetic demands during migratory movements. Indeed 200-400 deer are killed annually during migration while crossing highways in area 7 alone, during spring and fall migration. In addition, mortality resulting from habitat fragmentation, increased energy demands while navigating obstructions such as fences, embankments, and guard rails during migration. Understanding barriers to migratory corridors and driving factors for migration will aid NDOW in more effective management of mule deer populations and maintain multiple strategies within populations that likely will improve management of populations that exhibit multiple migratory strategies.

OBJECTIVES

To effectively manage healthy and sustainable mule deer populations and to manage responsible consumptive and non-consumptive use of mule deer populations throughout Nevada. Specific objectives or management actions include:

1. We will initiate a research project to determine causative agents for declines in mule deer populations, related to nutrition, habitat use, migration, movement patterns, competition, predation, and their effects on adult and juvenile survival and recruitment.

    a. Improve knowledge and understanding of the ecological relationships between mule deer and their habitats, especially where populations are affected by landscape-scale alteration of habitat.
    b. Improve understanding of the relationship between nutritional condition and reproductive success and the corresponding effects on survival and reproduction.
    c. Improve understanding of factors associated with the energetics of migration and their population level effects.
    d. Improve understanding of the relationships between population dynamics of mule deer and interactions with other big game species including competition and predation.
    e. Evaluate health status and disease incidence in mule deer herds and to attempt to identify and understand pathogens and causative agents responsible for unhealthy or diseased animals.
    f. To facilitate appropriate management of big game populations, distribution, migration, movement patterns, and extent of seasonal use areas.
    g. Distribute findings through multiple media available for the enhancement of public awareness and

mule deer specific knowledge.

2. We will initiate a research project to determine causative agents for declines in mule deer populations, related to nutrition, habitat use, migration, movement patterns, competition, predation, and their effects on adult and juvenile survival and recruitment.

    a. Improve knowledge and understanding of the ecological relationships between mule deer and their habitats, especially where populations are affected by landscape-scale alteration of habitat.
    b. Improve understanding of the relationship between nutritional condition and reproductive success and the corresponding effects on survival and reproduction.
    c. Improve understanding of factors associated with the energetics of migration and their population level effects.
    d. Improve understanding of the relationships between population dynamics of mule deer and interactions with other big game species including competition and predation.
    e. Evaluate health status and disease incidence in mule deer herds and to attempt to identify and understand pathogens and causative agents responsible for unhealthy or diseased animals.
    f. To facilitate appropriate management of big game populations, distribution, migration, movement patterns, and extent of seasonal use areas.
    g. Distribute findings through multiple media available for the enhancement of public awareness and mule deer specific knowledge.

3. Several endpoints are to be expected. For example GPS satellite collars with limited battery life will extend about 1-1.5 years and provide detailed data on animal locations, VHF collars will provide information for approximately 5 years, provided that telemetry flights continue to collect data for the duration of the expected battery life. Most of these data will be expressed as annual values, thus we will benefit from information on a yearly basis to examine the effects of stochastic variation among years on survival, nutritional condition, predation and competition. Nonetheless, there will be value in obtaining data on a per year basis as well as among years to examine specific occurrences such as juvenile recruitment and survival of both adults and juveniles.

    a. Annual survival would be obtained one year following collar deployment on animals.
    b. Movement patterns would be used to increase understanding of use of seasonal ranges, fawning areas, and effects of disturbance and fragmentation on migration strategies.

4. Quantifiable results will include; survival of adults and juveniles, juvenile recruitment, habitat use, cause specific mortality and effects of predation on marked individuals to estimate population level effects in each selected population of mule deer. Those results will increase our knowledge of each population and have direct application to management of mule deer populations in Nevada.

EXPECTED RESULTS

1. Nevada State Law has granted the Nevada Department of Wildlife (NDOW) the authority and responsibility to be the "steward" of Nevada's wildlife populations including all big game herds. Due to the relatively high public interest and demand in the recreational pursuit of big game (primarily hunting), it is imperative that NDOW take an active role in the conservation, management, and enhancement of Nevada's big game herds.
2. Annual surveys and estimates of big game populations and associated habitat conditions provide important data to determine status and trend of populations and their habitats. With added research we can increase our ability to isolate specific demographic parameters or processes, including competition and predation, which influence population change. This information will allow Game Division biologists to make sound and justifiable recommendations for management of mule deer populations. The resulting information also will allow NDOW to provide input to land managers on appropriate actions to take to maintain and improve big game habitats.
3. Objective evaluation of body condition, energy balance and reproductive health will provide accurate and useful information to assist in making scientifically-based decisions regarding population objectives, habitat, and harvest of Nevada's big game resource. Accurate estimates of nutritional condition will

enhance our understanding of reproductive potential, survival rate, energy balance and nutritional carrying capacity. Field ultrasound will directly measure pregnancy, body condition, and fetal rates, including size and number of fetuses.

4. Disease related events often have serious impacts to big game populations and generate social distrust in NDOW's abilities to manage populations, increased understanding of those processes will allow for a better understanding of the factors that contribute to these events. Consistent, ongoing evaluation of health and disease in mule deer populations will provide wildlife managers the ability to detect changes in health status of populations (i.e. decreased nutritional condition, mineral deficiency or toxicity; presence of previously unrecorded infectious disease agents, etc.) and allow NDOW biologists to respond in a timely manner to such events.
5. Knowledge of energetic costs associated with migratory strategies will improve the departments understanding of the benefits of differing strategies in variable climates and allow for more effective management of those strategies and allow for protection of migratory corridors. In addition, NDOW biologists will be able to provide more effective information to land managers regarding effects of landscape-scale change on migration patterns and strategies.
6. This project will allow NDOW biologists to more effectively manage populations of mule deer; and more detailed knowledge of the factors that influence productivity of mule deer populations will allow biologists to provide more detailed information to the public. Additionally, an additional benefit will include more efficient use of public funds directed towards management of wildlife.

APPROACH

Approach Specific to Each Objective

1. All mule deer populations will be managed in accordance with their corresponding Management Plan (Nevada Department of Wildlife. 2006). We will use a combination of VHF and GPS radio collars to measure survivorship of mule deer and determine animal locations, migratory movements, and movement patterns at a landscape scale. Highly accurate and much more frequent locations will be obtained from GPS collars; those data will provide detailed movements and locations of migratory pathways, use of habitats, location of fawning habitats, and potential interactions with competitors. Flights will be scheduled to determine locations and mortality of mule deer equipped with VHF radio collars.
    a. GPS collars and remote cameras will be used to determine highly accurate locations of animals as well as movements associated with home range use and migratory patterns. Those data will be used in combination with GIS maps of available habitats and resource selection functions to determine habitats selected or avoided by mule deer. Those models will provide information on the effects of habitat fragmentation at a landscape scale on mule deer populations. Personnel involved will include: NDOW mule deer staff specialist, NDOW area biologists, university professor, and technicians (including graduate and undergraduate students). Schedule: animals will be captured and equipped with radio collars during mid-winter and data on nutritional condition and reproduction will be collected during captures. Telemetry flights will begin immediately following deployment of radio collars and continue throughout the year.
    b. Use GPS and VHF radio collars, with telemetry flights, to discern annual survival of adult and juvenile mule deer. Conduct evaluations of body condition, reproductive status, and health of mule deer. Body Condition Scores (BCS) and reproductive status will be estimated by standard ocular and palpating procedures along with the use of ultrasonography, a non-invasive and highly efficient tool for determining nutritional condition through the accurate measurement of subcutaneous fat and selected muscle thickness in live animals (Stephenson et al. 1995, 1998, 2002, Cook et al. 2001). Teeth from harvested or killed mule deer and mountain lions may be collected and aged using cementum annuli (Gilbert 1966), and data will be summarized and analyzed to further understand the age structure of the population. Personnel involved will include: NDOW mule deer staff specialist, NDOW area biologists, university professor, and technicians (including graduate and undergraduate students). Schedule: animals will be captured and equipped with radio collars during mid-winter and data on nutritional condition and reproduction will be collected during captures. Telemetry flights will begin immediately following deployment of radio collars and continue throughout the year.
    c. A subset of animals with GPS collars will be deployed on mule deer exhibiting each of the 3

migratory strategies within each of 3 populations. Body condition scores, age, and reproductive data will be collected and analyzed for relationships between migratory strategy and reproductive success. Personnel involved will include: NDOW mule deer staff specialist, NDOW area biologists, university professor, and technicians (including graduate and undergraduate students). Schedule: animals will be captured and equipped with radio collars during mid-winter and data on nutritional condition and reproduction will be collected during captures. Telemetry flights will begin immediately following deployment of radio collars and continue throughout the year.

d. We will examine historic survey data for timing and location of releases of competitors in combination with GPS collar data to determine interactions of mule deer with competitors. We will examine effects of predation by mountain lions on mule deer to determine effects of predators on population dynamics of mule deer. Personnel involved will include: NDOW mule deer staff specialist, NDOW area biologists, university professor, and technicians (including graduate and undergraduate students). Schedule: animals will be captured and equipped with radio collars during mid-winter and data on nutritional condition and reproduction will be collected during captures. Telemetry flights will begin immediately following deployment of radio collars and continue throughout the year. We will begin to examine potential kill sites by mountain lions following deployment of radio collars on mule deer.

e. Conduct a focused wildlife disease investigation on mule deer in the vicinity of alfalfa fields in Humboldt County to diagnose the cause of un-thriftiness, loose stools, and elevated mortalities that has been ongoing for over 10 years. Mule deer on and off alfalfa fields will be equipped with GPS radio collars, and data will be collected on nutritional condition, reproductive success, diet, and survival. Animals exhibiting symptoms will be collected and necropsied and appropriate tissue samples will be collected and analyzed for presence of disease, mineral deficiency or toxicity. Personnel involved will include: NDOW mule deer staff specialist, NDOW area biologists, NDOW veterinary staff, university professor, technicians (including graduate and undergraduate students). Schedule: animals will be captured and equipped with radio collars during mid-winter and data on nutritional condition and reproduction will be collected during captures. Telemetry flights will begin immediately following deployment of radio collars and continue throughout the year. Collection of sick animals will begin as soon as they are observed in the study area.

f. Use those data collected, as described in the aforementioned procedures to increase the effectiveness and efficiency of management of mule deer populations in Nevada. Personnel involved will include: NDOW mule deer staff specialist, NDOW area biologists, university professor, and technicians (including graduate and undergraduate students). Schedule: animals will be captured and equipped with radio collars during mid-winter and data on nutritional condition and reproduction will be collected during captures. Telemetry flights will begin immediately following deployment of radio collars and continue throughout the year.

g. We will disseminate information through peer-reviewed publications, agency reports, educational materials, press releases, agency website, sportsman's publications, and popular articles. Personnel involved will include: NDOW mule deer staff specialist, NDOW area biologists, university professor, and technicians (including graduate and undergraduate students). Schedule: We will begin to dissemination information at the end of the year when annual data analysis is complete.

LOCATION(S)

A – Objectives met at this location include; 1a, 1b, 1d & 1g

B – Objectives met at this location include 1d & 1g

C – Objectives met at this location include 1a, 1b, 1e, 1f, &1g

D – Objectives met at this location include 1a, 1b, 1c, 1d, 1f, & 1g

E – Objectives met at this location include 1a, 1b, 1c, 1d,

1f, & 1g
F – Objectives met at this location include 1a, 1c, 1f, & 1g

ENVIROMENTAL COMPLIANCE

See associated table entitled "Assessment of Game Division Surveys and Inventories for ESA Compliance" for descriptions of surveys and how they avoid conflicts with or impacts to threatened and endangered species and their habitats. Specific to big game restoration efforts involving release of big game animals, the Game Division coordinates with public land management agencies during the planning process. The public land management agencies conduct NEPA on the release activity. Each agency will determine if the activity warrants an environmental assessment or if the activity is simply a categorical exclusion. NDOW provides necessary information to the public land management agency on the specifics (when, where, species, numbers, habitat use of resulting release complement, vehicles and aircraft involved in release, etc.) of the release for the completion of the appropriate NEPA process.

MULTI-PROGRAM FUNDING

No multi-program funding is anticipated.

CONTACTS

Project Coordinator and Principal Investigator: Tony Wasley, Mule Deer Staff Specialist
Co Principal Investigator: Dr. Kelley M. Stewart, Assistant Professor, Department of Natural Resources and Environmental Science, University of Nevada Reno, MS 186, 1000 Valley Rd. Reno, NV 89503.

ESTIMATED COSTS

Sub grant/Project Cost Summary

Sub grant/ Project #	Description	Estimated Costs				
		State Share, Tag/Licenses	Cash Donations	In-kind	Federal Share	Total
IV	Mule Deer Research	$44,605	$141,000	$5,000	$571,815	$762,420

LITERATURE CITED

Berger, J. 2004. The last mile: how to sustain long-distance migration in mammals. Conservation Biology 18:320-331.

Beier, P. and R. F. Noss. 1998. Do habitat corridors provide connectivity? Conservation Biology 12:1241-1252.

Carpenter, L. H. 1998. Deer in the West. In J. C. deVous, Jr, ed. Proceedings of the 1997 Deer/Elk Workshop, Rio Rico, AZ. Arizona Game and Fish Department, Phoenix, AZ.

Clements, C. D. and J. A. Young. 1997. A viewpoint: rangeland health and mule deer habitat. Journal of Range Management 50:129-138.

Cook, R. C., J. G. Cook, D. L. Murray, P. Zager, B. K. Johnson, M. W. Gratson. 2001. Development of predictive models of nutritional condition for Rocky Mountain elk. Journal of Wildlife Management 65:973-987.

Gilbert, E. F. 1966. Aging white-tailed deer by annuli in the cementum of the first incisor. Journal of Wildlife Management 30: 200-202.

Gill, R. B. 2001. Declining mule deer populations in Colorado: reasons and responses. Special Report 77. Colorado Division of Wildlife, Denver, CO.

Heffelfinger, J. R. and T. A. Messmer. 2003. Introduction. Pages ___ in J. C. DeVours, Jr, M. R. Conover, and N. E. Headrick, eds, Mule Deer Conservation: issues and management strategies. Berryman Institute Press, Logan UT.

Kie, J. G., R. T. Bowyer, and K. M. Stewart. 2003. Ungulates in western coniferous forests: habitat relationships, population dynamics, and ecosystem processes. Pages 296-340 in C. Zabel and R. Anthony eds, Mammal community dynamics in western coniferous forests: management and conservation. The Johns Hopkins University Press, Baltimore, MD.

McCullough, D. R. 1979. The George Reserve deer herd: population ecology of a K-selected species. University of Michigan Press, Ann Arbor, MI.

Nevada Department of Wildlife. 2006. Management plan for mule deer. Federal aid in wildlife restoration, W-48-R-37, Sub-grant II, Project 5.

Nicholson, M. C., R. T. Bowyer, and J. G. Kie. 1997. Habitat selection and survival of mule deer: tradeoffs associated with migration. Journal of Mammalogy 78:483-504.

Simberloff, D. J., A. Farr, J. Cox, and D. W. Mehlman. 1992. Movement corridors: conservation bargains or poor investments? Conservation Biology 6:493-504.

Stephenson , T. R., J. W. Testa, G. P. Adams, R. G. Sasser, C. C. Schwartz, and K. J. Hundertmark. 1995. Diagnosis of pregnancy and twinning in moose by ultrasonography and serum assay. Alces 31:167-172.

Stephenson, T. R., K. J. Hundertmark, C. C. Schwartz, V. Van Ballenberghe. 1998. Predicting body fat and body mass in moose with ultrasonography. Canadian Journal of Zoology 76:712-722.

Stephenson, T. R., V. C. Bleich, B. M. Pierce, and G. P. Mulcahy. 2002. Validation of mule deer body composition using in vivo and post-mortem indices of nutritional condition. Wildlife Society Bulletin 30:557-564.

Taylor, L. R., and R. A. J. Taylor. 1977. Aggregation, migration, and population mechanics. Nature 265:415-421.

Wasley, T. 2004. Mule deer population dynamics: issues and influences. Biological Bulletin No 14. Nevada Department of Wildlife, Reno, NV