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STATE OF NEVADA

DEPARTMENT OF WILDLIFE

Game Division

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MEMORANDUM

October 31, 2016

To: Nevada Board of Wildlife Commissioners, County Advisory Boards to Manage Wildlife, and Interested Publics

From: Brian Wakeling, Administrator, Game Division

Title: **Predation Management Fiscal Year 2016 Report**

Description: The Game Division will present the status of the 2016 Predation Management Report. Per Commission Policy 23, the Department shall prepare an annual Predation Management Status Report (Status Report) detailing results of the previous fiscal year's projects. This status report shall be presented at the last Commission meeting of each calendar year.

Presenter: Staff Specialist Pat Jackson and Game Division Administrator Brian F. Wakeling

Agenda No: X 24

Summary:

In accordance with Commission Policy 23, the Department annually presents a written and verbal Predation Management Report based on activities undertaken as guided by the Predation Management Plan. The activities in the Predation Management Fiscal Year 2016 Report occurred between July 1, 2015 and June 30, 2016, as directed by the Predation Management Plan (FY 2016 Plan) adopted in May 2015. Subsequent to the adoption of the FY 2016 Plan, legislation known as AB78 was signed into law. The Department attempted to anticipate the regulations that would be included in the law prior to final approval, but did not recognize all possible aspects. Consequently, the FY 2016 Plan included lethal management activities at a level lower than prescribed in statute. A state legislator involved in the passage of this law recognized that a transition would be necessary and indicated that an adjustment period would be appropriate; nevertheless the Department acknowledges that the activities undertaken following

the FY 2016 Plan failed to meet the statutory regulation. The accompanying report provides updates on all projects in detail.

The Department spent $312,175 on lethal predator removal during FY2016. This accounted for 54.7% of FY2014 revenues, not the 80% required by AB 78. The total expenditures under this plan was $675,525, of which $169,400 were from the Federal Aid in Wildlife Restoration funds.

Nevada Department of Wildlife

Predation Management Status Report

FY2016

October 26, 2016

State of Nevada

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Department of Wildlife

Tony Wasley, Director

Game Division

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EXECUTIVE SUMMARY

The goal of the Nevada Department of Wildlife's (NDOW's) Predator Management Program is to conduct projects consistent with the terrestrial portion of NDOW's Mission "to preserve, protect, manage, and restore wildlife and its habitat for the aesthetic, scientific, educational, recreational, and economic benefits to citizens of Nevada and the United States." Provisions outlined in NRS 502.253 authorize the collection of a $3 fee for each big game tag application, deposition of the revenue from such a fee collection into the Wildlife Fund Account, and use by NDOW to 1) develop and implement an annual program for the management and control of predatory wildlife, 2) conduct wildlife management activities relating to the protection of nonpredatory game animals and sensitive wildlife species, and 3) conduct research necessary to determine successful techniques for managing and controlling predatory wildlife. This statute also allows for: the expenditure of a portion of the money collected to enable the State Department of Agriculture and other contractors and grantees to develop and carry out programs designed as described above; developing and conducting predator management activities under the guidance of the Nevada Board of Wildlife Commissioners; and provide that unspent monies remain in the Wildlife Fund Account and do not revert to State General Funds at the end of any fiscal year.

NDOW maintains a philosophy that predator management is a tool to be applied deliberately and strategically. Predator management may include lethal removal of predators or corvids, non-lethal management of predator or corvid populations, habitat management to promote more robust prey populations which are better able to sustain predation, monitoring and modeling select predator populations, managing for healthy predator populations, and public education, although not all of these aspects are currently eligible for funding through predator fee dollars. NDOW intends to use predator management on a case-by-case basis, with clear goals, and based on an objective scientific analysis of available data. To be effective, predator management should be applied with proper intensity and at a focused scale. Equally important, when possible projects should be monitored to determine whether desired results are achieved. This approach is supported by the scientific literature on predation management. NDOW is committed to using all available tools and the most up-to-date science, including strategic use of predator management, to preserve our wildlife heritage for the long term.

In FY2016, 11 projects were included in the planned activities, with each project having committed funding. Included in NDOW's ongoing work is greater sage-grouse protection (Project 21 and subproject 21-02), mule deer fawn and bighorn sheep protection and recommendations for continuing redesigned work for FY2016 (Project 22-01, 22-074, 37, 38, and 40).

This report includes a report written by Wildlife Conservation Society on mountain lion, mule deer, and black bear is included (Project 32). A report on red fox genetics by written UC Davis is included (Project 35).

The planned budget for FY2016 was $556,000 from the Predation Management Fee Program. The expenditures were $675,525 with $169,400 of expenditures coming from Federal Aid in Wildlife Restoration funds.

Contributors to this status report include, Chris Hampson, Kari Huebner, Matt Jeffress, Mike Podborny, Katie Anderle, Pete Coates, Cody McKee, Shawn Espinosa, Pat Jackson, Jon Beckmann, Benjamin Sacks, and Brian Wakeling.

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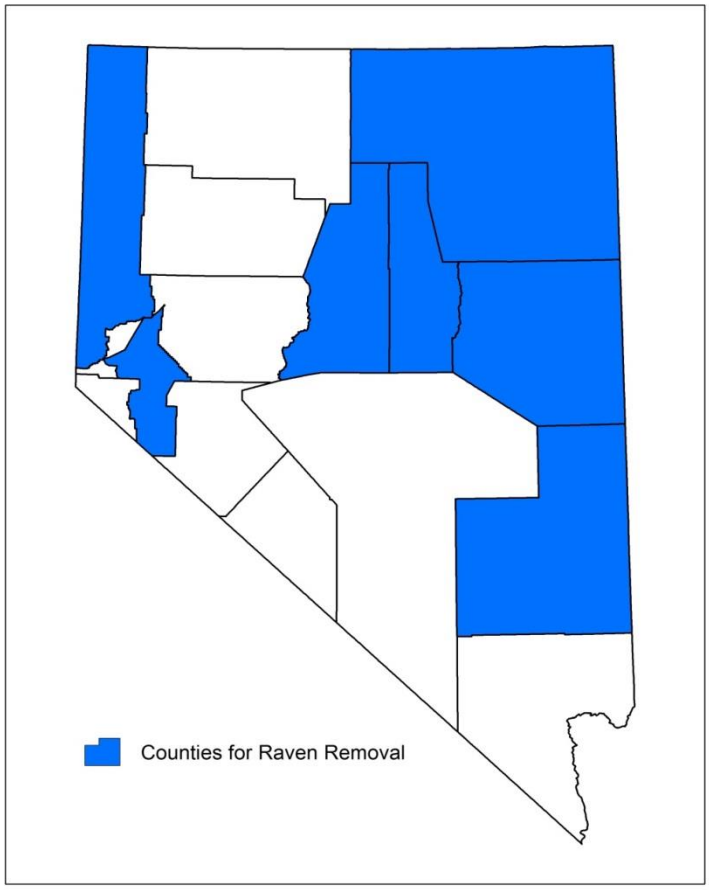
Project 21 Greater Sage-grouse Projection (Statewide)

Raven control efforts to conserve greater sage-grouse commenced in early March and extended throughout May 2016. The objective of this project is to increase greater sage-grouse nest success and recruitment. USDA Wildlife Services (USDA WS) performed raven control work through the placement of corvicide (DCR-1339) injected chicken eggs within occupied greater sage-grouse habitats. The main treatment areas consisted of eastern and northeastern Nevada in situations where concentrations of ravens have been noted and where habitat has been compromised, potentially by wildfire or anthropogenic subsidies (e.g. landfills and transfer stations). Another treatment area, the Virginia Mountains in western Nevada, is being used as an experimental area and details of that project are reported below (subproject 21-02).

Through the efforts of USDA WS personnel, an estimated 2,319 ravens were removed during spring 2016. The total number of ravens taken for project 21 and the Virginia Mountains (subproject 21-02) was 2,500, which is the maximum that NDOW can remove under the current USFWS depredation permit (#MB37116A-0). Ravens were removed in 11 game management areas during the spring of 2016.

Raven take by Management Area (MA) FY2016.

Area	Ravens Removed
MA 3	456
MA 6	69
MA 7	367
MA 8	45
MA 10	87
MA 11	275
MA 14	32
MA 15	165
MA 20	42
MA 22	194
MA 23	587
Total Ravens	2,319



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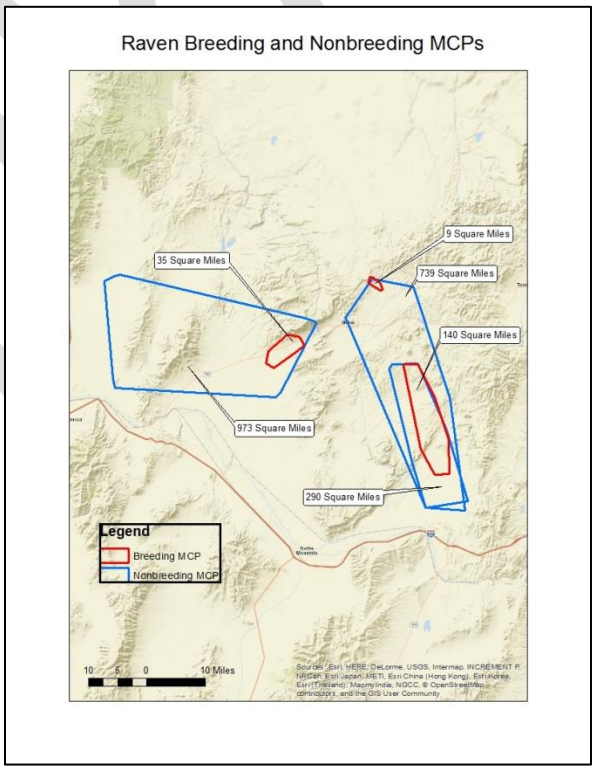
Raven Transmitters

In an effort to increase understanding of common ravens throughout the state of Nevada, test two comparable raven transmitters, and meet part of the non-lethal requirements in the USFWS depredation permit (#MB37116A-0), 5 ARGOS transmitters and 2 GSM transmitters were purchased to be deployed on common ravens.

In November 2015, NDOW field technicians captured six common ravens in and near Midas, NV. One bird was captured on November 18, 2015, approximately 15 miles SW of Midas. Three birds were captured at the Hollister Mine on November 20, 2015, with a fourth bird caught there on November 21, 2015. The last bird was captured at the Midas BLM Fire Station on November 23, 2015. Two of the birds captured at the Hollister Mine were outfitted with Northstar GSM transmitters while the remaining four birds were outfitted with ARGOS transmitters. One ARGOs transmitter did not stay on the bird and failed to provide any informative data on its movements. Based upon the data received from the remaining five devices, four of the birds were resident adults that stayed within the general area where they were captured, while the fifth bird didn't show any evidence of territorial fidelity. Two birds captured on November 20, 2015 appeared to be a mated pair that bred near the Hollister Mine. The male was fitted with an ARGOS device while the female was fitted with a GSM.

The failure rate of the GSM transmitters was 100%. Both devices stopped transmitting according to their predefined data collection schedule after November 30, 2015, while transmitting intermittently until June and August, respectively. This poor performance may have been due to the transmitters not receiving sufficient sunlight to charge their batteries, but the ARGOS devices, which were similar-sized and attached in the same manner worked as expected. The Northstar GSM devices may not be suitable for placing on common ravens.



Minimum convex polygons for territorial ravens.

Raven Enclosure

In an effort to remove a subsidy from common ravens and meet part of the non-lethal requirements in the USFWS depredation permit (#MB37116A-0), an exclosure around the Midas transfer station was completed during FY2016.

Unfinished exclosure at Midas transfer station.

Finished exclosure at Midas transfer station.

$3 Planned Expenditures	P-R Planned Expenditures	Wildlife Services Expenditures	NDOW Lethal Expenditures	NDOW Non-Lethal Expenditures	NDOW Salary, Travel, and Office	Total
$78,000	N/A	$51,815	$0	$44,304	$10,091	**$106,211**

Subproject 21-02 Virginia Mountains Sage-grouse Nests

Work was initiated during March and extended throughout May 2016 to determine the efficacy of raven control on the resident greater sage-grouse population within the Virginia Mountains located in southern Washoe County. Over a 2.5 month period, USDA WS deployed corvicide treated eggs within previously identified greater sage-grouse nesting habitats located around Sheep Springs, Spanish Flat, and lower Cottonwood Creek. An estimated 181 ravens were removed during the spring months.

Greater sage-grouse monitoring work is being conducted by the USGS Western Ecological Research Center. Seven years of baseline monitoring work have been conducted on this population to determine various vital rates and vegetative parameters in used versus random sites across multiple life phases. The information presented below provides summaries of the USGS field crew efforts from March through July 2016.

Telemetry Monitoring

USGS field crews trapped and deployed 13 VHF radio transmitters on female greater sage-grouse during spring 2016 near Spanish Flat and Sheep Springs. Field crews obtained 236 telemetry locations from 37 VHF marked greater sage-grouse during March–July 2016. Relocations extended from the California border near State Line Peak in the Fort Sage Mountains in the west, to Tule Ridge in the east, and as far south as the Dogskin Mountains.

Reproduction

USGS field crews located 15 nests, of which 4 failed and 11 were successful. Eight nests were within approximately seven km of Spanish Flat, four were within five km of Sheep Springs lek, and the remaining three were near West Cottonwood lek. The first nest was observed on 16 April, and the final successful nest hatched on 9 June. Of the 4 failed nests, two were abandoned and two were depredated. Of the two nests classified as depredations, one nest appeared to be depredated by ravens and the second was likely depredated by coyotes.

Nest Videography

USGS research crews set up video monitoring equipment on seven nests to record predation and nesting recess activity. Of these, six nests hatched, and one was abandoned. The female that abandoned was observed leaving the nest several times, in addition to normal recess activity, for extended periods until she eventually did not return to the nest over a week later.

Brood Monitoring

For each successful nest, USGS field crews collected a series of locations to track movement and space use of the female and her brood. Crews obtained a daytime location every 10 days and continued to track broods for 50 days post-hatch. In addition to our 11 successful nests we found one brood-rearing female who was not found on nest, bringing the total to 12 monitored broods, of which nine failed, two were successful, and one was of unknown status. Brood fates are as follows: three females lost their brood in the first 10 days; two females lost their broods between 10 and 20 days; one female was killed and lost her brood between 10 and 20 days; one female lost her brood between 10 and 40 days; two females were killed and their broods failed between 20 and 30 days; two females have successfully reared their broods to the 50 days post-hatch; and

we have not been able to monitor the remaining female and her brood as we have lost her signal and therefore cannot determine brood fate.

Habitat

USGS field crews completed 79 microhabitat surveys (45 at nest sites and 34 and brood locations). Each microhabitat survey is conducted at nest sites immediately following nest fate to better understand greater sage-grouse-habitat relationships. Crews collected data at three points for every nest, including two random points: one at a dependent random location based on nest location and one at an independent random location (generated randomly throughout the study area). Conducting microhabitat surveys at random points allows for the estimation differences between nesting sites and available habitat across the study area at different spatial scales. For each successful nest, field crews collected three locations for each brood on a 10-day rotation. Each cycle of locations consists of one day location and one dependent random location (based on day location). Habitat variables are measured at each location and also at random locations to characterize available nest and brood rearing habitat.

Raptor, Raven, and Livestock Surveys

USGS field crews conducted 319 raptor, raven, and livestock (RRHL) surveys. These surveys help identify avian predator composition and the relationship between predators and greater sage-grouse population dynamics. Surveys are completed after each lek count, and at telemetry locations, nest sites, brood locations, and random points.

Mortalities

USGS crews recovered the remains of 13 marked birds since the beginning of field operations in March. A GPS data logger was among the mortalities; data recovered on this unit will assist in a graduate student's thesis. Perhaps the most notable of the mortalities are the three females who were killed during the brood-rearing period. The fatalities are as follows: one female was found in a Golden Eagle nest; the second appeared to be due to a raptor, as all feathers were plucked; the third possessed chew marks on some of the feathers as well as her collar, indicating a mammalian predator.

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USGS Raven Modeling Report

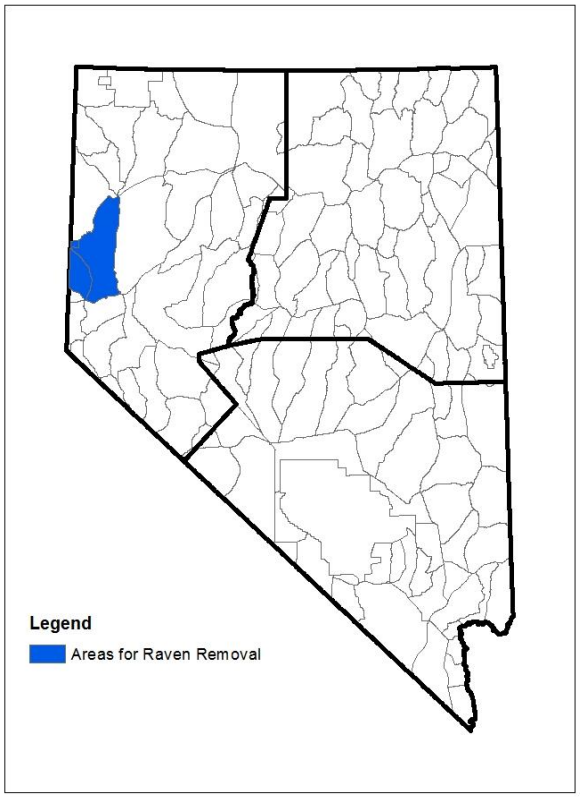
The USGS has provided a summary report (see appendix) for raven modeling conducted in the Virginia Mountains. The USGS states:

"This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government may be held liable for any damages resulting from the authorized or unauthorized use of the information."

$3 Planned Expenditures	P-R Planned Expenditures	Wildlife Services Expenditures	NDOW Lethal Expenditures	NDOW Non-Lethal Expenditures	NDOW Salary, Travel, and Office	Total
$50,000	N/A	$20,895	$0	$24,211	$10,091	**$55,197**

State Funds*	PR Funds*
$17,491	$52,472

*These funds were not from $3 predator fee.



Project 22 Mule Deer-Game Enhancement

In 2009, Project 22 was initiated statewide to provide flexibility and opportunity to respond quickly to conditions on the ground that biologists believe could be adversely affecting population trajectory of specific mule deer herds and other big game populations.

NDOW funds USDA WS and private contractors to remove predators given the constraints of weather, time, and available funding using aerial gunning, hounds, calling, call boxes, shooting, foot-hold traps, and snares to accomplish the treatment. Selective and timely management work focused on critical seasonal big game ranges. The timing of management work will be in accordance with individual project criteria, but occur primarily on critical winter ranges and summer fawning areas or in release-augmentation areas.

$3 Planned Expenditures	P-R Planned Expenditures	Wildlife Services Expenditures	NDOW Lethal Expenditures	NDOW Non-Lethal Expenditures	NDOW Salary, Travel, and Office	Total
Project 22	$0	N/A	$8,264	$0	$0	$10,091

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Subproject 22-01 Mountain Lion Removal to Protect California Bighorn Sheep

Attempts have been made to establish a California bighorn sheep population in Area 01. Significant levels of mountain lion-induced mortality have been observed. California bighorn sheep populations may require a reduction in mountain lion densities to reach population viability.

Between July 1, 2015 and June 30, 2016, 11 mountain lions were removed by USDA WS. Six mountain lions were removed in Unit 011, the other five were removed in Unit 013.

California Bighorn Herd Health (Biologist III Chris Hampson)
Unit 011 – Massacre Rim and Coleman Rim Herds
One of the two remaining collared ewes from the bighorn releases on the Massacre Rim died during the winter of 2015-2016. The ewe was part of a small group (5 to 6 animals) of sheep that had moved west across the flat to the Southwestern corner of the Vya Rim during December of 2014. The sheep were believed to have been pushed to the west due to excessive lion pressure on the Massacre Rim. The sheep moved west to the SE corner of the Vya Rim during the same period of time when 5 collared bighorn were killed by lions.

The collared ewe is thought to have died during the harsh winter of 2015-2016 that produced up to 5 feet of snow along the Vya Rim. The small group of sheep had lived in this area since December 2014. Biologists were forced to use snowshoes to access the mid-elevation rocky escarpment where the bighorn ewe died. The telemetry collar was removed from the carcass and several samples (lung, liver, and head) were also taken for lab analysis and examination by the NDOW Veterinarian. It appeared that the ewe died of exposure due to the heavy snowfall and cold temperatures. The ewe carcass was found in an exposed area just outside and a few feet away from a large juniper tree. The other sheep in the immediate area appeared to be healthy and bolted quickly away from biologists when approached.

The remaining collared ewe from the Massacre Rim remains alive on the southern end of the Massacre Rim near Big Point. This group of sheep has consistently remained on the southern end of the Rim, but on occasion (once every couple of months) the sheep have moved as much as 6 miles to the north along the top of the Massacre Rim. However, the bulk of the telemetry data shows that the sheep spend a majority of their time near the release site at Big Point on the southern portion of the Rim.

A recent observation from late July 2016, observed 20 bighorn near the big game guzzler on the south end of the Coleman Rim. All sheep looked healthy and appeared to be in good condition. One ewe had a colored ear tag from a recent release in the area.

Unit 013 – Hays Canyon Range
One of the five collared sheep from the Hays Canyon bighorn population died during the winter of 2015-2016. Biologists investigated the kill site with Wildlife Services personnel and determined that the young ram was chased down and killed by what appeared to be a pack of 3 to 4 coyotes. The ram was killed at the release site in Hays Canyon. The area of the kill site had 2 to 3 inches of snow which helped biologists understand what occurred and how the animal was

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killed. Skeletal remains were all that was left of the scavenged carcass even though biologists were on the scene within one to two days following the kill. Biologists brought the head of the ram to the NDOW veterinarian for sampling and examination.

Numerous reports and sightings of bighorn within Hays Canyon have been reported and observed by NDOW biologists and BLM personnel over the past year. All indications are that the small herd is healthy and doing well. Field investigations located an old lamb carcass to the north of Hays Canyon but no cause of death could be determined due to the length of time since the lamb had died. One old lion track was observed in the canyon but was believed to be more recent than the lamb kill. Information was passed on to Wildlife Services personnel.

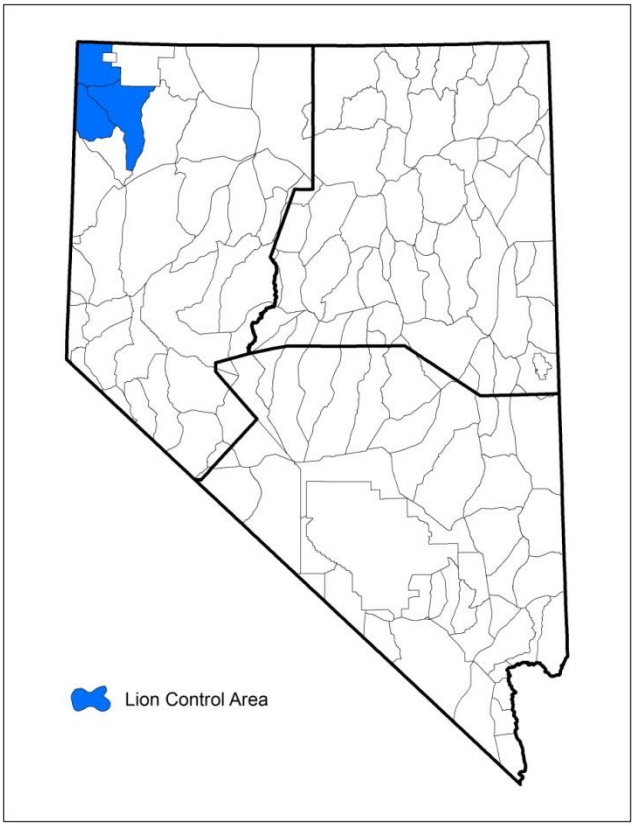
One 3 year-old collared bighorn ram was killed during the winter of 2015-2016. The ram was killed by a pack of coyotes on the north side of Hays Canyon. Tracks in the fresh snow provided good information to the biologist investigating the kill. The three other collared bighorn sheep are alive and well within the Hays Canyon Range. Telemetry data indicates that the Hays Canyon sheep have established themselves within the excellent sheep habitat between Hays Canyon and Little Hat Mountain.

In 2016-2017, Nevada Department of Wildlife biologists and staff are planning on increasing the number of bighorn that are collared within hunt Units 011 and 013. A capture is planned for the fall/winter of 2016-2017 to attach 10 more telemetry collars to bighorn that live within the 22-01 project area. This will enable biologists and staff to increase the amount of monitoring data collected for this project and will allow Wildlife Services to be better able to respond to any lion predation issues.

NDOW continues to monitor the sheep populations along the Massacre Rim and in Hays Canyon from both the air and the ground. The increased number of telemetry collars planned for this coming year will help NDOW to monitor the health and well-being of the sheep populations within project 22-01over the next few years.

NDOW continues to monitor the bighorn sheep populations along the Massacre Rim and in Hays Canyon. The most recent aerial survey located 34 bighorn sheep within the control areas of the Hays Canyon Range, Massacre Rim and Coleman Rim. Additional bighorn sheep have been observed from the ground. NDOW currently has 6 satellite telemetry collars functioning within the project area. Two are from the recent release on Massacre Rim and four are on bighorn sheep within the Hays Canyon Range. The telemetry collars help monitor the health and well-being of the bighorn sheep populations within subproject 22-01.

$3 Planned Expenditures	**P-R Planned Expenditures**	**Wildlife Services Expenditures**	**NDOW Lethal Expenditures**	**NDOW Non-Lethal Expenditures**	**NDOW Salary, Travel, and Office**	**Total**
$45,000	N/A	$54,094	$0	$0	$10,091	**$64,185**



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Subproject 22-074 Mountain Lion Removal and Diet Analysis for the Protection of Rocky Mountain Bighorn Sheep

Area 074 Rocky Mountain bighorn sheep herd experienced a die-off in 1999. Two years following the die-off, the lamb recruitment was low, remaining consistent with typical bighorn sheep die-offs. Since then the average lamb recruitment has been 48 lambs:100 ewes. This level of recruitment should have resulted in an increasing bighorn sheep herd; however the expected population rebound has not occurred.

The Contact Area is a major deer winter range. It is possible that mountain lions following the deer herd from summer range in the Jarbidge Mountains to winter range switch their diet to bighorn sheep when deer return to their summer range. Some mountain lions may be staying in the area on a year-round basis with their primary food source being Rocky Mountain bighorn sheep.

A contract was formed with Currant Creek Outfitters to conduct mountain lion removal in 074. Work ranged from March 23, 2016 until May 24, 2016. No mountain lions were removed. Current Creek Outfitters submitted an "Annual Predator Management Project Reporting Form", it can be found in the appendix of this document.

USDA Wildlife Services was scheduled to also begin work removing mountain lions in 074. Upon learning of the presence of a private contractor, USDA WS informed NDOW that due to a directive they could not also work the area while a private contractor was present.

Diet Analysis

USDA Wildlife Services collected tissue, blood, fur, and whiskers from each mountain lion removed in the field during FY2015. Blood was spun in a centrifuge to separate out serum. Samples were frozen and transported to the Nevada Stable Isotopes Lab at the University of Nevada, Reno. All samples were processed and are presented below. A change to the scope of this project precluded the collection of prey samples. No inference can be made on mountain lion diet without concurrent analysis of prey.

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Table of carbon and nitrogen weights of mountain lion tissue, whisker, fur, blood, and serum samples.

Sample	**d^{15}N (‰ vs. air)**	**wt.% N**	**d^{13}C (‰ vs. VPDB)**	**wt.% C**
Lion1 fur	9.3	15.3	-21.9	45.6
Lion2 fur	9.3	15.4	-21.4	45.2
Lion3 fur	8.0	15.4	-21.9	45.5
Lion1 whisker	9.3	16.4	-21.6	47.4
Lion2 whisker	9.2	16.0	-21.4	47.0
Lion3 whisker	7.8	16.3	-21.6	47.9
Lion1 blood	8.4	15.3	-23.0	51.4
Lion2 blood	8.5	16.0	-22.7	52.5
Lion3 blood	8.3	15.4	-22.5	52.1
Lion1 muscle	9.6	15.1	-23.4	49.4
Lion2 muscle	8.7	15.4	-22.7	49.8
Lion3 muscle	8.7	15.1	-22.9	49.9
Lion1 serum	9.6	12.7	-22.8	47.4
Lion2 serum	9.2	12.7	-22.4	43.4
Lion3 serum	10.1	13.5	-22.4	49.0

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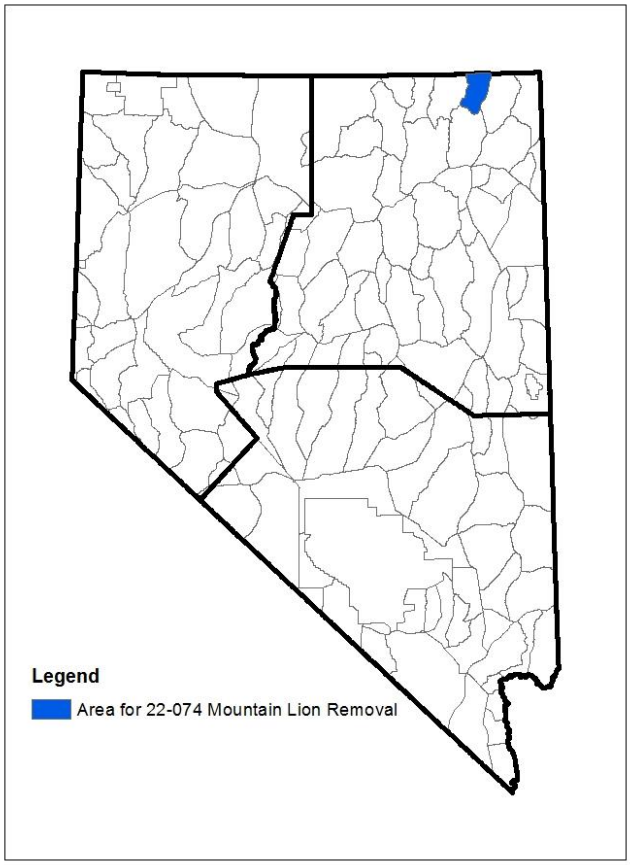
Bighorn Sheep Herd Health (Biologist III Kari Huebner)

The population is estimated to be less than 15 animals. Herd surveys will be conducted in October 2016. One ram and four ewes are currently collared and still alive. In addition to the five collared bighorn there are four unmarked ewes and five unmarked rams. As of August 2016, there was only one observed lamb. Recruitment still remains an issue. A minimum of two lambs were born in the spring of 2016 but did not survive past weaning.

$3 Planned Expenditures	P-R Planned Expenditures	Wildlife Services Expenditures	NDOW Lethal Expenditures	NDOW Non-Lethal Expenditures	NDOW Salary, Travel, and Office	Total
$45,000	N/A	$4,240	$25,000	$575	$10,091	**$39,907**



Subproject 22-16 Coyote Den Density Effects on Mule Deer Fawns and Other Wildlife Species

Subproject 22-16 was an attempt to understand the complexity in managing wildlife species in a recovering sagebrush ecosystem in central Nevada. Because of coyote denning work conducted by a private wildlife removal specialist in Area 14, it was decided the Diamond Mountains were not the ideal location for an experiment. The area was changed to Area 16.

To determine the occupancy of coyote dens, coyotes, predators, and other wildlife species in the Monitor Mountains, 120 trail cameras were purchased. A grid was created in ArcMap, identifying 113 locations for camera placement within the Monitor Mountains. Technicians deployed trail cameras in January, and were able to deploy 37 until project 22-16 was terminated. All field work was immediately suspended to minimize cost.

$3 Planned Expenditures	**P-R Planned Expenditures**	**Wildlife Services Expenditures**	**NDOW Lethal Expenditures**	**NDOW Non-Lethal Expenditures**	**NDOW Salary, Travel, and Office**	**Total**
$40,000	$120,000	$0	$0	$68,844	$10,091	**$78,935**

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Project 32 Mountain Lion, Black Bear and Mule Deer Interactions

Report by Dr. Jon Beckmann
Project Title: "Re-colonization of Large Carnivores and Resulting Species Interactions: Effects on Predation Behavior and Implications for Prey"

PIs: Dr. Jon Beckmann, Dr. Alyson Andreasen, Carl Lackey, Cody Schroeder, and Pat Jackson

Introduction

As with many areas in western North America, changes in species composition and predator-prey interactions occurred throughout the Great Basin upon arrival of settlers. In the Great Basin of Nevada, shifts in vegetation structure and composition occurred, with an expansion of browse at the expense of graze-land, largely thought to be due to grazing of vast numbers of livestock (Gruell and Swanson 2012). While these post-settlement disturbances had a drastic negative effect on bighorn sheep (*Ovis canadensis*) and pronghorn (*Antilocapra americana*) populations, mule deer (*Odocoileus hemionus*) responded favorably to the expanding browse and populations increased, presumably followed by increased numbers of mountain lions in the Great Basin (Berger and Wehausen 1991; Gruell and Swanson 2012; Woolstenhulme 2005). During the same time, black bears (*Ursus americanus)* and grizzly bears (*Ursus arctos*) were extirpated in the Great Basin of Nevada through targeted removals due to conflicts with humans, their livestock, and changes in land use patterns over the past century (Lackey et al. 2013). However, black bears have begun to re-colonize historic ranges in the Great Basin (Lackey et al. 2013). An on-going, long-term study on black bears in Nevada conducted by Jon Beckmann of WCS in partnership with Carl Lackey of NDOW demonstrated the success of black bear re-colonization in Great Basin ranges. Mountain lions (*Puma concolor*) have been the apex predator in the Great Basin for the past 80 or more years in the absence of bears and their primary prey, mule deer, now an important game species in Nevada, are in decline across the West (Robinson et al. 2002). Our data from an on-going, multi-year study on mountain lions in the western Great Basin and eastern Sierra Nevada range indicate that mountain lions and bears have frequent interactions at mountain lion kill sites where black bears take over and scavenge prey carcasses from mountain lions (Fig. 1). We anticipate that under certain conditions these competitive interactions between black bears and mountain lions may have non-negligible effects on mountain lion predation behavior potentially resulting in increased human-mountain lion conflicts and impacts on mule deer populations, while simultaneously facilitating recolonization of black bears into historic ranges.

The Great Basin of Nevada, where we recently documented the recolonization of black bears into historic ranges (Beckmann and Lackey 2008; Lackey et al. 2013), is comprised of over 80 percent public land, with multiple land uses including grazing allotments, hunting, trapping, and outdoor recreation, and thus provides an ideal study system to test predictions pertaining to carnivore re-colonization, conflict, and impact on prey populations in working landscapes.

This research is 1) identifying factors important in the restoration/natural re-colonization of black bears into historic ranges and important habitat for black bears and mountain lions across Nevada will be identified. In addition, this research 2) addresses problems of wildlife management and habitat to administer wildlife resources more efficiently, including understanding potential for

and predicting increased human-carnivore conflicts across the landscape thus being better able to mitigate for these potential conflicts associated with expanding black bear populations into historic Great Basin habitat. This research is allowing us to 3) obtain data that can be used by the Nevada Department of Wildlife to guide and direct regulation of hunting. For example, understanding how interactions between mountain lions and black bears affect population dynamics of each other or mule deer is important for sustainable use (i.e., sport harvest) for all three of these big game species in Nevada. For instance, scavenging by bears may affect reproductive output, survival, and recruitment of mountain lions and is important to understand since these populations will likely be different (i.e., lower) than models based on prey availability or harvest statistics alone would predict, particularly in fragmented habitat. Further, black bears that are re-colonizing historic ranges may substantially alter predator-prey dynamics (indirectly through competitive interactions with mountain lions), effectively acting as a second predator on mule deer populations; an important consideration because mule deer are in decline in several areas throughout Nevada and are an important big game species.

Progress Update

Captures and proximity collars

We have collared an additional five female mountain lions and one male lion with GPS PLUS Proximity collars; four lions in the Carson Range and two in the Pine Nut Range. Most additional mountain lion captures will occur during the coming winter. We also deployed GPS PLUS Proximity collars on 10 of 13 additional bears captured during June 2016. Of those 10 bears, their capture locations were split approximately evenly between the Carson Range and the Pine Nut Range. These 10 collared bears are in addition to six bears we collared in the second half of 2015. Of those six, three are in the Carson Range and three are in the Pine Nuts with all bears overlapping at least one of the collared lions' home range. During the past year, the GPS PLUS Proximity collars were successful in acquiring data on black bear-mountain lion interactions (see Fig. 2 as a 2016 example), linked successfully and functioned as planned when animals were within 200 meters generating these data important to addressing the questions in this project.

This project is providing a unique opportunity to combine the efforts of long-term studies being conducted on black bears and mountain lions in the western Great Basin of Nevada where black bears are naturally re-colonizing historic ranges.

Locating and analyzing kill sites by lions and interactions with bears

We are currently in the midst of the summer/fall field season where we are estimating mountain lion kill rates and prey selection across the study area by identifying GPS clusters made by collared mountain lions and investigating those clusters on the ground during months when bears are active. We are on pace to collect direct field data from >100 kill sites again in 2016, although the final number will be known at the end of the field season in Sept/Oct 2016. As a reference, during summer 2015 field crews from NDOW and WCS identified an additional 400 sites by mountain lions using GPS cluster analyses and collected direct field data from 156 kill sites. These data continue to be used to estimate kill rates, prey species and level of bear-lion interactions across varying levels of bear densities in the study area. These data are in addition to our already existing dataset consisting of kills made by 21 collared mountain lions in Nevada.

Creating Habitat Maps for bears using Resource Selection Function (RSF) Models
Using 20,000+ location data points from GPS collars that were attached to 7 male and 17 female black bears in backcountry regions of the Carson and Pinenut Mountain Ranges or at the urban-wildland interface, we modelled and mapped core habitat areas for both male and female black bears using Resource Selection Function (RSF) Models. Only adult animals were collared. GPS collars were set up to transmit location signals approximately every 4 hours and emit a mortality signal when an animal did not move for 48 hours.

We generated nine spatial data layers in a GIS (ESRI ArcMap 10.2.2) representing environmental features and the anthropogenic landscape in the study site. Although certain anthropogenic variables are often found in similar studies of wide-ranging large carnivores, such as distance to road and urban centers, we also used parameters that are specific to this landscape with biological support for their impact to large carnivore behavioral ecology, such as distance to recreation site, distance to trail, distance to railway, and human population density. We developed resource selection function (RSF) models for two levels of spatial analysis using coarse and fine scale landscape parameters (Fig. 3). The RSF analysis allowed us to estimate and map probability of habitat selection/use across the study site, allowing for predictions of habitat 'hotspots' for black bears as the population continues to expand and colonize new areas. Additionally, these models are scalable such that models/maps can be zoomed into specific areas of interest for assessing habitat selection probabilities. These models and resulting maps will also help in black bear management by NDOW now and in the future and our assessments of black bear and mountain lion interactions during this on-going project.

To-date this project is successfully moving forward in all aspects. This success is demonstrated by the number of successful collaring events of both bears and lions during the time period of this report and by the successful collection of data on mountain lion kill rates, prey selection, interaction rates with bears, etc. These data are critical to managing both bear and lion populations in the Great Basin and Sierra Nevada, especially given the changes in the bear population and distribution and the expanding human population in the region.

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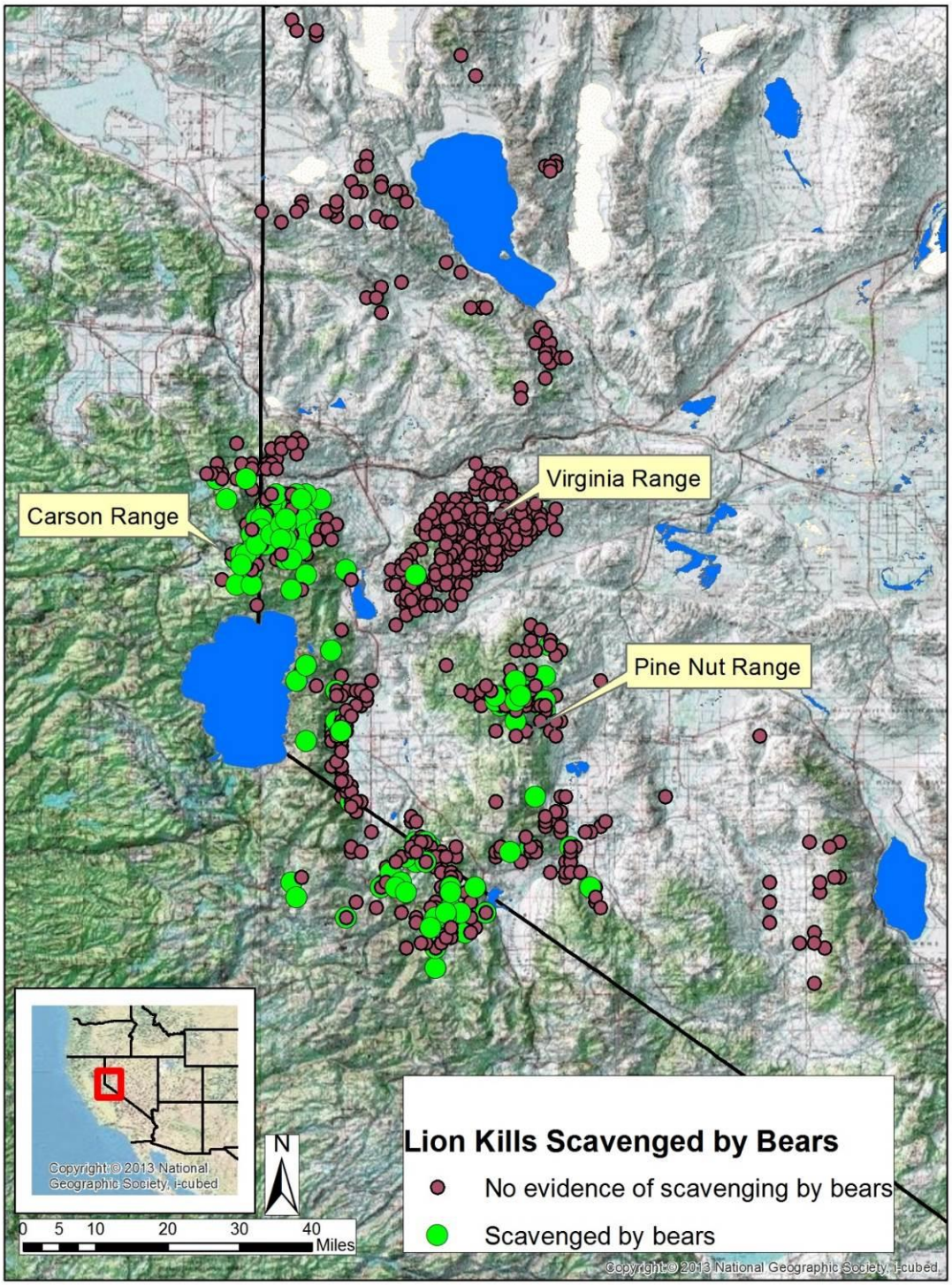

Figure 1. Example of mountain lion kills (n = 803), including kills where scavenging by black bears was recorded in the Carson Range (bears = high density), Pine Nut Range (bears = moderate density), and Virginia Range (bears = low density).

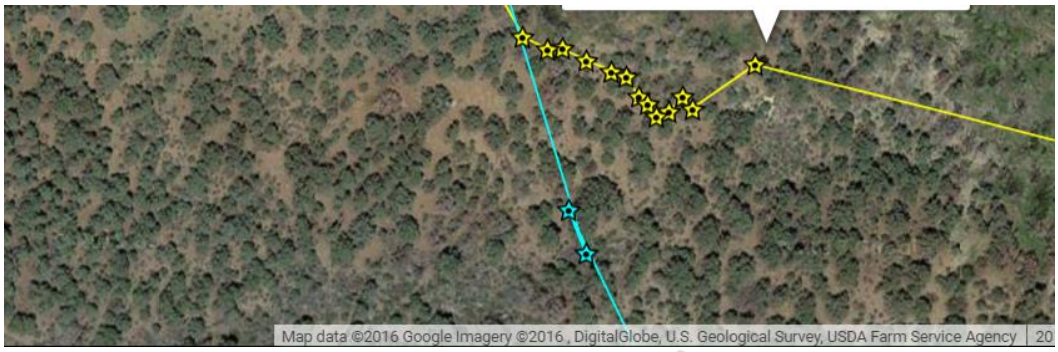

Figure 2. Example of a black bear (blue locations) and mountain lion (yellow locations) interaction in 2016 as revealed by data from GPS proximity collars. Captured black bears and mountain lions were fitted with Vectronic brand GPS PLUS collars with Proximity sensors to assess behavioral responses of each species upon close interaction. Collars were programmed to take 1 fix every 15 seconds when a collared bear and collared mountain lion are within 200 meters of each other.

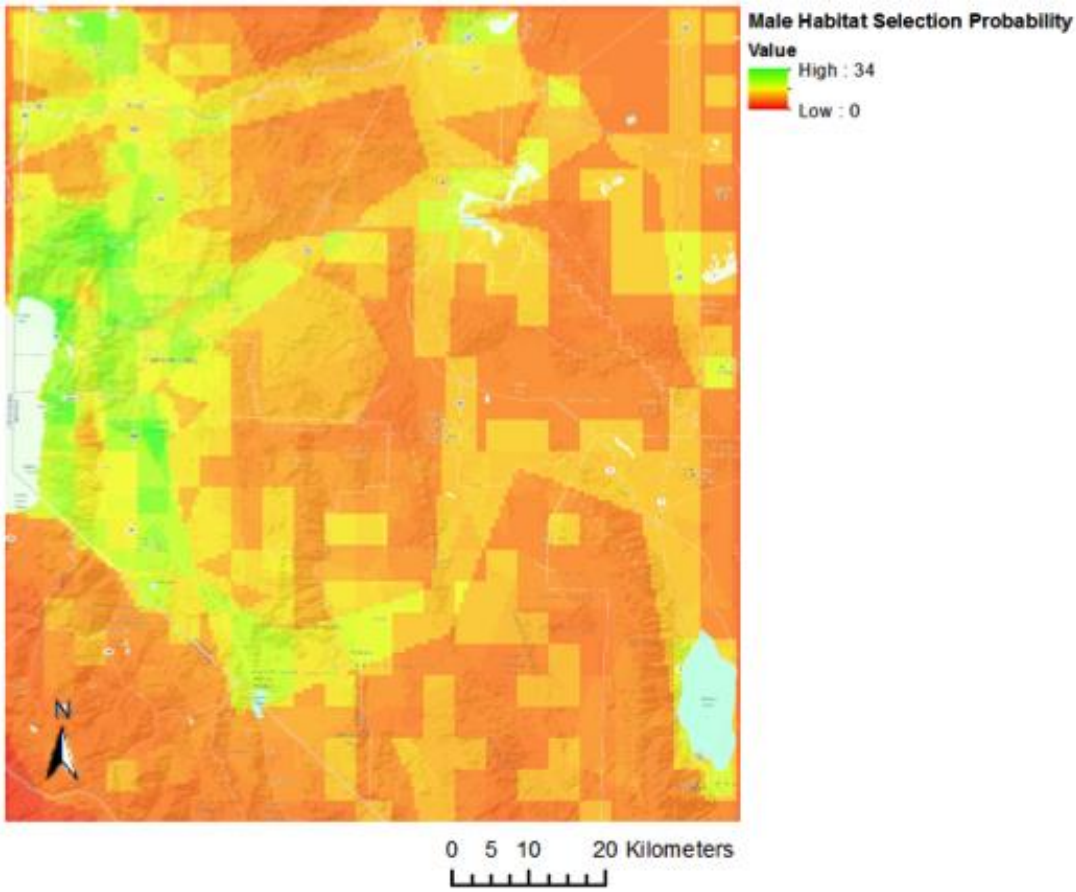

Figure 3. Model results of resource selection probability function (RSPF) displaying male black bear habitat selection in the western Great Basin (WGB) based on average habitat selection probability for all significant landscape variables.

Project 35 Using Genetic Testing To Identify Origin of Red Fox

Report by Benjamin N. Sacks

Objectives of the project are to determine (1) the distribution of native vs. nonnative red fox ancestry, (2) zones and extent of hybridization, and (3) geographic sources of nonnative ancestry.

In total, we collected 241 scats primarily at higher elevations of Great Basin mountain ranges and 52 tissue samples from trappers and road kills primarily at lower elevations during the reporting period. These samples were analyzed in conjunction with reference samples from neighboring states collected for related projects. Scats were collected predominantly from mid-to-high elevations areas of 7 Nevada mountain ranges—Ruby, East Humboldt, Snake, Toiyabe, Toquima, Schell Creek, and Monitor—only if they appeared to be from a canid and in the size range consistent with fox. Nevertheless, only a third of the samples were from red fox, whereas more than half were from coyotes (Table 1). The total number of scats collected in each of these mountain ranges served as a rough index of search effort. The proportion of these scats that were from red fox varied substantially among mountain ranges (Fig. 1). The Snake Range contained the highest relative abundance of red fox scats, followed by the Ruby and Toquima Ranges, whereas the Monitor Range only yielded a single red fox scat of 11 total. Most notably, out of 59 scats collected over a relatively broad spatial extent in the Toiyabe range, not a single red fox scat was recovered. Thus, the distribution of red foxes among the Great Basin ranges appears to be heterogeneous.

Using the red fox scat DNA sequences, and those from the tissue samples collected from trappers, we mapped the distribution of native and nonnative red fox mitochondrial haplotypes (Fig. 2). Haplotypes were strictly native from the Schell Creek Range, southern Snake Range, and the Monitor Range (a single sample), whereas both native and nonnative haplotypes occurred in the Ruby, Toquima, and Independence Ranges. The northern Snake Range had 3 foxes with nonnative haplotypes. The nonnative G haplotype was restricted to the northeastern-most portion of the state, whereas the nonnative O haplotype occurred furthest south. A single F or F5 haplotype was found in the Independence Range. This sample will need to be further resolved to determine if it was an F5, which has been previously found only in Utah, and would suggest origins from the east.

Table 1. List of species sampled based on sequences of 241 scats collected in northwestern Nevada, July 1, 2014–October 27, 2015.

Species	No. scats
Red fox	66
Coyote	108
Gray Fox	20
Kit Fox	2
Long Tailed Weasel	2
Bobcat	1
Yellow Bellied Marmot	1
No DNA Successfully Extracted	41
Total	241

To gain information on nuclear genetic ancestry and admixture, we genotyped red fox samples at 27 microsatellite loci. Preliminary analyses using these data indicate that the admixture patterns among multiple native and nonnative source populations are complex and cannot be clearly elucidated without additional samples and analyses. Nevertheless, some patterns were apparent based on an admixture analysis conducted in program Structure using reference data from known nonnative and presumptive native populations to assign the unknown genotypes from high elevation scat samples (Fig. 3).

Most notable, although admixture with nonnative red foxes appears to have significantly influenced the genetics of central Nevada red foxes at all elevations, those samples from high elevations of some of the northeastern Nevada red fox populations appear to potentially reflect relictual native populations. None of the Nevada red foxes assigned primarily as nonnative (yellow), although foxes from a litter sampled at low elevation in Garrison, UT, directly adjacent to the Snake Range, NV assigned as nonnative. Most red foxes sampled from the Snake Range clustered together as distinct from all but some in the Wasatch Range of UT (purple). Foxes from the northern portion of the East Humboldt Range and from Schell Creek Range assigned with Idaho Rocky Mountain foxes (blue). High elevation fox scats from the southern end of the Ruby Mountains, the Toquima Range, and a single sample from the Snake Range, along those trapped in the Independence Range and at the base of the Ruby/East Humboldt Ranges all composed a distinct genetic cluster (red). Consistent with the finding of nonnative mitochondrial haplotypes in north Snake and Toquima Ranges, some scats assigned to multiple clusters (i.e., suggesting admixture, white). Although tempting to attribute the red genetic cluster to a native Nevada Great Basin population, the notable abundance of nonnative mitochondrial haplotypes (Fig. 2) from the Independence Range and south and low-elevation Ruby Mountains suggest the alternative possibility that the red cluster reflects a native/nonnative hybrid swarm.

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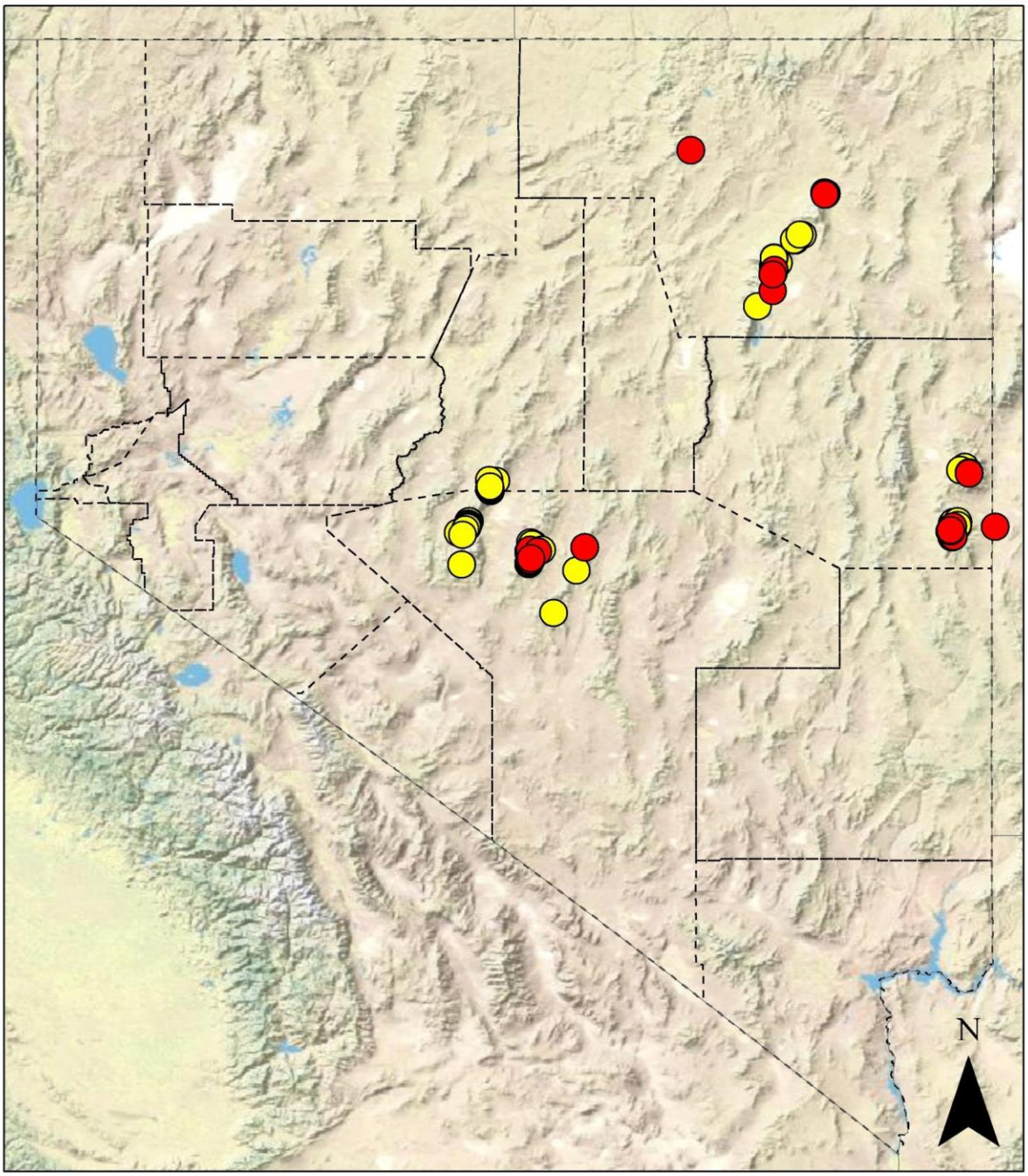

Figure 1. Distribution of 200 scats (of 241 collected) that were successfully sequenced and species-typed primarily among 5 Great Basin Mountain Ranges in Nevada, July 1, 2014–October 27, 2015, illustrating heterogeneous distribution of red foxes among mountain ranges.

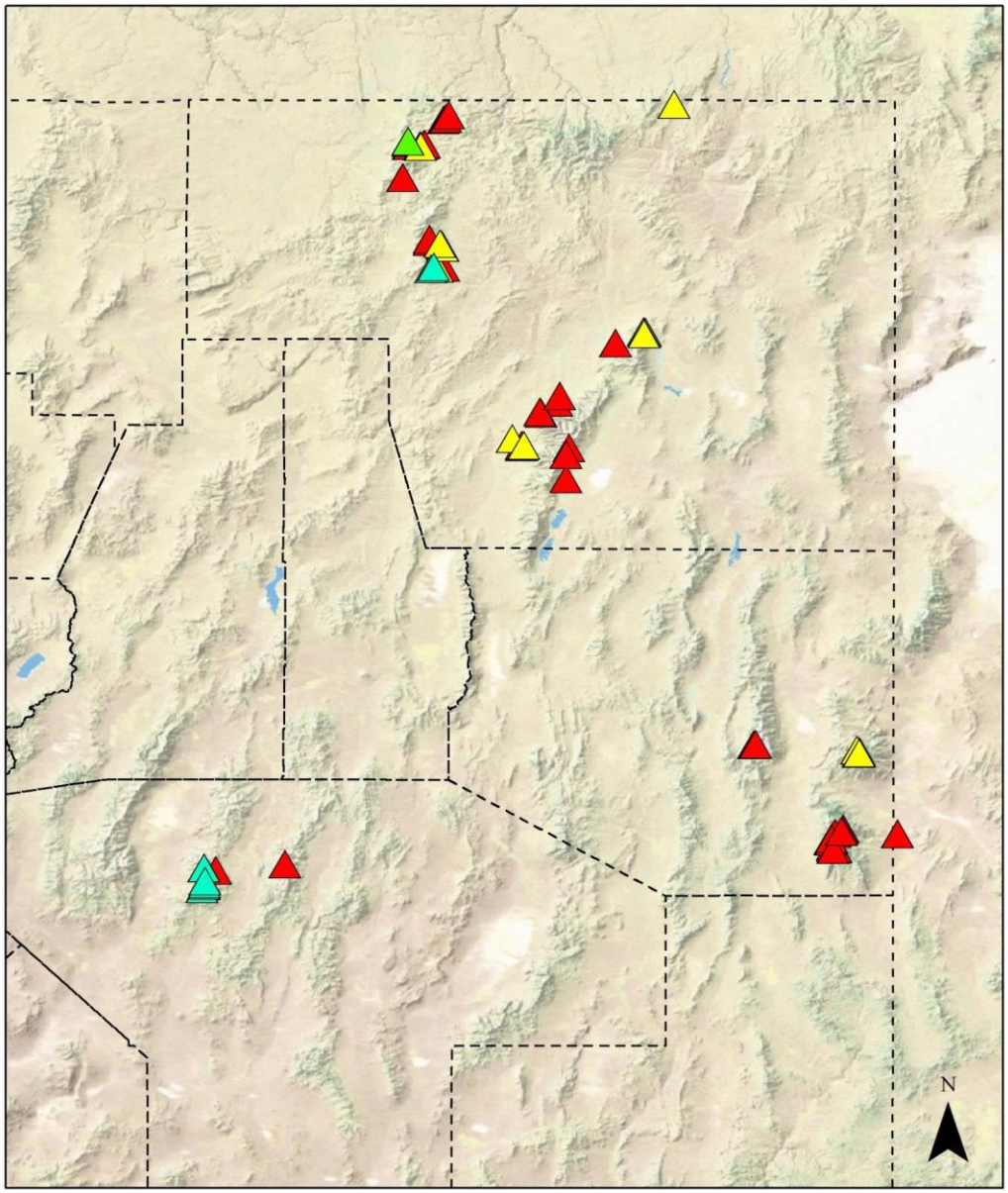

Figure 2. Distribution of native (red) and nonnative (yellow, blue, green) red fox mitochondrial DNA haplotypes in 97 scat and tissue samples collected primarily during July 1, 2013–October 27, 2015, from northeastern Nevada.

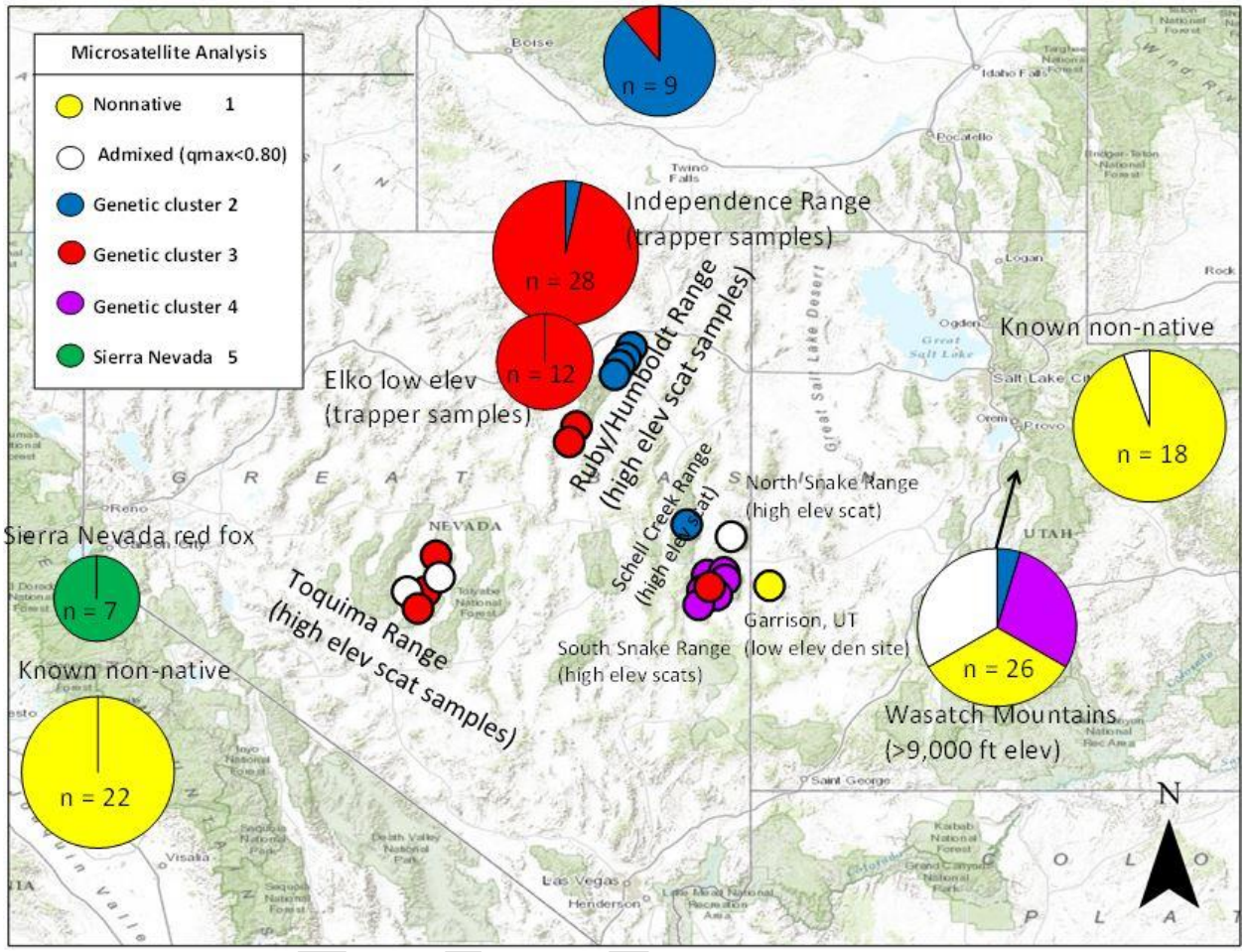

Figure 3. Distribution of red fox microsatellite genotypes colored according to genetic assignment in program Structure. Samples from high-elevation sites in Nevada (small circles) were treated as "unknowns" and assigned relative to 4 nonnative and potentially native reference samples (represented by pie charts) from Utah, California, Nevada (low elevation), and Idaho. Although reference samples were weighted by priors based on their sample population, posterior assignments of these samples in many cases differed from priors (e.g., Wasatch Mountains, which appeared highly affected by nonnative admixture).

$3 Planned Expenditures	P-R Planned Expenditures	Wildlife Services Expenditures	NDOW Lethal Expenditures	NDOW Non-Lethal Expenditures	NDOW Salary, Travel, and Office	Total
$2,500	$7,500	$0	$0	$9,750	$0	**$9,750**

Project 37 Big Game Protection-Mountain Lions

In some circumstances, culling of top predators is beneficial for protection of newly translocated big-game populations, small and isolated big-game populations, or big-game populations held below carrying capacity by predation (Hayes et al. 2003, Rominger et al. 2004, McKinney et al. 2006). The geographic range of mountain lions is larger than any big-game mammal in North and South America (Logan and Sweanor 2000), and specific areas may benefit from removal efforts that may target more than a single mountain lion.

A contract was formed with Canyon's West Guide Service to conduct mountain lion removal in the Snowstorm Mountains. Removal was conducted from March 30, 2016 until June 30, 2016. Two mountain lions were removed. Canyon's West Guide Service submitted an "Annual Predator Management Project Reporting Form", which can be found in the appendix of this document.

An underperforming population of bighorn sheep currently exists in Unit 115. In response, USDA WS removed two mountain lions in Unit 115 for the protection of bighorn sheep.

Snowstorm Bighorn Sheep Herd Health (Biologist III Matt Jeffress)
A combination of fall and winter surveys in 2015 documented a total of 38 California bighorn occupying the Snowstorms; yielding ratios of 48 rams:100 ewes:4 lambs. The year 2015 marked the second year of recruitment with 10-yearling California bighorn observed in May 2015. A combination of marked animals well distributed throughout occupied range, weeklong spring and summer ground surveys and a December/January trap-and-collaring event has resulted in a reliable estimate of the current population at 40 adults. Habitat Range conditions remain fair in the peripheral low elevations surrounding the Snowstorms. Due to the resiliency of the mid to upper elevations of the Snowstorm Range, much of the year-round California bighorn habitat remains in good to excellent condition.

As part of a greater effort to understand the dynamics of post die-off survivors in bighorn populations and how pathogens within surviving populations affect lamb recruitment, Washington State University, Idaho Fish and Game and South Dakota State University embarked on a study entitled "Investigating the Role of Super-Shedders in Respiratory Disease Persistence and Transmission in Bighorn Sheep." As part of the study, in late 2014 the Nevada Department of Wildlife gifted 11 California bighorn to South Dakota State University. The project has evolved into a field experiment looking at the effects of removing super-shedder ewes from the Snowstorm herd. In late 2015 and early 2016 the 25 remaining ewes on the Snowstorms were caught and sampled with all remaining unmarked ewes being collared using a combination of conventional vhf and satellite collars. The marked animals will allow the Nevada Department of Wildlife (NDOW) to continue monitoring Snowstorm California bighorn sheep in order to assess future performance as it relates to the removal of potential super-shedders and the amount of time elapsed since the initial die-off. Ten of the 25 sampled ewes were confirmed to be shedding *Mycoplasma ovipneumoniae* (*hereafter*, M. ovi) during the last round of sampling. These 10 ewes will be resampled in late 2016 and any ewe that is found to be shedding M. ovi during 2 consecutive sampling efforts will be removed from the population and donated to a research facility. Recruitment values will be collected for the next 5 years and these data, coupled with

pathogen samples collected in 2011, 2012 and 2014, will guide future management of the Snowstorm herd.

Due to the lack of recruitment between 2011 and 2014 this herd has continued to decline since the initial die-off in 2011. This herd declined from 160 in early 2011 to approximately 65 by 2012. It has further declined to approximately 40 animals in 2016. We acknowledge limited bighorn mortalities attributed to mountain lions have always occurred in the Snowstorms but never affected the herd sustainability. As part of the experiment, NDOW and NGO's have dedicated a great deal of time and funding to capturing and collaring animals, pathogen testing, and tracking interactions among subherds to identify "supper shedders". In early 2016 we detected a few of our collared animals killed by mountain lions. As part of the experiment, we are attempting to protect bighorn in which M. ovi is not detected and to cull those that are identified as "super shedders". Unfortunately, lion predation is occurring on animals that have cleared the pathogen analysis. Those predation events impact our research results and compromise the ability for the bighorn herd to recover if we are successful in identifying and removing the "super shedders".

Biologists have not documented mortalities of adult bighorn since the removal of 2 lions by contract hunter Dave Gowan this spring. Tracks of a single lion were observed in Kelly Creek in late May and it is believed this lion was not removed as part of the lion removal project. NDOW estimates a minimum of one lion remain on the Snowstorm Range. NDOW is hopeful continued lethal removal of lions through a combination of contract and sport harvest will greatly reduce or eliminate lion predation of bighorn in the Snowstorm Mountains for the duration of the "super shedder" study.

$3 Planned Expenditures	**P-R Planned Expenditures**	**Wildlife Services Expenditures**	**NDOW Lethal Expenditures**	**NDOW Non-Lethal Expenditures**	**NDOW Salary, Travel, and Office**	**Total**
$90,000	N/A	$8,570	$18,100	$0	$10,091	**$36,761**

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Project 38 Big Game Protection-Coyotes

Coyotes face an increase in caloric need when raising pups, both through an increase in parent energetic output and feeding growing pups. Parent coyotes have been found to be exclusively responsible for domestic sheep predation. Removing coyote pups from dens or preventing parents from breeding has been demonstrated to reduce predation on domestic livestock (Till and Knowlton 1983, Sacks et al. 1999, Seidler et al. 2014). Parent coyotes and their pups may consume a drastically different diet than their non-parent counterparts at the same time of year; this difference in diet likely requires larger prey, including mule deer fawns. Removing coyotes may increase mule deer fawn and other wildlife species reproductive output.

Upon approval of project 38, Area game biologists with pronghorn management responsibilities were asked whether or not their pronghorn herds may be underperforming due to coyote predation. Areas where predation by coyotes could be a factor limiting pronghorn populations received removal efforts from USDA Wildlife Services. From January through June USDA Wildlife Services conducted coyote removal, primarily with a fixed with helicopter for the benefit of pronghorn. A total of 417 coyotes were removed.

Area	Coyotes Removed
GMA 1	36
GMA 7	71
GMA 10	90
GMA 11	3
GMA 63	63
GMA 22	44
GMA 23	110
Total	417

$3 Planned Expenditures	**P-R Planned Expenditures**	**Wildlife Services Expenditures**	**NDOW Lethal Expenditures**	**NDOW Non-Lethal Expenditures**	**NDOW Salary, Travel, and Office**	**Total**
$90,000	N/A	$97,794	$0	$0	$10,091	**$107,885**

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Project 39 Predator Education

Due to the Assembly Bill 78, use of the $3 predator fee for predator education was no longer permitted. No funds were spent on this project.

$3 Planned Expenditures	P-R Planned Expenditures	Wildlife Services Expenditures	NDOW Lethal Expenditures	NDOW Non-Lethal Expenditures	NDOW Salary, Travel, and Office	Total
$1,500	$4,500	$0	$0	$0	$0	**$0**

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Project 40 Coyote Removal to Complement Multi-faceted Management in Eureka County

Mule deer populations in Diamond Mountains in Eureka County are believed to be underperforming due to competition with feral equids, pinyon-juniper expansion, and predation. To alleviate pressure on resources, the BLM conducted a feral horse round-up in the Diamond Mountains in January 2013, removing 792 horses. Eureka County and the Eureka County Advisory Board to Manage Wildlife directed the removal of pinyon and juniper trees on private range lands in the Diamonds and Roberts Mountains in 2008, 2009, and 2011. Wildlife Services removed coyotes in the area in 2011 and 2012. A private contractor removed coyotes in 2014. On-going removal of coyotes may assist mule deer population recovery.

From January until June USDA WS conducted aerial gunning of coyotes in the Diamond Mountains, removing a total of 515 coyotes.

114 Deer Herd Health (Biologist III Mike Podborny)

The spring fawn to adult doe ratio, recruitment, was very low in the springs of 2005, 2008 and 2009 and range from 18, 19, and 21 fawns per100 adults, respectively. These are the three lowest recruitment rates since helicopter surveys began in 1977 and indicate a declining population. Drought conditions existed during this time but the population did not rebound as exhibited by adjacent populations in the years following drought. The spring fawn ratios improved from 2010 to 2012 with a slight decline in 2013. Recruitment rates increased again in 2014 to 38 fawns:100 adults and 44 fawns:100 adults in 2015 both indicating growth in the population. The 2016 ratio of 37 fawns:100 adults followed a severe winter and was above all surrounding deer populations. Based on spring recruitment rates, the Unit 114 deer population has been improving since 2009.

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Overall Budget

Project	$3 Planned Expenditures	P-R Planned Expenditures	Wildlife Services Expenditures	NDOW Lethal Expenditures	NDOW Non-Lethal Expenditures	NDOW Salary, Travel, and Office	Total
Project 21	$78,000	N/A	$51,815	$0	$44,304	$10,091	**$106,211**
Project 21-02	$50,000	N/A	$20,895	$0	$24,211	$10,091	**$55,197**
Project 22	$0	N/A	$8,264	$0	$0	$10,091	**$18,355**
Project 22-01	$45,000	N/A	$54,094	$0	$0	$10,091	**$64,185**
Project 22-16	$40,000	$120,000	$0	$0	$68,844	$10,091	**$78,935**
Project 22-074	$45,000	N/A	$4,240	$25,000	$575	$10,091	**$39,907**
Project 32	$40,000	$120,000	$0	$0	$90,806	$10,091	**$100,897**
Project 35	$2,500	$7,500	$0	$0	$9,750	$0	**$9,750**
Project 37	$90,000	N/A	$8,570	$18,100	$0	$10,091	**$36,761**
Project 38	$90,000	N/A	$97,794	$0	$0	$10,091	**$107,885**
Project 39	$1,500	$4,500	$0	$0	$0	$0	**$0**
Project 40	$60,000	N/A	$36,402	$0	$0	$10,091	**$46,494**
USU Contract Obligations[b]	$0	$0	$0	$0	$10,948	$0	**$10,948**
Total[c]	**$556,000**	**$252,000**	**$296,075**	**$43,100**	**$249,437**	**$100,914**	**$675,525**

[a]This transfer of $3 predator fees for administrative support to the Department of Agriculture partially funds state personnel that conduct work for the benefit of wildlife at the direction of USDA WS (e.g., mountain lion removal to benefit wildlife).
[b]Amount covers final bill payed to Utah State University for project 25.
[c]Nevada Department of Wildlife spent $312,175 on lethal predator removal during FY2016. This accounted for 54.7% of FY2014 revenues.

Expected Revenues and Beginning Balance of Predator Fee

	FY 2014 Audited[a]	FY 2015 Actual	FY 2016 Actual	FY 2017 Projected
Beginning balance	$377, 674	$380,038	$544,631	$591,382
Revenues	$570,368	$574,312	$595,107	$574,312
Plan Budget	$526,360	$338,000	$556,000	$839,500
Expenditures	$568,004	$409,719	$548,356	--
Ending balance	$380,038	$544,631	$591,382	$326,194

[a]All actual and audited amounts are from the State Accounting System. Estimated revenues are projections based on recent receipts and budget expenditures are derived from the Predator Management Plan

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