Nevada Department of Wildlife

Predation Management Status Report

FY2015

October 27, 2015

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EXECUTIVE SUMMARY ii
PROJECT 21 1
Greater Sage-grouse Projection (Statewide) 1
PROJECT 21 3
Subproject 21-02 3
Virginia Mountains Sage-grouse Nests (Area 2) 3
PROJECT 22 6
Mule Deer-Game Enhancement 6
Subproject 22-01 6
Massacre Rim/Hays Canyon/Coleman Canyon: California Bighorn Sheep Protection 6
Subproject 22-074 9
Protection of Rocky Mountain Bighorn Sheep in Badlands-Contact Area 9
Subproject 22-014 11
Diamond Roberts Mule Deer Fawns 11
Subproject 22-205/207 11
Gabbs Valley Range Desert Bighorn Sheep Release Protection: Mineral County Units 11
PROJECT 25 11
Coyote Ecology Analysis 11
PROJECT 29 13
Roadway Carrion Management to Enhance Sage-grouse Populations 13
PROJECT 30 13
Landfill Waste Stream Management to Enhance Sage-grouse Populations 13
PROJECT 32 14
Cougar Black Bear and Mule Deer Interaction 14
PROJECT 33 32
Greater Sage-grouse Nesting Habitat Restoration 32
PROJECT 35 33
Using Genetic Testing To Identify Origin of Red Fox 33
Appendix A-1 1

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EXECUTIVE SUMMARY

The goal of the Nevada Department of Wildlife's (NDOW) Predation 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 every big game tag application. Changes to this statute in the 78th (2015) Session of the Nevada Legislature will apply to FY2016 Predator Plan. The fee is deposited into the Wildlife Fund account and used:

1. To manage and control predatory wildlife.
2. To pay for management activities relating to the protection of non-predatory game animals and sensitive wildlife species and related wildlife habitat.
3. To conduct research as needed to determine successful techniques for managing and controlling predatory wildlife, including studies necessary to ensure effective programs for the management and control of predatory wildlife.
4. To fund education of the general public concerning the management and control of predatory wildlife.

Additional provisions of the statute authorize the expenditure of money collected from the $3 fee to enable the U.S. Department of Agriculture and other Contractors and Grantees to develop and carry out programs described above and to develop and conduct predation management activities under the guidance of the Wildlife Commission. There is also a provision that money collected from the $3 fee remain in the Wildlife Fund Account and not revert to the General Fund at the end of any fiscal year.

In FY2015, 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), mule deer fawn and bighorn sheep protection and recommendations for continuing redesigned work for FY2016 (Project 22).

This report summarizes a portion of the data collected on Project 25, an extended abstract presented at an international conference and work regarding carrion and landfill manipulation (Projects 29 and 30). A report written by Wildlife Conservation Society on cougar, mule deer, and black bear is included (Project 32). There was no further work conducted on greater sage-grouse nesting habitat (Project 33). A report on red fox genetics by UC Davis is included (Project 35).

The authorized budget for FY2014 was $447,000 from the Predation Management Fee Program. The expenditures were $350,287, with $53,197 (15%) of expenditures coming from Federal Aid in Wildlife Restoration funds.

Contributors to this status report include Alyson Andreasen, Chris Hampson, Kari Huebner, Carl Lackey, Cody Schroeder, Shawn Espinosa, Pat Jackson, John Beckman, Benjamin Sacks, and Brian Wakeling. Editorial comments were received from USDA Wildlife Services.

PROJECT 21
Greater Sage-grouse Projection (Statewide)

Raven control efforts to conserve greater sage-grouse commenced in early March and extended throughout May 2015. 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 (Project 21-02).

Through the efforts of USDA WS personnel, an estimated 2,380 ravens were removed during spring 2015. The total number of ravens taken for both this project and the Virginia Mountains project previously mentioned was 2,500, which is the maximum that NDOW can remove under the current depredation permit (#MB37116A-0). Ravens were removed in 6 counties during the spring of 2015 (Table 1).

Table 1. Raven take by Game Management Area (GMA) and county during FY2015.

Area	County	Ravens Removed
GMA 6	Elko	45
GMA 7	Elko	457
GMA 8	Elko	32
GMA 10	Elko	40
GMA 10	White Pine	142
GMA 11	White Pine	113
GMA 14	Eureka	89
GMA 15	Lander	319
GMA 22	White Pine	90
GMA 22	Lincoln	249
GMA 23	Lincoln	804
Total Ravens		**2380**

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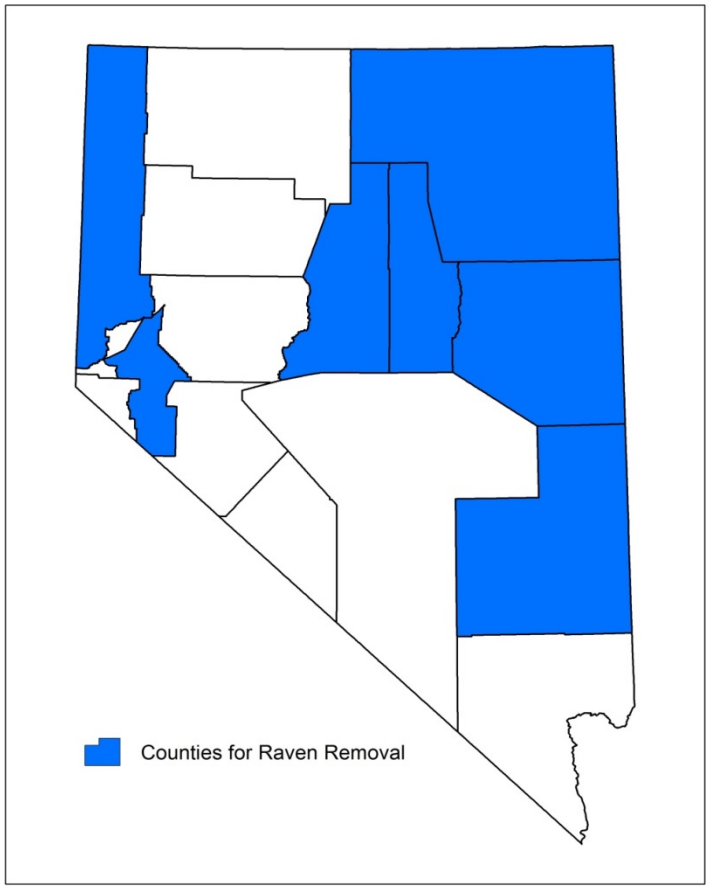
USDA WS personnel visited five potential locations (one each in GMA 6, 7, 10, and two in 14) and found no ravens present. This is likely due to previous years lethal removal. Additionally, two coyotes were removed in Units 221 and 222 through opportunistic ground shooting.

$3 predator fee allocated	$3 predator fee expended
$10,000	$45,041.13



PROJECT 21
Subproject 21-02
Virginia Mountains Sage-grouse Nests (Area 2)

Work was initiated during March and extended throughout May 2015 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 Wildlife Services deployed about 5,100 corvicide treated eggs within previously identified greater sage-grouse nesting habitats located around Sheep Springs, Spanish Flat, and lower Cottonwood Creek. An estimated 120 ravens were removed during the spring months.

Greater sage-grouse monitoring work is being conducted by the USGS Western Ecological Research Center. Six 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 April through July 2015.

Telemetry Monitoring
USGS field crews trapped and deployed 25 VHF radio transmitters on female greater sage-grouse during spring 2015 near Spanish Flat. Field crews obtained 236 telemetry locations from 42 VHF marked greater sage-grouse during March–July 2015. 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 23 nests, of which 13 failed and 10 were successful. Seven nests were within seven km of Spanish Flat, two were located in the north end of the Dogskin Mountains, and the remaining 14 were within five km of Sheep Springs. Possibly due to dry and warm spring conditions, we documented earlier nest initiation dates than in previous years. The first nest was observed on 28 March, and the final successful nest hatched on 7 May. Of the 13 failed nests, five were abandoned and eight were depredated. Of the eight nests classified as depredations, five nests showed sign of coyote or badger presence, and two nests appeared to be raven depredations. One nest was depredated by an unknown predator.

Nest Videography
USGS research crews set up video monitoring equipment on 10 nests to record predation and nesting recess activity. Of these, eight nests hatched, one was depredated by a coyote, and one nest was abandoned. Six nest depredations occurred prior to camera installation.

Brood Monitoring
For each successful nest, USGS field crews collected a series of locations to track movement and space use of the hen and her brood. Crews obtained a daytime and nighttime location within a 24-hour period every 10 days and continued to track broods for 50 days post-hatch. Of the 10 successful nests, one hen was unmarked and the brood could not be monitored after the nest hatched. Crews located an additional three brood-rearing females that were not located while on nest. Brood fates for the 12 monitored broods are as follows: one female lost her brood within

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the first ten days of monitoring; one female lost her brood between days 10 and 20; four females lost their broods between days 30 and 40; five females successfully raised their brood of chicks to at least 50 days (classified as successful). We were unable to determine the fate for one brood due to accessibility issues.

Habitat

USGS field crews completed 134 microhabitat surveys (72 at nest sites and 62 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 night location, 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 324 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.

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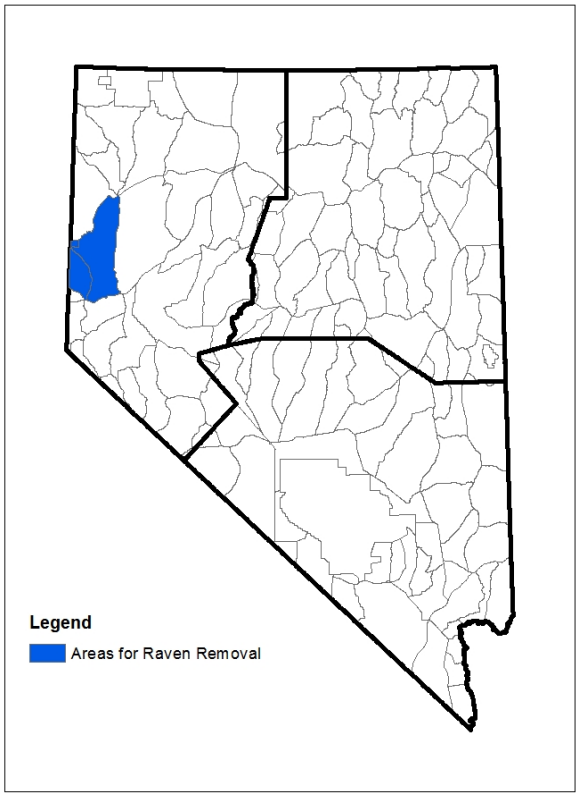
Mortalities

USGS crews recovered the remains of eight marked birds since the beginning of field operations in March. Three of these mortalities occurred between the fall and spring trapping period. Four mortalities showed mammalian sign present at the kill site, though scavenging activity may explain the sign observed. Mammalian sign at some mortality sites included coyote tracks and a cached carcass. We were unable to identify cause of death for the final mortality.

$3 predator fee allocated	$3 predator fee expended	*State Funds**	*PR Funds**
$50,000	$18,256.76	*$59,981*	*$179,941*

*Indicated monies spend unrelated to the $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 Wildlife Services 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 predator fee allocated	$3 predator fee expended
$40,000	$1,170.92

Subproject 22-01
Massacre Rim/Hays Canyon/Coleman Canyon: California Bighorn Sheep Protection

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, 2014 and June 30, 2015 six mountain lions were removed by USDA Wildlife Services. Three mountain lions were removed in unit 011, the other three were removed in unit 013. All mountain lions were removed with neck snares.

California Bighorn Sheep Herd Health

On December 8, 2015, NDOW augmented the Massacre Rim bighorn sheep population with the release of 15 bighorn sheep on the southern end of the Rim near Big Point. Within about two weeks of the release, two marked bighorn sheep mortalities were found or recorded as mountain lion kills. Mountain lions may have caused bighorn sheep to move from the Massacre Rim. This movement included previously released bighorn sheep and those sheep from the recent augmentation.

Within a month of the release, three other marked bighorn sheep from previous releases on the Massacre Rim and nearby Coleman Rim were also killed by mountain lions. Kill sites included one additional unmarked bighorn sheep mortality on Massacre Rim, one to the east of the Massacre Rim on Bitner Table, and one northeast of the Massacre Rim on the Sheldon's Guano Rim.

Five of the newly released bighorn sheep moved west across Long Valley and onto the southeastern corner of the Vya Rim (a distance of 8.5 miles), possibly to avoid mountain lions.

One of the five bighorn sheep that moved west was a marked ewe. She was observed from the ground shortly after moving to the Vya Rim along with four other ewes. During ground surveys in late summer 2015, the marked ewe was observed with two other ewes and two young lambs. These bighorn sheep remain in the same location on the Vya Rim 11 months later and monitoring is aided by the satellite telemetry collar and surveys from both the ground and air.

The second satellite telemetered ewe from the December augmentation remains on the southern end of the Massacre Rim. This ewe was also observed from the ground and during aerial surveys this past spring and summer. She was located most recently during flights in August 2015 with five other ewes and lambs. Another group of 5 bighorn sheep was observed near Big Point. Further to the north a group of 10 bighorn sheep was observed on the Little Sheldon portion of the Massacre Rim.

Severe drought conditions have played a role in reducing the number of bighorn sheep that remain along the Massacre Rim. Due to the extended drought a majority of the natural spring sources along the upper elevations of the Massacre Rim have dried up completely. The water sources that have dried up were important to the bighorn sheep in the area. Bighorn sheep were forced to move further east onto the Sheldon Refuge to locate more reliable water sources near Catnip Reservoir and the Guano Rim. Telemetry collar information showed their periodic movements back and forth from the Massacre Rim and the Sheldon.

Four mountain lions have been removed from the area of the Massacre Rim by Wildlife Services in 2015. Three males aged 6, 6 and 2 years of age and a female that was aged at 5 years. Two additional female lions have been removed from the Hays Canyon Range as of mid-October 2015.

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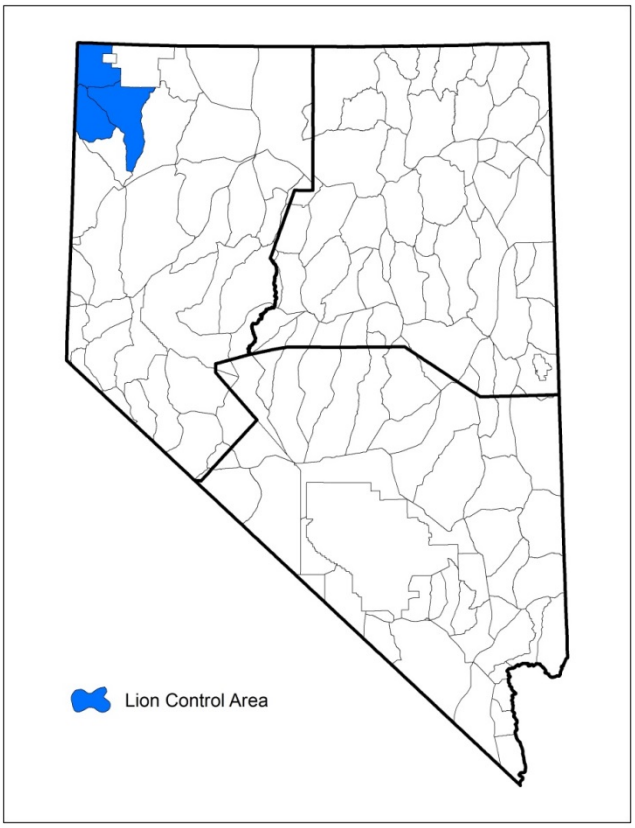
NDOW continues to monitor the bighorn sheep populations along the Massacre Rim and in Hays Canyon. The most recent aerial survey located 34 bighorn sheep within the control areas of the Hays Canyon Range, Massacre Rim and Coleman Rim. Additional bighorn sheep have been observed from the ground. NDOW 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 project 22-01.

$3 predator fee allocated	$3 predator fee expended
$25,000	$91,183.37



Subproject 22-074
Protection of Rocky Mountain Bighorn Sheep in Badlands-Contact Area

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 bighorn sheep numbers have remained stagnant.

The Contact area is a major deer winter range. It is possible that mountain lions following the deer herd to winter range from the nearby Jarbidge Mountains are remaining after the deer have left in the spring and switching their diet to bighorn sheep. Some mountain lions may be staying in the area on a year-round basis with their primary food source being Rocky Mountain bighorn sheep.

Three trips were made by USDA Wildlife Services (USDA WS) during spring 2015. The first of three trips was conducted to scout the area and determine the status of mountain lion presence. During this trip WS discovered a small population of bighorn sheep not found during helicopter surveys. This finding allowed area biologist to quickly conduct another round of helicopter surveys; due to reduced numbers of animals though, no tags were recommended for this unit.

During the following two trips WS was able to remove three mountain lions; two the second trip and another during the third. All three of these mountain lions were large adult males and removed in close proximity to one another. All mountain lions were pursued with hounds.

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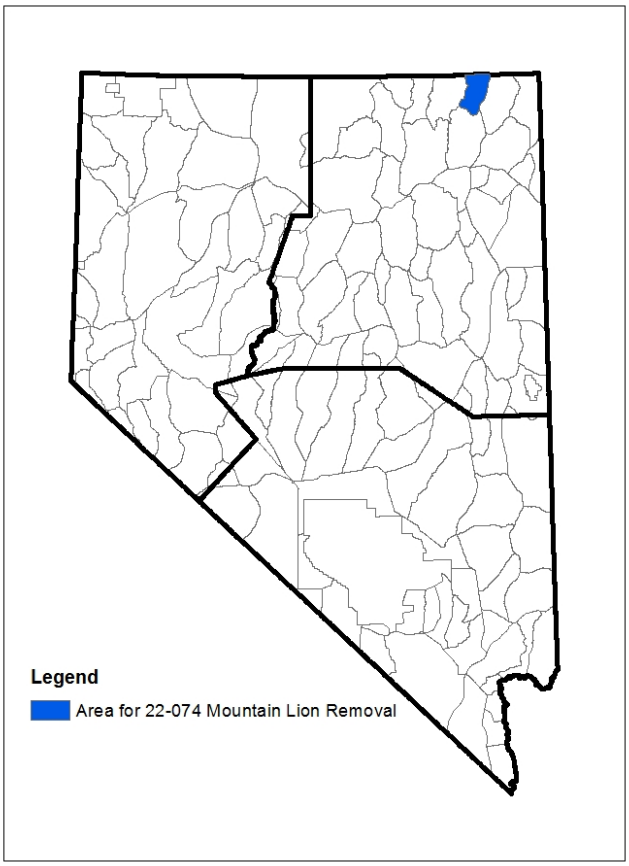
Bighorn Sheep Herd Health

Herd surveys were conducted on September 21, 2015. One ram and four ewes are currently telemetered. All five animals were found on the survey and an additional six rams and one ewe were classified. There were no lambs observed. At least an additional four marked ewes exist but were not found during the survey. The population is probably between 15-20 animals. It appears the disease event has ceased adult animals. Recruitment still remains low. We know of at least two lambs that were born in the spring, but did not survive past weaning. Another ewe died immediately after capture, possibly due to capture myopathy. A ram was lost during the spring to mountain lion predation.

$3 predator fee allocated	$3 predator fee expended
$15,000	$12,714.14



Subproject 22-014
Diamond Roberts Mule Deer Fawns

Subproject 22-14 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 experiment with the best way to discover coyote den locations two methods were tested; forward looking infrared (FLIR) and ground searches with a contractor to locate dens. FLIR systems have been used to find a wide array of wildlife species. FLIR searches have also been able to find other species den entrances. Unfortunately, Owyhee Air was not able to find any coyote dens during this search. Until further advances are made elsewhere using FLIR searches to find coyote dens, NDOW will not use this technique. A private contractor was able to locate one active den during a week of ground searches.

$3 predator fee allocated	$3 predator fee expended
$60,000	$9,627.44

Subproject 22-205/207
Gabbs Valley Range Desert Bighorn Sheep Release Protection: Mineral County Units

No funding was expended on this project.

$3 predator fee allocated	$3 predator fee expended
$15,000	$0

PROJECT 25
Coyote Ecology Analysis

The contract between Utah State University and NDOW ended in August 12, 2015. All field data has been collected. A new end date has been set for a final report. An oral presentation was made at the Wildlife Damage Management Conference. An extended abstract was also submitted (see appendix, A-1).

Coyote Telemetry
Between 2011 and 2014, 30 coyotes were captured and GPS telemetry collars were placed on them. Of these 30 units, one either completely malfunctioned or the animal left the study area and the collar was never found. Four marked animals were shot by hunters.

Lagomorph Surveys
Between 2011 and 2014, 96 lagomorph surveys were conducted. Distance from road and species was collected. These data will allow for lagomorph density estimates.

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Small Mammal Trapping

Between 2012 and 2014 small mammal trapping was conducted in four field sites in spring and fall, totaling 21,312 trap nights. The most abundant small mammal captured was the deer mouse. One trapping site had 333 deer mice captures and recaptures in 2012, 3 captures and recaptures in 2013, and 30 captures and recaptures in 2014. The other trapping sites had very similar trends. This represents a significant shift in biomass on the landscape (Fig 1).

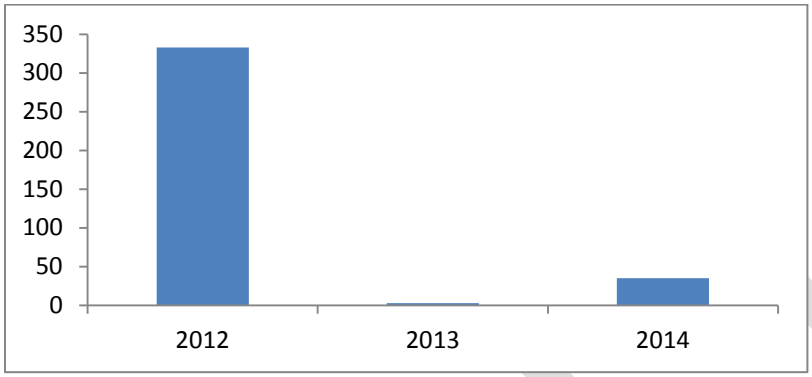

Figure 1. Differences in small mammal encounters in one small mammal trapping site.

Above data summaries include only part of data collected. NDOW reports and peer-reviewed manuscripts will be included in future predator reports as they are completed.

$3 predator fee allocated	$3 predator fee expended	P-R Funds expended
$92,000	$17,732.27	$53,196.82

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PROJECT 29
Roadway Carrion Management to Enhance Sage-grouse Populations
PROJECT 30
Landfill Waste Stream Management to Enhance Sage-grouse Populations

Road Kill Surveys and Disposal

From June 30, 2014 until July 1, 2015 186 carcasses were buried to prevent scavenging by ravens while conducting roadkill surveys (Fig 2).

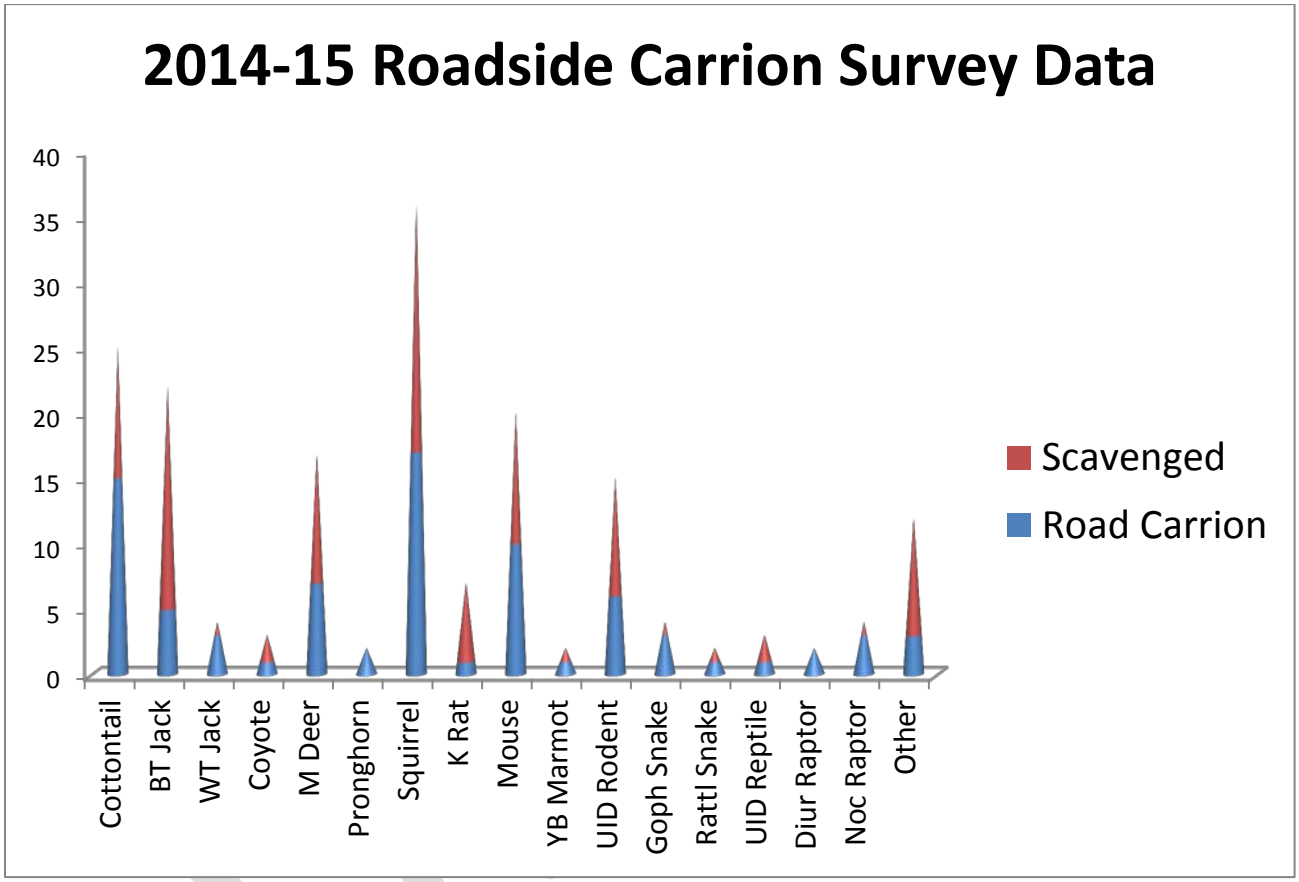

Figure 2. Roadkill found and buried. Note the amount of roadkill already scavenged pre-discovery.

Though NDOW supports non-lethal raven management, the road kill disposal portion of this project was stopped in November 2014.

Raven Nest Surveys
During the same time period 205 raven nests were surveyed and 68 nests were confirmed active. Eighteen waste management facilities were also surveyed for their policies on dealing with animal carcass disposal (table 2).

Table 2. List of survey questions for waste management facilities.

1) Do you have standard procedures for dealing with dead animals in your jurisdiction?
2) What types of dead animals do you handle?
3) How do you dispose of these dead animals?
4) Do you have an animal pit or any special location just for animals?
5) If so, where is it located?
6) Is it covered or protected from the elements and scavengers?
7) If so, how is it protected?
8) Is it routinely checked/covered? How often?
9) Do you feel like you have a problem with scavengers on your site?
10) Do you keep organic waste separate from inorganic waste?

Raven Monitoring
An exclosure at the transfer station at Midas, NV, was completed to prevent ravens from accessing trash, a human subsidy. To monitor these ravens, five ARGOS backpack transmitters and two GSM backpack transmitters were purchased.

$3 predator fee allocated	$3 predator fee expended
$55,000	$59,398.47

PROJECT 32
Cougar Black Bear and Mule Deer Interaction

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. 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 a four-year study on mountain lions in the western Great Basin and eastern Sierra Nevada range indicate that mountain lions have frequent interactions at mountain lion kill sites where black bears take over and scavenge prey carcasses from mountain lions (Andreasen, unpublished data; Figures 3, 4 & 5). 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 resulting in increased human-mountain lion conflicts and impacts on mule deer populations, while simultaneously facilitating recolonization of black bears into historic ranges.

While there have been conservation successes in re-establishing carnivores in North America, and subsequent increases in biodiversity, most of these successes have occurred in national park settings where the majority of our knowledge of large carnivores has been established. However, these 'pristine' and highly protected landscapes comprise only a small proportion of total lands in North America, and findings from research in national parks likely have little relevance in working landscapes: the remaining checkerboard of public and private lands outside of urban areas, where humans live, work, trap, hunt, and make a living from ranching, farming, and other endeavors—and where large carnivores are difficult to conserve because they conflict with humans and human economies. To adequately manage large carnivore populations outside of protected areas and secure their ecological roles it is imperative to: 1) gain an ecological understanding of large carnivores and their interactions outside of protected areas; 2) understand what factors facilitate or impede natural expansion into historic ranges; and 3) understand how re-expansion into historic ranges will subsequently impact existing carnivores and prey as well as conflicts with humans. The Great Basin of Nevada, where we recently documented the recolonization of black bears (*Ursus americanus*) into historic ranges (Beckmann and Lackey 2008; Lackey et al. 2013; Figures 3 & 4), 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.

Because black bears are recolonizing historic ranges relatively quickly in the western Great Basin, we have a narrow window of opportunity to understand the effects of these competitive interactions and subsequent effects on existing biota where mountain lions and mule deer are simultaneously present at higher densities than historic levels. Given that bear populations are increasing in number and geographic extent in almost all 35+ states in which black bears occur, species like grizzly bears are now beginning to expand into parts of the northern U.S. Rockies outside core areas of Yellowstone National Park, and mountain lion populations are also expanding eastward across the United States into historical habitat, much of these data will be key and useful to management of large carnivores and the prey populations they impact not only in Nevada but throughout the West (Williamson 2002). Further, given that many mule deer populations are currently declining throughout the West, understanding dynamic predator-prey systems will become even more imperative in the near future. Knowledge from the Great Basin, where black bears are re-colonizing historic ranges, mountain lions are present, and long-term

projects are already underway, will provide insight regarding re-colonization and its subsequent effects on existing carnivore and prey populations in Nevada as well to other working landscapes throughout North America.

While data suggest that a single predator in a single prey system is unlikely to cause a decline in ungulate prey populations, the addition of a second predator or prey species can substantially shift predator-prey dynamics such that prey are more likely to be held at low densities by predators (Messier 1994). Thus, 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. For instance, if bears aggressively usurp kills from mountain lions (i.e., kleptoparasitize), energy loss directly attributable to loss of food items is expected to result in increased kill rates for mountain lions (Murphy et al. 1998; Krofel et al. 2012). Mountain lions may also compensate for food losses by including additional prey items in their diet (i.e., bighorn sheep; Bolnick et al. 2010) or switching to prey items that are less energetically costly to capture (i.e., domestic livestock; Krofel et al. 2012). We therefore predict that these mechanisms mountain lions may use to compensate for food losses will likely increase with increasing densities of bears, thus leading to a potential increase in predation on mule deer and an increase in conflicts with humans. However, if bears passively scavenge after lions voluntarily abandon their prey, then black bear re-colonization into historic ranges is unlikely to affect mountain lion predation behavior or mule deer populations. Determining such subtleties in behavioral interactions is necessary to understand how bears that are currently recolonizing historic ranges may affect mountain lion population dynamics, mountain lion predation behavior, and both indirectly and directly affect mule deer populations.

In addition to potential effects on prey populations and human-carnivore conflicts, food subsidies gained by the dominant carnivore (e.g., bears) usurped from subordinate species (e.g., mountain lion) is likely to increase lifetime reproductive success of dominant species, increase population viability, and ultimately aide in population expansion into unoccupied ranges. These interactions documented between lynx (*Lynx lynx*) and wolverines (*Gulo gulo*) have been suspect in facilitating re-colonization of wolverines throughout Sarek National Park in Sweden (Mattisson et al. 2009). Further, both grizzly bears (Ruth et al. 2003) and black bears (Beckmann and Berger 2003) have been shown to redistribute across the landscape in response to food: from wildland areas into urban areas in the Sierra Nevada due to garbage, and from Yellowstone National Park to outside park boundaries in response to discarded remains of hunter-killed elk carcasses during the hunting season. In contrast, energy loss directly attributable to loss of food items is expected to reduce reproductive output, survival, and recruitment of subordinate species (e.g., mountain lion) as has been documented for spotted hyenas (*Crocuta crocuta*) experiencing kleptoparasitism by lions (*Panthera leo*) in Amboseli National Park in Africa (Watts and Holekamp 2008). These dynamics are particularly important to understand in working landscapes outside of national park settings, where species may be hunted for sport or subsistence, since these populations will likely be different (i.e., lower for prey and subordinate carnivore species) than models based on prey availability or harvest statistics alone would predict, particularly in fragmented habitat (Linnell and Strand 2000). Long-term data sets, particularly pertaining to large carnivores that evoke polarized emotions, help to ensure management decisions are grounded in the best available science. In addition, field-based data

increases the probability that species are able to be successfully managed for long-term survival and sustainable use (e.g., sport harvest).

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 an important big game species. Finally, long-term data sets, particularly pertaining to large carnivores that evoke polarized emotions, help to ensure management decisions can be grounded in the best available science.

Methods

Captures and proximity collars

This on-going project provides a unique opportunity to combine the efforts of two long-term studies being conducted on 1) black bears (Figure 4) and 2) mountain lions in the Great Basin of Nevada where black bears are naturally re-colonizing historic ranges (see Figure 7 for study area). During the past year, we began targeting additional bears, mountain lions, and mule deer for capture whose home ranges overlap, specifically to address these new questions pertaining to interspecific interactions, in three study areas in western Nevada with varying densities of bears (Carson Range: high density of bears; Pine Nut Range: medium density of bears; Granite Range: low density of bears; see Figure 5). 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 (Figures 8 & 9). 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 and 1 fix every 3 hours otherwise. Mule deer were fit with Vectronic brand GPS PLUS Vertex Survey collars to monitor daily survival of individuals and to estimate annual adult doe survival in each study area (Figure 12).

We used standard methods to capture animals. Mountain lions were located via snow tracking and captured by treeing with trained hounds, snares, and box traps (see Andreasen 2014 for details; Figure 8). We used culvert traps, snares, and trained dogs to capture bears (see Beckmann and Berger 2003; Beckmann and Lackey 2004, 2008 for details; Figure 9). Mule deer

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were captured using helicopter net gunning (Figure 10). To have the highest probability of overlap among individuals of each species, we captured mountain lions first during January-March 2015 and subsequently captured black bears within home ranges of collared mountain lions during the active season for bears (approx. March-October). To further maximize probability of recording carnivore-carnivore interactions, we monitored kill sites of collared mountain lions with real-time trail cameras and targeted black bears scavenging from lion kills for collaring with GPS proximity collars (Figure 4).

Fieldwork update: Captures and proximity collars

This project is providing a unique opportunity to combine the efforts of three long-term studies being conducted on 1) black bears 2) mountain lions and 3) mule deer in the Great Basin of Nevada where black bears are naturally re-colonizing historic ranges (Figures 4 & 6). To-date, we now have collected over 52,000 GPS location data points from 30+ mountain lions in western Nevada gathered between 2009 and 2015; over 33,000 GPS locations from 30+ collared bears in western Nevada collected between 2009 and 2015 (Figure 6); and mountain lion diet data from over 900 documented predation events from 25 individuals. In addition, we have survival and body condition data for over 100 mule deer in the Carson Range in western Nevada. During this past year, we collared an additional four female mountain lions with GPS PLUS Proximity collars; two lions in both the Carson Range and Pinenut Range. Subsequent to the lion captures, we deployed GPS PLUS Proximity collars on six additional female bears during this past year. Of the six bears, three are in the Carson Range and three are in the Pinenuts with all six 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, linked successfully and functioned as planned when animals were within 200 meters generating these data important to addressing the questions in this project (see Figure 12)

Locating and analyzing kill sites by lions and interactions with bears

Using detailed proximity data from GPS PLUS Proximity collars (i.e., four GPS fix per minute), we are estimating the frequency of scavenging events in which 1) bears aggressively commandeer prey items from mountain lions or 2) passively scavenge after the lion has left the predation site. Using standard GPS data (e.g., one fix every three hours), we: 1) estimate mountain lion kill rates and prey selection in the three study areas (with varying densities of bears) by identifying GPS clusters made by collared mountain lions and investigating those clusters on the ground during months when bears are active (Figure 3; Anderson and Linzey 2003; Andreasen 2014; 2) visit a subset of GPS clusters made by collared bears during fawning season to assess the potential that bears are killing deer fawns in addition to scavenging from lions; 3) determine if bears display attraction toward mountain lions or mountain lion kills more than expected by chance; 4) determine if mountain lions display repulsion away from bears more than expected by chance; 5) determine if diet breadth of mountain lions increases with bear density to include alternative prey by estimating diet breadth using the program IndSpec (Andreasen 2014; Bolnick et al. 2002); and 6) determine if mountain lion predation on domestic livestock increases with bear density.

Fieldwork Update: Locating and analyzing kill sites by lions and interactions with bears

During Summer 2015 (the period when most bear-lion interactions at kill sites occur based on previous data), 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 of those 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 433 mule deer killed by 21 collared mountain lions in Nevada suggesting that, on average during summer months when bears are active, 50 percent of mountain lion-killed deer are scavenged by black bears where bears are present (Beckmann and Berger 2003; Beckmann and Lackey 2008; Beckmann et al. 2004) at moderate to high densities (Figures 3, 4, and 5).

Correlates of Fitness

During capture of bears, mountain lions, and deer, we are measuring body fat (e.g., using ultrasound and traditional palpation methods) as a correlate of fitness (Stephenson et al. 2002; Cook et al. 2004). Pregnancy rates of deer will also be assessed with ultrasound during initial capture. Cub production of bears and mountain lions will be estimated by visiting dens to enumerate offspring (e.g., Beckmann and Berger 2003; Andreasen 2014; Figures 8 and 11). Offspring survival of bears and mountain lions will be monitored using expandable telemetry collars (GPS PLUS Vertex Survey collars with mortality sensors). Adult survival of bears, lions, and mule deer will be monitored daily with GPS collars with mortality sensors. The results pertaining to body condition, reproductive fitness, and survival will be used to determine if black bear expansion into historical ranges 1) is facilitated by scavenging from lion kills (e.g., measures of reproductive fitness are predicted to increase with an individual's scavenging rate); 2) decreases lions on the landscape (e.g., reproductive fitness and survival of lions are predicted to decrease with increasing bear density); and/or 3) indirectly affects mule deer populations (e.g., measures of reproductive fitness—body condition/pregnancy rates—are predicted to increase with increasing black bear density; however, mortality rates will be greater than areas with low bear density indicating greater additive mortality due to predation).

Fieldwork Update: Correlates of Fitness

Correlates of fitness for bears will be collected during the coming winter den season (winter 2015-16) for newly and previously collared bears. Newly collared female lions continue being monitored for kitten production and survival. Body fat and other correlates of fitness were collected on captured animals during standard handling and workup procedures for bears and lions.

Update: 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 from 2005-2010, we modelled and mapped core habitat areas for black bears across the study area using Resource Selection Function (RSF) Models (see Wynn-Grant, Lackey and Beckmann *In Prep* for details). During the period 2005-2010, WCS and NDOW research questions were focused primarily on backcountry females, although a few wildland-urban interface males and females were collared as well. 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. The landcover layer was generated by specialists at NDOW specifically for biodiversity assessments in western Nevada and projected at 1-meter resolution. We used nearest neighbor tools in ArcMap to reclassify the layer to $30m^2$ (fine) and $1km^2$ (coarse) spatial resolutions for analyses. Feature layers representing major water bodies, railways, recreation sites, stream and road systems, and trails were acquired from NDOW and the Douglas County, Nevada open access GIS resources. We used the Euclidean distance tool in ArcMap to create layers representing the straight-line distance from any map cell to the nearest feature. These layers were also reclassified for projection at both $30m^2$ and $1km^2$ spatial resolutions. Feature layers representing urban polygons and human population density were available from the USDA's Lake Tahoe Basin Management Unit. These were also manipulated in ArcMap with nearest neighbor tools to classify and project them at $30m^2$ and $1km^2$ spatial resolutions for analyses. See Wynn-Grant, Lackey, and Beckmann (*In Prep*) for details on model development and results.

We developed resource selection function (RSF) models for two levels of spatial analysis using the coarse and fine scale landscape parameters and male and female black bear location data collected from 2005-2010 (e.g., see Figures 11 and 12). 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.

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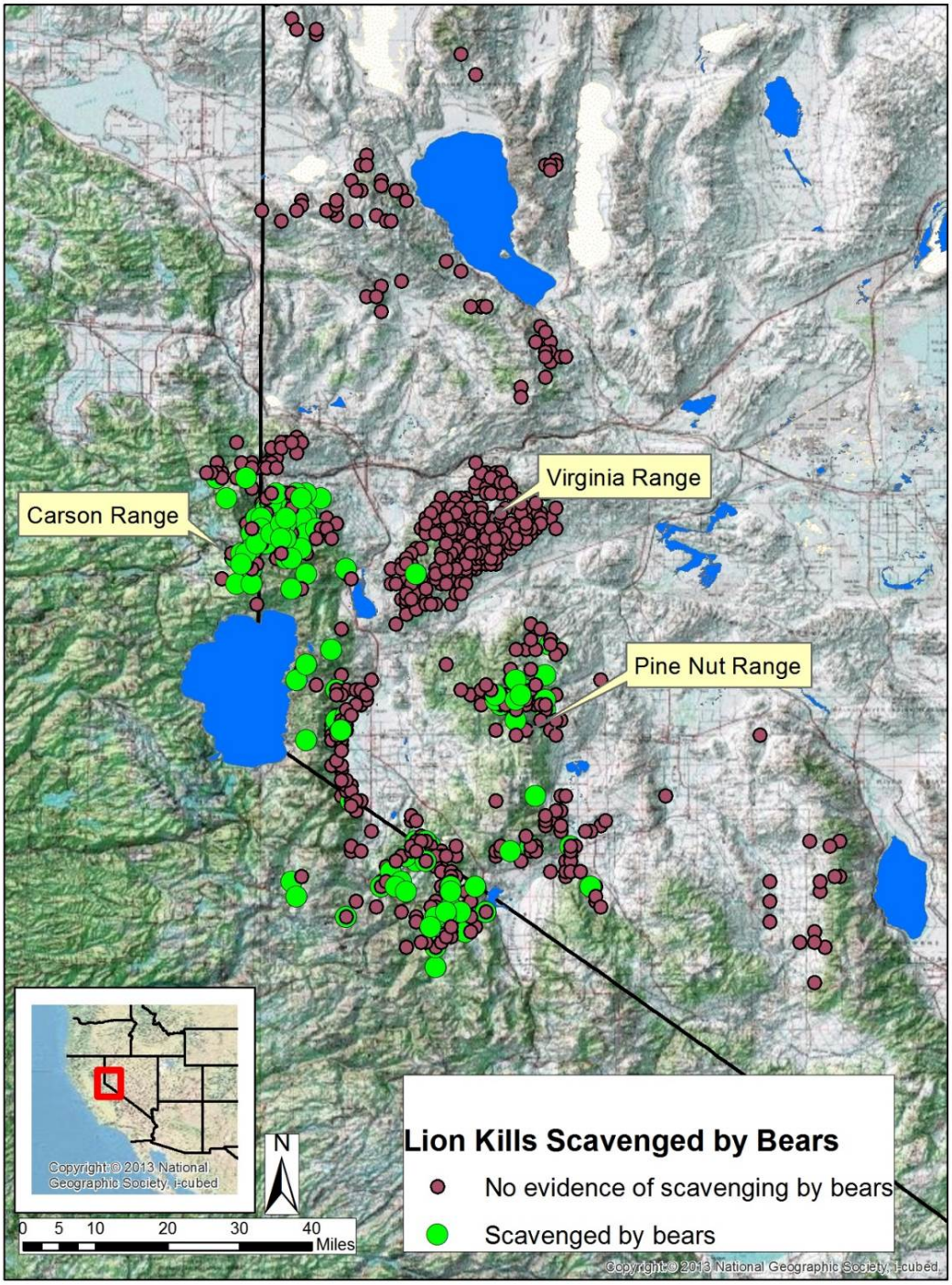

Figure 3. Mountain lion kills found between 2009 and 2012 (n = 803), including kills where scavenging by black bears was recorded in the Carson Range (bears = high density), Pine Nut Range (bears = moderate density), and Virginia Range (bears = low density).

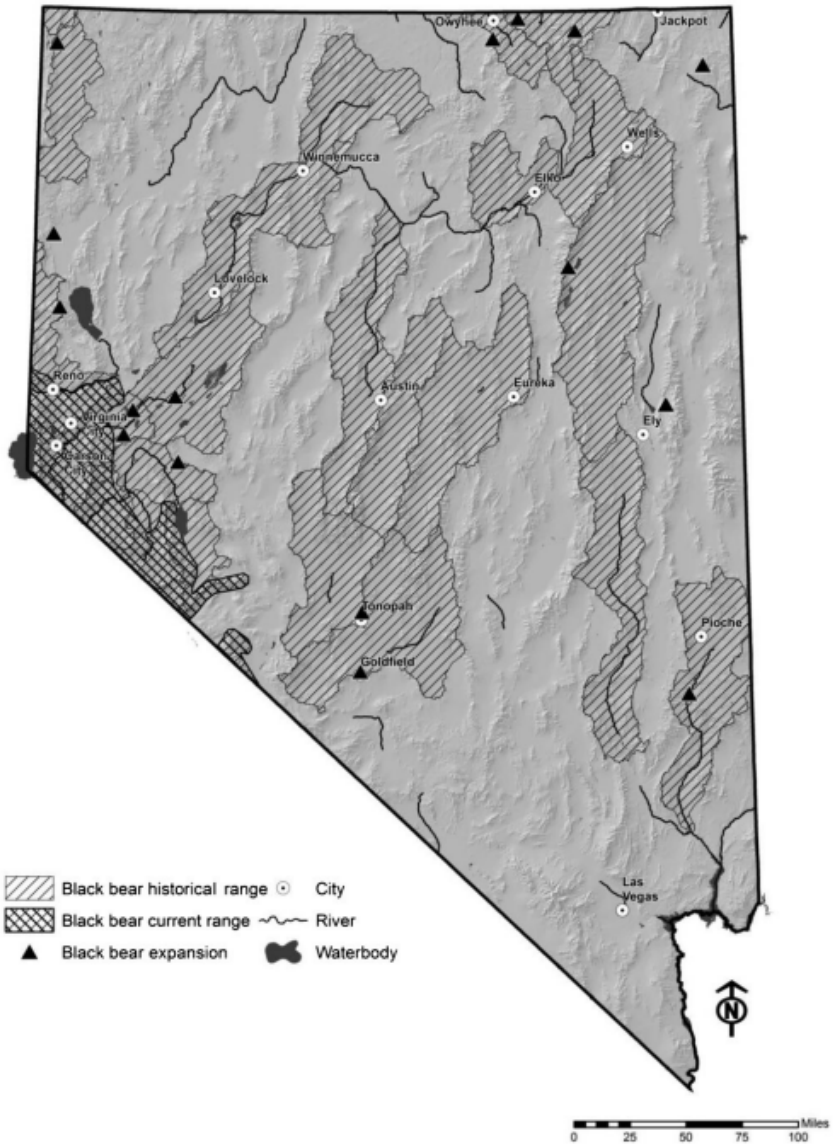

Figure 4. Map showing historical black bear habitat where bears were present and their current range (from Lackey et al. 2013).

Figure 5. Black bear scavenging from kill made by collared mountain lion. Photo from real-time camera.

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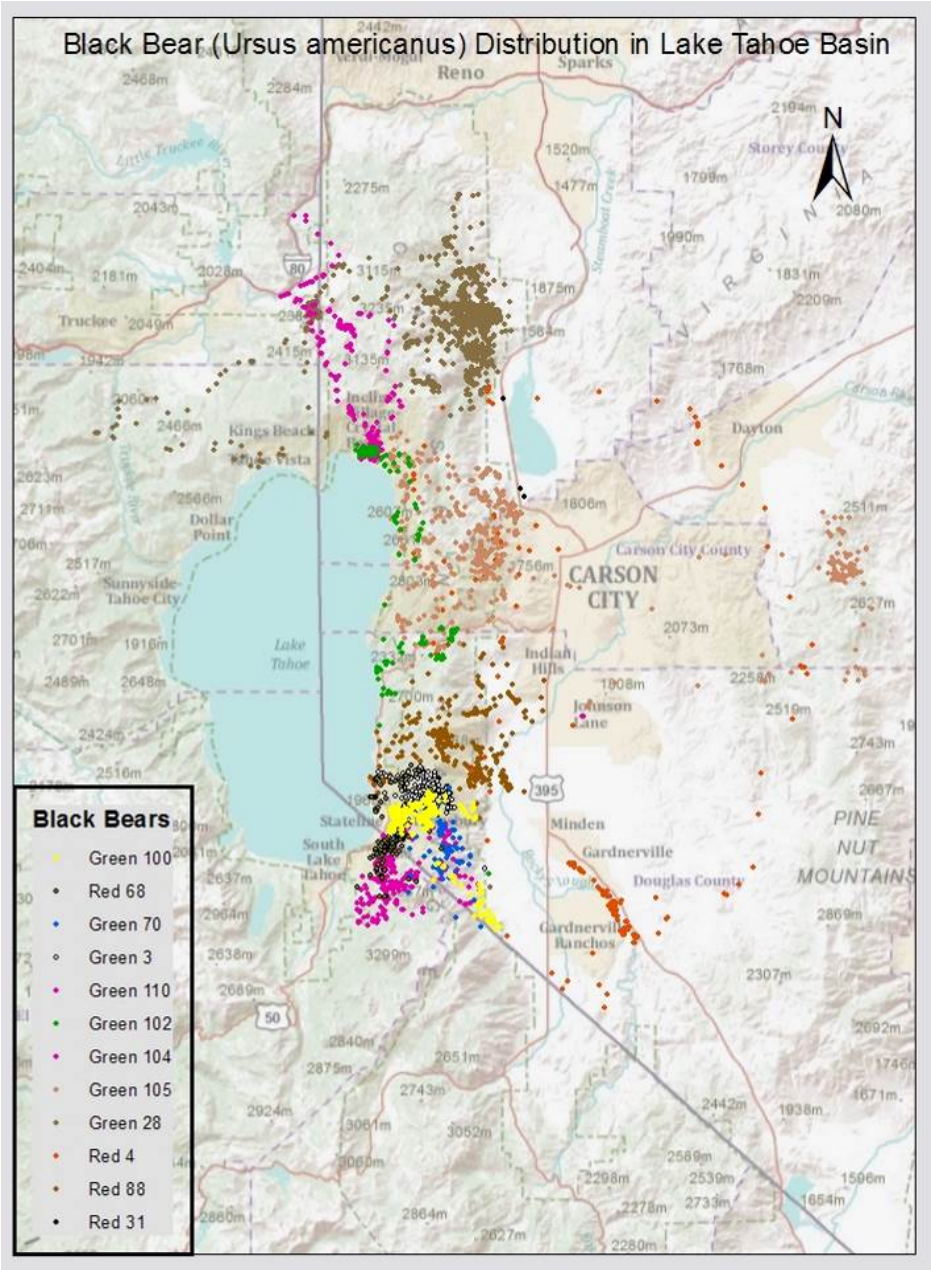

Figure 6. GPS locations from 12 black bears collared in western Nevada between 2006 and 2011.

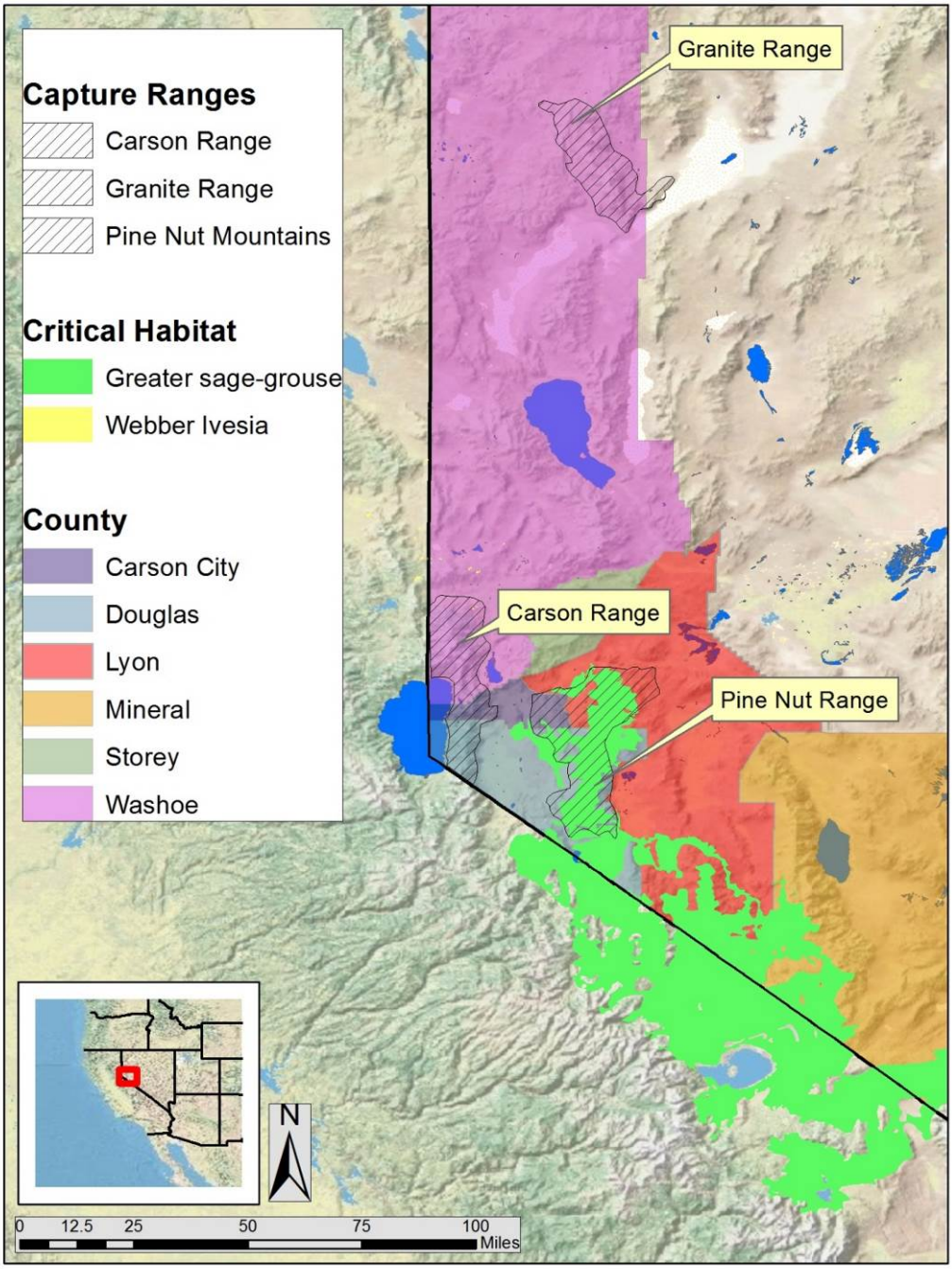

Figure 7. Mountain ranges (Carson Range, Pine Nut Range, and Granite Range) where captures of mountain lions, black bears and mule deer are occurring. Counties and habitat proposed (greater sage-grouse) or designated (Webber Ivesia) as critical habitats that intersect mountain ranges where captures will be focused are shown.

Figure 8. Mountain lion bayed up tree in Great Basin study area with trained hounds (top left); mountain lion being fitted with GPS collar (lower left); reversal being administered (top right); six-week-old mountain lion kitten being measured and fitted with expandable telemetry collar at birthing den (bottom right).

Figure 9. Black bear collared with GPS collar in study area.

Figure 10. Mule deer collared and released in western Great Basin study area. Photo © Cody Schroeder.

Figure 11. Weighing black bear cub at winter den.

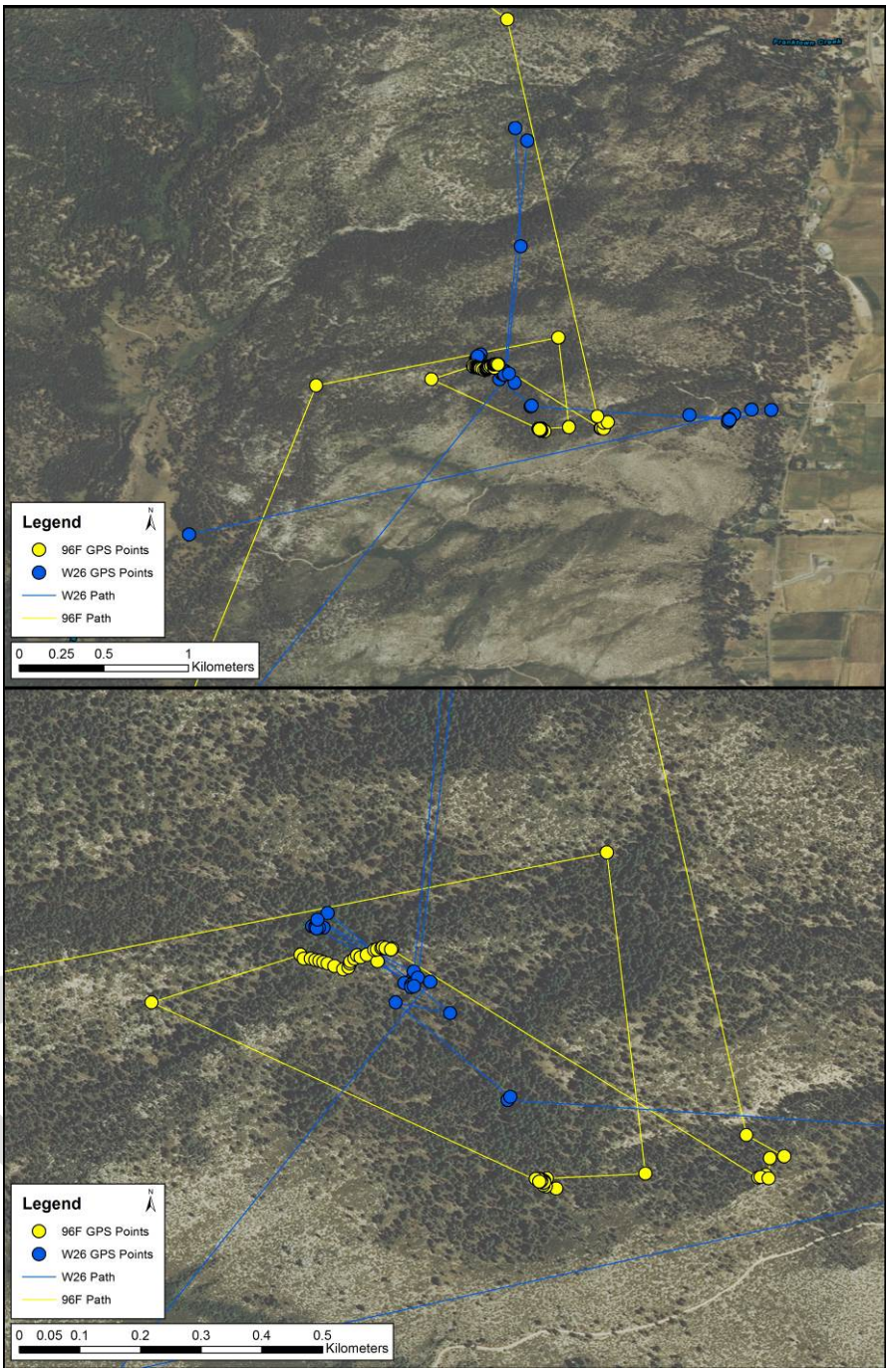

Figure 12. An example of the Vectronics GPS PLUS Proximity collars functioning properly and collecting interaction data (i.e. simultaneous points every 15 seconds for both animals) from a female lion (96F) and a female bear (W26) when they were within 200 meters of each other in 2015. The lower image is the same data zoomed more closely.

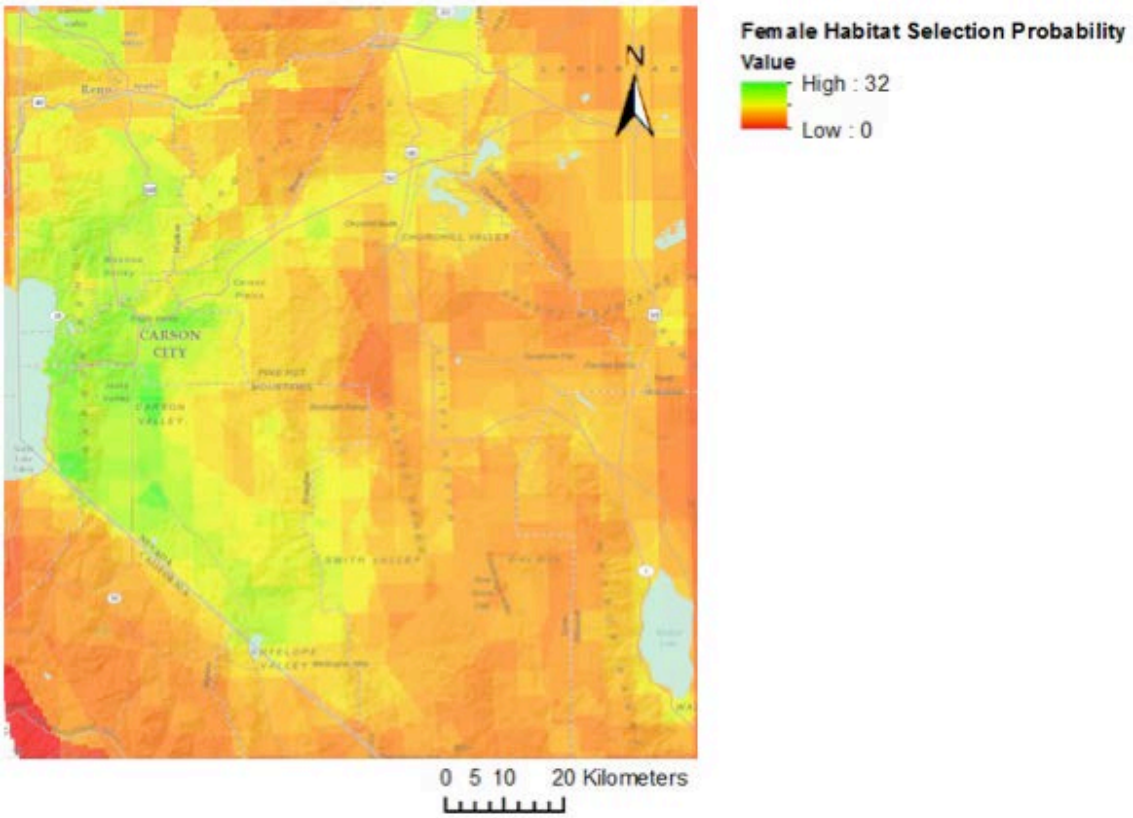

Figure 13. Resource selection function (RSF) model results displaying female black bear habitat selection probability in western Nevada based on average habitat selection probability for all significant landscape variables. Higher probability of use areas are represented in green and lower probability use areas in red (from Wynn-Grant, Lackey, and Beckmann *In Prep*).

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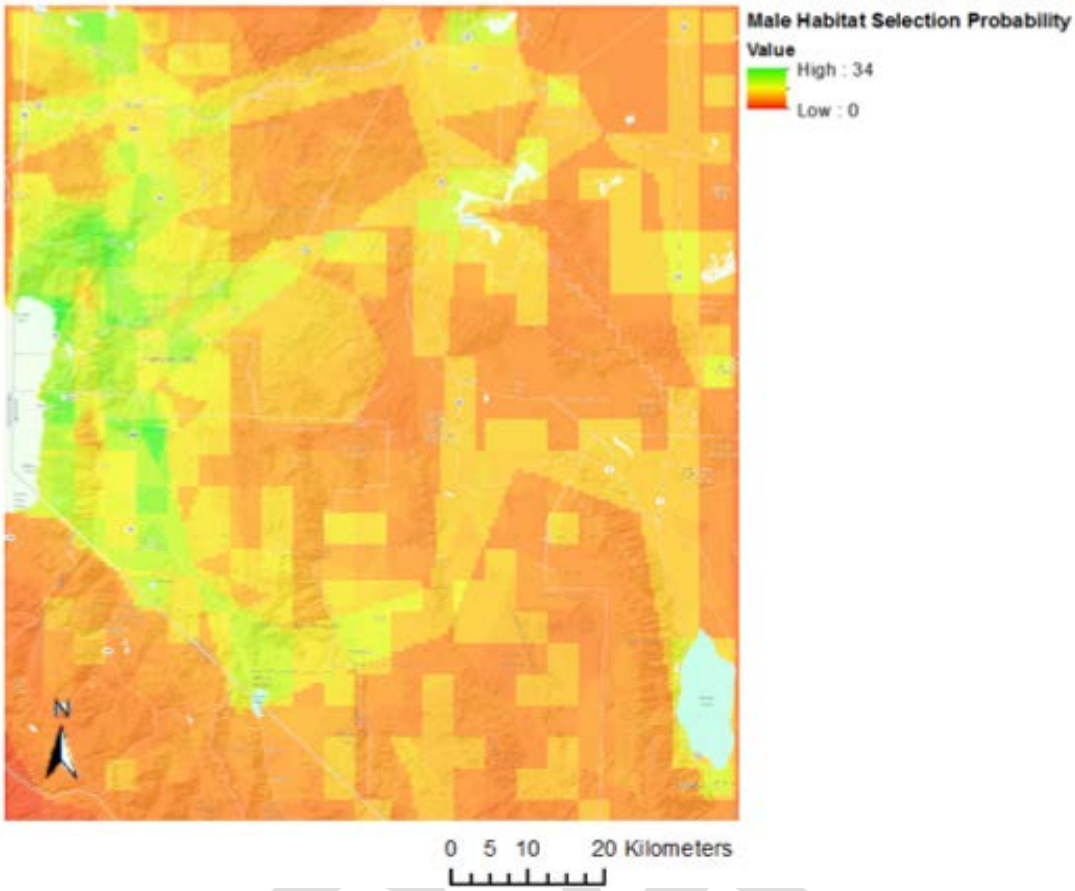

Figure 14. Resource selection function (RSF) model results displaying male black bear habitat selection probability in western Nevada based on average habitat selection probability for all significant landscape variables. Higher probability of use areas are represented in green and lower probability use areas in red (from Wynn-Grant, Lackey, and Beckmann *In Prep*).

$3 predator fee allocated	$3 predator fee expended
$25,000	$32,215.97

PROJECT 33
Greater Sage-grouse Nesting Habitat Restoration

No funding was expended on this project.

$3 predator fee allocated	$3 predator fee expended
$50,000	$0

PROJECT 35
Using Genetic Testing To Identify Origin of Red Fox

We were awarded $9,750 to genotype 65 red fox DNA samples to determine (1) native vs. nonnative ancestry, (2) genetic affinities of native and nonnative samples to assess hybridization, (3) genetic affinities of nonnative northeastern Nevada genotypes with those from populations in western Utah and southern Idaho to assess source of origin. All of the proposed laboratory analyses have been completed for 68 samples collected for this project and data analyses are currently under way.

Specifically, we sequenced and genotyped 68 red fox samples, including skin or muscle samples from foxes trapped from lower elevation areas during the 2013/2014 season and from scats collected from high elevation locations not accessed by trappers. The high-elevation collections were conducted by a graduate student who was paid for his time through a matching funding source (Wildlife Heritage Trust Account Grant, 15-17, $8,628).

Based on the preliminary sequencing data, we found a mixture of native and non-native mitochondrial haplotypes (maternal genotypes). In total 73% of haplotypes in Nevada were native. The proportion of haplotypes that were native was positively correlated with elevation and inversely correlated with latitude. This suggests that nonnative red foxes are entering Nevada from the north and occur primarily at lower elevations. Data analysis in progress will address the genome-wide relatedness of these foxes to one another and to surrounding native and nonnative populations and identify whether native and nonnative red foxes are interbreeding.

To confirm and more precisely identify geographic trends, additional samples and genetic data are needed from higher elevation and more southern locations. Additionally, more samples from trappers in the same locations will be important to control for temporal changes in haplotype frequencies associated with increased abundance of invading nonnative red foxes. Additional funds have been secured for field work to obtain samples from the Snake Range in Great Basin National Park in summer 2015 (Western National Parks Association, Scientific Research Grant, $7,215).

$3 predator fee allocated	$3 predator fee expended
$10,000	$9,750

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Budget

Project	$3 Fee Budget	P-R Budget	Lethal Expenditure	Non-lethal Expenditure	P-R Expenditure	Totals
Project 21	$10,000	$0	$45,041	$0	$0	**$45,041**
Sub Project 21-02	$50,000	$0	$18,257	$0	$0	**$18,257**
Project 22	$40,000	$0	$1,171	$0	$0	**$1,171**
Sub Project 22-01	$25,000	$0	$91,183	$0	$0	**$91,183**
Sub Project 22-14	$60,000	$0	$0	$9,627	$0	**$9,627**
Sub Project 22-074	$15,000	$0	$12,714	$0	$0	**$12,714**
Sub Project 22-205/207	$15,000	$0	$0	$0	$0	**$0**
Project 25	$23,000	$69,000	$0	$17,732	$53,197	**$70,929**
Project 29 and 30	$55,000	$0	$0	$59,398	$0	**$59,398**
Project 32	$25,000	$0	$0	$32,216	$0	**$32,216**
Project 33	$50,000	$0	$0	$0	$0	**$0**
Project 35	$10,000	$0	$0	$9,750	$0	**$9,750**
Totals	**$378,000**	**$69,000**	**$168,366**	**$128,724**	**$53,197**	**$350,287**

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Appendix A-1

Potential increases in high elevation coyote susceptibility to trapping efforts during breeding and gestation periods

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Dana J. Morin, PhD Candidate, Department of Fish and Wildlife Conservation, Virginia Tech, 106 Cheatham Hall, Blacksburg, VA, 24061

In Nevada, coyote removal is often conducted in high elevation areas. Removing these high elevation coyotes can be expensive and time consuming, often requiring aerial gunning. Trapping is a fast, inexpensive method that can be used to conduct coyote removals in easy access areas at lower elevations. Using GPS collar data from 6 coyotes collared in central Nevada, we tested the hypothesis that high elevation coyotes will embark on temporary treks outside of their territory into lower elevation areas during the coyote breeding/gestation period (16 December to April 15). We estimated temporary shifts territories by measuring the distance between successive activity centers. We also calculated the average elevation of activity centers. We compared individual coyote movements and elevation changes on a daily, weekly, monthly, and seasonal scale to determine if they alter home range use, increase travel distances, and travel temporarily into lower elevation areas. We did not detect an increase in distances between successive home range centers, suggesting the coyotes still actively maintained stable home ranges. However, we did find a difference in the average elevation between successive centers, indicating a shift in the core home range to lower elevations. On average, a 200 meter decrease in elevation was found for each coyote during the first half of the coyote breeding/gestation period. We believe these coyotes may have been more susceptible to trapping at lower elevations, and that further investigation is warranted.

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