Nevada Department of Wildlife

Predation Management Status Report

Fiscal Year 2024

State of Nevada

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Executive Summary

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.

In State Fiscal Year 2024, 13 projects were proposed and approved by the Wildlife Damage Management Committee and ultimately approved by the Nevada Board of Wildlife Commissioners. This included a project for the protection of Greater sage-grouse (Project 21), three projects intended to benefit bighorn sheep (Project 22-01, 22-074, and 37), a project aimed at providing pronghorn fawn protection (Project 38), two projects intended to benefit mule deer included one in Hunt Unit 144 (Project 40) and one through the Mule Deer Enhancement Program, and a mesopredator control project on various Wildlife Management Areas (Project 43). In addition to these lethal projects, 4 research and management (non-lethal) projects were continued to help strategically target areas for raven removal (Project 41), assessing the effects of mountain lion harvest in Nevada (Project 42) and passively estimated various big game populations (black bear and mule deer) using remote camera stations (Project 45 and 46).

The raven management project (Project 21) continues to be an important project to implement on behalf of Greater sage-grouse as research has demonstrated that ravens are the most common predator of sage-grouse nests and have negative population effects once their densities exceed 0.40 ravens per square kilometer. In state fiscal year 2024, USDA - Wildlife Services removed 1,719 raven within 18 priority areas. Wildlife Services also conducted 848 Raven, Raptor, Horse, and Livestock surveys per USGS protocol to determine the effectiveness of these efforts.

Efforts were made to evaluate and remove mountain lions through Project 22-01 in Hunt Units 011 and 013; however, no animals were removed due to very low detection rates. Project 22-074 was also temporarily paused as there have been no mortalities of radio-marked Rocky Mountain bighorn in Hunt Unit 074. Project 37 lethally removed 26 mountain lions, mostly on behalf of bighorn sheep across 9 mountain ranges in Nevada.

For Project 38, USDA – Wildlife Services removed 117 coyotes across 15 different Hunt Units on behalf of pronghorn while Project 40 removed 90 coyotes from Hunt Unit 144 in Eureka County to benefit mule deer. Spring 2024 fawn ratios from Hunt Unit group 141-145 was 41 fawns per 100 adults which is slightly better than the statewide average of 37 fawns per. In comparison, a fawn a ratio of 43 fawns per 100 adults was observed in the adjacent 151-156 Hunt Unit group.

Project 41 (Estimating Common Raven Densities and Space Use) is an ongoing research project with collaborators from the University of Nevada, Reno, Great Basin Bird Observatory, and the U.S. Geological Survey. During FY2024, research crews conducted 936 Raven, Raptor, Horse, and Livestock Surveys to determine the associations of ravens with anthropogenic development, estimate the effectiveness of direct lethal control (Project 21) and using other means such as oiling eggs within raven nests to reduce or eliminate hatching success.

For Project 43, USDA – Wildlife Services conducted work at four Wildlife Management Areas including Carson Lake, Overton, Argenta and Mason Valley. Across these management areas, 65 coyotes, 14 raccoons, 11 striped skunks and two feral cats were removed during the spring months to improve nest success for various upland game birds and waterfowl.

Project 44 monitors the selectivity of prey species for mountain lions in southeastern Nevada, with specific interest in variation post wild horse removal. Mountain lion GPS collar data is being used to identify location clusters formed while feeding. These are mapped and investigated to quantify the species, sex, and age class of the prey that collared lions are exploiting. To date, 1,538 cluster sites have been visited representing prey items killed from 2018 through spring 2024. These efforts have resulted in the location and identification of over 1,118 prey items. No evidence of predation was found at ~ 23% of sites. As of this writing, feral horses represent approximately 35% of carcasses identified (n = 416), and mule deer comprise 53% (n = 625). The remaining kills were coyotes, elk, and trace amounts of other species, or unidentified remains. No lion-killed bighorn sheep were detected this year.

Project 46 focuses on classifying and analyzing data collected from approximately 200 camera traps in northwestern Nevada to estimate the population size of several species including mule deer, black bear and even wild horses as well as analyzing data from weather stations. After 2.5 years of data collection, mule deer have been detected 1,865 times at 145 camera locations, feral horses 1,549 times at 80 locations, and mountain lions 65 times at 30 locations. Photo detections of these species were analyzed to understand habitat relationships for each species and co-occurrence patterns for the three species across the region. The study area is relatively large and encompasses the western portion of Humboldt and Pershing Counties, and all of Washoe County. Initial results from the project indicated an increase in the mule deer population from 3,389 (95% CI = 3,040 to 3,778) in 2021 to 4,372 (95% CI = 3,922 to 4,873) in 2022. Updated population estimates will be provided in 2025.

Project 47 was designed to strategically remove coyotes to benefit mule deer during periods of stress (winter migrations and heavy snowpack) or the fawning periods as part of the Mule Deer Enhancement Program. During fiscal year 2024, USDA - Wildlife Services removed 16 coyotes in Lincoln and White Pine County in Hunt Units 221, 222, 231 and 241.

Fiscal year 2023 predator fee revenues totaled $944,410 and there was a beginning balance from FY 2022 of $921,654 for a total of $1,866,064. A total of $1,106,142 was expended on the FY 2023 predator plan leaving a balance of $759,922 for FY2024. Revenue for FY 2024 was $722,141 for a total of $1,482,063 available for the FY2024 predator management plan. A total of $1,164,413 was spent on this plan in State Fiscal Year 2024.

Project 21: Greater Sage-grouse Protection (Common Raven Removal)

Project Narrative

Common raven (*Corvus corax*, hereafter "raven") control and monitoring efforts to conserve Greater sage-grouse (*Centrocercus urophasianus*, hereafter "sage-grouse") began in February and concluded in June of 2024. The objective of this project is to increase nest success of sage-grouse and thus, ultimately increase recruitment rates. USDA Wildlife Services (WS) and the Nevada Department of Wildlife (NDOW) coordinated with the U.S. Geological Survey (USGS) to identify treatment sites across the state and conduct monitoring to determine the effectiveness of raven control efforts.

Utilizing the SMaRT tool created by the USGS Dixon Lab and prioritization criteria set by NDOW, 18 priority areas (treatment polygons) in the following counties were generated to focus GRSG protection efforts:

Lander -	5	Humboldt –	2
Elko -	5	Lincoln –	2
Eureka -	2	Nye –	2

From February-June 2024, WS spent 3,731 staff hours (eight staff total) conducting surveys [USGS Raven, Raptor, Horse and Livestock (RRHL) protocol] and operational common raven damage management to protect Greater sage-grouse (GRSG) in 18 priority areas. A total of 848 RRHL surveys were conducted pre- and post-treatment.

Utilizing shooting and DRC-1339 via a chicken egg bait delivery system, WS removed a total of 1,719 common ravens from the control areas. Per USGS preliminary findings, post-treatment RRHL survey data showed a significant decrease in raven densities in the control areas. For more detailed information on raven survey methodology, effort and select results, please see Project 41 on page 13 of this report.

Project Summary

- USDA – Wildlife Services: Staffing
  - Eight staff were assigned to Project 21
    - Four in Austin (2 WS, 2 USU)
    - Two in Humboldt County
    - One in Elko
    - One in Lincoln County
- USDA – Wildlife Services: Surveying
  - 848 RRHL surveys were conducted (approximately 10 min./ea.).
  - Eight staff (6 WS and 2 USU) conducted the surveys.
- USDA – Wildlife Services: Shooting
  - 208 ravens were shot.
  - 190 ravens were harassed/hazed.
- USDA – Wildlife Services: Corvicide Application (DRC-1339)
  - 5118 egg baits placed.
    - 4234 eggs baits taken (84.68 grams DRC-1339)
    - 884 egg baits recovered.
    - Estimated 1,511 ravens taken.
- USDA – Wildlife Services: Raven Take Estimate (Shooting + DRC-1339)
  - 1,719 total ravens.

Budget Detail

Project 21: Greater Sage-grouse Protection

Personnel compensation		$102,222.13
Travel/Camp		$13,403.60
Vehicle Use		$15,496.39
Supplies and Equipment		$42,858.41
Aerial Services		-
Program Support (Admin/Indirect Costs)		$47,235.72
Project Total		$221,216.25
Principal Amount Proposed	$175,000	
Balance	-	***($46,216.25)***

Project 22-01: Mountain Lion Removal to Protect California Bighorn Sheep

Project Narrative

No collared California bighorn sheep remain in Hunt Units 011 or 013; however, USDA – Wildlife Services (WS) allocated time to investigate presence of mountain lions and potential kill sites during the late summer and early fall of 2023. WS personnel were able to locate two uncollared California bighorn sheep mortalities and set up equipment in the area to capture the offending mountain lion(s). The equipment was set until upland game seasons began in October and then pulled. From this juncture, dogs were used to continue to search for mountain lions however none were located, and further effort was discontinued. Other mountain lion removal projects within this vicinity are ongoing and funding from other projects can be used if necessary to remove additional mountain lions from these hunt units. Approximately 326 hours of effort over 30 days were expended on this project in FY2024.

Budget Detail

Project 22-01: Mountain Lion Removal to Protect California Bighorn Sheep		
Personnel compensation		$43,920.67
Travel/Camp		$6,814.52
Vehicle Use		$10,068.53
Supplies and Equipment		$933.31
Aerial Services		-
Program Support (Admin/Indirect Costs)		$16,761.59
Project Total		$78,498.62
Principal Amount Proposed	$100,000	
Balance		***$21,501.38***

Project 22-074: Monitor Rocky Mountain Bighorn Sheep for Mountain Lion Predation

Project Narrative

Rocky Mountain bighorn sheep populations have been established in portions of Nevada, but mountain lion predation can be a significant source for mortality that may threaten the population's viability. One collared bighorn sheep was killed by a mountain lion; however, it was very early in Fiscal Year 2024. The area biologists believe that mountain lion predation is not currently limiting the small bighorn sheep population, but even a small amount of predation has the potential to affect its viability.

The Hunt Unit 074 Rocky Mountain bighorn sheep herd experienced a die-off in 1999 and experienced another event in 2014 caused by *Mycoplasma ovipnuemiae* (M. ovi.). Two years following the initial 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 population rebound has not been realized as hoped. Continued observations of lambs and young 2–3-year-old rams is a positive indicator that the shedders of M. ovi. have either aged out or were successfully removed from the population. Continued monitoring will determine if recovery is taking place.

No surveys were conducted specifically for bighorn sheep in Hunt Unit 074 during the fall of 2023. However, opportunistic observations were made during Management Area 7 spring deer surveys in the Contact area. A total of 11 bighorns were observed composed of 3 rams: 4 ewes: 4 lambs. One ram observed looked to be over 6 years old. Four GPS collars are currently deployed on 3 ewes and one ram. There have been no documented predator related mortalities this year on any of the radio-marked Badlands bighorn sheep. One unit indicated a mortality in June of 2024 but did not appear to be a predator related loss. The exact cause of death was not able to be determined, but the head of the animal was collected and sent to Wildlife Health for M. ovi. testing.

The Badlands/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 yearlong basis with their primary food source being Rocky Mountain bighorn sheep.

Project Summary

No mountain lion removal efforts were conducted for this project during FY 2024.

Budget Detail
No expenditures to report.

Project 37: Big Game Protection – Mountain Lions

Project Narrative

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.

Mountain lion control efforts continue in the Granite Range of Washoe County (Hunt Unit 014) attempting to benefit mule deer. During this last fiscal year (FY2024), 9 mountain lions were removed between December of 2023 and June of 2024 in the Granite Range. The estimated mule deer population in this hunt unit for 2024 was 300 mule deer. Classification of mule deer during fall 2023 aerial surveys yielded a sample of 109 mule deer with a fawn ratio of 43 per 100 adults.

Desert bighorn sheep protection remains a priority for this program. Two mountain lions were removed in Hunt Unit 205 of Mineral County to reduce depredation on desert bighorn sheep in that unit. The removals both occurred on Mount Ferguson. Also in Mineral County, two lions were removed from the Silver Peak Range (Hunt Unit 211) in April and May to reduce predation on desert bighorn sheep. In Esmeralda County, 3 mountain lions were removed in April. One from Hunt Unit 211 and two mountain lions from Hunt Unit 213. In Churchill County, efforts were initiated to reduce potential mountain lion predation on desert bighorn sheep due to the removal of over 3,000 wild horses from the Stillwater (Hunt Unit 182) and Clan Alpine Ranges (Hunt Unit 183) and associated valleys. During May of 2024, 3 mountain lions were removed from Hunt Unit 183 (Clan Alpine Range) to assist with this effort.

Likewise, California bighorn sheep populations, which can be considered stable at low levels for the most part, can benefit from mountain lion removal and density reduction. As part of an effort to re-establish this species in the Montana Mountains of Hunt Unit 031, one mountain lion was removed from this range prior to translocation of 18 sheep from the Sheep Creek Range (Hunt Unit 068). In addition, to conserve a small population of California bighorn sheep in Hunt Unit 041, the Sahwave Mountains, two mountain lions were removed to reduce predation on this particular herd, which is estimated at just 30 animals.

In total, 26 mountain lions were removed during FY2024 to help conserve bighorn sheep and mule deer populations and are summarized below.

Project Summary

County	Hunt Unit	Location	Number Removed
Churchill	183	Clan Alpine	3
Elko	065	Emigrant Springs	1
Esmeralda	211	Volcanic Hills	1
Esmeralda	213	Monte Cristo	2
Humboldt	031	Montana	1
Humboldt	031	Bilk Creek	3
Mineral	205	Mount Ferguson	2

Mineral	211	Silver Peak Range	2
Pershing	041	Sahwave	2
Washoe	014	Granite	9
		Total:	26

Budget Detail

Project 37: Big Game Protection – Mountain Lions

Personnel compensation		$110,944.89
Travel/Camp		$17,922.66
Vehicle Use		$25,958.75
Supplies and Equipment		$11,781.70
Aerial Services		-
Program Support (Admin/Indirect Costs)		$45,234.06
Project Total		$211,842.06
Principal Amount Proposed	$100,000	
Balance	-	***($ 111,842.06)***

In addition to these costs, American Lion Specialists also worked in various locations, mainly in northwestern Nevada (e.g., Calico Mountains, Jackson Mountains, and Massacre Rim) to either remove or capture and mark mountain lions. The total expenditure for this work conducted in FY2024 was $33,000.

Project 38: Big Game Protection – Coyotes

Project Narrative

Coyotes face an increase in caloric need when raising pups, both through an increase in parent energetic output and feeding growing pups (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 nonparent 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, game biologists with pronghorn management responsibilities were asked whether their pronghorn herds may be underperforming (low fawn ratios) due to coyote predation. Areas where predation by coyotes could be a factor limiting pronghorn populations received removal efforts from USDA WS. Wildlife Serviced performed coyote removal efforts in Hunt Units 065, 102, 104 and 121 of Elko County; Hunt Unit 231 of Lincoln County; Hunt Units 161, 162 and 221 of Nye County, Hunt Units 011, 021 and 022 of Washoe County and Hunt Units 104, 132, 221 and 222 of White Pine County. A total of 117 coyotes were removed during these efforts in May and June of 2024 and 5 dens were removed.

Project Summary

County	Hunt Unit	Location	Number Removed
Elko	065		3
Elko	102		4
Elko	104		3
Elko	121		4
Lincoln	231		20
Nye	161	South End of Unit	32
Nye	162	South End of Unit	14
Nye	221		3
Washoe	011		7
Washoe	021		7
Washoe	022		11
White Pine	104		1
White Pine	132	South Egan Range	1
White Pine	221		8
White Pine	222		7
		Total:	117

Budget Detail

Project 38: Big Game Protection - Coyotes

Personnel compensation		$10,628.43
Travel/Camp		$3,098.04
Vehicle Use		$1,154.86
Supplies and Equipment		$641.21
Aerial Services		$57,777.41
Program Support (Admin/Indirect Costs)		$19,900.93
Project Total		$93,200.88
Principal Amount Proposed	$100,000	
Balance		***$6,799.12***

Project 40: Coyote Removal – Eureka County

Project Narrative

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. USDA WS removed coyotes in the area in 2011 and 2012. A private contractor removed coyotes in 2014. Intensive, timely and targeted removal of coyotes may assist mule deer population recovery.

During January, February, March and June of 2024, WS removed 90 coyotes in Hunt Unit 144 via aerial gunning and trapping.

Spring fawn ratios from Hunt Unit group 141-145 was 41 fawns per 100 adults which is slightly better than the statewide average of 37 fawns per 100 adults with a sample size of 2,044 deer. In comparison, a fawn a ratio of 43 fawns per 100 adults was observed in the adjacent 151-156 Hunt Unit group during the spring of 2024 with a sample size of 1,411 deer. The population estimate for Hunt Unit group 141-145 was 3,700 in 2024.

Project Summary

Month	Coyotes Removed
January	4
February	4
March	44
June	38
Total:	90

Budget Detail

Project 40: Coyote Removal – Eureka County		
Personnel compensation		$21,688.22
Travel/Camp		$3,276.27
Vehicle Use		$1,143.94
Supplies and Equipment		$369.19
Aerial Services		$34,059.94
Program Support (Admin/Indirect Costs)		$16,435.95
Project Total		$76,973.51
Principal Amount Proposed	$150,000	
Balance		***$73,026.49***

Project 41: Increasing Understanding of Common Raven Densities and Space Use in Nevada

Project Narrative

The purpose of this document is to provide a summary of the monitoring and research objectives for the common raven (*Corvus corax*) research project during the 2024 season. This summary does not represent a complete analysis of the data and findings. Instead, it provides a summary of field efforts and observations concerning ravens in Northern Nevada. This information is preliminary and subject to revision. It is provided to meet the need for timely best science. 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 this information.

The common raven (*Corvus corax*; hereafter, raven) has experienced a rapid increase in population numbers across the Great Basin for over 50 years. Recently, wildlife managers have expressed concern that the increasing raven numbers within the Great Basin, and Nevada in particular, may negatively impact Greater sage-grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) and other species of special conservation status. The Great Basin Bird Observatory (GBBO) and the U.S. Geological Survey (USGS) have been collecting intensive point count survey data on raven populations across approximately seven study sites throughout sagebrush ecosystems in the state of Nevada. These sites are separated to capture variation in site- and landscape-level physiographic and vegetation characteristics. The sites are also located in different climatic zones representing various levels of precipitation and temperature. Sites consist of various levels of anthropogenic impacts and represent variation in distances from urbanized areas. Demographic data on sage-grouse are being collected using VHF and GPS transmitters at each of these field sites. Raven survey data correspond to nesting sage-grouse locations and random locations to investigate raven impacts on sage-grouse nest survival. Information on the density of ravens in Nevada, percent increases over past decades, anthropogenic subsidies that influence raven numbers, and thresholds of raven numbers that impact prey species are mostly unknown and critical to raven management. Best available science is needed to inform effective management strategies to reduce ravens from preying on Nevada's wildlife species of conservation concern.

Raven Monitoring

Using raven count data collected over the last decade we developed a rapid assessment protocol for resource managers to estimate site-level density of ravens. This rapid assessment function (RAF) uses the average number of ravens per count survey to produce density estimates that are strongly correlated with more robust distance sampling methods (Brussee et al. 2021). In the Great Basin, it has been shown that raven densities greater than 0.4 ravens/km2 are associated with below average sage-grouse nest survival (Coates et al. 2020). Using the RAF, we estimated raven density across multiple study sites in Nevada during the 2012–2022 field seasons and plotted the corresponding trends (Figure 2 *in* unpublished report, "End of Season 2022 Progress Update – Raven Research," GBBO). In this report we provide the updated density estimates through June 2024 in Table 2. Due to a few exceptionally large groups of ravens observed during surveys at Susanville and Desert Creek, density estimates appear exaggerated. Therefore, a second density estimate was calculated by excluding raven groups greater than 20.

Our Raptor, Raven, Horse, Livestock (RRHL) protocol was implemented at study sites in California to increase sample sizes across spatial and climatic conditions and to leverage existing datasets. Because we conduct research throughout the Great Basin, we report estimates from areas in California, however, we note that all raven monitoring outside of Nevada was funded by separate sources and grants.

Raven Point Count Surveys

USGS and GBBO technicians conducted 48, 260, 500 and 128 raven point count surveys in March, April, May, and June respectively across all 12 of our Great Basin study sites with a grand total of 936 point count surveys from March – June. We detected 773 ravens to date (n = 48 in March, n = 233 in April, n = 412 in May, n = 80 in June), with an average of 0.83 ravens per survey. All 2024 raven survey data collected is provided in a tabular summary in Table 1 and all survey locations are displayed in Figure 1.

In eastern Nevada, study areas included Elko, Eureka, and Lander Counties. At the Cortez Mountains study area in Eureka and Lander counties, a total of 108 raven point count surveys were completed from March—June and observed 151 ravens in that time. At Cortez, 44 of the 108 point-count surveys were conducted at random locations throughout the study area. At the Pinion Range study area in Elko and Eureka counties, 122 surveys were completed from March through June and 97 ravens were observed in that time; 47 surveys were conducted at random locations.

Raven surveys were also conducted in two study areas located in western and central Nevada. Between March and June, 96 surveys were conducted at the Desatoya Mountains field site in Churchill and Lander Counties and 144 ravens were observed. Of these, 44 were conducted at random locations. In Washoe County, 79 surveys were conducted in the Virginia Mountains between March and June and 69 ravens were observed during this period. There were 30 surveys conducted at random locations in the Virginia Mountains.

In western Nevada, ravens were monitored at three sites within the Bi-State region bordering Nevada and California. At the Mount Grant field site, we completed 13 surveys from April—June and observed zero ravens in that time; zero of those were random surveys. In the Nevada portion of the White Mountains field site (e.g. the Northern White Mountains), we completed four surveys from April—June and observed two ravens. At the Desert Creek field site, 92 surveys were completed from March—June, with 51 of those surveys being random. Crews observed a total of 64 ravens during these surveys.

In California, one raven point count survey was conducted at the Bodie Hills field site in April and zero ravens were observed. We conducted 206 surveys at the Long Valley field site from April through June and observed 104 ravens in that period. Between April and June, 10 surveys were conducted at the Parker Meadows field site and two ravens were observed. During the period March-June, we conducted 100 surveys at the Susanville field site and observed 91 ravens. In the White Mountains South (California), 100 raven surveys were completed from April to June, with 91 ravens being observed.

Raven Nesting Surveys and Egg-Oiling

Wildlife managers in California have identified sage-grouse populations in Lassen and Modoc counties of northeastern California as in need of management support via manipulation of raven reproduction. Previous research in Nevada and California identified a measurable increase in sage-grouse nest survival probabilities when raven nests were oiled with non-toxic mineral oil during egg development (Sanchez et al. 2022). With funding from the Bureau of Land Management, we monitored raven nests in the Susanville area of California and applied oil to some raven nests (n = 14). Because both, sage-grouse and ravens, frequently cross state boundaries in this region, we also monitored raven nests in the Virginia Mountains and in northern Washoe County of Nevada but did not apply oil to raven nests in Nevada.

We monitored 43 raven nests across three study areas in 2024. Thirty nests were monitored in the Susanville area, ten nests were monitored in the Virginia Mountains, and three nests were monitored on both sides of the California and Nevada borders in northern Washoe County.

Because raven chicks are altricial and sometimes cannot be observed from the ground for a couple weeks following hatch, we can only estimate nest survival from nests that can be observed via a camera on an extension pole, allowing for us to count eggs or chicks. In 2024, only 26 of the 43 nests were accessible by ground crews and we therefore did not estimate nest survival by nesting ravens. In future seasons, we plan to deploy a camera equipped drone to better observe nests that we cannot otherwise access.

Apparent nest survival, which can include biases for nests that appear failed wherein chicks are predated quickly after hatching and not observed, or if nests are destroyed before chicks are visible from the ground (e.g., wind), represents only those nests where we observed incubation and then observed chicks or fledglings. Apparent nest survival in Northern Washoe was 1.0 (1/1 nests hatched) and we were unable to determine fate of two nests. In Susanville, we applied oil to fourteen nests; one of which partially hatched and thirteen failed to hatch. Removing oiled nests from apparent survival calculations, 15 nests hatched, one failed (apparent survival of 0.94), and no nests remained with unknown outcomes. In the Virginia Mountains, eight out of nine raven nests hatched (apparent survival of 0.89) and one nest fate was unknown.

In addition to the nest monitoring and egg-oiling, two adult ravens were captured on nest and fitted with GPS transmitters. Both individuals were believed to be female based on behavior. Each individual's nest was oiled before capture. In the future, movement patterns will be looked at pre and post egg treatment.

Project Summary

Research crews documented 43 raven nests across 3 sites in northwestern Nevada and northeastern California. Of these, 25 nests hatched, 15 failed, 3 had unknown fates and 14 raven nests with eggs were oiled to prevent hatching. Twelve nests were observed in transmission lines, 3 nests were on buildings or structures and 28 nests were discovered in cliffs and trees. Two ravens were captured and fitted with GPS-satellite tracking devices. The table below indicates survey effort by month during the spring of 2024 for raven, raptor, horse and livestock and the number of ravens detected during those surveys.

Month	RRHL Surveys	Ravens Detected (# of Sites)
March	48	48 (6)
April	260	233 (12)
May	500	412 (11)
June	128	80 (11)

Budget Detail

Total Expenditure during State Fiscal Year 2024 = $218,750.00

Project 42: Assessing Mountain Lion Harvest in Nevada

After assessing data needs in Phase I, the University of Nebraska, Lincoln developed a Bayesian population model for mountain lions in Nevada using age-at-harvest data as the empirical foundation. The framework of the model was a matrix population model that incorporated age and sex-specific survival and adult female fecundity. Population size was constrained by the number of cohort-specific harvest and non-harvest mortalities observed across consecutive years. In the absence of representative survival and reproductive data, estimates for survival, harvest and non-harvest rates, and fecundity were integrated as informed priors characterized by estimates from published literature and current radio-tracking data (spatially constrained). The model indicated the mountain lion population in Nevada was stable ($\lambda = 0.99$) with a male bias.

Estimates for harvest rates were higher for males (6.3%) than females (4.7%); yet, there was no statistical difference in non-harvest rates between the sexes. Assuming estimates of age for young of the year were accurate, both harvest and non-harvest rates were less than 0.5%. The model also indicated there was substantial interannual variation in survival and adult harvest and non-harvest rates. While the present model was able to achieve realistic population estimates for mountain lions in the state of Nevada, interpretation of model predictions depends on a few key assumptions. First, although priors for model parameters (i.e., population vital rates) were informed by either past or present vital rate estimates, these parameters were not simultaneously estimated through robust statistical methods applied to empirical data as would be expected in a true integrated population model context. Using informative priors can be beneficial provided they match or encompass reality. However, the more these informative priors deviate from reality, the more likely they will induce bias in model results. Second, the current model was sensitive to starting population priors such that if these starting population estimates were too far below what was likely realistic for this population, the model would fail to converge due to the inability of the population to maintain adequate numbers of individuals that would later appear in empirical annual harvest and non-harvest counts. If the starting population was too far above realistic values, the population would experience exponential growth and push estimates for harvest and non-harvest rates toward zero. Despite an unknown initial population size, the model performed quite well using age-at-harvest numbers as constraints on 'future' population size, particularly on the lower bounds. Third, the current model assumed harvest rates, non-harvest rates, and survival did not vary in relation to either harvest effort or environmental conditions. The model estimates for harvest rates, non-harvest rates, and survival were reasonable considering we had limited flexibility to account for interannual variation due to the absence of harvest data or a stronger mechanistic understanding of the environmental conditions that might affect harvest success. However, support for a random effect of year in harvest rates, non-harvest rates, and survival indicated that year-to-year variation was present. Fourth, probability of a female breeding was entirely dependent on the model-defined prior and therefore relied on our assumptions of what such a probability might be. Although these are important and influential assumptions, the model can be improved upon through targeted data collection and robust statistical sub-model integration that will reduce the population model's reliance on informed parameters.

The approximate population size of mountain lion across the entire State of Nevada between 1987 and 2015 was between 3,000 and 3,500 animals. Reported harvest during the 2023-2024 season was 148 mountain lions which represents approximately 5 percent of the lower population estimate range. No expenditures were realized for this project in State Fiscal Year 2024.

Project 43: Mesopredator removal to protect waterfowl, turkeys, and pheasants on Wildlife Management Areas

Project Narrative

This project was established to assist upland game and waterfowl population on the Department's Wildlife Management Areas (WMAs), particularly during the nesting season, by removing small mammalian predators (mesopredators) such as skunks, raccoons, coyotes, foxes and even feral cats in some instances. Some WMAs have higher than expected populations of mesopredators due to habitat suitability and, in some cases, juxtaposition to suburban development and agricultural areas. These situations, which apply to WMAs such as Argenta, Mason Valley, Overton and Carson Lake, can influence mesopredator abundance such as raccoons, skunks, coyotes and feral cats. Here, we will outline mesopredator removal by USDA-Wildlife Services for each WMA where this work was conducted during State Fiscal Year 2024.

Project Summary

- Carson Lake WMA – a total of 17 coyotes were removed during March of 2024. The intent here was to enhance nest success for waterfowl and shorebirds using this management area.
- Overton WMA – Five bobcats, 13 coyotes, 4 raccoons, 7 striped skunks and one gray fox were removed from Overton WMA from February through April of 2024. These efforts were conducted to enhance nest success for upland game birds such as Gambel's quail and Rio Grande turkey as well as waterfowl and shorebirds.
- Argenta WMA – two feral cats and 4 striped skunks were removed from the Argenta WMA during May of 2024.
- Mason Valley WMA – A total of 35 coyotes were removed from the Mason Valley WMA during March and April of 2024. Additionally, 10 raccoons were also removed. The removal of these animals was intended to benefit nesting upland game birds such as California quail, wild turkey and waterfowl species.

Budget Detail

Project 43: Mesopredator removal

Personnel compensation		$20,748.03
Travel/Camp		$3,214.03
Vehicle Use		$2,798.15
Supplies and Equipment		$2,307.39
Aerial Services		-
Program Support (Admin/Indirect Costs)		$7,891.86
Project Total		$36,959.46
Principal Amount Proposed	$50,000	
Balance		***$13,040.54***

Project 44: Lethal Removal and Monitoring of Mountain Lions in Area 24

Project Narrative

A major concern for many western state wildlife agencies is the current growth trajectory of wild horse (*Equus ferus caballus*) populations, and the lack of authority possessed by state agencies to address it with meaningful solutions. The State of Nevada harbors approximately 60% of all federally managed wild horses in the west while also hosting a multitude of big game hunting opportunities. For this reason, the Nevada Department of Wildlife (NDOW) has expressed interest in determining what, if any, effect wild horse overabundance is having on mountain lions and by extension, their native prey species, such as mule deer (*Odocoileus hemionus*), and bighorn sheep (*Ovis canadensis*). Given these concerns, our goal is to evaluate the relationships between feral horses and the native species they interact with in the arid regions of western North America. Specific project objectives include:

1) To determine relative proportion of mountain lion diet consisting of feral horses versus other ungulate prey in southeastern Nevada.
2) To test whether mountain lions switch to bighorn sheep or increase predation rates on mule deer following removal of feral horses.
3) To determine effect of feral horse removal on movement and home range of mountain lions.
4) To determine dietary overlap between mule deer and feral horse during the growing season.

This report summarizes progress with respect to these objectives as of July 31, 2024.

Project Summary

*Fieldwork and data collection*Since summer 2023, we have had a full-time field crew consisting of 1-4 individuals working out of Caliente, Nevada. Three streams of data are being collected. These consist of mountain lion captures and subsequent GPS location data, a passive photo survey based on remote camera observations, and field evaluation of mountain lion prey remains. Each is discussed in turn, below.

Personnel
Peter Iacono left the project in summer 2023, following successful completion of his MS thesis. In January 2024 we promoted Hannah Klugman from technician to MS student to backfill this vacancy. Hannah has been on the project for almost three years and is familiar with all aspects of data collection and logistics. She is projected to defend in spring 2026.

Mountain lion captures
We currently have 3 collared mountain lions on the air, two of which occupy the Delamar Mountains and one in the southern Clover Mountains. Lion captures are currently taking place at approximately annual intervals, with more tentatively slated for autumn 2024. Collars are programmed to record a GPS fix once every 4 hrs.

Photo survey. The summer of 2024 marked three full years of photo monitoring. A camera grid consisting of 50 cameras in the Clover and Delamar Mountains has collected over 400,000 photographs of wildlife. The survey is being maintained year-round and used to estimate prey availability. These data are serving as the primary predictor variable in subsequent models of prey selection (see Iacono et al. 2024).

In addition, two randomly selected springs have been monitored; one in the Delamar Range, and the other in the Clover Mountains. We worked with a USU wildlife undergraduate on a senior thesis analyzing these data. Figure 1 below illustrates the circadian rhythms of mule deer and feral horses with respect to water visitation.

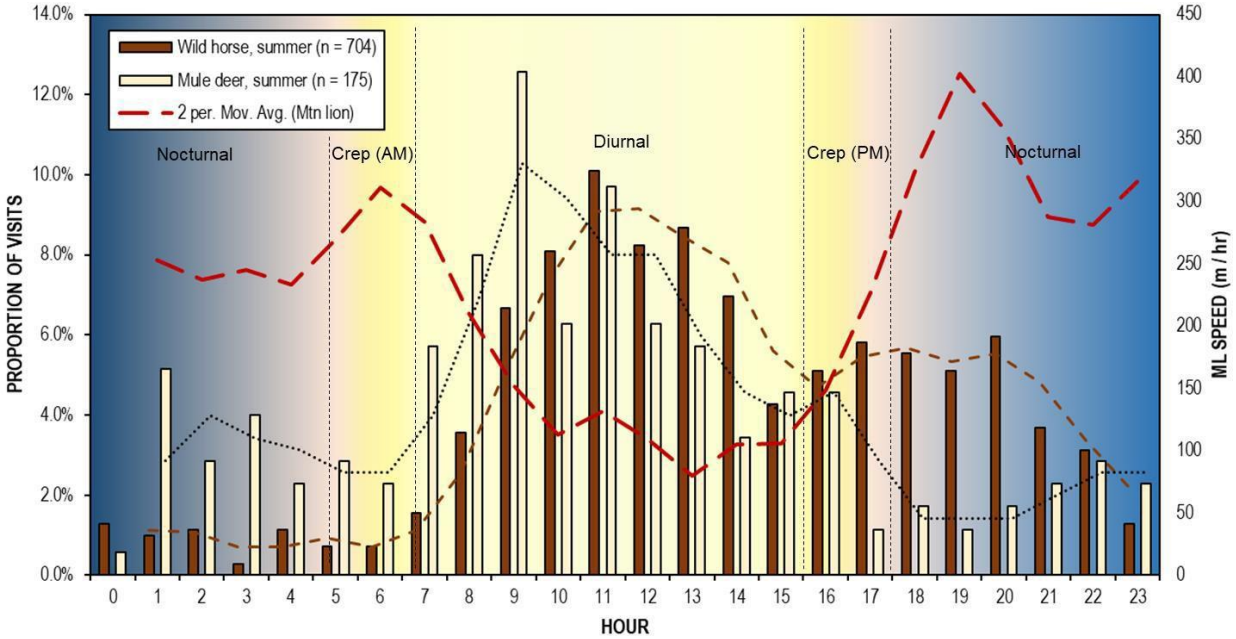


Figure 1. Circadian patterns in water visitation by mule deer (beige bars) and feral horses (brown bars). Mountain lion movement activity times are represented by the red dashed line.

Prey composition

We are using mountain lion GPS collar data to identify location clusters formed while feeding. These are mapped and investigated to quantify the species, sex, and age class of the prey that our sample of collared lions is exploiting. To date, 1,538 cluster sites have been visited representing prey items killed from 2018 through spring 2024. These efforts have resulted in the location and identification of over 1,118 prey items. No evidence of predation was found at ~ 23% of sites. As of this writing, feral horses represent approximately 35% of carcasses identified (n = 416), and mule deer comprise 53% (n = 625). The remaining kills were coyotes, elk, and trace amounts of other species, or unidentified remains. No lion-killed bighorn sheep were detected this year.

Scientific products

The first chapter of Peter Iacono's MS thesis was published in July 2024 in the journal *Ecosphere*. This paper evaluates changes in mountain lion prey composition following the removal of > 400 horses in preparation for range restoration efforts brought about by three fires that burned the study area in 2020 (Iacono et al. 2024). No significant changes in prey composition were detected. Collection of data related to predator captures and movements in the Delamar/Clover Mountains, estimating deer and horse abundance via camera grid, and mountain lion prey composition in the local ungulate community (including bighorn sheep) is slated to continue through 2025.

Bighorn Sheep herd health (Game Biologists Matthew Shank and Kade Lazenby)
The Delamar Mountain bighorn sheep herd exhibited higher lamb recruitment than previous years in 2024. However, the overall population continues to remain stable at low levels. Why the bighorn sheep herd in the Delamar Mountains remains stable at low levels is not well understood, although several known factors affect the herd. Mountain lion predation has been documented within the Delamar Mountains and may have a limiting effect on the small population. Disease-related mortalities from *Mycoplasma ovipneumoniae* have also been documented in this herd in 2015. In addition, bighorn sheep may be dispersing to adjacent mountain ranges.

Drought and habitat loss are compounding factors that may make bighorn sheep within the Delamar Mountains more susceptible to a depressed population. Drought conditions have deteriorated habitat quality over the last several years. According to the U.S. drought monitor, most of the area was in exceptional or extreme drought between September 2020 and December 2023. Precipitation received during the summer and fall of 2023 and the winter of 2023-2024 was greater than the documented mean. In 2023, Community Environmental Monitoring Program weather stations in Pioche and Alamo registered 115% and 150% of average precipitation respectively, which should have led to improved range conditions and may explain the above average lamb production. Habitat conditions in the area continue to be affected by pinyon and juniper encroachment and feral horse use. In 2020 multiple wildfires burned large areas of preferred bighorn sheep habitat in the area. Severe drought conditions, limited water distribution, and removal of preferred habitat have put the Delamar Mountain bighorn sheep herd at higher risk of population collapse. Ongoing predator control efforts and maintenance of water development projects are very important for the future of this bighorn sheep population.

The last aerial survey in the Delamar Mountains was conducted in September of 2024. This survey resulted in the observation of 52 bighorn sheep classified as 20 rams, 22 ewes, and 10 lambs. This survey effort was extensive and provided vital knowledge of the population growth rate. This is how the lamb ratio of this survey compares to previous years (26 lambs:100 ewes in 2017, 8 lambs:100 ewes in 2019, 45 lambs:100 ewes in 2020, 25 lambs: 100 ewes in 2022 and 45 lambs: 100 ewes in 2024), the population is in a “recovery” pattern currently. Hunter harvest success has remained high in the unit with the success being (100% in 2023, 100% in 2022, 60% in 2021, and 100% in 2020). Drought conditions in 2023 may have led to lower sample size and ewe to lamb ratios. Overall sample size was low in unit 241 but recruitment seems promising and can aid in recovery.

Work plans for the 2024-25 fiscal year include the following objectives:

1) Increase sample of GPS-collared mountain lions on study area during Autumn-Winter 2024.
2) Hire and train an additional technician to maintain data collection during winter 2024-25.
3) Enter and analyze photo data collected since spring 2023.
4) Submit the second manuscript from P. Iacono’s MS thesis evaluating prey selection in a multi-prey community (winter 2024/2025).
5) Send fecal samples to lab and analyze second year of diet results from mule deer--horse dietary overlap study (spring 2025).

Budget Detail

Total Expenditure during State Fiscal Year 2024 = $31,953 (American Lion Specialists)

Project 46: Investigating Potential Limiting Factors Impacting Mule Deer in Northwestern Nevada

Project Narrative

Recent decades have seen Northwest Nevada's mule deer herds decline, resulting in fewer tags issued and lower-quality hunt experiences. Several factors may be contributing, including predation, drought, improper livestock grazing practices, wildland fire, invasive plant species, and competition from feral horses. A combination of these factors is likely at play, and it is the Department's desire to better understand the situation. This project aims to use remote data collection technologies (i.e., camera traps and weather stations) to study mule deer, mountain lion and feral horse populations in northwest Nevada. This information will lead to a better understanding of mule deer abundance and population regulation in the region and inform management of this underperforming population.

During FY 2023-24 efforts focused on classifying and analyzing data collected from 200 camera traps in 2022-23 and analyzing weather station data. After 2.5 years of data collection, we have detected mule deer 1,865 times at 145 camera locations, feral horses 1,549 times at 80 locations, and mountain lions 65 times at 30 locations. Photo detections of these species were analyzed to understand habitat relationships for each species in Northwest Nevada, and co-occurrence patterns for the three species across the region.

Preliminary results suggest that mountain lion occurrence at camera locations is more related to mule deer occurrence than feral horse occurrence, and that local topography may be an important mediator of this relationship. Mule deer detections were also analyzed using the time-to-event (TTE) model to estimate mule deer density and abundance in Northwest Nevada. Preliminary abundance estimates from 2022 were comparable, but slightly higher than 2021 estimates, indicating cameras and the TTE model show promise for estimating mule deer abundance at broad spatial scales. However, further refinements to the model, which will occur in FY 2024-25 will be needed to draw firm conclusions about mule deer abundance trends in the study area since the start of the project (late 2020). Data were collected from more than half of cameras and all weather stations at the end of the fiscal year. Data from the remaining cameras will be checked early in the State Fiscal Year 2025.

Project 46 continues to progress as expected, with 3.5 years of camera data obtained by the end of the State Fiscal Year 2024. Preliminary analysis indicates that all deliverables of the project will be obtained. Cameras and weather stations remain in the field as of the start of FY24 to collect a final year of data before equipment is removed at the end of the FY24 as originally proposed. The project should be extended at least until the end of FY25 so that we can finish analyzing the data we have collected thus far and meet project deliverables. Given progress to date on analyses, we anticipate we can meet project deliverables with the data collected thus far. Any additional data collected at the end of State will only further strengthen our inference on the population trends, optimal monitoring protocols, and factors of limiting mule deer in northwest Nevada.

Project Summary

Research products finalized during the 2023-24 FY include two peer-reviewed manuscripts. One manuscript quantified the distribution and habitat requirements of female black bears with cubs in their Nevada range in the journal Ecology and Evolution (link); a second manuscript quantified factors correlated with western gray squirrel expansion into piñon-juniper woodland in the Journal of Mammalogy (link). Both publications relied on data collected under Project 45 (black bear distribution and abundance in Nevada). A third manuscript on drivers of carnivore species richness in western Nevada is currently being revised for publication in the Journal of Biogeography.

Budget Detail

Total Expenditure during State Fiscal Year 2024 = $183,780

The total initial budget for this project was $160,000; however, Project 45 was combined with this project which added another $20,000 for a total of $180,000 for the project.

Project 47: Mule Deer Protection

Project Narrative

Underperforming mule deer populations will be identified by local mule deer enhancement program committees. Working with the mule deer oversight committee, NDOW staff, and outside collaborators, predation as a limiting factor will be assessed. If predation is determined to be a likely limiting factor, one of two steps may be taken:

1. Address predation through projects 37, 38 or 47 for MDEP identified projects.
2. Working with an outside collaborator, conduct experimental management to address predation and create a model to inform the department when predator removal will and will not benefit mule deer populations.

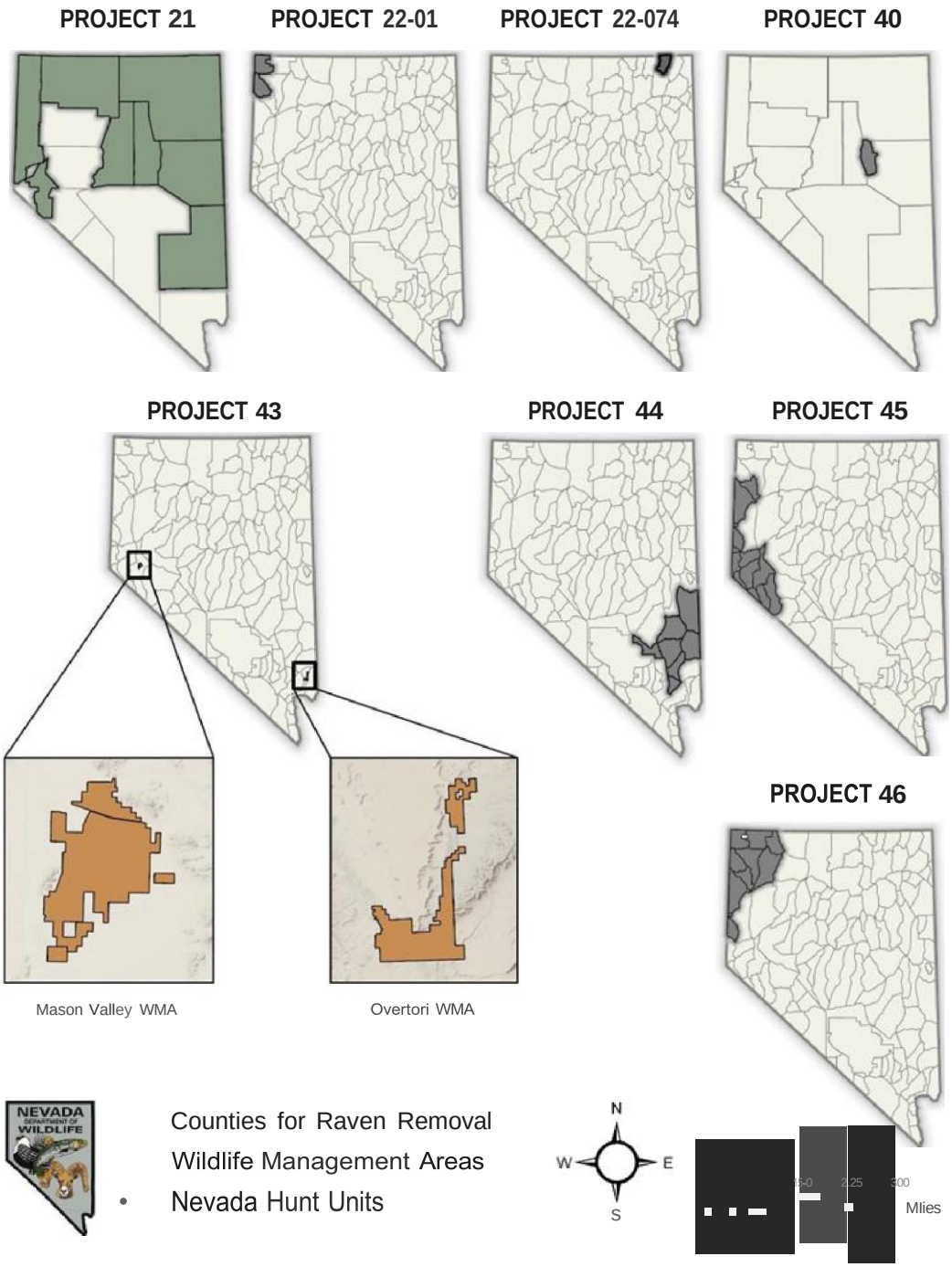
Project Summary

USDA – Wildlife Services removed 16 coyotes in Lincoln and White Pine County during June of 2024 to potentially lessen fawn predation. Six coyotes were removed in the Wilson Creek Range of Hunt Unit 231 and 4 coyotes were removed in the Delamar Range of Hunt Unit 241 in Lincoln County. In White Pine County, 3 coyotes each were removed from Hunt Unit 221 near Preston and Hunt Unit 222.

Budget Detail

Project 47: Mule Deer Protection		
Personnel compensation		$3,391.03
Travel/Camp		$876.56
Vehicle Use		$ -
Supplies and Equipment		$2,550.00
Aerial Services		$39,593.47
Program Support (Admin/Indirect Costs)		$12,600.59
Project Total		$59,011.65
Principal Amount Proposed	$100,000	
Balance		***$40,988.35***

Project Areas:



Project	$3 Planned Expenditures	P-R Planned Expenditures	P-R Actual Expenditures	Wildlife Services Expenditures	NDOW Non-lethal Expenditures	Balance
Department of Ag Transfer [a]	$14,000	N/A	$0	$0	$14,000	$0
Project 21	$175,000	N/A	$0	$221,216.25	$0	*($46,216.25)*
Project 22-01	$100,000	N/A	$0	$78,498.62	$0	$21,501.38
Project 22-074	$20,000	N/A	$0	$0	$0	$20,000.00
Project 37	$100,000	N/A	$0	$211,842.06	$0	*($111,842.06)*
Project 38	$100,000	N/A	$0	$93,200.88	$0	$6,799.12
Project 40	$150,000	N/A	$0	$76,973.51	$0	$73,026.49
Project 41	$75,000	$225,000	$175,000	$0	$43,750	$81,250.00
Project 42*	$5,000*	$15,000*	$0	$0	$0	$20,000.00*
Project 43	$50,000	N/A	$0	$36,959.46	$0	$13,040.54
Project 44	$125,000	$0	$0	$0	$64,953[b]	$60,047.01
Project 45*	$5,000*	$15,000*	$0	$0	$0	$20,000.00*
Project 46	$40,000	$120,000	$137,835	$0	$45,945	*($23,779.98)*
Project 47	$100,000	$0	$0	$59,011.65	$0	$40,988.35
Total[c]	$1,059,000	$375,000	$312,835	$777,702.43	$168,648	$174,814.60

[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] This amount was paid to American Lion Specialists for capture work associated with the Delamar and Clover Mountains project (Project 41) and the Sheldon NWR capture project with expenditures totaling $31,952.99 and lion removal work associated with Project 37 in the amount of $33,000.

[c] Fiscal year 2023 predator fee revenues totaled $944,410. The Department needed to allocate about $755,528 on lethal removal to meet the requirements set forth by Assembly Bill 78. Proposed predator projects for fiscal year 2024 included $861,191.94 for lethal work, $777,702.43 was spent on lethal removal in fiscal year 2024.

* Balances associated with these projects were transferred to cover other costs. Project 42 concluded, leaving that balance available for other projects. Projects 45 and 46 were combined into one project allowing for a total of $180,000 for that project.

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