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Western Ecological Research Center

Greater Sage-grouse Project, Nevada

2015 General Information and Protocols for Field Operations and Monitoring

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Prepared for:
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1.0 Introduction

Greater Sage-grouse (*Centrocercus urophasianus*; hereafter, sage-grouse), are the largest grouse species in North America and occupy sagebrush steppe ecosystems, which dominate the western portion of the continent. They are a large, round-winged, chicken-like bird with a mottled, cryptic pattern (Figures 1 & 2). Both sexes have a black belly, but males have a large white ruff around their neck. Air sacs on the chest of the males are inflated as part of their mating display.

Sage-grouse range has declined substantially since Euro-American settlement of western North America (Schroeder et al. 2004), and population numbers have been reduced in many states (Connelly et al. 2004), including Nevada. Sage-grouse are thought to be an important indicator species for the health of sagebrush steppe ecosystems based on their specific needs at different life-stages within these communities (Connelly et al. 2004). Sage-grouse are sensitive to landscape disturbances that often accompany human uses of sagebrush habitats; however, such land uses are often economically important. Anthropogenic alterations to the landscape, such as habitat loss and fragmentation resulting from energy exploration and infrastructure development, urbanization and agricultural conversion are primary threats to sage-grouse populations (Connelly et al. 2000). Furthermore, common raven (*Corvus corax*; hereafter raven) populations, a synanthropic sage-grouse nest predator, are increasing throughout the western United States (Sauer et al. 2011) as transmission lines and other tall structures used for nesting and perching (Steenhof et al. 1993; Knight and Kawashima 1993) become more prevalent across the landscape. Biologically sound and scientifically defensible information on the responses of sage-grouse to such disturbance is therefore necessary to develop strategies for minimizing impacts and conducting effective mitigation.

Figure 1. A male sage-grouse displaying on a lek (Left) and a male sage-grouse after a successful trapping attempt (Right).

Sage-grouse have recently been designated as a candidate species under the Endangered Species Act; however, in the Great Basin, relationships between habitat selection and population vital rates of sage-grouse are not well-understood. Furthermore, information on direct and indirect effects of anthropogenic activities, such as energy exploration and development, on sage-grouse populations are currently limited. The U.S. Geological Survey (USGS) Western Ecological Research Center (WERC) therefore initiated an intensive study to monitor patterns in movement, habitat selection, and population vital rates throughout all life stages of sage-grouse populations within the state of Nevada. To accomplish this, we are conducting multiple before-after-control-impact studies (BACI) designed to measure sage-grouse population response during pre- through post-construction phases of multiple energy development projects. The results we expect from this study will help conserve sage-grouse populations by 1) contributing to our overall knowledge of sage-grouse population demographics and space-use; 2) providing

sound scientific data to implement effective mitigation strategies; and 3) developing effective conservation and management guidelines.

Figure 2. A female sage-grouse foraging on a mountain top (Left), and a female sage-grouse after a successful trapping attempt (Right).

2.0 Study Sites

Pine Nut Mountains

Populations within the Bi-State Planning Area (BPA) are genetically distinct and were recently designated as a Category 3 Candidate Species by the U. S. Fish and Wildlife Service. Evidence suggests that habitats selected by sage-grouse during different life-stages within the BPA are different than range-wide populations. Changes in vegetation communities throughout the Pine Nut Mountains of Nevada are thought to have contributed to sage-grouse population decline. Pinyon pine (*Pinus monophylla*) and Utah juniper (*Juniperus osteosperma*) woodlands are expanding into sagebrush steppe, which replace sagebrush (Miller and Wigand 1994, Miller and Tausch 2001) and is thought to reduce sage-grouse populations (Connelly et al. 2004). Encroaching Pinyon and Juniper (hereafter PJ) woodlands reduce understory vegetation as tree density increases (Miller et al. 2005), which has been reported for the Pine Nut Mountains (Bi-State Local Planning Group 2004).

Biologically sound and scientifically defensible information on the Pine Nut sage-grouse population is needed within the BPA to better inform management decisions. Research objectives in the Pine Nut Mountains are to 1) better understand habitat selection of sage-grouse within the Pine Nut Mountains in relation to PJ thinning; 2) identify key habitats that influence vital rates of sage-grouse populations; 3) identify movement patterns and corridors across the landscape; and 4) obtain blood samples for genetic analyses to determine if the Pine Nut population is genetically distinct from other populations within the BPA.

Although populations are declining in the Pine Nut Mountains, 10 leks have been identified within two primary lek complexes. An active "north" complex consisting of one primary lek (NOPN 7) and several satellite leks, and a "south" complex consisting of two documented lek locations with varying levels of recorded activity (Bi-State GSP). Linkages between the North and South portions of this PMU, as well as between this PMU and the Desert Creek PMU, to the south are poorly understood. Detailed locations of sage-grouse marked with radio-transmitters and Global Positioning System (GPS) transmitters will help identify movement patterns and corridors between these seasonally used habitats.

Virginia Mountains

As the need for renewable energy grows nationwide, it is anticipated that Nevada will generate 15% of energy using wind, solar, and geothermal sources by 2013. Approximately 67% of public land in the state of Nevada is administered by the U. S. Department of Interior, Bureau of Land Management (BLM). Due to limited power transmission capabilities in Nevada, new utility scale transmission lines will be constructed to provide a conduit for many wind-based facilities. The increase in development of anthropogenic structures in the environment may have detrimental effects on wildlife populations. Information regarding the direct and indirect impacts of developing anthropogenic structures in sage-grouse habitat is lacking. Infrastructure from energy development may affect habitat selection and seasonal movement patterns of sage-grouse. Long-term, indirect effects are probably the most important and complex. For example, anthropogenic structures may cause increased predation rates on grouse, despite continuing population declines. Common ravens are generalist predators of eggs and chicks and have increased 300% in the past 27 years in the U.S. Ravens thrive in human-altered landscapes and anthropogenic structures (e.g., transmission towers) are used as nesting and perching substrates. Tall structures that intersect nesting habitat may have detrimental effects on sage-grouse population persistence. Therefore, we will investigate the effects of development of renewable energy on sage-grouse populations in the Virginia Mountains of northwestern Nevada.

The Virginia Mountains is a potential site for future wind and solar energy developments. The study site encompasses approximately 691 km² of BLM and private lands. California borders the western side while Pyramid Lake runs along the eastern portion of the Virginia Mountains. There are two known active leks within the study area. Sheep Springs lek is located near Fish Springs Ranch on the northern slope of the Virginia Mountains, and Spanish Flat is approximately 14 km southeast of Sheep Springs, near Tule Peak.

Tuscarora Mountains and McGinnis Hills

ORMAT Inc. has recently established geothermal energy facilities at McGinnis Hills in Lander County and Tuscarora Mountains in Elko County. Impacts of geothermal development on sage-grouse populations is largely unknown. It is thought that noise levels directly displace grouse from breeding areas, but distances and values have not been identified to help guide management. A major goal of this research is to identify potential negative impacts during geothermal exploration and production on sage-grouse population dynamics in order to develop and implement effective mitigation plans.

The McGinnis Hills study area is a 44,206 ha isosceles triangle north of Highway 50, near Austin, With Mount Prometheus serving as the southern tip, the left edge of the triangle extends 27 km north along the ridge of the Toiyabe Range and southeast across Grass Valley, near Bates Mountain. Grass Valley Road runs through the center of the study area and serves as the western boundary of the lekking grounds, which cover an area approximately 1,024 ha. The McGinnis Hills study area is topographically diverse consisting of both high and low elevation sagebrush communities which interface with conifer and riparian areas.

The Tuscarora study site is located 77 km north of Elko, NV, and encompasses 50,602 ha of the Independence Valley and surrounding mountain ranges. At the north and western edges of the valley are the Tuscarora Mountains, with the Independence Mountains extending south to north on the east side of the valley. Highway 226 provides access to much of this area. The sage-grouse lek sites are found within a 579 ha polygon at the north end of the valley, with the foothills of the Tuscarora Mountains and Highway 226 serving as study site boundaries. These lek sites are near the geographic center of the study area, and at the center of a complex of multiple hotsprings. These hotsprings highlight a unique characteristic of the study site and, combined with the South Fork of the Owyhee River, Bull Run Reservoir and numerous tributaries and wet upland springs, provide a relatively large amount of surface water in the study area. Together, these natural water sources enable two major industries within the valley—livestock ranching and geothermal energy production.

SWIP Corridor (Southwest Intertie Project)

The negative and positive associations between energy-related tall anthropogenic infrastructure in the ecosystem and sage-grouse populations are not well understood. Sage-grouse distribution and population persistence may be influenced by development in multiple ways. For example, transmission line development may influence predator communities, habitat quality, or cause fatality through direct collisions. Although research has identified potential indirect effects (defined as cause-effect relationship with intermediate effect), the mechanisms are largely unknown. For example, infrastructure has been shown to increase numbers of raptors and ravens by providing alternative perching and nesting substrates. Therefore we initiated a BACI study design to investigate the effects of tall anthropogenic structures on sage-grouse populations in northeastern Nevada.

The Southwest Intertie Project (SWIP) Corridor of Nevada, also known as the "One Nevada Transmission Line," outlined over 500 miles of transmission line to be developed by Great Basin Transmission, LLC. This project is proposed to extend from north Jerome County, Idaho, south to the Harry Allen Substation in Clark County, Nevada. Study leks were subsampled at incremental distances from the SWIP corridor to assess impacts of construction and infrastructure on vital rates of local sage-grouse populations in Elko and White Pine Counties. Five distance classes from the SWIP corridor were created: 0 – 1.9, 2.0 – 5.9, 6.0 – 15.9, 16.0 – 25.9, and 26.0 – 50.99 km. Three leks were selected for each of the first three distance categories and one lek selected within the 16 – 25.9 and 26.0 – 50.99 km distance classes, for a total of 11 leks identified for monitoring at varying distances to the SWIP corridor. In 2010, the proposed SWIP corridor was rerouted to avoid direct contact with the Chalk Springs and Primrose Flat leks. The varying distances of selected leks to the SWIP corridor will provide a sufficient sample size to monitor impacts of transmission line construction on sage-grouse population dynamics.

Midway (Pancake/White Pine Mountains)

Midway Gold Corp. is developing two mineral extraction sites, Pan and Gold Rock, within the study area in Eureka and White Pine Counties. We will monitor populations of sage-grouse in the Pancake and White Pine Mountain Ranges of Eastern Nevada in order to assess the impacts of mining development and infrastructure on sage-grouse population vital rates, changes in habitat selection, and changes in predator (raven/raptor) demographics. The study area is located primarily within the Pancake and White Pine Mountain Ranges and within the Newark, Cathedral, Railroad, and Little Smokey Valleys in White Pine County, NV. The Pan project is located approximately 22 miles southeast of Eureka, Nevada, at the northern end of the Pancake Mountains. The Gold Rock Project Site is located approximately 8 miles southeast of the Pan property, on the east side of the Pancake Range. Based on NDOW lek data, we have identified eight leks in the study area ranging from ~ 1.5 to > 25 km from proposed mining activities (including proposed mine sites and infrastructure). In 2011, a total of 188 male sage-grouse were observed on all leks combined (NDOW data). These eight leks will provide a sufficient sample size and adequate distribution of breeding birds for monitoring at varying proximities to mining activities.

Desatoya Mountains

In cooperation with BLM, NDOW, and private landowners, the Desatoya Mountains Habitat Resiliency, Health and Restoration Project is a proposed landscape-scale, integrated habitat restoration and maintenance project within the Desatoya Mountain Range in Churchill and Lander Counties, NV, encompassing approximately 230,000 acres. The project's major goal is to improve wildlife habitat that has been degraded by PJ encroachment, overgrazing, and fire suppression, through enhancement of sagebrush steppe, meadow, riparian, and aspen communities. Expansion of PJ reduces the quality of suitable habitat by altering vegetation dynamics in these communities, including declines in shrub, forb, and grass species diversity and abundance.

Habitat restoration and enhancement techniques will include various PJ removal treatments (20 – 100% removal) and fence construction to improve habitat for sage-grouse and other wildlife. We will initiate a similar research design as with other sites to monitor the response of sage-grouse populations to sagebrush steppe restoration in the Desatoya Mountains. This project will prioritize on enhancing wet meadow complexes that are

critical brood rearing habitat areas. We have identified and plan to monitor eight leks in the Desatoya Mountains and Smith Creek Valley.

Huntington Valley and Mary's River (Nobel Energy)

In cooperation with NDOW, USGS personnel plan to monitor sage-grouse at two main study areas, of which hydraulic fracturing activities are occurring within Elko County, NV. We will focus primarily on lek monitoring in areas and radio telemetry of sage-grouse associated with these leks. This initial investigation will lead to a general understanding of sage-grouse movement patterns, demography, and habitat at the study sites in relation to the energy extraction activities. This initial year will also provide important baseline information for an extended study that investigates broader responses of sage-grouse populations to anthropogenic activities.

We propose to monitor sage-grouse populations in two areas located in Elko County, NV. The selection of project areas will be based on the where oil exploration and extraction activities are actually occurring on the landscape, and in consultation with Noble Energy and NDOW biologists. These areas may likely include the Mary's River Exploration and Huntington Valley Project Areas.

The Mary's River Exploration Project Area is located in the Tabor Flats area, about 6 km west of Wells, and includes about approximately 39,500 acres of land, of which 52% is administered by the BLM with the remainder in private ownership. Bishop Creek and the Humbolt River occur within the boundaries of the project area. Elevation ranges from 1600 – 1750 m. Hydraulic fracturing will likely be carried out within the first couple of years at this site. New roads and drill pads are likely to be constructed, as well as maintenance to existing roads. Operations will take place outside of the sage-grouse breeding season (late summer and fall) to minimize disturbance. A recent survey effort indicated that five known greater sage-grouse leks, two unknown leks and one historic lek occur within 6.5 km of the study area (Hayden-Wing Associates 2014, unpubl. report). The five leks are Antelope Springs, Bishop Flats 1, Bishop Flats 2, Black Mountain (Barry's), and North Tabor Flats. The only assigned trend lek by NDOW among these five is Black Mountain.

The Huntington Valley Project Area is the other proposed monitoring site located south of Elko near Jiggs, and includes approximately 63,500 acres. Huntington Creek and the Smith Creek occur within the boundaries of the project area from the north. Elevation ranges from 1650 – 1770 m. This area consists of five known sage-grouse leks located within approximately 6.5 km from Huntington Valley Project Area, which were Achurra, Branzell, Carville Creek, Green Mountain, and Little Cottonwood lek (Hayden-Wing Associates 2014, unpubl. report). Branzell and Green Mountain leks are considered trend leks by NDOW.

Both sites consists of typical sagebrush communities of northeastern Nevada, with major land cover types comprised of Wyoming and mountain big sagebrush (*Artemisia tridentata*), as well rabbitbrush (*Chrysothamnus* spp.) and other nonsagebrush shrubs at lower elevation. Cheatgrass (*Bromus tectorum*) occurs in many areas throughout the sites.

3.0 Project Objectives

Our overall study objective is to evaluate population response of greater sage-grouse and other wildlife to energy development, mining, and habitat restoration projects within Nevada. Therefore, we initiated a before-after-control-impact (BACI) study design at each site to measure potential impacts of implemented and proposed projects on sage-grouse population vital rates, changes in habitat selection and space-use, and changes in predator demographics. We are using radio telemetry to monitor daily and seasonal movement patters; obtain nest and brood locations; estimate individual, nest, and brood survival; and measure habitat components at used and random locations. We plan to continue this research as part of an on-going study and will produce annual reports containing preliminary findings. Site specific objectives are outlined below.

Pine Nut Mountains

1. Measure lek persistence and changes in male attendance
2. Develop resource selection functions (RSF) during the reproductive life-stages of female grouse using multi-scale analysis (measurements from field and GIS)
3. Estimate nest and brood survival rates in relation to vegetation characteristics selected by sage-grouse at multiple spatial scales
4. Estimate nest and brood survival rates in relation to predator abundance (extensive predator surveys will be conducted to develop a predator abundance indices by species)
5. Identify nest predators using continuously recording DVR with micro-cameras (unambiguous identification of predators is important to fully understand interactions between the predator community and habitat characteristics)
6. Identify seasonal utilization distributions (UD) and movement patterns by sex and age
7. Initiate GPS satellite transmitter monitoring on a subset of adults to obtain more robust daily and seasonal movement, usage, and behavioral patterns before and after treatment of pinyon-juniper
8. Collect blood samples from each bird

Virginia Mountains

Short-term objectives

1. Estimate collision mortality associated tall structures using radio-telemetry
2. Conduct radio-telemetry on a subsample of grouse and measure the effects of anthropogenic structures and road development on probability of occurrence and movement paths using Brownian bridge models
3. Conduct breeding bird surveys before and after anthropogenic development with controls and measure the effects on abundance and number of breeding bird species
4. Survey sage-grouse leks (traditional breeding grounds) before and after energy development with controls and measure differences in male attendance using inference models in Program R

Long-term objectives

1. Conduct field surveys of ravens in sagebrush areas before and after development with controls and estimate changes in population densities and nest density (an effective egg and sage-grouse chick predator) using Program DISTANCE
2. Conduct field surveys of ravens and calculate resource selection functions in relation to anthropogenic structures using binomial mixed models in Program R
3. Measure the effects of raven densities on nest and brood survival of sage-grouse using Program MARK.
4. Conduct habitat measurements at nesting and use areas of greater sage-grouse to develop models and incorporate in maps that identify areas of potential risk to sage-grouse for renewable energy development

McGinnis Hills and Tuscarora Mountains

Purpose

1. Develop an effective collaboration between ORMAT and management and research agencies to better our knowledge of actions that meet energy demands while conserving sage-grouse populations
2. Identify and estimate the positive and negative effect of geothermal related factors on sage-grouse movement, vital rates, and lek attendance using a well-designed study
3. Develop multiple publishable products, based on these findings, which could be used in guideline standards at the national and state level for geothermal energy development
4. Develop a spatially-explicit map of sage-grouse habitat in relation to the geothermal site to better-inform upcoming decisions by land managers and developers

Short-Term objectives

5. Estimate probability of lek persistence and identify changes in grouse lek attendance and visitation rates in relation to variation in noise associated with geothermal activity

6. Estimate probability of lek persistence and identify changes in grouse lek attendance and visitation rates in relation transmission lines, roads, and facilities associated with geothermal activity
7. Estimate raven densities by habitat type and in relation to distance to transmission lines and facilities.
8. Identify seasonal use areas, movement corridors, and identify patterns in movement between seasonal habitat in relation to power lines and facilities

Long-term Objectives (10-year period)

1. Develop and assess nest and brood survival inference models
    a. Investigate interactions between habitat selection, geothermal-related anthropogenic factors, and fitness (e.g., nest survival)
    b. Investigate covariates of distance to right-of-way, raven abundance, and sign of badger activity, as well as individual covariates (e.g., grouse age).
    c. Evaluate covariates at multiple spatial scales
2. Identify changes in composition of predators that depredate sage-grouse nests in relation to power lines and facilities
3. Measure changes in numbers of ravens nests and nesting substrate (anthropogenic versus natural) in relation to power lines and facilities

SWIP

1. Quantify collision mortality associated with tall structures and transmission lines
2. Measure lek persistence and changes in attendance in relation to distance from the transmission corridor using before and after data
3. Measure raven densities by habitat type and in relation to distance from transmission corridor using control and impact study sites
4. Evaluate the effects of tower designs (lattice versus tubular type structure) on frequency of raven and raptor nesting and perching and potentially different perch devices
5. Use Global Positioning System (GPS) transmitters to evaluate differences in spatial use of habitats by sage-grouse
    a. Investigate movements between important seasonal habitats, and evaluate the potential of the southern SWIP corridor to act as a barrier to such movements
    b. Evaluate seasonal home range size between control and treatment sites and as a function of distance to the transmission line
6. Measure changes in numbers of ravens nests and nesting substrate (anthropogenic versus natural) in relation to distance to transmission corridor
7. Develop and assess nest, brood, and adult survival inference models
    a. Investigate relationships between habitat selection and fitness (e.g., nest survival)
    b. Investigate covariates of distance to transmission corridor, raven abundance, and sign of badger activity, as well as individual covariates (e.g., grouse age)
    c. Evaluate covariates at multiple spatial scales
8. Identify changes in composition of predators that depredate sage-grouse nests in relation to distance to the transmission corridor, as well as between control and impact sites

Midway

1. Measure lek persistence and changes in attendance in relation to distance from mine sites and infrastructure, including roads and transmission lines
2. Measure raven densities by habitat type and in relation to distance from mining infrastructure such as roads, transmission lines, and buildings, as well as similar infrastructure not related to mining activities and in contiguous sagebrush habitat

3. Use Global Positioning System (GPS) transmitters to evaluate differences in spatial use of habitats, as well as seasonal movements between habitats, for sage-grouse breeding at varying distances from mining activities
    a. Investigate movements between important seasonal habitats, and evaluate the potential of mining infrastructure to act as a barrier to such movements
    b. Evaluate seasonal home range size as a function of distance to mine infrastructure
4. Measure changes in numbers of ravens nests and nesting substrate (anthropogenic versus natural) in relation to mine infrastructure and in adjacent control landscapes
5. Develop and assess nesting, chick survival, and adult survival models
    a. Investigate relationships between habitat selection and fitness (e.g., nest site selection vs. nest survival)
    b. Investigate covariates of distance to infrastructure, infrastructure type, habitat composition, raven abundance, micro- and macro-habitat composition, as well as individual covariates (e.g., grouse age)
    c. Evaluate covariates at multiple spatial scales
6. Identify changes in composition of predators that depredate sage-grouse nests in relation to distance to mine infrastructure
7. Evaluate winter habitat selection and dietary preferences of sage-grouse, to include evaluation of preferential use of different sagebrush species and subspecies by sage-grouse for both food and cover

Desatoya Mountains

Short-Term objectives (1 – 3 years) – Generate baseline information about populations for the purpose of informing conservation and management decisions, especially those decisions that relate to conifer treatment. Baseline information will consist of:

1. Estimation of population vital rates using VHF telemetry data and field monitoring
2. Estimation of space use patterns using GPS telemetry and GIS

Long-Term objectives (3 – 10 years) – Evaluate the effects of conifer treatment on space use and demographic rates of sage-grouse populations in order to:

1. Provide a basis for understanding the effectiveness of removing conifers
2. Establish a framework for predicting outcomes to sage-grouse populations under different treatment scenarios
3. Test the reliability of the conservation planning tool cost-benefit ratio assessment from the short-term objective
4. Refine the conservation planning tool to incorporate demographic rate information so that it may have further benefits to population viability

Huntington Valley and Mary's River (Nobel Energy)

1. Habitat and Space Use – Use radio telemetry to evaluate differences in spatial use of habitats, as well as seasonal movements between habitats, for sage-grouse breeding at varying distances from fracking activities
    a. Identify areas of seasonal habitat and corridors used by sage-grouse between those areas
    b. Estimate utilization distributions (UD) of sage-grouse to measure probability of spatial use
    c. Develop high resolution and spatially-explicit maps of seasonal habitat use for sage-grouse at each area of investigation
2. Population Dynamics – Conduct lek surveys and telemetry of individual sage-grouse to estimate:
    a. Patterns of lek attendance in relation to distance from hydraulic fracking activity and associated infrastructure
    b. Survival probabilities across sage-grouse life phases (nest, chick, juvenile, and adult)
    c. Indirect effects of ravens on survival probabilities

4.0 Trapping and Capture Protocol

4.1 Capture Data Collection and Reporting

We will deploy VHF or GPS transmitters and obtain various morphometric measurements and biological samples from captured sage-grouse. Researchers will monitor grouse closely for the first few days following release to assess possible capture related mortalities, which should be reported immediately to help improve trapping methodologies. All radio-marked individuals should be monitored on a regular basis, and any recovered mortalities should be examined to determine cause of death. Whole or partial carcasses should be preserved by storing in a freezer for later analysis. Details of the recovery should be included with the carcass to aid in determination of cause of mortality. Pictures and detailed notes should also be maintained.

4.2 Trapping Methods

Trapping of sage-grouse may be accomplished by a variety of means. The most effective and least invasive method is spotlighting roosting birds at night, resulting in an injury/mortality rate <1% in Colorado (Giesen et al. 1982; Wakkinen et al. 1992). Other techniques have also been used to capture sage-grouse, including walk-in traps on leks (Shroeder and Braun 1991), drop nets, and net launching devices. However, these methods tend to be more invasive and have a higher risk of injury to birds. Therefore, spotlighting will be the primary method for capturing sage-grouse on this project. Other techniques may be employed under special circumstances.

Sage-grouse are typically captured during the spring and/or fall. Spring trapping is conducted during the breeding season when birds roost close to leks. Fall trapping is conducted when it is dry, and birds are often congregated near water sources. Trapping at either time of year offers unique opportunities to gather data during different life stages of the bird. During spring, researchers should attempt to catch grouse while they are roosting and avoid disturbance prior to dawn, allowing them to move to lek sites undisturbed. Spring trapping should be terminated before females have initiated nesting to avoid nest abandonment. Trapping should be avoided until fall except in emergency situations, such as the need to refit or remove a radio transmitter. During fall trapping, juveniles should not be radio-collared until they are a minimum of ten weeks of age. Juvenile birds are difficult to sex early in the fall season, making it difficult to properly fit radio-transmitters, considering sexually-dimorphic growth. Fall trapping typically is terminated when access to the study site is limited. Researchers should use good judgment not to over-disturb any particular population or individual bird. Whenever possible, we prefer to limit trapping efforts to periods of no longer than three consecutive nights in a single area.

The optimum time to conduct trapping is during dark phases of the moon. Generally, a week before and after the new moon offers long, dark nights. However, successful trapping has occurred during very bright moon conditions. Typically, trapping efforts begin at least one and a half hours to two hours after sunset so that the birds have some time to settle into their roosting locations. We have successfully captured grouse as dawn approaches, so efforts should continue as it begins to get light. Generally, our efforts cease 30 to 45 minutes prior to sunrise. Inclement weather should not deter trapping efforts, within reason. Light precipitation can be beneficial to trapping efforts by deterring birds from flushing. However, trapping crews should always take necessary precautions to ensure their safety, health, and wellbeing while in the field.

Capture crews typically consist of two or three people. One person operates the spotlight and leads the capture effort, while the second person is the primary netter. When a third crew member is present, he/she is the secondary netter. Most grouse are caught by technicians working on foot, using a battery powered spotlight. Occasionally, it may be possible to capture grouse with the use of a truck or ATV. Net diameter of approximately 2.5 – 3 ft attached to a 3 m extension handle is most effective. Netting should be about 1.5 inch mesh or smaller, with enough room to comfortably hold grouse against the ground but not excessive to minimize struggling by the bird when caught.

4.2.1 Spotlighting

Spotlighting allows trapping crews to identify sage-grouse from a great distance. The spotlights we use have been fitted with a shield to help focus the beam and prevent washing the surrounding area with excessive light. While searching for grouse, the spotlighter uses a pair of binoculars placed on top of the spotlight to obtain an optimum view of the search area (Figure 3). The cover of darkness is an important aspect while trapping sage-grouse. While spotlighting, the best place for the netter(s) is directly behind the spotlighter. As the beam of light moves, the netting crew should also move to avoid the light. This allows the spotlighter to observe the area without accidentally exposing the trapping crew.

The purpose of the spotlight/binocular combination is to search for the reflective "eye-shine" produced by the bird's *tapetum lucidum*, which is a reflective tissue layer in or behind the retina of some animals. Depending on the vegetative conditions and the distance between observer and bird, the body of the grouse is not always visible at the time of initial sighting. Generally, the body of the grouse cannot be observed until the crew begins their final, rapid approach to the bird. When the eyes of a sage-grouse are illuminated with the spotlight, the resulting eye-shine should have a blue or purple sparkle. The eye-shine has been described as having the appearance of a small blue diamond. Most often, the source of a false sighting is from ice crystals, water droplets, spiders, or various small mammals. Occasionally, littered bottles and cans can also produce a reflection that resembles the eye-shine of grouse. Animals such as mice and rabbits tend to move to avoid the spotlight, while grouse generally stay in the same spot. Turning the spotlight off and on can induce a blinking reaction. If the reflection is from an inanimate object or spider there will not be any blinking. Additionally, the spotlighter can try leaning their torso to the left and/or right with the spotlight on the same reflective spot. This slight change in angle is especially effective in eliminating false sightings caused by ice or water. If the eye-shine remains despite this slight change in angle, further investigation may be warranted, particularly if the shine blinks.

Figure 3. Spotlighting at night (left) and a sage-grouse illuminated by the spotlight (right).

Taking your time to be careful and deliberate while spotlighting is invaluable in locating grouse, but a balance must be struck between being thorough and covering enough ground to maximize trapping effort. Each spotlighter must develop their technique and preferences for spotlighting through practice. While walking between spotlighting vantage points, the use of headlamps or flashlights is perfectly acceptable to illuminate the path of the crew. Exaggerating steps (lifting the leg up higher than a normal walking motion -- as if you were stepping over a low bench) can make a tremendous difference when trying to walk through shrub cover or across a rocky patch of ground. In addition to reducing falls, exaggerated steps also tend to be quieter than dragging your feet through vegetation.

When a bird is spotted, we use a noise device (Foxpro ZR2, or similar, predator caller) to broadcast white noise at a loud volume. This helps to mask our footsteps as we approach. Generally, the white noise is turned on at

a lower volume when the bird is still at a distance from the crew, but as the crew approaches the bird, the volume is increased. To maximize the noise-masking effect, the speaker should be turned to face the bird.

4.2.2 Trapping Approach

Once a bird is spotted and the decision is made to attempt to capture (birds already marked should not be captured again), the crew should move deliberately to capture the bird(s). The spotlighter should make mental notes of any distinguishing features such as rocks, bushes, or clumps of grass near the grouse that may aid in the rapid relocation of the grouse as the crew moves closer for a capture attempt. We do not want to keep the light on the grouse's location any longer than is necessary to confirm the exact location of the bird, so use of easily identifiable landmarks becomes essential. As the crew moves-in closer to the bird, the spotlighter's perspective of the immediate area will change. The appearance of a hillside can be dramatically different when looking across drainage, as opposed to beginning an ascent up that same hillside towards a bird.

To close the distance between the trapping crew and the bird, most crews find that walking a straight, deliberate, and direct path to the bird yields the best results. An approach that is aimed head-on towards the front of the bird is ideal because of the spotlight's ability to blind both eyes, and the reduction of the bird's ability to detect its own shadow. Trying to circle around a bird's location can cause the crew to lose the bird's location or accidentally walk too close to the bird and cause it to flush. Keep in mind that if the white noise is loud enough, the crew may not be able to hear a grouse flushing. Walking for shorter distances and periodically confirming the bird's location with the spotlight typically works best. Minor corrections in course are often required as the crew closes the gap between them and the bird. If a bird's location is lost, simply retracing your steps until the bird is relocated will often resolve the problem. Taking just a few steps to the immediate left or right can change the angle viewed through the binoculars enough so that the spotlighter can see around vegetation or rocks that may block the grouse from view. If a bird is lost and the spotlighter is unable to relocate it, do not quit searching out of frustration. Sage-grouse rely on camouflage as their primary defense. They tend to want to stay in one place, but if they do move, they will often walk away from a disturbance rather than flushing.

Before beginning the final approach on a grouse, the spotlighter should be able to positively confirm the bird's location without the use of the binoculars. This distance can vary greatly depending on terrain and ground cover. Generally, it is possible to confirm a bird's location without binoculars from between 20 and 50 m. There are times when the distance may be as short as 7 to 10 m. The white noise should be loud at this point. Communication between members of the trapping crew can be challenging, so it is important that everyone knows what to do prior to this point. At close distances, grouse may not exhibit the distinctive eye-shine that would be visible from greater distances (with or without binoculars). The spotlight should be turned on and left on, centered on the grouse. The arm holding the spotlight should be extended vertically, as if the spotlight was pinning the bird to the ground with the beam of light. The light should be shaken rapidly back and forth but still shinning on the bird the entire time. The main focus of the beam should remain on the bird, but other areas will still be illuminated by the wash of light from the spotlight. Since headlamps and flashlights should be off for the final approach, the trapping crew can use the wash from the spotlight to aid in navigation for the final few meters.

If a net gun is to be used for the capture, the netter should hand the gun to the spotlighter in the manner decided upon by the crew. The desired effect on the bird is to be temporarily blinded/disoriented by the bright light of the spotlight and unable to discern the crew's approach because of the white noise. Running is not necessary, but the approach should be executed quickly. As soon as the grouse is within an appropriate range, the net gun should be fired, and the pole net should be set on top of the grouse.

Our experience suggests that being able to rapidly confirm the location of a bird, get to that bird quickly, use the least amount of spotlighting, and begin the final approach as soon as possible yields the best results. Not every capture is possible to execute in this manner, and successful captures do not always follow this pattern or go as planned. It is still possible to capture birds when things don't go exactly right.

4.2.3 Netting

The netter's primary duty is to capture and secure the grouse. Netters should attempt to capture birds primarily while they are on the ground. Birds that have flushed should be allowed to fly to avoid injury. Netters should remain out of the spotlight at all times until they need to manually secure a netted bird at the time of capture. During the final approach to capture a bird, the netter should avoid stepping into the light. Instead, the netter should utilize the extension pole and allow the length of the pole to close the distance between the trapping crew and the bird. The net should also be kept out of the beam of light until it is in motion to capture the bird.

It is important for the netter to keep pace with the spotlighter during the final approach so that the whole crew reaches the bird at the same time. When deploying the extension pole net, the net should be "swept" from the side of the netter to the bird. The pole should remain horizontal to the ground at all times. At no time is it ever acceptable to arc the pole/net over the head and slam it to the ground. Furthermore, when the net is placed on top of a grouse, the hoop and the pole should be placed onto the ground as one horizontal and level piece. The pole should not be angled down to the ground to capture birds. An angled net can result in breaking the hoop or the pole, and it can potentially leave an opening for the bird to escape through.

After capturing birds in the net, netters should hold the pole and hoop down to the ground so that the bird cannot escape from under the net. The netter should work their way up the pole, and immediately secure the grouse with both hands. The grouse must be held relatively firmly around the wings and body until the grouse ceases to struggle. The spotlighter or an additional crew member will help the netter remove the bird from the net for handling. For the bird's safety, it is imperative that they be restrained quickly enough so that they cannot struggle in the net but gently enough so that they are not injured by rough handling.

4.3 Use of Net Guns

Use of the net gun offers the opportunity to increase our effectiveness in trapping sage-grouse. The net gun used on this project is a Super Talon™ from Advanced Weapons Technology, Inc. The Super Talon™ is marketed as a non-lethal (less-lethal) device for law enforcement and animal capture applications. This does not mean that there is no risk of injury from the use of this equipment. Accidental discharge or inappropriate handling of the net gun may increase the chance of injury or death. Understanding how this equipment works and how to properly handle the system is essential to minimize the risk associated with its use. As a rule, the net gun should be treated like a firearm. Users should always assume that the net gun is loaded. The net gun should never be pointed at anything that is not intended to be captured.

Parts of the Net Gun

The net gun system consists of six basic components. Three of these pieces fit together to form the main body/handle of the net gun, while the other three fit together to complete the net cone. The main body consists of: the back cap, the handle, and the trigger housing. The net cone consists of the firing head, the net, and the safety cap.

Resetting the Trigger

Resetting the trigger is an important part of preparing the net gun to be fired. Every time that the net gun is fired, the trigger must be reset. To reset the trigger, the trigger housing must be removed from the handle. The safety should be left in the fire position ("on"). With the firing button facing up, the end of the trigger housing that holds the net cone should be facing away from the re-setter. By looking into the trigger, the re-setter should be able to see the rubber seal on one of the doors inside the trigger (silver). The hinge on this door should also be facing up so that the door naturally hangs down in a closed position. In a single, smooth motion, the trigger housing can be rotated toward the re-setter so that the firing button is facing down and the re-setter is looking down the end of the trigger housing that holds the net cone. The hinged brass door should be seated squarely in the trigger housing at a right angle. The safety ring may now be slid to the safe position ("off"). If the trigger has been reset properly, the

doors within the trigger should not move or come out of place when the unit is shaken. When the trigger is not pressurized, these doors will come loose from their position if the safety is moved into the fire position ("on"). If this happens, the trigger must be reset prior to pressurizing the gun. Once the net gun has been pressurized, the safety may be moved into the firing position ("on") without the doors becoming unseated. **Failure to reset the trigger properly could result in a failure of the gun to fire correctly, or an accidental discharge of the net gun! If any part of the trigger housing is not working properly, do not use the net gun until you are sure that it is safe to do so.**

Reloading Nets

Reloading nets allows us to reuse Super Talon™ nets after they have been fired. To prepare the firing head for a repacked net, the ring around the firing end of the firing head needs to be removed. This ring will hold the safety cap once the net has been repacked. To reload the net, the weights must be removed from the net. Eight weights should be present on each net. Once the weights are removed, the net should open easily. The net should be laid out on an even, clean, flat surface. The weights should now be reattached. While holding the firing head over the net, the weights may be placed into the holes in the front of the firing head, one at a time, and in a counter clockwise direction. With all eight weights seated in the firing head, the net should drape over the sides of the firing head. Exercise care to ensure that the net remains untangled and hangs freely from the firing head. The net may now be gathered carefully lengthwise. To replace the net into the firing head, the strings leading from the net must be parted around the opening in the firing head that will contain the packed net. Starting with the farthest end of the gathered net, the net should be coiled around the interior of the net cavity. When the net is completely inside the firing head, the safety cap and ring may be replaced on the firing head. Care should be used to ensure that none of the strings that connect the weights to the net become caught in the ring when closing the safety cap. If strings become caught in the ring, the net will not fully escape from the firing head, and the net will not properly deploy. This may result in the loss of the targeted bird. **Do not attempt to follow the instructions enclosed with the net gun as provided by Advanced Weapons Technology, Inc. -- the "z-fold" method that they describe will result in nets that do not deploy correctly! If any part of the firing head assembly is not in good working order, do not use that firing head until you are sure that it is safe to do so.**

5.0 Handling and Marking

5.1 Extracting sage-grouse from net(s)

The netter should move quickly to control the bird after it's captured. The first priority is to restrain the wings and hold the bird to the ground to prevent flapping under the net. Excessive flapping between the ground and net can cause injury to the bird. The second person reaches under the net and places both hands over the bird. When the transfer of control is complete the bird can be safely removed from the net (Figure 4).

If a net gun is used (generally in conjunction with a pole net), the extraction procedure is similar as described above. Once free of the pole net, the process of removing the bird from the net gun net may begin. In most cases, grouse will fit through the openings in the net. By starting at the head of the grouse, individual strands of netting may be moved so that the net can be pulled from back from the head of the grouse, toward the bird's posterior. Essentially, this results in pushing the bird through an existing opening in the net. The plastic safety cap must always be recovered after firing the net gun.

5.2 Handling Techniques

Once the bird has been successfully removed from the net and is under control, elastic wing bands may be used to restrain birds by placing it around the body and wings (Figure 5). Restraints placed around a grouse should be snug enough to effectively hold the bird but still provide enough flexibility to allow the bird to breath. Any change in the status of the bird's health or consciousness must immediately be addressed. The bird should be put in the band

head-first so that the band moves “with the grain” of the bird’s feathers until the band will sufficiently hold the bird’s wings in place (especially over the shoulder/wrist).

Figure 4. Properly extracting a sage-grouse from a net (left) and holding a bird to examine the wing (right).

Holding sage-grouse always requires using two hands. They are powerful birds and their rapid wingbeats enable them to escape if not paying attention. The palms and fingers should wrap around the wings and cover the ventral half of the bird with finger tips touching the keel. Having your finger tips on the keel provides a solid anchoring point from which the hold of the bird can be based. Both thumbs should wrap around the top of the bird and cross the wings just behind the shoulder and wrist (nearly over the shoulder). This placement should reduce the amount of leverage and power that a bird is able to generate in the event that it resists restraint.

Between 30% and 50% of a bird’s body weight is located on the chest and shoulders. With such a large proportion of their body weight directly adjacent to their respiratory system, we can minimize some of the stress associated with handling and holding grouse by keeping them in a naturally upright orientation for as much of the processing as possible. The bird should always be returned to an upright position between measurements or when measurements or samples are not being collected. To minimize the amount of stress that is inflicted on the bird, all birds should be held out and away from the body whenever possible. If the bird manages to get its wings out, quickly move the bird away from your body to prevent the bird from breaking any flight feathers that would result from flapping against a hard surface.

When finished processing a bird, it should be released as quickly as possible. Walk about 20 – 30 m from the processing site, and create space among shrubs or other cover by or with your foot. Make sure there is sufficient cover available when selecting a release site. Hold the bird in front of you and spin a full three circles. This will disorient the bird, increasing the chance that it will not flush. Put the grouse in the area that was cleared and walk away quickly.

5.3 Banding

Leg Bands are placed on sage-grouse to provide information on movements, survival, and hunter harvest. All captured sage-grouse will be fitted with a leg band, regardless of whether the bird is VHF or GPS marked. When adult birds are captured, they receive leg bands on their left leg. Any sub-adult bird receives a leg band on its right leg. It is helpful to remember the saying “kids always think that they are ‘right’, so sub-adult birds get a band on the right leg.” Each leg band should close around the metatarsus so that the ends are flush, and ends should not overlap. Specialized banding pliers and needle-nosed pliers are used to ensure proper attachment of leg bands.

Figure 5. The proper technique to hold sage-grouse with thumbs over the wings (A) and fingertips anchored on the bird's sterna keel (B). The blue fabric on the bird is a wing band.

5.3 Signs of Stress

Stress can be a dangerous side effect of trapping and handling sage-grouse. Behavior that includes a drooping head, closed eyes, or an open bill that appears to be gasping for air, requires immediate action. If a bird is in danger of becoming over-stressed, temporarily stop processing the bird, turn off head lamps, and remain quiet and still until the bird begins to recover. The bird can be held next to a shrub while gently placing its feet on the ground. Contact with the ground and shrubs generally revive individuals enough that they try and escape. The wellbeing of captured birds is of paramount concern. If handling and processing procedures are jeopardizing the health of the bird, it should be released immediately.

6.0 Transmitter Attachment

6.1 VHF Collar Construction

Building collars prior to attachment increases the speed in which the collar can be safely and properly attached to a grouse (Figure 6). The steel cable used to secure the collar must first be trimmed to an approximately 15 cm and fitted with a sleeve (or crimp) on one end. A 7 – 8 cm piece of black plastic tubing, used as a sheath covering the steel cable, should have a small notch cut at the midway point for the antenna. The notch should be small so that the tube remains as durable as possible. The steel cable is fed through the hole on the side of the transmitter where the antenna extends from. The antenna and steel cable are then fed through the tube, until the tip of the antenna reaches the notch in the tube. The antenna should be fed through the notch while the cable remains inside the tube. This allows for the cable to be thread through the opposite hole in the transmitter while the antenna extends from the tube to maximize transmission of the VHF signal, while allowing for a comfortable fit. Each component will be bent, sized, or trimmed as needed during the attachment process.

6.2 VHF Collar Attachment

Once a bird has been captured, the trapping crew must decide if the bird should be fitted with a radio-transmitter. The sex, age, or condition of captured birds may be used to determine whether a bird should be collared or not. During fall, juveniles that cannot be accurately sexed should not be outfitted with transmitters. With additional construction materials, the VHF collars weigh between 22 – 24 g. Transmitters should weigh less than 3% of total body weight; therefore, a grouse should weigh at least 750 g before attaching a VHF transmitter.

The collar should be initially placed around the bird's neck so that the transmitter rests between the throat and the breast, and the cable/tube combination runs across the top of the neck. Bending the cable and tube so that it roughly follows the contour of the bird's neck prior to attachment will aid in checking the fit of the collar. To check collar fit, the free end of the cable should be pulled through the corresponding hole of the transmitter and pulled so that the tube rests snuggly against both sides of the transmitter. With the transmitter and cable looped around the bird's neck, hold the cable against the transmitter firmly with the forefinger and thumb and gently pull on the collar in an attempt to remove it from the bird's neck. Place the thumb on the bird's beak to help keep the head in place, ensuring the bird's neck is not accidentally injured while checking for the proper collar fit. Be very careful while checking for a proper fit as it is easy to accidentally overextend the bird's neck or cause other damage while trying to slip the collar over the grouse's head. It is acceptable for a small amount of cable to be exposed on the necklace if the tubing is slightly shorter than the cable. The amount of exposed cable should be minimized, but this is not necessarily a reason to rebuild the tubing on the collar.

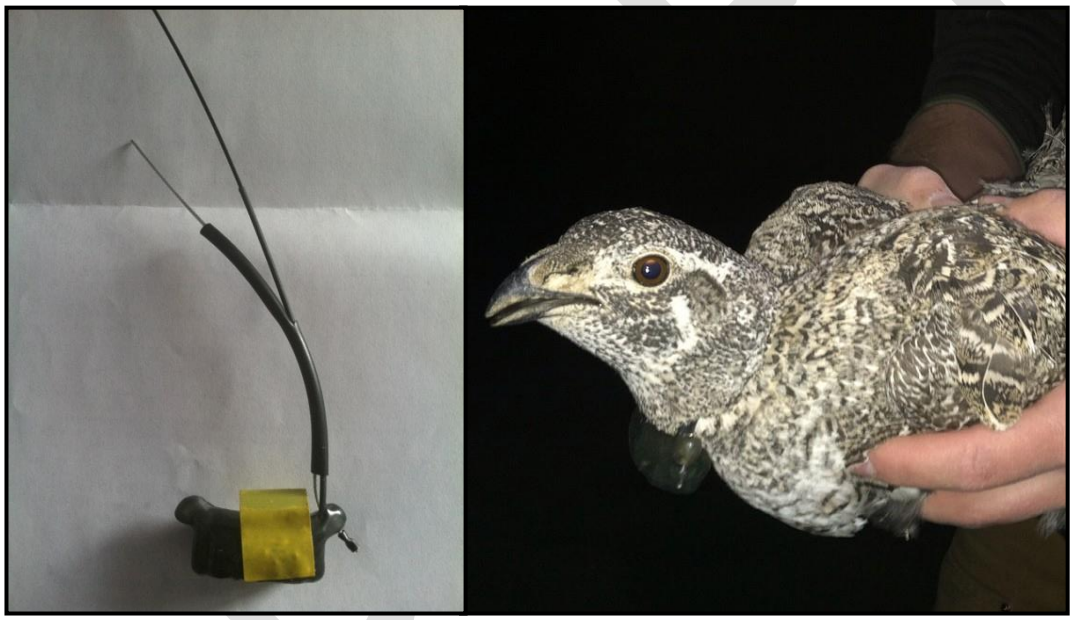

Figure 6. VHF transmitter construction (left) and female sage-grouse outfitted with a VHF collar (right).

To complete the attachment of the collar to the bird, the second sleeve should be crimped to the steel cable. Any extra cable should be removed with wire cutters. Run your fingers along the antenna, bending it to roughly follow the contour the grouse's back so it is not sticking straight up into the air. When both sleeves are in place, re-check the transmitter for proper fit. With the collar resting in a natural position on the bird, there should be ample space between the grouse's neck and the transmitter for large pieces of food to be passed through the bird's esophagus. One or two fingers should easily fit between the neck and the collar to allow ample space. If the fit is not correct, the process can be quickly repeated by simply cutting and replacing the cable. Be very careful to not cut the antenna. Practicing deploying collars with the supervision of experienced handlers is essential.

6.3 GPS Backpack Construction

Prior to deploying GPS transmitters on sage-grouse, units must be mounted onto foam pads and straps must be made to secure the unit to the bird. We use a backpack style, rump mounted approach with nylon ribbon straps that loop around the bird's legs. GPS units must be fully charged before deployment to ensure they function properly. Remove the magnets and place units in full sunlight for one to two days. When charged, apply an epoxy solution to the base of the unit and place it on a foam pad. Let dry for a full 24 hours. To create leg loop straps, cut 24 inch nylon ribbon strands and 2.5 inch elastic bands. Mark the center of the nylon ribbon, and 2.5 inches to either side, with white out. Secure thread to one end of the elastic band with a needle. Run the soft point needle through the nylon ribbon until it reaches the farthest white out mark. Pull the needle through the nylon ribbon at that white out mark. Run the elastic through the ribbon until the trailing end reaches the white out mark closest to the starting point (the opposite white mark from where the needle was pulled through). Secure the elastic and nylon using a separate needle and thread. Pull the nylon over the elastic, with aid of the needle and thread, until the white mark on the nylon reaches the elastic. Tie off the nylon and elastic using the needle and thread. The Teflon ribbon should appear bunched. It is important to allocate extra space here to allow growing room.

6.4 GPS Backpack Attachment

Practice and training are required to safely outfit sage-grouse with GPS transmitters. Units too tight may cause injury or inhibit movement, while units too loose can result in a slip. The first person will sit on the ground holding the grouse with its head facing him/her. Make sure one ferrule is put on each end of the strap. The unit is first place on the rump with the nylon strap facing the bird's anterior, while both antennas extend out over the tail. Begin by carefully looping the nylon strap around one leg. Run your fingers along the strap and pull out feathers to create a snug fit. Ensure this is done gently, their skin is quite delicate and can rip easily. Never tighten the strap by pulling on the end closest to you; this greatly increases the risk of tearing skin. Run the nylon through the metal loop on the GPS unit and thread it back through the ferrule and temporarily secure with an alligator clip. It is easier to use scissors to cut a very thin sliver at the end of the nylon strap to aid in threading it through the ferrule. Repeat the same process for the second leg.

Figure 7. Attachment of GPS transmitter to a sage-grouse.

Check the fit by moving the unit up and down the bird's back. There should be about an inch of play on both ends and leg loops should be snug but not digging into the bird's skin. After the first fitting, the process generally needs to be repeated to ensure proper fit. Run your fingers along each leg loop to check there are no major clumps of feathers underneath. When satisfied the unit is fit properly, use wire cutters or pliers to crimp the

ferrules (Figure 7). This can take quite a bit of strength, so always double check by attempting to pull a ferrule off to make sure they are adequately secured. When ferrules have been crimped, cut off the extra nylon ribbon. Use super glue to seal both ends of the ferrule to the nylon. Finally, use a permanent black marker to color the ferrules.

7.0 Morphological and Biological Data Collection

Basic morphometric measurements and biological samples will be collected from all captured sage-grouse. Morphometric measurements include the culmen, flattened wing chord, tarsus, and weight. Feathers and fecal samples will be taken from all birds, and blood will be extracted from a subsample of captured grouse. If the health or condition of a bird deteriorates at any time during processing, release the bird without obtaining further measurements/samples.

7.1 Culmen

The culmen is the dorsal ridge of the beak. It is measured from the distal tip of the upper mandible to the edge of the bill/skin interface (Figure 9). This measurement is collected with a digital caliper and is recorded to the 100th of a millimeter (e.g. 32.09 mm). To take this measurement, one finger can be gently placed under the bird's beak to help hold the head in place. The other hand is then free to work the caliper and collect the reading. One outside jaw of the caliper is slid along the culmen until the end of the beak is felt at the bill/skin interface. The caliper can be closed until the space between outside jaws just barely touches the distal tip of the beak. The tip of the beak should just barely graze across the caliper. Three culmen measurements are collected from each bird. When using digital calipers, do not look at the numbers on the display of the caliper while collecting the measurement. This ensures that you do not inadvertently bias the reading. Always zero the calipers before each measurement to obtain the most accurate reading.

7.2 Flattened wing chord

Flat wing chord is measured using a wing board with the wing flattened against the board so that the maximum measurement can be recorded (Figure 8). This measurement is taken to the nearest 10th of a centimeter (e.g., 26.7 cm). With one hand, secure the bird's wrist in place at the "0" mark against the guide on the wing board. The wing should be extended at a 90° angle from the body. The primaries should be flattened with the other hand, measuring the tip of the longest primary. The measurer's hand should be holding the primaries flat and in place while collecting the reading.

Figure 8. Measuring flat wing chord.

If at any point the bird begins to struggle or flap its wings, the person holding the bird should quickly move the bird up and away from the wing board and all crew members so that the bird does not injure itself. The person conducting the measuring should also remove the wing board and move away from the bird. The wing should be "reset" between each measurement by removing the wing from the wing board before taking the next measurement. Two measurements are collected for each wing.

7.3 Body mass (Weight)

Weight is collected for each grouse to the nearest gram (e.g., 1147g) with an electronic scale (Figure 9). The scale must be placed onto level ground prior to taking measurements. Placing the wing board underneath the scale helps to provide a flat surface with enough height to help keep the bird from touching the ground. The grouse should be secured with a wing band prior to weighing. To prevent the bird from escaping while it is being weighed, the bird should be rotated upside down. The rotating should be done as quickly as possible. Typically, grouse will struggle briefly during and immediately after being turned upside down but will generally become still once they have been placed on the scale. Researchers must not touch the bird while being weighed. Caution should be taken to ensure that no obstructions are confounding weight measurements, such as blades of grass or other debris, and that no part of the bird is resting on anything other than the weighting platform.

7.4 Tarsometatarsal length (Tarsus)

The tarsal measurement is collected from the tarsometatarsal bone in the lower part of a grouse's foot (fusion of the foot and ankle bones; Figure 9). It is measured from the notch of the intertarsal joint (tibiotarsal articulation – which would be the hock or ankle on other animals) to the base of the toes. This measurement is collected with calipers, and is recorded to the 100th of a millimeter (e.g. 54.14mm). This measurement is easier to collect when the bird is in a near vertical position so that the bird's head is leaning back towards the holder and the bird's tail is pointing toward the person taking the measurement. One jaw of the calipers is placed in the tibiotarsal articulation. Generally, you can feel the calipers "slip" into place in the joint between the two bones. From this position, the calipers can be closed until the other jaw touches the knuckle at the base of the middle toe, which should be very near the scale/feather interface. Three tarsus measurements are collected from each leg on each bird.

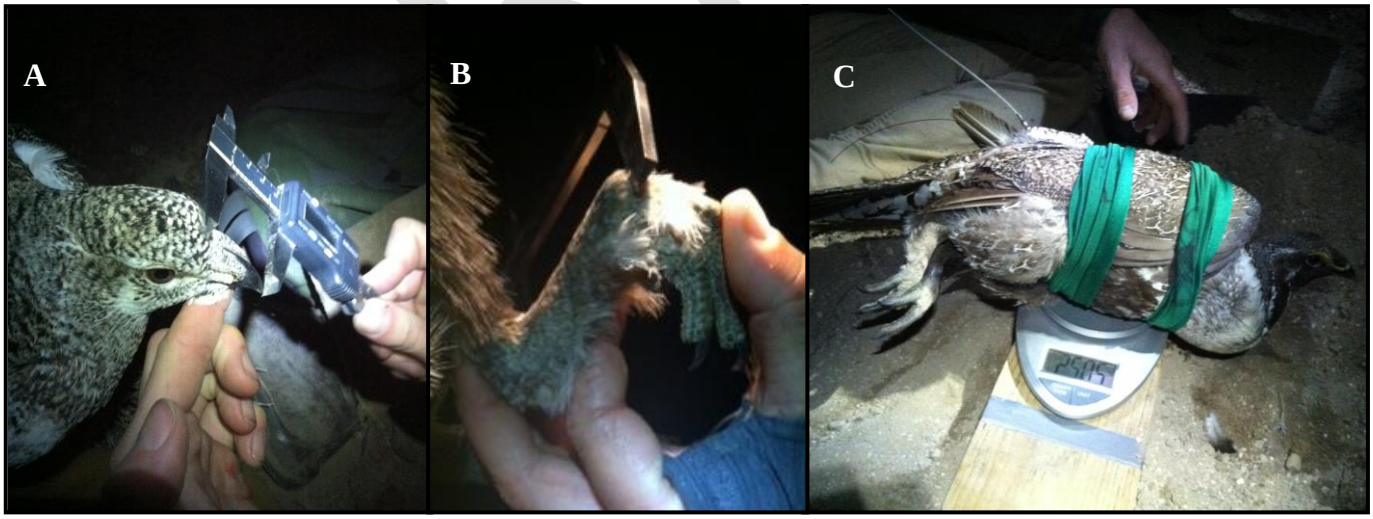

Figure 9. Obtaining measurements for (A) culmen, (B) tarsus, and (C) body mass.

7.5 Feather Samples

Feather samples will be obtained from all capture sage-grouse. Typically, grouse will lose several feathers in the trapping process. These can be collected in a plastic bag and marked with the bird's band ID, age, sex, field site,

date, and UTMs. If feathers are not available on the ground, two or three breast feathers should be taken from the bird. Feathers should be held near its base to prevent the shaft from breaking, and removed with a strong, quick pull. Do not touch the base of the feather as this is where DNA is extracted from.

7.6 Fecal Samples

Fecal samples will be collected if present at the roost site. Do not collect "stress" fecal material that the bird excretes when being handled and processed. Place samples in a plastic bag and label with the bird's band ID, age, sex, field site, date, and UTMs.

7.7 Blood Samples

Blood samples will be taken from the brachial vein in captured sage-grouse. Prior to obtaining blood, a needle, cotton ball, and collection tube should be prepared. Break the seal on the needle by drawing in air to prevent potential complications while drawing blood. One person positions the grouse on its back and holds out a wing. Feathers should be plucked around to expose the brachial vein. When the vein is visible and clear of feathers, the second person inserts the needle in a similar orientation as the vein. Be careful not to push the needle through the vein. Once inserted, slowly extract blood into the syringe until approximately 2 ml of blood is collected. When sufficient blood is collected, place a cotton ball over the vein and pull the needle out. Close and put pressure on the wing to help stop bleeding. To transfer blood from the syringe to the collection tube, first place the protective nozzle over the needle and twist to remove it. The blood can now be emptied into the collected tube. Make sure the sample is placed in a plastic bag and labeled with the band ID, age, sex, field site, date, and UTMs. When the grouse has recovered, release the bird according to standard release methods. This is a specialized and difficult sampling technique that requires extensive training under experienced individuals.

8.0 Lek Count Protocol

Each lek should be counted at least four times during 15 March – 15 May. Counts should be spread out evenly over this time period to observe maximum male attendance. Counts are conducted between a half hour before and 1.5 hours after sunrise. Due to variation in attendance, counting times for a particular lek should vary. In other words, a lek should not be consistently counted first or last in the morning. Although males at some leks may display well into the morning, others see a notable decrease once the sun hits the lek. Birds will often display later in the morning when there is more cloud cover.

During each lek count, make note of the behavior if they are not lekking, such as walking around or hunched down. If the entire lek is not actively displaying, then it will impact the final count and you will need to flush the lek. If no birds are at an active lek, record all other data and put a 0 for your three counts. Always attempt to flush the lek if you do not see birds. You can still include this as one of the four counts for the lek, if it only happens once. At least three of the four lek counts must have birds present for an active lek. If you ever have a question about what you should record, the best policy is to write it down. Excess data can always be erased later, but you cannot recover what isn't recorded. In addition to counts, record the date, start and stop times, lek UTMs, observer UTMs, weather, the time of sunrise, other animals at the lek, and any other observations. Take a bearing and distance for ravens, raptors, and livestock and record behavior.

Figure 10. Males displaying on a lek (left), and technicians conducting a lek count (right).

When arriving at a lek, choose an area to park that gives you the best view of the entire lek. Staying in the car is helpful as grouse are less likely to flush. For the initial scan of the lek use both binoculars and a spotting scope to identify the lekking area (Figure 10). Scan either left to right or right to left and record your count. Switch your scanning direction and repeat two more times for a total of three counts. If possible, wait two minutes between counts. Record the number of males and females separately. If you cannot determine sex, record it as unknown. The goal is to count every single male on the lek, if possible. For some leks, flushing is necessary as the cover is too dense for a normal count. Before flushing, complete the scanning count. Approach the lek on foot quickly, and keep in mind where you saw birds during the initial count so that you know where they will take off from. Use the binoculars as needed to count the birds as they fly and identify males from females. Make sure to thoroughly walk the area since not all grouse will flush with the first group. Indicate on your lek form that this was a flush count and add it as a fourth count from the other three that you did prior to flushing. Scan the surrounding area and make not of other males forming satellite leks within close proximity of the primary lek. Record all occurrences of mating that you see. Multiple leks should be counted in a single morning when they are close enough together to do so. Do not perform a count if winds exceed 20 mph (about 32 kph), it is raining heavily, or it is snowing too heavily to see. However, if you arrive at the lek sight before realizing that the weather is too poor for counting, carry out the count and record all data. Grouse often do not lek the morning after a night of heavy snow. Light rain or moderate wind is acceptable, and temperature does not typically affect lekking activity.

9.0 Radio Telemetry Protocol

9.1 Radio Telemetry Components

We will conduct intensive ground tracking of sage-grouse using radio telemetry to monitor movement, reproduction, and survival. Telemetry techniques will vary depending on the type of location, which is explained below. The four main components of radio telemetry include a transmitter, receiver, coaxial cable, and receiving antenna. We outfit grouse with battery powered necklace-style Very High Frequency (VHF) transmitters equipped with a mortality sensor. Each transmitter has a unique frequency that emits a set number of beeps per minute. We use R-1000 portable telemetry receivers from Communication Specialists Inc. that can be set to receive frequencies within a specified range. The receiver contains several dials and keypad for changing the frequency, volume, and gain. The gain changes the signal strength, which is useful when trying to determine the exact direction of a transmitter. Antennas used on the project include omni and Yagi antennas that connect to the receiver by a coaxial cable.

The omni antenna is one directional and resembles a radio antenna on a vehicle. It has a magnetized based that is placed on the top of a truck. The coaxial cable runs from the omni through the window to the receiver inside the truck. Omni antennas cannot determine what direction a signal is coming from, but it is very useful for scanning large areas to get a general idea of where birds are. The Yagi is a hand held, three element antenna that can determine the direction of a signal. When the Yagi is pointed in the direction of the transmitter, the number of bars will increase and the signal becomes louder.

Radio telemetry equipment list:

- Yagi antenna (omni antennas should be with the vehicle at all times)
- Charged radio receiver
- Coaxial cable with BNC connectors
- List of targeted frequencies
- Radio telemetry data form (or use GoCanvas app)
- Compass
- GPS unit (if you do not have an iPhone with a GPS)
- Binoculars
- Anemometer
- Thermometer
- Backpack for gear
- Magnets and electrical tape to silence any collars that might be located from a mortality
- Clean bags for the collection of mortalities. Paper bags are sufficient for feathers and feces. Gallon sized zip lock bags and unused trash bags are acceptable for grouse carcasses
- Permanent marker for labeling any samples collected
- Camera (charged or with extra batteries)
- Watch
- Cell phone, satellite phone, or SPOT beacon

9.2 Radio Telemetry Techniques

There are many different techniques used to locate an animal with telemetry, and each person tends to have a slightly different method. This protocol will list several techniques that have been effective for this and other projects. This protocol can only be used as a reference, as telemetry should be taught by an experienced person. When searching for grouse, make sure that you close all gates that you open immediately after you drive through them. Private property should be marked with signs, or with orange or white paint on the tops of fences. Do not enter private property unless given permission.

When scanning, it is most effective to scan frequencies from high points, such as peaks or hills, from several different vantage points in an attempt to triangulate a bird's position. Begin searching where the bird was last seen or trapped, and it is always useful to scan for multiple frequencies while driving or hiking to locate missing birds that may have moved to new areas. Ridges or mountains can completely block a signal, while scanning in a valley can reduce the quality and range of a signal. In flat terrain, standing in the bed of the truck can provide enough elevation to help pick up a signal. Signals can also bounce off hillsides, cliffs, etc. Bounce can sound as loud as or louder than the true signal source, even though it's coming from a completely different location. A signal can also be funneled down a canyon, so that it sounds like the grouse is at the entrance to the canyon when it's actually much further up. Learning to recognize when you have a good signal takes practice, and sometimes the only way to determine the actual location of a grouse is to scan from numerous locations.

To scan for a frequency, the Yagi should be held vertically or horizontally (in relation to the horizon) and swept in a 360 degree circle (Figure 11). Scanning should be done at a slow enough pace so that the Yagi is able to pick up a signal. It is possible to hear a signal with one orientation of the antenna but not the other. Holding the Yagi in a vertical orientation will be able to pick up signals at a greater distance. However, when sufficiently close,

holding the yagi horizontally can increase accuracy. In addition, the gain must be reduced to decrease its sensitivity in order to narrow down the general direction of a signal. While tracking and getting closer to the transmitter, try to keep the gain at the lowest level that allows you to hear the signal. This will enable you to reduce the scanning area and more easily discern where is signal is coming from. Also, try to keep the volume constant to avoid confusion between gain strength and volume level of the signal.

Once transmitters are deployed they often undergo what's called "drift." This is where the frequency at which you can actually hear the transmitter has changed or drifted from its original frequency. Typically transmitters on this project drift about 0.002-0.005 down from the original frequency in the month or so after release. This means that when you are looking for a collared bird for the first time, or haven't found a bird in a while, the original plus a range of frequencies should be scanned. If the original frequency was 159.450, you might scan between 159.4450 and 159.450. The range of frequencies and increments you use to scan through them will depend on how much the collars typically drift and what type of receiver you are using.

Figure 11. Technicians conducting radio telemetry in the field.

There are four types of locations that we'll be using: presence/ absence, homing, triangulation, and mortalities. When possible, try to avoid flushing grouse on all location types to minimize disturbance. There are occasions, particularly during general telemetry locations, where grouse are more prone to flush and it is difficult to avoid this outcome.

Presence/absence

Presence/absence locations essentially involve just listening for live or mortality signals. This is typically done when time is limited and we are not able to walk in and locate a bird. When birds cannot be located, status should at least be determined weekly to be included in survival estimates. Scanning from high vantage points provides the best opportunity to quickly assess fate.

Homing or Walk-ins

Homing is the most common technique used in radio telemetry studies. This is when the tracker tries to get a visual on the animal and mark its exact location. Methods vary for this techniques depending on the type of location. Specific techniques are described below.

Triangulation

Triangulation involves taking three separate bearings with a compass, which creates a triangle in which location is estimated. Each bearing is taken from a different location, which is marked with the GPS. The size of your triangle is a factor of how accurate your azimuth is, how far apart your points are, how quickly you can get all three points,

and how great the difference is between your azimuths. You should have more than 20 degrees difference between azimuths at the very least, though it is better to have more like 90 degrees difference. Triangulation is useful for locating an animal that might run or fly away from the tracker if he or she tries to approach it, getting a general location before a walk-in, or when you physically cannot approach the animal.

With the compass a bearing is taken towards the loudest (strongest) point of the signal. This bearing is called an azimuth. It is important to make sure that your GPS is taking a location with good accuracy (3 meters is best). When you hold the compass you need to be sure that there is no metal close to it that may affect the bearing. This includes the truck. Electronics will also alter your bearing, so make sure to keep phones and GPS units well away from the compass during a reading.

Mortalities

When a collar stays stationary for 8 hours, the frequency rate doubles from about 45 to 90 beeps per minute. This is called a mortality signal and indicates that the grouse has either been killed or has slipped its collar. When a mortality signal is heard it is important to walk in on it as soon as possible. It can be useful to get an initial triangulation to aid in finding the collar. Collars from mortalities that have been in the field for an extended period may be difficult to find, especially if the carcass, feathers, or other sign have been dispersed or are no longer present.

When you believe you are within 3-5 meters but cannot find the collar, it can be useful to detach the antenna (leaving the coaxial cable attached to the receiver) and hold the end of the cable just slightly above the ground and walk in the area you believe the collar is located. The receiver with just the coaxial cable cannot give you direction, but the volume of the signal will increase as you get closer.

When the collar is found, take photos of and assess the surrounding area before removing the collar. Describe everything that you see in your notes. Search the area by circling around the collar up to 25 – 50 m out to look for additional feathers, bones, dens, nest sites, power lines, or anything else that might be relevant. Examine the feathers you find, especially the primaries, for signs of predation. Look at the base of the shaft (calamus) to see if the feather was plucked (no damage evident and no skin attached) or chewed (crushed shaft). Examine the rachis (the center of the feather) for bite marks, which indicates mammalian predation. Search near tall structures for feathers or bones. This might indicate a plucking post that a raptor used. If you find a mostly intact grouse, do not touch the bird with your bare hands. Use gloves or one of your collection bags (a garbage bag or large zip lock bag) to pick up the carcass and deposit it into a collection bag. Place it into a freezer immediately after you return to the base camp.

It is possible, however unlikely, for a collar to be hanging from a bush and swaying in the wind. In this case the collar would not switch to a mortality signal, so anytime a grouse appears not to have moved in 48 hours, and is not nesting, walk in and get a visual confirmation that the bird is alive.

9.3 General locations

During spring (April – May), general telemetry locations should be obtained for all females every three days, if possible, in order to determine nest initiation date. During the summer season (June – August), females that are not nesting or do not have broods should be located weekly to monitor seasonal movements. Males should either be located or monitored for live/dead signals approximately weekly, depending on time. Males are given the lowest priority and should only be located when extra time is available.

9.4 Nest locations

The majority of time during spring is devoted to searching for and locating nests. From mid-April through approximately the end of May, females should be located every three days to determine its nesting status. When a nest is found, subsequent nest checks should be conducted every three days until fate is determined. Fate is

recorded as successful (≥ 1 egg hatched) or unsuccessful. All nests should be flagged with florescent tape so habitat sampling can be conducted. Hatch date is recorded as the average between the last visit and date determined successful. For unsuccessful nests, further investigation is required to determine if the nest was depredated, abandoned, or failed due to another cause. Avian depredated nests, often by ravens, are characterized by eggshells with a hole in its side, or the eggs are missing completely (Figure 12). There is generally little nest material displacement. Mammalian depredated nests can exhibit a variety of signs including crushed eggshells, eggshell fragments, or digs. Photos should always be taken at both successful and unsuccessful nests. This is especially important to help determine cause of failure if difficult to assess in the field.

It is imperative to avoid flushing hens while nest searching and conducting nest checks. While searching for potential nesting hens, we use a circling technique to try and spot the bird before getting close enough to cause flushing. When approximately 50 m from a potential nesting female, begin to move in a circular fashion around the bird, making sure not to approach head on. It is ideal to first circle the bird at a radius of about 30 – 50 m to get the general area the bird is located. Continue closing in around the bird making smaller circles. Nesting hens usually do not flush until you are within a few meters of the nest and are extremely difficult to see. When sufficiently close, scan the area thoroughly with binoculars. Nests are generally well hidden in or under a shrub and sometimes may only be seen from a particular angle. It is helpful to take a few steps, scan the area, and repeat the process until the hen is spotted. Often, all you can see of the hen is the curve of her back, or sometimes her head. Look for sage brush with darker than average shadows under the base. While it is important not to approach the area of the bird too quickly, sometimes remaining close to the nest too long can cause a bird to flush. When the hen is located, record UTMs and provide a detailed description of nest location. Drawings or photos can aid in relocating the nest after nest fate.

Figure 12. Nesting hen (top left); successful nest (top right); depredated egg (bottom).

When conducting nest checks, a visual of the hen sitting on the nest is not necessary. It is extremely difficult to spot a nesting female even if the nest location is known. To avoid disturbance or alerting predators to a nest location, it is preferable to listen for the hen's frequency from at least 30 m away to determine if she is still nesting. If radio signal strength indicates the hen is no longer sitting on the nest, carefully approach the nest until it can be determined the hen is nesting or not.

9.5 Brood locations

Brood locations are conducted at 10-day intervals and include both day and night locations. The first brood check will occur 10 days after the estimated hatch date, and will only include a day location. At 10 days old, the hen will most likely be brooding or covering chicks, so they may not be visible. Rather than flushing the hen to get a chick count, make note of any behavior that indicates chicks are present. Other behaviors that suggest chicks are present include females clucking and running along the ground in an attempt to lure you away from chicks. The first night location will occur during the 20 day brood check. The purpose of the night brood check is to get an accurate chick count. Therefore, it is extremely important to approach the brood with caution to avoid flushing. If a brood is suspected to have failed (i.e. no chicks present during check), a subsequent night check should be made within 48 hours to confirm the brood was unsuccessful.

Radio telemetry protocols for locating broods are similar to those used while nest searching. Within approximately 50 m of a brood, use the circling method as described above to slowly close in around the brood. If possible, try to locate the brood before flushing. However, this can be difficult when broods reach around 30 days old. Chicks are cable of some flight around 20 days and will likely flush within 10 – 20 m on approach. If flushed, mark the location with florescent flagging so the location can easily be found to conduct habitat sampling.

10.0 Videography Equipment, Installation, & Maintenance at Sage-grouse Nest Sites

10.1 Site Selection

Site selection occurs after a nest location has been confirmed. The installation of videography equipment may be initiated if the nest meets necessary criteria. Before disturbing the nesting hen, she must be allowed to incubate her clutch for approximately one week. By allowing her this initial incubation period, she has time to become invested in the development of her clutch, and therefore becomes less likely to abandon her nest. Ideal candidate nests for camera installation are typically within 1 km of the nearest road access, offer enough vegetative cover to conceal the equipment, and are accessible enough so that batteries and SD memory cards may be exchanged at a rate of every two to four days. However, camera systems have successfully been installed between 1.5 and 2 km from roads depending on conditions and habitat types, so the 1.5 km suggested distance is not strictly adhered to.

10.2 Equipment

For video monitoring of grouse nests, we use:

- "Lipstick" micro cameras
- Coaxial cables with BNC connectors for video feed
- RC connectors for power supply
- DVR units for recording
- SanDisk (SD) memory cards for data collection
- Power splitters (such as miniature extension cords with multiple outlets)
- AC/DC power inverters
- DC power sockets with alligator clips to connect to batteries

- Sealed, rechargeable 12v batteries for the power supply ("jumped" together with electrical wire)

Depending on specific pieces of equipment, various connectors and adapters are often required to unify the equipment into a functioning system. Typically, cameras are mounted immediately adjacent (within 0.5 m) to the nest bowl on a metal stake (attached with bailing wire). The bulk of our camera equipment and batteries is then housed inside a weather resistant plastic box to protect the electronics from the elements or animal tampering. This is hidden in a shrub 15 – 20 m from the nest site. Once hidden in a shrub, this box is covered with a large, black garbage bag and camouflaged burlap to provide further protection. The burlap is covered with appropriate vegetation to disguise the box as part of the shrub and thereby minimize the detectability of our equipment.

Other pieces of equipment used in the installation of camera systems include a monitor to verify a good picture and proper camera placement, rubberized gloves to reduce the impact of human scent, a scent blocking spray, a hammer to install the mounting stake and assist in digging the cable trench, extra bailing wire to aid in camera mounting and camouflaging, and extra electrical wire to ensure that all batteries can be jumped together. If any spare parts of the camera system are available, it is generally a good idea to carry extras into the field for an installation in case equipment is lost or broken during the install.

10.3 Preparation

Every camera system should be checked prior to deployment at a nest site to ensure that installation can be executed in a timely manner and without having to abort installation prematurely. Working back to the camera box from the camera, the camera lens should be clean and clear of obstructions. On many cameras, a layer of sagebrush bark is glued on top of camouflaged duct tape to provide a solid base of natural camouflage. The camera is connected to the coaxial cable with two connections. The BNC connector allows the video feed to reach the DVR. This connection often requires several adapters to successfully connect the camera to the cable. The RC connection provides power to the camera. The coaxial cable may have male and female ends for the RC connection. Care should be exercised during the installation to ensure that the cable can be properly attached to the camera before the cable is buried and camouflaged. The "video" wire is connected to the DVR's "Video In" (or "AV In") port. Again, this often requires adapters and/or an additional wire. If the DVR unit has multiple wires to choose from, the yellow connector is typically for video input and the white connector is typically for audio input. This should be verified with a test recording prior to deployment. The "power" wire generally has either a red or black connector. This generally does not require adapters but may require an additional wire.

Both the camera's and the DVR's power can be plugged into the power splitter (the miniature extension cord or solid state outlet splitter). The power splitting device is plugged directly into the AC/DC power inverter. The inverter is then plugged into the DC socket with attached alligator clips, and the alligator clips are then attached to the terminals on the battery system. The positive terminal of the first battery should be directly connected to the positive terminal of the second battery, while the negative terminal of the first battery is directly connected to the negative terminal of the second battery. Extreme care must be exercised to never connect a positive terminal to a negative terminal. Personnel can be electrocuted or shocked by improperly connecting electrical wires. Additionally, improper battery terminal connection could result in damage to sensitive electrical equipment or start a fire. When attaching the alligator clips to the battery system, the red clip should be attached to the positive (+) terminal, and the black clip should be attached to the negative (-) terminal. To ensure that the system is connected and operating properly, connect a monitor to view the image supplied by the camera. This is accomplished by connecting the monitor's video wire to the DVR's "Video Out" (or "AV Out") port. The monitor's power supply can be connected to the same battery terminals as the camera system, but should have its own set of an inverter and DC socket/alligator clips.

Once the system has been verified to be in good working order, a small, discrete piece of tape (or other marker) can be placed on the top of the camera to expedite the proper alignment of the camera during installation. This tape or marker should be placed on the rim of the camera, and out of sight so as not to impede the picture or generate potential "wash-out" of the picture when the infra-red lights are illuminating the nest at night.

10.4 Installation

Installation of videography equipment is best done while the hen is on her morning recess. By installing the camera system during a recess, the need to flush the hen from her nest is eliminated. Consideration should be given to the weather at the time of the installation. Generally, it is best to avoid installing a camera system during any form of precipitation. Snowfall and rainfall may increase the likelihood of a hen abandoning her nest.

If it is not possible to install a camera system while the hen is on her recess, as many aspects of the installation as possible should be completed before the hen is flushed from nest. Checking for predators in the area before flushing the hen may reduce the risk of nest detection. By completing the majority of a camera installation before flushing an incubating hen, time the hen is off nest can be minimized, thus allowing her to promptly resume her normal incubation patterns.

When initiating the installation of the camera equipment, first obtain visual confirmation that the nest appears intact. This will help confirm that the installation process should continue and allows the installation crew to better assess where their equipment should be placed and what types of vegetation they will need to collect to best conceal their equipment. Figures 13 through 19 illustrate proper camera installation.

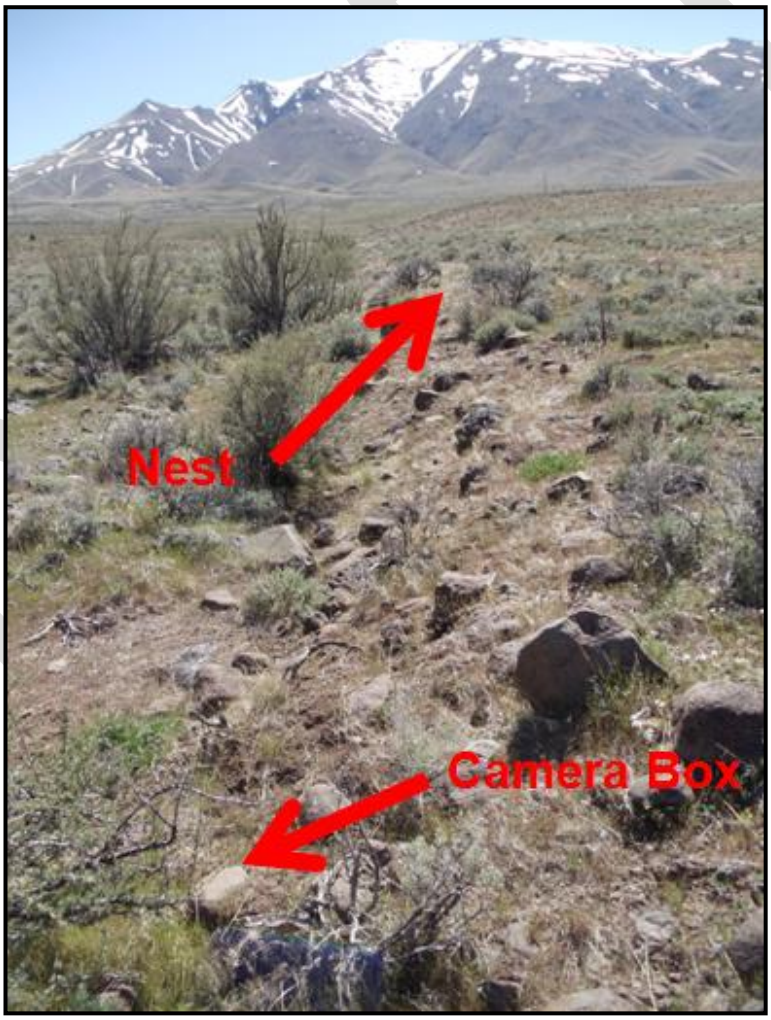

Figure 13. This picture illustrates what an installation site looks like prior to beginning the camera installation. The nest is near the top of the picture, while the shrub that will house the DVR and batteries (Camera Box) is just out of the picture, off to the lower left.

Figure 14. A technician is squatting near the trench, preparing to install the camera at the nest bowl (left). Both pictures show what the trench looks like during and after the installation process. The trench has been filled in and camouflaged to minimize its detectability (right).

Figure 15. A hen eyes the installation crew as they prepare to install a camera inside nest bowl (top left).The shrub chosen to house the camera box prior to installation (top left). The camera box while it is being prepared, during the installation (top right). The shrub (bottom left) has been restored to show minimal evidence of disturbance.

Figure 16. A view from the main entrance into the nest-bowl (top left). The camouflaged camera is in the middle of this picture (top right). A close-up of the installed camera shows how the camera is installed in the shrub (in the "Y" of two branches, and secured with bailing wire). Even though the image from this camera looks good in daylight, the few leaves in front of the infra-red LEDs may cause severe washing-out of the image at night if they are allowed to remain in place (bottom left).3 Red arrows point to the front (left) and back (right) of the camera (bottom right).

Figure 17. The above stills from camera systems: (A) a hen incubating her clutch; (B) a hen returning to the nest bowl after her recess; (C) a hen sits on her clutch as her chicks pip; (D) with the hen gone, chicks wander around the nest bowl before following the hen into the sage-steppe.

Figure 18. The above stills from camera systems are: (A) a raven removing an egg from the nest-bowl after flushing the hen from the nest; (B) a badger prepares to remove eggs from the nest-bowl after flushing the hen from the nest.

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Figure 19. A technician points to a recently installed camera box (top). A recently installed camera, as seen from behind the camera (center). A close up of the same camera reveals how camouflaged the camera and mounting system are (bottom).

11.0 Habitat Sampling Protocols

Several different types of vegetation surveys are conducted on this project. Each survey uses a different combination of techniques, but the execution of each technique remains consistent throughout all surveys. Detailed explanations on each methodology and sampling design are described below.

11.1 Unique ID Formula

To prevent confusion between different study sites, years, and types of surveys, we will be using a unique ID formula for each survey conducted. This system will facilitate management of large quantities of data that is collected annually.

Basic formula:

Year - Study Site - ID # - Survey Type I - Survey Type II + Type ID

Year: (YY) A two-digit identifier for the year (e.g. 2012 = 12)

Study Site: The name for each study site is given a two letter abbreviation. These abbreviations include: Northern SWIP (NS), Southern SWIP (SS), Tuscarora (TS), McGinness (MC), Midway (MI), Desatoyas (DE), Bull Run Basin (Sharptail site) (SH), Huntington Valley (HV), Susanville (SV), and Virginia Mountains (VM).

ID #: Every radio marked bird has been fitted with a unique leg band identification number (e.g., 14-NV1234). The band ID will serve as a bird's reference number when compiling data regarding a particular individual. In the case of independent random points where points are not associated with a bird, the feature identification (FID) number created in ArcGIS is used (e.g., FID001).

Survey Type I: The first survey type refers to whether the point was used by a bird or generated randomly. Three classifications are used. Used (U) points are locations used by a bird that is confirmed by visual inspection. Dependent random points (DR) are generated in the field using a random direction and distance based on the location of a used point. Independent random points (I) are randomly generated throughout each study site using ArcGIS.

Survey Type II: The second survey type refers to the style of survey conducted. These styles include nest style surveys (N), brood style surveys (B), and general telemetry style surveys (T).

Type ID: The type ID is a numeric label for each point. For nest surveys, the nest attempt number from that season is used (e.g., N1, N2). If the survey measures the first nest attempt that has been found for a bird in a single season, the number given to that point is N1. If the survey is for a re-nesting attempt, the number is changed accordingly (e.g., N2). For brood rearing locations, the interval and time (day or night) is added to the unique ID. If the used point was a night brood check at 20 days post hatch, the type ID would be "10N" (full entry: B10N). For telemetry points, the date the telemetry location was obtained is used as the type ID. A location on May 31st would be written as 0531 (full entry: T0531).

Examples of unique IDs

Used point for a first nesting attempt of a hen with band ID 14-NV1234 from the Tuscarora, 2012:

12-TS-14NV1234 -U-N1

Dependent random habitat survey associated with the second nesting attempt of a hen with band ID 14-NV2345 from Northern SWIP, 2012:

12-NS-14NV2345-DR-N2

Nest-style habitat survey for independent random point FID362 in McGinnis, 2013:

13-MC-FID362-I-N

Used point for hen with band ID 14-NV3456 during a 20 day post-hatch daytime brood location at Midway, 2013:

13-MI-14NV3456-U-B20D

Used nocturnal general telemetry relocation on 6/15/2011 for bird with band ID 14-NV4567 from the Pine Nuts:

11-PN-14NV4567-U-T0611N

11.2 Habitat Measurements

11.2.1 Daubenmire Frame

The Daubenmire cover class method was developed to systematically place a quadrat frame along a transect to measure percent cover for various vegetative and mineral cover categories (Daubenmire, 1959). Frame dimensions are 20 X 50 cm, and the center point (marked with tape) of the longer arm should always be aligned with the center point of the location to be measured. If the point is in the middle of the nest bowl, the center of a 50 cm arm of the frame would overlap the center of the nest bowl. If the center point is along a transect, the center point of the 50 cm long arm would overlap the designated point along the transect (such as the 10 or 25 m point). The remainder of the frame is placed to the right of the line, as seen in the direction of travel from the center point of the survey. If the point to be measured is the center point of the survey, the direction of travel is assumed to be along the first transect. This should result with the frame being off-centered from the transect with the longer arms of the frame parallel to the direction of the transect, and the center of one of the longer arms centered over (or under) the point to be measured.

Figure 20. Field technician estimating percent cover using a daubenmire frame (left) and visual obstruction board (right).

The observer estimates the area inside the frame that is covered by each listed type of ground cover (Figure 20). The percent cover estimate is an estimate of the amount of the area of the frame that is covered by each type of cover. Plants do not need to be rooted within the frame to be included in the measurements. We are estimating total cover, not basal coverage. Over-hanging leaves and branches should be included as part of the ground cover if they ex tend over/into the frame. It is common for percent cover to exceed 100% because each of these types of cover may be stratified. For example, bare ground, littler, small forbs and short grasses may be covered by a larger shrub. After estimating percent cover for a cover class, the estimate must be converted into one of the predetermined cover classes. The cover classes are numbered 1-7 (1: 0-5% cover, 2: 6-15% cover, 3: 16-25% cover, 4: 26-50% cover, 5: 51-75% cover, 6: 76-95% cover, 7: 96-100% cover).

The use of cover classes helps to eliminate observer bias and variation between observers. For this study, we are estimating the percent cover of perennial grass, annual grass, perennial forb, annual forb, residual cover, litter, bare ground, rock, and shrub.

Cover classes

- Perennial grass: Grasses that grow for more than two years. Biennial grasses are also included in this category.
- Annual grass: Grasses that complete their life cycle in a single year.
- Perennial forb: Herbaceous flowering plants that live for more than two years. Biennial forbs are also included in this category.
- Annual forb: Herbaceous flowering plants that complete their life cycle in a single year.
- Residual cover: Herbaceous plant material that is dead but still rooted. Typically, this is last year's growth that has not yet decomposed enough to become litter. Normally, residual cover could potentially be identified to the species level, though this is unnecessary for our purposes. Non-woody vegetation that is considered "residual cover" generally retains a dead, light brown color. Color alone is not an indicator for residual cover or litter. For this study, dead shrubs are not considered residual cover; rather, they are included in the shrub cover class.
- Litter: Dead and decaying plant material that is no longer rooted. Litter is often broken into smaller pieces and is generally unidentifiable to the species level. Litter often fades from the dead, light brown color of residual cover to light gray as material approaches the transformation to humus. Color alone is not an indicator for residual cover or litter.
- Bare ground: Exposed soil or gravel. Small rocks that would not impede plant growth are considered bare ground.
- Rock: Solid aggregate of mineral material that is often impermeable to water and would normally impede plant growth. Rocks/pebbles larger than about a quarter are considered rock.
- Shrub: Woody plants that generally have multiple stems and are normally less than 5 m tall.

11.2.2 Vegetation Heights

Vegetation heights will be recorded within five cover classes: sagebrush, other shrub (non-sagebrush), perennial grass, perennial forb, and residual grass. Each height should be measured from the plant that is closest (not the tallest) to the center point of the transect line or nest bowl. These measurements are recorded to the nearest centimeter and must be within 0.5 m from the point. If no plants are present within 0.5 from the center point, that

category receives a height of 0. If the point for the set of measurements is at the 10 m distance along a transect, the closest of each type of plant to that 10 m point should be recorded.

Heights are measured from the ground to the top of the plant, in a straight, vertical line. Shrub and grass heights should be taken from their natural position, and do not include the inflorescence that extends beyond the top of the canopy. When measuring heights, shrubs or grasses should not be manipulated or stretched out to alter the natural droop height of the plant.

11.2.3 Nest Bowl Characteristics

When conducting habitat sampling for nests, several nest bowl measurements will be taken at the center point for nest sites, dependent random nest surveys, and independent random nest surveys.

Nest bowl data and measurements (nearest cm) include:

- Center shrub species
- Maximum height of the center shrub
- Maximum width of the center shrub
- Maximum width of the widest point perpendicular to the shrub's "greatest width"
- Nest bowl litter depth – only measured at actual nest sites

The center shrub is the shrub that provides the most cover over the nest bowl. In the case of two shrubs evenly covering a nest bowl, use your best judgment and choose the individual that appears to provide more cover. For random surveys (DR and I), the center shrub is the shrub closest to the GPS waypoint that a sage-grouse could reasonably fit underneath.

11.2.4 Random Shrub Height

Along each transect, 10 random shrub heights (to the nearest cm) that intersect the transect line should be measured. Try to spread them out somewhat evenly over the length of each transect. For example, a random height taken every 3 – 4 steps along a 25 m transect is generally sufficient. If there are not enough shrubs present along the transect, it is acceptable to measure shrub heights a few meters away from the transect as long as the distance from the center point does not exceed the length of the transect. Shrub height measurements for one transect should not encroach on shrubs that are closer to another transect.

11.2.5 Line Intercept Method (Shrub Canopy Cover)

For each transect, a string or measuring tape is laid out in a straight line in a randomly generated direction. The random bearing of the first transect is used as a reference for generating subsequent bearings for the remaining transects in any particular survey. Any shrub that intercepts the line above or below the line is measured and recorded to the nearest centimeter when looking down at the line from directly above the point being measured (Figure 21). The threshold for our gap width is 5 cm. If there is a break in the shrub canopy that is less than 5cm, the canopy is assumed to be continuous. If there is a break in the shrub canopy that is larger than 5 cm, the gap is not included in the measurement and two separate measurements will be taken. Canopy cover is not recorded if a shrub intersects less than 5 cm of the line.

When multiple individuals of the same species overlap and form a continuous section of canopy, they can be recorded as a single occurrence. When multiple individuals from different species overlap, the species of shrub on the top of the canopy (when viewed from directly above) should be recorded. Other shrub species occurring inside the canopy or in the understory should NOT be measured.

Species' measurements are broken down and recorded into different distance classes along each transect. From the center point of the survey, all shrubs that intercept the transect up to the 5 m point are included in the 5 m class. Any shrub that intercepts the line from the 5 m point to the 10 m point is recorded in the 10 m class. The same criteria are applied to the 25, 50, and 100 m classes.
An example of how measurements are recorded is given below, where "S" represents a species of shrub, and "X" represents an individual measurement of shrub canopy cover:

S1- 5(X, X, X) 10(X, X) 25(X,X,X,X,X)

In this example, species "S1" intercepts the transect in 3 and 2 occurrences at the 5 and 10 m classes, respectively. Species S1 did not occur in the 25 m class, so it receives a 0. It is preferred to record all distance classes for a species, even when absent at one or more distance classes, to avoid confusion while recording data in the field and entering data at the end of the season.

Figure 21. Technicians measuring shrub canopy cover using the line intercept method.

11.2.6 Visual Obstruction Board

The visual obstruction (VO) method is used to measure horizontal and vertical vegetative cover using a Jones' coverboard (Jones, 1968). This is accomplished by counting individual squares that are at least 50% visible. The study utilizes a 25 x 25 cm piece of plywood that is painted in a checker-board pattern with alternating red and white squares for maximum visibility. Each square of the painted pattern is 5 x 5 cm so that there are 5 squares along each side, with a total of 25 squares on the entire board. When counting squares, if < 50% of the square is visible, it should not be counted. If > 50% of the square is visible, it should be included in the observer's count.

Visual obstruction board placement varies depending on the survey type, and protocols will be outlined for each in the next section. However, the same method is used at all points where visual obstruction is measured. At each point, readings are taken from three different directions (each separated by 120°) and at three different angles (0°, 45°, and 90°) from the ground. At the nest or center location, the VO board is placed flat on the ground directly over the nest bowl or center point (randomly selected nest site). At the 10 and 25 m points, the VO board is placed directly under the transect line for each distance, which should be marked with electrical tape.

The 90° reading measures vertical cover, simulating what an avian predator can see when viewed from directly above. With the board placed flat in the nest bowl or on the ground along a transect, stand directly over the

board and count all squares with > 50% visibility. It is only necessary to record one 90° measurement for each set of VO board measurements because it should remain the same regardless of where you are standing.

The 0° and 45° angles measure horizontal cover. The 0° reading simulates a terrestrial predator's viewpoint at ground level. The 45° reading simulates an avian predator's viewpoint when scanning the landscape while flying. For both angles, the board should be placed upright on a side so that the checker-board pattern is facing the observer. The observer should take readings 2 m from the board in the randomly generated bearing. To take the 0° reading, place a hand on the ground and rest your head on your hand (Figure X). Close the eye closest to your hand and count all squares with > 50% visibility. Take the 45° reading while standing at the 2 m mark, again counting all squares with > 50% visibility. This process should be repeated for the remaining two bearings for the 0° and 45° angles.

11.2.7 Visual Obstruction Ball

The Visual Obstruction Ball and the Visual Obstruction Board techniques both measure vegetative cover using slightly different methods. The purpose of using both techniques is to compare results. The VO Ball method is thought to provide a more accurate measure of cover. While the observer counts and records the number of squares for the VO Board method, a photo is taken of a red ball from the same locations and angles as defined for VO Board method for the VO Ball method. The number of pixels contained within the electronic image of the ball, compared to the total area encompassed by the entire unobstructed ball, is used to calculate percent cover.

11.3 Habitat Survey Type

11.3.1 Nest and Brood Habitat Survey

Habitat sampling will be conducted following nest fate (at both successful and unsuccessful nests), at all day and night brood locations, and random points. Each nest or brood habitat survey consists of three 25 m transects arranged in a symmetrical pattern. Each transect is separated by 120° angles with the nest or brood's telemetry location serving as the center point (Figure 23). The direction of the first transect is determined by obtaining a random number between 0 and 359 °. Add 120° to get the bearing for the second transect, and the same procedure applies for the third transect. Photos will also be taken for each survey location (Figure 22.) One photo will be of the unique ID on the datasheet to identify that particular survey. One photo should also be taken in each cardinal direction to include the nest location or center point in the photo.

Nest Locations

A total of three habitat surveys will be completed for each nest:

One survey at the nest site
One survey at a dependent random location (DR)
One survey at an independent random location (I)

The dependent random locations are determined by obtaining a random direction (bearing) and distance (between 50 – 500 m) from the nest. Independent random points are generated using ArcGIS. The center location for a random nest survey will be a shrub closest to the UTM coordinates where a sage-grouse could reasonably use as a nest site (i.e. under a sagebrush or other shrub).

Brood Locations

All brood-rearing hens are located with radio-telemetry on a 10 day interval. Each cycle of locations consists of one night and one day location obtained within the same 24 hour period. For each 10 day cycle, a total of three habitat surveys are completed:

One survey at the used night location
One survey at the used day location
One survey at a dependent random location (based on the day location)

The dependent random location is determined by obtaining a random direction (bearing) and distance (between 50 – 850 m) from the day location of the brood. The center location for a random brood survey will be the exact UTM coordinates.

Habitat Measurements

VO Board readings and daubenmire frame measurements are taken from the center point (nest/brood location or random point), as well as at the 10 and 25 m points for all three transects. A total of seven VO Board readings and daubenmire frame measurements should be taken during each habitat survey. Every time the Daubenmire frame is used, vegetation heights are also measured for sagebrush, other shrub, perennial grass, perennial forb, and residual grass. Shrub canopy cover is measured along each of the three transects delineated into 5, 10, and 25 m distance classes. Ten random shrub heights are also collected from each transect. Protocols for taking the described measurements and example data sheets are given in Habitat Measurements (Section 11.2) and Checklists and Forms (Section 18.0).

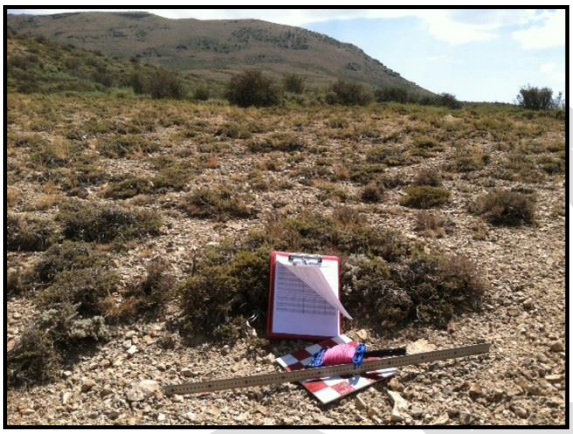


Figure 22. Example of a photo taken at a night brood location.

11.3.2 Movement (Telemetry) Based Habitat Survey:

There are certain circumstances where general habitat surveys will be conducted on general telemetry locations. This includes females with failed nests or broods, and males. Each movement habitat survey associated with a used point also has corresponding dependent random and independent random habitat surveys. Random habitat surveys are conducted in the same manner as used points. Dependent random surveys are located in a random bearing and direction (between 50 and 850 m) of the used point. Independent random locations are generated using ArcGIS. Each movement based habitat survey consists of two 25 m transects arranged in a straight line (180°) with the telemetry point serving as the center point (Figure 24).

Habitat Measurements

VO Board readings and daubenmire frame measurements are taken from the center point (telemetry location), as well as at the 10 and 25 m points along the first transect. Along the second transect, only daubenmire frame measurements are taken at the 10 and 25 m points. Every time the Daubenmire frame is used, vegetation heights are also measured for sagebrush, other shrub, perennial grass, perennial forb, and residual grass. Shrub canopy cover is measured along each of the three transects delineated into 5, 10, and 25 m sections. Ten random shrub heights are also collected from each transect. Protocols for taking the described measurements and example

data sheets are given in Habitat Measurements (Section 11.2) and Checklists and Forms (Section 18.0). Each movement based habitat survey also has a pinyon/juniper survey associated with the same point.

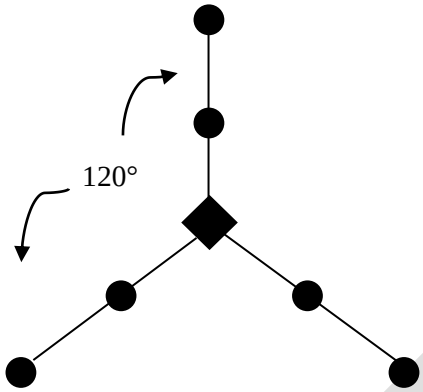
11.3.3 Pinyon/Juniper (PJ) Survey

The Pinyon/Juniper (PJ) survey consists of four transects projected out from a central point (Figure 25). The used location, dependent random point, or independent random point serves as the central point. Four 100 m transects extend from the central point and are separated by 90° angles. The bearing for the first transect is randomly generated and subsequent transects are based off the first bearing. From each of the five points (the four projected waypoints, and the one central point), the observer scans the area for the closest Pinyon or Juniper tree. A bearing is taken to that closest tree with a magnetic compass. The distance is measured by either using a laser range finder, or walking to the tree and using the "Go to Waypoint" function on a GPS unit. The nearest tree from the initial tree is then recorded. A second bearing and distance is recorded, but this time the bearing and distance is from the first tree, not necessarily from the observer. This same process is repeated for each of the four projected waypoints. Each recorded PJ that is located is classified into one of four size classes based on height of the tree.

Class 1: 0-1m Class 2: 1-2m Class 3: 2-3m Class 4: more than 3 m tall

From the center point, the "Closest Perceived Threat" is recorded. This is the closest potential perching surface above shrub height (Class 2 or greater). As with the other data recorded in the survey, a bearing and distance is recorded for the "Closest Perceived Threat"

Nest and Brood Habitat Survey



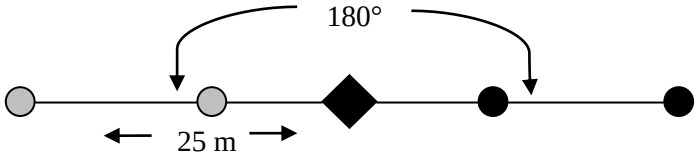
◆ Center point – The direction for the first transect is randomly generated and serves as the basis from which all other transects are derived. This first random direction also serves as the first direction for the visual obstruction board. Seven visual obstruction board readings are recorded (90°, 0° and 45° angles) for each set of measurements. One set of Daubenmire frame readings with associated height measurements are collected.

● 10 and 25 m points, all 3 transects – Seven visual obstruction board readings are recorded (90°, 0° and 45° angles). One set of Daubenmire frame readings with associated height measurements are collected.

—— Shrub Canopy/Line Intercept measurements collected and separated in to their appropriate distance classes. Random shrub heights are collected along transects.

Figure 23. Survey design for nest and brood locations, as well as dependent and independent random locations associated with used points.

Movement (Telemetry) Based Habitat Survey



◆ Center point – The direction for the first transect is randomly generated and serves as the basis from which the other transect is derived. This first random direction also serves as the first direction for the visual obstruction board. Seven visual obstruction board readings are recorded (90°, 0° and 45° angles) for each set of measurements. One set of Daubenmire frame readings with associated height measurements are collected.

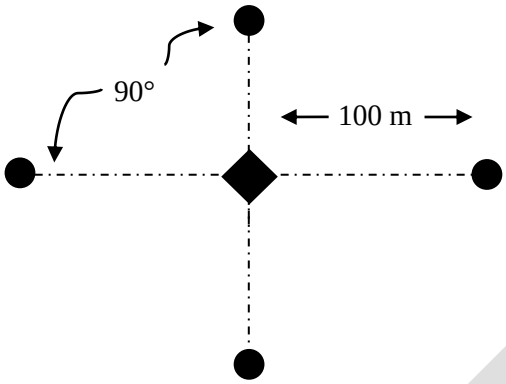
● 10 and 25 m points, 1st transect – Seven visual obstruction board readings are recorded (90°, 0° and 45° angles) for each set of measurements. One set of Daubenmire frame readings with associated height measurements are collected.

○ 10 and 25 m points, 2nd transect – 1 set of Daubenmire frame readings with associated height measurements.

—— Shrub Canopy/Line Intercept measurements collected and separated in to their appropriate distance classes. Random shrub heights are collected along transect.

Figure 24. Survey design for general telemetry (movement) locations, as well as dependent and independent random locations associated with used points.

Pinyon/Juniper (PJ) Survey



◆ Center point – The distance and bearing of the closest Pinyon pine or Juniper is recorded. The distance and bearing to the PJ closest to "the closest PJ" is also recorded, relative to "the closest PJ. The "Closest Perceived Threat" is also recorded with a distance and bearing.

● 100 m from center point – The distance and bearing of the closest Pinyon pine or Juniper is recorded. The distance and bearing to the PJ closest to "the closest PJ" is also recorded in relation to "the closest PJ"

Figure 25. Pinyon/Juniper survey design for used sage-grouse locations, as well as dependent and independent random locations associated with used points.

12.0 Raptor, Raven, Horse, and Livestock Surveys

Common ravens are known to be effective sage-grouse nest predators (Coates et al. 2008). Raptors and livestock may also have direct or indirect effects on local grouse populations including predation and altering sagebrush communities. Therefore, we conduct surveys for ravens, raptors, horses, and livestock (RRHL) at all telemetry or used locations as well as dependent and independent random locations. Used points include lek counts, nest checks, brood checks, general telemetry locations, and mortality locations. For every survey completed at a used site, a RRHL survey must also be completed at an independent random location.

RRHL surveys consist of 10 minute point counts. Always use predetermined locations for bird surveys, and do not try to time the survey to see or avoid seeing birds. For lek sites, telemetry locations, and random survey locations that are NOT associated with a nest, it is acceptable to move as much as 10 meters from the survey point to a spot with the best view of the landscape. This is especially true if there is a large object, like a juniper, close to the survey point. If your view of the sky is still blocked by more than 40%, then still conduct the survey but record this in your notes.

Surveys should be conducted immediately following nest checks and all telemetry locations. However, counts should not be conducted within 50 m of a nest while the nest is active in order to avoid potentially cuing in a predator to the nest location. Surveys will predominately be conducted during the nesting season but will also include the brood-rearing season. Surveys will be completed throughout the study site, but an emphasis should be placed on locations within 1000 m of nests. A random RRHL survey should be coupled with every survey conducted at a used location. If surveys were completed following five nest checks, five surveys should also be conducted at independent random points. Random surveys should be done as soon as possible following those at used locations, preferably within a week, in order to assess predator abundance and distribution in relation to grouse activities.

Survey Equipment

- Binoculars
- GPS unit
- Compass
- Range finder
- Watch
- Forms with pencil or data logger
- Anemometer
- Bird identification book (for after the survey)

Begin a survey by scanning the entire 360° area equally (Figure 26). Split time between scanning with binoculars and the naked eye. Some birds can be more easily spotted with a particular method depending on the terrain or distance. When scanning, all sections of the sky and land should be equally searched. Scan from the ground slightly below the horizon up through the sky directly above you. Move the binoculars over to the next segment directly adjacent to the area just searched and continue scanning down through the sky and horizon. Repeat this process until the entire 360° is searched. While scanning, lower the binoculars every few minutes and scan quickly all around with the naked eye. If focused too long on scanning in one direction, a bird flying closely behind you might be missed. It is sometimes useful for two people to conduct the survey. With two people, only one person should scan for birds while the other records data. If the data recorder sees a bird that the observer does not, he/she should not indicate this in any way. This increases observer effort and thus biases data analyses.

On the RRHL GoCanvas form, record the following information after conducting the survey:

- Field Site
- Survey ID

- Date
- Start time (military time)
- Cloud cover (mostly cloudy, partly cloudy, clear)
- Average wind speed (kph) and make a not if it is an estimate
- Wind class (Beaufort scale; Table 1)
- Observer initials
- UTM coordinates of the survey location
- Presence of livestock (cattle, horses (feral and domestic), sheep, etc.)
- Subsidies

Table 1. Beaufort wind scale

Beaufort Wind Scale			
0	1 mph	Calm	Smoke rises vertically.
1	2 mph	Light	Smoke drifts.
2	5 mph	Light Breeze	Leaves rustle.
3	10 mph	Gentle Breeze	Lighter branches sway.
4	15 mph	Moderate Breeze	Dust rises. Branches move.
5	21 mph	Fresh Breeze	Small trees sway.
6	28 mph	Strong Breeze	Larger branches move.
7	35 mph	Moderate gale	Trees move.
8	42 mph	Fresh gale	Twigs break.
9	50 mph	Strong gale	Branches break.
10	59 mph	Whole gale	Trees fall.
11	69 mph	Storm	Violent blasts.
12	75+ mph	Hurricane	Structures shake.

Subsidies are any form of anthropogenic structure or food and water resources that may influence raven and raptor presence in a particular area. Ravens capitalize on tall structures (i.e., power lines) for nesting and perching substrates (Figure 26). Therefore it is critical all subsidies are accurately recorded. Subsidies include farms (irrigated and dryland agriculture), water resources (agricultural irrigation, stock ponds and watering troughs, reservoirs, gutters), livestock operations and holding pens/corrals/stockyards, power lines, fences, roads, dead animals, artificial nesting platforms, tall trees if the landscape is otherwise treeless (landscaped trees and shelterbelts), landfills and trash containers, etc. Describe the subsidy, its compass bearing, and distance from the observer. Enter the information in the space provided separated by commas, and no spaces are necessary. Do not include the degree symbol or meters. It is extremely important that subsidies are entered in this format.

- Example: Power line,275,942,Farm,34,255

For nests, note any bird activity near the nest, especially if you can determine if the nest is currently occupied. Use your discretion when deciding when to count a subsidy. If it is close enough that you could see a raven/raptor with binoculars near the subsidy, then count it. If you know of a subsidy but cannot see it from your survey point (i.e. a large farm with livestock just over the hill) then still count it, as it may influence raven and raptor presence and abundance.

For every raptor, raven, or livestock detected, record the time, distance (m), and bearing when first detected. During the 10-minute survey, birds and livestock may be attracted or repelled by the observer's presence. Therefore, it is imperative (for unbiased statistical analyses) that you record the time, distance, bearing and behavior of birds/livestock at the time and location they were first detected on the landscape, regardless of whether or not they eventually flew directly over, or intercepted the survey point. For each raven or raptor observation,

record the bird's behavior, which includes: perching, standing on ground, foraging flight (i.e., flying relatively low with movement and posture consistent with searching the ground below), soaring, active flight (i.e. flying relatively high in a straight line direction), copulating, nest incubation and sentry, and territorial defense (aggressive behavior toward other birds). Livestock behavior includes standing, grazing or browsing, walking or running.

When a ravens, raptors, or livestock are detected, record the following information:

- Species using its 4 digit code
- Count
- Observation time
- Distance (m) recorded as either an observer estimate, or determined by a range finder
- Bearing to the bird from the observer
- Behavior

If more than one species is detected at the same time, use a new form for each species. If several birds of the same species are close together, use one line and bearing to the center of the group of birds. Raptors should be identified to species when possible. If the bird species is unknown try to ID it to genus, and describe it in the notes. Do not count the same bird more than once. Try to keep in mind which direction the bird is headed, and where in the sky it is relative to where you're searching. If you count one bird on its own and record it, then see it with a second (or more) birds, record the data for the second bird only, but mention the fact it is with the first bird in the activity section. If a bird is detected even just a minute outside the 10 minute survey time, do not count it.

Figure 26. Technician conducting a RRHL survey (left). An example of a subsidy: raven nest and powerline (right).

13.0 Badger Surveys

13.1 Survey Method

After nest fate is determined, we conduct surveys for the American badger (*Taxidea taxus*; hereafter badger). Surveys are conducted at all nest, dependent, and independent random points. Four points are projected in 4 random directions (90° apart) at a distance of 100 m from the center point (Figure 27). Each survey consists of 6 transects arranged in a bowtie pattern with 4 m wide transects (2 m on either side of the line of travel) centered on the nest bowl. The total distance travelled for each survey is 680 m. Within each transect we detect and record fresh, intact badger holes; collapsed holes; small digs or scrapes; scat; and tracks. These measurements are used to develop a badger activity index. Data are recorded on the Badger Sign Sampling Form (18.0 Checklists and Forms).

From the center, the observer walks to the first point (100 m), then cuts diagonally to the next point (140 m) (Figure 14). Next, the observer surveys through the center point, and out to the third point (100 m each, or 200 m total). Cutting diagonally (140 m), the observer should be at the third point. Surveying this final transect (100 m) should return the observer to the center point.

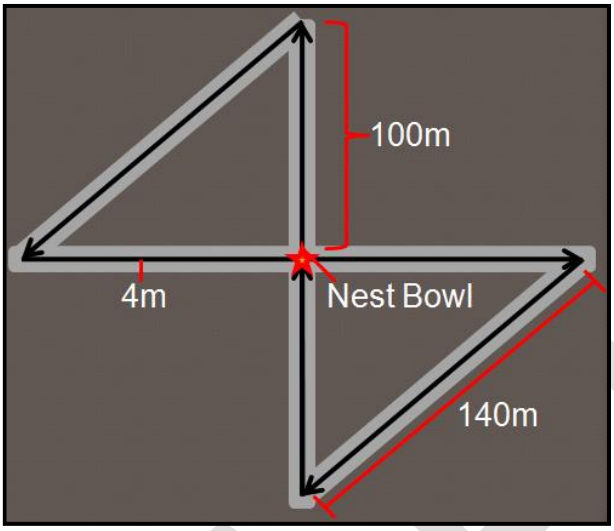


Figure 27. Survey design to measure badger presence.

13.2 Identifying Badger Sign

Badgers are largely nocturnal and are primarily found in grasslands, farms, deserts, and other treeless areas with ample rodent supply. Burrows are an obvious sign of badger presence. They are prolific diggers and can excavate many burrows within their home range. Badgers live in burrows called setts, which consist of one to several entrance tunnels that leads to a central sleeping chamber. Burrows are generally elliptical in shape, 20 – 30 cm wide, and have a flattened bottom. They resemble a 'D' shape on its side that is similar to a badger's outline. Large mounds of soil are generally present at the entrance at recently excavated burrows. Rocks that have been scored (in attempt to dislodge them) are also a sign badgers have been using an area (Figure 28). During summer, badgers are very active and can create and stay in a different den every few nights. During fall and winter, badgers enter a semi-dormant state in which they use one den for the season. Badgers prey on mammals, ground nesting birds, invertebrates, carrion, as well as fungi and some plants. Many digs are therefore a result of searching for food.

Figure 28. Freshly excavated burrow (left), scored rock (center), and scat (right).

Tracks are also an obvious sign badgers are using an area. However, they can appear similar to coyote tracks. Claw marks are farther from the toe pad in badger tracks, and the front tracks have a pigeon-toed appearance (Figure 29). In canine tracks, the leading edge of the heel pad has only one lobe and the trailing edge of the heel pad has two lobes. In feline tracks, claw marks are generally not present. In natural environments, the variance of the heel pad between canines and felines is more noticeable than the presence or absence of claw marks. Canine heel pads have one lobe on the leading edge of the heel pad while the leading edge of a feline heel pad has two lobes. While both dogs and cats only have four digits present in their track, all five digits appear in a skunk track and a badger track. While badger prints are similar to the front tracks of a skunk they are larger. The hind track varies considerably between a skunk and a badger. Depending on soil conditions, the claw marks on a badger track should be prominent.

Badger scat varies considerably in shape and dimension. They are long and tubular, or twisted, folded, pointy piles that are somewhat segmented. When opened, badger scat has a powerful, pungent smell. They are about 1 – 2 cm in diameter and 7 – 15 cm long. Badgers often defecate underground so scat can be difficult to find.

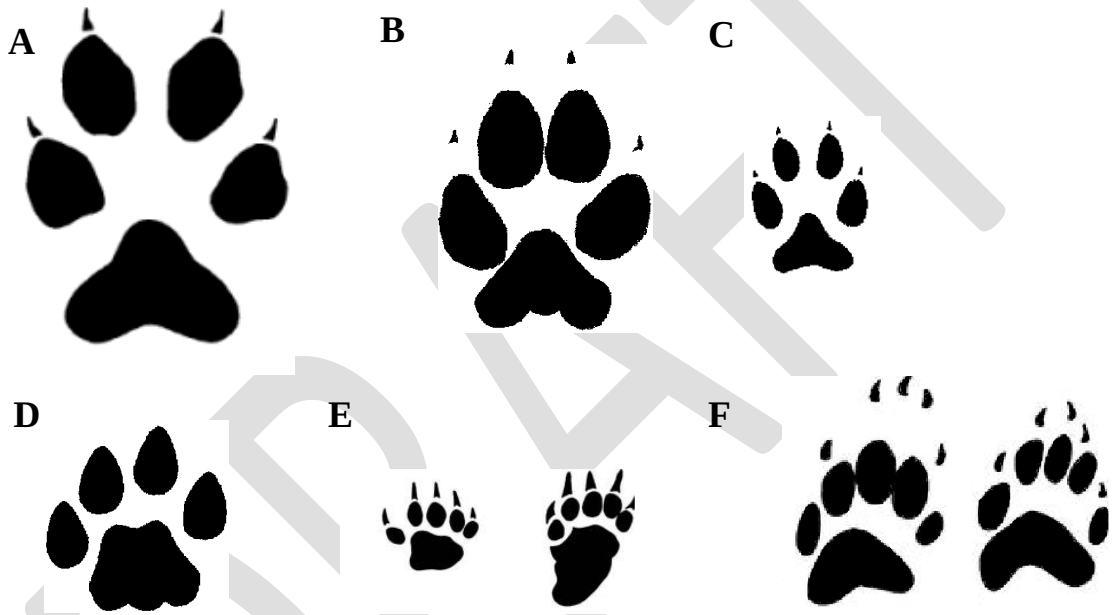


Figure 29. Tracks of: (A) large dog (~4 in.); (B) coyote (~3 in.); (C) kit fox (<2 in.); (D) bobcat (~2 in.); (E) skunk (~ 1 ½ in.) (front and hind prints); and (F) badger (~2 in.) (front and hind prints).

14.0 Field Truck Protocol

Each field truck key should be labeled with a small ID tag that lists the license plate number, color, make, model and year. Additionally, a small leather case should be attached to the primary set of keys to hold the GSA gas credit card and receipts for that truck. One spare key should be attached to the underside of each truck for use in the case of emergencies and another spare key should remain in the Sage-Grouse key lock box at the Dixon Field Station.

Each key that is removed from the lock box must to be signed out. The sign-out sheet is placed directly below the lock box. To sign out a truck, an individual must list their name, the license of the truck in use, the location, and the date and time signed out and back in. The white board to the right of the lock box is used to keep

track of the locations of all sage-grouse field trucks. If you are taking a truck out into the field, please update the white board accordingly with your destination.

We typically have four different types of trucks in use during the field season. Below is a detailed description of each type of truck.

Short-term GSA truck – These G trucks are short-term rental trucks that we get from GSA. We only rent these trucks for the duration of the field season by the month.

Short-term Non-GSA truck – When we cannot get enough short-term GSA rental trucks, we rent trucks from private rental companies by the month for the duration of the field season. These trucks can be identified by a CA or NV license plate (rather than a government plate).

Long-term GSA truck – These are G trucks that are owned by GSA and we rent them from GSA year round. We pay for mileage and monthly rent on these trucks.

I truck – I trucks can be identified by an "I" at the beginning of the license plate number. These trucks are owned by specific USGS projects.

Please see the Gas and Purchases Protocol for details on how to record GSA gas card purchases and other purchases of field supplies.

15.0 Gas and Vehicle Purchases Protocol

This protocol details how the Sage-Grouse project keeps records of gas, maintenance and mileage on field trucks and other purchases for our projects. It is very important that the information reported is complete, accurate and timely. If some aspect of your submission is unclear or missing, a reply email will be sent to you from the sggasreceipt email asking you to complete the missing information. Please reply with the corrected information in a timely manner and do not immediately delete the receipt photo off of the field iPhone for these purposes.

15.1 GSA and I Truck Gas Purchases

At the time of fill-up and gas purchase with a GSA or I truck credit card (all G and I trucks have a GSA credit card) a picture needs to be taken of the receipt and sent to sggasreceipt@gmail.com. The picture of the receipt should either be in the body of the email or an attachment. Make sure that the receipt photo is in focus and that the vendor, date and amount of the purchase are clear. The subject of the email should be written as shown below, and must include the project/field site (abbreviations preferred, if known), Gas, truck license plate #, and truck mileage at time of fill-up (Figure 30).

Example:
To: sggasreceipt@gmail.com
Subject: TS, Gas, I431432, 96358 mi

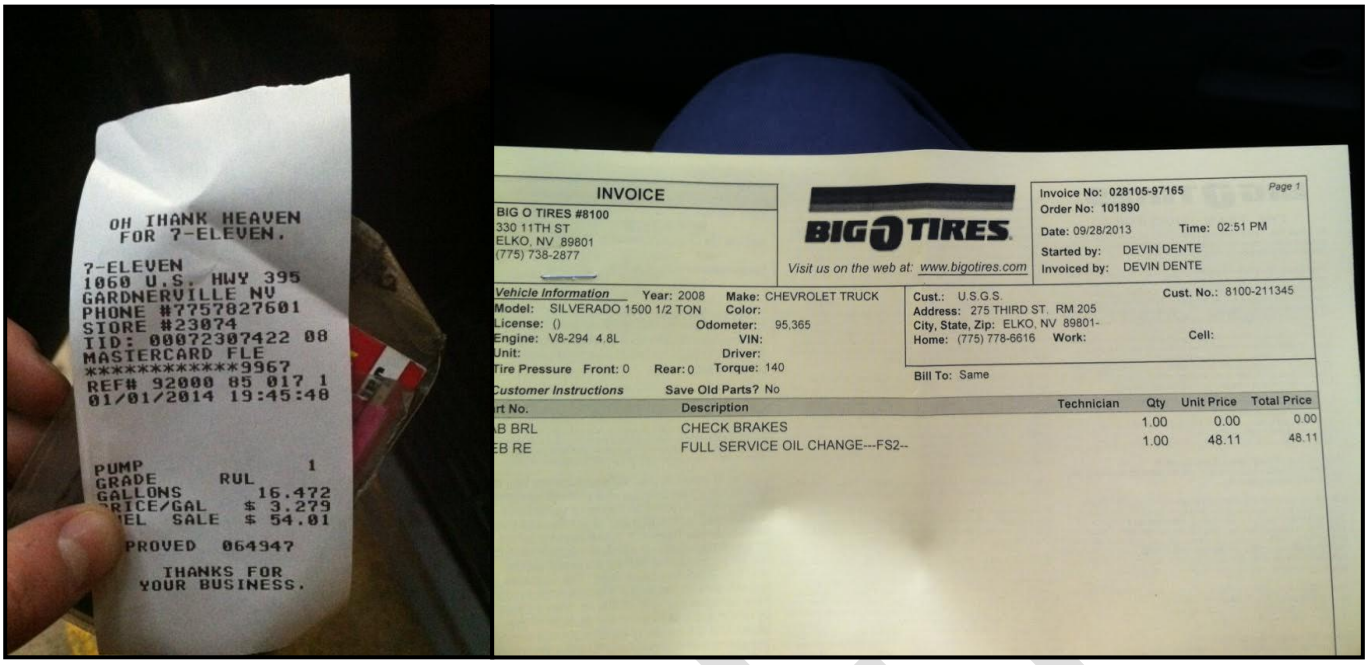


Figure 30. Example of a gas receipt photo (left) and a maintenance purchase receipt photo submitted to sggasreceipt@gmail.com.

15.2 Truck Maintenance Purchases

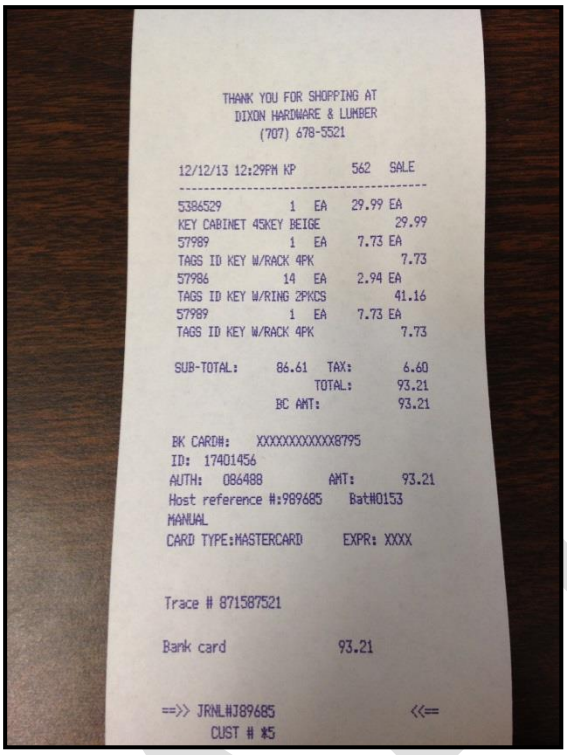
After any truck maintenance purchase is made, a picture of the purchase receipt should be sent to sggasreceipt@gmail.com. The picture of the receipt should either be in the body of the email or an attachment. Make sure that the receipt photo is in focus and that the vendor, date and amount of the purchase are clear. If there are multiple pages to the receipt (some truck maintenance receipts may have a sheet detailing the maintenance the truck received and a smaller receipt with the purchase) please be sure to email photos of ***both*** receipts. The subject of the email should be written as shown below, and must include the project/field site (abbreviations preferred, if known), maintenance type (oil change, new tire, battery, etc.), truck license plate #, and truck mileage at time of maintenance (Figure 30).

Example:
To: sggasreceipt@gmail.com
Subject: MI, Oil change, I431432, 96358 mi

15.3 Project Purchases

After any project purchase is made, a picture of the purchase receipt should be sent to sggasreceipt@gmail.com. The picture of the receipt should either be in the body of the email or an attachment. Make sure that the receipt photo is in focus and that the vendor, date and amount of the purchase are clear. The subject of the email should be written as shown below, and must include the project/field site (abbreviations), "Purchase," the name of the CC holder, and Vendor. In the body of the email, please briefly list the products that you purchases (especially if it is not listed on the receipt) (Figure 31).

To: sggasreceipt@gmail.com
Subject: MC, Purchase, Katie, Ace hardware
Body: spotlights, propane, batteries



THANK YOU FOR SHOPPING AT
DIXON HARDWARE & LUMBER
(707) 678-5521

12/12/13 12:29PM KP 562 SALE

5386529	1 EA	29.99 EA	
KEY CABINET 45KEY BEIGE			29.99
57989	1 EA	7.73 EA	
TAGS ID KEY W/RACK 4PK			7.73
57986	14 EA	2.94 EA	
TAGS ID KEY W/RING 2PKDS			41.16
57989	1 EA	7.73 EA	
TAGS ID KEY W/RACK 4PK			7.73

SUB-TOTAL: 86.61 TAX: 6.60
TOTAL: 93.21
BC AMT: 93.21

BK CARD#: XXXXXXXXXXXX8795
ID: 17401456
AUTH: 086488 AMT: 93.21
Host reference #:989685 Bat#0153
MANUAL
CARD TYPE:MASTERCARD EXPR: XXXX

Trace # 871587521

Bank card 93.21

==>> JRNL#J89685 <<==
CUST # #5

Figure 31. Example of a project purchase receipt sent to sggasreceipt@gmail.com

If the purchase has an electronic receipt, please make sure to forward it to the sggasreceipt email and include in the body of the email all of the information that is normally listed for a purchase. Purchases made from the USGS Amazon account will automatically be sent to the sggasreceipt email. Please contact Michelle Fearon at either mfearon@usgs.gov or sggasreceipt@gmail.com with any questions.

16.0 Vehicle Damage Protocol

Any incident that results in damage to a truck must be reported to the field manager (Katie Andrle) as soon as possible. It is the responsibility of the field crew leader to inspect each vehicle for damages on a daily basis. A written description to include the vehicle license plate, driver, date, detailed description of the incident, and resulting damage is required within one day of an accident/incident. I will be making regular site visits to inspect all vehicles and will keep a detailed truck damages file. If I notice damage that I have not been made aware of, an investigation will occur. Ultimately, it is the crew leader's responsibility to monitor their vehicles, and if the driver at the time of the accident cannot be identified, the crew leader will be held accountable. Each situation will be unique and will be dealt with on a case by case basis. If we determine that the damage(s) caused were due to carelessness or unsafe driving, a suspension from driving may occur, and the driver may be held responsible for costs associated with repairs. A suspension from driving may also mean you will be unable to perform field duties. If more than one careless/reckless incident occurs, the responsible person may be terminated from employment.

We take safe and careful driving very seriously. Many of the vehicles we operate do not belong to the project. Therefore, any damages that occur during the season, regardless of severity, will have to be repaired using funds that support running our field projects.

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Appendix I: Vegetation

Adapted from: Great Basin National Park Flora and Fauna Guide
January 2012: http://www.great.basin.national-park.com/bird.htm#shrub

Tree Guide

Utah Juniper (Juniperus osteosperma)

Utah juniper is one of the most abundant and widely scattered trees of the region. Typically found between 3,000 and 8,000 feet, this tree grows amongst pinyon and sagebrush. The short scale-like needles are 1/8 inch long and last several years. Foliage and branches are stiff. Seeds are borne in berry-like scaled cones. The cones, when mature, are up to a half-inch in diameter and bronze in color with a bluish white frosting. Male and female cones are found on the same tree. Bark consists of many layers of fibrous elongated shreds.

Rocky Mountain Juniper (*Juniperus scopulorum*)

Rocky Mountain Junpier is similar to the Utah Juniper but tends to prefer cooler moister sites. The foliage is a finer texture and appears somewhat lacy compared to Utah Juniper. Cones are bluish when mature and only about 1/3 inch in diameter. These soft pulpy cones are only found on the female tree.

Single leaf Pinyon Pine (*Pinus monophylla*)

Singleleaf pinyon pine grows between 5,000 and 9,000 feet and is often mixed with Utah Juniper and sagebrush. It grows better in places where Utah Juniper is already established and moderates microclimate by providing shade. Pinyon migrated into the region eleven thousand years ago after the retreat of the glaciers. Normally this reddish barked tree is small and many branched. This is the only pine to have a single needle fascicle. The needles are usually round or cylindrical in cross section, rigid and sharp. They curve toward the branch and are about 1 ½ inches long. Cones contain wingless edible seeds.

Ponderosa Pine (*Pinus ponderosa*)

Ponderosa pine is found throughout the west. Like pinyon pine, ponderosa migrated into the area since the last ice age. Ponderosa pine in this region are usually found between 7,000 and 8,500 feet on dry rocky slopes. Trees can reach heights of 100 feet. The bark on older trees is made up of broad orange or reddish plates consisting of thin scales. Young trees are blackish or dark brown with narrow furrows in the bark. Twigs are orange brown. Needles are about five inches long, thick and flexible, they come two to a bundle. Cones are 3 to 6 inches long and reddish to yellowish. They produce a mottled purple winged seed. Ponderosa rely heavily on fire to burn back the accumulated litter on the forest floor so that the seedling roots can find the moist mineral soil. Fire also kills back fir seedlings that will shade out the sun-loving ponderosa seedlings.

White Fir (Abies concolor)

White fir is the most widespread western fir. Its bark is thin, gray and smooth in young trees. It darkens and thickens into furrows and ridges with age. The 2 to 3 inch long needles are Flat, Friendly and Flexible. The white fir gets its name from its silvery blue needles. The yellow- green cones grow erect on the upper branches and are 3 to 5 inches long. Cones are rarely found on the ground. They disintegrate with the scales and winged seeds falling, leaving only the cone axis behind. White fir is common between 7,000 and 9,500 feet in elevation.

Englemann Spruce (*Picea engelmannii*)

Englemann spruce grows from 7,500 feet to timberline. At timberline this tree will form krumholtz, becoming a shrubby thicket. The bark is thin, covering the trunk with loosely attached, rounded, red-brown scales. The dark

green one-inch leaves are flexible, sharply pointed, square in cross section and grow upward on the twigs. Englemann spruces are often rounded at the top with gently arched limbs. Cones hang down from uppermost branches. Cones are 1 to 2 ½ inches long with thin, flexible, jagged scales. Seeds are dark and winged. These trees are vulnerable to fire and windstorms because of their thin bark and shallow root system.

Douglas Fir (Pseudotsuga menziesii)

Douglas fir is the most valuable lumber tree of the west. Although it is not a true fir, Douglas fir's one-inch needles are also Flat, Friendly and Flexible. Bark of young trees is gray and smooth becoming darker and scaly with age. Very old trees display deep furrows in the bark. Cones are red-brown, 2 to 4 inches long with three pointed bracts extending from beneath the cone scales. Seeds have one wing. One of its distinguishing characteristics is long, shiny, pointy brown buds. Douglas fir is common between 6,500 and 9,000 feet. It may live up to 1,000 years.

Limber Pine (*Pinus flexilis*)

Limber pine generally grows on exposed sites from 8,000 feet to timberline. The bark is smooth and white on young trees becoming scaly and almost black with age. White Pine County receives its name from the limber pine (early settlers mistook it for white pine). Needles are 1 ½ to 3 inches long in bundles of five. They grow in short bottlebrush-like tufts on the ends of the twigs. Cones are 3 to 10 inches long with thick, woody, unarmed scales. The unwinged seeds are eaten and spread by nutcrackers, jays and chipmunks. The twigs are thick and flexible, a necessity to survive the snows and winds of the higher elevations. Limber pine will form krumholz at timberline. Limber pine grows with and is often confused with bristlecone pine. Limber pine's tufts are shorter and the needles are longer than bristlecone pine. Limber pine can live 3,000 years.

Great Basin Bristlecone Pine (*Pinus longaeva*)

Great Basin bristlecone pine is the oldest living organism. The oldest known living bristlecone is 4,600+ years old, and is located in the White Mountains near Bishop, California. It usually grows between 9,000 and 11,500 feet, although specimens can be found at lower elevations. Bristlecone grows on exposed rocky sites above the continuous forest. It is usually found on limestone or dolomite but will also grow on quartzite or volcanic rock. It forms woodlands alone or with limber pine and Engelmann spruce. At timberline this tree will form krumholtz. At lower elevations it retains its upright shape but stops growing taller at 15 to 30 feet. Trees in protected sites may grow to heights of 60 feet. Wind and snow at higher elevations cause the crown to become bushy and distorted.

Wind-blown sand and ice crystal polishes the trunk, often wearing away sections of the tree. Needles are short, one-inch long, and in packets of five. The dark green needles surround the twig and tufts may extend back a foot or more along the branch. Needles can last up to forty years. Developing cones are purple, which helps absorb heat. After two years they turn brown at maturity. The woody scales on the three inch long cones are each tipped with a fragile cat claw-like bristle. Although the seeds are winged, the bristlecone is heavily dependent on nutcrackers to help with dispersion. Bristlecones survive longest where conditions are most strenuous. They are slow growing and easily out-competed by faster growing trees, so they have adapted to the harshest conditions where other trees cannot establish.

Curlleaf Mountain Mahogany (*Cercocarpus ledifolius*)

Curleaf mountain mahogany is a drought resistant tree common on dry hillsides and ridges between 6,000 and 9,000 feet. It is a small tree with a tendency to be round crowned and sprawling. The bark is red brown and thick with a rough scaly surface. Wood is reddish, resembling true the mahoganies of the tropics. The leaves are evergreen, thick and leathery with curled under margins. They are dark green above and light green underneath. The foliage is a favorite food of deer as it is green year round. Yellow flowers produce hairy seeds in the fall. Each seed is tipped with a 2 to 3 inch tail-like style. These tails twist hygroscopically, meaning in moist weather they are straight but in dry weather they curl like a corkscrew. This twisting bores the seed down into the soil, anchoring it and increasing the chance of germination. The wood makes excellent fuel and it is so heavy that it will not float in water. Navahos used the roots as part of a red dye. Other Native Americans used the stiff wood for bows.

Quaking Aspen (*Populus tremuloides*)

Quaking aspen usually grows between 6,000 and 8,000 feet but can grow up to 11,000 feet. Aspens are usually found in damp places along watercourses. Trunks are straight and topped with small high open crowns. The bark is smooth and light on young trees becoming darker with furrows on older trees. The bark does not peel. Leaves are nearly round, about 2 inches in diameter, and fringed with marginal teeth. Leaf blades are attached to twigs by long slender leaf stalks, which act as pivots so that the leaves quake in the breeze. Flowers appear before the leaves and produce cottony seeds. Aspens rarely reproduce by seeds in this region. Most new trees are clones of the parents, produced by root sprouts. Aspens grow in groves, which turn the hillsides golden in the fall. They are usually short lived, 100-200 years, due to heart rot fungus. Aspen is an important food source for animals, especially beaver. Beaver prefer the inner bark on aspen to that on other trees. Today aspen is used for packing material, match sticks, and in paper pulp. A close relative of aspen, the Narrowleaf Cottonwood (*Populus angustifolia*), is common along stream channels of lower canyon, below 7,000 feet.

Rocky Mountain Maple or Dwarf Maple (*Acer glabrum*)

Rocky mountain maple is a shrubby tree of the conifer forests between 5,000 and 8,000 feet. It grows in moist, shady areas where there is a break in the canopy allowing light to penetrate. It usually looks like a large shrub but can reach heights of twenty five feet, and has a trunk of 6 to 8 inches. The reddish bark is smooth and thin. The twigs, buds and leaf stalks are reddish. The leaves are deep green and have three deeply divided lobes. Sometimes the leaves are so deeply lobed that the lobes form leaflets. Leaves are held perpendicular to the sun. The fruits are rose colored with two parallel wings. Deer browse heavily on these trees.

Water Birch (*Betula occidentalis*)

Water birch is the only native birch of the region. This small shrubby tree grows in clumps near flowing streams between 5,000 and 8,000 feet. Bark is thin, smooth and dark bronze. The bark does not peel like the paper birch. Lenticular scars are prominent. Twigs are slender and warty with a tendency to droop. Leaves are 1 to 2 inches long by 3/4 to 1 inch wide with sharply toothed margins. The upper leaf surface is dark green with a light green lower surface. The water birch is important as bird habitat especially where it grows alongside stream descending through the otherwise dry basins. Native Americans ate the sap and inner bark. The wood makes an excellent fuel.

Serviceberry (*Amelanchier* spp.)

Serviceberry is also known as shadbrush or shadblow. This shrubby tree is found in canyons, mountainsides and foothills. The bark is usually smooth but sometimes ridged. Leaves are nearly round, about one inch in diameter. The tip of the leaf has coarse teeth. Clusters of small white petaled flowers yield a small, black, apple-like fruit. The fruit is sweet but bland. Native Americans used the dried fruit in pemmican and for a violet dye. Branches were used for arrows and baskets.

Western Chokecherry (*Prunus virginiana*)

Western chokecherry is a common tree of stream bottoms and moist hillsides. It can grow to a height of 30 feet or more. It has smooth dark bark on young trees that becomes gray and slightly furrowed with age. Twigs are brown with prominent lenticular scars. Leaves are shiny green and finely toothed. Flowers are white and form in clusters. Fruit is cherry-like, dark red to black and very bitter. They are eaten by birds and deer. The leaves contain cyanide and are poisonous to domestic livestock. With enough sugar the fruit makes a good jam. Native Americans ate the fruits and used them in pemmican. Fruits and twigs were also used in some ceremonies.

Willow (*Salix* spp.)

Willow are primarily found along stream courses and in swampy meadows. Individual species are difficult to distinguish due to hybridization. Generally willow are a fast growing short-lived species. Leaves are alternate and short stalked with finely toothed margins. Leaves are usually much longer than wide. The flowers, two inch catkins, appear before the leaves and produce cottony seeds. Willow twigs were important to Native Americans for basket weaving. The inner bark was made into a tea to reduce fever and relieve pain. The active ingredient in aspirin, salicylic acid, is derived from some willows.

Shrub Guide

Mormon Tea, Joint Fir or Ephedra (*Ephedra* spp.)

Species of ephedra are erect and shrubby plants with green jointed smooth twigs that branch into three. Terminal buds are conical and tiny. Male and female plants are separate. Yellowish "flowers" are solitary or in whorls in the axils of the stems. The fruit is small and cone-like, which reflects the distant relationship to conifers. Ephedrine, an antidepressant and anticongestive drug is produced from some Asiatic species of Ephedra. Both Native Americans and Mormons made a tea from the dried stems. The seed are also edible. Nevada Ephedra (*Ephedra nevadensis*) is common in the drier desert areas. Its stems are evergreen and olive in color. The branches are stout and spreading. Green Ephedra (*E. viridis*) inhabits moister locations among the pinyon and juniper. The stems are bright yellow-green. The branches are slender, parallel, and point upwards.

Rubber Rabbitbrush or Gray Rabbitbrush (*Ericameria nauseosa*)

Rubber rabbitbrush grows to 10,000 feet in dry open places, often with sagebrush. It can grow from 30 cm to 2 m in height. The erect woody stems are flexible and covered with dense felt-like hairs. The narrow, linear leaves are hairy and alternate with entire margins. Yellow flower heads appear in dense clusters at the ends of the stems in August. This composite produces only disk flowers. They are surrounded by several rows of papery overlapping bracts. The seeds are wind dispersed. Flowers yield a yellow dye and cause allergies in some people. Native Americans used the twigs in basket weaving and in a tea reputed to be good for colds. Twigs contain a trace of rubber and were chewed by Native Americans. In World War II, rubber rabbitbrush was investigated as a source of rubber but its production was not cost effective. Green Rabbitbrush (*Chrysothamnus viscidiflorus*) grows in the same areas as rubber rabbitbrush. It lacks hairs on stems and foliage giving it a greener look. Stems and flowers are sticky.

Sagebrush (*Artemisia* spp.)

Sagebrush tolerates a great range of elevations and ecological conditions. They are indicator species of the Great Basin. Big Sagebrush (*A. tridentata*) is the most common sagebrush and the state flower of Nevada. Big sagebrush is a branched, erect, evergreen shrub with aromatic gray-green alternate leave. Leaves are lobed at the tip and have silvery hairs on both sides. Numerous, small, stalk-less yellow flowers appear in erect clusters in August. Flowers are wind pollinated and cause allergies in some people. Native Americans utilized sagebrush. Seeds were eaten and tea from the leaves was used as an antiseptic and as a cure for colds and stomach ailments. Leaves provided a green dye. A hair tonic and a tonic to treat worms were made from the plant. Fibrous branches provided tinder for fires and were woven into cloth. Branches were used in smudging before a hunt. Today some sagebrush species provide absinthe, a fragrance.

Other common species of sagebrush include Dwarf Sagebrush (*A. arbuscula*), which is smaller than big sagebrush and has three lobed leaves that are wide and wedge shaped. Black sagebrush is considered a subspecies of dwarf sagebrush. Both grow on poor rocky soil. Sliver Sagebrush, A. cana, and Bud Sagebrush, A. spinescens, are also found in the park. Silver sagebrush looks similar to big sagebrush from a distance but it is smaller and the leaves are generally not lobed. Bud sagebrush grows amongst shadscale. It is distinctive for its spines. It tolerates the most arid condition of the sagebrush species.

Four-winged Saltbush (*Atriplex canescens*)

Four-winged saltbush is a salt tolerant plant found below 8,500 feet in dry sandy areas. It has small gray-green, densely branched stems. It grows between 1 and 2 m tall. Leaves are numerous, alternate, evergreen, and lance shaped with entire margins. Leaf surfaces are gray and hairy above and below. New growth is covered with scarf, minute white scales that protect against drying. Male and female plants are separate. The female produces tiny yellow flowers that yield a large number of conspicuous four winged seeds that are light green and papery, drying to nearly white.

Shadscale (*Atriplex confertifolia*)

Shadscale is related to saltbush. Like saltbush, it does well in alkaline and saline soils. Shadscale is spinier than saltbush. The small, rigid branches bear grayish, hairy leaves that taper and become woody and spiny. The bush may reach one meter in height. The leaves are 2 cm long, ovate and deciduous. The small flowers are wind pollinated. Male and female appear on separate plants. Both shadscale and saltbush are important forage plants.

Greasewood (*Sarcobatus vermiculatus*)

Greasewood is a common desert shrub of alkaline areas up to 7,000 feet. This white barked shrub had rigid spiny branches with linear, alternate, bright green succulent leaves. Male and female plants are separate. Male flowers are rose colored and form spikes at the end of branches. Female flowers are inconspicuous, in the axils of the leaves. Fruit is small and globular, surrounded by winged membranes. Young twigs were boiled and eaten by Native Americans.

Winterfat (*Ceretoides lanata*)

Winterfat is a small shrub, rarely growing more than one meter tall. Small hairs cover the entire plant, which give it a whitish appearance. Leaves are generally short and narrow and curled towards the underside. Larger spring leaves die back and are replaced in midsummer by smaller hairy or scaly leaves. The flowers are small and cottony. Winterfat is an important forage plant for wildlife and livestock. It is a good source of protein and vitamin A. Native Americans boiled leaves and stems to produce an infusion used to treat eye problems, headlice and baldness.

Spanish Bayonet, Blue Yucca or Banana Yucca (*Yucca baccata*)

Spanish bayonet is found in the lower elevations of the Great Basin. Sword-like leaves are roseate, densely clustered, thick, rigid and pointed at the tips. These fibrous leaves were important to native cultures for weaving. Large white flowers produce large fleshy fruits that resemble short bananas and taste like apples. Flower petals, stalks and seeds are also edible. Roots produce soap.

Fern Bush (*Chamaebatiaria millefollium*)

Fern bush is a fragrant plant of the rocky soils of the pinyon juniper forest. It grows 1 to 2 m high. Leaves appear like miniature fern fronds. Leaves are tiny and clustered in whorls near the tips of the twigs. White flowers grow in clusters. Flowers have five petals, five sepals, and numerous stamens and produce a dry brown fruit pod. Native Americans made a tea from the leaves to ease cramps and stomach aches. Fern bush is now used as an ornamental shrub.

Bitterbrush or Antelope Bitterbrush (*Purshia tridentata*)

Bitterbrush is common among sagebrush. It grows in sandy or rocky well-drained soil. It is a close relative of cliffrose and will hybridize with it. The three-lobed wedge-shaped leaves are small and bright green. Leaf margins are curled under. The undersides of these deciduous leaves are hairy. Flowers have bright yellow flowers and produce a small one seeded achene. Seeds are prized by rodents, ants and birds. The small roots of the plant are infected with fungi that take the place of root hairs and absorb water and nutrients for the plant. Native Americans valued the shaggy bark as a source of fiber and the leaves as medicine.

Desert Sumac, Squawbush or Skunkbush (*Rhus trilobata*)

Desert sumac is a smooth brown barked shrub found above 4,000 feet. It usually grows on dry rocky slopes but can grow in moist valleys. It grows 1 to 2 m high and wide. Leaves are alternate and compound with three lance-shaped, shiny, toothed or lobed leaflets. Leaflets are 1 to 3 cm long. Leaves turn red in autumn and are aromatic when crushed. Tiny yellow flowers appear in dense clusters before the leaves develop. The reddish-orange berries are edible. They have been used to make a lemonade-like drink and were also ground up into cakes. Native Americans used the stems in basket weaving and the berries in dyes.

Cliffrose (*Cowania mexicana*)

Cliffrose is a shrub of the dry rocky hillsides from 3,500 to 8,000 feet. It grows 1 to 4 m tall but can reach 8 m in height. The erect crown is composed of stiff, irregularly shaped branches. Bark is red-brown and shreds into long narrow strips on older trees. Wedge shaped, evergreen leaves are tiny, less than one inch long, and have 5 to 7 lobes and slightly hairy undersides. The pale yellow flowers resemble a simple rose. They produce dry, hard seeds with a long hairy plume that aids in wind dispersion.

Common or Dwarf Juniper (*Juniperus communis*)

Common juniper is a circumpolar shrub found in the Great Basin region above 7,500 feet. Twigs are yellowish and three angled, possessing tiny needle-like leaves in whorls of 3 to 5 at each node. Needles are chalky white on the upper surface. Common juniper lacks the scaled leaves of other junipers; its leaves remain in the juvenile state. Dark blue berry-like cones contain 1 to 3 seeds. Native Americans used the berries in pemmican. Needles were used to produce a tea high in vitamin C and A. More recently the berries have been used as a spice and to flavor gin.

Red Osier Dogwood (*Cornus sericea*)

Red osier dogwood is a shrub of the shaded riparian areas to 9,000 feet. This shrub has smooth straight red stems. The bright green, opposite leaves are lance shaped with entire margins. The prominent lateral veins curve toward the leaf tip. Small white flowers with four petals and four sepals form flat-topped clusters. Large white bracts appear petal-like, making the flowers seem large. A cherry-like bluish fruit is produced in the fall. The fruit is unpalatable. Native Americans did use the twigs in basket weaving and the roots for red dye. Extracts were also made for fevers and coughs.

Oregon Grape (*Berberis repens*)

Oregon grape is a low growing evergreen shrub with stiff, spiny, holly-like leaflets on alternate compound leaves. The yellow flowers grow in clusters and yield small purplish grape-like berries in the fall. A yellow dye can be extracted from the roots. Native Americans used a preparation from the roots in checking dysentery. Jelly is made from the berries.

Blue Elderberry (*Sambucus cerulea*)

Blue elderberry is a shrub of moist, porous soils along streams, hills and field edges. It may have multiple trunks. Bark is brown and smooth on young twigs, gray and furrowed on older twigs. The four paired, lance shaped leaflets have finely toothed margins. Leave size ranges from 2.5 to 15 cm long. Small white flowers grow in flat-topped dense clusters. Small bluish fruit form similar flat-topped clusters. The berries are edible and are an excellent source of vitamin C and A, calcium, iron and potassium. Native Americans used the fruits in pemmican. Today they are used in wines and jellies. Twigs and stems have large central spongy piths that Native Americans removed to make flutes. They also used various parts of the plant to make infusions for colds and tuberculosis and a general

tonic. Red Elderberry (*S. racemosa*) is found at higher elevations. It can be distinguished from blue elderberry by red berries in dome topped clusters. It has caused cases of poisoning.

Snowberry (*Symphoricarpos* spp.)

The snowberry genus consists of several shrub species. Tubular white to pink flowers form small clusters of 5 – 15 and produce white edible fruits in the fall. Leaves are 1.5 – 5 cm long and rounded. Native Americans used the leaves in smoking and made small bows from the twigs.

Greenleaf Manzanita (*Arctostaphylos patula*)

Manzanita inhabits dry sunny sites in the open forests below 9,500 feet. It prefers cooler areas than sagebrush. The crooked, ridged stems have a thin, shiny, smooth bark that peels and is dark red to chocolate in color. Bright, round, alternate, evergreen leaves have entire margins. Leaf orientation varies depending on the amount of light and heat. Shrubs in shady areas have horizontal leaves to catch all available light; ones in sunny areas have vertical leaves to reduce water loss. Terminal clusters of small white to pink urn shaped flowers appear in late spring. Fruit is edible apple shaped berries. Berries can be used in jams, jellies and cider. Native Americans used the leaves as a diuretic.

Currants and Gooseberries (*Ribes* spp.)

Golden currant (*R. aureum*), wax currant (*R. cereum*), and plateau gooseberry (*R. velutinum*) are three species in our study area that range from moist to dry areas. All have alternate, palmately lobed or compound leaves. Their small flowers are borne in clusters at the leaf axils. The sepals fuse into a pink, white, or yellow tube to form "flowers". An edible orange or red fruit appears in the late summer. Currants lack spines and have larger flower clusters than gooseberries. They serve as an alternate host to white pine blister rust. The blister rust destroys the valuable white pine timber of the east. Many *Ribes* east of the Mississippi River have been destroyed to protect the white pine (*Pinus strobus*).

Wild Rose or Wood's Rose (*Rosa woodsii*)

Wild rose looks like a domestic rose but with smaller petals and leaves. It inhabits the cool, moist, generally shaded places below 9,000 feet. Stems are reddish with stout curved spines. Stalked, alternate leaves are divided into leaflets. The 5 to 9 saw-toothed leaflets are green and smooth above, paler below. Five-petalled pink flowers with numerous stamens appear in the early summer. The fruit, or hips, remain after the leaves fall. Rose hips are high in vitamin C and A. In fact, the juice from the hips is 24 times richer in vitamin C than orange juice. Hips are used in tea, wine, jam, and jellies. Native Americans ate the hips and petals and made a tea from the roots. The inner bark yields a yellow dye.

Red Raspberry (*Rubus idaeus*)

Red raspberry is found on the talus slopes and canyon bottoms to timberline. The woody stems are covered with stiff bristles. Leaves are green above, lighter below, and divided into 3 to 5 leaflets. White flowers in the spring produce a red fruit that is used in jams, jellies and pies. Leaves are used to make tea.

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Written by: Liz Thorin, March 1999

Appendix II: Checklists and Forms

This section is designed to serve as a master list of forms and checklists that this project may use in the field. Some of these forms may be or have already been replaced with electronic forms in GoCanvas. In the event of technical problems, these forms may provide a temporary solution to continue data collection without an electronic data management system.

SAGE-GROUSE LEK COUNT DATA COLLECTION FORM FOR NEVADA

LEK ATTRIBUTES

LEK NAME:_____ LEK ID:_____

LEK STATUS:_____

	EASTING	NORTHING
GPS COORD (NAD83)	_____	_____

SURVEY ATTRIBUTES

DATE OF SURVEY_____ START TIME: _____

OBSERVER NAME(S) _____ END TIME: _____

SURVEY METHOD_____ SUNRISE: _____

TEMPERATURE (F°)_____ CLOUD COVER_____

WIND CLASS_____ DIRECTION_____

PRECIPITATION_____

WEATHER (COMMENTS): _____

_____

LEK COUNT DATA

	COUNT 1	COUNT2	COUNT3	COUNT4
MALES	_____	_____	_____	_____
FEMALES	_____	_____	_____	_____
UNKNOWN	_____	_____	_____	_____

HIGH COUNT MALES_____ FEMALES_____ UNKNOWN_____

IF NO BIRDS OBSERVED, DID YOU OBSERVE SIGN AT THE LEK? _____

OTHER ANIMALS AT LEK

_____

Greater Sage-grouse Trapping Attempt Form

	Record 1	Record 2	Record 3	Record 4	Record 5
Date:					
Time:					
Easting:					
Northing:					
Method:					
Approach:					
Sptlt Platform:					
Outcome:					
Dist. @ Flush:					
Attempt #:					
# of Birds:					
Sex of Bird(s):					
Weather:					
Wind (mph):					
# of People:					
Initials (S)(N):					
	Record 6	**Record 7**	**Record 8**	**Record 9**	**Record 10**
Date:					
Time:					
Easting:					
Northing:					
Method:					
Approach:					
Sptlt Platform:					
Outcome:					
Dist. @ Flush:					
Attempt #:					
# of Birds:					
Sex of Bird(s):					
Weather:					
Wind (mph):					
# of People:					
Initials (S)(N):					

Method is Net Gun, (Extension) Pole, NG/Pole, or Hand; Approach is on Foot, ATV, or Truck; Sptlt Platform is on Foot, ATV, or Truck; Outcome includes NG Catch, Pole Catch, NG Miss, Pole Miss, Hand Catch, Hand Miss; Dist. @ Flush is the distance you were from the bird when it flushed

DATASHEET – Greater Sage-grouse Radio-Marked in Nevada

BAND ID#	_____	_____	_____
FREQUENCY	_____	_____	_____
Sex	_____	_____	_____
Age	_____	_____	_____
Flat wing (1R)	_____	_____	_____
Flat wing (1L)	_____	_____	_____
Flat wing (2R)	_____	_____	_____
Flat wing (2L)	_____	_____	_____
Culmen (1)	_____	_____	_____
Culmen (2)	_____	_____	_____
Culmen (3)	_____	_____	_____
Tarsus (1R)	_____	_____	_____
Tarsus (1L)	_____	_____	_____
Tarsus (2R)	_____	_____	_____
Tarsus (2L)	_____	_____	_____
Tarsus (3R)	_____	_____	_____
Tarsus (3L)	_____	_____	_____
Weight	_____	_____	_____
Easting	_____	_____	_____
Northing	_____	_____	_____
Date (mm/dd/yy)	_____	_____	_____
Time	_____	_____	_____
Photo #'s	_____	_____	_____
Blood Check	**Y / N**	**Y / N**	**Y / N**
Fecal Sample	**Y / N**	**Y / N**	**Y / N**
Feather Sample	**Y / N**	**Y / N**	**Y / N**

Notes _____ _____

_____

_____ _____

2012 Sage-grouse Telemetry Form

Date	Bird ID	Frequency	Observer	Weather	Wind	Location Type	Location Method
Bird Status	Bird Activity	Time 1	Easting 1	Northing 1	Azimuth 1	Time 2	Easting 2
Northing 2	Azimuth 2	Time 3	Easting 3	Northing 3	Azimuth 3	Elevation	Accuracy
Disturbance	Bird Easting	Bird Northing	Distance from Bird	Notes			
Date	Bird ID	Frequency	Observer	Weather	Wind	Location Type	Location Method
Bird Status	Bird Activity	Time 1	Easting 1	Northing 1	Azimuth 1	Time 2	Easting 2
Northing 2	Azimuth 2	Time 3	Easting 3	Northing 3	Azimuth 3	Elevation	Accuracy
Disturbance	Bird Easting	Bird Northing	Distance from Bird	Notes			
Date	Bird ID	Frequency	Observer	Weather	Wind	Location Type	Location Method
Bird Status	Bird Activity	Time 1	Easting 1	Northing 1	Azimuth 1	Time 2	Easting 2
Northing 2	Azimuth 2	Time 3	Easting 3	Northing 3	Azimuth 3	Elevation	Accuracy
Disturbance	Bird Easting	Bird Northing	Distance from Bird	Notes			
Date	Bird ID	Frequency	Observer	Weather	Wind	Location Type	Location Method
Bird Status	Bird Activity	Time 1	Easting 1	Northing 1	Azimuth 1	Time 2	Easting 2
Northing 2	Azimuth 2	Time 3	Easting 3	Northing 3	Azimuth 3	Elevation	Accuracy
Disturbance	Bird Easting	Bird Northing	Distance from Bird	Notes			
Date	Bird ID	Frequency	Observer	Weather	Wind	Location Type	Location Method
Bird Status	Bird Activity	Time 1	Easting 1	Northing 1	Azimuth 1	Time 2	Easting 2
Northing 2	Azimuth 2	Time 3	Easting 3	Northing 3	Azimuth 3	Elevation	Accuracy
Disturbance	Bird Easting	Bird Northing	Distance from Bird	Notes			

2015 Corvid and Raptor Point Count Survey Form (NAD83)

Date (MM/DD/YY) _____ **Observer Initials**_____ **UTM: E**_____
Point or Unique ID: _____ **N**_____
Sky (% Cloud or precip):_____ **Wind (5mph range):**_____

Start Time (24hr)

Cattle/sheep present near point? Y / N
Other subsidies near point? Distance, bearing, & describe
_____

Species & Number	Time (24hr)	Distance (m) Range finder	Observer estimate (if different)	Compass Bearing	Activity: perched, in flight, soaring/hovering/kiting, on nest, etc… Comments	Projected UTM

Other Notes:
_____
_____

Date (MM/DD/YY) _____ **Observer Initials**_____ **UTM: E**_____
Point or Unique ID: _____ **N**_____
Sky (% Cloud or precip):_____ **Wind (5mph range):**_____

Start Time (24hr)

Cattle/sheep present near point? Y / N
Other subsidies near point? Distance, bearing, & describe
_____

Species & Number	Time (24hr)	Distance (m) Range finder	Observer estimate (if different)	Compass Bearing	Activity: perched, in flight, soaring/hovering/kiting, on nest, etc… Comments	Projected UTM

Other Notes:
_____
_____

Unique ID Formula: (Year - Study Site - ID # - Survey Type I - Survey Type II + Type ID)

Year: YY

Study Site: Bull Run Mts (SH) Northern SWIP (NS) Southern SWIP (SS)
Mount Grant (MG) Pine Nut Mts (PN) Virginia Mts (VM) Other _____
McGinnis (MC) Tuscarora (TS) Midway (MI)
Desatoya Mountains (DE)

ID #: Bird Band ID Independent Random # (FIDxxx)

Survey Type I: Used = U Dependent Random = DR Independent Random = IR

Survey Type II: Nest = N Brood = B Telemetry = T

Type ID: Nest # Brood Interval + Day (D) or Night (N)*
Telemetry = Date of relocation (mmdd) + Day (D) or Night (N)
*Brood interval is 05 (5 day), 10 (10 day), 15 (15 day), etc.

Example:

Actual used point of first nesting attempt of the hen with band #000 from the Bull Run mts in 2012:

12-BR-000-U-N1

Dependent random survey associated with the second nesting attempt of the hen with band #000 from the Egan Range in 2012:

12-EG-000-DR-N2

Nest-style survey for independent random point #000 in Gollaher mts from 2012:

12-GL-000-IR-N

Dependent random point for hen with band #000 in the Mount Grant study site, based on her diurnal brood rearing location (25 days post hatch) in 2012:

12-MG-000-DR-B25D

Used point from a nocturnal general telemetry relocation (dated May 31st) for the bird with band #000 from the Pine Nut mts in 2012:

12-PN-000-U-T0531N

Used (day) point for the hen with band #000 at her brood reading location 10 days post-hatch in the Virginia mts in 2011:

11-VM-000-U-B10D

Greater Sage-grouse Vegetation Sampling Form

Date (MM/DD/YY) _____

Time (24:00) _____

Observer Initials_____

Unique ID: _____

UTM: E_____ **N**_____

Site Photo #(s):

_____ _____

_____ _____

Nest Shrub/Center Shrub Characteristics (Nest Only)

Species
Max Height (cm)
Greatest width of vegetation (cm)
Perpendicular Width (cm)
Depth of litter in bowl (cm)
Notes:

Daubenmire Frame Cover Classification

Cover Type	**Estimated Cover Class: 1**= 0-5% **2**=6-15% **3**=16-25% **4**=26-50% **5**=51-75% **6**=76-95% **7**=96-100%								
Bearing									
Distance	**0m**	**10m**	**25m**	**10m**	**25m**	**10m**	**25m**	**10m**	**25m**
Perennial grass									
Annual grass									
Perennial forb									
Annual forb									
Residual cover									
Litter									
Bare ground									
Rock									
Shrub									

Vegetation Height - Tallest droop height, 1cm increments of nearest plant within 0.5m arc (exclusive of seed stalks)

Cover Type	**0m**	**10m**	**25m**	**10m**	**25m**	**10m**	**25m**	**10m**	**25m**
Sagebrush									
Other Shrub									
Perennial Grass									
Perennial Forbs									
Residual Grasses									

	Initials	Date
Field Check	_____	_____
Entered	_____	_____
Final Check	_____	_____

Visual Obstruction Board

Bearing	Nest/Location Center			First Transect:					
Distance	0m			10m			25m		
Side of Board	0º	45º	90º	0º	45º	90º	0º	45º	90º
First									
Second			XX			XX			XX
Third			XX			XX			XX

Bearing	Second Transect:						Third Transect:					
Distance	10m			25m			10m			25m		
Side of Board	0º	45º	90º	0º	45º	90º	0º	45º	90º	0º	45º	90º
First												
Second			XX			XX			XX			XX
Third			XX			XX			XX			XX

Shrub Canopy Cover

Shrub Species	Line Intercept 1 (cm) **Bearing:**
Random Heights	

Shrub Species	Line Intercept 2 (cm) **Bearing:**
Random Heights	

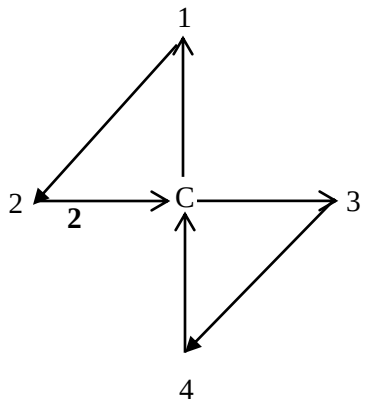
Shrub Species	Line Intercept 3 (cm) **Bearing:**
Random Heights	

BADGER SIGN SAMPLING FORM

Date (MM/DD/YY) _____ **Time** (24:00) _____ **Observer Initials**_____

Unique ID: _____ **UTM: E**_____ **N**_____

Circle the corresponding category below for this vegetation survey:



Center Point to Point 1 **Bearing:**			
Intact, Fresh		Scrape or Dig	
Intact, Old		Badger Present	
Collapsed		Scat/Tracks	

Point 1 to Point 2			
Intact, Fresh		Scrape or Dig	
Intact, Old		Badger Present	
Collapsed		Scat/Tracks	

Point 2 to Center Point **Bearing:**			
Intact, Fresh		Scrape or Dig	
Intact, Old		Badger Present	
Collapsed		Scat/Tracks	

Center Point to Point 4 **Bearing:**			
Intact, Fresh		Scrape or Dig	
Intact, Old		Badger Present	
Collapsed		Scat/Tracks	

Point 4 to Point 3			
Intact, Fresh		Scrape or Dig	
Intact, Old		Badger Present	
Collapsed		Scat/Tracks	

Point 3 to Center Point **Bearing:**			
Intact, Fresh		Scrape or Dig	
Intact, Old		Badger Present	
Collapsed		Scat/Tracks	

Pinyon/Juniper Encroachment Sampling Form

Date (MM/DD/YY) __________________ **Time** (24:00) __________________ **Observer Initials**__________________

Unique ID: ___________________________ **UTM: E**__________________ **N**__________________

	Easting	Northing	Nearest	Bearing	Hght	Class	Nrst frm	Bearing	Height	Class
Center										
Threat										
Bearing 1										
Bearing 2										
Bearing 3										
Bearing 4										

— —

Date (MM/DD/YY) __________________ **Time** (24:00) __________________ **Observer Initials**__________________

Unique ID: ___________________________ **UTM: E**__________________ **N**__________________

	Easting	Northing	Nearest	Bearing	Hght	Class	Nrst frm	Bearing	Height	Class
Center										
Threat										
Bearing 1										
Bearing 2										
Bearing 3										
Bearing 4										

— —

Date (MM/DD/YY) __________________ **Time** (24:00) __________________ **Observer Initials**__________________

Unique ID: ___________________________ **UTM: E**__________________ **N**__________________

	Easting	Northing	Nearest	Bearing	Hght	Class	Nrst frm	Bearing	Height	Class
Center										
Threat										
Bearing 1										
Bearing 2										

Bearing 3										
Bearing 4										

———

Date (MM/DD/YY) ___________________ **Time** (24:00) ___________________ **Observer Initials**__________________

Unique ID: ____________________________ **UTM: E**___________________ **N**___________________

	Easting	**Northing**	**Nearest**	**Bearing**	**Hght**	**Class**	**Nrst frm**	**Bearing**	**Height**	**Class**
Center										
Threat										
Bearing 1										
Bearing 2										
Bearing 3										
Bearing 4										

Appendix III: Aging Upland Game Birds

Upland Game Identification

Northern Prairie Wildlife Research Center

A Basic Guide for Aging and Sexing the Bird in Your Hand

Some Basics

This guide covers all six species of non-migratory game birds in North Dakota — ring-necked pheasant, sharp-tailed grouse, Hungarian partridge, ruffed grouse, sage grouse and wild turkey. Certain indicators of age apply to most of these species… most of the time.

But the indicators may change as the season goes on. Jerry Kobriger, upland game management supervisor for the Game and Fish Department, says it's usually easier to separate juveniles from adults in September than it is in November, when all feathers e usually done growing.

For all species except pheasant, the key to age is hidden in the wing, specifically the outer three large feathers, called primaries. For identification purposes, these feathers are numbered. The outermost primary is number 10, the next one in is nine, the third one is eight, and so on. Each species has 10 primary feathers.

For all our upland game species except pheasants, the key to determining whether the bird is an adult or young-of-the-year is the appearance of the outer three primary wing feathers. The outermost large wing feather is numbered 10. The next one in is number nine, the next one is eight, and so on. While this is a sharptail wing, the numbers of the feathers are the same for all species.

A good general rule and 10 primaries. Pull back some of the small cover feathers so you can see the "quill" part of the primary feather. If the quill part is blue and soft, that indicates the feather is still growing.

This photo shows the underside of a sage grouse wing. You can judge this bird as an adult, because the ninth and 10th primaries are still growing, as evidenced by the blueish "quill" section. If the eighth or seventh primaries look like the feathers in this photo, and the ninth and 10th primaries are not growing, the bird is a juvenile. These characteristics apply to all uplands species except pheasant.

Later in the season, when all feathers are completely grown, the "quill" part of the outer primaries will be white and hard. When this occurs, gauging the appearance of the outer three primaries will tell you if the bird is a juvenile or adult.

"If the outer two feathers (number nine and 10) are still growing," Kobriger says, "then it's an adult." On the other hand, if the number eight and/or seven primaries are still growing, then the bird is likely a juvenile.

When wing primaries are fully grown, the quill part becomes hard and white or light gray. "Then you have to look at the wear and contour between eight and nine and 10," Kobriger says.

This photo shows the outer three primaries of an adult sage grouse. Note the rounded tips and smooth edges. Adults of all upland species as well as fully-molted juvenile pheasants, exhibit the same characteristics -- rounded feather tips and smooth edges.

To check the wear o feathers are somewhat rounded a d, the bird is likely a juvenile.

The outer three primaries shown here are attached to the wing of a juvenile sage grouse. Note the pointedness and frayed edges on the eighth and ninth primaries. These characteristics are the same for juveniles of all upland species except pheasants.

This rule applies to a juvenile is determined by the le

Also note the specks and more mottled coloring of the juvenile wing, compared to the adult. Refer to these pictures when you get to the sage grouse section.

Sex determination is different for each species. For pheasants, the difference is obvious. For sharptails, key indicators are coloration of the central two tail feathers and the feathers on the top of the head. For Huns, it's the feather coloration on the shoulder of the wing, and for turkey it's the color pattern of the breast feathers. The sex of a ruffed grouse is best determined by the length of the central two tail feathers, while sage grouse are sexed by the color pattern of the feathers under the tail.

Just a few feathers and part of a wing or foot is all it takes for Game and Fish upland game biologists to know the age and sex of a harvested bird. You'll have the whole bird. It should be easy, right?

The following sections contain text and photos that should provide basic knowledge of upland game identification. Have it handy when you clean your birds. It will help you learn more about the birds you bagged. If you use it enough, you may reach a point where you no longer need it.

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Reston, VA [vaww51]

Appendix IV: Sexing Upland Game Birds

Upland Game Identification

Northern Prairie Wildlife Research Center

A Basic Guide for Aging and Sexing the Bird in Your Hand

Sage Grouse

Not many hunters take advantage of North Dakota's short, three-day sage grouse season, which is confined to the southwestern-most corner of the state. But some hunters see this large native upland game bird as a trophy, and pursue them every year. Veteran sage grouse hunters can often identify adult male birds on the wing.

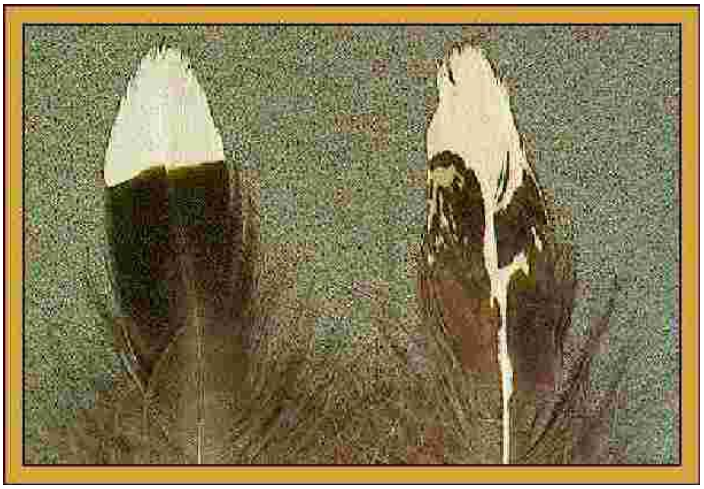
Adult male sage grouse are often found alone or in small groups during the mid-September season. At the same time, hens are usually still with their broods.

If you put an adult hen and an adult male sage grouse side-by-side, the male is the bigger one. However, size comparison is not often available, so you need to look at feathers to determine sex.

The key feathers for determining sex of sage grouse are found under the tail. These feathers are black with white tips, but the female feathers differ from those of the male.

The feathers that can tell you whether a sage grouse is a male or female are found underneath the tail. The white rachis or spine on the black feathers with white tips indicates this bird is a female.

The photo below shows feathers from the underside of the tail of male and female sage grouse. The male feather is all black, with a solid white tip. The rachis or spine of the female feather is white. In addition, the female feather also has white or buff-colored specks in the black area.



A closeup of feathers taken from the underside of male and female sage grouse tails. The male feather, solid black with a white tip, is on the left. The female feather on the right has a white rachis or spine, and some additional buff-colored markings.

One way to age sage grouse, according to Jerry Kobriger, is the pointedness of the tips of the number eight, nine and 10 primary wing feathers. The photos in the "Some Basics" section of this guide show a good example of juvenile and adult wing feathers. The juvenile primaries are narrow and more pointed when compared to the adult primaries. In addition, the ends of the juvenile primaries are frayed, while the adult primary ends are smooth.

The molt of the primaries can also be a good indicator of age. If the outer two primaries, number nine and 10, are growing (see photo in "Some Basics" section), the bird is likely an adult. If the number seven or eight primary is growing, or is missing (which means they are molted and haven't started growing, the bird is likely a juvenile.

The sage grouse season runs for only three days. During that time in mid-September, both juvenile and adult birds can exhibit a variety of stages of molt, Kobriger says.

U.S. Department of the Interior | U.S. Geological Survey
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