Seasonal Habitat Use, Movements and Vital Rates in the Parachute/Piceance/Roan Population of Greater Sage-Grouse

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SUMMARY

The Colorado Division of Wildlife (CDOW) proposes to conduct a study of the Parachute/Piceance/Roan (PPR) population of greater sage-grouse during 2007 and 2008. The PPR is one of several small, spatially fragmented populations of sage-grouse in Colorado. The CDOW is interested in working with energy companies and other land owners and managers in the PPR area to sustain the PPR grouse population and plan for future management actions. The objectives of the study are to obtain current, baseline information on the genetic characteristics; measures of reproduction and survival rates; and patterns of habitat use and seasonal movements of sage-grouse in this population. This information will be useful in assessing the current population status and expected future trend of PPR sage-grouse, and for identifying alternative management strategies for this population.

In order to include an adequately large, representative sample size of PPR sage-grouse in this study, the CDOW is seeking access to privately-owned lands throughout the study area, as well as additional funding support. Currently, EnCana has provided access to its lands and substantial funding support for the project. This proposal includes a detailed budget showing how additional funding support would be used, provided that access to a larger proportion of PPR sage-grouse is also obtained.

RESEARCH NEED

Greater sage-grouse (*Centrocercus urophasianus*) (hereafter referred to as sage-grouse) historically inhabited sagebrush steppe habitat in at least 13 states and 3 Canadian provinces, and now occur in 11 states and 2 provinces (Schroeder et al. 2004). Sage-grouse are of particular conservation concern because populations have experienced dramatic range-wide declines over the past 4 decades (Connelly et al. 2004). In addition, some view sage-grouse as an umbrella species for sagebrush habitats (Rich and Altman 2002).

Habitat loss, fragmentation, and degradation are commonly suggested as reasons leading to the decline of sage-grouse and other sagebrush obligate avian species (Knick et al. 2003). Populations are migratory, moving >10 km to access seasonal habitats across large sagebrush landscapes, or are more sedentary, using the same habitats throughout the year to meet their life history requirements (Connelly et al. 2000). Impacts of human influences or other environmental perturbations may be more pronounced in populations that are small because persistence of small populations is affected by stochastic environmental, genetic, and demographic parameters that may overwhelm the natural variation of these parameters in small populations (Mills et al. 2005).

The largest, most persistent (>500 breeding birds) populations of greater sage-grouse in Colorado are found in Jackson, Moffat, Rio Blanco, and Routt counties (Braun 1995). Small (<200 males), isolated populations of sage-grouse are found in Colorado in the Parachute/Piceance/Roan (PPR) area in Garfield County, northern Eagle and southern Routt Counties (Schneider and Braun 1991), northwest Larimer County, and the Meeker/White River area in eastern Rio Blanco County. Significant oil and gas development activity is occurring in and/or planned for the Piceance Basin, and industry has expressed their interest in evaluating mitigation efforts and understanding the baseline habitat use, movements, and vital rates of this population.

Sage-grouse from Eagle County, North Park, and Middle Park, Colorado function as a genetically-related group. Birds within each group are genetically similar, while genetic relatedness differs between groups (Oyler-McCance et al. 2005). The genetic relatedness of sage-grouse inhabiting the PPR area is unknown compared to other populations in Colorado or elsewhere (Oyler-McCance et al. 2005). Therefore, collection of genetic samples from grouse in the PPR will be useful in comparing genetic relatedness to other populations. Genetic

information is imperative in the event that future translocations of sage-grouse to and from the PPR population are needed.

The Colorado Division of Wildlife has been concerned with persistence of the PPR sage-grouse population since at least the early 1990s and discontinued hunting this population in the mid-1990s due to declining wing receipts and other indicators that the population may have been declining. Limited information is available for PPR sage-grouse including habitat use and seasonal movements (Krager 1977, Hagen 1999), lek complexes (Krager 1977), and harvest data used to compute sex and age ratios (CDOW 1995). However, the limited information that does exist does not provide a clear picture as to historical or current population levels or trends in vital rates.

EXPECTED RESULTS AND BENEFITS

Results from this study are intended to provide important information that can be applied by land managers to enhance conditions that promote persistence and growth of the PPR sage-grouse population. This will be accomplished by collecting data that provide industry and agency managers a better understanding of the habitat use, seasonal movements, genetics, and vital rate demography of this small isolated population of greater sage-grouse.

The specific objectives of this proposed research project are to:

1. Obtain baseline information on genetic characteristics of sage-grouse in the PPR population. This information will be used to assess current levels of genetic variability within the PPR population, and to compare genetic characteristics of PPR sage-grouse with other sage-grouse populations. These results will be useful in planning for potential future efforts to augment the PPR sage-grouse population with grouse from other populations.
2. Acquire current estimates of reproductive parameters (nesting effort, clutch size, egg success, nesting success, and renesting success) and survival rates of PPR sage-grouse. Survival rate

estimates will be obtained for adults, and if adequate resources and access are available, for juvenile sage-grouse. We also will attempt to determine causes of grouse mortalities. Information on survival and reproduction will be used to develop models of population persistence and growth, and expected impacts of various environmental changes and management strategies on the population dynamics of PPR sage-grouse.

3. Measure movements and seasonal habitat use patterns of PPR sage-grouse on a landscape level, and measure micro-habitat characteristics at breeding, summer, and winter and nocturnal habitats. These results will be combined with results of a Bureau of Land Management habitat inventory project (Sauls et al. 2006) to validate and refine a habitat model for PPR sage-grouse, that can be used by land managers to identify important areas for sage-grouse and plan habitat restoration and enhancement projects within the range of PPR sage-grouse.

Given the current status of this small population of sage-grouse and the landscape changes that are expected to occur over the next 5-10 year, there is a pressing need to obtain current, detailed baseline information on the population ecology of PPR sage-grouse and provide this information to managers. Results from this study will also provide useful comparisons with a similar study of sage-grouse in another small, isolated population in northern Eagle and southern Routt counties (Graham and McConnell 2004, Graham and Jones 2005).

STUDY AREA

The area occupied by the PPR population of sage-grouse is located in Rio Blanco and Garfield counties (Fig. 1). Hagen (1999:9) described the area: "The Piceance Basin-Roan Plateau is bordered on the north by the White River and on the south by the Colorado River. The Utah boarder is ~80 km to the west and the Grand Hogback borders the basin on the east. The study area encompasses approximately 1,400 km^2 of the ~ 3,000-km^2 region. The specific

boundaries of the study area are the Dry Fork of Piceance Creek and Big Duck Creek to the north, and Skinner Ridge, Jack Rabbit Ridge, and Roan Creek to the southwest and south. Cathedral Bluffs defines the western limit and Colorado Highway 13 is the eastern boundary. Piceance Creek bisects the eastern third of the study site."

Currently, CDOW researchers have access to only a small portion of the area occupied by the PPR population, including publicly-owned lands and the North Parachute Ranch property owned and managed by EnCana. Expanded access to additional lands used by sage-grouse is important to the success of this study in order to ensure that sample sizes are adequate to obtain accurate and precise estimates of the variables of interest, and that the sample of sage-grouse included in the study is representative of the entire PPR sage-grouse population. Based on the latest 3-year running average of strutting males counted in the PPR (128 males), this population can support at least 256 females. A desirable sample size would be 40 – 60 radio-marked females from leks across the PPR range. In a 2006 pilot study, due to access limitations, a total of 16 females and 13 males were radio-marked. These small sample sizes can provide useful information to land managers on the limited area currently included in the study, but will not provide strong inference to the entire PPR population.

The climate of the Piceance Basin is semiarid and exhibits extreme differential levels of monthly precipitation. Consecutive months often receive little precipitation. Mean annual precipitation was 35.3 ± 18.7 cm for eight weather stations in the region for 1951-70 (Cottrel and Bonham 1992) and snowfall comprised ~ 50% of the total precipitation. The mean annual temperature varies from7^{o} C at 1,800 m to -1^{o} C at 2,700 m.

The topography of the study areas has been described as a structural basin (Tiedeman and Terwilliger 1978) or a plateau that is dissected by narrow drainages. The sagebrush steppe consists of undulating north-south ridges parallel to each other. The ridge tops vary in width

from 0.5 to 3 km, and 1 to 30 km in length. The ridges are gently rolling; however, the drainages that separate them are steep. Specifically, the ridges in the southern part of the study area are divided by canyons that drop nearly 1 km, vertically, in <500 m, horizontally; typically the elevation change is more gradual. Elevations vary from 1,800 m on Piceance Creek to 2,700 m at the upper reaches of the plateau. The higher elevation areas are known locally as the "summer range" as they are the location for summer grazing of livestock.

Vegetation is dependent upon slope, aspect, and elevation. Three subspecies of big sagebrush (*Artemisia tridentata*) occupy the basin, and location of *Artemisia tridentata ssp*. is dependent upon soil type (Cottrell and Bonham 1992). Basin big sagebrush (*A. t. tridentata*) is the prevalent vegetation throughout the drainages at elevations of 1,800 – 2,000 m (Cottrell and Bonham 1992). Typically basin big sagebrush grows taller and denser than mountain big sagebrush (*A. t. vaseyana*) and Wyoming big sagebrush (*A. t. wyomingensis*) (Cottrell and Bonham 1992). *A. t. wyomingensis* is restricted to upland ridges at elevations of 1,900 – 2,000 m (Cottrell and Bonham 1992). *A. t. vaseyana* is confined to high mountain areas at elevations > 2,100 m (hereafter all references to big sagebrush will refer to *A. t. vaseyana*, unless otherwise noted).

Pinyon pine (*Pinus edulis*) and juniper (*Juniperus spp.*) woodlands dominate the landscape until ~2,100 m. Big sagebrush, Utah serviceberry (*Amelanchier utahensis*), Gambel oak (*Quercus gambelii*), and antelope bitterbrush (*Purshia tridentata*) comprise most of the transition vegetation type. Low and rubber rabbitbrushes (*Chrysothamnus viscidiflorus, C. nauseosus*) are prevalent throughout the basin. Elevations of 2,400 to 2,600 are dominated by big sagebrush interspersed with bunchgrass meadows. North aspects often host substantial groves of quaking aspen (*Populus tremuloides*), serviceberry, and mountain snowberry (*Symphoricarpos oreophilus*). Big sagebrush and Douglas-fir (*Pseudotsuga menziesii*) dominate

south and northwest aspects at elevations > 2,500 m, respectively. Free water can be scarce in dry years or late in the summer as most springs are in the bottom of steep canyons."

METHODS

Capture and Marking of Adults and Juveniles

During the spring of 2007 and 2008 (possibly the fall of 2007 and 2008) a sample of sage-grouse will be captured and radio-marked. As noted above, sample sizes will depend upon current and/or additional funding and access. Sage-grouse will be captured using spot-lighting (Giesen et al. 1982, Wakkinen et al. 1994) techniques. An additional technique, the CODA net launcher, may be employed (Appendix A). All grouse captured will be weighed using an electronic scale (to the nearest 1 g) and marked uniquely using numbered leg bands. The age and gender of each grouse captured will be determined using wing (Dalke et al. 1963) and other plumage or morphological characteristics.

Female grouse will be preferentially captured and equipped with 17-g necklace-mounted radio transmitters with a 4-hour mortality circuit (Fig. 2). Alternatively, some male greater sage-grouse may be fitted with the same transmitters if an adequate number of females can not be captured (Table 1). Each transmitter will have a minimum battery life of 18 months and will have a 30 cm antenna that will lie between the wings and down the back of the grouse. The radio transmitter will be 0.8% and 0.56% of the body weight of an adult and yearling male, respectively. The transmitter weight will be slightly heavier for females but will consist of 1.0% or 1.2% of the body weight for adult and yearling females, respectively.

If needed, additional grouse will be captured and fit with radio-transmitters while they are with radio-marked females in the fall. Grouse will be captured when they are estimated to be approximately 16 weeks of age using similar spotlight techniques. The radio-tagged female will be radio located at dusk to find her general use and roosting area and then located after dark. All

juveniles captured will be radio-marked if their body mass weight exceeds 900 g. Primary feather measurements and molting sequence will be documented to ascertain the gender of the juvenile. All juvenile grouse will be banded with aluminum leg bands.

Capture and Marking of Chicks

If additional funding partners and expanded access is granted, the research project will be expanded to investigate chick survival from 1-day to 1 year of age.

Once monitoring reveals the successful hatch of a nest, all chicks in the brood will be captured 1-2 days after hatching. Broods from 20 successful females will be captured. Radio-marked females will be located < 2 hours after sunrise in order to capture chicks while the female is brooding. Chicks will be captured by hand and held in cotton bags for processing. All chicks within the broods will be weighed and have a secondary feather collected. Three 3 chicks within the brood will be randomly selected and a 1.4 gram, 60 day radio-transmitter will be attached along the dorsal midline between the chick's wings following the procedure of Burkepile et al. (2002) (Fig. 2). All chicks from the brood will be placed in the same brood bag to facilitate thermoregulation and acclimation while chicks are processed. Chicks will then be released together on-site and monitored (<1 hr) to confirm the immediate survival of the chicks. In addition, broods will be located latter in the day (> 2 hours after introduction) and < 2 hours before sunset to determine chick survival and female acceptance into the brood.

Brood counts will be made during week 5, and then again during week $\geq$ 8 when chicks will be recaptured, chick transmitters removed, and re-radio-marked with < 3.9 gram, 195-day juvenile transmitters (Fig. 3). Radio-marked chicks (now juveniles) will be captured at night with a spotlight and long-handled hoop nets by individually tracking them. Juveniles will be banded with aluminum leg bands, weighed, and the primary feathers measured at time of re-capture. Brood counts will provide estimates of brood survivorship and natural adoption rates.

Surviving juveniles will be captured and fit with an adult transmitter (Fig. 4) in the same manner as previous noted.

Genetics

Blood samples will be obtained by clipping the toenail of all sage-grouse, and 2 - 3 drops of blood will be placed into a microfuge tube previously coated with EDTA (Oyler-McCance 1999). The blood samples in addition to feather samples will be frozen at –20°C and stored at the Rocky Mountain Center for Conservation Genetics and Systematics in the Department of Biological Sciences at the University of Denver (S. Oyler-McCance, pers. comm.).

Seasonal and Daily Movements

Following release, the movements and survival of radio-marked grouse will be monitored 1-2 times/week. General locations will be determined by triangulation and radio-tagged birds will not be flushed. Hand-held Yagi antennas, attached to a receiver/scanner, will be used to located radio-marked grouse. The loudest-signal method will be used to locate grouse/transmitters (Springer 1979). Monitoring periods will be distributed equally among 3 diurnal periods; morning (< 4 hours following sunrise), midday (> 4 hours after sunrise) and evening (< 4 hours before sunset). All grouse will be circled at a 50 – 100 m radius (Apa 1998) to determine habitat type use. A precise Universal Transverse Mercator (UTM) location will not be possible at the time of location (the bird will not be flushed). In an attempt to have a more precise use location, the observer will select a location approximately 50 m in one of the 4 cardinal directions from the estimated location of the bird. The observer will take a Global Positioning System (GPS) location, and then manually correct the UTM location. General cover types will be recorded as shrub steppe (sagebrush), wet meadow, mountain shrub, oakbrush, grassland or agricultural field.

Radio-marked females with radio-marked chicks will be monitored daily to determine survival of chicks, and location of brood. Brood positions will be determined by locating the female and circling to within 25 m. Position and relationship (i.e., distance) of radio-marked chicks in relation to the female will also be recorded. In addition, cover type will be determined at all locations. Daily observation of broods will continue for 28 days or until death. Attempts will be made to find all chicks immediately after becoming separated or missing from broods to determine fate and/ or cause of mortality. Brood locations will be collected equally among 4 time periods: brooding (< 2 hour after sunrise or before sunset), morning (0800-1100), mid-day (1100-1400), and afternoon (1400-1800) throughout the study. After day 28, radio-marked chicks and females will be located every 1-3 days depending on feasibility.

A fixed-wing aircraft will assist to locate any grouse not located by ground monitoring or lost during ground monitoring efforts. General locations will be identified aerially and ground locations will be identified within 48 hours.

The frequency of locations obtained will depend on the availability of field personnel. Weekly locations will be obtained from mid-April through August. A minimum of bimonthly locations will be obtained from September through March.

Microhabitat Characteristics

Nests

If a female is suspected of incubation, the nest location will be determined using binoculars as described by Apa (1998). Once a female is identified as incubating, she will not be disturbed during the incubation bout. Diagrams of the nest location will be drawn to assist in nest location after the completion of nesting. The precise UTM location will be collected following the cessation of nesting (successful or unsuccessful). A nest will be considered successful if ≥ 1 egg hatches (Rearden 1951). Four 10-m transects will be placed in the cardinal

directions intersecting at the nest bowl. The nest shrub species and height will be measured. The height of the lowest live and dead nest bush branch above the nest bowl will be measured from the edge of the nest bowl. Canopy cover (foliar intercept) of the shrub species overstory will be determined using line-intercept (Canfield 1941). The intercept by the lowest possible taxa will be measured (Fig. 5). Height of the of the nearest nest bush type shrub within 1 m of the transect line will be measured at 2.5 m, 5 m, and 10 m. Grass height will be measured for the nearest, tallest grass part at the points where the edge of the nest bowl and the transect's intercept, and at the 1 m point on each transect.

The percent of forbs and grass cover by lowest possible taxa, bareground, and litter horizontal understory cover will be estimated using 50 x 50 cm microplots (Daubenmire 1959) (Fig. 6). Eleven cover classes will be used and delineated as follows: Trace: 0-2%, 1: 3-9%, 2: 10-19%, 3: 20-29%, 4: 30-39%, 5: 40-49%, 6: 50-59%, 7: 60-69%, 8: 70-79%, 9: 80-89%, 10: 90-100%. The first 2 microplots will be located on opposing sides of the nest bowl. Subsequent plots will be placed systematically along the transects at 2.5, 5, and 10 m. In addition, the distance to nearest visible roadways, telephone poles, powerlines, and fence posts will be determined.

The same vegetation data collection techniques will be applied to at least one random location for each nest. Random locations will be obtained by using randomly selected UTM coordinates in the study area. Grouse movements will delineate the study area boundary.

Brood-rearing/Unsuccessful Female/Male

Females with broods, unsuccessful females, and males will be located by the loudest-signal method 1-2 times per week. At each location, date, time, UTM coordinates, slope and aspect will be recorded. Any unsuccessful females and males will be located in the same manner

as females with broods. When females with broods are circled, the intersection point of flags placed in the cardinal directions will be used to identify the center of the brood location.

At the center of each brood location identified for vegetation sampling, the same vegetational structural characteristics will be measured. One random site will be selected for each brood vegetation site and the same vegetation sampling will occur.

Analyses

All statistical analyses will be performed with statistical analysis software (SAS; SAS Institute 2003). Modeling will embrace information-theoretic approaches to select the best-supported models explaining alternative hypotheses (Burnham and Anderson 2002).

Bird locations will be entered into a geographic information system for analysis. Habitat selection and movements will be evaluated with these data. The appropriate scale of analysis may include home ranges (Johnson's [1980] second order of selection) or evaluation of components within home ranges (Johnson's [1980] third selection order) or other geographic areas such as buffers or seasonal ranges. Univariate and multivariate statistics will be used to characterize habitat and examine differences. Analysis of variance, multivariate analysis of variance, or other multivariate procedures such as principal components analysis will be used to evaluate habitat characteristics at nest and brood locations.

Survival rates for birds during the first year will be estimated for gender (male and female) and study area with the Kaplan-Meier product limit estimator (Kaplan and Meier 1958) modified for staggered entry (Pollock et al. 1989). Survival variance estimates will be calculated following Greenwood (1926) and compare survival rates between groups and study areas with a log-rank test (Cox and Oakes 1984:105). Survival will be modeled following multiple years of data collection to include covariates such as year, age, gender, and weather covariates. Covariates used to predict nest success will be similar to covariates used to model survival.

TIMELINE AND BUDGET

A complete timeline (Table 1) and budget (Table 2) are provided for the base and expanded project research project.

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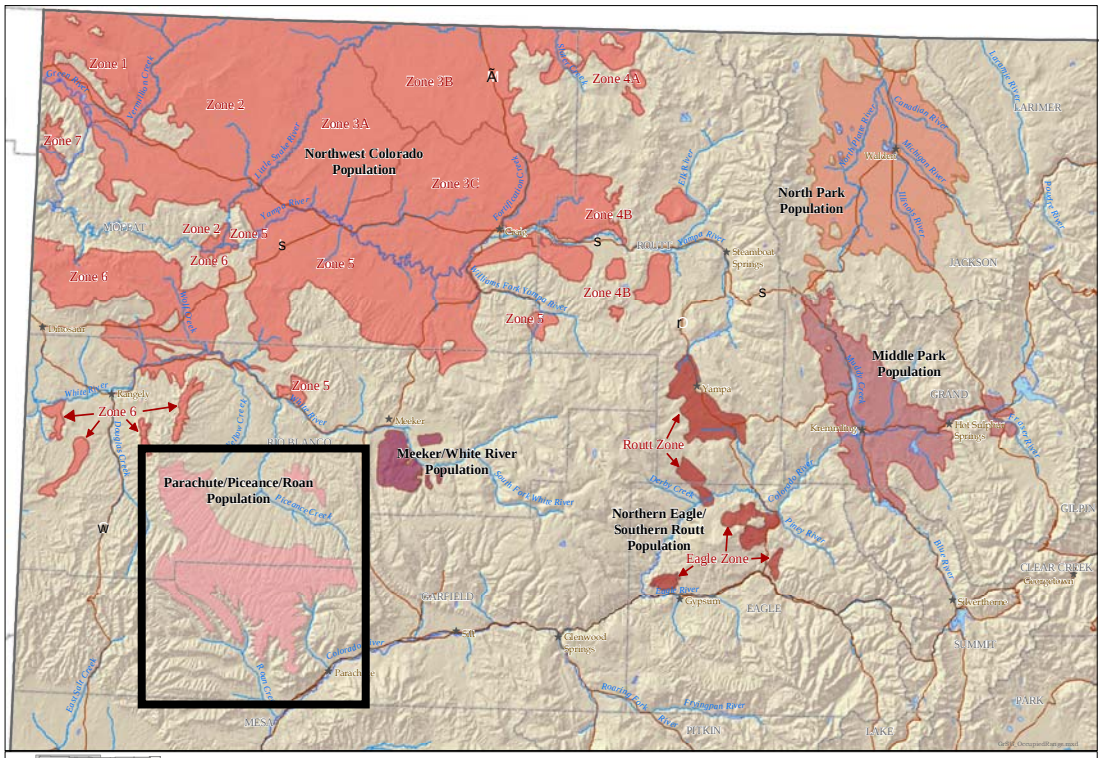

Figure 1. Location of the PPR study area in relation to the overall statewide range of greater sage-grouse in northwestern Colorado.

Figure 2. Attachment of a necklace mounted transmitter on a female greater sage-grouse.

Figure 3. Attachment of a 1.4 gram transmitter to a 1-day-old greater sage-grouse chick.

Figure 4. Attachment of a necklace mounted transmitter on a 16-week-old female greater sage-grouse before removal of the 4 gram juvenile transmitter that was attached at 60 days of age.

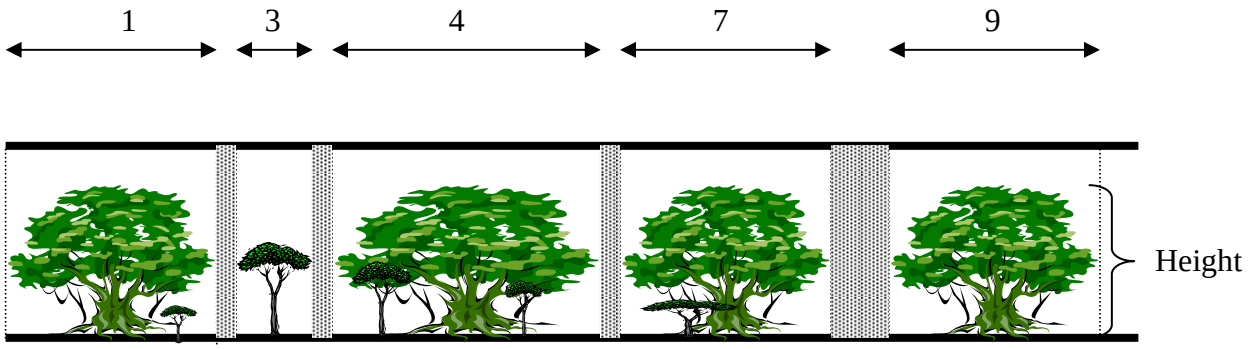

Figure 5. Visual representation of differing shrub layers in a shrub community. Intercepts 1, 3, 4, 7, and 9 represent the foliar intercept. The shaded area is not included in the shrub intercept.

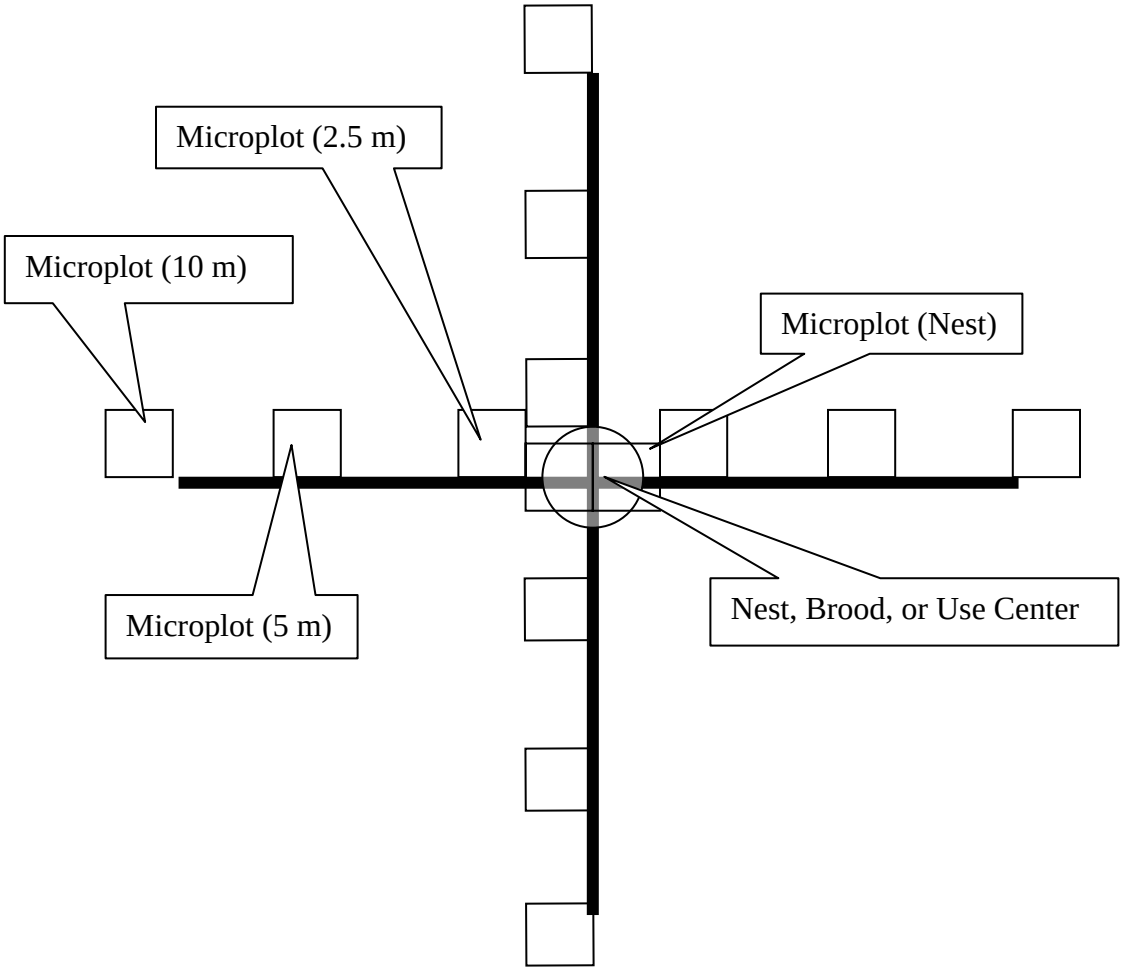

Figure 6. Vegetation sampling protocol at nest, brood, and use locations.

Table 1. Proposed time schedule for evaluation of potential impacts of oil and gas development to greater sage-grouse, Roan Plateau, Colorado, 2007.

Task	Initiation	Ending
Capture grouse, collect genetic samples, attach transmitters	March 15, 2007	April 15, 2007
Monitor adults and chicks	April 1, 2007	March 2008
Nest monitoring	April 15, 2007	June 30, 2007
Trap chicks and attach transmitters (if project is expanded	May, 2007	June 2007
Conduct vegetations sampling at nest and brood locations	May 1, 2007	August 30
Fall capture of grouse, collect genetic samples, attach transmitters	September 1, 2007	October 15, 2007
Aerial flights to evaluate fall and winter survival and movements (periodically)	April 15, 2007	March 2008