Chapter 12

SAGE-GROUSE (*Centrocercus urophasianus*)

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I. INTRODUCTION – Characteristics of greater sage-grouse (*Centrocercus urophasianus*) populations and habitats have been described in numerous studies throughout the species' range (see Knick and Connelly 2011). Connelly et al. (2000b) developed guidelines for managing sage-grouse populations and habitats, and stressed monitoring is a critical element of any effective management program.

Most studies of sage-grouse ecology have relied on previously published techniques for assessing rangeland vegetation, and for monitoring and trapping sage-grouse (Canfield 1941, Giesen et al. 1982, Emmons and Braun 1984, Wakkinen et al. 1992, Burkepile et al. 2002, Connelly et al. 2000a, and others). In recent decades, sage-grouse populations have declined (Coates et al. 2021) and numerous factors continue to threaten the species and its habitats (Connelly and Braun 1997, Wambolt et al. 2002, Connelly et al. 2004, Knick and Connelly 2011, U. S. Department of Interior 2015). Standard techniques for monitoring populations and habitats will provide consistent data sets that permit comparisons among areas and years. Connelly et al. (2003) compiled and attempted to standardize all the major techniques useful for monitoring sage-grouse habitats and populations. The following information is largely taken from their report. Some important additions (e.g., lek definitions) and edits have been made to adapt the information for use in Wyoming.

This manual provides information relevant to WGFD staff, but the techniques described below are also intended for use by external entities, including scientific researchers and environmental consultants conducting surveys for Wildlife Environmental Review reporting. Proponents of projects seeking to develop in sage-grouse habitat in Wyoming should contact the Department to receive project-specific consultation for survey needs. More information is available at: https://wgfd.wyo.gov/Habitat/Habitat-Protection-Program

II. POPULATION MONITORING AND ASSESSMENT – The foundation of an effective conservation strategy for sage-grouse is a standardized monitoring program that assures meaningful population status and trend information is collected. The monitoring program must generate regular reports that can be used to analyze factors affecting sage-grouse populations on a local scale, in order to implement local conservation plans. As well, the data should be suitable for statewide analyses and comparisons with similar data sets from other states. The WGFD sage-grouse database fulfills these needs. The database houses results of lek observations and harvest data including age and sex composition derived from wing barrel collections. The database provides a basis for local, regional, and statewide analyses of sage-grouse status and trends.

For WGFD employees, the link to the sage-grouse database is on the intranet home page. The database requires a username and password for access. To obtain access, please contact the Wildlife GIS Analyst or

the Sage-grouse/Sagebrush Biologist. There are recorded presentations highlighting all aspects of the database, which the Wildlife GIS Analyst will share internally upon request. There is also a user manual, accessed through the Help menu within the database. Raw outputs and value added spatial data created from the database are sensitive and access is restricted outside the Department. Please send entities requesting these sensitive data to the Wildlife GIS Analyst or the Sage-grouse/Sagebrush Biologist. A suite of lek data (tables, definitions, spatial data, etc.) are created every year and released in the late summer/early fall. Instructions for accessing this data will be distributed internally soon after its annual release.

A. Breeding Populations – Sage-grouse gather on traditional display areas called leks each spring. This behavior enables biologists to collect data used to track breeding populations. Most lek population monitoring is done early morning (1/2 hour before to 1 hour after sunrise), under reasonably good conditions (calm to light wind, partly cloudy to clear), from early March to early May. Lek checks for strutting sign may take place till May 31st. Appropriate ranges of survey dates depend on the elevations at which leks are found and the persistence of winter conditions. In milder climates at lower elevations, sage-grouse begin displaying during late February. Sage-grouse may also begin displaying at this time in response to mild winter weather. At higher elevations, lek attendance persists through early or mid-May.

The following definitions have been adopted for the purposes of collecting and reporting lek data. This section, A, is distributed with the annual lek data. It may contain duplicate information found elsewhere in this chapter. For detailed methods, please see section 1, Locating and Mapping Leks and section 2, Breeding Surveys, below:

- **Lek** – A traditional courtship display area attended by male sage-grouse in or adjacent to sagebrush dominated habitat. A lek is designated based on observation of two or more male sage-grouse engaged in courtship displays. The official lek location should be recorded as a point at the activity center of a lek. If a leks activity center moves far enough away from a previous location where detection and observation would be hindered, then the location should be changed to reflect the new activity center. Updates to the lek center point should be considered for distances more than 30 meters. Some consideration should be given to the consistency of the change in activity over the course of subsequent years. If the location is adjusted, records of prior locations and year of change should be retained in the comment section of the database. Before a suspected lek is added to the database, it must be confirmed by visiting the lek during the appropriate time of day, during the strutting season. Sign of strutting activity (tracks, droppings, feathers) can also be used to confirm a suspected lek. Sub-dominant males may display on itinerant (temporary) strutting areas during years when populations peak. Such areas usually fail to become established leks. Therefore, a site with small numbers of strutting males (<5) should be confirmed active for two years before the site is considered a lek and added to the lek database. There is the option of recording strutting sites in the database that have not met this requirement as “miscellaneous strutting sites”.

- **Satellite Lek** – A relatively small lek (usually less than 15 males) within about 500 meters of a large lek often documented during years of relatively high grouse numbers. Locations of satellite leks should be encompassed within the primary lek perimeter boundary. Birds observed on satellite leks should be added to the number of birds observed on the primary lek.

- **Lek Perimeter** – The outer perimeter of a lek and associated satellite leks (if present). Perimeters of all leks should be mapped by experienced observers using accepted protocols (Section 1.b.iv below). Perimeters may vary over time as population levels or habitat and weather conditions fluctuate. However, mapped perimeters should not be adjusted unless grouse use consistently (2 or more years) demonstrates the existing perimeter is inaccurate. If the center of activity moves outside the perimeter, collect a new perimeter and update the center point. The lek location must be identified and recorded as a specific point **within** the lek perimeter. This point represents the center of breeding activity typically observed on the lek.

- **Lek Count** – A monitoring technique that documents the number of male sage-grouse observed at a particular lek and is based on repeated observation.

    - Visit leks at least three times annually, at 7-10 day intervals within a 4 week period after the peak of mating activity. The interval between visits may extend up to 14 days to accommodate weather delays. In Wyoming hen attendance typically peaks in early April but may vary with seasonal conditions and elevation, while the number of males observed on a lek is usually greatest in late April or early May when attendance by yearling males increases. Later visits should target peak male attendance. Coordinate with the local Game and Fish biologist for the appropriate start and end dates.
    - Conduct lek counts only from the ground. Tallying male sage-grouse from the air is not as accurate and is not comparable to counting from the ground.
    - Visit leks between ½ hour before sunrise and 1 hour after.
    - Visit leks only when wind speeds are less than 15 kph (~10 mph) and no precipitation is falling.
    - Predators should be absent and the birds have not flushed. If predators are present, or the birds recently flushed, that visit will be considered a lek survey, see definition below.

- **Lek Route** – A lek route is a group of leks in relatively close proximity that represent part or all of a discrete breeding population/sub-population. Leks should be visited on routes to facilitate replication by other observers, increase the likelihood of recording satellite leks, and account for shifts in distribution of breeding birds. Lek routes should be set up so an observer following criteria described above can visit all leks within 1.5 hours. Data should be recorded individually for all leks on a route following the lek count or survey protocol.

- **Lek Survey** – A monitoring technique designed primarily to determine whether leks are active, but can also report number of grouse attending a lek. A lek survey typically consists of one to two visits that may or may not adhere to the more stringent lek count protocol. Lek surveys shall start 30 min before sunrise and may extend to 90 minutes after sunrise. Aerial observations are always lek surveys. Some leks may only be surveyed due to topography preventing accurate observation of all males at once, or due to restricted land access that necessitates an aerial survey. Strive for the most accurate observation possible. Lek surveys can be conducted from the initiation of strutting in early March until early-mid May, depending on the site and spring weather. Coordinate with the local Game and Fish biologist to narrow down an appropriate time frame for lek monitoring.

  External users of the data should be aware that when large numbers of leks (50+) are surveyed, the resulting trends of lek attendance over a long period of time parallels trends derived from lek counts (three visits each spring)(Fedy et al 2011). Note that Wyoming's definition of a "lek

survey" includes data that other western states term "lek count" data. Other states also refer to presence/absence checks and these are the equivalent of Wyoming's checks for sign (presence of feathers or caecal droppings) to determine if a lek is active or not.

- **Annual status** – Annual lek status is assessed based on annual lek activity, and is categorized as one of the following:

  - **active** – Any lek that has been attended by male sage-grouse during the strutting season. Acceptable documentation of grouse presence includes observation of birds using the site or signs of strutting activity. See Section II.A.1.b.iv below for acceptable signs of strutting activity.

  - **inactive** – Any lek where sufficient data indicates no strutting activity took place throughout a strutting season. Absence of strutting grouse during a single visit is not sufficient documentation to establish a lek is inactive. This designation requires documentation that no birds were present on the lek during at least two ground visits separated by at least 7 days. The visits must be conducted under ideal conditions (site visits between April 1 and May 7, no precipitation, light or no wind, ½ hour before to 1 hour after sunrise). A ground check for sign of the known **exact** lek location/perimeter late in the strutting season (between April 15th and May 30th) during which sign (droppings/feathers) of strutting activity (see Section 1.b.iv below) is not found may be used in lieu of one of the ground visits conducted under ideal conditions. Data collected by aerial surveys cannot be used to designate inactive status.

  - **unknown** – Leks for which active/inactive status has not been documented during the course of a strutting season. The "unknown" status designation is not desirable and should be used in rare instances, except for leks not scheduled to be checked in a particular year. Each lek should be checked enough times to determine whether it is active or not. It is preferable to conduct two good field checks during the breeding season, or one good field check and one ground check late in the strutting season looking for sign, every other year and confirm the lek is "inactive" rather than check it once every year during the breeding season and have it remain in "unknown" status. If an observer does not see birds during multiple aerial searches of the same lek, the annual lek status will be unknown.

- **Management Status** – Based on its annual status, or annual status trends, a lek is assigned to one of the following categories for management classification purposes:

  - **occupied lek** – A lek that has been active during at least one strutting season within the prior ten years. Occupied leks are protected through prescribed management actions during surface disturbing activities.

  - **unoccupied lek** –Two classifications of unoccupied leks are "destroyed" and "abandoned" (defined below). Unoccupied leks are not protected during surface disturbing activities.

    - **destroyed lek** – A formerly active lek site and surrounding sagebrush habitat that has been destroyed and is no longer suitable for sage grouse breeding. A lek site that has been strip-mined, paved, converted to cropland or undergone other long-term

habitat type conversion is considered destroyed. Destroyed leks are not monitored unless the site has been reclaimed to suitable sage-grouse habitat.

- **abandoned lek** – A lek in otherwise suitable habitat that has not been active during a period of 10 consecutive years. To be designated abandoned, a lek must be "inactive" (see above criteria) in at least four non-consecutive strutting seasons spanning the ten years. The site of an "abandoned" lek should be surveyed at least once every ten years to determine whether it has been reoccupied by sage-grouse.

- **undetermined lek** – Any lek that has not been documented as active in the last ten years, but survey information is insufficient to designate the lek as unoccupied. Undetermined leks are not protected through prescribed management actions during surface disturbing activities until sufficient documentation is obtained to confirm the lek is occupied. This status should be applied only in rare instances, and effort should be made to determine the leks management status.

  - Over time, there are a few circumstances which have resulted in defaulting to an undetermined management status for a select number of leks. In many of these cases the main impediment to ascertaining the status of undetermined leks is ground access, usually prohibited by private land. If ground access is not a foreseeable option, special consideration will be made to use the available survey techniques to determine the management classification of these leks. To use aerial surveys to update an undetermined lek classification, the lek and its associated 2 mile buffer shall be aerially surveyed by following the protocols outlined in section 1.b.i, a minimum of two times per year from April 1 to May 7, separated by at least 7 days. Confirmation of a lek as "unoccupied and abandoned" would require aerial surveys which failed to find strutting sage-grouse in at least 6 years spanning a 10-year period.

1. Locating and Mapping Leks –

a. Rationale –Leks must be located and status documented before designing a program to monitor sage-grouse breeding populations. Leks can be detected by searching from the ground or air in early March to early May. The protocol for lek surveys or searches using a fixed wing airplane, helicopter, aerial infrared imagery (IR), or unmanned aerial vehicle (UAV) are similar. Techniques for these methods for both lek searches and lek surveys are outlined below. Proponents of development projects should consult with WGFD to determine the need and extent of searches for new leks. For full ground observation protocol please see the breeding surveys protocol in section II.A.2 below, and the lek definitions in section II.A above.

b. Application –

i Aerial Fixed-wing or Helicopter –Strutting male sage-grouse are highly visible during early morning hours when the sun illuminates their white chests. Aerial lek observations can be conducted by flying lek to lek or along transects. Flying lek to lek may be useful in isolated areas, areas inaccessible by ground vehicles (due to snow or mud), or small populations where most leks are known, or in areas that are flown annually. Fly along

transects to conduct lek searches. For transects, fly north-south approximately 500m -1 km (0.6 mi) apart throughout suitable breeding habitats. Lek observations and lek searches conducted during flights are biased toward larger leks; small leks (<15 birds) are more difficult to detect. Conduct flights only on calm, clear mornings. Do not survey if winds exceed 15 kph (10 mph) or if more than scattered cloud cover is expected. Males can be seen from more than 1.0 km (.6 mi) in early morning sun, but cloud cover greatly reduces illumination and contrast at this distance. In marginal light, fly narrower transects. High winds not only make traveling a straight transect difficult, but also affect strutting behavior. Under such conditions, fewer males strut continuously, and they tend to flush at greater distances. Minimize disruption of known leks during aerial searches and surveys. If flight transects overlap known leks, record observations for those leks or conversely avoid known leks if another observer has ground access or is responsible for surveying in a given year. This information can be obtained by coordinating with the local Game and Fish biologist.

Fly transects about 100-150 meters (300-450 ft) above ground level (AGL). Department personnel must follow the "Low Altitude Aircraft Operations Standards, Procedures and Safety" policy. This policy indicates that no more observers than are necessary to accomplish the survey are allowed on a flight. The exception to this is a new observer to be accompanied by an observer experienced in sage-grouse flights. Every low altitude flight should be reviewed by the Department employee in charge. Plan the flight so the observer always looks away from the sun. Begin north/south search patterns at the east edge of the survey area and progress westward to avoid flying over leks before they are seen. Pay particular attention to old lakebeds, stock watering areas, and other relatively open sites largely surrounded by sagebrush with 15 to 25% canopy cover. Conduct aerial observations or searches from ½ hour before sunrise to 1 hour after. Flights can be extended to 1½ hours after sunrise during the portion of the breeding season when male attendance peaks.

Male sage-grouse respond to approaching aircraft in various ways that can affect results. In some cases, they may continue to strut as the aircraft approaches and flies past or overhead. In other cases, grouse will "squat" as they do when an avian predator approaches. Sage-grouse virtually disappear when they squat, therefore observers should scan well ahead and laterally to the next transect line to detect males before the aircraft approaches closely or flies overhead. Based on past research, up to a third fewer birds are detected by aerial observations compared to ground observations. Therefore aerial observations are always considered surveys. Sage-grouse may also flush from the lek location and fly in a group or as scattered individuals. For observations, record the minimum number of birds observed in the sage-grouse lek database, or in data submitted to the Department. For example if you observed 10-20 males strutting, record 10 males. Any observation of flying grouse, especially in a group of several birds should be marked as a possible lek location and the area should be searched again during a later flight.

Search intervals can be increased to 1.5 km (about 1.0 mile) in poor habitat and areas with no recent history of use by sage-grouse. On the other hand, narrower search intervals of the 500m-1km are advised in areas where habitat alteration or human development is anticipated, to assure the area is thoroughly searched.

ii Aerial Infrared Imagery (IR) - Can be used to search for new leks and to observe known leks (Coates et al 2019, Gillette et al. 2013). Recent advances that include high-definition video as an on-board complement to infrared imagery are allowing observers to post-process results and more accurately tally attending males, in addition to improving the ability of observers to distinguish males and females. Basic protocols for aerial observations, season, weather, and time of day apply for observations using infrared technology.

iii Unmanned Aerial Vehicle (UAV) – Also referred to as drones. To date, the use of UAVs for observing leks has been limited. Minimal research has been conducted to determine the efficacy of this tool, as well as the potential for negative impacts (e.g., disturbance, lek abandonment) to sage-grouse. Observations from helicopter and fixed-wing planes anecdotally show an influence on male display behavior and therefore limit inference on undetected males, likely due to their low altitude and engine noise. Sage-grouse may be similarly affected by using UAVs. Requirements for minimum altitude will vary by the imaging system carried aboard the UAV; however, based on Hanson et al. (2014) and Thompson (2018), UAVs should remain 60 m AGL to minimize behavioral responses that could impact lek tallying, including cessation of lekking behavior or flushing. Operators should consider greater altitudes for observations if the UAV model in use exceeds 60 decibels (dB) in associated noise (Hodgson et al. 2016). UAVs should be launched at least 200 m from the near edge of the lek, and from behind visual obstruction to obscure operators from lekking birds (Thompson 2018), or far enough to not disturb birds but still provide an unobstructed line of sight to the UAV over the lek (Hanson et al. 2015). UAVs should be equipped with thermal infrared cameras as sage-grouse are more visible in the infrared spectrum (Gillette et al. 2013, Hanson et al. 2015). Flight patterns will vary with nadir and forward-looking (flyover) or side-looking camera positions (orbit). UAVs are limited in flight altitude, duration and distance from the pilot, but their use is expected to expand as airframes and camera technology continue to improve, and costs decline. Currently, it is only practical to use small UAVs to observe single or small groups of leks. The same protocol used during ground-based observations for season, time of day, and weather should be followed for UAV based visits. As large UAVs become more useful and available, general protocols for lek observations should be followed.

iv Ground Searches – In areas with relatively good access, observers can locate leks by driving along roads in suitable breeding habitat and stopping every ½ mile to listen for sounds of displaying grouse. In suitable breeding habitat, try and locate high topography areas to aid in searches. During calm mornings, displaying sage-grouse may be heard from a distance of 1.5 km (about 1 mi). Ground searches can begin an hour before sunrise. In less accessible areas, searches can be done from a mountain bike, trail motorcycle, 4-wheel all-terrain vehicle, on horseback, or afoot. Use binoculars or a spotting scope to look for displaying birds within openings and areas of less dense sagebrush.

Leks can also be located by looking for evidence after fresh snowfall the prior night or early morning. Lek activity is minimal during stormy weather and the birds may flush at the first sign of an intruder. However, some male sage-grouse will attend leks virtually

every morning throughout the spring period, regardless of weather. Search locations of suspected leks immediately following a snowfall. If grouse use the area, they will leave tracks in the snow. The number of tracks may give some indication of the relative size of the lek. In addition, leks are occasionally discovered when concentrated tracks, droppings, and feathers are encountered during other field activities (e.g., big game winter mortality transects).

Leks characteristically have concentrations of scattered fecal pellets, feathers, tracks and trampled vegetation (Fig. 1). In addition, strutting sites are usually marked by large numbers of caecal droppings (miniature black "cow pies") (Fig. 1). Caecal droppings are initially green, but cure to black quickly in the sun. Presence of green caecal droppings and fresh tracks indicate the lek was active earlier in the morning. In contrast, fecal deposits on winter ranges and roost sites are typically discrete piles next to sagebrush (Fig. 2). Fecal droppings can last for years, though they fade with time. On the other hand, caecal droppings usually decay within days or weeks depending on precipitation. Always have field personnel record locations where this sign of a lek is observed. To confirm the site is a lek, it must be visited during early morning strutting hours to document attendance by male sage-grouse.

Fig. 1. Lek sign: scattered fresh fecal pellets (olive green and white), fresh caecal droppings (black/green "tar") and scattered feathers.

Fig. 2. Roost sign: pile of fecal pellets with decaying caecal dropping in lower right portion of photo.

v Lek Identification – Not every site where sage-grouse are seen strutting is a lek. Grouse that have been flushed from a lek often resume strutting at a different location for the remainder of the morning, and then return to the actual lek the following night. Juvenile males sometimes pursue females as they leave a lek. Groups of strutting juvenile males have been observed up to 0.8 km (½ mi) from the lek as they follow the females. Therefore, additional confirmation is necessary to verify a site where males are seen strutting is actually a lek. A ground survey to search for sign of prolonged activity at the site can also separate true leks from temporary strutting sites.

vi Lek Perimeters - The eight local sage-grouse conservation plans, the Governor's Sage-Grouse Executive Order 2019-3 and various federal agency planning documents recommend or stipulate protective measures based on occupied lek perimeters (see also Section V). Distance-based stipulations such as "No Surface Occupancy (NSO)" and "Controlled Surface Use" (CSU), and other management practices are more effective when the action is based on lek perimeters rather than lek centers. Perimeters can be

collected with a handheld GPS unit or mobile application. The general concept and collection techniques outlined below, apply to all methods.

Mapping Lek Perimeters with a GPS Unit

1. Only observers familiar with the recent history (>1 year, > 3 observations) of each individual lek should map its perimeter given day-to-day variation of grouse use. Any perimeter mapping exercise is an approximation of grouse use and requires some judgment. However, observers should strive for accuracy and refrain from buffering perimeters.
2. Record waypoints in UTMs using NAD 83 datum.
3. Do not disturb grouse on the lek. Map perimeters after the birds leave for the day. Locate the perimeter based on cumulative observations and grouse sign. While walking the perimeter, record waypoints at approximately 10-meter intervals.
4. Also, record a single waypoint representing the lek center. This should be located in the center of strutting activity. The center point MUST be within the current perimeter.
5. Download the waypoints. Use a file extension that allows the ability to directly transfer data between the GPS units and various GIS software packages. Examples are .txt, .csv, .dbf, .kmz, .kml, or .shp format. Geodatabases containing feature classes are also acceptable.
6. Email the data to the Wildlife GIS Analyst who will convert the data into polygon format, store, and distribute the data as required.

c. Analysis of Data – Numbers and distribution of occupied and abandoned leks are monitored through time to assess population trends, changing habitat conditions and impacts of disturbance. Lek locations are also incorporated into GIS layers for future reference by persons planning or commenting on development activities, and by persons who are preparing habitat management plans or mitigation projects.

d. Disposition of Data

i Lek Centers and Perimeters: The outer perimeter of a lek and associated satellite leks (if present). Record the center point and perimeter of all leks in UTM demarcations using NAD83 datum and enter the center point information in the Wyoming Sage-grouse Database. Perimeters of all leks should be mapped by experienced observers using accepted protocols, leks with a larger amount of birds should receive higher priority. Perimeters may vary over time as population levels or habitat and weather conditions fluctuate. However, mapped perimeters should not be adjusted unless grouse use consistently (2 or more years) demonstrates the existing perimeter is inaccurate. If the center of activity moves outside the perimeter, collect a new perimeter and update the center point. The lek location must be identified and recorded as a specific point **within** the lek perimeter. This point represents the center of breeding activity typically observed on the lek.

ii Flight Tracks: Submit flight tracks to the Wildlife GIS Analyst. Consultants or project proponents conducting aerial searches should contact WGFD Wildlife GIS Analyst for a template of required data which would be submitted to WGFD. This information should include flight tracks of aerial surveys (ideally as a GPS flight track), along with

metadata documenting effort, including date of survey, survey start and end times, wind speed, cloud cover, plane's altitude above the ground level, aircraft type, observer(s), and the reason for the survey. During flights, birds may be observed flushing, but this does not necessarily mean there is a lek (especially with small numbers of birds). In these instances, it is incumbent upon the biologist to follow-up with ground surveys to determine whether and where a lek may occur. Follow-up ground checks for leks should also be made during the sage-grouse breeding season to verify any potential new leks where birds are located from the air.

2. Breeding Surveys –

a. Rationale – Observing male sage-grouse on leks is a common means of collecting data used to monitor sage-grouse populations. Methods accepted by researchers and managers are used to document the actual number of male sage-grouse observed on a particular lek (Jenni and Hartzler 1978, Emmons and Braun 1984, Fedy and Aldridge 2011). Although lek observations are widely employed to monitor sage-grouse populations, some researchers have questioned their usefulness (Beck and Braun 1980). However, problems tend to arise more because the protocols are not rigorously followed than from any inherent flaw in the techniques themselves. For example, some leks have been visited at the wrong time of the year or during periods of wind or precipitation. All observers should receive adequate training before observing leks. Proper methods for conducting lek counts and lek surveys are described above. Training guides are also available from the WGFD Sage-Grouse/Sagebrush Biologist or the Wildlife GIS Analyst. Coordination with local WGFD biologists is important to ensure that excess lek visits and human disturbance does not occur during lek monitoring.

b. Application – Subdominant males are often less active and visible than are dominant males occupying the center of the lek. Consequently, subdominant birds are easily overlooked during a single observation. A lek can be observed effectively in the following manner:
   i Find a location that affords good visibility of the entire lek. If the lek is very large (100 or more birds) it may be necessary to select two or more vantage points. Be careful not to get so close that your presence disturbs the grouse.
   ii Record the time the observation begins.
   iii Tally the birds from left to right (or vice versa), tallying males and females separately.
   iv Wait one to two minutes and then tally from right to left again.
   v Wait one to two minutes and tally from left to right once more.
   vi Record the highest individual tally of male grouse and female grouse, and then move to the next lek.

   Refer back to section II.A Breeding Populations, above, for specific lek monitoring protocols.

   Some sage-grouse will move among several leks throughout a breeding season (Dalke et al. 1960, 1963, Fremgen et al. 2017a). Therefore, changes in attendance at a particular lek may actually reflect birds shifting to nearby leks. Moreover, birds may cease using a lek because of disturbance or changes in vegetation. The disappearance of a lek may or may not mean the population is declining. To assess actual changes in a grouse population, all leks along an established lek route, see definition in section II.A: Breeding Populations, must be visited annually. Select routes that enable all leks on the route to be visited within 1.5 hours. If weather conditions deteriorate after you begin a lek route, the route should be run again.

If no birds are observed on a lek that was occupied in prior weeks or years, the observer should exit the vehicle and, with the engine off, listen for sounds of displaying grouse. Birds will sometimes relocate to a new lek site when they are subjected to continuing disturbance. If a predator flushes grouse from a lek, and it is still reasonably early in the morning, the grouse may also resume displaying nearby once the predator leaves the area.

Before establishing lek routes in a given area, give some thought to the number of personnel available to observe leks. It is much better to plan fewer visits yielding high quality data than to compromise data by scheduling more visits than personnel can reasonably handle. A Game and Fish biologist or wildlife management coordinator should assign personnel to observe leks. It is acceptable for persons from outside the agency to observe leks if they are properly trained. Leks with the longest history of consistent data collection should be included in routes, as these provide a basis for long-term trend assessment. Leks most vulnerable to impacts from a management activity or disturbance should be visited three times each spring if possible. Pre-, during-, and post-treatment observations provide important information for determining project impacts and appropriate mitigation.

If the exact location of a lek is known, its activity status can be checked any time of day, up till May 30th, based on presence of sign. Site visits also give observers an ideal opportunity to precisely map the lek by walking its perimeter and recording the coordinates.

The ideal time of day to conduct lek surveys is 30 minutes before until 90 minutes after sunrise. Under some conditions, sage-grouse will strut up to two hours or more after sunrise. Prolonged attendance usually coincides with: 1) presence of hens on the lek; 2) dim light conditions (overcast skies, fog, or light snowfall); or 3) the dark or "new" phase of the moon, when little strutting activity occurs at night. Males generally stop strutting early on mornings when hens are absent (late in the strutting season) or near the full moon, when much of the strutting and breeding take place at night. During the full and nearly full moon, sage-grouse may strut all night and males will occasionally initiate strutting at sunset or shortly after. At these times, leks can occasionally be surveyed in the evening. However, nighttime surveys do not meet the stringent lek count criteria described earlier in this chapter.

c. Analysis of Data – Before compiling and analyzing data from lek observations, proof all raw data to assure the information was collected properly. To assess breeding population trends, the minimum information required is a record of the number of active leks in a given area over a period of years. The most effective means of tracking populations and analyzing changes is to examine the number of males per lek. If the number of leks does not change over a period of years, then the average number of males per lek should constitute the basis for assessing the breeding population. Although females are generally encountered when visiting a lek, they are difficult to accurately tally because of their secretive nature and cryptic appearance. The number of females observed may provide some indication when breeding peaks; however, these data should not be used to assess population changes. The Wyoming sage-grouse database and Job Completion Report have improved data storage, retrieval, analysis and reporting both at regional and statewide scales. All current and historical data should be entered into the database.

d. Disposition of Data – Enter all data from lek visits into the Wyoming Sage-grouse Database. These data are annually summarized and analyzed in the Sage-grouse Job Completion Report.

B. Brood Production – Brood production is monitored for several purposes: 1) low production can indicate problems with habitat or effects of drought and other stressful weather patterns; 2) production is useful to forecast the availability of birds during the upcoming hunting season; 3) production can be an indicator of the success of habitat treatments; and 4) increasing or decreasing brood production can foretell the beginning of a population recovery or downward trend, respectively. Production is expressed as the proportion of females with broods or the ratio of juveniles to adult females, and can be assessed using one or more of the following techniques: brood observations, brood routes and wing surveys (Autenrieth et al. 1982).

1. Brood Observations and Routes –

a. Application – Brood observations are simply records of all sage-grouse broods observed incidentally by any field personnel working in an area. Once they are tallied, brood observations provide some indication of the juvenile to adult ratio and proportion of hens with broods. Brood route surveys are usually scheduled during late June, July, and early August. Routes are generally established in areas of known sage-grouse concentrations, often in or adjacent to wet meadows, riparian zones, and agricultural areas. Routes are followed on foot or horseback, or in a vehicle driven at speeds <32 kph (20 mph) and are completed in the morning (sunrise to about 0900) and evening (1800 to sunset). Record each brood separately, indicating the size of the brood, its location, and whether a hen is present. Also, tally groups of unsuccessful females and males as they are encountered. Chicks are quite secretive, therefore it is usually necessary to flush the brood to obtain an accurate tally. A trained bird dog can help the observer locate more broods. If a sufficient sample of grouse broods is observed, this technique can provide a reliable indication of production trends.

b. Analysis of Data - Brood observations are somewhat better than anecdotal information, but not easily replicated. It can also be difficult to interpret comparisons of brood data among years. The following information is derived from brood route data: birds/km, broods/km, average brood size, and ratio of chicks to adult hens. Brood routes are the only economical means to assess production within non-hunted or lightly-hunted populations from which relatively few wings are collected. Productivity can also be assessed using hens marked with transmitters, however this is a much more intensive and costly method.

3. Wing Collections –

a. Rationale – Sage-grouse wings collected during hunting seasons are used to estimate the age and sex composition of harvested birds. Within hunted populations of sage-grouse, wing surveys are the most useful technique available to estimate production (chicks/hen) provided an adequate sample can be obtained. A sample size of 150 wings would be ideal, however, may not be possible due to lower harvest rates and shorter seasons.

b. Application – Wings are normally collected in “wing barrels” (Fig. 3) strategically placed along egress routes or by Department personnel at hunter check stations. Wing barrels

should be painted a conspicuous color and placed at road intersections where vehicles are required to slow or stop. Signs should be attached to the barrels, instructing the hunter to remove one (1) wing from each harvested bird and place it in the barrel. Wings should be collected at least twice during the season – the Monday following opening weekend and at the end of the season. Wings should not be stored in plastic. Rather, place wings in paper grocery sacks that are clearly labeled with the wing barrel name/location and the collection date. Sacks of wings should be frozen and stored until the wings can be examined to determine age and sex. Wings are usually "read" at an annual "wing-bee" held in November each year. The wing-bee format allows participants to share their experience and expertise, which greatly enhances the learning process for those with less experience. The Wyoming Game & Fish Department's Sage-grouse Working Group published a "Sage-grouse Sex and Age Guide" (Attachment 1) based on Braun's "A Key for Age/Sex Identification from Wings of Hunter-Harvested Sage-grouse". Use this guide to determine age and gender from wing plumage characteristics of harvested grouse.

Fig. 3. Sage-grouse wing barrel with instruction sign.

c. Analysis of Data – Data from wing collections are compiled to assess trends in production and to compare production among geographic areas. However, these data may not accurately represent population trends. For example, a range type conversion could impact or eliminate a portion of the winter habitat used by a population while breeding habitat remains intact. Afterward, the overall population may decline because mortality has increased on winter range, yet this decline might not be evident from production statistics (the ratio of juveniles to adult females), which could remain stable. Thus, it is best to view production information in conjunction with other data to make inferences about population trends.

d. Disposition of Data – Production data should be entered into the Wyoming Sage-grouse Database and summarized in the applicable Job Completion Reports.

C. Winter Habitat Selection

1. Documentation of Winter Use Areas and Delineation of Winter Concentration Areas –

   a. Rationale – Knowledge about winter use areas can be helpful as biologists review proposed development actions or land use plans, and is also an important consideration for planning habitat treatments. In addition, the information can help biologists identify seasonal movement patterns within migratory populations of grouse. However, no specific method is recognized to census grouse populations during winter. In part, this is because grouse distribution can vary markedly from winter to winter, although birds do show fidelity in using the same geographic areas from year to year. Birds may be spread out over large areas during mild winters but concentrate in relatively small portions of their range in severe winters (Beck 1977). Sage-grouse feed almost exclusively on sagebrush leaves and buds during winter. They tend to select wintering sites where sagebrush is 10-14 inches above the snow and canopy cover may range from 10 to 30 percent. Foraging areas tend to be on flat to generally south facing slopes or on ridges where sagebrush height may be less than 10 inches but the snow is routinely blown clear by wind. Under winter conditions with high snow levels, grouse will often congregate in taller or exposed stands of sagebrush located on deeper soils in or near drainage basins. Under these conditions, winter habitat may be limiting. On a landscape scale, suitable winter habitats need to be available to meet this seasonal winter habitat need.

      Winter Concentration Areas (WCA) are a type of designation, similar to a crucial winter designation for big game that uses documented winter sage-grouse data for delineation. As per the current Governor's Sage-Grouse Executive Order 2019-3, Appendix E, these WCA are defined as places where large numbers of sage-grouse congregate and persistently occupy between December 1 and March 14 and therefore should be identified for protection. Identification of WCA should be based on habitat features and repeated observations of winter use by biologically significant numbers of sage-grouse (e.g. – groups greater than or equal to 50 sage-grouse) using a data driven statistically rigorous modeling approach (e.g. – validated Resource Selection Function).

   b. Application – Winter use areas can be documented by searching for grouse, or sign, from a 4-wheel drive vehicle, snowmobile, or on foot. Winter habitats can also be located from either a fixed-wing aircraft or helicopter by looking for live grouse and tracks when snow cover is available. The use of helicopters verses fixed wing aircraft have demonstrated much better detection rates for both live birds and tracks. Aerial searches can often be done in conjunction with surveys for other wildlife (e.g. elk trend counts/classifications). Typically north-south transects flown from ½ to ¾ miles apart is preferred, but can vary depending on weather conditions, terrain, and flight objectives. East-west transects can also be used during winter months when the sun is located further south in the hemisphere. Flight distance above ground level (150' to 200') that flushes grouse results in a much better detection of both live birds and bird tracks. Documentation should include date, observations of live grouse, grouse tracks, locations of observations and search tracks, etc. Under good conditions (bright sun and fresh, uncrusted snow) grouse tracks are quite easy to detect from 300 feet or lower elevation above ground. Tracks are usually seen in groups. Individual tracks tend to wander in a "snakelike" pattern rather than a straight line, and the birds' abdomens plow the snow. If winter use documentation is collected for the purpose to delineate WCA, additional efforts should be made to count most all grouse associated with each located flock. Where live grouse or fresh tracks are found (ground or air), the

observer(s) should break away from their search transect in an attempt to circle around to tally all the birds associated with that flock. The flushing of birds is necessary to get the best possible count.

In Wyoming, the falconry season for sage grouse extends through March 1. Falconers often hunt grouse in winter and can be a good source of information to help locate potential wintering areas. Many have volunteered to record grouse observations.

At a minimum, record the approximate size and location of each flock you observe during winter. Additional descriptive information, particularly cover type (including species of sagebrush), topography, and snow depth, is also valuable.
However, it may not be possible to collect all this information from an aircraft. Data should be acquired over a series of years and varying snow conditions to obtain a more complete picture of grouse distribution.

c. Disposition of Data – Observations should be entered into the Wildlife Observation System (WOS). The identification and designation of WCA requires a fairly rigorous process that is currently being formulated. In general this process includes 1) data collection and analysis using a combined habitat/observation model; 2) consultation and coordination with affected managers, agencies, land owners, and other users; 3) Sage-Grouse Implementation Team and WGFD Commission approval. Winter concentration areas do not account for all habitats sage-grouse use during winter, nor are they restricted to "severe winter relief" habitats. Important winter habitats should be described in the applicable Job Completion Report.

III. TRAPPING, MARKING, AND TRANSLOCATION –

A. Trapping –

1. Rationale – Sage-grouse are captured and handled predominantly for two purposes: 1) to mark individual birds; and 2) to collect biological samples for analysis. If samples are collected, this is generally done in conjunction with a marking study. Marking has been employed as a method to study sage-grouse populations for over 70 years. Techniques have been refined and the quality of radio transmitters, GPS collars, and GSM transmitters has improved considerably. Sage-grouse can be captured most effectively in spring and late summer. Selection of suitable techniques depends on terrain, access, weather, and population size. All sage-grouse trapping and handling requires a Chapter 33 permit from WGFD. Coordinate with the Permitting Officer and follow all conditions outlined in the permit.

2. Application –

a. Spotlighting. During March and much of April, male and female sage-grouse often roost on or near leks at night. This behavior is especially common when attendance by hens is at its peak, usually the last week of March and first week of April. (In higher elevations, hen attendance may peak in mid-April). At these times, birds are fairly easy to capture by spotlighting (Giesen et al. 1982, Wakkinen et al. 1992). One difficulty is that males are much easier to see and hence, captured more often than females. Moreover, males tend to roost in the center of a lek while females are found near the edges. The peripheral areas can

be more difficult to traverse with a 4-wheel drive vehicle. To overcome these difficulties, researchers have adapted the standard spotlighting technique on foot by employing binoculars (to spot and determine sex of birds from a distance) and by broadcasting loud music (a form of "white noise") to conceal approaching footsteps.

Trapping begins after complete darkness. The crew drives slowly toward the lek area in a 4-wheel drive vehicle or ATV. As the vehicle approaches, the crew scans the ground with a ≥ 1 million candlepower spotlight and binoculars to locate roosting grouse (Wakkinen et al. 1992). As the crew moves around the lek, the driver should stop every 100-200 meters to scan the lek and nearby area. If possible, drive to higher ground near the lek to gain a better vantage for spotting birds roosting in heavier cover.

Sage-grouse eyes reflect light at night, and resemble sparkling green emeralds in the spotlight. Depending on terrain and vegetation, this eye reflection can be visible from over 200 m. Normally, spotters are able to identify the white breast feathers of males when they are viewed from less than 100 m. However, it may not be possible to distinguish sex at longer distances. The bird's location relative to the lek also provides an indication of the bird's probable gender. Males tend to roost alone in the comparatively open area of the lek, or sometimes on sparsely vegetated ridges adjacent to the lek. Females tend to be more secretive, roosting near sagebrush cover at the perimeter, and sometimes in small groups.

A netter dressed in dark clothing walks alongside the vehicle. As the vehicle gets closer to the grouse, the spotter will eventually see it easily without binoculars. At this point, the spotter begins to shimmy the spotlight rapidly, keeping the light focused on the roosting grouse. This produces a strobe-like effect that further confuses the grouse. Netters on the ground are unlikely to see the bird at this point but when they see the light begin to shimmy rapidly, they move 5-10 m to the side of the vehicle while staying out of the spotlight. Even if the bird is not visible, the netter must concentrate on the center of the light. Eventually, the bird will come into view. As the vehicle's side is about to pass the grouse, the trapper should place the net over the bird. The net should be swung relatively low and parallel to the ground rather than down from overhead like a butterfly net – to do so increases the risk of injuring the grouse. If the netters are somewhat slow, the driver should begin to circle the bird at a distance of about 5 m until the netters are able to position themselves for a capture attempt. Throughout this activity, the spotter continues to shimmy the spotlight directly on the bird's eyes to keep it mesmerized.

Once the grouse is in the net, the netter should restrain it by holding the wings next to the bird's body and wait for help to remove it from the net. To reduce the chance of injury or escape, a grouse should not be allow to struggle loosely in the net. An experience netter can remove grouse from the net and safely handle them without additional help. As soon as the spotter sees the captured grouse is under control, they should begin searching the immediate area (out to about 100 m) to locate other grouse. If another bird is found, the trapping crew can proceed after it. If the crew waits until the captured bird is processed, nearby birds will likely flush before another approach can be made.

Most sage-grouse are caught within a few meters of the vehicle. A capture should only be attempted at longer distances (up to 20 m) when a grouse is roosting in a rock pile or muddy area where driving is unsafe. The same procedure should be followed, but the netter must

move quite rapidly and take special care to stay out of the light. Personnel may consider carrying a portable power-pack while spotlighting from a vehicle in case grouse are found roosting in inaccessible areas. Spotlighting on foot is generally the best method to capture birds associated with a radio-marked bird (usually a hen and her brood), or to replace a transmitter.

Spotlighting is not very effective on bright, moon-lit nights because birds can easily see approaching trappers well before spotlights have any effect. Avoid spotlighting within 3 days of a full moon unless the sky is heavily overcast.

b. Walk-in Traps – Various walk-in traps (Gill 1965, Schroeder and Braun 1991) are also effective for capturing sage-grouse on leks (Schroeder 1997, Leonard et al. 2000, Aldridge and Brigham 2002) and on summer foraging habitats (Connelly 1982). Walk-in traps can be round, square, or rectangular. They are typically about 50 cm (20 in) high, and 100 to 150 cm (40-60 in) deep (round traps are 100-150 cm (40-60 in) in diameter). Each trap has a funnel opening that provides unobstructed entrance but hinders the bird's escape. Normally, wings or leads connect several traps or "pods" together and direct walking grouse into the trap entrances. Leads are generally 25 to 75 meters long, about 35 cm (14 in) high, and are set to intercept hens moving onto a lek or grouse moving onto a feeding area. Traps should be constructed of nylon or cotton netting. Never use poultry netting because it can inflict deep cuts into grouse when they struggle to escape. A latching door can be installed on the side or roof of each trap to provide access for removing birds. Personnel should constantly tend traps when they are set. Otherwise, a captured bird can injure itself while struggling in the trap; a predator may detect and kill it; or it can suffer from stress and overheating.

c. Mist Nets – Mist nets can be used to capture sage-grouse on summer range (Connelly 1982, Browers and Connelly 1986). Researchers have also attempted to use mist nets on leks, but typically only 1 or 2 males are caught each morning. As soon as the grouse are become entangled, they must be removed to prevent injuries and this disrupts breeding activities for the remainder of the morning. However, mist nests can be an effective means to capture broods on summer foraging areas. They have also been used in conjunction with walk-in traps. By placing mist nets behind walk-in traps, birds that would otherwise flush at the trap entrance may be caught. As with walk-in traps, mist nets must be tended continually to avoid injuring birds.

d. Drop Nets – Drop nets have been used to capture sage-grouse on leks (Leonard et al. 2000). However, they tend to disrupt lek activities and are not as efficient as other trapping methods.

e. Cannon and Rocket Nets – For many years, cannon and rocket nets were widely used to capture grouse on leks. More recently, some researchers have used the CODA Netlauncher™ to capture hens on leks (Hausleitner 2003, T. L. Maechtle personal communication). However, cannon and rocket nets also disrupt lek activities and may not be as efficient as other trapping techniques.

f. Pointing Dogs – Sage-grouse chicks up to about 4 weeks of age can be caught with the aid of a well-trained pointing dog (Dahlgren et al. 2010). Connelly et al. (2003) used pointing dogs to capture the chicks of radio-marked hens by first locating and flushing the hen. The

dog was allowed to search an area within a radius of 200 m/yd from where the hen flushed. The dog will normally point within 50 cm (20 in) of a chick's location. Once it is spotted, the chick can then be picked up by hand. A long-handled net is useful to catch older chicks (> 2 weeks old). This technique requires the use of very steady, experienced dogs.

3. Analysis of Data – Analysis of marking data is discussed in Section III.B.3 below. Maintain records of all grouse that are captured or recaptured, including numbers, age and sex, location, time and date, weather conditions, and method of capture. Note any capture-related mortalities and the circumstances involved, so techniques can be modified if necessary.

4. Disposition of Data – Report results of all capture projects in research reports and applicable job completion report. Coordinate with the WGFD Permitting Officer to submit Chapter 33 data as outlined by the permit.

B. Marking –

1. Rationale – Sage-grouse are marked to serve various research and management purposes such as movement and distribution studies, survival studies, home range delineation, nesting studies, assessment of impacts from development or other land uses, and monitoring response to habitat treatments. Marking methods and devices have included cataloging pigmentation patterns on tail feathers or clipping tail feathers (Wiley 1973), leg-bands (Patterson 1952, Dalke et al. 1963), ponchos (Wallestad 1975), colored backtags (Autenrieth 1981), radio transmitters (Wallestad 1975, Autenrieth 1981, and many others), GPS (Global Positioning System), and GSM (Global System for Mobile Communications) units. Patagial tags can also provide some movement and distribution data at a relatively low cost.

2. Application –

a. Data Collection of Marked Birds– Radio transmitters are an effective means of documenting seasonal habitat selection and movements by sage-grouse. Data from radio telemetry studies can also be used to estimate daily, seasonal, and annual survival rates. Biologists have used radio-transmitters to study sage-grouse since at least 1965 (Autenrieth 1981). Unfortunately, early transmitters weighed >70 g (≥5% of an adult female's weight) and had relatively short battery lives. Because of the potential effects these larger, heavier transmitters had on grouse behavior and survival, and their brief span of operation, data and conclusions from early studies should be interpreted cautiously. By the mid- to late 1970s, transmitters weighed about 25 g (≤ 2% of an adult female's weight) and would generally last 6 months or more. Throughout the 1970s and early 1980s, researchers employed variations of a backpack harness (Brander 1968) to attach transmitters on sage-grouse. During the early 1980s, we learned backpack harnesses increase susceptibility to predation and thus switched to a poncho-mounted transmitter (Amstrup 1980).

Poncho-mounted transmitters were placed on sage-grouse throughout much of the 1980s and early 1990s. Both battery and solar powered transmitters were used. Poncho openings were custom fit to individual birds. The poncho was attached by pulling the opening over the bird's head and arranging or "preening" feathers around the poncho material. The transmitter was fixed to the poncho so it would lie against the bird's crop. Although the method provided a quick, reliable way to place radio-transmitters on sage-grouse, solar

transmitters mounted in this fashion occasionally malfunctioned. During summer, sage-grouse often feed on succulent forbs including dandelion (*Taraxacum officianale*), salsify (*Tragopogon dubius*), lettuce (*Lactuca* spp.) and hawksbeard (*Crepis acuminata*). A milky substance contained in these plants often runs down the bird's bill, onto the breast feathers. The substance can collect and harden on transmitters and will cause solar transmitters to stop functioning as it accumulates on light panels. By the mid-1990s, most research biologists were using a necklace-mounting system and battery-powered transmitters on sage-grouse. The necklace is generally made of plastic-coated cable. This type of radio-harness is somewhat lighter than a poncho, but attaches just as quickly to the bird's neck area. The transmitter itself can be attached more readily to a necklace than to a poncho. The necklace cable must be loose enough to avoid constricting the crop and potentially harming the grouse. Normally, a finger's width of room is left between the bird's throat and cable. This enables the bird to forage normally, yet is sufficient to retain the transmitter. Necklace transmitters shall not be attached to male sage-grouse (Fremgen et al. 2017b).

A tremendous amount of biological information has been acquired and published from studies of radio-marked sage-grouse. However, virtually all birds fitted with radio transmitters were more than 10 weeks old. Prior to 1998, few if any attempts were made to place radios on grouse chicks younger than 10 weeks. A technique suitable for chicks had to address several practical limitations. Foremost was the physical challenge of designing a radio and attachment device suitable for chicks as young as 1 day and weighing just 30 grams. A transmitter life of at least 2 weeks was desired, but the device also needed to pose low risk to grouse chicks. A simple attachment system was developed for sage-grouse chicks (Burkepile et al. 2002, Gregg and Crawford 2010). The procedure involves piercing the skin just in front and behind the transmitter with a 20-gauge hypodermic syringe. Sutures are threaded through the syringe and through holes in the transmitter, and then tied off. Cyanoacrylic glue ("Superglue") is applied to the knots to enhance security of the attachment. VHF transmitters generally require a person with an antenna to physically find the location of the bird from either the ground or aircraft. The bird's location can be honed or triangulated. Using VHF devices is labor intensive, provides lower resolution results and the battery typically lasts 1.5-2 years.

Global Positioning System (GPS) technology revolutionized the ability to monitor sage-grouse movements in Wyoming (Bedrosian 2010 and many others). Although the technology is relatively expensive, it provides multiple locations per day allowing more precise determination of habitat use and movement patterns. Locations upload to satellites at regularly scheduled internals. A built-in solar panel allows for a battery life equal to the bird's lifespan. GPS devices are less labor intensive and provide higher resolution results. GSM (Global System for Mobile Communications) are being deployed more frequently and download all data each time a cellular connection is made. The transmitters can hold onto months' worth of data if they are out of cellular range but they can permanently "disappear" if a bird or transmitter goes down out of range. Solar rump-mounted GPS transmitters differ from traditional VHF necklaces in terms of weight, juxtaposition and visibility. Fedy et al. (2012) tested for different movement patterns between compiled data from GPS-marked sage-grouse (3 studies) and VHF-marked sage-grouse (8 studies), and found no difference in movement patterns. The style and weight of transmitters should be carefully considered and tailored to the study objectives, given recent concerns about increased mortality risk from transmitters (Severson et al. 2019).

3. Analysis of Data – Several types of data are obtained from marking studies. Information on harvest rates, survival, and seasonal movements can be derived from band return data (Zablan et al. 2003). If a sufficient number of grouse are marked and subsequently recaptured, the population size can be estimated through a mark-recapture analysis. The sample of captures and recaptures necessary to estimate a population depends on the size of the population and the geographic area it occupies. Re-sight data from birds marked with patagial tags are used predominantly to determine local distributions and movements and to identify migration patterns. Radio-telemetry, GPS, and GSM studies are typically done to document seasonal habitat use, response to disturbances, distribution and movement patterns, and survival rates. Methods applied to analyze data depend on the specific purpose(s) for which the study was designed and conducted.

4. Disposition of Data –Radio frequencies of telemetry transmitters, from VHF only and GPS/VHF combination transmitters, must be entered in the Department's telemetry frequency database. Both databases are managed by Science, Research & Analytical Support Unit in Cheyenne.

   Results of studies involving marked birds are typically published in special reports prepared by the investigators. An annual report must be submitted and all data uploaded to Movebank for all studies requiring a Chapter 33 permit to capture sage-grouse. The annual report must include capture records, recorded observations of marked grouse, and all telemetry or satellite GPS data as applicable. Criteria for use and distribution of these data are currently being developed. In addition, progress and final reports should be included in the applicable Job Completion Reports.

C. Translocation – Please request the Wyoming Game and Fish Department Greater Sage-grouse and Sharp-tailed Grouse Trapping and Translocation Guidelines from the Sage-grouse/Sagebrush Biologist. The purpose of those guidelines is to ensure the capture and subsequent intrastate or interstate translocation of wild greater sage-grouse grouse in Wyoming is conducted in conformance with Wyoming Statutes and Wyoming Game and Fish Commission Regulations and Policy. In addition, those guidelines are intended to ensure trapping and translocation of sage-grouse grouse within Wyoming is planned and conducted in a uniform manner statewide, takes into consideration the biological and sociological concerns such activities generate, and the animals' welfare.

IV. HABITAT ASSESSMENT – Habitat assessments may be necessary to evaluate the impacts of development, plan and implement habitat projects, assess site recovery following disturbances as well as many other reasons. The Habitat Assessment Framework (Stiver et al. 2015) was developed as a hierarchical approach to conservation. The protocols and techniques within the framework have been well established and are recommended for use for any level of habitat assessments necessary for sage-grouse. In addition the Wyoming Game and Fish Department developed protocols for treating sagebrush (updated July 2019) that need to be considered whenever planning habitat projects. (https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Sage%20Grouse/SageTreatProtocols_July2019.pdf)

V. NOISE MONITORING - Please see the Wyoming Game and Fish Department Protocols for Measuring and Reporting Sound Levels at Greater Sage-grouse Leks which can be accessed on the WGFD

website. This document includes protocols, background, and supporting science. All sound level information should be entered in the Wyoming Sage-grouse Database.

IV. ENVIRONMENTAL COMMENTS AND RECOMMENDED MANAGEMENT PRACTICES – It is imperative that Department staff refer to the current Wyoming Governor's Sage-Grouse Executive Order and associated documents when conducting wildlife environmental reviews (WERs) of actions potentially impacting sage-grouse habitats, or when developing habitat management plans. Similarly, proponents of projects should be aware that areas of sage-grouse habitat, including occupied leks and their buffered zones, core areas, connectivity areas, and winter concentration areas may be subject to stipulations for development. The Department's Habitat Protection Program coordinates the review of proposed development projects, federal land-use plans, and policies that have the potential to impact fish and wildlife in Wyoming, including the implementation of the Sage-Grouse Executive Order. For consultation and more information: https://wgfd.wyo.gov/Habitat/Habitat-Protection-Program. Additional resources include: Cagney et al. (2010), Connelly et al. (2000b), Paige and Ritter (1999), and Wyoming Game and Fish Department (2014).

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FORMS: The most current lek form can be obtained from the lek database. Sage-grouse observations that are not associated with the lek should be made in the wildlife observation system (WOS). The most updated form to record wing data is below.

Wing Barrel:_____

Collection Date	Adult		Yearling		Juvenile	
	Males	Females	Males	Females	Males	Females
Totals						

Other Species Wings:_____

Chicks Per Hen:_____

Sage Grouse Wing Analysis Summary Form

Year: _____ MANAGEMENT AREA: _____

Adult Males: _____ Percent of All Wings: _____
Adult Females: _____ Percent of All Wings: _____
Adult Unknown: _____ Percent of All Wings: _____
Total Adults: _____

Yrling Males: _____ Percent of All Wings: _____
Yrling Females: _____ Percent of All Wings: _____
Yrling Unknown: _____ Percent of All Wings: _____
Total Yearlings: _____

Chick Males: _____ Percent of All Wings: _____
Chick Females: _____ Percent of All Wings: _____
Chick Unknown: _____ Percent of All Wings: _____
Total Chicks: _____

Unknown Sex/Age: _____ Percent of All Wings: _____

Grand Total for all Sex/Age Groups: _____

Chick Males: _____ Percent of All Chicks: _____
Yrling Males: _____ Percent of Adult + Yrling Males: _____
Adult Males: _____ Percent of Adult + Yrling Males: _____
Adult + Yrling Males: _____ Percent of Adults + Yrlings: _____
Total Males: _____ Percent of All Sex/Age Groups: _____

Chick Females: _____ Percent of All Chicks: _____
Yrling Females: _____ Percent of Adult + Yrling Females: _____
Adult Females: _____ Percent of Adult + Yrling Females: _____
Adult + Yrling Females: _____ Percent of Adults + Yearlings: _____
Total Females: _____ Percent of All Sex/Age Groups: _____

Chicks: _____ Percent of All Wings: _____
Yearlings: _____ Percent of All Wings: _____
Adults: _____ Percent of All Wings: _____

Chicks:Hen _____

Sage Grouse Sex and Age Guide

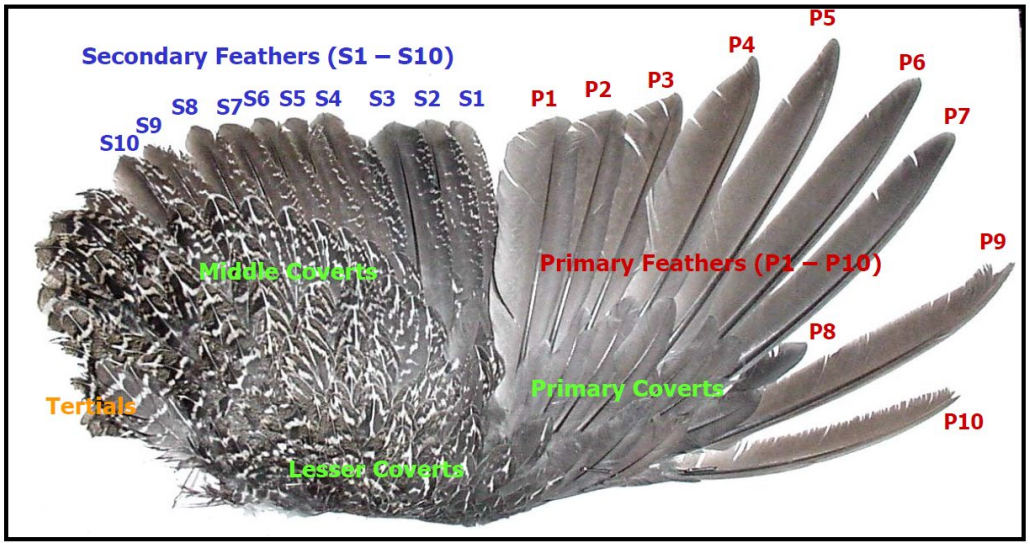
Sage Grouse Working Group

Wyoming Game & Fish Department

January 2002

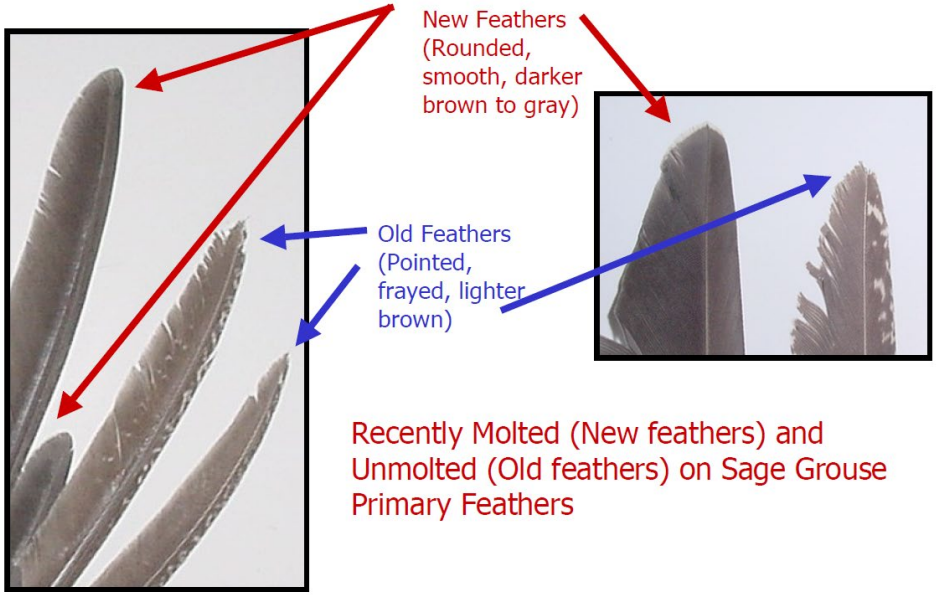
The following information is based on the publication "A Key for Age/Sex Identification from Wings of Hunter-Harvested Sage Grouse" by Clait E. Braun, Colorado Division of Wildlife. Photos were taken during the 2000 and 2001 Wing Bee at the Yoder Bird Farm, Wyoming Game and Fish Department.

Sage Grouse Wing



3

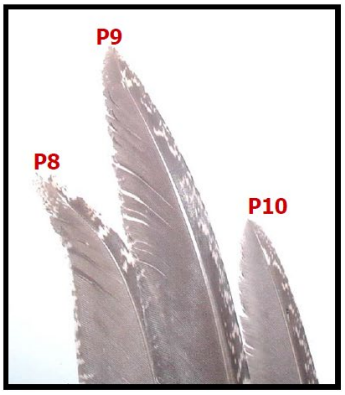
Molted and Unmolted Primaries



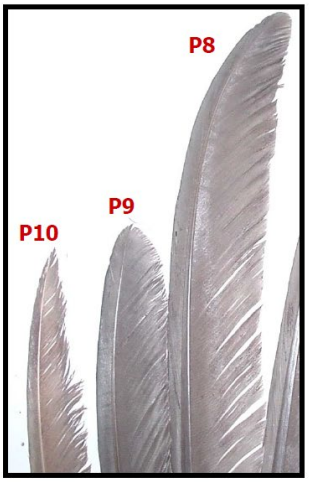
Recently Molted (New feathers) and Unmolted (Old feathers) on Sage Grouse Primary Feathers

4

Juvenile, Yearling, and Adult Primaries



Juvenile Primary Feathers
(Pointed Feathers)



Yearling Primary Feathers
(Juvenile Pointed P10 with New Adult P9 and P8 Feathers)

Adult Primary Feathers
Unmolted Feathers are Faded & Frayed and Molted Feathers are Gray

Juvenile feathers are pointed. Old (unmolted) feathers are faded brown and frayed. Adult feathers are rounded.

5

Juvenile and Adult Secondary Feathers

Juvenile (Left) and Adult
(Right) Secondary 1 Feathers

Juvenile (Left) and Adult (Right) Secondary 1 Feathers. Note that the juvenile feather is pointed, whereas the adult feather is rounded.

6

Juvenile and Adult Tertial Feathers

Juvenile (Left) and Adult (Right) Tertial Feathers

Juvenile (Left) and Adult (Right) Tertial Feathers

7

Juvenile and Adult Upper Wing Coverts

Juvenile Coverts

Adult Coverts

Juvenile (Left) and Adult (Right) Coverts

8

Procedures for Sage Grouse Wing Examination

1. Spread wing.
2. Locate all 10 primary and secondary feathers (or the blank spots if they are molted). Do outer two primaries (10 and 9) appear rounded (adult) or pointed (yearling or young)?
3. Is first secondary rounded (usually yearling or adult) or pointed (young)?
4. If outer two primaries appear pointed, do they appear worn and faded (yearling) or dark, fresh, and unworn (young).
5. Assign gender based on comparative size (larger = male, smaller = female) of wing in each age class.
6. Record length (mm) of youngest (most recently replaced and still growing) primary of young only to estimate hatch date.
7. Follow key if necessary.

Adult Males

Primaries 10 and 9 rounded and similar in appearance to primaries 7 and 6.

All primaries rounded, primary 9 if present, longer than 200mm.

If primary 9 is not present, primary 10 is longer than 165mm.

If neither primary 10 or 9 is present, primary 1 is longer than 140 mm.

Adult Male, Full Molt, Missing P10

Adult Males

Primaries 10 and 9 rounded and similar in appearance to primaries 7 and 6.

All primaries rounded, primary 9 if present, longer than 200mm.

If primary 9 is not present, primary 10 is longer than 165mm.

If neither primary 10 or 9 is present, primary 1 is longer than 140 mm.

Adult Male, Old P10

11

Adult Males

Primaries 10 and 9 rounded and similar in appearance to primaries 7 and 6.

All primaries rounded, primary 9 if present, longer than 200mm.

If primary 9 is not present, primary 10 is longer than 165mm.

If neither primary 10 or 9 is present, primary 1 is longer than 140 mm.

Adult Male, Old P9 and P10

12

Adult Males

Adult Male, Old P8

Primaries 10 and 9 rounded and similar in appearance to primaries 7 and 6.

All primaries rounded, primary 9 if present, longer than 200mm.

If primary 9 is not present, primary 10 is longer than 165mm.

If neither primary 10 or 9 is present, primary 1 is longer than 140 mm.

13

Adult Females

Adult Female, Full Molt

Primaries 10 and 9 rounded and similar in appearance to primaries 7 and 6.

Primary 9, if present, less than 199mm.

If primary 9 is not present, primary 10 is less than 160mm.

If neither primary 10 or 9 is present, primary 1 is less than 140 mm.

14

Adult Females

Primaries 10 and 9 rounded and similar in appearance to primaries 7 and 6.

Primary 9, if present, less than 199mm.

If primary 9 is not present, primary 10 is less than 160mm.

If neither primary 10 or 9 is present, primary 1 is less than 140 mm.

Adult Female, Molting P10 and P8. Such a wing pattern is highly unusual.

15

Adult Females

Primaries 10 and 9 rounded and similar in appearance to primaries 7 and 6.

Primary 9, if present, less than 199mm.

If primary 9 is not present, primary 10 is less than 160mm.

If neither primary 10 or 9 is present, primary 1 is less than 140 mm.

Adult Female, Old P6.

Note color change between P5 and P6

16

Nesting Success in Sage Grouse based on Primary Molt Pattern

Adult hens retaining old primaries 9 through 6 (in combination 9 and 8; 9, 8, and 7; or 9, 8, 7, and 6) may be considered as successfully hatching their clutch.

Hens that have molted all primaries or are retaining only old primary 10, may be considered as unsuccessfully hatching their clutch.

Most wings with fully molted (replaced) primaries are likely from yearling females because of low nest success and early advent of molting.

C. E. Braun, unpublished data

Data from Southwest Wyoming since 1997 suggest very low nest success using old P8 and very high success using old P9. Radio collar data suggest hens retaining P9 may or may not have been successful. Accuracy of this technique is highly dependant upon when the wings were collected. Care must be give to use only wings collected early in the season, usually around mid-September or earlier.

17

Yearling Males

Yearling Male Old P10

Primaries 10 and/or 9 pointed when compared to primaries 8, 7, and 6.

Primaries 10 and 9 pointed, worn, and faded.

Secondary 1 broad and round.

Primary 9, if present, more than 200mm.

If primary 9 is missing, primary 10 is greater than 160mm.

18

Yearling Males

Primaries 10 and/or 9 pointed when compared to primaries 8, 7, and 6.

Primaries 10 and 9 pointed, worn, and faded.

Secondary 1 broad and round.

Primary 9, if present, more than 200mm.

If primary 9 is missing, primary 10 is greater than 160mm.

Yearling Male Old P10 and P9

19

Yearling Females

Primaries 10 and/or 9 pointed when compared to primaries 8, 7, and 6.

Primaries 10 and 9 pointed, worn, and faded.

Secondary 1 broad and round.

Primary 9, if present, less than 200mm.

If primary 9 is missing, primary 10 is less than 160mm.

Yearling Female Old P10 and P9

20

Yearling Females

Yearling Female Old P8

Primaries 10 and/or 9 pointed when compared to primaries 8, 7, and 6.

Primaries 10 and 9 pointed, worn, and faded.

Secondary 1 broad and round.

Primary 9, if present, less than 200mm.

If primary 9 is missing, primary 10 is less than 160mm.

21

Yearling Females

Yearling Female Old P9

Primaries 10 and/or 9 pointed when compared to primaries 8, 7, and 6.

Primaries 10 and 9 pointed, worn, and faded.

Secondary 1 broad and round.

Primary 9, if present, less than 200mm.

If primary 9 is missing, primary 10 is less than 160mm.

22

Yearling Females

Primaries 10 and/or 9 pointed when compared to primaries 8, 7, and 6.

Primaries 10 and 9 pointed, worn, and faded.

Secondary 1 broad and round.

Primary 9, if present, less than 200mm.

If primary 9 is missing, primary 10 is less than 160mm.

Yearling Female Molting P7. Such a wing pattern is highly unusual.

23

Yearling Females

Primaries 10 and/or 9 pointed when compared to primaries 8, 7, and 6.

Primaries 10 and 9 pointed, worn, and faded.

Secondary 1 broad and round.

Primary 9, if present, less than 200mm.

If primary 9 is missing, primary 10 is less than 160mm.

Yearling Female Adult P8 and P9 Molting P7. Such a wing pattern is highly unusual.

24

Yearling Females

Primaries 10 and/or 9 pointed when compared to primaries 8, 7, and 6.

Primaries 10 and 9 pointed, worn, and faded.

Secondary 1 broad and round.

Primary 9, if present, less than 200mm.

If primary 9 is missing, primary 10 is less than 160mm.

Yearling Female Adult P9 and Molting P8. This wing pattern is unusual.

25

Juvenile (Chick) Males

Primaries 10 and 9 and possibly 8 and 7 pointed.

Primaries new in appearance.

Secondary 1, if present, pointed.

Primary 9 greater than 190mm.

Primary 10 more than 160mm if juvenile primaries 8 and/or 7 present.

Chick Male Molting P7 (with Juvenile Secondary)

26

Juvenile (Chick) Males

Primaries 10 and 9 and possibly 8 and 7 pointed.

Primaries new in appearance.

Secondary 1, if present, pointed.

Primary 9 greater than 190mm.

Primary 10 more than 160mm if juvenile primaries 8 and/or 7 present.

Chick Male Molting P7 (without Juvenile Secondary)

27

Juvenile (Chick) Males

Primaries 10 and 9 and possibly 8 and 7 pointed.

Primaries new in appearance.

Secondary 1, if present, pointed.

Primary 9 greater than 190mm.

Primary 10 more than 160mm if juvenile primaries 8 and/or 7 present.

Chick Male Molting P6 (with Juvenile Secondary)

28

Juvenile (Chick) Females

Primaries 10 and 9 and possibly 8 and 7 pointed.

Primaries new in appearance.

Secondary 1, if present, pointed.

Primary 9 less than 190mm.

Primary 10 less than 160mm if juvenile primaries 8 and/or 7 present.

Chick Female Molting P9 (unusual) with Juvenile Secondary 1

29

Juvenile (Chick) Females

Primaries 10 and 9 and possibly 8 and 7 pointed.

Primaries new in appearance.

Secondary 1, if present, pointed.

Primary 9 less than 190mm.

Primary 10 less than 160mm if juvenile primaries 8 and/or 7 present.

Chick Female Molting P8

30

Juvenile (Chick) Females

Primaries 10 and 9 and possibly 8 and 7 pointed.

Primaries new in appearance.

Secondary 1, if present, pointed.

Primary 9 less than 190mm.

Primary 10 less than 160mm if juvenile primaries 8 and/or 7 present.

Chick Female Molting P7 (with Juvenile Secondary 1)

31

Juvenile (Chick) Females

Primaries 10 and 9 and possibly 8 and 7 pointed.

Primaries new in appearance.

Secondary 1, if present, pointed.

Primary 9 less than 190mm.

Primary 10 less than 160mm if juvenile primaries 8 and/or 7 present.

Chick Female Molting P6 (with Juvenile Secondary 1)

32