# Greater Sage-grouse Range-wide Population Monitoring Guidelines

## Part A: Standards for Collection and Reporting Greater Sage-grouse Lek Count Data

*A Product of the* **Western Agencies Sage and Columbian Sharp-tailed Grouse Technical Committee**

*Sponsored by the* **Western Association of Fish and Wildlife Agencies**

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Note: This is a revised version of this document released to correct a typographical error in the definition of an “active” lek on page 15.

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# Introduction

Counts of displaying males on leks have been the primary method to monitor sage-grouse (greater sage-grouse, *Centrocercus urophasianus*, and Gunnison sage-grouse, *C. minimus*) since scientific investigations of these species began, with the first lek counts recorded in the 1940s (Batterson and Morse 1948, Patterson 1952, Connelly and Schroeder 2007, Johnson and Rowland 2007). Sage-grouse leks are monitored for multiple reasons, to: 1) estimate the trend and potentially the size of sage-grouse breeding populations; 2) determine the location and conservation importance of populations to minimize disturbance and assist in siting of conservation actions; 3) determine whether specific population segments can sustain harvest and help designate season length and bag limits; and 4) inform species distribution models and help guide research. The location, occupancy and/or activity status of sage-grouse leks are commonly used in management and regulatory frameworks as indicators of sage-grouse habitat. Habitat management categories, used to regulate human activity or to direct habitat conservation and management actions, are delineated in part by lek location and density. Simple distance buffers also are placed around leks, within which certain disturbance activities are discouraged, restricted or excluded to conserve the associated nesting habitat (Coates et al. 2013, Manier et al. 2014).

Lek data and their application to estimate population trends or size have become increasingly important in recent years to support management actions identified in state sage-grouse and federal land-use plans, increasing the resilience of those plans to continued legal scrutiny. In addition to informing direct species management (e.g. hunting quotas), most western states use population information generated from lek count data for adaptive purposes. For example, population "triggers" have been incorporated into recent Bureau of Land Management (BLM) and U.S. Forest Service (FS) land use plans, which when "tripped" may result in habitat management changes. Federal agencies are also developing adaptive management frameworks that rely on sage-grouse lek counts to evaluate effectiveness of conservation measures over time. Therefore, accurately estimating sage-grouse population trends and size is important to inform management actions and outcomes, and conservation goals. Recent research confirms that lek counts are correlated with changes in sage-grouse population size validating their use as a population monitoring tool (Doherty et al. 2010, Fedy and Aldridge 2011, Fedy and Doherty 2011, Garton et al. 2011, Blomberg et al. 2013, Coates et al. 2016, Dahlgren et al. 2016, McCaffery et al. 2016, Monroe et al. 2016, Coates et al. 2021).

Male greater sage-grouse congregate in the spring at traditional locations, specifically known as strutting grounds, and generally referred to as leks, to perform their strutting display and breed with females. Previous guidelines for counting leks (Autenrieth et al. 1982, updated by Connelly et al. 2003) identified data collection methodology and how to use the resulting count data as an index of population abundance. Statistical techniques can account for the multiple sources of potential bias in lek counts, obtaining the most accurate estimates of sage-grouse population trends and size (Johnson et al. 2007, Coates et al. 2014, Davis et al. 2014, McCaffery and Lukacs 2016, McCaffery et al. 2016). These sources of bias include variable lek attendance by males, imperfect detection probability, inter-lek movements, variation in observer error, unidentified leks, and variable sex ratios (see this document, Part B. In prep). Differential efforts in monitoring leks with few, intermittent (high interannual

**Figure 1.** Wyoming Game and Fish Department biologist Nyssa Whitford conducting a visual count of a sage-grouse lek. Photo: Tom Christiansen.

variability in activity), or no sage-grouse males challenge consistency in lek count procedures. Existing lek count guidelines and sampling frameworks do not address these differences and biases, and therefore may affect accurate estimation of population size and trends. Therefore, updated sage-grouse lek count data collection and data storage protocols are needed.

The use of sage-grouse lek locations has also taken on increased significance as many states have implemented mandatory mitigation programs. States and federal agencies have categorized sage-grouse habitats (e.g., priority habitats) to help inform management plans, and identify lek buffers and other development restrictions surrounding leks. Therefore, consistent guidelines that transcend political boundaries and management plans are necessary to ensure that sage-grouse throughout their range are identified and counted in a comparable manner to provide consistent management applications, and to consistently estimate population trends and size at various spatial scales across the range of the species.

## Purpose and Need

States have identified a need to revise sage-grouse monitoring guidelines to fulfill the data requirements of recent statistical population models and that are consistent across political boundaries. The revisions described herein will ensure male counts provide accurate estimates of population trends and size at various spatial scales across the range of the species, and support consistent management decisions. These revisions will also improve consistency for the collection, storage, and use of lek data, thereby improving the analyses of population change and management. These guidelines are in two parts, Part A (Standards for Collection and Reporting Greater Sage-grouse Lek Count Data) and Part B (Sample Design and Data Analysis). We recognize that each state may have different lek reference and status definitions than those used here. However, the definitions in this document will allow each state to report their data in a common format and communicate using common definitions.

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Specific objectives of Part A are to:

- Provide updated lek monitoring guidelines, including definitions of lek dynamics and status;
- Provide updated basic field protocols for counting leks on the ground or from the air;
- Provide recommendations regarding minimums for data collection and reporting.

Specific objectives of Part B are to:

- Review basic sample strategies, data collection, and the various methodologies used to collect samples;
- Review various population trend and size analysis techniques, the data requirements for each, and methods that account for biases associated with lek counts;
- Provide recommendations for research needed to improve analyses of sage-grouse population trends and size.

# Lek Count Standards

Visiting and counting all leks (See Appendix 1 f or definition of lek and related terms) each spring is the ideal protocol, and currently, states with lower numbers of leks attempt to do so (e.g., California, Colorado, North Dakota, South Dakota, Utah, and Washington). Visiting every lek annually in states with larger numbers of leks is impractical, and those states generally count a sample of leks and monitor others for presence/absence. For example, many states count a set group of leks annually (e.g., trend routes or lek routes), while others might be counted on a random assignment or opportunistic basis. Several sources of bias or error can exist in lek count data, including:

- Detectability or sightability of males on leks
- Male lek attendance rates (temporally, daily, seasonally, or annually)
- Inter-lek movements by males leading to double counting or undercounting
- Variation among observers

- Variation among survey methods (e.g., ground observer versus aerial infrared versus drone)
- Inconsistent sample effort or sample design
- Non random selection of leks visited each year
- Male to female sex ratio is unknown and/or varies annually
- Incorrect identification of male, female or unknown birds
- Influence of unknown and uncounted leks

These sources of error can affect the precision and/or accuracy of statistical trend or population size estimation. Statistical techniques can be employed to account for some of these errors, but many traditional approaches to collecting lek data may lack attributes to inform these calculations. The following protocols incorporate data needs to allow for corrective statistical techniques, thereby improving lek trend and population size estimation precision and/or accuracy. Detailed information on how these data will be used can be found in Part B (Sample Design and Data Analysis).

## Field Protocols for Lek Counts and Presence-Absence Checks

Dependent on capacity, all active leks should have a count, presence-absence check, or be part of a sampling grid, following appropriate protocols. Lek and conservation status definitions are provided in Appendix I. These definitions provide the basis for determining a common language for management status. However, lek status is inherently recorded within, and derived from lek count data.

Lek visits are categorized based on their objective (Autenrieth et al. 1982; Connelly et al. 2000, Connelly et al. 2003):

- **Lek counts** are early morning counts of the number of males attending a lek. They can be conducted either on the ground or aerially and generally occur from 2-3 weeks before to 2-3 weeks after the peak of hen attendance.
- **Presence-Absence Check** denotes when an observer visits a lek, either on the ground or via aircraft, outside the morning count period or other count parameter, to determine whether leks are active or inactive via presence of birds or sign (e.g., presence of feathers or caecal droppings, sound from an inaccessible lek). Presence-absence checks do not typically obtain a count of males attending that lek.

Both lek counts and presence-absence checks can be informative to sage-grouse management, however only lek counts can be used to assess sage-grouse population trends and size. Presence-absence checks assign activity and management status classifications, and inform future sampling design decisions. Ground-based efforts are the primary method for counting leks; however, counts may be conducted using any monitoring method where detection probabilities are documented or have detection probabilities demonstrated to be equal to or superior to that of ground counts (e.g., aerial infrared counts of known locations). Methods with a lower detection rate than ground counts, for which the detection rate is known, may be used in the same analytical framework after correcting for those lower rates. An area-based sampling scheme, where the entire range of sage-grouse in the area of interest is gridded using a standard geometric tessellation (division into hexagons, squares, etc.) and all known leks

**Figure 2.** Greater sage-grouse male displaying amongst hens on a Utah lek. Photo: Scott Root UDWR.

**Figure 3.** Greater sage-grouse tracks in Smith Creek Valley, Nevada indicating presence of sage-grouse. Photo: Shawn Espinosa, NDOW.

are counted within grid cells selected for sampling, can result in unbiased estimates at a specified degree of precision. Searches may also be conducted to find previously undetected leks. If new leks are found, managers will need to determine whether lek counts or presence-absence checks will be appropriate for future efforts, as defined by the management objectives for that area.

## Ground Protocol

The following protocol is recommended regardless of the objective of a lek visit. This basic protocol should also be followed when searching for new leks or conducting area-based sampling.

- Season—generally early-March to mid-May, depending on elevation and persistence of winter weather. The ideal timing is during a four-week period starting with the peak of hen attendance on leks, which is often variable among years and locations.
- Visits – Leks should be counted on a minimum of 3 days per season at 7 to 14-day intervals unless alternate sampling strategies are being used (see part B)
- Time of day—30 minutes before to 90 minutes after sunrise.
- Weather—Ideal conditions are clear to partly cloudy skies, little to no wind (<15 kilometers per hour [kph]), and no precipitation. If weather conditions preclude normal display activities, additional counts may be needed.
- Disturbance—If disturbance due to humans, livestock, predators, other wildlife, etc. preclude normal display activities, additional counts may be needed.

## Lek Location

Lek location should be recorded as a point location at the activity center of a lek. If a lek's activity center moves far enough away from a previous location, where detection and observation would be hindered then the location should be recorded to reflect the new activity center. We recommend that no change should be made for distances less than 200 meters. Lek name should remain consistent through time for shifting locations. Frequently shifting activity centers, or multiple activity centers may be recorded as sub-leks by the state agencies, with lek location reported as a point best representing the activity centers. Some consideration should be given to the consistency of the change in activity such as whether the change is consistent over the course of the season or over the course of subsequent years. If the location is adjusted, records of prior locations should be retained by the state agency. If a polygon is recorded by a state to document lek location a centroid should be used for range-wide database reporting.

## Lek Counts

Lek counts from the ground are conducted by trained observers from a vehicle, from a concealed observation point or from a distance that precludes disturbance. Observers should use a spotting scope or binoculars. Observers should attempt counts when protocol conditions (described above) are met, but counts outside of protocol conditions may also be recorded along with weather and time covariates. Multiple leks can be counted in a single morning if count protocol conditions can be met.

1. Locate a spot (or spots if an exceptionally large lek, or leks with limited visibility) close enough to provide good visibility of the entire lek yet far enough away to not disturb birds based on observer presence (typically more than 100 meters).
2. Record weather conditions and time at the start of the count.
3. Count the birds from left to right, or right to left. Switch pattern on subsequent counts during the morning.
4. Record the observation time and number of males, females, and unknown sex sage-grouse separately.
5. Continue to observe leks for signs of birds/movement, wait at least 2 minutes, then count again and record the

**Figure 4.** Greater sage-grouse on a lek in Utah. Photo: UDWR

observation time and the number of males, females, and unknown sex sage-grouse separately. (Count objectives may impact number of and duration between counts, see part B).

6. Repeat a third time. If male counts have increased on both the second and third count, conduct a fourth count.
7. Document disturbances such as predators, livestock, feral or wild horses and burros, etc. that may have impacted the count.
8. Count data can be recorded electronically in the field to minimize transcription and other errors, improve error checking, and speed up access to data.

## Presence-Absence Check

Ground checks for lek activity are conducted by trained observers and typically occur after most males have stopped attending the lek for the day or following the end of the prescribed lek counting period (typically early to mid-May). A presence-absence check records presence or absence of sage-grouse use of a lek area when a count cannot be obtained.

1. Observers should approach the lek location while scanning for male sage-grouse. If sage-grouse are present, a count using the lek count protocol can be collected.
2. If no male sage-grouse are present, observers should continue to the recorded lek point and examine the ground for recent sage-grouse sign, such as pellets (Appendix III), feathers, or tracks.
3. If fresh sign is found, observers should return to the lek in subsequent days to obtain a count. This reduces errors that may occur as the result of difficulty in distinguishing between pellets on leks and other types of locations (Appendix III).
4. If no sign is initially found at the recorded lek location, the observer should walk in widening circles around the point and scan the ground for sign.
5. Observers should collect data regarding the date and time of checks, general or specific location of fresh sign (see Appendix III, Figure 6), weather conditions, and any other environmental data recorded for a count.

## Aerial Protocol

Many states use aircraft to access known leks in remote areas or to search for new leks. However, methods using fixed-wing aircraft with a biologist observer(s) no longer meet current standards for lek counts due to low detection rates relative to other methods, the propensity to flush birds well in advance of the aircrafts approach, and difficulty in determining sex. Current aerial counts are conducted with experienced observers in helicopters or fixed-wing airplanes using aerial infrared camera technology. Season, time of day, and weather protocols used during ground-based counts should be followed for aerial counts.

For new lek searches, transects should be flown along parallel transects at 500 m to 1 km intervals in a north to south direction, and observed in succession from east to west. This transect layout allows observers to take advantage of the best light conditions as strutting males are highly visible during early morning hours when the sun illuminates their white chests. Transect intervals can be modified based on habitat suitability, weather conditions and objectives. Aerial counts can be conducted by flying lek to lek. This method may be useful in isolated areas, areas inaccessible by ground vehicles (due to snow

or mud), for small populations where most leks are known, or in areas that are flown annually.

Careful pre-flight planning is essential for effective and efficient counts. Flight transects and known leks should be plotted in advance so these data can be made available to the pilot and observers. As with the ground protocol, flying should be avoided in inclement weather where surface winds are expected to exceed 15 kph and precipitation is forecasted. Times where patchy fog or a low cloud ceiling is forecasted should be avoided for safety and sightability reasons. For helicopters, flight speeds should be about 90 kph at about 30 meters above ground level (AGL).

The following is recommended for helicopter counts:

- Passive Observation: Ideally, when counting birds from an aircraft, observers should obtain a count by hovering far away from the lek so as not to flush the birds off the lek. If the first count is deemed inadequate or birds flush prior to completing the count, a second count can be made by flying closer to the lek and counting the birds as they flush. However, flushing should be avoided if possible.
- Flush Counts: If birds flush prior to the first count, every attempt should be made to count them as they flush. Closing the distance to flushing birds may aid in obtaining an accurate count.
- Although it is difficult to get an accurate count of flushing birds from an aircraft, it is usually possible to classify the number of birds observed into groups (e.g., 1-10, 11-20, etc.).
- Record whether or not you observed displaying birds or if birds were only flushed. If possible, record the number of displaying males observed and the total birds flushed (i.e., unable to distinguish sexes).

Any potential new leks should be verified on the ground whenever possible. Similarly, leks that were inactive during one aerial count should be rechecked on a different flight day or a ground visit to determine lek status.

## Aerial Infrared Protocol

Aerial infrared imagery can be used to search for new leks and to count 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 count attending males relative to previous aerial techniques, in addition to improving the ability of observers to distinguish males and females. Basic

**Figure 5.** Aircraft used for aerial infrared lek searches and lek counts. Photo: Owyhee Air Research

protocols for aerial counts, season, weather, and time of day apply for counts using infrared technology. For detailed sample design and sightability correction see part B.

## Drone Protocol

To date, the use of drones for counting 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. Counts 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 drones. Requirements for minimum altitude will vary by the imaging system carried aboard the drone; however, based on Hanson et al. (2014) and Thompson (2018), drones should remain 60 m AGL to minimize behavioral responses that could impact lek counts, including cessation of lekking behavior or flushing. Operators should consider greater altitudes for counts if the drone model in use exceeds 60 decibels (dB) in associated noise (Hodgson et al. 2016). Drones should be launched at least 200 m from the near edge of the lek, and from behind visual obstruction to obscure drone operators from lekking birds (Thompson 2018), or far enough to not disturb birds but still provide an unobstructed line of sight to the drone over the lek (Hanson et al. 2014). Drones should be equipped with thermal infrared cameras as sage-grouse are more visible in the infrared spectrum (Gillette et al. 2013, Hanson et al. 2014). Flight patterns will vary with nadir and forward-looking (flyover) or side-looking camera positions (orbit).

Drones 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 drones to count single or small groups of leks. The same protocol used during ground-based counts for season, time of day, and weather should be followed for drone-based counts. As large drones become more useful and available, general protocols for lek counts should be followed.

# Data Collection and Storage

Most state wildlife agencies use paper forms to record lek data, which are later transcribed into electronic databases, usually by someone other than the person who collected the data (WAFWA, unpublished survey results). Using paper forms creates the potential for lost or misplaced data, may introduce transcription errors, precludes real-time error checking, and delays analysis of lek count data. Several mobile applications (e.g., Survey123 for ArcGIS© and Cyber Tracker) have been developed for real-time digital entry of lek data using smartphones, tablets, or field computers. Such applications also have the advantage of automatically recording date and time of the count, geographic location, and potentially other parameters (such as temperature) that may be used when modeling attendance rates or detectability.

Several approaches to electronic storage and retrieval of lek count data are in use across the West. Traditionally, most states used databases or spreadsheets that stored peak male counts only in a wide format, with a row for each lek and a column for each year containing a high count. Peak-count databases are problematic in that they do not accommodate multiple counts per lek in a year, and they typically create a cell for every lek in the database every year regardless of lek activity. Within peak male databases, a blank cell typically means that lek was not counted that year, but this needs to be clearly defined to prevent confusion and errors in analyses. Additionally, some population estimation techniques require replicate count data (see Part B); formatting and storage for replicate counts are best accommodated in long format (one row per lek visit). Recent work by USGS has highlighted the need for consistent range-wide reporting, and these guidelines adopt some definitions from that work (Coates et al. 2021, O'Donnell et al. 2021).

Analyses of lek count data should utilize corrections for male attendance and male detectability. Therefore, it is important to collect and record those data needed as covariates. Lek databases should minimally include data of multiple counts within a season and ideally multiple counts within a day for number of males, females, and unknown sex grouse. Weather conditions (e.g., air temperature, wind speed, precipitation and cloud cover) should also be recorded. See Appendix II for suggested data reporting schema.

# Appendix I: Definitions

The following lek and lek status definitions are recommended as a common cross-boundary means to communicate about and qualify data, particularly for range-wide analyses. Lek status definitions correspond to definitions used in range-wide analysis (Coates et al. 2021, O'Donnell et al. 2021). We recognize that each state may have different lek reference and status definitions than those used here. However, the definitions here should allow each state to report their data in a common format. For example, a state may use different qualifiers to distinguish an active lek from an inactive lek, but should be able to query their data to fit the WAFWA definitions, as needed. However, greater uniformity in definitions would improve the rigor of range-wide scale analyses and associated management recommendations.

## Lek Reporting Definitions

| Term | WAFWA Definition |
|---|---|
| Lek | A lek is a traditional location where at least 2 male greater sage-grouse congregate during at least 2 springs within a 10-year period to perform their strutting display and opportunistically breed with females. Although males are territorial on leks and occupy an area, not a point, the representative location for the lek is the estimated or calculated center of the display activity. The 'lek' is the standard reporting and analysis unit for evaluating population status and long-term trends. Because males may alter their display locations within and between years (for numerous possible reasons), these multiple locations 'within' the lek have been referred to as "sub-leks", "satellite leks", "alternative leks", or "temporary leks". The location provided for the overall 'lek' should represent the dominant, largest, and/or most recent annual activity center. The lek identifier is the critical piece of data to remain consistent over time, the location can shift over time. |
| Sub-lek | A sub-lek is similar to a lek in most respects, except that its location represents an actual activity center for a specific year or series of years while a lek can represent multiple sub-leks over an extended number of years. Sub-leks are generally ≤¼ the average inter-lek distance from other sub-leks included within the same lek. In relatively static situations, there may be only one sub-lek within a lek. The sub-lek is not used to evaluate population status and long-term trends and is not included in the data reporting schema (Appendix II), but may be used to examine breeding behavior, habitat use, or other aspects of natural history. |
| Undetermined Lek | A location where male sage-grouse are displaying that has not been documented in multiple years, and does not meet the definition of a lek. Sage-grouse may spontaneously display in an alternate location that is not maintained through time; therefore, any undetermined leks should be verified in subsequent breeding seasons. |

## Status Definitions

| Term | WAFWA Definition | Previous Terms |
|---|---|---|
| Active | A lek that has 2 or more males counted during two or more years within the last 10 years. | |
| Inactive | A lek at which all observations within the last 10 years have been less than 2 males and that has had at least 2 males recorded during a lek count between 11 to 20 years ago. | |
| Historical | A lek at which all observations within the last 20 years have been less than 2 males, but previously met the definition of a lek. | Historic (Coates et al. 2021) |
| Pending Active | A lek with one observation of at least 2 males in the last 10 years and at least one observation of at least 2 males more than 10 years ago. This status captures leks insufficiently monitored to classify as Active, Inactive, or Historical but contains a more recent observation than Pending Historical. | Pending New (Coates et al. 2021) |
| Pending Historical | A lek with insufficient observations in the last 10 years to classify as Active, Inactive, Historical, or Pending Active. This requires one observation of at least 2 males recorded 11 to 20 years ago and at least one observation of at least 2 males more than 20 years ago. | Pending Old (Coates et al. 2021) |

## Outmoded Definitions

These definitions are not used in range wide reporting, but are often used in state plans and included here to help reduce confusion between range-wide reporting definitions and definitions used in individual state plans.

| Term | Definition |
|---|---|
| Satellite Lek<br>Alternative lek<br>Temporary Lek | See Sub-lek |
| Lek complex | 1. A grouping of leks that likely have frequent movement of individuals between leks.<br>2. A single lek recorded in multiple locations in multiple years in relatively close proximity. |
| Lek route | A logistical group of leks that are counted together on the same morning, often by the same observer(s). |

# Appendix II:
# Data Reporting Schema

We recommend that states or provinces include fields in their lek database that *allow the following to be exported* when reporting data. Some states or provinces may use a different unit or standard, but units should be converted to a common unit, as needed, for range-wide analyses (e.g., convert °F to °C). Collection and storage of the recommended data are needed for many of the population trend and size analyses discussed in Part B.

| Field | Data Type | Unit/ Standard | Domain Values | Note |
|---|---|---|---|---|
| State or Province | Text (2 Character) | Postal two letter | WA, OR, CA, ID, NV, UT, MT, WY, CO, ND, SD, AB, SK | |
| Lek Name | Text (256 Character) | Plain Text (utf8) without special characters | NA | Only report established leks. (>=2 males in >= 2 years) |
| Lek ID | Text (256 Character) | Plain Text (utf8) without special characters | NA | Report if Lek ID is different from lek name. |
| Latitude | Numeric (Float) | DD, WGS 84 | NA | Report lek centroid, not observer location. |
| Longitude | Numeric (Float) | DD, WGS 84 | NA | |
| Date | Numeric (Long Integer) | YYYYMMDD | NA | |
| Time | Numeric (Short Integer) | 24H HHMM | NA | Time at which the individual count was completed for within day counts. Time of peak count for daily high count. When no birds are seen record arrival time. Report in local time. |
| Count Method | Text (Not Limited to Domains) | Categorical, Plain Text (utf8) without special characters | ground count (undisturbed), ground count (flushed), presence -absence check, aerial helicopter, aerial fixed-wing, aerial infrared, aerial drone | May be additional types. |
| Count Type | Text (Limit to Domains) | Categorical | Within Day Repeated, Daily High, Season High | May be additional types. |
| Air Temperature | Numeric (Short Integer) | Celsius | NA | |
| Snow Ground Cover | Numeric (Short Integer) | Percent | constrain to 0-100 | |

| Field | Data Type | Unit/ Standard | Domain Values | Note |
|---|---|---|---|---|
| Wind Speed | Numeric (Short Integer) | Beaufort Scale | 0 (Calm - Smoke rises vertically. <1 mph), 1 (Light Air - Direction shown by smoke drift but not by wind vanes. 1-3 mph), 2 (Light Breeze - Wind felt on face, leaves rustle. 4-7 mph), 3 (Gentle Breeze - Leaves and small twigs in motion. 8-12 mph.), 4 (Moderate Breeze - Raises dust and loose paper, small branches moved. 13-18 mph), 5 (Fresh Breeze - Small trees in leaf begin to sway. 19-24 mph.), 6 (Strong Breeze - Large branches in motion, whistling heard in power lines. 25-31 mph), 7 (High Wind - Whole trees in motion, inconvenience felt when walking against the wind. 32-38 mph), 8 (Fresh Gale - Twigs break off trees, impedes progress. 39-46 mph), 9 (Strong Gale - Slight structural damage. 47-54 mph), 10 (Storm - Seldom experienced inland, trees uprooted. 55-63 mph), 11 (Violent Storm - Rarely experienced, widespread damage. 64-72 mph), 12 (Hurricane Force - Devastation. >73 mph) | |
| Precipitation | Text (256 Character) | Categorical, Plain Text (utf8) without special characters | None, Light Rain, Moderate Rain, Heavy Rain, Light Snow, Moderate Snow, Heavy Snow, Light Sleet, Moderate Sleet, Heavy Sleet, Thunder Showers, Hail | May be additional types. |
| Cloud Cover | Text | Integer or Range | | Text to accommodate states/provinces that collect in predefined ranges |
| Males | Numeric (Short Integer) | Integer | NA | Number of sage-grouse counted |
| Females | Numeric (Short Integer) | Integer | NA | |
| Unknown | Numeric (Short Integer) | Integer | NA | |
| Sign | Text (Limit to Domains) | Categorical | Yes (Feather), Yes (Dropping), Yes (Other), No | Only applicable to Presence Absence Check. Should also include descriptive comments. |
| Potential Disturbance | Text (Limit to Domains) | Categorical | No, Yes (Coyote), Yes (Avian Predator), Yes (Livestock), Yes (Wild Ungulate), Yes (Human - Ground), Yes (Human - Aerial), Yes (Other) | Flag in cases of potential disturbance. Should also include comment. |
| Count Quality | Text (Limit to Domains) | Categorical | Accurate, Suspect, Likely Inaccurate | Document confidence in count accuracy. E.g. Disturbance after a count is complete will still yield an accurate count. |
| Comment | Text (256 Character) | Plain Text (utf8) without special characters | NA | |

# Appendix III: Sage-grouse Droppings Identification and Age

Sage-grouse defecate regularly throughout the day and night, and as a result, the number of droppings (pellets) is roughly correlated with the amount of time they spend in a particular area (Schroeder et al. 2020). Consequently, if a lek is active, sage-grouse droppings should be present. Fortunately, sage-grouse droppings are relatively simple to identify.

Fecal pellets are by far the most common type of dropping and reflect the recent food consumption. These pellets tend to be relatively dry, 2-3 cm long, slightly curved, and have the shape of an untapered cylinder (Fig. 1). The pellet size can vary by age and sex of the bird (adult males are largest), and the shape can also vary slightly (pellets of adult males tend to be less curved). Appearance also varies depending on the type of food consumed (Fig. 2). Sage-grouse fecal pellets are distinguishable from other animals that inhabit sagebrush ecosystems, including mule deer, jackrabbits, gray partridge, and sharp-tailed grouse (Fig.3). Although sharp-tailed grouse have fecal pellets similar in length and overall appearance, their

**Figure 1.** Typical sage-grouse pellets illustrating the size, slight curve, and untapered cylinder. These droppings contained sagebrush leaves, and when broken, they have a faint smell of sagebrush. Quarter for scale (23.5 mm diameter).

**Figure 2.** These droppings were deposited by breeding-aged male sage-grouse. They do not have as much of a curved appearance as those shown in Fig. 1. The pellets on the left were made by a bird consuming canola, and the pellets on the right were made by a bird consuming wheat (neither is typical for sage-grouse). Despite the slight differences in appearance, these droppings are unlikely to be confused with other species in the area.


**Figure 3.** Appearance of droppings, other than sage-grouse, in habitats where sage-grouse are typically found.

droppings are smaller in diameter. Roosting and loafing sites may have numerous pellets in a pile, reflecting the length of time spent at each site. In contrast, feeding and display locations may have scattered single droppings. Because sage-grouse often spend the night on leks, it is not unusual to have a mixture of pellet piles and single pellets. Although a damp fecal pellet is easily identifiable as fresh, dry pellets can be more difficult. A relatively fresh pellet broken in half should be noticeably darker green on the inside than the outside (Fig. 4); there may be negligible differences with a pellet several months old.

A second type of sage-grouse dropping is a caecal dropping (Fig. 5). Caecal droppings are created when the contents of the caeca are emptied. Caecal droppings are generally dark green or brown when fresh and extremely wet. When caecal droppings dry, they usually look like a 10-20 $cm^2$ spot of black tar. Because caecal droppings are usually deposited in the morning, they are common on lek sites. For example, a group of caecal droppings in close proximity to each other may represent a flock of females.

**Figure 4.** Pellets that are relatively fresh (dry, but from the most recent winter) tend to be faded on the outside but darker green on the inside.

**Figure 5.** Caecal droppings tend to be dark green or brown when fresh (left) or black when older (right). When completely dry, they often look like a small pool of black tar.

**Figure 6.** An example of fresh pellets and caecal dropping at a lek site in western Nevada within the Bi-State Distinct Population Segment.

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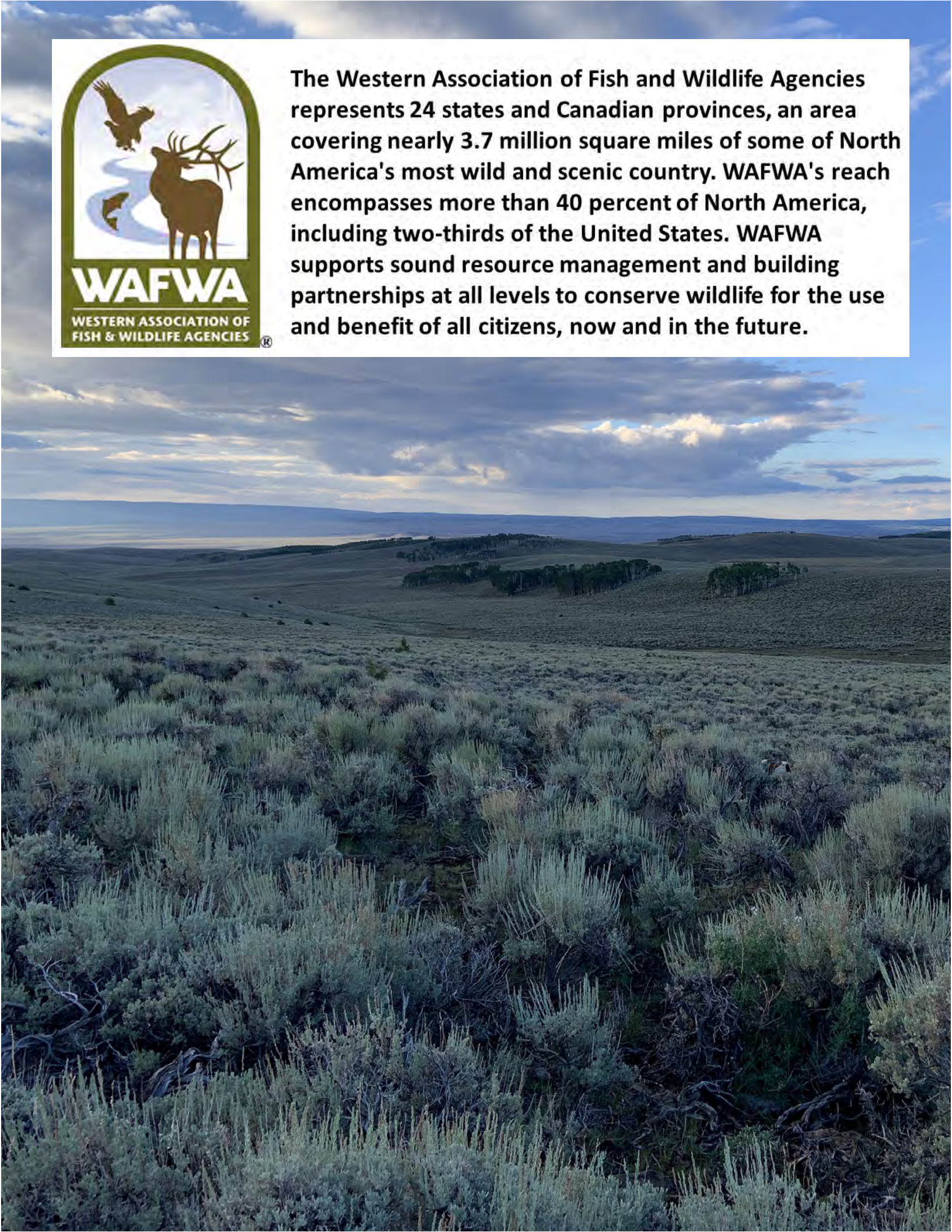

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