Statewide

Sage-Grouse
Job Completion Report
2016

June 2016-May 2017

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Wyoming Sage-Grouse Job Completion Report

Conservation Plan Area: **Statewide Summary**
Period Covered: **6/1/2016– 5/31/2017**
Prepared by: **Tom Christiansen – Sage-grouse Program Coordinator**

INTRODUCTION

Wyoming is home to more greater sage-grouse than any other state. About 38% of the rangewide sage-grouse population lives in Wyoming and 90% of estimated historic habitat in Wyoming is still occupied by the bird. There are over 1,800 known occupied sage-grouse leks in Wyoming. Department personnel and others surveyed 89% of these leks in the spring of 2017. Results of the survey indicate 1,190 leks were confirmed active, 301 confirmed inactive, and 139 unknown or unchecked. The average number of males observed on leks was 32/active lek, 11 percent fewer than the 36/active lek observed in the spring of 2016, suggesting a population decrease. However this figure is substantially higher than the low of 13/active lek reported in 1996.

Management of greater sage-grouse habitat in Wyoming is based on a "core area" strategy of limiting human disturbance in the most important sage-grouse habitats. This strategy is codified by a Governor's executive order. The current Executive Order (2015-4) was signed by Governor Matt Mead in July of 2015. The Executive Order and related materials are available at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management. The Core Areas are shown in Figure 1.

In 2015 the U.S. Fish and Wildlife Service issued a decision of "not warranted" for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. This means the State of Wyoming maintains management authority over sage-grouse in Wyoming and management emphasis focuses on implementation of the core area strategy. In its decision document, the Service specifically cited Wyoming's core area strategy as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude the need for a future listing. The Service plans to re-examine the issue in 2020 to ensure planned conservation efforts are implemented and the status of the species remains unwarranted for listing. Federal land use planning documents are largely consistent with the Wyoming strategy. However, the new federal administration has signaled its intent to review of all federal sage-grouse management plans. The implications of this review are not yet known.

The 2016 Legislature approved the 2017-2018 biennium General Fund budget which again included funding for the sage-grouse program. Allocation of over $1 million of these funds by the state's 8 local sage-grouse working groups (LWGs) (Figure 2) to local projects began in mid-2016. However, the 2017 legislature returned budget responsibility of the sage-grouse program back to the Department due to state budget shortfalls. This action shifted the funding burden from the state as a whole, based largely on mineral severance taxes, to hunters and anglers, the primary funding source of the WGFD. A hunting license fee increase specifically crafted to replace legislative funding was approved by the legislature and LWGs will maintain their existing role in recommending how funds will be allocated.

Wyoming hosted the 30th WAFWA Sage and Columbian Sharp-tailed Grouse Workshop in Lander in June 2016 which was attended by 193 grouse managers, researchers, and advocates.

The 2017 state legislature passed a billing allowing private bird farm operations to collect sage-grouse eggs from the wild for purposes of establishing a captive flock. The Department and Commission are therefore required to develop regulations to permit this activity.

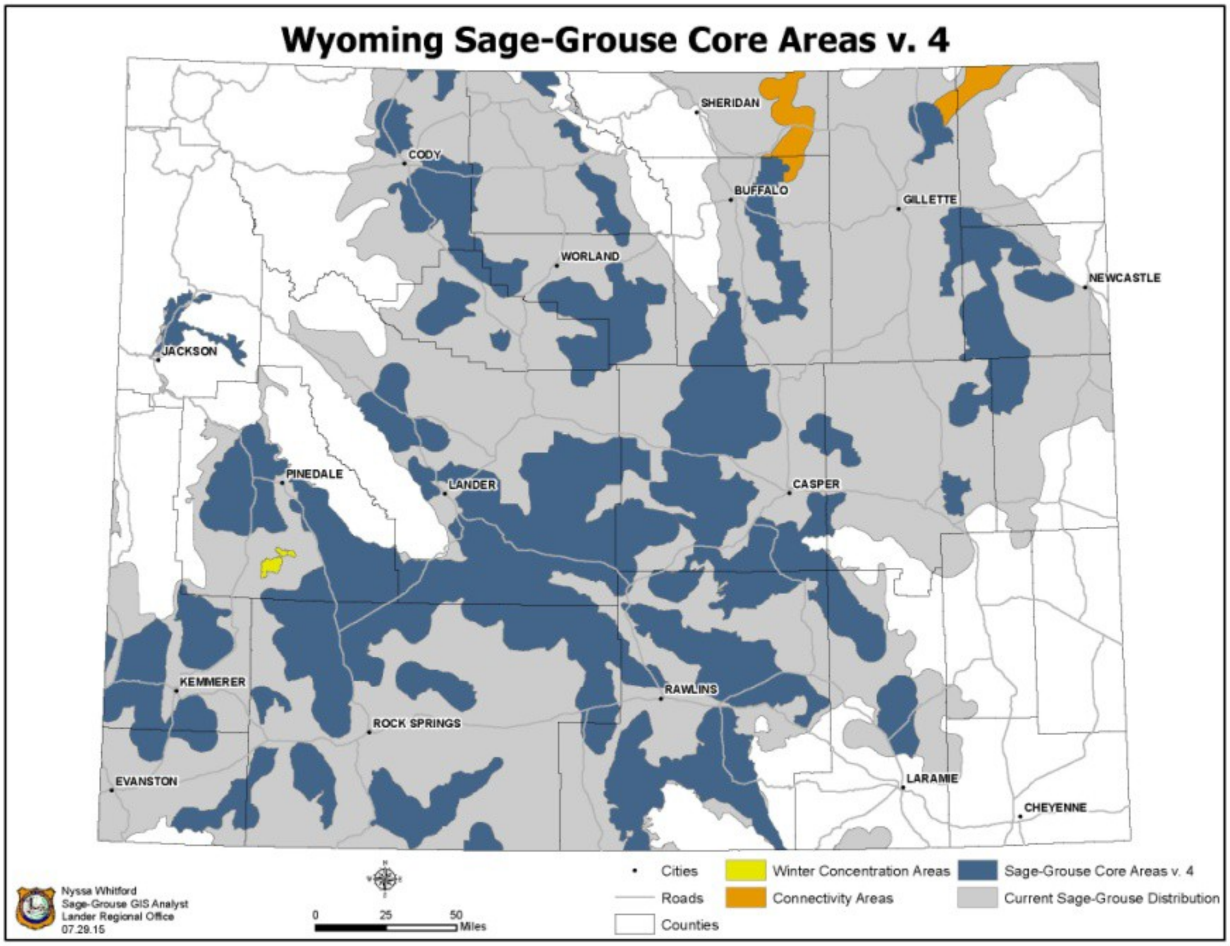


Figure 1. Wyoming Core Areas (version 4).

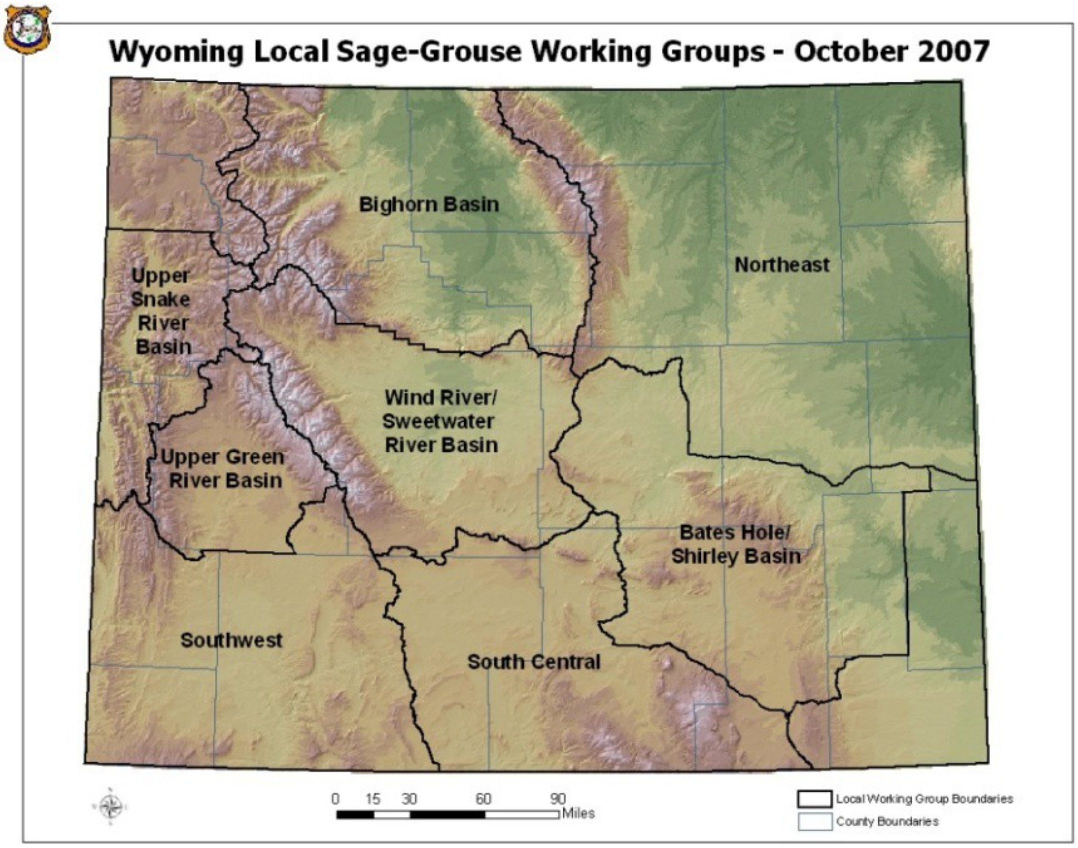


Figure 2. Wyoming Local sage-grouse working group boundaries.

BACKGROUND

The greater sage-grouse is the largest species of grouse in North America and is second in size only to the wild turkey among all North American game birds. It is appropriately named due to its year-round dependence on sagebrush for both food and cover. Insects and forbs also play an important role in the diet during spring and summer and are critical to the survival of chicks. In general, the sage-grouse is a mobile species, capable of movements greater than 50 km between seasonal ranges. Radio telemetry studies conducted in Wyoming have demonstrated that individuals or sub-populations within most sage-grouse populations in the state are migratory to varying extent. Despite this mobility, sage-grouse appear to display substantial amounts of fidelity to seasonal ranges. Sage-grouse populations are characterized by relatively low productivity and high survival. This strategy is contrary to other game birds such as pheasants that exhibit high productivity and low annual survival. These differences in life history strategy have consequences for harvest and habitat management.

Greater sage-grouse once occupied parts of 12 states within the western United States and 3 Canadian provinces (Figure 3). Populations of greater sage-grouse have undergone long-term population declines. The sagebrush habitats on which sage-grouse depend have experienced extensive alteration and loss. Consequently, concerns rose for the conservation and management of greater sage-grouse and their habitats resulting in petitions to list greater sage-grouse under the Endangered Species Act (see following ESA Status section). Due to the significance of this species in Wyoming, meaningful data collection, analysis and management is necessary whether or not the species is a federally listed species.

Sage-grouse are relatively common throughout Wyoming, especially southwest and central Wyoming, because sage-grouse habitat remains relatively intact compared to other states (Figures 3 and 4). However, available data sets and anecdotal accounts indicate long-term declines in Wyoming sage-grouse populations over the last six decades.

Past management of sage-grouse in Wyoming has included:

- Population monitoring via lek counts and surveys, harvest statistics, and data derived from wing collections from harvested birds. Lek counts and surveys have been conducted in Wyoming since 1949.
- The protection of lek sites and nesting habitat on BLM lands by restricting activities within ¼ mile of a sage-grouse lek and restricting the timing of activities within a 2-mile radius of leks. The Core Area Strategy (CAS – described below) has expanded and strengthened these protections in core areas.
- The authorization and enforcement of hunting regulations.
- Habitat manipulations, including water development.
- Conducting and/or permitting applied research.

Prior to 2004, Job Completion Reports (JCRs) for greater sage-grouse in Wyoming were completed at the WGFD Regional or management area level. In 2003, the WGF Commission approved the Wyoming Greater Sage-Grouse Conservation Plan (State Plan) and a Sage-Grouse Program Coordinator position was created within the WGFD. The State Plan directed local conservation planning efforts to commence. In order to support the conservation planning efforts, JCRs across the State changed from reporting by Wyoming Game & Fish Dept. regional boundaries to those of the eight planning area boundaries (Figure 2). The 2004 JCR reviewed and summarized prior years' data in order to provide a historical perspective since that document was the first statewide JCR in memory. Additionally, Patterson (1952) provides an invaluable reference for sage-grouse, not only in Wyoming, but across the range of the species.

Sage-grouse data collection and research efforts across Wyoming began to increase in the early 1990s due to the increasing concerns for sage-grouse populations and their habitats (Heath et al. 1996, 1997). Monitoring results suggest sage-grouse populations in Wyoming were at their lowest levels ever recorded in the mid-1990s. From 1996-2006 however, the average size of leks increased to levels not seen since the 1970s. From 2006-2013, average lek size declined though not to levels recorded in the mid-1990s. Average lek size increased 112% from 2013 to 2016 but declined 11% in 2017.

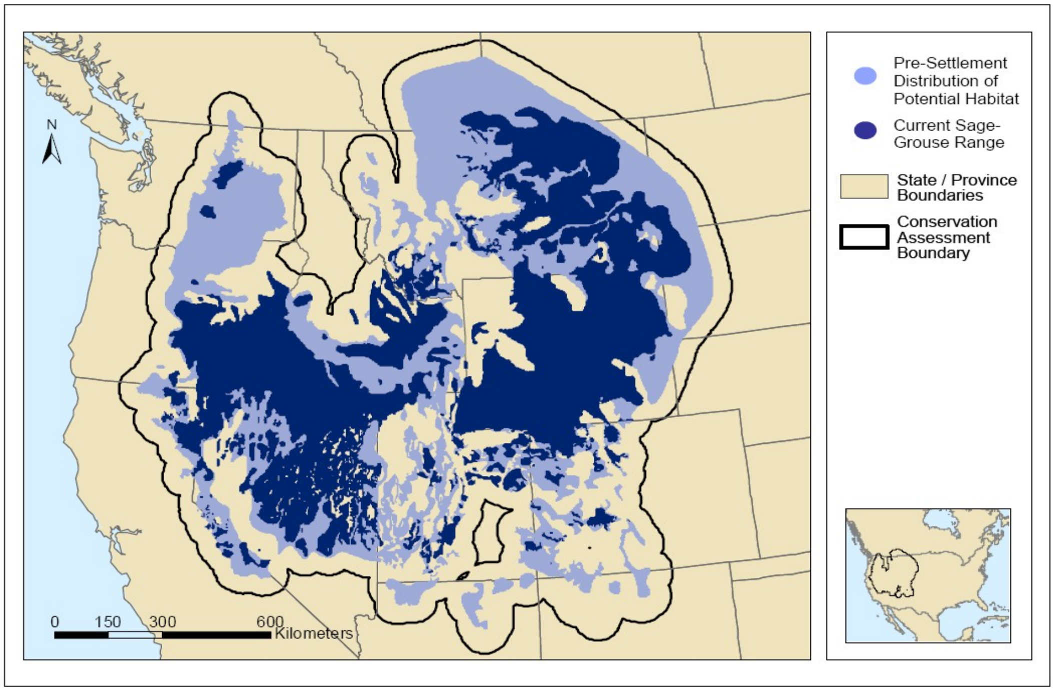


Figure 3. Current distribution of sage-grouse and pre-settlement distribution of potential habitat in North America (Schroeder 2004). For reference, Gunnison sage-grouse in SE Utah and SW Colorado are shown.

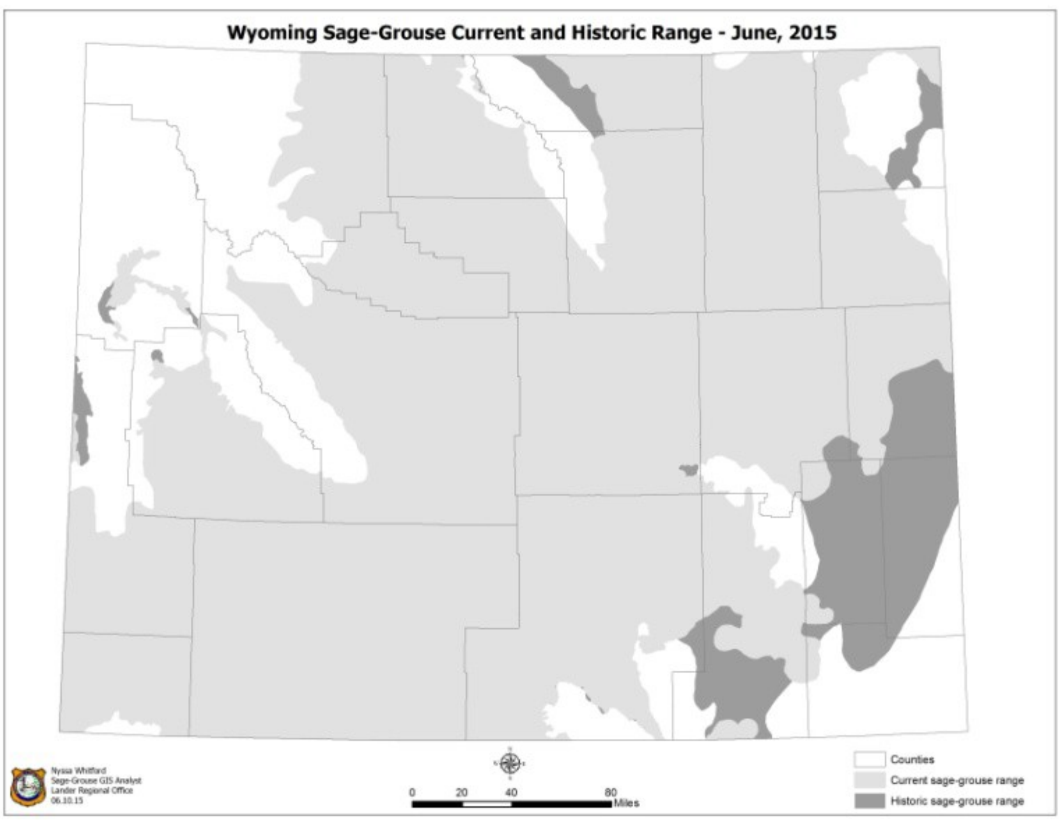


Figure 4. Sage-grouse range in Wyoming (updated 2015).

METHODS

Methods for collecting sage-grouse data are described in the sage-grouse chapter of the WGFD Handbook of Biological Techniques (Christiansen 2012), which is largely based on Connelly et al (2003). The definitions used in lek monitoring are attached (Attachment A).

RESULTS

Lek monitoring

While lek counts and surveys have been conducted in Wyoming since 1948, the most consistent statewide data were not collected until the mid-1990s. The number of leks checked in Wyoming has increased markedly since 1949. However, data from the 1950s through the 1970s is unfortunately sparse and by most accounts this is the period when the most dramatic declines of grouse numbers occurred. Some lek survey/count data were collected during this period as the historical reports contain summary tables but the observation data for most individual leks are missing, making comparisons to current information difficult. Concurrent with increased monitoring effort over time, the number of grouse (males) also increased (Figure 5). The increased number of grouse counted was not necessarily a reflection of a population increase; rather it was resultant of increased monitoring efforts.

The average number of males counted/lek decreased through the 1980s and early 90s to an all time low in 1995, but then recovered to a level similar to the late 1970s in 2006 (Figure 7). Again, fluctuations in the number of grouse observed on leks are largely due to survey effort not to changes in grouse numbers exclusively, but certainly the number of male grouse counted on leks exhibited recovery between 1995 and 2006 as the average size of leks increased and is generally interpreted to reflect an increasing population. The same cannot be said for the 2006- 2013 period during which the average number of cocks observed on leks declined, though not to levels documented in the mid-1990s. From 2013-2016, average lek size increased 112%. In 2017, average lek size declined 11% but remains 19% higher than the 10-year (2007-2016) average of 26.6 males/active lek. Thus, there has been a long-term decline and short-term cyclic increases and decreases in the statewide sage-grouse population. The short-term trends in statewide populations are believed to be largely weather related. In the late 1990s, and again in 2004-05, timely precipitation resulted in improved habitat conditions allowing greater numbers of sage-grouse to hatch and survive. Drought conditions from 2000-2003 and again later in that decade are believed to have caused lower grouse survival leading to population declines. These trends are valid at the statewide scale. Trends are more varied at the local scale. Sub-populations more heavily influenced by anthropogenic impacts (sub-divisions, intensive energy development, large-scale conversion of habitat from sagebrush to grassland or agriculture, Interstate highways, etc.) have experienced declining populations or extirpation.

Past analyses suggest Wyoming sage-grouse populations are cyclic (Fedy and Doherty 2010, Fedy and Aldridge 2011). While weather and climate undoubtedly influence sage-grouse population cycles, such influences have not been quantified and factors other than weather (predation, parasites) may also play a role. It is important to acknowledge and control for the cyclic nature of sage-grouse when conducting impact studies and monitoring grouse response to management.

Since only "occupied" leks are being reported on Table 1, it is important to consider trends in the numbers of active versus inactive leks in addition to the average size of active leks. During a period of population decline, the size of active leks typically declines and the number of inactive leks increases. The converse is typically true of an increasing population. Therefore the magnitude of both increases and decreases is usually greater than what is indicated by the average lek size alone.

Average female lek attendance is not reported since our data collection techniques are not designed to accurately capture these data and is therefore not a useful figure in assessing population trend.

Lek monitoring data for the 2017 breeding season are summarized in Tables 1a-d and Figures 6-11. Department personnel and others checked 89% (1,630/1,828) of the known occupied leks in 2017 (Table 1-c). Male attendance at all leks visited (counts and surveys) averaged 31.6 males per lek during spring 2016, an 11% decrease from the 35.6 males/lek observed in 2016 and 24% below the 41.7 males/lek observed in 2006. For the 10-year period (2008-2017), average male lek attendance ranged from 16.8 males/lek in 2013, the lowest average males per lek since 1997, to a high of 33 males/lek in 2008.

The proportion of active, occupied leks remained stable at 82% in 2016 and 80% in 2017.

In 2017, 6,731 fewer male sage-grouse were observed on 51 fewer active leks checked. Cumulatively, the lek attendance data suggest there were fewer grouse in bio-year 2016 than in 2015. It is important to note that the number of leks sampled increased over the 10-year period and the same leks were not checked from year to year. However leks that were checked consistently over the same period demonstrated the same trends except in some local areas as described in the local JCRs.

Small changes in the statistics reported between annual JCRs are due to revisions and/or the submission of data not previously available for entry into the database (late submission of data, discovery of historical data from outside sources, etc). These changes have not been significant on a statewide scale and interpretation of these data has not changed.

While a statistically valid method for estimating population size for sage-grouse has not yet been applied in Wyoming, monitoring male attendance on leks provides a reasonable index of relative change in abundance in response to prevailing environmental conditions over time. However, lek data must be interpreted with caution for several reasons: 1) the survey effort and the number of leks surveyed/counted has varied over time, 2) not all leks have been located, 3) sage-grouse populations cycle, 4) the effects of unlocated or unmonitored leks that have become inactive cannot be quantified or qualified, and 5) lek locations may change over time. Both the number of leks and the number of males attending these leks must be quantified in order to estimate population size.

Five independent analyses have assessed changes in long-term sage-grouse populations at rangewide, statewide, population and sub-population levels in recent years (Connelly et al. 2004, WAFWA 2008, 2015, Garton et al. 2011, Nielson et al. 2015). The trends reflected by these analyses are generally consistent with each other and with that shown in Figure 6. In 2013, WAFWA contracted with the University of Montana to develop better sampling designs and population trend estimators. This contract resulted in the development of a generalized integrated population model to estimate annual abundance from counts of males at breeding leks (McCaffrey and Lukacs 2016). This tool will be further tested and implemented as appropriate in Wyoming.

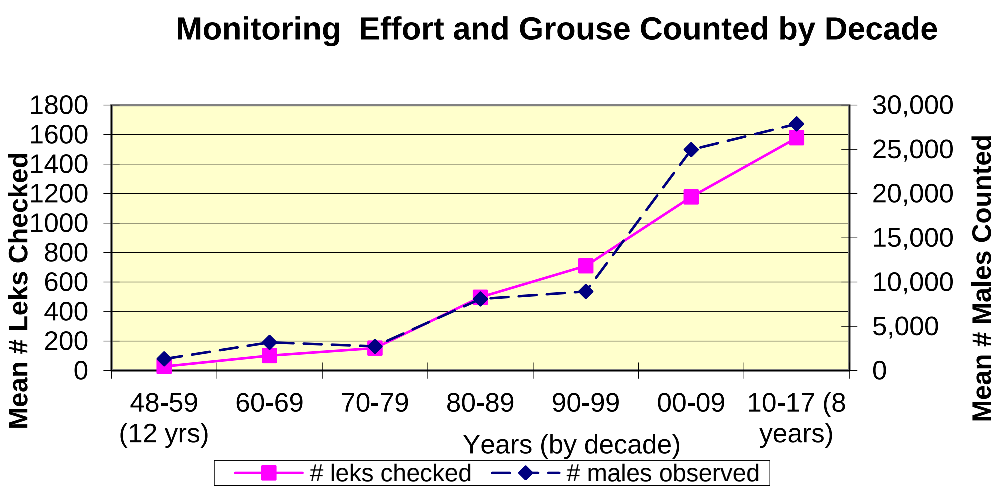


Figure 5. Mean annual numbers of leks checked (monitoring effort) and male grouse counted in Wyoming 1948-2017 by decade.

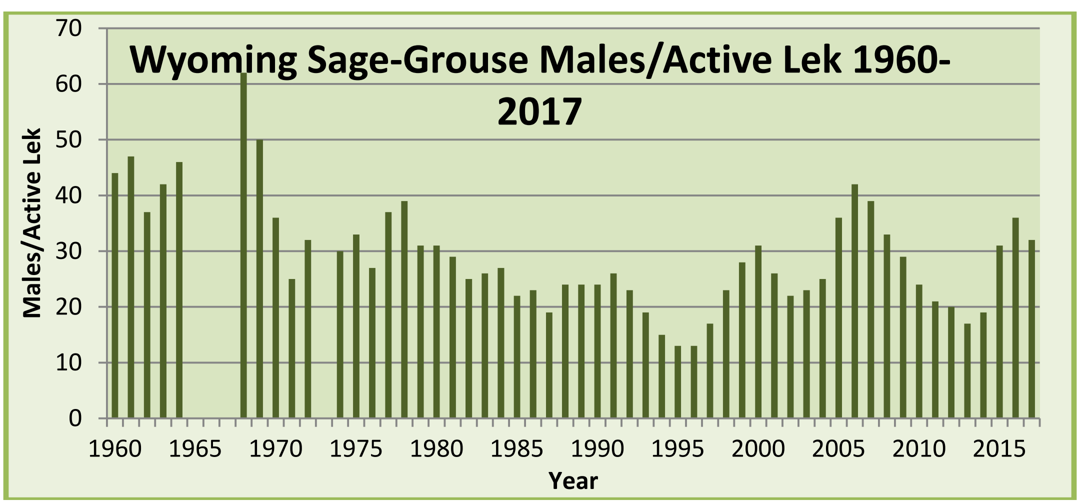


Figure 6. Average number of males per lek counted in Wyoming from 1960-2016 with a minimum of 100 leks checked each year.

Table 1a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2008	1657	566	34	19461	39.3
2009	1683	580	34	15550	32.1
2010	1714	647	38	14154	27.2
2011	1751	646	37	11308	22.5
2012	1786	716	40	12662	23.0
2013	1798	646	36	10617	20.7
2014	1801	772	43	11467	20.6
2015	1829	743	41	19530	34.2
2016	1843	738	40	23457	40.2
2017	1828	690	38	18703	35.5

Table 1b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2008	1657	824	50	16143	27.6
2009	1683	857	51	15032	25.5
2010	1714	824	48	11578	20.1
2011	1751	837	48	10143	18.7
2012	1786	824	46	8633	16.6
2013	1798	933	52	7657	13.4
2014	1801	844	47	8609	16.4
2015	1829	878	48	16974	27.7
2016	1843	943	51	19714	31.4
2017	1828	940	51	17737	28.3

Table 1c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2008	1657	1390	84	35604	33.0
2009	1683	1437	85	30582	28.5
2010	1714	1471	86	25732	23.5
2011	1751	1483	85	21451	20.5
2012	1786	1540	86	21295	19.9
2013	1798	1579	88	18274	16.8
2014	1801	1616	90	20076	18.6
2015	1829	1621	89	36504	30.9
2016	1843	1681	91	43171	35.6
2017	1828	1630	89	36440	31.6

Table 1d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2008	1097	159	134	1256	87.3	12.7
2009	1093	188	156	1281	85.3	14.7
2010	1116	193	162	1309	85.3	14.7
2011	1082	217	184	1299	83.3	16.7
2012	1123	245	172	1368	82.1	17.9
2013	1117	287	175	1404	79.6	20.4
2014	1107	355	151	1462	75.7	24.3
2015	1214	271	136	1485	81.8	18.2
2016	1257	280	144	1537	81.8	18.2
2017	1190	301	139	1491	79.8	20.2

1) Occupied - Active during previous 10 years (see official definitions)
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented
3) Inactive - Confirmed no birds/sign present (see official definitions)

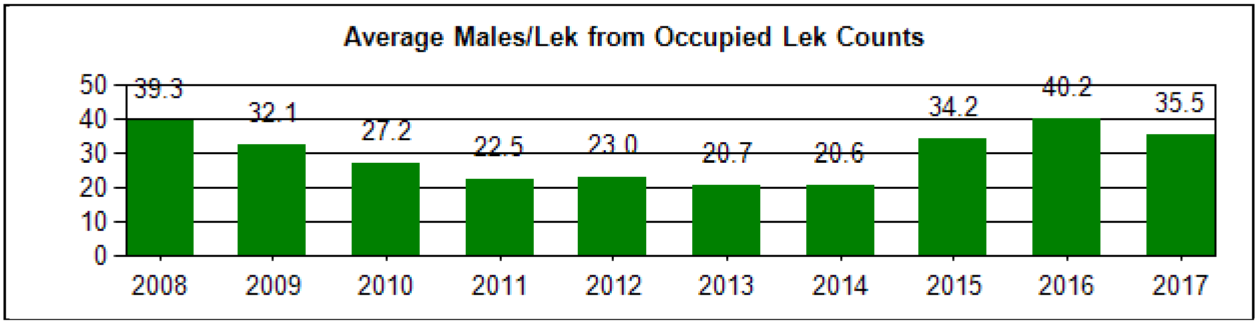


Figure 7. Average males/lek from occupied lek counts.

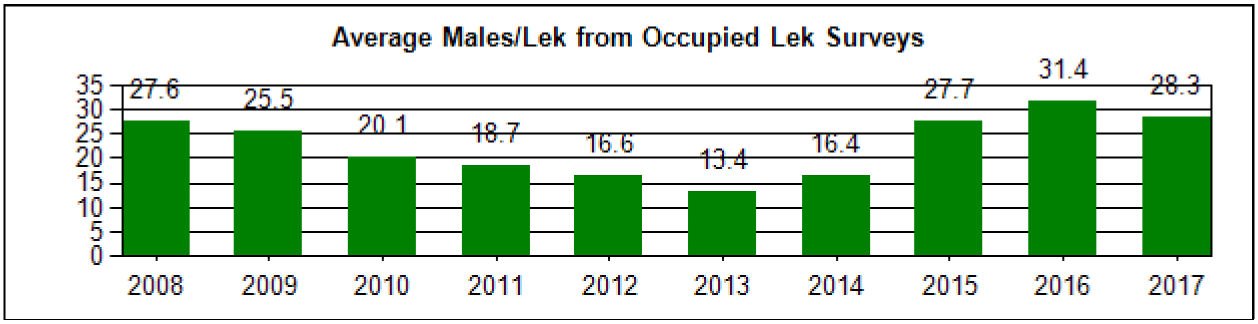


Figure 8. Average males/lek from occupied lek surveys.

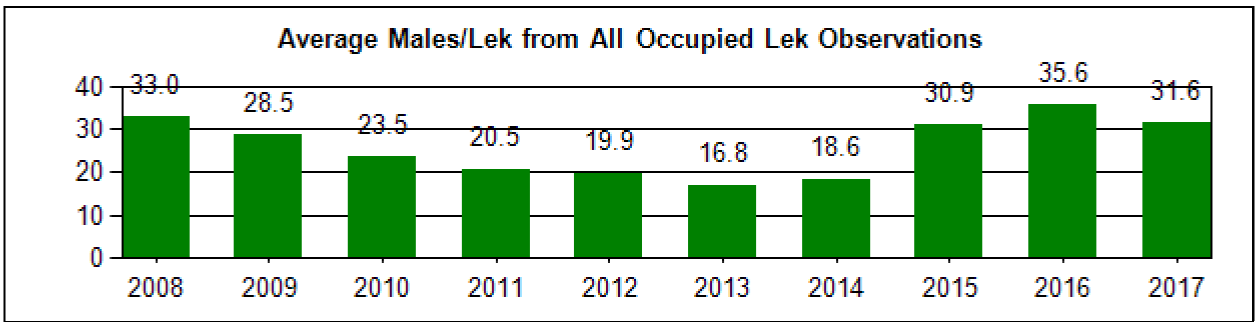


Figure 9. Average males/lek from all occupied leks checked (counts+surveys).

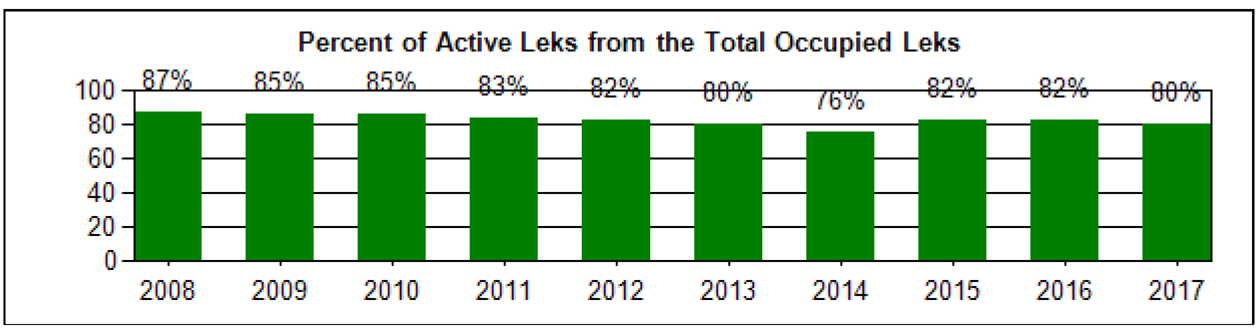


Figure 10. Percent active leks from the occupied leks checked with known status.

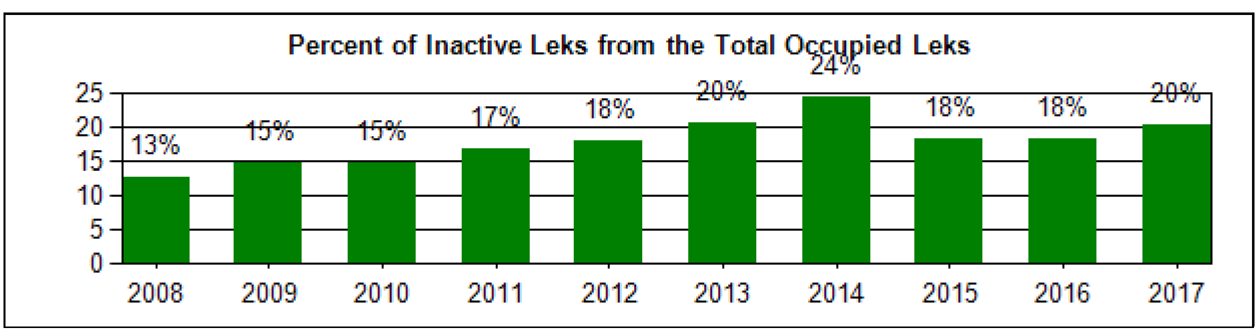
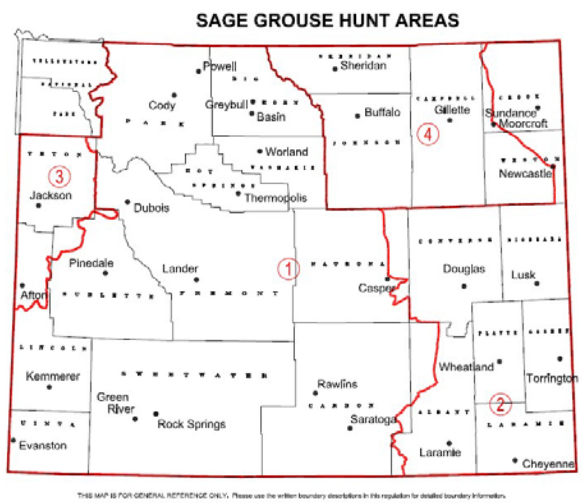


Figure 11. Percent inactive leks from the occupied leks checked with known status.

Hunting season and harvest

As a result of concerns about the issue of hunting and its impact to sage-grouse, a white paper was prepared in 2008 then revised in 2010 (Christiansen 2010), presented to the WGF Commission and distributed through the WGF web page. The science and public policy basis for managing sage-grouse harvest in Wyoming are covered in detail within that document. Similarly, the Western Association of Fish and Wildlife Agency directors adopted a policy statement on the topic in the summer of 2010 (Attachment D in Christiansen 2010).

The 2016 hunting season (Figure 12, Table 2) for most of the state (Area 1) was 2 days longer than 2015 due to the calendar effect of opening the season on the third Saturday of September. In 2015 the third Saturday was September 19, but in 2016 it was September 17.



Area	Season Dates	Daily/Poss. Limits	Falconry
1	Sept. 17-Sept. 30	2/4	Sept. 1-Mar. 1
2, 3	Closed	Closed	Closed
4	Sept. 17-Sept. 21	2/4	Sept. 1-Mar. 1

Figure 12 and Table 2. 2016 sage-grouse hunting season map and regulations.

Hunting seasons and harvest in Wyoming are shown in Tables 3a-b. Due to concerns over low populations, the statewide hunting season was shortened and the daily bag limit decreased to two sage-grouse in 2002 and has remained very conservative since that time. Two areas, eastern Wyoming and the Snake River Drainage in northwest Wyoming are closed to sage-grouse hunting (Figure 14).

Delaying and shortening the season and decreasing the bag limit dramatically decreased the numbers of sage-grouse hunters and their harvest. Hunters were also sensitive to the plight of grouse populations and did not take the opportunity to hunt sage-grouse as much as they had in the past. The data presented in Table 3b and Figures 15-18 indicate hunter numbers and harvest was relatively stable between 2015 (4,299 hunters/10,498 birds) and 2016 (4,674 hunters/10,526 birds). The trend in the number of birds harvested is generally correlated with lek attendance trends.

Tables 3 a-b. Sage Grouse Hunting Seasons and Harvest Data

Year	Season Start	Season End	Length	Bag/Possesion Limit
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009-1	Sep-19	Sep-30	12	2/4
2009-4	Sep-19	Sep-21	3	2/4
2010-1	Sep-18	Sep-30	13	2/4
2010-4	Sep-18	Sep-20	3	2/4
2011-1	Sep-17	Sep-30	14	2/4
2011-4	Sep-17	Sep-19	3	2/4
2012-1	Sep-15	Sep-30	16	2/4
2012-4	Sep-15	Sep-17	3	2/4
2013-1	Sep-21	Sep-30	10	2/4
2013-4	Sep-21	Sep-23	3	2/4
2014-1	Sep-20	Sep-30	11	2/4
2014-4	Sep-20	Sep-22	3	2/4
2015-1	Sep-19	Sep-30	12	2/4
2015-4	Sep-19	Sep-21	3	2/4
2016-1	Sep-17	Sep-30	14	2/4
2016-4	Sep-17	Sep-19	3	2/4

Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2007	10378	5180	10699	1.0	2.0	2.1
2008	10302	4745	10065	1.0	2.2	2.1
2009	11162	4732	10812	1.0	2.4	2.3
2010	11057	4732	11434	1.0	2.3	2.4
2011	10290	4568	11186	0.9	2.3	2.4
2012	9869	4700	11342	0.9	2.1	2.4
2013	5726	3383	7672	0.7	1.7	2.3
2014	7094	3526	8642	0.8	2.0	2.5
2015	10498	4299	10231	1.0	2.4	2.4
2016	10526	4674	11476	0.9	2.3	2.5
Avg	9,690	4,454	10,356	0.9	2.2	2.3

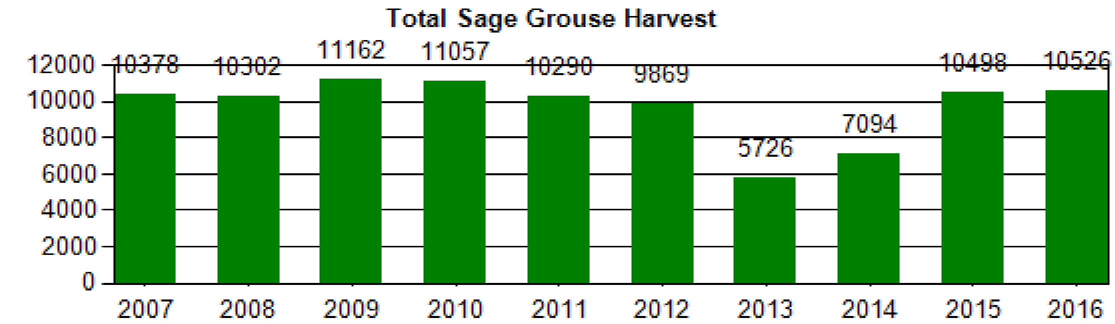


Figure 13. Wyoming statewide sage-grouse harvest 2007-2016.

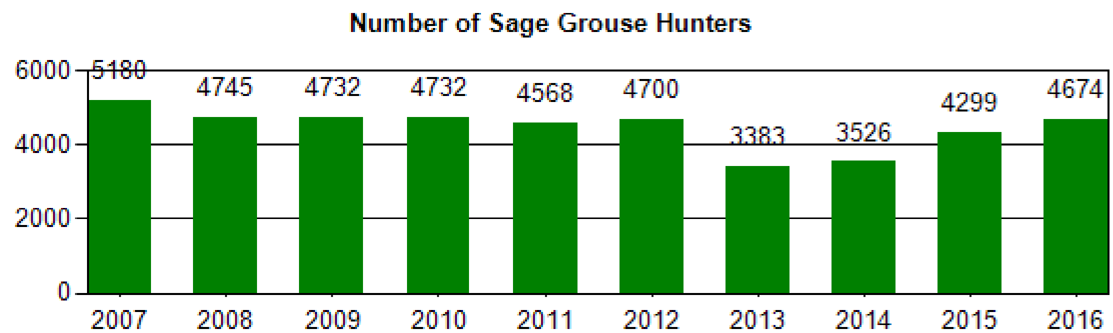


Figure 14. Wyoming statewide sage-grouse hunter numbers 2007-2016.

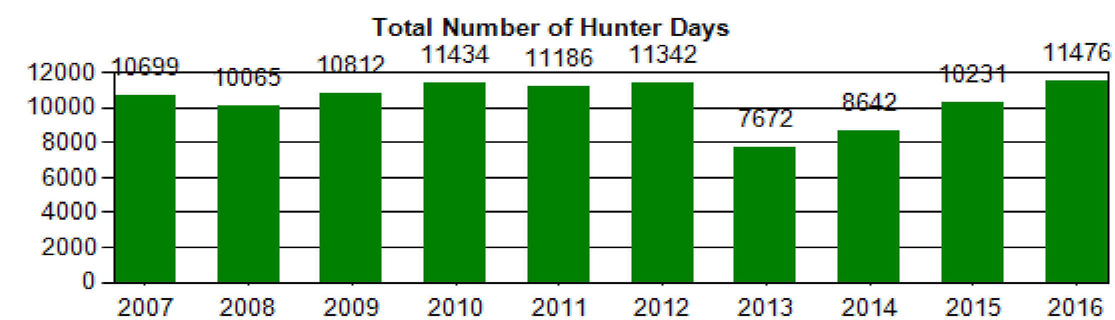


Figure 15. Wyoming statewide number of hunter days 2007-2016.

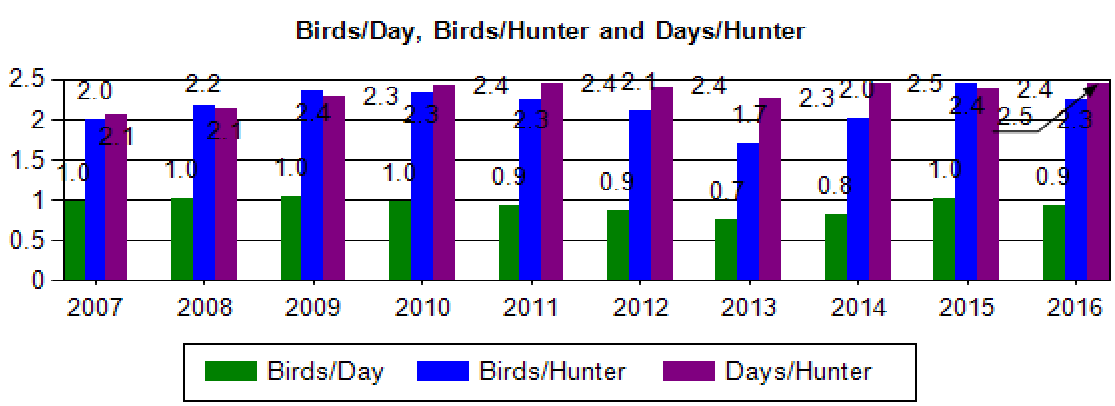


Figure 16. Wyoming statewide birds/day, birds/hunter and days/hunter 2007-2016.

The number of sage-grouse wings collected from hunters decreased by 9% in 2016. In 2016, 2,097 wings were recorded (Table 4), which is about 20% of the estimated harvest. This is equal to the 10-year average of 20% and the changes between years are minor.

The 2016 chick:hen ratio (based on harvested wing analysis) was 0.9 chicks per hen (Table 4 and Figure 17). This level of productivity is typically associated with a declining population. This is consistent with the 2017 lek data (all lek checks), which indicated an 11% decrease in the average numbers of males on leks (Table 5). When 1997-2016 data are pooled, average male lek attendance declined an average of 12% when chick:hen ratios the previous fall were less than 1.4:1, averaged 0% change when chick:hen ratios the previous fall were 1.4 to 1.6:1 and increased an average of 32% when chick:hens ratios were 1.7:1 or higher. Additional data are required to strengthen the statistical basis of these analyses.

Prior to 1997, wing analysis results may be questioned in some parts of the state since most personnel were not well trained in techniques.

Table 4. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult Male	Percent Adult Female	Percent Yearling Male	Percent Yearling Female	Percent Young Male	Percent Young Female	Chicks/ Hens
2007	2015	20.8	32.9	3.4	5.8	16.9	20.2	1.0
2008	2154	14.4	25.8	4.6	6.7	20.3	28.0	1.5
2009	2550	14.1	29.1	5.9	8.3	17.1	25.6	1.1
2010	2169	10.1	39.8	2.6	5.9	11.2	16.6	0.9
2011	2425	8.9	31.2	4.0	5.6	21.3	29.0	1.4
2012	1938	13.4	36.6	4.5	8.8	15.5	21.2	0.8
2013	1258	12.0	35.8	2.3	6.5	18.8	24.4	1.0
2014	1533	9.5	23.9	2.5	7.8	28.8	27.5	1.8
2015	2300	12.7	25.8	3.6	5.4	24.8	27.7	1.7
2016	2097	16.9	33.0	4.5	7.6	16.7	21.2	0.9

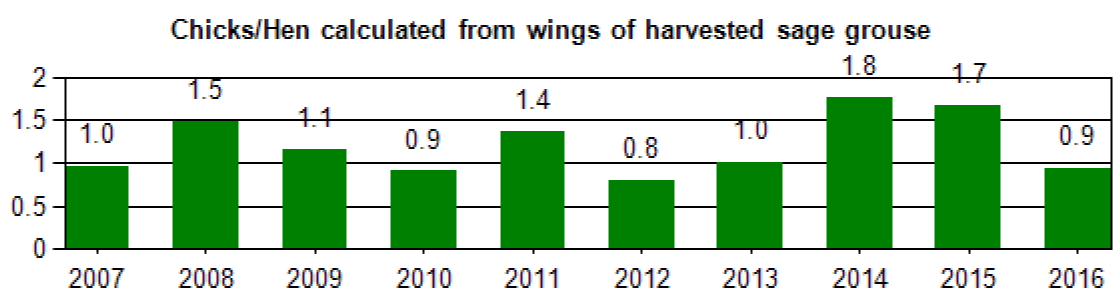


Figure 17. Chicks/Hen 2007-2016 based on wings from harvested grouse.

Table 5. Potential influence of chick production, based on wings from harvested birds, on population trend as measured by male lek attendance.

Year	Chicks:Hen (based on wings from harvested birds)	Change in male lek attendance the following spring
1997	1.9	+36%
1998	2.4	+21%
1999	1.8	+13%
2000	1.1	-20%
2001	1.6	-15%
2002	1.6	+3%
2003	1.5	+4%
2004	2.4	+57%
2005	2.0	+17%
2006	1.2	-5%
2007	0.8	-16%
2008	1.5	-16%
2009	1.1	-21%
2010	0.9	-13%
2011	1.4	-7%
2012	0.8	-16%
2013	1.0	+11%
2014	1.8	+66%
2015	1.7	+16%
2016	0.9	-11%

Weather and Habitat

Sage-grouse nest success and chick survival have been linked to habitat condition, specifically shrub height and cover, live and residual (remaining from the previous year) grass height and cover, and forb cover. The shrubs (primarily sagebrush) and grasses provide screening cover from predators and weather while the forbs provide food in the form of the plant material itself and in insects that use the forbs for habitat. Spring precipitation is an important determinant of the quantity and quality of these vegetation characteristics. Residual grass height and cover depends on the previous year's growing conditions and grazing pressure while live grass and forb cover are largely dependent on the current year's precipitation.

Weather and climate have been linked to sage-grouse population trends (Heath et al. 1997, Blomberg et al 2014a/b, Caudill et al. 2014). Most of the Local Conservation Planning Area JCRs include sections on weather and sage-grouse relationships. In general, spring precipitation is positively linked to chick:hen ratios, which are in turn, linked to the following year's lek counts of males. However, periods of prolonged cold, wet weather may have adverse effects on hatching success, plant and insect phenology and production and chick survival. Untimely late snow storms in May and early June of 2009, 2010, and 2016 likely contributed to reduced nesting success and chick survival. Efforts to quantify/qualify these effects in a predicable fashion over meaningful scales have largely failed.

Calendar year 2012 was the hottest, driest year documented in Wyoming since record keeping began 118 years previous (NOAA 2012). The lack of spring moisture in 2012 meant little production of important food plants and insects, therefore lower chick survival and more birds than usual were likely forced to move to either higher elevation or irrigated meadows and steam courses.

While 2013 saw increased precipitation over 2012, the residual effects 2012 continued to impact sage-grouse productivity. With the exception of mid-May snowstorms, most of Wyoming experienced favorable spring conditions in 2014 and 2015. Many areas of the state experienced heavy precipitation and even flooding in May 2016, which is correlated with that year's reduced nesting success and chick survival.

<u>Habitat and seasonal range mapping.</u>

While we believe that most of the currently occupied leks in Wyoming have been documented, other seasonal habitats such as nesting/early brood-rearing and winter concentration areas have not been identified. Efforts to map seasonal ranges for sage-grouse will continue by utilizing winter observation flights and the on-going land cover mapping efforts of the USGS (Fedy et al. 2014), BLM, WGF, the Wyoming Geographic Information Science Center (WYGISC) of the University of Wyoming and others.

CONSERVATION STRATEGIES

Endangered Species Act Status

In September 2015 the U.S. Fish and Wildlife Service issued a decision of "not warranted" for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. This means the State of Wyoming maintains management authority over sage-grouse in Wyoming. In its decision document, the Service specifically cited Wyoming's core area strategy as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude the need for a future listing. The Service plans to reexamine the issue in 2020 to ensure planned conservation efforts are implemented and the status of the species remains unwarranted for listing.

Governor's Core Area Strategy (CAS) and Executive Order

Management of greater sage-grouse habitat in Wyoming is based on a "core area" strategy of limiting human disturbance in the most important sage-grouse habitats. This strategy is codified by a Governor's executive order. The current Executive Order (2015-4) was signed by Governor Matt Mead in July of 2015. The Executive Order and related materials are available at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management

The Core Area Strategy is being implemented across the state under the guidance of a state/federal interagency team of specialists which meets on a regular basis to discuss issues related to implementation of the strategy. A key component of the strategy's implementation is the Density and Disturbance Calculation Tool (DDCT). This tool was developed by agency GIS specialists as an interactive, on-line application through the University of Wyoming's Geographic Information and Science Center. Training sessions are provided to industry and agency staff required to use the DDCT.

Federal land use planning documents are largely consistent with the Wyoming strategy. However, the new federal administration has signaled its intent to review of all federal sage-grouse management plans. The implications of this review are not yet known.

Conservation Planning

In 2000, the WGFD formed a citizen/agency working group for the purpose of developing a statewide strategy for conservation of sage-grouse in Wyoming. The working group completed its task and in 2003 The Wyoming Greater Sage-Grouse Conservation Plan (WGFD 2003) was approved by the Wyoming Game and Fish Commission. The State Plan was largely reliant on implementation by local working groups. The state's eight LWGs all submitted final conservation plans between 2006 and 2008. In 2012, the local working groups began the process of updating their plans with current information to make them consistent with the Wyoming Core Area Strategy, address the Service's 2010 listing decision and incorporate new science. This effort was completed in this reporting period. The updated plans were presented to the Wyoming Game and Fish Commission in March 2014.

From 2005-2016, Local Working Groups were allocated approximately $6.3 million to support implementation of local sage-grouse conservation projects. The source of this funding was the State of Wyoming General Fund as requested by the Governor and approved by the legislature. The 2016 Legislature appropriated another $1.1 million for the 2017-18 biennium. Allocation of these funds began July 1, 2016. Subsequently, the 2017 legislature returned budget responsibility of the sage-grouse program back to the Department due to state budget shortfalls. This action shifted the funding burden from the state as a whole, based largely on mineral severance taxes, to hunters and anglers, the primary funding source of the WGFD. A hunting license fee increase specifically crafted to replace legislative funding was approved by the legislature and LWGs will maintain their existing role in recommending how funds will be allocated.

During this reporting period, twenty-four (24) projects (Attachment C) were funded. Most of the projects are supported by multiple cost-sharing partners. Cumulatively, two-hundred-twenty (220) projects have been approved since 2005. Projects include habitat treatments/restoration, improved range management infrastructure and grazing management plans, applied research, inventories, monitoring and public outreach. Not all of the 2017-18 funds have been allocated. Additional projects will be considered and approved in late 2017 and early 2018.

Natural Resources Conservation Service (NRCS) Sage-Grouse Initiative (SGI)

The NRCS has implemented its Sage-Grouse Initiative (SGI) across Wyoming and 10 other sage-grouse states. Details of this initiative can be obtained from the NRCS Wyoming State Office or from the Sage-Grouse Initiative website http://www.sagegrouseinitiative.com .

Statewide USFWS Candidate Conservation Agreement with Assurances (CCAA)

A mechanism to achieve the goals of the statewide sage-grouse conservation effort is development of statewide agreements (Candidate Conservation Agreements with Assurances (CCAA), Candidate Conservation Agreements (CCA), Memoranda of Agreement (MOA) and incentives to insure management actions on private and public lands will continue in a manner that is ecologically, economically, and culturally sustainable. These Service administered agreements provide a means for conserving species through proactive conservation measures that reduce the potential for additional regulatory requirements that result when species become listed as threatened or endangered. Individual ranches are able to participate in conservation practices appropriate to their ranch.

OTHER ISSUES

30th Western States Sage and Columbian Sharp-tailed Grouse Workshop

Wyoming hosted the 30th WAFWA Sage and Columbian Sharp-tailed Grouse Workshop in Lander in June 2016 which was attended by 193 grouse managers, researchers, and advocates. Abstracts from this workshop can be downloaded from the WAFWA website.

Wyoming to North Dakota Translocation Project

Wyoming Game and Fish Department personnel worked with their North Dakota Game and Fish Department counterparts, Utah State University researchers and others to capture and translocate 60 sage-grouse (40 hens, 20 cocks) from Wyoming to North Dakota in an effort to prevent extirpation of the North Dakota population. The effort will be repeated in 2018 and researchers will determine not only the success of the translocation, but the effects of translocation on the source population in Wyoming. This study is part of a larger collaborative effort involving translocation projects in Utah and California/Nevada. Although monitoring has just begun, translocated sage-grouse moved long distances shortly after release, including into Montana and South Dakota. Another translocation is scheduled for 2018.

Sage-grouse Bird Farm Legislation

The 2017 state legislature passed a billing allowing private bird farm operations to collect sage-grouse eggs from the wild for purposes of establishing a captive flock. The Department and Commission are therefore required to develop regulations to permit this activity in the 2017 bio-year.

West Nile Virus

West Nile virus (WNv) was first confirmed in sage-grouse in 2003 in the northern Powder River Basin and is now considered a potential threat to sage-grouse populations. Research efforts have resulted in several published papers and theses that describe the disease and its potential impact to sage-grouse populations (Walker and Naugle 2011 and references therein).

Monitoring efforts in 2016 again included: 1) intensive monitoring of radio-collared sage-grouse during the late summer on study sites across Wyoming, 2) WGF field personnel were directed to collect late summer sage-grouse mortalities and submit them for testing, and 3) press releases were distributed requesting the general public, especially landowners, to report late summer sage-grouse mortalities. No West Nile virus mortality was documented during this reporting period.

Energy Development

The issue of energy development and its effects to sage-grouse and sagebrush habitats continues to be a major one in many portions of the state in spite of the recent downturn in fossil fuel industries. The topic is of major interest in Local Working Group efforts and the JCRs for the local conservation areas contain additional detail on the issue. Research efforts continue on oil and gas development impacts. During this reporting period three peer-reviewed manuscripts based on Wyoming research were published (Gamo and Beck 2017, Green et al. 2017, Juliusson and Doherty 2017). One area of research need identified during the 2015 Core Area Strategy revision is identifying natural gas development impact thresholds relative to sage-grouse winter concentration areas. That topic is being pursued by the SGIT. Research relative to wind energy development also continues and two journal articles, both associated with the Seven Mile Hill study in Carbon County, were published during this reporting period (LeBeau et al. 2017 a,b).

The results of these research efforts inform and guide management actions associated with the Wyoming Core Area Strategy.

RESEARCH AND PUBLICATIONS

See Attachment D for a compilation of current sage-grouse research being conducted in Wyoming. This information was compiled by Dr. Jeff Beck at the University of Wyoming. Attachment E is a listing of Wyoming-based research reports and peer-reviewed publications to date.

MANAGEMENT RECOMMENDATIONS

1) Implement Governor Mead's Sage-Grouse Executive Order and Core Area Strategy.

2) Continue to implement local conservation plans in all 8 planning areas.

3) Test the sage-grouse population model developed by Paul Lukacs at the University of Montana in cooperation with USFWS and WAFWA.

4) Continue to refine and de-bug the sage-grouse database and Job Completion Report intranet program.

5) Continue to map lek perimeters and integrate these data into the WGF lek database. Priority for this effort should be based on the lek size of lek and impending development actions that may impact leks.

6) Personnel monitoring leks should review and consistently follow established lek monitoring protocol each year.

7) Map seasonal habitats (nesting/early brood rearing, winter concentration areas) for sage- grouse using data from the on-going land cover mapping project and sage-grouse observations.

8) Cooperate with the sage-grouse translocation to North Dakota in 2018. Evaluate continued participation in the project following the 2018 translocation and monitoring.

9) Regulate and enforce the sage-grouse bird farm law (House Enrolled Act No. 91 of the 64th Legislature of the State of Wyoming) in a manner that is compliant with the intent of the law and protects wild populations of sage-grouse to the extent possible. Monitor and document the outcomes and implications of the law and regulations and report results to policy makers and the public.

LITERATURE CITED:

Blomberg, E. J., D. Gibson, M. T. Atamian, and J. S. Sedinger. 2014a. Individual and environmental effects on egg allocations of female greater sage-grouse. Auk 131:507–523.

Blomberg, E.J., J.S. Sedinger, D. Gibson, P.S. Coates, and M.L. Casazza. 2014b. Carry-over effects and climatic conditions influence the postfledging survival of greater sage-grouse. Ecology and Evolution doi: 10.1002/ece3.1139

Caudill, D., M. R. Guttery, B. Bibles, T. A. Messmer, G. Caudill, E. Leone, D. K. Dahlgren, and R. Chi. 2014. Effects of climatic variation and reproductive trade-offs vary by measure of reproductive effort in greater sage-grouse. Ecosphere 5(12):154. http://dx.doi.org/10.1890/ES14- 00124.

Christiansen, T. 2012. Chapter 12: Sage Grouse (*Centrocercus urophasianus*). Pages 12-1 to 12- 55 in S.A. Tessmann and J.R. Bohne (eds). Handbook of Biological Techniques: third edition. Wyoming Game and Fish Department. Cheyenne, WY.

Christiansen, T. 2010. Hunting and sage-grouse: a technical review of harvest management on a species of concern in Wyoming. Wyoming Game and Fish Department, Cheyenne.

Connelly, J. W., K. P. Reese and M. A. Schroeder. 2003. Monitoring of greater sage-grouse habitats and populations. Station Bulletin 80. University of Idaho College of Natural Resources Experiment State. Moscow, ID.

Connelly, J.W., S.T. Knick, M.A. Schroeder and S.J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies. Unpublished report. Cheyenne, WY.

Fedy, B. C. and K. E. Doherty. 2010. Population cycles are highly correlated over long time series and large spatial scales in two unrelated species: greater sage-grouse and cottontail rabbits. Oecologia 165:915-924.

Fedy, B.C. and C.L. Aldridge. 2011. The importance of within-year repeated counts and the influence of scale on long-term monitoring of sage-grouse. Journal of Wildlife Management 75(5): 1022-1033.

Fedy, B. C., C. L. Aldridge, K. E. Doherty, M. O'Donnell, Beck, J. L**.,** B. Bedrosian, M. J. Holloran, G. D. Johnson, N. W. Kaczor, C. P. Kirol, C. A. Mandich, D. Marshall, G. McKee, C. Olson, C. C. Swanson, and B. L. Walker. 2012. Interseasonal movements of greater sage-grouse, migratory behavior, and an assessment of the core regions concept in Wyoming. Journal of Wildlife Management 76:1062–1071.

Fedy, B.C., K.E. Doherty, C.L. Aldridge, M. O’Donnell, et al. 2014. Habitat prioritization across large landscapes, multiple seasons, and novel areas: an example using greater sage-grouse in Wyoming. Wildlife Monographs 190:1–39.

Gamo, R.S. and J.L. Beck. 2017. Effectiveness of Wyoming's sage-grouse core areas: Influences on energy development and male lek attendance: Environmental Management 59(2)189-203.

Garton, E.O., J.W. Connelly, J.S. Horne, C.A. Hagen, A. Moser, and M. Schroeder. 2011. Greater sage-grouse population dynamics and probability of persistence. Pp. 293 – 382 *in* S.T. Knick and J.W. Connelly (editors). Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian biology (vol. 38). University of California Press, Berkeley, CA.

Green, A.W., C.L. Aldridge, and M.S. O'Donnell. 2017. Investigating impacts of oil and gas development on greater sage-grouse: Journal of Wildlife Management 81(1):46-57.

Heath, B. J., R. Straw, S.H. Anderson, J. Lawson. 1997. Sage-grouse productivity, survival and seasonal habitat use near Farson, Wyoming. Research Completion Report. Wyoming Game & Fish Dept., Cheyenne.

Juliusson, L.M. and K.E. Doherty. 2017. Oil and gas development exposure and conservation scenarios for greater sage-grouse: Combining spatially explicit modeling with GIS visualization provides critical information for management decisions. Applied Geography 80:98-111.

LeBeau, C.W., J.L. Beck, G.D. Johnson, R.M. Nielson, M.J. Holloran, K.G. Gerow, and T.L. McDonald. 2017a. Greater sage-grouse male lek counts relative to a wind energy development. Wildlife Society Bulletin 41:17-26.

LeBeau, C.W., G.D. Johnson, M.J. Holloran, J.L. Beck, R.M. Nielson, M.E. Kauffman, E.J. Rodemaker, and T.L. McDonald. 2017b. Greater sage-grouse habitat selection, survival, and wind energy infrastructure. Journal of Wildlife Management 81:690–711.

McCaffery, R. and P.M. Lukacs. 2016. A generalized integrated population model to estimate greater sage-grouse population dynamics. Ecosphere 7(11) art. e01585. http://doi.org/10.1002/ecs2.1585.

Nielson, R.M., L.L. McDonald, J. Mitchell, S. Howlin, and C. LeBeau. 2015. Analysis of greater sage-grouse lek data: Trends in peak male counts 1965-2015. Western EcoSystems Technology, Inc., Cheyenne, Wyoming, USA.

NOAA National Climatic Data Center. 2012. State of the Climate: National Overview for Annual 2012. http://www.ncdc.noaa.gov/sotc/national/2012/13.

Patterson, R. L. 1952. The Sage Grouse in Wyoming. Sage Books. Denver, CO.

Schroeder, M.A., C.L. Aldridge, A.D. Apa, J.R. Bohne, C.E. Braun, S.D. Bunnell, J.W. Connelly, P.A. Deibert, S.C. Gardner, M.A. Hilliard, G.D. Kobriger, S.M. McAdam, C.W. McCarthy, J.J. McCarthy, D.L. Mitchell, E.V. Rickerson, and S. J. Stiver. 2004. Distribution of sage-grouse in North America. The Condor 106:363-376.

Walker, B.L. and D.E. Naugle. 2011. West Nile virus ecology in sagebrush habitat and impacts on greater sage-grouse populations. Pp. 127 – 144 *in* S.T. Knick and J.W. Connelly (editors). Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian biology (vol. 38). University of California Press, Berkeley, CA.

Western Association of Fish and Wildlife Agencies (WAFWA). 2008. Greater sage-grouse population trends: An analysis of lek count databases 1965-2007. Unpublished Report. Sage and Columbian Sharp-tailed grouse Technical Committee, WAFWA. 126 pp.

Western Association of Fish and Wildlife Agencies (WAFWA). 2015. Greater sage-grouse population trends: An analysis of lek count databases 1965-2015. Unpublished Report. Western Association of Fish and Wildlife Agencies, Cheyenne, WY. 54 pp.

Wyoming Game and Fish Department. 2003. Wyoming Greater Sage-Grouse conservation plan. Wyoming Game and Fish Department, Cheyenne, WY. 97 pp.

Wyoming Game and Fish Department. 2010. Recommendations for development of oil and gas resources within important wildlife habitats, version 6.0, revised April 2010. Wyoming Game and Fish Department, Cheyenne, WY. 236 pp.

Attachment A:
Wyoming Sage-Grouse Lek Definitions:
(Revised November 2012)

The following definitions have been adopted for the purposes of collecting and reporting sage-grouse lek data. See the sage-grouse chapter of the Wyoming Game and Fish Department's Handbook of Biological Techniques for additional technical details and methods.

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. Before a suspected lek is added to the database, it must be confirmed by a survey conducted 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 added to the lek database.

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 lek perimeter boundaries. Birds counted on satellite leks should be added to those counted on the primary lek for reporting purposes.

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.v below); larger leks 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+ years) demonstrates the existing perimeter is inaccurate. The lek location must be identified and recorded as a specific point **within** the lek perimeter. This point may be the geographic center of the perimeter polygon calculated though a GIS exercise, or a GPS waypoint recorded in the field, which represents the center of breeding activity typically observed on the lek.

Lek Complex - A cluster of leks within 2.5 km (1.5 mi) of each other, between which male sage-grouse may interchange from day to day.

Lek Count - A census technique that documents the number of male sage-grouse observed attending a particular lek, lek complex, or leks along a lek route based on repeated observation.

- Conduct lek counts at 7-10 day intervals over a 3-4 week period after the peak of mating activity. Although mating typically peaks in early April in Wyoming, the number of males counted on a lek is usually greatest in late April or early May when attendance by yearling males increases.
- Conduct lek counts only from the ground. Aerial counts are not accurate and are not comparable to ground counts.

- Conduct counts from ½ hour before sunrise to 1 hour after.
- Count attendance at each lek a minimum of three times annually during the breeding season.
- Conduct counts only when wind speeds are less than 15 kph (~10 mph) and no precipitation is falling.
- All leks within a complex should be counted on the same morning.

Lek Count 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 counted 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 under "Lek Count" can count all leks within 1.5 hours.

Lek Survey - A monitoring technique designed primarily to determine whether leks are active or inactive. Obtaining accurate counts of males attending is secondary.

- Ideally, all sage-grouse leks would be counted annually. However, some breeding habitat is inaccessible during spring because of mud and snow, or the location of a lek is so remote it cannot be routinely counted. In other situations, topography or vegetation may prevent an accurate count from any vantage point. In addition, time and budget constraints often limit the number of leks that can be visited. Where lek counts are not feasible for any of these reasons, surveys are the only reliable means to monitor population trends. Lek surveys are designed principally to determine whether leks are active or inactive, requiring as few as one visit to a lek. Obtaining accurate counts of the numbers of males attending is not essential. Lek surveys involve substantially less effort and time than lek counts. They can also be done from a fixed-wing aircraft or helicopter. Lek surveys can be conducted from the initiation of strutting in early March until early-mid May, depending on the site and spring weather. When large numbers of leks are surveyed (50+) the resulting trends of lek attendance over time mirror that of lek counts.

Annual status – Lek status is assessed annually based on the following definitions:

- **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.

- **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 no birds were present on the lek during at least 2 ground surveys separated by at least 7 days. The surveys 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) or a ground check of the exact lek location late in the strutting season (after 4/15) during which sign (droppings/feathers) of strutting activity is not found. 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. Excepting leks not scheduled to be checked in a particular year, the “unknown” status designation should be applied only in rare instances. Each lek should be checked enough times to determine whether it is active or not. It is preferable to conduct two good field checks every other year and confirm the lek is "inactive" rather than check it once every year and have it remain in “unknown” status.

Management status - Based on its annual status, a lek is assigned to one of the following categories for management 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 lek sites 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 (also see “unknown” above).

Attachment B:

STATE OF WYOMING
EXECUTIVE DEPARTMENT
EXECUTIVE ORDER

Order 2015-4
(Replaces 2011-5 and 2013-3)

GREATER SAGE-GROUSE CORE AREA PROTECTION

WHEREAS, the State of Wyoming is proud of its rich wildlife heritage and is one of few states remaining in the United States where wildlife exist in great abundance; and

WHEREAS, the Greater sage-grouse (*Centrocercus urophasianus*), an iconic western species, inhabits much of the sagebrush-steppe habitat in Wyoming; and

WHEREAS, the sagebrush-steppe habitat type is abundant across the State of Wyoming; and

WHEREAS, the State of Wyoming currently has the greatest population of Greater sage-grouse across the range; and

WHEREAS, the State of Wyoming has management authority over Greater sage-grouse populations in Wyoming; and

WHEREAS, the United States Department of the Interior has determined that listing the Greater sage-grouse range-wide as a threatened or endangered species is currently precluded making it a candidate species; and

WHEREAS, in response to the U.S. Fish and Wildlife Service finding under Listing Factor D, the State of Wyoming and partner federal, state and local agencies have developed and put into place a comprehensive and effective set of regulatory mechanisms designed to conserve the Greater sage-grouse; and

WHEREAS, it is the desire of the State of Wyoming and it is in the best interest of the State and the Greater sage-grouse that Wyoming maintain legal primacy for this species; and

WHEREAS, the State of Wyoming continues to be committed both logistically and financially to conserving the Greater sage-grouse; and

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WHEREAS, the State of Wyoming recognizes the necessity of a robust and scientifically rigorous system of monitoring; and

WHEREAS, agencies of the State of Wyoming have established oversight mechanisms and implemented management stipulations in compliance with this and previous Executive Orders; and

WHEREAS, the listing of the Greater sage-grouse would have a significant, adverse effect on the land and natural resource management of the State of Wyoming beyond that necessary to maintain and enhance Greater sage-grouse populations and habitat; and

WHEREAS, the listing of the Greater sage-grouse would have a significant, adverse effect on the economy of the State of Wyoming, including the ability to generate revenues from State lands; and

WHEREAS, the listing of the Greater sage-grouse would have a significant, adverse effect on the custom and culture of the State of Wyoming, and would substantially obstruct and conflict with ongoing and effective collaborative efforts to conserve Greater sage-grouse; and

WHEREAS, the Wyoming State Legislature, federal, state and local agencies, industry, conservation organizations, and landowners have dedicated significant time and resources to conserve Greater sage-grouse populations in Wyoming; and

WHEREAS, in order to maintain and enhance Greater sage-grouse populations and adequate sagebrush-steppe habitat, the State of Wyoming has developed and implemented a Greater sage-grouse Core Area Protection strategy; and

WHEREAS, this Executive Order is the State of Wyoming's primary regulatory mechanism to conserve the Greater sage-grouse and preclude the need for listing the bird as a threatened or endangered species pursuant to the Endangered Species Act of 1973; and

WHEREAS, the Sage-Grouse Implementation Team serves as the oversight team in implementing this Executive Order and the Wyoming State Legislature established the Team as a statutory body (W.S. § 9-19-101) to provide recommendations regarding regulatory actions necessary to maintain and enhance Greater sage-grouse populations and habitats in Wyoming; and

WHEREAS, Wyoming's Greater sage-grouse Core Area Protection strategy protects significant quantity and quality of Greater sage-grouse habitat and protects a substantial portion of Wyoming's Greater sage-grouse; and

WHEREAS, on April 17, 2008, the Office of the Governor requested that the U.S. Fish and Wildlife Service review Wyoming's Greater sage-grouse Core Area Protection strategy to determine whether it was a "sound policy that should be moved forward" and on May 7, 2008, the U.S. Fish and Wildlife Service responded that the "core population area strategy… is a sound framework for a policy by which to conserve Greater sage-grouse in Wyoming"; and

WHEREAS, in its March 23, 2010 status determination for the Greater sage-grouse (Decision; 75 Federal Register 13910, 13974) the U. S. Fish and Wildlife Service stated, "the Service believes that the core area strategy[,] if implemented by all landowners via regulatory mechanisms, would provide adequate protection for sage-grouse and their habitats in that State[;]" and

WHEREAS, in a letter dated November 10, 2010, the U.S. Fish and Wildlife Service again confirmed that "[t]his long-term, science-based vision for the conservation of Greater sage-grouse has set the stage for similar conservation efforts across the species range," and that "the Core Population Area strategy for the Greater sage-grouse provides an excellent model for meaningful conservation of Greater sage-grouse if fully supported and implemented"; and

WHEREAS, the State of Wyoming, the Bureau of Land Management, the U.S. Forest Service, and other land management agencies have coordinated Greater sage-grouse Core Area Protection conservation actions across their boundaries which encompass approximately 15 million acres of habitat for the Greater sage-grouse in Wyoming; and

WHEREAS, federal land management agencies including the Bureau of Land Management and the U.S. Forest Service are revising or amending their respective Land and Resource Management Plans consistent with this Executive Order to prioritize conservation of Greater sage-grouse and their habitats; and

WHEREAS, Candidate Conservation Agreements with Assurances (CCAA) through the U.S. Fish and Wildlife Service and the Sage-Grouse Initiative (SGI) through the Natural Resources Conservation Service on private lands, complemented by Candidate Conservation Agreements (CCA) on public lands, are a proven means of investing in the future of rural land management; and

WHEREAS, significant investments of both time and money have been made by all stakeholders to see the successful implementation of the Greater sage-grouse Core Area Protection strategy; and

WHEREAS, science, information, and data continue to emerge regarding the habitats and behaviors of the Greater sage-grouse; and

WHEREAS, the review process built into Wyoming's Greater sage-grouse Core Area Protection strategy provides a mechanism to evaluate this emerging science, information, and data and has resulted in updated management recommendations from the Sage-Grouse Implementation Team.

NOW, THEREFORE, in consideration of the recommendations of the Sage-Grouse Implementation Team and pursuant to the authority vested in me by the Constitution and Laws of the State, and to the extent such actions are consistent with the statutory obligations and authority of each individual agency, including those found in the Wyoming Regulatory Takings Act, W.S. §§ 9-5-301 through 9-5-305, I, Matthew H. Mead, Governor of the State of Wyoming, do hereby issue this Executive Order providing as follows:

1. State agencies shall strive to maintain consistency by following the procedures outlined in this Executive Order, while recognizing that adjustments to the stipulations may be necessary based upon local conditions, opportunities, and limitations. The goal is to minimize future disturbance by co-locating proposed disturbances within areas already disturbed or naturally unsuitable.

2. Valid existing rights shall be recognized and respected. Activities existing or permitted in Core Population Areas prior to August 1, 2008, will not be required to be managed under Core Population Area stipulations. Activities existing or permitted prior to the date of this Executive Order and within Core Population Areas added as a result of this Executive Order will not be required to be managed under Core Population Area stipulations (see Attachment A, Figure 2). Examples of existing activities include oil and gas, mining, agriculture, processing facilities, housing, and other uses that were in place prior to the development of the Core Population Areas. Federal and state permitted activities, within a defined project boundary (such as a recognized federal oil and gas unit, drilling and spacing unit, mine plan, subdivision plat, utility ROW, grazing allotment etc.), shall be allowed to continue within the existing boundary even if the use exceeds recommended stipulations (see Attachment A, Figure 1).

3. It is critical that existing land uses and landowner activities continue to occur in Core Population Areas, particularly agricultural activities on private lands. Functioning ranches and agricultural lands provide crucial ecological and habitat services to wildlife. The failure or loss of these areas could have damaging implications to wildlife and their habitats. The loss of these important lands in their current status and role(s) could impact conservation objectives for Greater sage-grouse and other species (USFWS, February 5, 2015, Memo to State Directors and Field Supervisors: Service Position on Livestock Grazing and Working with the Rangeland Owners to Conserve Sage-Grouse).

4. For the most part, activities on private lands are not subject to state or federal agency review or approval. Only those activities which state agencies are required by state or federal law to review or approve are subject to review for consistency. Core Population Areas have been mapped to include additional habitat beyond that strictly necessary to prevent the listing of Greater sage-grouse. The additional habitat included within the Core Population Area boundaries is adequate to accommodate continuation of existing land uses and landowner activities. Existing land uses and landowner activities deemed to have negligible or no impacts to Greater sage-grouse are exempt from review for consistency under this Executive Order (see Attachment C).

5. Land uses and activities proposed inside Core Population Areas for which stipulations have not been developed in this Executive Order may be authorized on a case-by-case basis only when it can be demonstrated to the satisfaction of the permitting agency, and based upon recommendations made by the Wyoming Game and Fish Department, that the activity will avoid negative impacts to Greater sage-grouse.

6. Regulatory agencies and departments of the State of Wyoming including, but not limited to, the Office of State Land and Investments, Department of Environmental Quality, State

Engineer's Office, Industrial Siting Council and the Oil and Gas Conservation Commission, shall prioritize the maintenance and enhancement of Greater sage-grouse habitats and populations inside the Core Population Areas, connectivity areas, and winter concentration areas identified in Attachment A, Figure 1.

7. Development consistent with the stipulations set forth in Attachment B shall be deemed sufficient to demonstrate that the activity will avoid negative impacts to Greater sage-grouse.

8. Incentives to accelerate or enhance required reclamation in habitats adjacent to or within Core Population Areas should be developed, including but not limited to stipulation waivers, funding for enhanced reclamation, and other strategies. It is recognized that some incentives may result in reduced numbers of Greater sage-grouse outside of Core Population Areas.

9. Where consistent with the Greater sage-grouse conservation goals set forth herein, a non-regulatory approach should be used to influence management actions and activities within Core Population Areas. Permit stipulations should reflect unique localized conditions, including soils, vegetation, development type, predation, climate, and other local realities.

10. Wyoming is managing approximately 15 million acres of Core Population Area habitat to maintain high quality Greater sage-grouse habitat and maintain and enhance populations within normal variability.

11. Fire suppression efforts in Core Population Areas should be emphasized, recognizing that other local, regional, and national suppression priorities may take precedence. Public and firefighter safety remains the number one priority for all fire management activities.

12. The State of Wyoming will support research of activities in winter concentration areas where biologically significant numbers of Greater sage-grouse nesting in Core Population Areas are suspected of congregating. Further, the State of Wyoming will develop appropriate local, science-based standards to manage disturbance in identified and mapped winter concentration areas (see Attachment A, Figure 1).

13. To ensure continued sustainability of Wyoming's economy, all efforts to encourage, enhance, and prioritize development outside of Core Population Areas shall be made. State and federal agencies, with other relevant stakeholders, should work collaboratively to develop a strategic plan to achieve a beneficial balance between Greater sage-grouse protection and Wyoming's economy. Incentives, prioritization of projects outside of Core Population Areas, and streamlining permit processes should be considered.

14. State and federal agencies, including the U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Forest Service, Wyoming Game and Fish Department, and other stakeholders shall work collaboratively to ensure a uniform and consistent application of

this Executive Order to maintain and enhance Greater sage-grouse habitats and populations.

15. State agencies shall work collaboratively with all appropriate stakeholders to maintain and enhance Greater sage-grouse habitats and populations consistent with the language and spirit of this Executive Order.

16. The State of Wyoming will support voluntary enrollment and expanded coverage for conservation easements, CCAA, CCA, and commensurate improvements and investments by the U.S. Department of Agriculture and the U.S. Fish and Wildlife Service, where appropriate. These efforts should be focused and prioritized to take place in Core Population Areas.

17. Local Working Groups will continue to be engaged through the Local Working Group Charter.

18. The State of Wyoming will engage in adaptive management that will include the involvement of state and federal land management and regulatory agencies as appropriate (see Attachment B).

19. State agencies shall report all conservation and permitted actions occurring within Greater sage-grouse Core Population Areas annually, or more frequently, as determined necessary.

20. The State of Wyoming shall work with federal, state, county, private and non-governmental organization partners to collect data to determine the condition of each Core Population Area in relationship to the goals of the Wyoming's Greater sage-grouse Core Area Protection strategy.

21. Absent substantial and compelling information that adjustments are necessary to protect the integrity of the Greater sage-grouse Core Area Protection strategy, these Core Population Areas, connectivity areas, identified and mapped winter concentration areas, and protective stipulations identified in this Executive Order shall not be altered for a minimum of 7 years.

22. The State of Wyoming shall continue to monitor and document Greater sage-grouse populations and development activities to ensure that permitted activities under this authority do not result in negative impacts to Greater sage-grouse outside cyclical trends.

23. This Executive Order, together with its attachments, constitutes Wyoming's strategy for the conservation of the Greater sage-grouse and their habitats. Attachments A through I

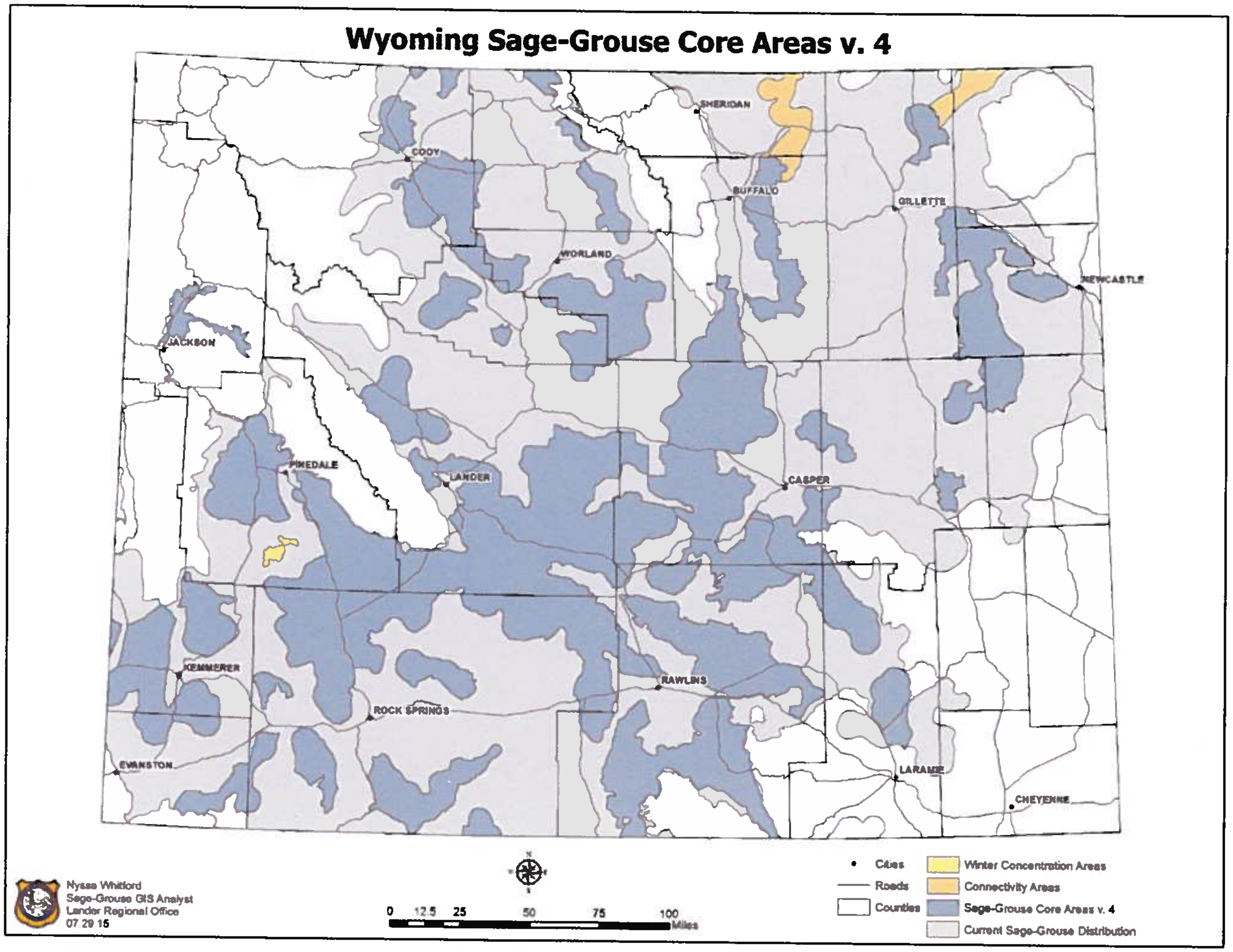
are expressly adopted and incorporated by reference herein, and each shall have the full force and effect of this Executive Order.

Given under my hand and the Executive Seal of the State of Wyoming this 29 day of July, 2015.

Matthew H. Mead
Governor

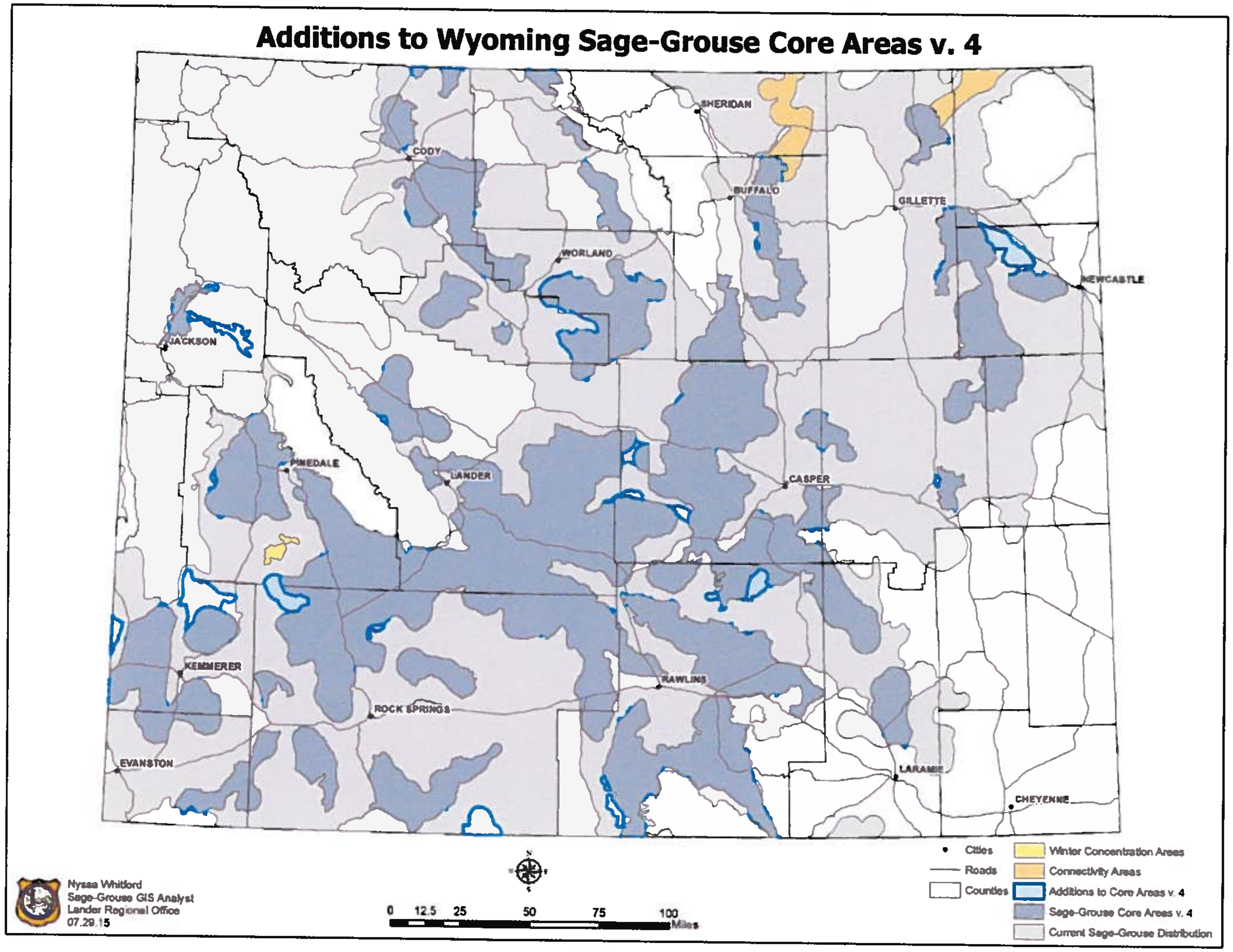
EXECUTIVE ORDER 2015-4
ATTACHMENT A

Figure 1.



Executive Order 2015-4
Attachment A
Page 1 of 7

Figure 2.


Additions to Wyoming Sage-Grouse Core Areas v. 4
SHERIDAN
CODY
BUFFALO
GILLETTE
WORLAND
NEWCASTLE
JACKSON
PINEDALE
LANDER
CASPER
KEMMERER
RAWLINS
ROCK SPRINGS
EVANSTON
LARAMIE
CHEYENNE
Cities
Roads
Counties
Winter Concentration Areas
Connectivity Areas
Additions to Core Areas v. 4
Sage-Grouse Core Areas v. 4
Current Sage-Grouse Distribution
0 12.5 25 50 75 100 Miles
Nyssa Whitford
Sage-Grouse GIS Analyst
Lander Regional Office
07.29.15

HOW THE WYOMING GREATER SAGE-GROUSE CORE AREA PROTECTION STRATEGY WAS DEVELOPED

Beginning in 2007, the Sage Grouse Implementation Team was charged with three primary tasks: (1) identification of areas where Greater sage-grouse and their habitats would be most effectively conserved, (2) development of a strategy to reduce or eliminate potential threats to the species, and (3) development of methodology to evaluate, document and track potential impacts over time. The following describes those efforts to date.

1. Establishment of Greater Sage-Grouse Core Population Areas

Greater sage-grouse lek location and attendance data as identified through modeling of bird populations and habitat were overlaid with areas of valid existing rights to produce the Greater sage-grouse Core Population Area map for Wyoming (Figure 3). This iterative process consisted of a series of reviews conducted in the field by Local Working Group (LWG) and others with a thorough understanding of local Greater sage-grouse use to assure that areas included as core habitat were a true representation of actual conditions on the ground. Similar processes were used in 2010 (Figure 4) and 2015 (Figure 5) to refine the Core Population Area mapping, resulting in the current Core Population Areas.

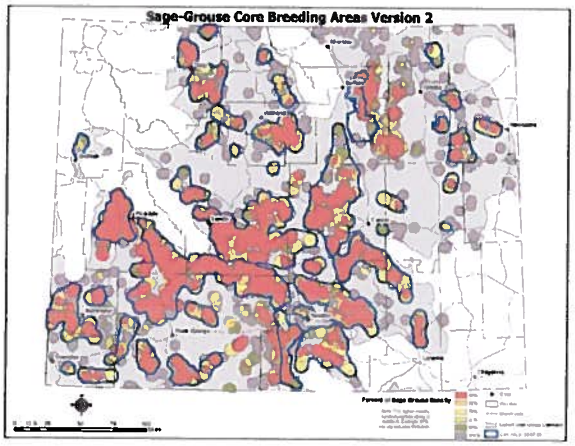


Figure 3. Greater sage-grouse breeding density and Core Population Areas (Version 2) associated with Executive Order 2008-2.

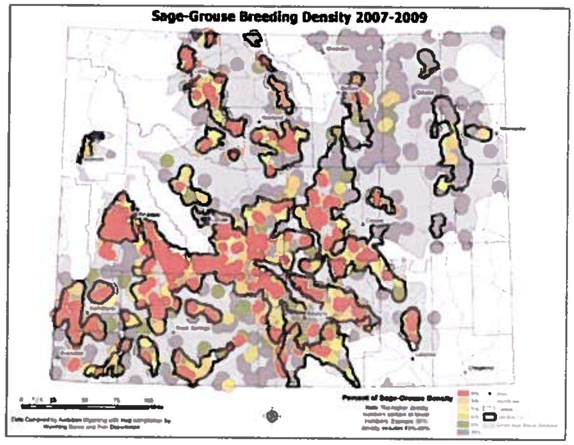


Figure 4. Greater sage-grouse breeding density and Core Population Areas (Version 3) associated with Executive Orders 2010-4 and 2011-5.

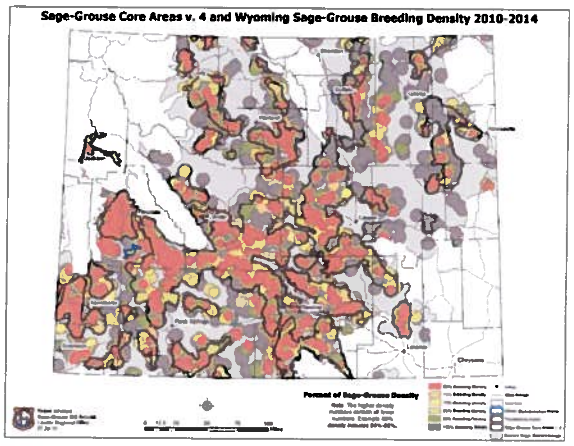


Figure 5. Greater sage-grouse breeding density and Core Population Areas (Version 4) associated with Executive Order 2015-4.

A kernel density function was applied to the lek location and attendance data to develop the final Greater sage-grouse density maps and later adjustments (Doherty et al. 2010, 2011). The red areas on Figures 3 and 4 represent the breeding habitat for 65% of Greater sage-grouse in Wyoming based on lek size and location. The maps illustrate population proportions at a given time, not trends over time. This method was based on breeding birds and did not take into account late brood-rearing and wintering seasonal habitats. During the 2010 revision of Core Population Area boundaries in Wyoming, both late brood-rearing and winter use were considered in the process and most of these seasonal habitats associated with birds in the existing Core Population Area were included in the final product (Figure 4). The eight LWGs assisted in the revision process by using highly-detailed habitat imagery (1 meter NAIP) and reviewing new lek and development data. These activities were open to the public and other interests throughout the process.

The resultant 2008, 2010 and 2015 (Figures 3, 4, and 5) Core Population Areas encompass approximately 83% of the Greater sage-grouse population, on approximately 24% of the surface area of the State of Wyoming (unpublished data, Wyoming Game and Fish Department, Gamo et al. 2013).

Connectivity Areas

Connectivity corridors are recognized as areas important for maintaining the transmission of genetic material between populations. These corridors have been identified as the most likely dispersal routes used by Greater sage-grouse to travel between potentially isolated populations in Wyoming to populations in neighboring states. Viable corridors reduce the threat of creating isolated populations in Wyoming and adjacent populations in neighboring states. Connectivity corridors are managed to limit anthropogenic development and have been delineated to increase the likelihood of natural immigration/emigration important for maintaining genetic variability in Core Populations Areas.

Winter Concentration Areas

The identification of Core Population Areas is intended to capture all seasonal requirements for Greater sage-grouse; however, there is a recognition that in some cases Core Population Areas may not capture all Greater sage-grouse needs (Aldridge and Boyce 2007, Doherty et al. 2008, Doherty et al. 2011). Specifically, winter concentration areas, defined as places where large numbers of Core Population Area Greater sage-grouse congregate and persistently occupy between December 1 and March 14, should be identified and protected. Identification of winter concentration areas should be based on habitat features and repeated observations of winter use by biologically significant numbers of Greater sage-grouse (e.g., groups of ≥50 Greater sage-grouse) using a validated Resource Selection Function (RSF) modeling approach.

2. Management Goals and Mitigation in the Greater Sage-Grouse Core Area Protection Strategy

The Wyoming Greater sage-grouse Core Area Protection strategy represents a proactive identification of a set of conservation actions to maintain and enhance a viable and connected set of populations before the opportunity to do so is lost (Doherty et al 2011). The strategy is based on the identification of important habitat areas for Greater sage-grouse and a set of actions that when taken are intended to ensure the long-term survival of Greater sage-grouse populations in Wyoming. The strategy follows an established hierarchy of *avoidance*, understanding that the primary mission is avoiding impacts to and protecting the best remaining habitat for Greater sage-grouse; *minimizing* impacts where they cannot first be avoided; and when Core Population Area thresholds are exceeded, *compensating* for any unavoidable impacts to Greater sage-grouse.

Avoidance

Preferred development plans avoid negative impacts in Core Population Areas and other Executive Order delineated habitats used by Core Population Area Greater sage-grouse. This maximizes protections for both Greater sage-grouse and sagebrush habitat. Avoidance can be both spatial and temporal.

Minimization

When development occurs within Core Population Areas and other Executive Order delineated habitats used by Core Population Area Greater sage-grouse, all reasonable options are pursued to minimize impacting additional suitable habitat and/or maintaining impacts below identifiable thresholds to the greatest extent possible. This may result in new disturbance within Core Population Areas, but the disturbance is managed not to exceed Executive Order thresholds and result in no discernible impacts at the population level. Development plans are managed to limit disturbance to less than 5% and no more than an average of one oil and gas pad or mining site per 640 acres within the Density Disturbance Calculation Tool (DDCT) project area.

Compensation

The complexity of developing compensatory mitigation projects that provide biologically meaningful benefits to Greater sage-grouse populations requires rigorous standards for mitigation to be defined and developed. Performance standards (e.g., net benefit to Greater sage-grouse), monitoring requirements, and adaptive management plans should explicitly link landscape conservation actions to Core Population Areas and other Executive Order delineated habitats used by Core Population Area Greater sage-grouse and statewide landscape conservation objectives for Greater sage-grouse. See also Attachment H.

3. Use of the DDCT in Managing the Greater Sage-Grouse Core Area Protection Strategy

A 4-mile radius around active leks captures 74-80% of nesting females associated within their lek of breeding. The 4-mile distance has been confirmed by multiple studies as having particular importance to Greater sage-grouse in the West, including the majority of seasonal habitats associated with an individual lek, and falls within a reasonable range of buffers (Manier et al. 2014) for Greater sage-grouse. This radius accounts for all types of disturbance within the background of measurable impacts to Greater sage-grouse in field studies. By using the 4-mile radius, the DDCT achieves both a realistic consideration of impacts in a relevant assessment area, while avoiding dilution of existing disturbance being considered in conjunction with any one proposed development.

Core Population Area Monitoring and Management:

A system of interagency coordination has been developed to monitor and track development and conservation activities across Core Population Areas to determine whether development actually meets the thresholds of this Executive Order (see Attachment B).

Literature Cited:

Aldridge, C. L. and M. S. Boyce. 2007. Linking occurrence and fitness to persistence: habitat-based approach for endangered greater sage-grouse. Ecological Applications 117:508–526.

Doherty, K. E., D. E. Naugle, B. L. Walker, and J. M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management 72:187–195.

Doherty K.E., J.D. Tack, J.S. Evans, and D.E. Naugle. 2010. Breeding densities of Greater sage-grouse: A tool for range-wide conservation planning. BLM Completion Report: Interagency Agreement # L10PG00911. Bureau of Land Management. Washington, D.C.

Doherty, K. E., D. E. Naugle, H. E. Copeland, A. Pocewicz, and J. M. Kiesecker. 2011. Energy development and conservation tradeoffs; systematic planning for Greater sage-grouse in their eastern range. Pp. 505-516 *in* S. T. Knick and J. W. Connelly (editors). Greater sage-grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology (vol. 38). University of California Press, Berkeley, CA.

Gamo, R. S., J. D. Carlisle, J. L. Beck, J. C. Bernard, and M. E. Herget. 2013. Can the greater sage-grouse serve as an umbrella species for other sagebrush-dependent wildlife? The Wildlife Professional.

Manier, D.J., Bowen, Z.H., Brooks, M.L., Casazza, M.L., Coates, P.S., Deibert, P.A., Hanser, S.E., and Johnson, D.H., 2014, Conservation buffer distance estimates for Greater Sage-Grouse—A review: U.S. Geological Survey Open-File Report 2014–1239, 14 p., http://dx.doi.org/10.3133/ofr20141239.

USFWS. 2014. Greater Sage-Grouse Range-Wide Mitigation Framework v. 1.0

EXECUTIVE ORDER 2015-4
ATTACHMENT B

Permitting Process and Stipulations for Development in Greater Sage-Grouse Core Population Areas

PERMITTING PROCESS

Point of Contact

The density of disruptive activities (1/640) and surface disturbance (5%) will be analyzed via the Density/Disturbance Calculation Tool (DDCT), and will be conducted by the Federal Land Management Agency or project proponent (as determined by the BLM Field Office Manager) on federal surface/mineral and the project proponent on non-federal (private, state). The DDCT analysis is then evaluated against Executive Order 2015-4 thresholds.

When State agency permit is needed, without a need for a federal permit:

The first point of contact for addressing Greater sage-grouse Core Population Area issues for any state permit application should be the Wyoming Game and Fish Department (WGFD). Project proponents should contact WGFD at least 45-60 days prior to submitting their application. More complex projects will require more time. It is understood that WGFD has a role of consultation, recommendation, and facilitation, and has no authority to either approve or deny the project. The purpose of the initial consultation with the WGFD is to become familiar with the project proposal and ensure the project proponent understands the DDCT and recommended stipulations. Project proponents need to have a thorough description of their project and identify the potential effects on Greater sage-grouse prior to submitting an application to the permitting agency.

When Federal agency permit is needed, with or without a State permit:

When a project requires federal action prior to approval, the proponent should contact the federal agency responsible for reviewing the action. The federal agency and the proponent will determine the best process for completing the DDCT and receiving recommendations from WGFD. Project proponents need to have a thorough description of their project and identify the potential effects on Greater sage-grouse prior to submitting an application to the permitting agency (see Attachment D).

Maximum Density and Disturbance Process

Density and Disturbance Calculation: The DDCT, (ddct.wygisc.org), is a spatially based tool that calculates both the average density of disruptive activities and total surface disturbance within the area affected by the project, or DDCT assessment area. The DDCT assessment area is created based on an initial radius around projects proposed in Greater sage-grouse Core Population Areas (Doherty et al. 2011), and subsequent radius around any occupied, Core

Population Area leks within the initial radius (see Figures 1 – 2). A 4-mile radius is used to identify 75% of the Greater sage-grouse use around a lek (Walker et al. 2007, Fedy et al. 2012). Any portion of the analysis area not found in core is removed (see Figure 3). All activities will be evaluated within the context of maximum allowable disturbance (disturbance percentages, location and number of disturbances) of suitable Greater sage-grouse habitat (see Attachment F for definition of suitable Greater sage-grouse habitat and disturbance of suitable Greater sage-grouse habitat) within the DDCT assessment area (see Figure 4). This tool allows for better siting of projects rather than averaging the density/disturbance calculation per section.

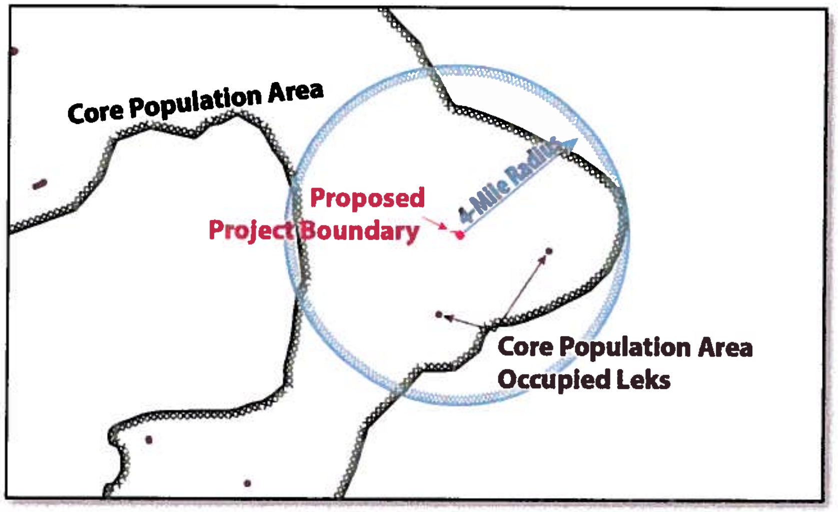


Figure 1 – DDCT assessment area step 1, proposed project boundary.

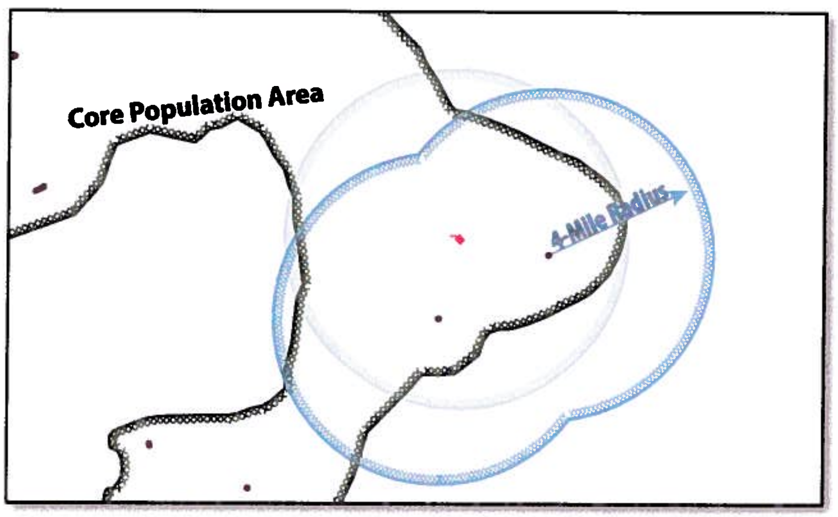


Figure 2 - DDCT assessment area step 2, lek boundaries.

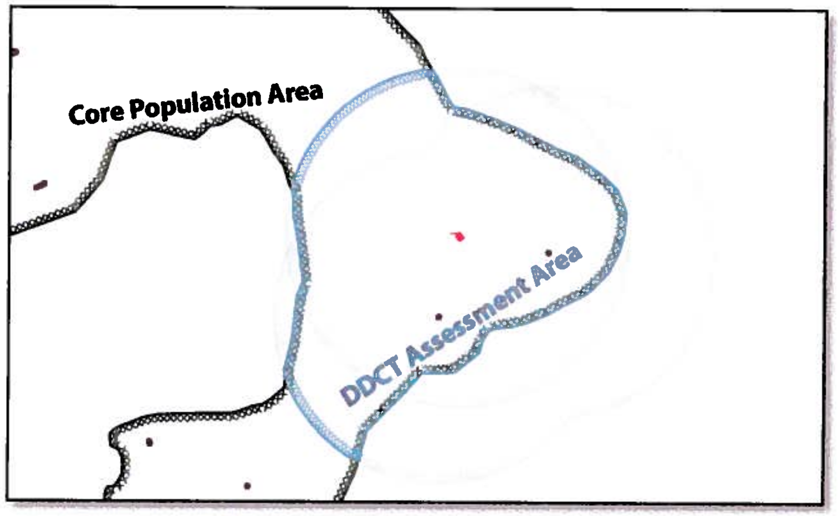


Figure 3 - DDCT assessment area step 3, remove non-core population areas.

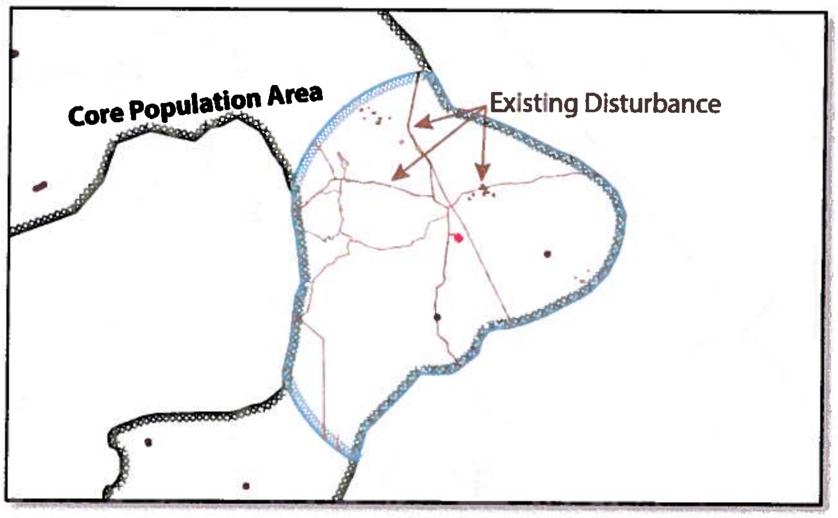


Figure 4 - Existing and proposed disturbance in the DDCT assessment area.

All lands within Core Population Area boundaries are considered suitable habitat unless documented. Mapped unsuitable habitat is treated as neither suitable habitat, nor disturbance, which results in the area being removed from the DDCT assessment area altogether.

Density and disturbance analysis: The total number of discrete disruptive activity features, as well as the total disturbance acres within the DDCT assessment area will be determined through an evaluation of:

- Existing disturbance (Greater sage-grouse habitat that is disturbed due to existing anthropogenic activity and wildfire).
- Approved permits (that have approval for on the ground activity) not yet implemented.

- Validation of the digitized disturbance through on the ground evaluation.

Avoiding and Minimizing Impacts

See Attachment A.

The following is the suggested administrative process for avoiding and minimizing impacts, as necessary.

For valid existing rights: If the proposed project DDCT is at or above Executive Order thresholds, the project proponent, WGFD and the permitting agency must determine whether or not there are ways to avoid or minimize impacts to Greater sage-grouse before issuing a permit to proceed.

The proponent will work with the permitting agency to site the project within the permit/lease area in a way that will likely have the least amount of impact on local Greater sage-grouse populations (i.e., existing anthropogenic disturbance, geographically remote from Greater sage-grouse habitat, unsuitable habitats). The surface disturbance and disruptive activity resulting from the proposed project will still count towards the 5% disturbance and 1/640 density thresholds (unless the proponent can show that there is a 0.6 mile buffer of unsuitable habitat between the proposed disturbance and suitable habitat). It is understood that project locations are often resource specific and that certain projects may not be able to be relocated to another location.

The proponent and the permitting agency will evaluate the DDCT area and the affected Greater sage-grouse Core Population Area for areas where additional reclamation/restoration actions or management of invasive species (especially within the proponents permit/lease area(s)) could reduce the amount of overall disturbance.

The proponent and the permitting agency should consider other opportunities to improve Greater sage-grouse habitat (i.e., conservation easements, additional reclamation of disturbed habitats in suitable habitats that are no longer necessary).

Should the proponent and the state permitting agency not come to agreement; the Sage Grouse Implementation Team (SGIT) will review the information. The BLM and U.S. Forest Service both have their own appeal process to handle disagreements but may coordinate through the SGIT.

Permitting

The complete analysis package (DDCT results, map book, and worksheet), and recommendations developed by consultation and review outlined herein will be forwarded to the appropriate permitting agency(s). WGFD recommendations will be included, as will other recommendations from project proponents and other appropriate agencies. Project proponent shall have access to all information used in developing recommendations. Where possible and when requested by the project proponent, State agencies shall provide the project proponent with potential development alternatives other than those contained in the project proposal.

If the permit for which a proponent has applied expires, another DDCT analysis is required before issuing a new permit. An additional DDCT is not required for Permit extensions or renewals when no changes are being authorized.

The Executive Order in effect at the time of a complete formal application will remain in effect through the final permit.

Projects that have formally applied for a permit (e.g., CPCN, CUP, NOA, NOI, Initiation of scoping, other permits, or other official public action declaring the project, etc.) should comply with the Executive Order in effect when the project application was made. It is recognized that project planning and permitting can take years to move to a final permit.

EXEMPT ACTIVITIES

A list of exempt ("de minimus") activities, including standard uses of the landscape is available in Attachment C.

GENERAL STIPULATIONS

These stipulations are designed and intended to maintain existing suitable Greater sage-grouse habitat by permitting development activities in Core Population Areas in a way that will avoid negative impacts to Greater sage-grouse.

General stipulations are recommended to apply to all activities in Core Population Areas, with the exception of exempt ("de minimus") actions defined herein (see Attachment C) or specifically identified activities. The specific industry stipulations are considered in addition to the general stipulations.

Surface Disturbance

Core Population Area: Surface disturbance will be limited to 5% of suitable Greater sage-grouse habitat per an average of 640 acres over the entire DDCT assessment area. The DDCT process will be used to determine the level of disturbance. Distribution of disturbance may be considered and approved on a case-by-case basis. Unsuitable habitat should be identified in a seasonal and landscape context, on a case-by-case basis, outside the 0.6 mile buffer around occupied leks. This will incentivize proponents to locate projects in unsuitable habitat to avoid creating additional disturbance acres. The primary focus should be on protection of suitable habitats and minimizing habitat fragmentation. See Attachment F for a description of suitable, unsuitable habitat and disturbance.

Non-Core Population Area: There are no limitations to disturbance outside the 0.25 mile no surface occupancy buffer.

Surface Occupancy

Core Population Area: Within 0.6 miles of the perimeter of occupied Greater sage-grouse leks there will be no surface occupancy (NSO). NSO, as used in these recommendations, means no permanent surface facilities including roads shall be placed within the NSO area. Other activities may be authorized with the application of appropriate seasonal stipulations, provided the resources protected by the NSO are not adversely affected. For example, underground utilities may be permissible if installation is completed outside applicable seasonal stipulation periods and significant resource damage does not occur. Seasonal protections are to be determined on principal usage of site by Greater sage-grouse. The primary purpose of the 0.6 restriction around leks is to avoid disturbing leking birds and to maintain habitat integrity (Holloran 2005, Hess and Beck 2012). This necessitates the limitation of traffic or infrastructure that would encourage human activity around occupied leks.

Non-Core Population Area: Within 0.25 miles of the perimeter of occupied Greater sage-grouse leks there will be NSO (Braun et al. 2002). NSO, as used in these recommendations, means no permanent surface facilities including roads shall be placed within the NSO area. Other activities may be authorized with the application of appropriate seasonal stipulations, provided the resources protected by the NSO are not adversely affected. For example, underground utilities may be permissible if installation is completed outside applicable seasonal stipulation periods and significant resource damage does not occur.

Seasonal Use

Core Population Areas (Holloran 2005): Activities will be allowed from July 1 to March 14 outside of the 0.6 mile perimeter of an occupied lek in Core Population Areas where breeding, nesting and early brood-rearing habitat is present.

Non-Core Population Areas (Braun et al. 2002, Dzialak 2011): Activity will be allowed from July 1 to March 14 outside of the 0.25 mile perimeter of an occupied lek. A 2-mile seasonal buffer from March 15 to June 30, applies to occupied leks where breeding, nesting and early brood-rearing habitat is present. Activities in unsuitable habitat may also be approved year-round on a case-by-case basis. Activities may be allowed during seasonal closure periods as determined on a case-by-case basis.

Special Considerations: Where credible data support different timeframes for these seasonal restrictions, dates may be shifted 14 days prior to or subsequent to the above dates, but not both.

Winter Concentration Areas: In areas identified as winter concentration areas, activities will be allowed March 14 to December 1. Activities in unsuitable habitat may also be approved year-round on a case-by-case basis (except in specific areas where credible data shows calendar deviation). Activities may be allowed during seasonal closure periods as determined on a case-by-case basis.

Production and Maintenance Activities: Production and maintenance activities are exempt from seasonal use stipulations.

Geophysical Exploration

Geophysical exploration which includes minimal disturbance (3 inch diameter drill holes or just "vibrating") may be permissible in accordance with seasonal stipulations. Staging areas should be located outside of Core Population Areas, covered through a DDCT process, or placed on existing disturbance.

Transportation

Locate new collector or arterial roads that will have relatively high levels of activity (accessing multiple wells, housing development) greater than 1.9 miles from the perimeter of occupied Greater sage-grouse leks (Lyons and Anderson 2003). Locate new local roads used to provide facility site access and maintenance greater than 0.6 miles from the perimeter of occupied Greater sage-grouse leks. Construct roads to minimum design standards needed for production activities.

Collector or Arterial Roads are single-lane or double-lane roads, with travel ways 12 to 24 feet in width. They collect traffic from local roads and connect to arterial roads or public highways. They are operated for intermittent or constant service.

Local Roads are single-lane roads with travel ways 12 to 14 feet in width. They connect terminal facilities, such as well sites, to collector, local, arterial, or other higher-class roads. They are operated for low-volume traffic.

Overhead Power Lines (Avian Power Line Interaction Committee (APLIC) 2015)

It will be necessary to construct significant new transmission infrastructure to transport electricity generated in Wyoming to out-of-state load centers. Currently, it is unknown what type of lines impact Greater sage-grouse populations, how, and to what extent (Messmer, et al. 2014). There will be new distribution and transmission lines that will need to be built to service existing approved projects.

For purposes of consistency with this Executive Order there is established a transmission line corridor through Core Population Areas in south central and southwestern Wyoming as illustrated on Attachment I. This 2-mile wide corridor represents the State of Wyoming's preferred alternative for routing electric transmission lines across the southern portion of the state while reducing impacts to Core Population Areas and other natural resources.

New transmission lines constructed within corridors identified in this Executive Order (see Attachment I) or within ½-mile either side of existing or permitted (prior to August 1, 2008) 115 kV or larger transmission lines, creating a corridor no wider than 1-mile shall be considered consistent with this Executive Order if construction occurs within the corridor between July 1 and March 14 (or between July 1 and December 1 in Executive Order identified and mapped winter concentration areas). New transmission lines constructed within ½-mile either side of 115kV or larger transmission lines in existence or permitted prior to the date of this Executive Order and within Core Population Areas added as a result of this Executive Order, creating a corridor no wider than 1-mile, shall be considered to be consistent with this Executive Order if construction occurs within the corridor between July 1 and March 14 (or between July 1 and December 1 in Executive Order identified and mapped winter concentration areas).

New transmission lines outside the above described corridors but within Core Population Areas should be authorized or conducted only when it can be demonstrated that the activity will avoid negative impacts to Greater sage-grouse. If it is absolutely necessary to site new distribution and transmission lines through a Core Population Area outside of an existing corridor, lines should be sited to minimize negative impact on Greater sage-grouse or their habitats, and preferentially consider siting along or adjacent to existing long-term linear disturbance features whenever possible (i.e., along existing occupied above ground utilities or roads).

Proponents are encouraged to apply appropriate Best Management Practices (BMPs) specific to electric utility facilities (see APLIC 2015); otherwise, locate overhead lines at least 0.6 miles from the perimeter of occupied Greater sage-grouse leks.

Lines permitted but not located in an Executive Order transmission corridor will be counted towards the 5% disturbance calculation (line disturbance is equal to ROW width X length and includes all access roads, staging areas, and other permanent surface disturbance associated with construction outside of the ROW).

Noise

New project noise levels, either individual or cumulative, should not exceed 10 decibels (as measured by L_{50}) above baseline noise at the perimeter of a lek from 6:00 pm to 8:00 am during the breeding season (March 1 to May 15). Specific noise protocols for measurement and stipulations for implementation will be developed as additional research and information emerges.

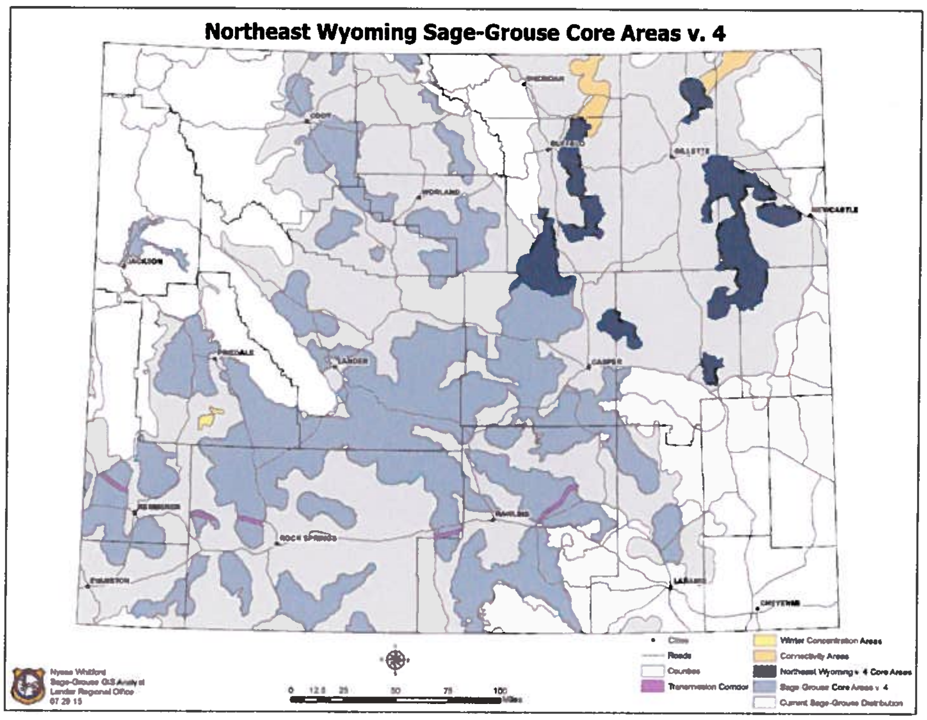
Vegetation Removal

Vegetation removal should be limited to the minimum disturbance required by the project. All topsoil stripping and vegetation removal in suitable habitat is limited to between July 1 and March 14 in areas that are within 4-miles of an occupied lek. Production and maintenance activities (surface mining) outside seasonal stipulations are considered permissible once the vegetation is removed outside the seasonal stipulations. Initial disturbance in unsuitable habitat between March 15 and June 30 may be approved on a case-by-case basis. It is important that the "viability" of the topsoil is maintained. A set of BMPs for protecting top soil are outlined in Attachment G.

Sagebrush Treatment

Sagebrush eradication is considered disturbance and will contribute to the 5% disturbance factor. Northeast Wyoming, as depicted in Figure 5, is of particular concern because sagebrush habitats rarely exceed 15% canopy cover and large acreages have already been converted from sagebrush to grassland or cropland. Absent solid demonstration that the proposed treatment will not reduce canopy cover to less than 15% within the treated area, habitat treatments in Northeast Wyoming (Figure 5) should not be conducted. In stands with less than 15% cover, treatment should be designed to maintain or improve sagebrush habitat. Sagebrush treatments that maintain sagebrush canopy cover at or above 15% total canopy cover within the treated acres will not be considered disturbance. The WGFD has developed a Vegetation Treatment Protocol (July 8, 2011 or updated version) for treating sagebrush to be consistent with this Executive Order. Treatments in Core Population Areas shall follow the Protocol or the treatment acreage may be considered disturbance.

Figure 5



Reclamation

Reclamation should re-establish native grasses, forbs and shrubs during interim and final reclamation to achieve cover, species composition, and life form diversity commensurate with the surrounding plant community or desired ecological condition to benefit Greater sage-grouse and replace or enhance Greater sage-grouse habitat to the degree that environmental conditions allow. Seed mixes should include two native forbs and two native grasses with at least one bunchgrass species. See Attachment E. Where sagebrush establishment is prescribed, establishment is defined as meeting the standard prescribed in the individual reclamation plan. Landowners should be consulted on desired plant mix on private lands. The operator is required to control noxious and invasive weed species, including cheatgrass. Rollover credit, if needed, will be outlined in the individual project reclamation plan.

Credit may be given for completion of habitat enhancements on bond release or other minimally functional habitat when detailed in a plan. These habitat enhancements may be used as credit for reclamation that is slow to establish in order to maintain the disturbance cap or to improve nearby Greater sage-grouse habitat.

Conditions for determining when disturbed lands are now considered suitable can be found in Attachment F.

Monitoring/Adaptive Response

Proponents of new projects are expected to coordinate with the permitting agency and local WGFD biologist to determine which leks need to be monitored and what data should be reported by the proponent. Certain permits may be exempted from monitoring activities pending permitting agency coordination. If declines in affected leks (using a three-year running average during any five year period relative to trends on reference leks) are determined to be caused by the project, the operator will propose adaptive management responses to increase the number of birds. If the operator cannot demonstrate a restoration of bird numbers to baseline levels (established by pre disturbance surveys, reference surveys and taking into account regional and statewide trends) within three years, operations will cease until such numbers are achieved.

PREEXISTING OIL AND GAS UNITS

In administering oil and gas plans of development in Core Population Areas, logical and systematic planning will occur in accordance with the terms of oil and gas unit agreements established prior to August 1, 2008 and the goals of this Executive Order. In administering oil and gas plans of development in Core Population Areas added as a result of this Executive Order, logical and systematic planning will occur in accordance with the terms of oil and gas unit agreements in existence prior to the date of this Executive Order and the goals of this Executive Order. This will be accomplished by concentrating activity within existing unit boundaries even if disturbance and density exceed Executive Order thresholds within the DDCT assessment area.

Each situation should be addressed with flexibility and an understanding of the local landscape, habitats, and other factors.

Federal oil and gas units in effect prior to August 1, 2008 are not subject to new Greater sage-grouse mitigation measures contained in Attachment B of this Executive Order with the exception that unit operators cannot initiate activities resulting in new surface occupancy within 0.6 miles of the perimeter of an occupied Greater sage-grouse lek. Federal oil and gas units in effect prior to the date of this Executive Order within Core Population Areas added as a result of this Executive Order are not subject to new Greater sage-grouse mitigation measures contained in Attachment B of this Executive Order with the exception that unit operators cannot initiate activities resulting in new surface occupancy within 0.6 miles of the perimeter of an occupied Greater sage-grouse lek.

For oil and gas development approved under the annual plan of development and associated surface disturbance proposals by the unit operator, the unit operator is required to complete the DDCT process including the appropriate worksheet when submitting those applications. It is understood that the level of existing and future development in pre-August 1, 2008 Federal oil and gas units may exceed Executive Order thresholds. It is understood that the level of existing and future development in Core Population Areas added as a result of this Executive Order for Federal oil and gas units may exceed Executive Order thresholds.

The DDCT results and worksheet completed for the pre-August 1, 2008 oil and gas unit activity will be used solely to track disturbance data inside the unit boundary to obtain baseline data for use in Executive Order monitoring and to calculate existing and future planned disturbance. For activity in federal oil and gas units in effect prior to the date of this Executive Order within Core Population Areas added as a result of this Executive Order, the DDCT results and worksheet completed will be used solely to track disturbance data inside the unit boundary to obtain baseline data for use in Executive Order monitoring and to calculate existing and future planned disturbance. Proponents and agencies are still expected to minimize surface disturbance whenever possible and follow all other existing, applicable lease stipulations. As projects are completed, as-built footprints will be collected and the disturbance layer updated with the as-built information.

For project proposals located outside unit boundaries, wherein a DDCT assessment area for the project proposal encompasses parts of pre-August 1, 2008 oil and gas units, disturbance will be based upon the existing disturbance, annual plans of development, or other relevant information regarding development provided by the unit operator, the BLM Reservoir Management Group or other credible sources of information such as the Wyoming Oil and Gas Conservation Commission. For project proposals located outside unit boundaries established prior to the date of this Executive Order, wherein a DDCT assessment area for the project proposal encompasses parts of oil and gas units in Core Population Areas added as a result of this Executive Order, disturbance will be based upon the existing disturbance, annual plans of development, or other relevant information regarding development provided by the unit operator, the BLM Reservoir Management Group or other credible sources of information such as the Wyoming Oil and Gas

Conservation Commission. In the absence of an annual plan of development or other relevant information, the unit affected will be considered fully developed for the purpose of calculating existing disturbance per the DDCT process.

For new development inside the boundary of a Federal oil and gas unit in effect prior to August 1, 2008 that is not directly related to oil and gas development (e.g., vegetation treatment or gravel pits), the project proponent will be required to comply with all aspects of this Executive Order. For new development inside the boundary of a Federal oil and gas unit in effect prior to the date of this Executive Order within Core Population Areas added as a result of this Executive Order that is not directly related to oil and gas development (e.g., vegetation treatment or gravel pits), the project proponent will be required to comply with all aspects of this Executive Order.

SPECIFIC STIPULATIONS
(to be applied in addition to general stipulations)

Oil and Gas

Oil and gas well pads and associated infrastructure densities are not to exceed an average of one pad per square mile (1/640) and suitable habitat disturbed not to exceed 5% of suitable habitat within the DDCT assessment area. As an example, the number of well pads within a two mile radius of the perimeter of an occupied Greater sage-grouse lek should not exceed 11, distributed preferably in a clumped pattern in one general direction from the occupied lek.

Mining

For development drilling or ore body delineation drilled on tight centers, (approximately 100' X 100') the disturbance area will be delineated by the external limits of the development area. Assuming a widely-spaced disturbance pattern, the actual footprint will be considered the disturbance area.

Monitoring results will be reported annually in the mine permit annual report and to WGFD. Pre-disturbance surveys will be conducted as required by the appropriate regulatory agency.

The number of active mining development areas (e.g., operating equipment and significant human activity) is not to exceed an average of one site per square mile (1/640) within the DDCT.

Surface disturbance and surface occupancy stipulations will be waived within the Core Population Area when implementing underground mining practices that are necessary to protect the human health, welfare, and safety of miners, mine employees, contractors and the general public. The mining practices include but are not limited to bore holes or shafts necessary to: 1) provide adequate oxygen to an underground mine; 2) supply inert gases or other substances to prevent, treat, or suppress combustion or mine fires; 3) inject mine roof stabilizing substances; and 4) remove methane from mining areas. Any surface disturbance or surface occupancy necessary to access the sites to implement these mining practices will also be exempt from any stipulation.

Coal mining operations will be allowed to continue under the regulatory and permit-specific terms and conditions authorized under the Wyoming Environmental Quality Act (WEQA) and the Surface Mining Control and Reclamation Act of 1977 (SMCRA) as administered by the Wyoming Department of Environmental Quality (WDEQ).

i. There is the expectation that coal activities as permitted under the WEQA and SMCRA will be implemented to protect Greater sage-grouse and their habitat in Core Population Areas to a high level.

ii. In Core Population Areas, to avoid significant "negative" impacts to Greater sage-grouse, unsuitability criteria for state high sensitive species (i.e., Greater sage-grouse), will be applied to each coal lease application during the federal coal leasing process. This process includes consultation with the State to identify any lands within the application area that are essential for maintaining high priority wildlife (i.e., Greater sage-grouse). Where appropriate, BLM will find such lands to be unsuitable for further federal coal leasing consideration. Incorporation of new leases into existing mining operations is considered allowable by the State without further regulatory obligations under the Greater sage-grouse Core Area Protection strategy, beyond the current requirements under the WEQA and SMCRA.

iii. In Core Population Areas, it is understood that there will be exceptions for minimal impacts due to existing mines as they expand their existing operations through modified mine plans and new leases.

iv. The USFWS has agreed that SMCRA is an adequate regulatory mechanism to protect Greater sage-grouse (USFWS letter dated November 10, 2010). Permitting under the WEQA is required to be equally or more stringent than SMCRA (Section 503 SMCRA 1977).

Connectivity Corridors

See Attachment A.

The suspension of federal and state leases in connectivity corridors (see Attachment A) is encouraged where there is mutual agreement by the leasing agency and the operator. These suspensions should be allowed until additional information clarifies their need. Where suspensions cannot be accommodated, disturbance should be limited to no more than an average of 5% per 640 acres (DDCT Process) of suitable Greater sage-grouse habitat within connectivity corridors.

For protection of connectivity corridors (see Attachment A), a NSO buffer of 0.6 miles around occupied leks or their documented perimeters is required. In addition, a March 15 to June 30 timing limitation stipulation is required within nesting habitat within 4 miles of occupied leks.

Underground Rights of Way

The State of Wyoming and federal management agencies have worked to develop utility corridors in current Resource Management Plans (RMPs). One of the primary purposes of these utility corridors is to encourage placement of future linear development (i.e., pipelines, water lines, fiber optics, etc.) adjacent to existing infrastructure to reduce habitat fragmentation. It is the intent of this Executive Order to continue to incentivize co-location of new pipelines in RMP designated utility corridors. New pipelines proposed in RMP established utility corridors will be required to complete DDCT calculations prior to construction. To allow for accurate future DDCT calculations for projects adjacent to but outside the utility corridors, applicants will submit to the SGIT as-built construction diagrams within 60 days of construction completion that delineate all areas of temporary and permanent disturbance in Core Population Areas including the construction and permanent rights-of-way, roads, storage yards, laydown areas and extra temporary work spaces. The pipeline proponents are not expected to meet Executive Order thresholds within the utility corridor, but the project construction would be subject to appropriate seasonal timing stipulations. The locations of permanent above-ground facilities (such as block valves, compressors, etc.) will be subject to Executive Order thresholds if located outside the designated corridor. Pipelines outside RMP designated utility corridors, but in Core Population Areas, are required to comply with the 5% disturbance per the DDCT analysis.

Wind Energy Development

Wind development is not recommended in Greater sage-grouse Core Population Areas, but will be reevaluated on a continuous basis as new science, information and data emerges.

PROCESS DEVIATION OR UNDEFINED ACTIVITIES

Development proposals incorporating less restrictive stipulations or development that are not covered by these stipulations may be considered depending on site-specific circumstances. The proponent must have data demonstrating that the alternative development proposal will avoid negative impacts to Greater sage-grouse in Core Population Areas. Proposals to deviate from standard stipulations will be considered by a team including WGFD and the appropriate land management and permitting agencies, with input from the USFWS. To deviate from standard stipulations project proponents need to demonstrate that the project development would meet at least one of the following conditions:

- No suitable habitat is present in one contiguous block of land that includes at least a 0.6 mile buffer between the project area and suitable habitat;

- No Greater sage-grouse use occurs in one contiguous block of land that includes at least a 0.6 mile buffer between the project area and adjacent occupied habitat, as documented by total absence of Greater sage-grouse droppings and an absence of Greater sage-grouse activity for the previous ten years; or

- Implementation of a development/mitigation plan that has demonstrated through previous research avoids negative impacts to Greater sage-grouse. The demonstration must be based on monitoring data collected and analyzed with accepted scientific based techniques.

Literature Cited:

Blickley, J. L., D. Blackwood, and G. L. Patricelli. 2012a. Experimental evidence for the effects of chronic anthropogenic noise on abundance of greater sage-grouse at leks. Conservation Biology 26:461-471.

Blickley, J. L., K. R. Word, A. H. Krakauer, J. L. Phillips, S. N. Sells, C. C. Taff, J. C. Wingfield and G. L. Patricelli. 2012b. Experimental chronic noise is related to elevated fecal corticosteroid metabolites in lekking male greater sage-grouse (*Centrocercus urophasianus*). PLoS One 7:e50462.

Braun, C. E., O. O. Oedekoven, and C. L. Aldridge. 2002. Oil and gas development in western North America: effects on sagebrush steppe avifauna with particular emphasis on sage grouse. In Transactions of the North American Wildlife and Natural Resources Conference 67:337-349.

Doherty, K. E., D. E. Naugle, B. L. Walker, and J. M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management 72:187-195.

Doherty, K. E., D. E. Naugle, and J. S. Evans. 2010. A currency for offsetting energy development impacts: horse-trading sage-grouse on the open market. PLoS One 5:e10339.

Doherty, K. E., D. E. Naugle, H. E. Copeland, A. Pocewicz, and J. M. Kiesecker. 2011. Energy Development and Conservation Tradeoffs: Systematic planning for greater sage-grouse in their eastern range. S. T. Knick and J. W. Connelly (editors). Greater sage-grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology 38. University of California Press, Berkeley, USA.

Dzialak, M. R., S. L. Webb, S. M. Harju, C. V. Olson, J. B. Winstead, and L. D. Hayden-Wing. 2013. Greater sage-grouse and severe winter conditions: identifying habitat for conservation. Rangeland Ecology and Management 66:10-18.

Fedy, B. S., C. L. Aldridge, K. E. Doherty, M. O'Donnell, J. L. Beck, B. Bedrosian, M. J. Holloran, G. D. Johnson, N. W. Kaczor, C. P. Kirol, C. A. Mandich, D. Marshall, G. McKee, C. Olson, C. C. Swanson, and B. L. Walker. 2012. Interseasonal movements of greater sage-grouse, migratory behavior, and an assessment of the core regions concept in Wyoming. Journal of Wildlife Management 76:1062-1071.

Hess, J. E., and J. L. Beck. 2012. Disturbance factors influencing greater sage-grouse lek abandonment in north-central Wyoming. The Journal of Wildlife Management 76:1625-1634.

Holloran, M. J. 2005. Greater sage-grouse (*Centrocercus urophasianus*) population response to natural gas field development in western Wyoming. Dissertation, Department of Zoology and Physiology, University of Wyoming, Laramie, USA.

Kaiser, R. C. 2006. Recruitment by greater sage-grouse in association with natural gas development in western Wyoming. Thesis, University of Wyoming, Laramie, USA.

Lyon, A. G. and S. H. Anderson. 2003. Potential gas development impacts on sage grouse nest initiation and movement. Wildlife Society Bulletin 31:486-491.

Walker, B. L., D. E. Naugle, and K. E. Doherty. 2007. Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management 71:2644-2654.

EXECUTIVE ORDER 2015-4
ATTACHMENT C

Exempt ("de minimis") Activities

The following are considered "de minimis" activities:

1. Drilling and outfitting of agricultural or residential water wells (including tank installation, pumps, and agricultural water pipelines) more than 0.6 miles from the perimeter of an occupied lek. Construction within 0.6 miles is allowed from July 1 through March 14, after a habitat evaluation has occurred, and provided development does not occur on the lek. New tanks shall have escape ramps.

2. Electric utilities are obligated by regulation to serve customers with safe and reliable electric service. Likewise, utilities must comply with agency Greater sage-grouse protective stipulations. In order to allow electric utilities the operational ability to provide and maintain service to their customers while affording adequate protection for Greater sage-grouse, distribution lines within 0.6 miles from an occupied lek are considered "de minimus" provided that: (1) construction of lines occurs from July 1 through March 14; (2) such lines are not constructed on the lek itself; and (3) a habitat evaluation has occurred. For general and operational maintenance activities of existing distribution lines, the electric utility shall use appropriate/applicable Best Management Practices for electric utilities (Avian Power Line Interaction Committee 2015). Coordination of ongoing activities with Wyoming Game and Fish Department (WGFD) is encouraged.

3. Preventative or required county road maintenance activities within the right-of-way (blading/smoothing, filling pot holes, graveling, culvert replacement, right-of-way maintenance, cattle guard maintenance, etc.) are considered "de minimis". Road construction activities (vertical or horizontal realignment, roadway widening, new construction, bridge replacement, etc.) are not considered "de minimis" and may require completion of a Density/Disturbance Calculation Tool (DDCT) analysis (Pendleton 2015).

4. Authorized or required cultural, paleontological, and biological resource and land surveys.

5. Emergency response and public health and safety issues.

6. Existing animal husbandry practices (including branding, docking, herding, trailing, etc.).

7. Existing farming practices and reclamation seeding (excluding conversion of sagebrush habitats to agricultural lands).

8. Construction of agricultural reservoirs, less than 10 surface acres and more than 0.6 miles from the perimeter of an occupied lek. Construction within 0.6 miles is allowed from July 1 through March 14, after a habitat evaluation has occurred, and provided that development does not occur on the lek.

9. Construction of aquatic habitat improvements, less than ten wetland or water surface acres, more than 0.6 miles from the perimeter of an occupied lek. Construction within 0.6 miles is allowed from July 1 through March 14, after a habitat evaluation has occurred, and provided development does not occur on the lek.

10. Irrigation (excluding the conversion of sagebrush habitats to new irrigated lands).

11. Spring development; if the spring is protected with fencing and enough water remains at the site to provide mesic (wet) vegetation. Fences should be constructed to be highly visible to Greater sage-grouse (i.e., buck-and-rail, steeljack, etc.) and/or marked to minimize collision potential.

12. New fencing more than 0.6 miles from the perimeter of an occupied lek. New fences or new stretches of fences, with high potential for collisions should be marked or be designed to minimize risk. Construction within 0.6 miles is permitted so long as construction does not occur from March 15 to June 30 or on the lek itself; coordination with WGFD is strongly suggested.

13. Maintenance of existing fence.

14. Herbicide applications within existing road, pipeline, and power line rights-of-ways, application within reclamation areas for weed control, application adjacent to structures or other applications for spot treatments. Pesticide treatment for Grasshopper/Mormon cricket control following Reduced Agent-Area Treatments protocol. Other required or authorized pesticide treatments for state or county listed species or vector treatments for other diseases such as West Nile Virus. All treatments must be done in accordance with regulations and labels. Coordination with Weed & Pest Districts is strongly encouraged.

15. Grazing operations that utilize recognized management approaches (allotment management plans, Natural Resource Conservation Service grazing plans, prescribed grazing plans, etc.).

    It is Wyoming's primary premise that grazing activities are compatible with Greater sage-grouse conservation and may improve habitat for Greater sage-grouse. Grazing management practices maintain or enhance Wyoming rangelands. Properly managed rangelands are capable of sustaining robust Greater sage-grouse populations and a diversity of plant species important to Greater sage-grouse habitat. (USFWS, February 5, 2015, Memo to State Directors and Field Supervisors: Service Position on Livestock Grazing and Working with the Rangeland Owners to Conserve Sage-Grouse)

    The State of Wyoming will collaborate with appropriate Federal agencies to: (1) develop appropriate conservation objectives; (2) define a framework for evaluating situations where Greater sage-grouse objectives are not being achieved on Federal land, to determine if a causal relationship exists between improper grazing (by wildlife, wild horses or livestock) and Greater sage-grouse conservation objectives; and (3) identify appropriate site-based action to achieve Greater sage-grouse conservation objectives within the framework.

If grazing adjustments are believed necessary to achieve Greater sage-grouse conservation objectives, coordination among land management agencies and permit/lease holders shall take place. Monitoring data used within the framework will, at a minimum: reflect 5 years of information, include rangeland health assessments, and require conclusion or action to be based on 3 out of 5 consecutive years of data (*i.e.*, Y1-2-3, Y2-3-4, Y3-4-5). These requirements may be waived in case of a catastrophic event such as fire. Further, the State recognizes there is a distinction between conservation objectives and land health standards and that it is possible to achieve land health standards while not achieving Greater sage-grouse conservation objectives and vice-versa. Federal agency participation in the implementation of this Executive Order in no way precludes them from managing federal surface for rangeland health.

EXECUTIVE ORDER 2015-4
ATTACHMENT D

Federal and State Permitting Agency Coordination

Background:

The Density/Disturbance Calculation Tool (DDCT) process and review of project compliance with Executive Order 2015-4 will be coordinated through the DDCT web application (ddct.wygisc.org).

The proponent should provide the most complete and comprehensive description of a project as possible. Splitting a project into smaller components can cause delay in review and could risk denial of a permit necessary for the entire project. It is recommended that proponents thoughtfully consider and include for review potential future development(s) and/or infrastructure associated with or that may be needed to support the current proposed project.

If the proponent has a concern that a project will not comply with this Executive Order, the proponent should contact the Wyoming Game and Fish Department (WGFD) and the appropriate land management and/or permitting agencies as soon as possible. Noncompliance with this Executive Order is not an automatic permit denial and all projects will be reviewed and potential impacts to local Greater sage-grouse populations and habitat will be assessed. Advanced planning with the permitting agencies and WGFD is the recommended way to resolve issues.

If the proponent submits a DDCT that is not in compliance, the agencies involved will need to discuss all options and potential impacts to local Greater sage-grouse populations and habitat. Initiating these discussions in advance of the final DDCT submittal may yield timelier review/decision results.

1. If federal surface/mineral is involved, the proponent works with the appropriate federal land management agency on the DDCT process and disturbance delineations, then:

    - The federal agency submits the DDCT (and worksheet) for technical review to the DDCT Data Steward at the Wyoming Geographic Information Science Center. The Data Steward will work with the federal agency in completing the technical review process (Note: the federal agency may use a contractor to make the corrections). When completed, the federal agency also submits the DDCT worksheet to the Data Steward.
    - Once technical review is completed, the Data Steward submits the DDCT final results and DDCT worksheet to WGFD Habitat Protection Program (HPP) for policy review.
    - WGFD HPP coordinates with state agencies and the federal agency if there are issues with Executive Order exceedances or compliance.
    - WGFD HPP sends a letter regarding Executive Order compliance and recommendations to the federal agency and copies the proponent and permitting agencies that may also be involved in the project.

- If agencies have questions about the recommendations, they should contact WGFD HPP.

2. If federal surface or mineral is not involved, the project proponent (NOTE: could be a consultant) completes the DDCT process, then:

   - Submits the DDCT to the Data Steward for technical review. The Data Steward will work with the proponent to complete the technical review process. When completed, the proponent submits the DDCT worksheet to the Data Steward.
   - The Data Steward submits the DDCT final results and DDCT worksheet to WGFD HPP for policy review.
   - WGFD HPP coordinates with state agencies if there are issues with Executive Order exceedances or compliance.
   - WGFD HPP sends a letter regarding Executive Order compliance and recommendations to the proponent and copies permitting agencies.
   - If agencies have questions about the recommendations, they should contact WGFD HPP.

Letters from WGFD:

Letters from WGFD will determine whether or not the project complies with the process and stipulations outlined in this Executive Order and may provide recommendations on whether the permit should be issued and/or recommendations on how impacts to the Greater sage-grouse may be minimized. State agencies will be the point of contact for conducting a DDCT analysis for locatable minerals. These recommendations may or may not be accepted by the permitting agency and incorporated in the conditions of the permit. If there are changes to the project, the proponent should complete the DDCT review process again.

The permitting agency should document whether or not the recommendations were accepted and incorporated as part of permit. If the permitting agency is unable to implement a recommendation, the agency should document the circumstances which preclude incorporation into the permit. For example, it is not within the agency's regulatory authority or it is not physically or legally possible to make the recommended changes.

EXECUTIVE ORDER 2015-4
ATTACHMENT E

Vegetation Monitoring for Suitability Criteria of Reclaimed Areas

Goal: Measurements that should be taken when there is uncertainty concerning the status of reclaimed areas contributing to suitable habitat.

If sagebrush canopy cover is 5%, or greater, as measured by the method described in the Bureau of Land Management's Sage-Grouse Habitat Assessment Framework, it is considered suitable habitat.

When sagebrush canopy cover is less than 5%, but within 60 meters of greater than 5% sagebrush canopy cover, measure to determine compliance with the following conditions:

Measure for 2 (or more) desirable native grasses at least one of which is a bunchgrass in appropriate sites. The species present in the reclaimed area should be reflected in an appropriate reference site, described in the ecological site description (ESD) for the reclaimed site(s), or be representative of pre-disturbance species data. A reference site will be agreed upon and determined by the land management agency or owner, Wyoming Game and Fish Department and the proponent. It is recognized that reference sites could be numerous for linear features.

- The **frequency** of occurrence of grass is expected to meet or exceed 70% of the frequency of grass as measured on the reference site, as described in the ESD for the reclaimed sites(s), or as represented in the pre-disturbance species data. Grass **canopy cover** measurement is expected to meet or exceed 70% of the grass canopy cover as measured on the reference site, as described in the ESD for the reclaimed sites(s), or as represented in the pre-disturbance species data.

Likewise, measure for 2 desirable native forbs.

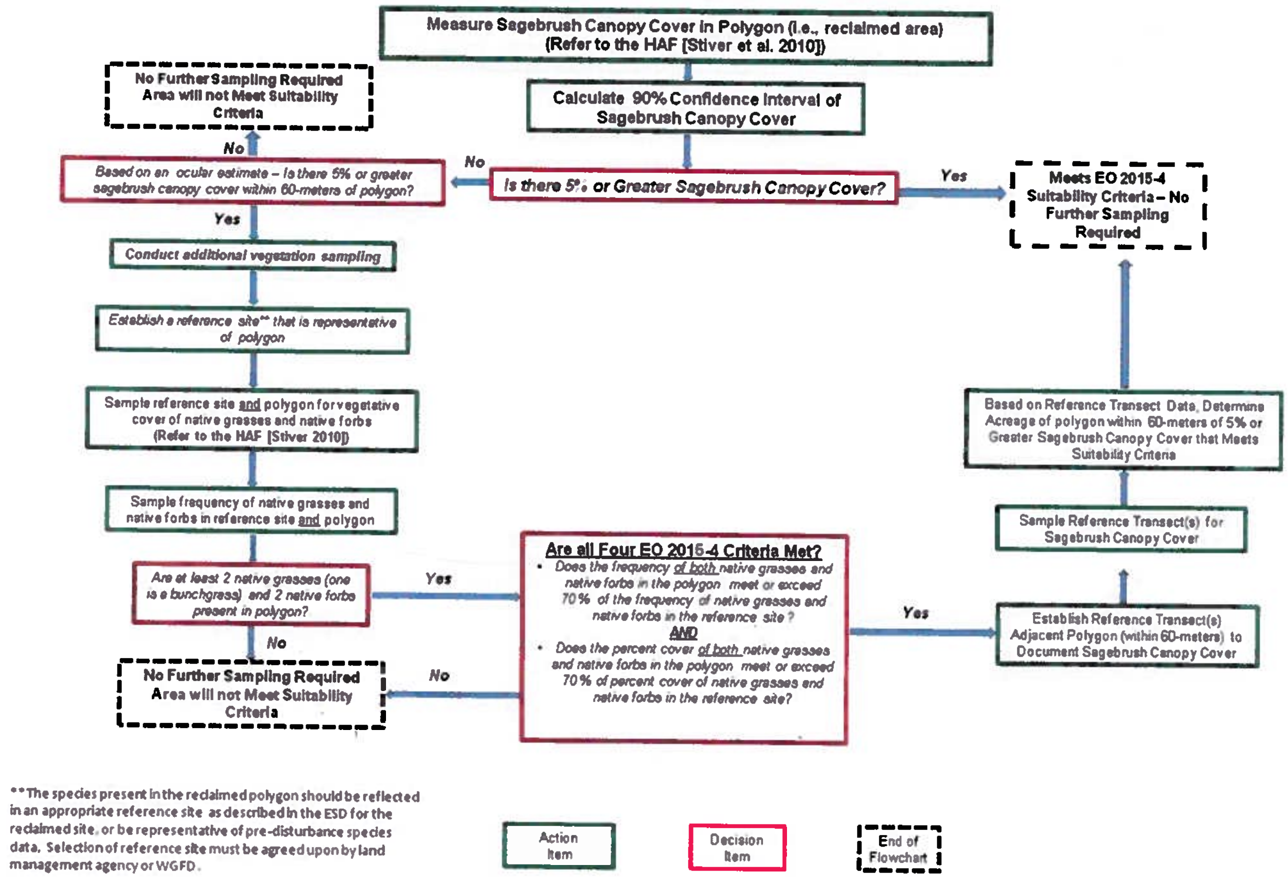
- The **frequency** of occurrence of forbs is expected to meet or exceed 70% of the frequency of forbs as measured on the reference site, as described in the ESD for the reclaimed sites(s), or as represented in the pre-disturbance species data.
- Forbs **canopy cover** is expected to meet or exceed 70% of the forb canopy cover as measured on the reference site, as described in the ESD for the reclaimed sites(s), or as represented in the pre-disturbance species data.

Methodology

- Sampling timing for grasses, forbs, and shrubs is typically not later than July 1.
- Canopy cover for grasses/forbs: Line Point Intercept (see Habitat Assessment Framework).
- Frequency for grasses/forbs: Plot (rectangles, squares or circles) frequency computed as number of quadrats with the species of interest rooted within it, divided by the total

number of quadrats that are sampled. This value will be multiplied by 100 to yield frequency as a percentage. It is recommended that a minimum of 5 to 10 transects, 30 to 50 meters wide be conducted with a minimum of 10 to 20 quadrats (e.g. Daubenmire frame or quadrat appropriate to the site) placed equidistantly along each transect.

- Canopy cover for sagebrush: Line Intercept (see Habitat Assessment Framework).
- Sample size: The Habitat Assessment Framework provides sample size recommendations. Final estimates must include a 90% confidence interval computed around the mean values estimated from vegetation sampling.



Decision-based Flowchart for Vegetation Sampling Methods and Suitability Determination (Source: TRC 2015)

Executive Order 2015-4
Attachment E
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EXECUTIVE ORDER 2015-4
ATTACHMENT F

Greater Sage-Grouse Habitat Definitions

Greater sage-grouse require somewhat different seasonal habitats distributed over large areas to complete their life cycle. All of these habitats consist of, are associated with, or are immediately adjacent to, sagebrush. An abbreviated description of a complex system cannot incorporate all aspects of, or exceptions to, what habitats a local Greater sage-grouse population may or may not utilize. Refer to the Bureau of Land Management's Sage-Grouse Habitat Assessment Framework for further information.

"Suitable" Greater sage-grouse habitat (nesting, breeding, brood-rearing, or winter) is within the mapped occupied range of Greater sage-grouse, and:

1. has 5% or greater sagebrush canopy cover (for nesting, brood-rearing and/or winter) as measured by the point intercept method. "Sagebrush" includes all species and sub-species of the genus Artemisia except the mat-forming sub-shrub species: frigida (fringed) and pedatifida (birdfoot);

2. is riparian, wet meadow (native or introduced) or areas of alfalfa or other suitable forbs (brood rearing habitat) within 275 meters of sagebrush habitat with 5% or greater sagebrush canopy cover (for roosting/loafing); or

3. is reclaimed habitat containing at least 2 native grasses (at least one bunchgrass in appropriate sites) and 2 native forbs (see Reclamation, Attachment B) and no point within the grass/forb habitat is more than 60 meters from adjacent 5% or greater sagebrush cover.

"Transitional" Greater sage-grouse habitat is land that has been treated or burned prior to 2011 resulting in less than 5% sagebrush cover but is actively managed to meet a minimum of 5% sagebrush canopy cover with associated grasses and forbs by 2021 (as determined by analysis of local condition and trend) and may or may not be considered "disturbed". Land that does not meet the above vegetation criteria by 2021 should be considered disturbed.

Habitat treatments must meet the current Wyoming Game and Fish Department Protocols for Treating Sagebrush to be consistent with Executive Order 2015-4, Greater Sage-grouse Core Area Protection, or the habitat treated will be considered disturbed. Following wildfire, lands shall be considered "disturbed" pending an implemented management plan with trend data showing the area returning to functional Greater sage-grouse habitat.

- Areas burned by wildfire (after 2011) shall be treated as disturbed pending an implementation management plan with trend data showing the area returning to functional Greater sage-grouse habitat. This is specific only to wildfire. This direction is not intended for other incentive/mitigation/habitat treatment situations.

- The goal is to incentivize restoration of wildfire burns to return as much of the affected burned area back to suitable habitat as quickly as possible. This is a landscape effort and is not considered mitigation banking. This process should be used when wildfire is impacting the disturbance percentages.

- A Technical Team comprised of the U.S. Forest Service, Bureau of Land Management, Natural Resource Conservation Service, the Wyoming Game and Fish Department, Office of State Lands and Investments Forestry Division, Wyoming Department of Agriculture (Weed and Pest), local working groups, conservation districts and private landowners would develop the plan and trending data. It would be the responsibility of the project proponent to conduct the monitoring. An upward trend would be determined through the collection of five years of data and review by the Technical Team.

"Unsuitable" Greater sage-grouse habitat[1] is land within the historic range of Greater sage-grouse that did not, does not, and will not provide Greater sage-grouse habitat due to natural ecological conditions such as badlands, canyons or forests.

"Disturbed" suitable Greater sage-grouse habitat[1] is land that has been converted from formerly suitable habitat to grasslands, croplands, mined or otherwise physically disturbed areas. To evaluate the 5% disturbance cap per average 640 acres using the Density/Disturbance Calculation Tool (DDCT), suitable habitat is considered disturbed when it is removed and unavailable for immediate Greater sage-grouse use. These areas may provide habitat at some time in the future through succession or restoration. Disturbed suitable habitats could also include those permanent disturbances such as major reservoirs and cities that once were considered suitable.

The following items are guidelines for determining disturbed habitat for the DDCT process:

a. Long-term removal occurs when habitat is physically removed through activities that replace suitable habitat with long-term occupancy of unsuitable habitat such as a road, well pad or active mine.

b. Short-term removal occurs when vegetation is removed in small areas, but restored to suitable habitat within a few years of disturbance, such as a successfully reclaimed pipeline, or successfully reclaimed drill hole or pit.

c. There may be additional suitable habitat considered disturbed between two or more long-term (greater than 1 year) anthropogenic disturbance activities if the activities are located such that Greater sage-grouse use of the suitable habitat between these activities is significantly reduced due to the close proximity (less than 1.2 miles apart, 0.6 mile from each activity) and resulting cumulative effects of these large scale activities. Exceptions

[1] The BLM Habitat Assessment Framework definition of "unsuitable" includes both "disturbed" and "unsuitable" habitats as defined above.

may be provided.

d. Land in Northeast Wyoming (see Attachment B, Figure 8) that has had sagebrush removed post-1994 (based on Orthophoto interpretation), and not recovered to suitable habitat will be considered disturbed when using the DDCT.

EXECUTIVE ORDER 2015-4
ATTACHMENT G

Best Management Practices for Soils on Resource Extraction Sites

1. Get to know the nature of the soil(s) on the site where you are working. Good basic information can be obtained from the Natural Resource Conservation Service Soil Survey and more detailed information can easily be gathered by digging a few soil pits and testing some soil properties on the site (pH, Electrical Conductivity, Texture, Calcium Carbonate content and gravel content).

2. Topsoil should be removed from the site before resource extraction activities and stored in suitable stockpiles to protect this valuable resource from loss or contamination during resource extraction. Topsoil is important to timely site reclamation. Topsoil should be salvaged while at a low moisture content. Avoid mixing A horizons with B horizons if the B horizons are salty and or clayey.

3. Topsoil stockpiles should be located in an area where they will not be disturbed by resource extraction activities or contaminated by foreign or spilled materials. Movement of stockpiles should be kept to a minimum. Stockpiles should be designed to minimize exposure to erosional forces and bury as little undisturbed soil as possible.

4. Upon completion of resource extraction activities or interim reclamation, topsoil should be respread on the disturbed site to approximate original conditions. Vegetation should be reestablished on the replaced soil as quickly as possible to stabilize the site and prevent erosion. Regular monitoring should be conducted to be sure that revegetation and stabilization of the site proceed according to expectations and no site degradation occurs.

5. The use of commercial fertilizers is generally not recommended for native rangeland reestablishment due to the possibility of increased annual weeds. Soil testing should be completed prior to reestablishment of native plants on highly disturbed soils and, if necessary, the appropriate amendments should be used.

6. It is important not to over-estimate the amount of vegetation removal (habitat loss) in a given year.

7. In order to minimize impacts to soil resources, an alternative to large-scale advanced removal of soil is to skim the surface of the soil with a motor patrol between July 1 and March 14. This may be useful or applicable where operational plans are uncertain or where there is a desire to "live-spread" soils at some point in the period of March 14 – July 1.

    - Leave as much root intact as possible.
    - Leave vegetative biomass in wind-rows to reduce wind and water erosion.

8. If unexpected changes in operational plans require vegetation removal between March 14 and July 1, a nest survey shall be completed by a competent biologist within 1 week prior to any vegetation removal in suitable habitat. Results shall be submitted to the appropriate regulatory agency with a copy to Wyoming Game and Fish Department (WGFD). If a nest is discovered, operations will not be allowed to proceed until after July 1 or otherwise approved by WGFD.

Source: Peter Stahl and Jay Norton, Wyoming Reclamation and Restoration Center, University of Wyoming

EXECUTIVE ORDER 2015-4
ATTACHMENT H

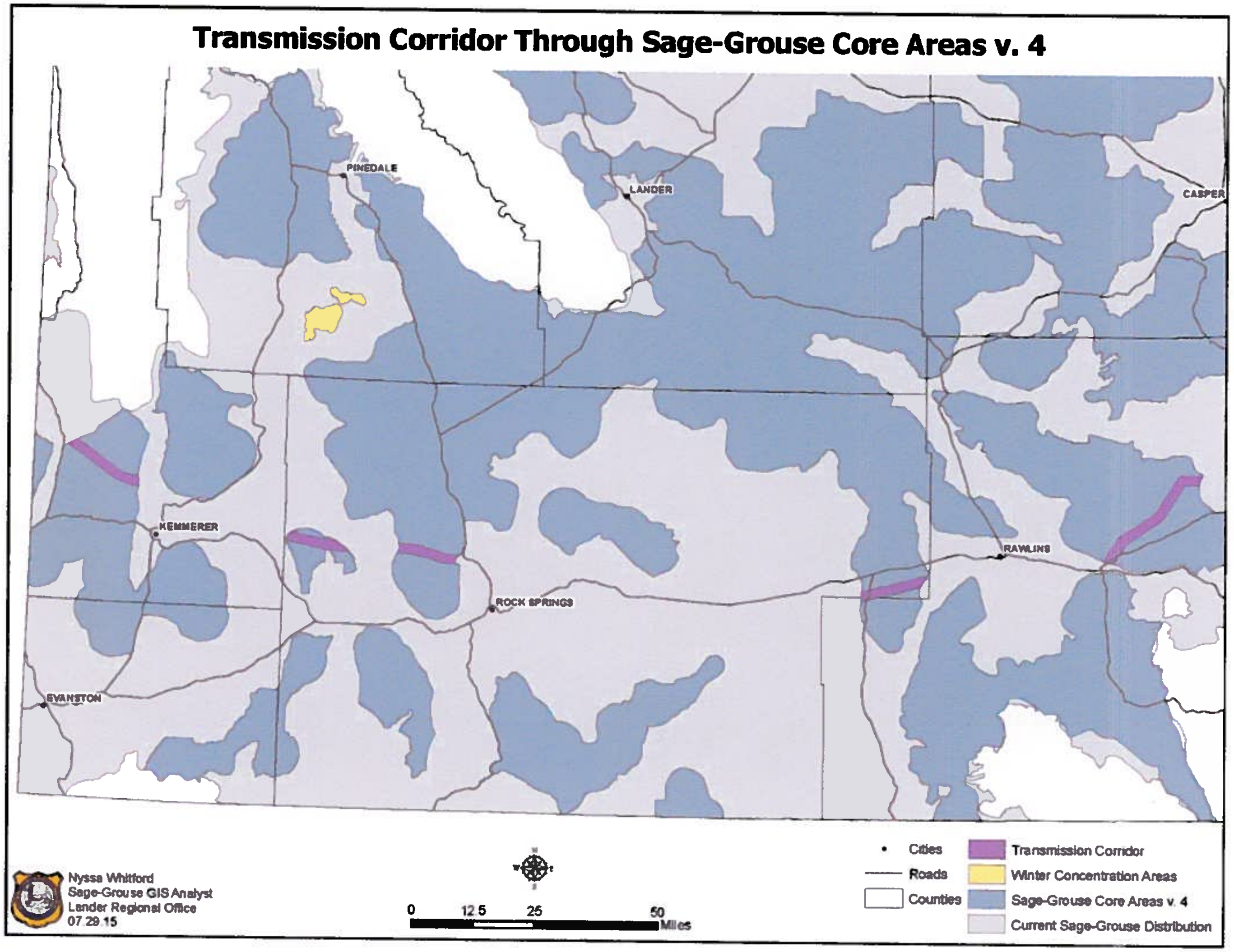
Compensatory Mitigation

Compensatory mitigation is an essential component of a long-term conservation strategy, where avoidance and minimization are either inadequate or impossible to assure perpetuation of a species of concern. By its nature, compensatory mitigation may be applicable "on-site", but may often be achieved more effectively "off-site" in order to maintain a landscape-scale result that is beneficial to a species, and not a particular population or group of animals. Compensatory mitigation must be secured prior to any negative impact to a species or its habitat occurs.

Compensatory mitigation that occurs "off-site" should meet the complete life-cycle needs of the species, be secured for an adequate time to assure the replacement of resources that are lost as a result of any negative action impacting the species, and be critically evaluated to provide adequate biological assurances that the initial impact, and any associated mitigation will maintain the species and its habitat until the impact has been removed and the species is recovered at the site of impact. Compensatory mitigation must provide an adequate ratio of assurance that the conservation of the species will not be compromised due to the failure of compensation measures to adequately protect the species, including management changes, natural disasters, and other impacts.

The State of Wyoming recognizes compensatory mitigation as a strategy that should be used when avoidance and minimization are inadequate to protect Core Population Area Greater sage-grouse. Any compensatory mitigation proposal must include approval from the State of Wyoming to assure the species considered is adequately protected, and that the benefits proposed for a species under the jurisdiction of the State of Wyoming are real, adequate, and fully realized prior to the time of acceptance.

EXECUTIVE ORDER 2015-4
ATTACHMENT I



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Attachment I
Page 1 of 1

Attachment C: Wyoming sage-grouse projects supported with 2017-18 Wyoming General Fund Appropriation.

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
197 – Habitat quality relative to predators research	2017-18	Big Horn Basin, Southwest, Bates Hole/ Shirley Basin	$87,000	$87,000 requested/approved	Research to determine if predator composition and abundance differs between core and non-core habitat	Oregon State University	On-going
198 – Cheatgrass thresholds research	2017-18	Big Horn Basin	$150,000	$87,000 requested/approved	Research to identify thresholds to aid in landscape-scale cheatgrass management	University of Wyoming, Sublette Co. Weed & Pest, Willbur-Ellis, SW and SC LWGs	On-going
199 – SG and raven interactions and habitat use in the Big Horn Basin	2017-18	Big Horn Basin	$128,400	$80,000 requested; $20,000 approved	Research to quantify raven and sage-grouse interactions and evaluate response to raven removal	WY ADMB, Meeteetse CD, Fidelity Exploration, Wyoming Woolgrowers, Park County Predator Mgt Board, Hayden-Wing Associates	On-going
200 – Bates juniper treatment	2017-18	Bates Hole/ Shirley Basin	$150,000	$20,000 requested/approved	Mechanical juniper removal from sage-grouse habitat	BLM, RMEF, National Wild Turkey Federation	On-going
201 – Seppie Springs sagebrush thinning	2017-18	Bates Hole/ Shirley Basin	$45,600	$20,000 requested/approved	Fine-scale strip mowing in mountain big sagebrush to enhance native grasses and forbs	WGFD, WWNRT, private landower	On-going
202 – Casper cheatgrass treatments	2017-18	Bates Hole/ Shirley Basin	$42,450	$7,500 requested/approved	Bacterial cheatgrass treatments on 3 locations (Stonehouse, Sand Hills, Schnoor)	WGFD, WWNRT, private landowners	On-going
203 – Audubon youth education	2017-18	Bates Hole/ Shirley Basin	$60,000	$17,500 requested/approved	School programs on sagebrush ecosystem	Audubon, Sage-Grouse Initiative, National Resource Defense Council	On-going
204 – Rankin Creek riparian exclosure	2017-18	South-Central	$50,000	$10,000 requested/approved	Riparian exclosure	BLM, WWNRT, RMEF, Permittee	On-going
205 – Standard Allotment guzzler	2017-18	South-Central	$9,800	$8,300 requested/approved	Wildlife water guzzler installation	BLM; Water for Wildlife	On-going

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
206 – Identification of Winter Concentration Areas	2017-18	South-Central, Southwest	$150,000	$150,000 requested/approved	Use aerial infrared technology and GIS to develop RSF models of sage-grouse winter concentration areas	University of Wyoming, Oregon State University	On-going
207 – Characterizing nesting habitat on eastern edge of range	2017-18	Northeast	$334,943 (multi-year)	$25,000 requested/approved	Pool existing data to conduct analyses that will better describe and nesting habitat in Northeast Wyoming	Thunder Basin Grasslands Prairie Ecosystem Assoc., Peabody Energy, ICF International, Thunderbird Wildlife Consulting	On-going
208 – Douglas Core Area wildfire restoration	2017-18	Northeast	$382,700 (multi-year)	$25,000 requested/approved	Restoration of a wildfire area within the Douglas Core Area	DCA Restoration Team, private landowners	On-going
209 – Evaluating restoration revegetation outcomes	2017-18	Northeast	$50,000	$22,781 requested/approved	Research to determine reclamation seeding success	University of Wyoming, University of Waterloo, BLM, Anadarko, private landowners	On-going
210 – Assessing avian response to habitat restoration	2017-18	Northeast	$75,250	$75,250 requested/approved	Research to determine sage-grouse and songbird response to gas field restoration	University of Waterloo, University of Wyoming, BLM, Anadarko, private landowners	On-going
211 – Albert Creek wet meadow restoration	2017-18	Southwest	$41,000	$10,000 requested/approved	Restore channelized and degraded streambed to historic channel	USFWS Partners, Uinta County CD, Anadarko, grazing permittees	On-going
212 – Sage-grouse geophagy	2017-18	Upper Green River Basin, Southwest	$327,000	$20,000 requested/approved	Continuing research to determine movements and habitat use of sage-grouse relative to geophagy and determine significance of geophagy	Utah State University, BLM, WLCI Ruby Pipeline, EnCana, WY Dept of Ag, Bridger Teton National Forest, BLM, Teton Raptor Center	On-going

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
213 – Spread Creek gravel mine sage-grouse ecology	2017-18	Upper Snake River Basin	$158,500	$38,500 requested/approved	Research to determine sage-grouse movements, productivity and habitat use relative to a gravel mine	Grand Teton National Park, Teton Raptor Center, USFS	On-going
214 – Gros Ventre Restoration	2017-18	Upper Snake River Basin	$14,500	$3,500 requested/approved	Restore sagebrush habitat on an abandoned hayfield	USFS, private landowner, Teton Weed & Pest, Jackson Hole Wildlife Foundation	On-going
215 – BTNF weed control	2017-18	Upper Snake River Basin	$70,522	$4,000 requested/approved	Rapid detection and early response weed control on BTNF lands	USFS, Teton Weed & Pest, YCC/JHWMA, RMEF	On-going
216 - Response of SG to sagebrush treatments Phase IV	2017-18	Wind River-Sweetwater River, South-Central, Bates Hole-Shirley Basin, Big Horn Basin, Southwest	$1,232,608 to date	$241,223 requested/approved	Continuing research to determine sage-grouse demographic and habitat use response to sagebrush treatments	University of Wyoming, Kelly Ornith. Research Fund, BLM, WY Reclamation & Restoration Center, WWNRT	On-going
217 – South Hudson Weed Control	2017-18	Wind River-Sweetwater River	$82,700	$35,000 requested, $20,000 approved	Noxious weed surveys and treatment	WWNRT, BLM, Private Landowners, WYDOT, WSLB, Fremont Weed & Pest	On-going
218 – SGI support	2017-18	Wind River-Sweetwater River	$1,500	$1,500 requested/approved	Travel/training support for NRCS SGI personnel	NRCS, Popo Agie CD	On-going

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
219 – Sage-grouse arts and education	2017-18	Wind River-Sweetwater River, Upper Green River Basin, Bates Hole/Shirley Basin	$62,881	$30,000 requested; $26,517 approved	Statewide community education about sage-grouse and sagebrush through visual arts	Lander Art Center, AT Lander Arts & Sciences, TNC, WGFD, NRCS, USFWS, WY Audubon, WY Outdoor Council, Fremont School Dist #1	On-going
220 – Linking lek habitat structure to grouse behavior	2017-18	Wind River – Sweetwater River	$63,807	$33,614 requested $15,000 approved	Research to determine if micro-habitat influences lekking behavior	University of California-Davis	On-going

GREATER SAGE-GROUSE RESEARCH CONDUCTED IN WYOMING IN 2017

Presented to State of Wyoming and Wyoming Game and Fish Department

Compiled by:

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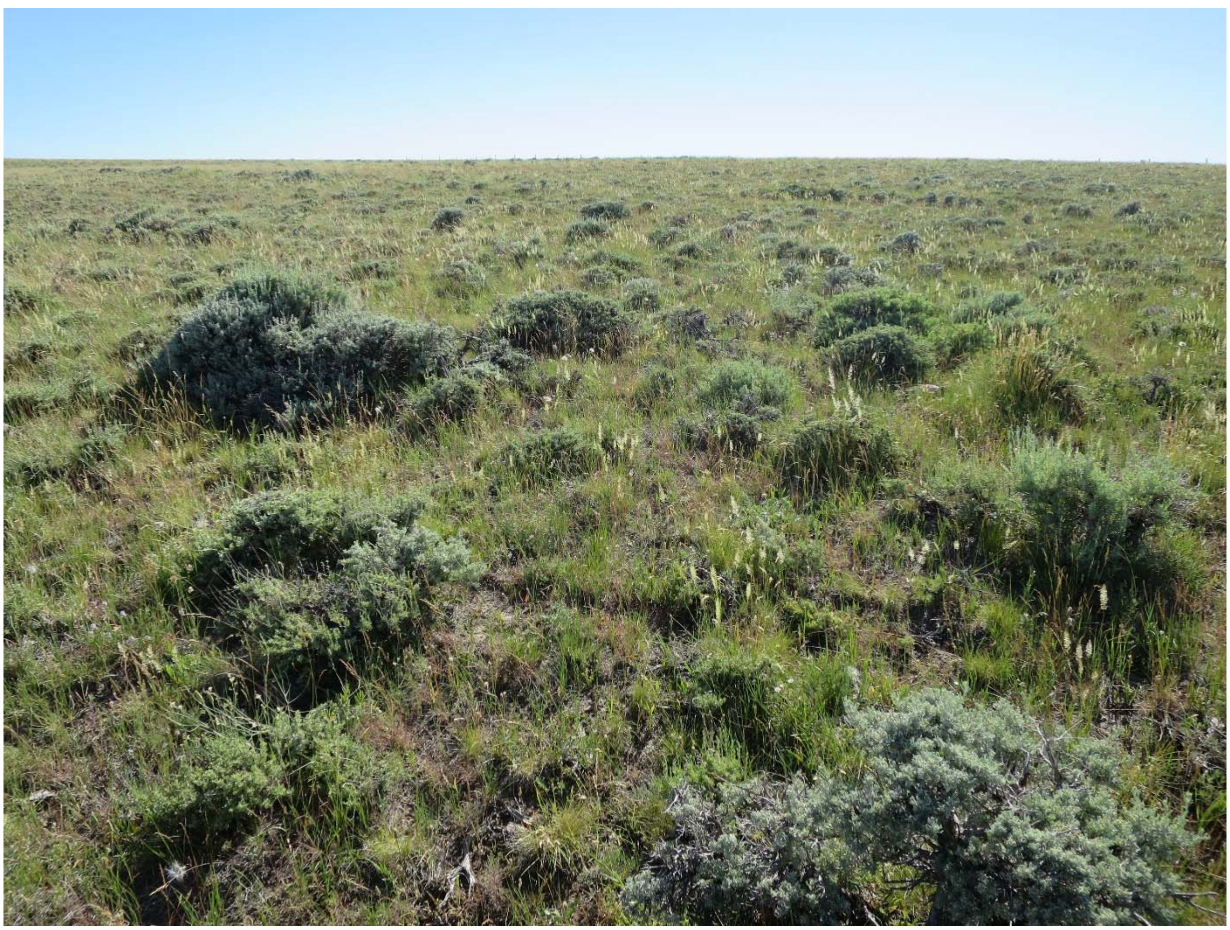
November 5, 2017

Research studies are listed alphabetically by last name of principal contact or investigator. Please feel free to contact principal contacts or investigators with specific questions.



Greater Sage-Grouse Breeding Habitat in the Wyoming Basin, spring/summer 2017
Photo courtesy of Janine Mistrick

1. EVALUATING BIODIVERSITY OF SAGEBRUSH-DEPENDENT SPECIES WITHIN SAGE-GROUSE HABITAT: AN EXAMPLE FROM THE WYOMING BASINS

Contact: Dr. Cameron Aldridge; E-mail: Cameron.Aldridge@colostate.edu; Phone: (970) 226-9433

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Sagebrush (*Artemisia* spp.) steppe ecosystems have experienced drastic changes resulting in loss, fragmentation, and degradation of remaining habitat. As a result, sagebrush-dependent fauna have experienced population declines. Threats to list the Greater Sage-grouse (*Centrocercus urophasianus*) under the Endangered Species Act have resulted in west-wide conservation efforts to protect sage-grouse habitats, actions presumed to also benefit other sagebrush fauna. To evaluate the effectiveness of using Sage-grouse to conserve biodiversity of sagebrush-dependent species, we first developed and compared data-driven spatial occupancy and abundance models for seven sagebrush obligate/associated species across the greater Wyoming Basins Ecoregional Assessment (WBEA) area (345,300 km^2). Our models predicted 63,784 km^2 of optimal Sage-grouse habitat. Protection of these areas for conservation may provide added benefits for some species, such as Sage-Thrashers (*Oreoscoptes montanus*), where 73% of predicted breeding habitat was captured across the range of Sage-grouse in the WBEA. However, Brewer's sparrows (*Spizella breweri*) may not be as well protected by the Sage-grouse umbrella, with only 39% of predicted breeding habitat captured across the range of Sage-grouse within the WBEA. Mapping biodiversity hotspots using models of four songbirds (Brewer's Sparrow, Sage Thrasher, Sagebrush Sparrow (*Artemisiospiza nevadensis*), Green-tailed Towhee (*Pipilo chlorurus*)), pronghorn (*Antilocarpa americana*), and Greater short-horned lizard (*Phrynosoma hernandesi*), Sage-grouse habitat will capture an estimated 40-60% of biodiverse areas containing ≥4 (of 6) species of conservation concern. If Sage-grouse are to be an effective umbrella for sagebrush ecosystems, biodiversity of other sagebrush species should be considered in conservation efforts. We will submit a peer-reviewed manuscript summarizing this work in 2018.

Funding provided by: Western Association of Fish and Wildlife Agencies, Sagebrush Science Initiative and U.S. Geological Survey

2. MULTI-SCALE STATEWIDE WYOMING GREATER SAGE-GROUSE TRENDS DETERMINED BY POPULATION VIABILITY ANALYSIS

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We are investigating trends for Wyoming Greater Sage-grouse populations at multiple scales and management boundaries using population viability analysis (PVA) to determine local- and meta-population dynamics. Our objective was to use lek count data provided by the WGFD to determine the population growth rate (λ) statewide, by local Working Group Areas, Core Areas, Core Areas by Working Group Areas, and at nine nested spatial scales based on lek clusters. See "Hierarchical Clustering of Greater Sage-Grouse Leks to Improve upon the Detection of Population Persistence, Sinks, and Sources" by O'Donnell et al. for cluster development specifics. We used average peak male counts per lek annually (1993-2015) in a PVA to test density-independent (DI) and density-dependent (DD) models to determine λ for each management area-based population. Population trends determined by management areas are relevant as these boundaries are used to implement management plans and limit development disturbances at leks. Clusters are defined by fine- and broad-scale habitat and climate attributes relevant to sage-grouse biology; therefore, trends within these clusters are more likely to be correlated and yield more precise trend estimates with PVA than other population demarcations. We developed our suite of DI and DD models and applied them by Working Group and Core Areas; we finalized the development of lek clusters and are in the process of applying PVA across cluster scales using lek count data (1993-2017). We published our management areas-based PVA in 2017 and will submit a manuscript for peer-review assessing sage-grouse population viability by clusters in early 2018.

Funding provided by: U.S. Geological Survey and Wyoming Landscape Conservation Initiative through USGS

Publication: Edmunds, D.R., C.L. Aldridge, M.S. O'Donnell, and A.P. Monroe. 2017. Greater sage-grouse population trends across Wyoming. Journal of Wildlife Management, Early On-Line doi:10.1002/jwmg.21386.

3. PREDICTING HABITAT USE FOR GREATER SAGE-GROUSE USING A SPATIALLY-EXPLICIT DEMOGRAPHIC APPROACH IN WYOMING

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Prioritizing habitats for conservation is a challenging task, particularly for species with fluctuating populations and seasonally dynamic habitat needs. Although the use of resource selection models to identify and prioritize habitat for conservation is increasingly common, their ability to characterize important long-term habitats for dynamic populations are variable. To examine how habitats might be prioritized differently if resource selection was directly and dynamically linked with population fluctuations and movement limitations among seasonal habitats, we constructed a spatially explicit individual-based model for a dramatically fluctuating population requiring temporally varying resources. Using greater sage-grouse (*Centrocercus urophasianus*) in Wyoming as a case study, we used resource selection function maps to guide seasonal movement and habitat selection, but emergent population dynamics and simulated movement limitations modified long-term habitat occupancy. We compared priority habitats in RSF maps to long-term simulated habitat use. We examined the circumstances under which the explicit consideration of movement limitations, in combination with population fluctuations and trends, are likely to alter predictions of important habitats. In doing so, we assessed the future occupancy of protected areas under alternative population and habitat conditions. Dynamic models of habitat use and the explicit inclusion of population dynamics and movement propensities via spatial simulation modeling frameworks may provide an informative means of examining long-term habitat use, particularly for fluctuating populations with complex seasonal habitat needs.

Funding provided by: U.S. Geological Survey and Wyoming Landscape Conservation Initiative through USGS

Publication: Heinrichs, J.A., C.L. Aldridge, M. O'Donnell, and N.H. Schumaker. Using dynamic population simulations to extend resource selection analyses and prioritize habitats for conservation. 2017. Ecological Modelling 359: 449-459.
https://doi.org/10.1016/j.ecolmodel.2017.05.017

4. GREATER SAGE-GROUSE RESPONSES TO FUTURE CUMULATIVE AND INTERACTING CLIMATE AND ENERGY DEVELOPMENT IN WYOMING

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The persistence of Greater Sage-grouse in Wyoming depends on future habitat changes, including oil and gas development and climate-induced changes in habitat. Yet, we have a poor understanding of the potential magnitude of these effects and how these stressors may shape future sage-grouse outcomes in Wyoming. We have developed a series of future landscape change maps, which were used to update seasonal habitat selection maps, and quantify potential future Sage-grouse responses. Within the Wyoming Landscape Conservation Initiative (WLCI) study area of southwestern Wyoming, we simulated future loss and fragmentation of sagebrush habitats resulting from oil and gas development and associated roads infrastructure. Models were parameterized using realistic oil and gas development scenarios, using algorithms previously developed and tested in southwestern Wyoming (by collaborator Garman). Climate change scenarios were incorporated as climate-induced changes in sagebrush. Future changes in habitat were coupled with behavioral responses (e.g., habitat selection, avoidance, fitness consequences) within a spatially explicit individual-based model to quantify the likely range of impacts on sage-grouse distribution, abundance, and persistence. The effects of industrial development were compared to climate-induced impacts and their combined influences on Sage-grouse persistence were also evaluated. Analysis has been completed and the manuscript will be submitted for peer review in 2017.

Funding provided by: U.S. Geological Survey and Wyoming Landscape Conservation Initiative through USGS

5. ASSESSING GREATER SAGE-GROUSE RESPONSES TO TRANSMISSION LINE DEVELOPMENT PROJECTS IN WYOMING

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Wind energy is rapidly developing in Wyoming and the BLM is facilitating the development of new transmission line projects in sensitive grouse habitats in southern Wyoming. Although impact assessments are being conducted for the Gateway South, West, and TransWest Express projects, little is known about how transmission line infrastructure could directly and indirectly impact Sage-grouse populations through time. We used sagebrush and seasonal sage-grouse habitat (resource selection function) layers to characterize the amount of sage-grouse habitat implicated in the three transmission line projects in Wyoming. To characterize the indirect impacts of transmission line development on sage-grouse populations, we are simulating a range of behavior and demographic responses to transmission lines within a spatially-explicit individual-based model. Results will indicate the range of possible impacts to Sage-grouse and will map areas where development is more likely to impact sage-grouse. This framework could further be developed to assess habitat equivalencies and the impacts of wind farms and energy corridors. We are looking to secure additional funding to expand this project and publish these results.

Funding provided by: U.S. Geological Survey

6. EVALUATING THE INFLUENCE OF CHANGING SAGEBRUSH HABITAT CONDITIONS ON SAGE-GROUSE POPULATION TRENDS

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Development of remote-sensing products that estimate vegetation attributes in sagebrush-dominated communities has offered the ability to characterize sage-grouse habitat at broad spatial scales. However, to date these products have been static and do not show changes in habitat quality over time. USGS researchers (Homer and others) now have remote-sensing products of sagebrush, herbaceous, and bare-ground cover estimated at 2-5 year intervals in southwestern Wyoming (1996-2015). We are using this information to model changes in counts from 181 leks in southwestern Wyoming in response to changes in sagebrush cover measured around lek sites and over time. We also jointly estimated the scale of effect of vegetation cover on population trends with a kernel smoother. This approach could be useful for monitoring changes in sage-grouse populations in response to changes in habitat over broad spatial and temporal scales. This approach also could be applied to predictions of future changes in vegetation, such as in response to climate change or disturbance such as fire and energy development, and will be applied range-wide as part of a multi-partner sage-grouse population monitoring effort. We are working on analyses and a manuscript will be submitted for peer review later in 2018.

Funding provided by: U.S. Geological Survey and Wyoming Landscape Conservation Initiative through USGS

7. EFFECTIVENESS OF VEGETATION RECOVERY STRATEGIES IN SAGEBRUSH ECOSYSTEMS

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The historic loss of vegetation and subsequent recovery trajectories after disturbances in sagebrush ecosystems are not well understood. Establishing rates of sagebrush recovery will aid in characterizing the restoration and management efforts and identifying the most effective sagebrush restoration strategies. Recently, we have assembled spatial datasets characterizing disturbance-specific information from energy development, fire, mechanical, and chemical treatments within Wyoming. We demonstrate that by pairing these spatial datasets with historic sagebrush habitat maps (SBMap; percent cover by 30-m pixels; every 2−5 years from 1985–2015, see publications by Homer and others) within the Wyoming Landscape Conservation Initiative region (WLCI), we can evaluate the rate of 'ecological recovery' as well as the time to 'reclamation recovery' as defined by reclamation guidelines. We are currently examining variation in these recovery rates among reclaimed areas around abandoned well pads across the WLCI, evaluating the contribution of weather, soils, and other factors on recovery rates. The resulting vegetation recovery curves will aid in identifying sagebrush and habitat recovery expectations for a number of species of conservation of interest, including the greater sage-grouse, and directly inform management efforts outlined within the Secretarial Order 3336 and within the recently revised BLM and USFS resource management plans. We plan on extending this approach to other disturbance types and vegetation treatments across Wyoming. We are currently completing analyses and a manuscript will be submitted for peer review early in 2018.

Funding provided by: U.S. Geological Survey and Wyoming Landscape Conservation Initiative through USGS

8. PATTERNS IN SAGE-GROUSE POPULATION DYNAMICS CORRESPOND WITH PUBLIC GRAZING RECORDS AT BROAD SCALES

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Grazing may influence Greater sage-grouse population trends because herbaceous cover is important for nesting and brood rearing. However, responses of sage-grouse population to grazing management have yet to be evaluated across large spatial extents. We used grazing records collected by the Bureau of Land Management from grazing allotments across Wyoming to examine for sage-grouse responses to grazing timing and intensity. We used annual counts of displaying males from 743 lek sites (2004-2014) and modeled population trends using state space models in a Bayesian framework. We found grazing can have both positive and negative effects on sage-grouse populations depending on grazing timing and intensity. Sage-grouse populations responded positively to higher levels of grazing that occurred later (after peak vegetation productivity), but populations declined when similar grazing levels occurred earlier, likely reflecting sensitivity of cool-season grasses to grazing during their growing period. We also found support for the hypothesis that effects of grazing management vary with local vegetation productivity. While the exact mechanisms behind these trends remain to be tested at finer scales, our findings may inform future grazing management policies by BLM and other agencies, as well as on private lands. This work is completed and was published in early 2017.

Funding provided by: U.S. Geological Survey and Wyoming Landscape Conservation Initiative through USGS

Publication: Monroe, A.P., C.L. Aldridge, T.J. Assal, K.E. Veblen, D. A. Pyke, and M.L. Casazza, 2017. Patterns in greater sage-grouse population dynamics correspond with public grazing records at broad scales. Ecological Applications 27:1096−1107.

9. HIERARCHICAL CLUSTERING OF GREATER SAGE-GROUSE LEKS TO IMPROVE UPON THE DETECTION OF POPULATION PERSISTENCE, SINKS, AND SOURCES

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We assessed how naïve hierarchical clustering of leks can better inform monitoring and management of Greater Sage-grouse by regionalizing the landscape and identifying the connectivity of lekking habitats using graph theory. Our objectives include (1) identifying biologically important and relevant landscape characteristics; (2) developing hierarchical clusters and habitat connectivity; (3) identifying relevant spatial scales of covariates; and (4) identifying appropriate cluster sizes (i.e., the number of leks per cluster). Our study area included two disparate sage-grouse habitats: Wyoming and Nevada. The multi-scaled statewide hierarchical clustering relies on a least-cost (LC) minimum spanning tree (MST, of graph theory) developed from lek locations (vertices) and terrain-based least-cost paths (edges). The LCMST was broken into subgraphs based on inter-lek movement distances informed from telemetry data (Coates et al., unpublished data) and barriers identified from ecological minimums (Knick et al. 2013). We evaluated covariates at six scales and with two distance methods, Euclidean and Mahalanobis, using the Spatial "K"luster Analysis by Tree Edge Removal (SKATER) clustering algorithm (Assuncao et al. 2006). We selected the top model, per subgraph, by minimizing the within cluster heterogeneity and maximizing the between cluster heterogeneity (AIC_c selection), which were calculated from one of the two distance methods. We have completed developing the approaches and software for defining and evaluating the clusters. After finalizing the clusters and a manuscript (to be submitted for peer review in 2017), future efforts will (1) apply rigorous simulations for sensitivity analysis between the top cluster models and sage-grouse management zones (see "Multi-scale statewide Wyoming Greater Sage-grouse trends determined by population viability analysis" by Edmunds et al.), (2) extend these methods range-wide, (3) evaluate range-wide population trend analysis, and (4) evaluate the clusters with genetic similarities and dissimilarities as this data becomes available.

Funding provided by: U.S. Geological Survey and the Bureau of Land Management

10. THE COMPLEXITIES OF SAGE-GROUSE LONG-TERM MONITORING DATABASE SYSTEMS

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The Wyoming Game and Fish Department (WGFD) maintains a database of Greater Sage-grouse lek locations and annual field observations (e.g., lek counts). Because of the importance of these data and repetitive use by researchers and managers for population trend monitoring, we developed open source Program R code to assist with using these data for long-term monitoring based on policies defined in the WGFD Handbook of Biological Techniques (Chapter 12; Christiansen 2012). Our code refines this database to include only observations meeting the four main criteria for counts as defined in the handbook (p. 12-8): 1) ground counts, 2) time constraints of 30 minutes before and 90 minutes post sunrise (modified from 60 minutes based on Monroe et al. 2016), 3) no precipitation, and 4) wind ≤10 mph. While these criteria are often not explicitly identified in the database, our code is able to search fields, such as "comments," to identify where an observer may have simply noted (e.g., "raining hard during count") that a criteria was not met. The WGFD 2017 database (1948-2017) included 131,084 records. Our process identified the following number of records not meeting the defined protocols: 44,610 with missing time or incorrect format; 114 with missing date or incorrect format; 6,927 that were the type of the method excludes surveys; 35,080 not defined as a "count;" 3,391 that did not meet time since sunrise requirements; and 526 that did not meet weather criteria (e.g., wind > 10 mph). From these results, we had a 69.2% decrease in observations, but notably, the reduction was mostly associated with observations before WGFD established standards. The impetus for these efforts was threefold: 1) provide results and tools to WGFD, 2) standardize workflows, and 3) support ongoing sage-grouse research (e.g., see Edmunds et al. and O'Donnell et al. [Clusters]). While we recognize that all records in this database were not meant to be used for sage-grouse trend assessment, particularly prior to full implementation of standardized protocols, our methods allow for a repeatable but flexible approach to refining this large database to meet a variety of research and management needs.

Funding provided by: U.S. Geological Survey and Wyoming Landscape Conservation Initiative through USGS

11. PROBING THE SAGE-GROUSE GENOME FOR SIGNATURES OF ADAPTIVE GENETIC VARIATION

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Identifying and maintaining genetic adaptations to environmental variation is key for developing sound conservation and management strategies. Genomics can greatly augment our ability to precisely characterize the genetic basis of important adaptations within extant populations. We have generated the first high-quality genome assemblies for both Gunnison and greater sage-grouse. Leveraging these whole-genome sequences as a reference, we are using a landscape genomics approach to scan for genetic loci correlated with environmental variables across Wyoming. Our recent work on adaptive genetic variation has identified a suite of single-nucleotide polymorphisms (SNPs) to demonstrated elevated rates of divergence among sage-grouse populations at the range-wide level. Some of these are present in biochemical pathways that may be important as counter-adaptations to toxic plant secondary metabolites (PSM) produced by sagebrush (*Artemisia* spp.) as a defense against herbivory. To date we have performed whole-genome resequencing for 15 sage-grouse samples from the Jackson Hole population. These sequences have been successfully aligned to our sage-grouse reference genome, allowing us to identify unique genetic variants in both gene-coding and non-coding regions across the genome. We are also accumulating additional tissue samples to conduct a restriction associated DNA sequencing study (RAD-Seq) of additional Wyoming samples this fall in order to evaluate variation in these candidate genes across the state. Ecological data will be obtained from recently-developed fine-scale sagebrush mapping products, and climate data will be pulled from WorldClim databases. We are using the Bayesian statistical framework implemented in the program BayEnv to identify correlations between SNPs and environmental variation. We will submit a peer-reviewed manuscript summarizing this work in 2017.

Funding provide by: U.S. Geological Survey

12. SOUND LEVELS AT GREATER SAGE-GROUSE LEKS, PINEDALE ANTICLINE PROJECT AREA, WYOMING, APRIL 2013-2017

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Skip Ambrose and Chris Florian, Sandhill Company, Castle Valley, UT

John MacDonald, John MacDonald PE, Winter Park, FL

The Bureau of Land Management's Pinedale Anticline Project Area Supplement Environmental Impact Statement developed a "Wildlife Monitoring and Mitigation Matrix" that identifies specific species to be monitored as well as criteria to be measured and changes that will be monitored. The greater sage-grouse was identified as a species to be monitored, and one criterion for this species was sound levels at leks. The objective of this project was to monitor sound levels at greater sage-grouse leks in and near the PAPA area south of Pinedale, WY.

A total of 12414 hours of acoustic data were collected at 23 leks in and near the PAPA from 2013-2017 (2000 hours 2013, 1617 in 2014, 2280 in 2015, 3674 in 2016, and 2843 in 2017). Sound levels at leks were directly related to the distance to the nearest pad with gas field activity and the type of activity at that pad. At leks <1500 m from gas field activity, mean annual $L_{50,0\text{-}24}$ = 28.7 dBA; at leks >1500 m from gas field activity, mean annual $L_{50,0\text{-}24}$ = 23.2 dBA. Sound levels at leks varied little among years except in situations where gas field activity changed significantly.

Funding: Pinedale Anticline Project Office, Bureau of Land Management, Pinedale, WY

13. RESPONSE OF GREATER SAGE-GROUSE TO TREATMENTS IN WYOMING BIG SAGEBRUSH

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Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) has been treated through chemical application, mechanical treatments, and prescribed burning to increase herbaceous forage species released from competition with sagebrush overstory. Originally intended to provide more forage for livestock, these techniques have been applied to improve habitat for sagebrush wildlife species including greater sage-grouse (*Centrocercus urophasianus*). Treatments are intended to rejuvenate sagebrush plants and increase herbaceous production. Studies evaluating habitat treatments have reported varied results and generally lack the replication necessary for evaluation of demographic rates and fine-scale habitat use of sage-grouse in response to treatments. Our study, centered near Jeffrey City, Wyoming is designed as a Before-After Impact-Control study with 3 years of pre-treatment and at least 5 years of post-treatment data comparing demographic rates and habitat selection patterns within treated and non-treated sites. We initiated our study in spring 2011 by capturing female sage-grouse and affixing VHF necklace-mounted or GPS rump-mounted transmitters to measure nest and brood-rearing success, and adult female survival. During winter 2014, we mowed 489 ha (1,208 acres) of sagebrush habitats across 2 mowing treatment areas and applied Spike® 20P on 607 ha (~1,500 acres) across 2 herbicide treatments areas in May 2014. To date, we have monitored demographic parameters from n = 507 marked females. Identifying sage-grouse demographic and habitat use responses will aid in determining the efficacy of habitat treatments intended to enhance habitat for sage-grouse and other species associated with the sagebrush biome.

Funding provided by: Wyoming Game and Fish Department, Wyoming Sage-grouse Conservation fund; Bates Hole/Shirley Basin, Bighorn Basin, South-Central, and Wind River/Sweetwater River Local Sage-grouse Work Groups; Wyoming Reclamation and Restoration Center; Wyoming Wildlife and Natural Resource Trust; Lander Field Office-Bureau of Land Management; and Margaret and Sam Kelly Ornithological Research Fund.

Publication: Smith, K.T., and J.L. Beck. *In press*. Sagebrush treatments influence annual population change for greater sage-grouse. *Restoration Ecology* DOI: 10.1111/rec.12589

14. EFFECTS OF MOWING AND HERBICIDE TREATMENTS ON THE NUTRITIONAL QUALITY OF SAGEBRUSH IN CENTRAL WYOMING

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Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) is the most abundant subspecies of big sagebrush and has been treated through chemical application, mechanical treatments and prescribed burning to improve habitat conditions for greater sage-grouse (*Centrocercus urophasianus*). Although the response of structural attributes of sagebrush communities to treatments is well understood, there is a need to identify how treatments influence the quality of sagebrush as winter food for wildlife. Our purpose was to identify how mowing and tebuthiuron treatments intended to reduce sagebrush canopy cover influenced dietary quality of Wyoming big sagebrush in central Wyoming. Two study areas were mowed in January and February 2014 and tebuthiuron was applied in two study areas in May 2014. We constructed 6 exclosures in each of these four study areas (24 total), which encompassed 30 m x 30 m areas of treated and untreated sagebrush within each exclosure. Samples of current annual growth were collected from 18 sagebrush plants from treatment sites and 12 plants from control sites within each exclosure during November 2013–2015. Samples were analyzed for crude protein and plant secondary metabolites known to influence dietary selection of sagebrush by sage-grouse and other sagebrush occurring herbivores. Our results suggest mowing and tebuthiuron treatments may slightly increase crude protein concentrations directly after treatments without immediate changes in plant secondary metabolites. Future work should evaluate not only how treatments influence sage-grouse habitat use and reproductive success, but how treatments influence other wildlife species in fragile sagebrush ecosystems.

Funding provided by: Wyoming Sage-grouse Conservation Fund; Bates Hole/Shirley Basin, South-Central, and Southwest Wyoming Local Sage-Grouse Work Groups; and, Wyoming Wildlife and Natural Resource Trust.

Publication: Smith, K.T., J.S. Forbey, and J.L. Beck. *In Review*. Effects of mowing and tebuthiuron treatments on the nutritional quality of Wyoming big sagebrush.

15. GREATER SAGE-GROUSE MIGRATION ECOLOGY AND RESPONSE TO BENTONITE MINING IN THE BIGHORN BASIN, WYOMING

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Wyoming contains 70% of the world's bentonite clay deposits, and mines in the Bighorn Basin produce >50% of Wyoming's annual supply. Bentonite is extracted by open-pit mining that leads to disturbance, fragmentation, and loss of sagebrush habitat. Plans call for mining to increase in sagebrush communities; therefore, our primary study objective was to monitor (for 4 years; spring 2011–spring 2015) the demographic rates and habitat selection patterns of greater sage-grouse in areas with greater (Shell) and lesser (Hyattville) amounts of bentonite mining activity. We monitored female survival, nest success, and brood survival with radio telemetry. To help guide reclamation we sampled vegetation in microhabitat plots at nests, early-brood locations, and at paired random locations. We are currently conducting analyses and writing manuscripts relative to habitat selection and demography of grouse relative to their exposure to disturbance. Our second study objective is describing the migration behavior of these populations using GPS-marked grouse. Observations have indicated a wide variety of migratory behavior including differences in the proportion of each population that is migratory, timing, distance, duration, destination, and differences among seasons. We are currently conducting analyses and writing manuscripts relative to timing, duration, and habitat selection along migration routes. Field data collection for our study finished in 2015.

Greater sage-grouse sample sizes obtained in the eastern Bighorn Basin, Wyoming, 2011–2015.

Sample	Female		Male	Nest	Brood	Microhabitat Plots	
	VHF	GPS	GPS			Nest	Brood
Shell	72	20	6	78	26	76	62
Hyattville	210	66	10	226	100	214	103

Funding provided by: American Colloid Company.

Publication

Pratt, A.C., K.T. Smith, and J.L. Beck. 2017. Environmental cues used by greater sage-grouse to initiate altitudinal migration. The Auk: Ornithological Advances 134:628–643.

16. GREATER SAGE-GROUSE MALE SURVIVAL AND CONSEQUENCES OF MIGRATION BEHAVIOR IN THE BIGHORN BASIN, WYOMING

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This research is being conducted in conjunction with the research project "Greater Sage-Grouse Migration Ecology and Response to Bentonite Mining in the Bighorn Basin, Wyoming." Our first objective is to investigate the feasibility of using mark-recapture methods to estimate male survival. If successful, we will relate male survival relative to different landscape characteristics. Males were marked by capture and leg bands or by genetic markers obtained from feather and fecal samples. During spring 2011-2015 we captured, banded, and collected a genetic blood sample from 220 males associated with 20 leks in the eastern Bighorn Basin. During 2012-2015, we also collected feather and fecal samples from these same leks. About 2/3 of the collected samples have had DNA extracted (feathers n = 950, fecal n = 45) and about 1/3 of the extracted samples have been genotyped. Of the genotyped samples about 2/3 are representing unique individuals available for recapture (not 2 samples from the same individual within a year). We will continue to process collected samples as funding is available. Additional funding to continue sample processing was recently obtained in conjunction with Beth Fitzpatrick and Melanie Murphy (University of Wyoming). Our second study objective is to investigate the feasibility of using stable isotope methods to classify migration behavior. If successful, we will investigate if there is any breeding body condition, survival, or reproductive consequences of different behavior. Observations of radio-marked grouse have revealed that individuals that make farther inter-seasonal movements are associated with summer habitat at high-elevation sites while those that make shorter movements are associated with summer habitat in hayflields/pastures. Results from summer-captured grouse (2011-2013; n = 94) show differences in 13C, 15N, 18O, and 2H isotope values between the 2 groups. These differences will allow for classifying (at 75% classification accuracy) spring-captured grouse with unknown behavior by measuring the stable isotope signatures in their feathers that were grown during the previous summer. Final lab analyses of unclassified grouse samples have been recently completed.

Funding provided by: American Colloid Company, Bighorn Basin Local Sage-Grouse Working Group, Animal Welfare Institute, and the Margaret and Sam Kelly Ornithological Research Fund.

17. FITNESS CONSEQUENCES OF MIGRATION STRATEGY AND SEASONAL HABITAT PROTECTIONS FOR GREATER SAGE-GROUSE

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Our study aimed to delineate seasonal habitats and assess differential fitness related to migration strategy and seasonal habitat use of greater sage-grouse (*Centrocercus urophasianus*: hereafter "sage-grouse"). In addition, we evaluated benefits gained for sage-grouse through the implementation of the Wyoming Core Area Strategy relative to protection of habitat and differences in nest, brood, and annual female survival. We compared the proportion of seasonal habitats that were within or outside Core Areas as delineated with 75% and 95% kernel density contours (KDE). The proportion of summer and winter habitats (95% KDE) that overlapped Core Areas was 0.69 of summer and 0.50 of winter habitat within a Core Area. We found no differences in nest or brood survival among migration strategies or within and outside Core Areas. However, females that did not migrate out of their respective winter habitat had lower risk of death, which highlighted year-round benefits of winter habitat. Females had lower risk of death during winter with the lowest risk occurring during winter in Core Areas. Higher temperature and lower snow water equivalent during the breeding season and fall were detrimental to female survival; whereas, neither had an effect on winter survival. Although Core Areas encompassed a large proportion of winter habitat, our results indicate that Core Areas (as delineated) were not the most direct way to protect winter habitat for sage-grouse. During winter, sage-grouse gathered within habitat conducive to winter survival, indicating that disturbances within these winter habitats may have broad consequences for sage-grouse populations.

Funding provided by: American Colloid Company; Anadarko Petroleum Corporation; Bates Hole, Big Horn Basin, Southwest, South-Central and Wind River/Sweetwater River Wyoming Local Sage-Grouse Work Groups; Bureau of Land Management; Jack H. Berryman Institute; Lincoln County Predator Management Board; Margaret and Sam Kelly Ornithological Research Fund; Predatory Animal District of Sweetwater County; School of Energy Resources at the University of Wyoming; State of Wyoming Legislature through the Wyoming Wildlife and Natural Resource Trust; Utah Agricultural Experiment Station; Uinta County Predator Management Board; Wyoming Animal Damage Management Board; Wyoming Game and Fish Department; and Wyoming Sage-grouse Conservation Fund of the Wyoming Game and Fish Department.

Publication

Dinkins, J. B., K. J. Lawson, K. T. Smith, J. L. Beck, C. P. Kirol, A. C. Pratt, M. R. Conover, and F. C. Blomquist. *In press*. Quantifying overlap and fitness consequences of migration strategy with seasonal habitat use and a conservation policy. Ecosphere

18. INFLUENCE OF HUMAN ACTIVITIES AND ENVIRONMENTAL CHANGE ON GREATER SAGE-GROUSE POPULATION TRENDS: ANTHROPOGENIC DEVELOPMENT, HABITAT, HUNTER HARVEST, FIRE, AND WEATHER

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Hunter harvest of greater sage-grouse (*Centrocercus urophasianus*; hereafter "sage-grouse") has been regulated by wildlife agencies during most of the past century. Wildlife agencies have maintained season regulations with the intention of providing sustainable hunting opportunities. Range-wide population declines of sage-grouse have prompted wildlife agencies to restrict harvest with increasingly conservative hunting regulations since the mid-1990's. Sage-grouse populations are known to oscillate over time, and population growth can be influenced by seasonal weather and habitat disturbance. From 1995–2013, we compared sage-grouse lek trends from 21 relatively distinct sage-grouse populations in 9 western U.S. states and 2 Canadian provinces. We stratified populations into 3 categories with 8 different harvest histories (non-hunted [n = 2], continuously hunted [n = 3], and hunting season discontinued between 1996–2003 [n = 3]) to evaluate the potential impact of harvest on sage-grouse populations. Concomitantly, we assessed the effects of proportion burned, forested and agricultural habitat; winter, spring, and summer precipitation; and human population, road, and oil and gas well densities on initial and time-varying lek counts. Density-dependent models fit lek trend data best for 7 of the 8 harvest histories. In general, higher proportions of burnt, forested, and cropland; and greater human population and oil and gas well densities were associated with lower equilibrium abundance. We found mixed results regarding the effect of hunting regulations on instantaneous growth rate (r). The cessation of harvest from 1996–2001 in approximately half of the largest sage-grouse population in this analysis was associated with higher r. Continuously harvested sage-grouse populations with permit hunting seasons had higher r during years with higher proportion of area exposed to permitted hunting rather than general upland game seasons. However, more liberal hunting regulations were positively associated with higher r in populations continuously harvested under general upland game hunts. Our results suggest that discontinuing harvest in the largest population resulted in greater population growth rates; however, this was not the case for smaller populations. Most state and provincial wildlife agencies were adept at monitoring changes in lek trends and subsequently limiting hunting opportunities to prevent hunting sage-grouse facing drastic declines in lek trends.

Funding provided by: Anadarko Petroleum Corporation

Publication

Dinkins, J. B., J. L. Beck, and K. J. Lawson. *In review*. Influence of environmental change, harvest exposure, and human disturbance on lek count trends of greater sage-grouse

19. PREDICTION OF ANNUAL ESTIMATED HARVEST OF GREATER SAGE-GROUSE BASED ON SEASON REGULATIONS, SURVEY BIAS, AND HUNTER ACCESS

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During the past 100 years, regulated harvest of greater sage-grouse (*Centrocercus urophasianus*; hereafter ”sage-grouse”) has been overseen by 11 state and two provincial wildlife management agencies. These agencies progressively changed harvest season regulations to reduce potential negative effects of hunter harvest. Changes to season regulations are the primary mechanism that wildlife agencies use to limit the number of sage-grouse harvested annually. Concurrently, there has been recognition that survey bias existed historically, and factors other than harvest regulations lead to differential exposure to harvest (e.g., cities, human population density, land ownership, roads, and weather during the hunting season). We evaluated the influence of harvest season regulations, harvest survey variables, and exposure to harvest variables on the annual estimated number of harvested sage-grouse. Our analysis spanned 1995–2013 and included harvest data from 8 U.S. states. Estimated harvest numbers were positively associated with possession limit, earlier and wetter opening weekends, and closer proximity to a city. Mail-in harvest surveys and general upland game hunts produced higher harvest estimates compared to permit, phone, and web surveys and sage-grouse specific hunts, respectively. Harvest regulations implemented by management agencies were effective at reducing the number of harvested sage-grouse.

Funding provided by: Anadarko Petroleum Corporation

20. COMPARISON OF SONGBIRD POPULATION TRENDS TO SAGE-GROUSE LEK TRENDS: ASSESSING SAGE-GROUSE CORE AREAS AND UMBRELLA SPECIES CONCEPT

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Conservation strategies including the umbrella species concept promote the potential of multiple species benefitting from protection of large areas necessary for one species continued viability, such as Wyoming's Sage-grouse Core Area Policy. Greater sage-grouse (*Centrocercus urophasianus*; hereafter: sage-grouse) have been identified as an umbrella species for many other sagebrush-obligates including songbirds. Sagebrush-obligate songbirds and sage-grouse have undergone population declines throughout the western United States attributed to similar habitat issues. To assess the umbrella species concept and conservation benefit of the Core Area Policy, we compared trends of sagebrush-obligate songbirds from the Breeding Bird Survey and sage-grouse leks, 1996–2013, to evaluate if their trends were similar. We compared trends within and outside of Core Areas in the Powder River Basin and Wyoming Basins, Wyoming. Trends of sagebrush-obligate songbirds were generally not similar to sage-grouse (within or outside of Core Areas). In Wyoming, sage-grouse trends declined more outside of Core Areas. Even though differential trends of sage-grouse within and outside of Core Areas were likely a relic of historically higher habitat quality within Core Areas, our results indicated Core Areas were successful at maintaining higher sage-grouse trends compared to areas not protected under the Core Area Policy. While Core Areas were well placed for sage-grouse, sagebrush-obligate songbird trends did not follow the same pattern. This suggests that protection of only the best remaining sage-grouse habitat may not be a suitable conservation strategy for other sagebrush-obligate birds, and undermines the utility of the umbrella species concept as an effective universal approach to conservation.

Funding provided by: Wyoming Wildlife and Natural Resource Trust

21. LANDSCAPE MANAGEMENT FOR SAGEBRUSH AND GRASSLAND BIRD GUILDS IN THUNDER BASIN, WYOMING

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The Thunder Basin National Grasslands (TBNG) of northeastern Wyoming are composed of a heterogeneous mosaic of sagebrush (*Artemisia spp.*), short-grass and mixed-grass plant communities. Portions of TBNG have been designated as core area for greater sage-grouse (*Centrocercus urophasianus*), and are also important for other sagebrush bird species. However, the grassland also contains some of the largest complexes of black-tailed prairie dogs (*Cynomys ludovicianus*) in North America; these colonies provide important habitat for shortgrass bird species (e.g., mountain plover [*Charadrius montanus*]), and are also prioritized as a reintroduction zone for the endangered black-footed ferret (*Mustela nigripes*). Because conservation of diverse species in the same landscape requires spatial optimization of management approaches, we initiated a study in 2015 to determine how shortgrass and sagebrush bird species are influenced by the composition and spatial configuration of habitat patches in the Thunder Basin landscape. From 2015-2017 we surveyed birds on transects placed across sage-grouse leks ("sagebrush," n=10), prairie dog colonies ("shortgrass," n = 10), and also across edges between colonies and adjacent habitat ("edge," n = 41). We will use data collected between 2015-2017 to generate models of single species density as a function of local and landscape habitat variables. We are especially interested in how the size and configuration of prairie dog colonies influences sagebrush species in this landscape. However, because sage-grouse have low detectability on point counts, we will use lek data to examine sage-grouse response to colony abundance and configuration in the landscape.

Funding provided by: Wyoming Agricultural Experiment Station, Rangeland Resources Research Unit of the USDA-Agricultural Research Service, Laramie Audubon Society, and Margaret and Sam Kelly Ornithological Research Fund

22. EFFECTIVENESS OF CORE AREA CONSERVATION METRICS FOR SAGE-GROUSE: CAN WE IDENTIFY DISTURBANCE THRESHOLDS?

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The Wyoming Core Area Policy for greater sage-grouse (*Centrocercus urophasianus*) limits surface disturbance at 5% to constrain landscape change within areas of high sage-grouse population densities. We designed our study to evaluate effectiveness of the 5% disturbance cap on sage-grouse nest and brood survival in relation to habitat use by female grouse during nesting and brood-rearing. To explore these relationships we used nest (n = 1,049), brood-rearing (n = 2,810), and random (to represent available habitat; n = 19,595) locations from VHF- and GPS-marked females compiled from 6 distinct study areas across Wyoming including from 2008–2011. Female grouse were exposed to differing types of energy development and surface disturbance. We quantified surface disturbance for each study area with the Wyoming Density and Disturbance Calculation Tool and explored different functional relationships (e.g., linear, quadratic) between nest and brood survival and disturbance using a mixed effects Cox proportional hazard model. Nest survival was best explained by a linear relationship at the 0.25-km^2 scale. As percent surface disturbance exposure at this scale increased the risk of nest failure also gradually increased. When a nest was exposed to more than one type of disturbance at the 0.25-km^2 scale the risk of nest failure increased at a greater rate. We did not detect a direct relationship between percent disturbance exposure and brood survival. However, across consecutive brooding locations, broods exposed to disturbance at the 1-km^2 scale were at greater risk of brood loss compared to broods not exposed to disturbance at this scale. Most nest (79.9%) and brood-rearing (83.3%) locations were located in areas with 0–3% disturbance. The minimal number of nest and brood-rearing locations that were within areas that had disturbance values greater than 3%, likely restricted our ability to detect survival consequences of habitat use in higher disturbance areas.

Funding provided by: Wyoming Wildlife and Natural Resource Trust

23. IDENTIFICATION OF WINTER CONCENTRATION AREAS IN SOUTH-CENTRAL WYOMING: ABUNDANCE AND RESOURCE SELECTION

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Availability and use of winter habitat by greater sage-grouse (*Centrocercus urophasianus*) has the potential to influence viability of sage-grouse populations and should receive considerable attention when prioritizing areas for sage-grouse habitat conservation. The Wyoming Sage-grouse Executive Order outlines the need to identify Winter Concentration Areas (WCAs), defined as winter habitats where sage-grouse consistently aggregate in groups of 50 or more individuals. Unfortunately, documentation of WCAs lags behind our knowledge of sage-grouse winter habitat requirements and space use during other critical periods. Our study was designed to detect locations of unknown WCAs while assessing abundance and resource selection to refine our understanding of winter habitats and critical use areas for sage-grouse. We used aerial infrared videography in winter 2017 to identify potential WCAs in south-central and southwest Wyoming to evaluate abundance and winter habitat selection as influenced by biological attributes, environmental, and anthropogenic features across the region. We located 110 sage-grouse flocks comprising 4,908 individuals (mean: 45, range: 2–895). Predicting WCAs was difficult using count-based abundance models as abundance was generally unrelated to habitats used by sage-grouse flocks. However, habitat selection modelling produced predictive models that validated well with independent datasets. Selection of high quality habitats generally occurred irrespective of flock size, but individuals in larger flocks selected the best winter habitats across the study area. Areas of predicted high quality habitats overlapped well with identified concentrations of wintering sage-grouse and may be used to focus efforts to identify additional areas with persistent occurrence of sage-grouse during winter.

Funding provided by: Wyoming Game and Fish Department, Wyoming Sage-grouse Conservation Fund; South-Central and Southwest Local Sage-grouse Work Groups.

24. USING DEMOGRAPHIC AND SPACE-USE DATA TO INFORM AND ASSESS EFFECTS OF GRAVEL EXTRACTION IN GRAND TETON NATIONAL PARK

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Greater Sage-grouse are a species of concern for Grand Teton National Park National Park Service due to negative long-term population trends and genetic isolation. The sagebrush flats of Spread Creek within Grand Teton National Park host an active lek, nesting and wintering habitat and is adjacent to an annually active gravel extraction facility. Due to the potential for disturbance from the gravel pit operations to sage-grouse lekking, movements, and demography in this area, we initiated a study to help inform dates for mining activities and investigate the potential effects of gravel extraction operations. Extraction continued at low levels late in the summers of 2016 and 2017 and we anticipate increased and earlier operations in 2018 and 2019. The study is designed to inform activity dates based on local nesting behaviors and investigate any potential differences in movements, habitat use, and nesting demography of sage-grouse between years of low and high levels of pit operations. In 2016-2017, we found 11 active nests from 12 hens outfitted with GPS transmitters and gathered movement data from 19 grouse (14 hens and 4 males). Mean incubation initiation was 7 May in 2016 and 14 May in 2017 (range, 2-21 May both years combined). Re-nesting initiation was 6 June in 2017 (no re-nesting detected in 2016). Hens left successful nests in mid-June, but as late as 4 July for re-nests in 2017. We will use these nesting dates to inform extraction activities in cooperation with Grand Teton National Park. We will also compare 2016-17 movement data to additional data we will collect in 2018-19 to determine if mining activities have any effect on grouse habitat use in the area.

Funding provided by: Grand Teton National Park, Upper Snake River Basin Sage-grouse Working Group

25. EFFECTIVENESS OF SAGE-GROUSE CORE AREAS AS AN UMBRELLA FOR NON-GAME SAGEBRUSH SPECIES OF GREATEST CONSERVATION NEED

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We investigated how effective Greater Sage-Grouse is as an umbrella species for the conservation of non-game wildlife, specifically sagebrush-associated wildlife designated as Species of Greatest Conservation Need (SGCN). Our findings will be useful to managers interested in indirectly conserving SGCN under the streamlined approach of the sage-grouse umbrella. We addressed the following objectives at differing spatial scales to rigorously test sage-grouse as an umbrella species: 1) quantify overlap statewide between sage-grouse core areas and the habitat of 52 SGCN using GIS data; 2) determine whether high sage-grouse abundance corresponds with high abundance of sagebrush-obligate SGCN songbirds in the field; 3) evaluate whether sage-grouse nest-site quality and selection match those of sagebrush-obligate SGCN songbirds in the field; and 4) examine the responses of sagebrush-obligate SGCN songbirds (abundance, nesting success, etc.) to sagebrush-reducing habitat treatments implemented to improve sage-grouse brood-rearing habitat. We have completed field work near Jeffrey City, WY (4 seasons, 2012-2015). Preliminary findings by objective: 1) Core areas covered 0-63% of associated SGCN's suitable habitat; 2) Sage-grouse abundance was a generally poor indicator of sagebrush-obligate songbird abundance; 3) Sage-grouse nest-site quality and selection did not match those of sagebrush-obligate songbirds; and 4) SGCN songbirds nested in the vicinity of mowed areas, but did not appear to use the mowed footprint, or benefit from habitat treatments. Full results appear in Jason Carlisle's dissertation (Carlisle 2017, University of Wyoming, link to PDF) and are in the process of peer-reviewed publication.

Funding provided by: Wyoming Game and Fish Department, Southwest and Wind River/Sweetwater River Basin Local Working Groups, UW Biodiversity Institute, UW Dept. of Zoology and Physiology, Wyoming Chapter of The Wildlife Society, WEST/McDonald Research Award for Quantitative Analysis in Wildlife Ecology, Wyoming INBRE Program, UW Program in Ecology, UW Museum of Vertebrates, and Laramie Audubon Society.

26. RESOURCE DENIAL AS A MEANS TO REDUCE AVIAN PREDATION OF GREATER SAGE-GROUSE

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Common ravens are significant nest predators of greater sage-grouse, and raven populations have increased dramatically across the western U.S. over the last century. Several authors have hypothesized anthropogenic food subsidies, especially during the winter, have allowed raven populations to expand and that removal of these food subsidies may be a viable option to manage ravens in the western U.S. We tested this hypothesis last winter by preventing ravens from foraging at the Kemmerer landfill and by removed all roadkill within 32 km of Kemmerer. After we started removing food, number of ravens roosting around Kemmerer decreased by 35%. Concomitantly, raven numbers increased 13% at our control roost site (i.e., Solvay Soda Ash Mine). More data and further analysis of these data are required to draw conclusions regarding the efficacy of this technique, but our first-year results are encouraging.

Funding provided by: Wyoming Animal Damage Management Board, Utah Agricultural Experiment Station.

27. GREATER SAGE-GROUSE TRANSLOCATION FROM WYOMING TO NORTH DAKOTA

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Wildlife translocations and population augmentations continue to occur and are an important management option for wildlife managers. Grouse populations throughout the world are imperiled and managers have used translocation techniques for various grouse species and populations. Past efforts have often lacked resources to monitor the success of the translocated individuals and we are often left with little information to understand how or why the management action was a success or failure. The majority of grouse translocation efforts that have been monitored at some level have often failed in the short term, or if some immediate success, then in the long-term. There is no information currently concerning impacts to the source population or the comparison of population dynamics between the source and translocated birds. We are translocating 40 female and 20 male sage-grouse during the springs of 2017 and 2018 from the Stewart Creek area, north of Rawlins, WY to southwest North Dakota, where sage-grouse numbers have been declining for several years. All translocated birds will be radio-marked and monitored for survival and reproductive rates. We are also radio-marking 20 female sage-grouse within the source population and monitoring survival and reproduction. We will also be using artificial insemination techniques to see if this changes reproductive rates of females. These same techniques are being used in the Bi-State population in California and a population in west-central Utah. We will be able to compare techniques and develop translocation protocols based on the comparison of translocated and source populations. We also plan on publishing a thesis and submitting a couple of publications for peer-review based on this research.

Funding provided by: North Dakota Game and Fish Department

28. GREATER SAGE-GROUSE GEOPHAGY DURING THE WINTER

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Greater sage-grouse have been documented eating soil during the winter near Pinedale, WY. Our objectives included 1) understand why this behavior is happening, including what nutrient the birds are seeking, 2) how this behavior affects winter habitat selection, and 3) if this behavior influences survival and reproductive rates the following spring and summer. We are trapping and radio-marked up to 30 individual grouse. We will monitor their movements and habitat selection. We are also collecting soil samples at geophagy sites and at random to assess differences. We will collect sagebrush leaf samples at feeding sites from plants that are fed on and plants in the area that are not selected to evaluate any differences in nutrient content. We will also collect sage-grouse pellets from flocks with radio-marked birds to see if we can detect any differences in micro nutrients based on time since visiting a geophagy site. Samples of calcium, salt, and phosphorous will be placed at geophagy sites to see if visiting sage-grouse will select for one or more of these nutrients. During the following spring and summer we will follow radio-marked females to monitor their reproductive rates and assess whether geophagy behavior can be related to reproductive rates. We plan on publishing a thesis and a couple of peer-reviewed publications concerning this research.

Funding provided by: Bureau of Land Management, Southwest Wyoming Sage-Grouse Local Working Group

29. COMPARISON OF AVIAN AND MAMMALIAN PREDATORS IN SAGE-GROUSE CORE AND NON-CORE AREAS: ASSESSING PREDATOR ABUNDANCE AND RESPONSES TO ANTHROPOGENIC FEATURES

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Greater sage-grouse (*Centrocercus urophasianus*: hereafter sage-grouse) abundance and distribution in western North America has declined over the last century. Many factors have contributed to this decline, including habitat loss and fragmentation from human development with an associated potential for increased predation rates from avian and/or mammalian predators. While human development influences sage-grouse demographic rates and habitat selection, development also provides an increased number of perch and nesting structures used by avian predators—including ravens that can negatively influence sage-grouse nest success. Wyoming's Sage-grouse Core Areas were developed to add protections to important habitat for sage-grouse by reducing human development. Core Areas have maintained higher sage-grouse trends compared to Non-Core Areas, which could be explained by lower predation rates. However, no study has compared predator abundance within and outside Core Areas. We performed avian point counts along 233, 8.05-km transects throughout 11 counties in the Wyoming Basin during the 2017 summer. An avian point count was performed every mile and transects were stratified between sage-grouse Core and Non-Core Areas. Human structures were recorded at each point count location. This information will be added to BBS data and human disturbance data previously quantified. We plan to survey coyotes and potentially other mammalian predators during the 2018 summer by performing line transect surveys with fixed-wing flights or other survey techniques. Our study will determine: (1) what habitat or structural factors are associated with higher predator abundance, and (2) if avian and mammalian predator abundance differs between Core and Non-Core Areas.

Funding provided by: Bates Hole/Shirley Basin, Big Horn Basin, and Southwest Wyoming Sage-Grouse Local Working Groups; and Oregon State University

30. STATE-WIDE GENETIC CONNECTIVITY FOR GREATER SAGE-GROUSE IN WYOMING

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Principal Investigators

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Greater sage-grouse population connectivity has been identified as a priority management issue by multiple state and federal management agencies. We are working on a large-scale project to assess levels of population connectivity using genetic approaches. This project assisted in the delineation of related populations and described possible sub-population boundaries. The research also identified likely barriers to the movement of individuals among populations. One objective of the State's Game and Fish Agency is to maintain connectivity. To accomplish this, we must understand more about the genetic diversity and the likelihood and nature of impacts from any inbreeding that is identified and the association between the seasonal habitats of the species and the subpopulations that use them. We have published 4 peer-reviewed manuscripts associated with this research.

Funding provided by: U.S. Bureau of Land Management, Wyoming Game and Fish Department, U.S. Geological Survey.

Row, J.R., S.T. Knick, S.J. Oyler-McCance, S.C. Lougheed, and B.C. Fedy. 2017. Developing approaches for linear mixed modeling in landscape genetics through landscape-directed dispersal simulations. Ecology and Evolution. DOI: 10.1002/ece3.2825

Fedy, B.C., J.R. Row, and S.J. Oyler-McCance. 2016. Integration of genetic and demographic data to assess population risk in a continuously distributed species. Conservation Genetics doi:10.1007/s10592-016-0885-7.

Row, J.R., S.J. Oyler-McCance, and B.C. Fedy. 2016. Differential influences of local subpopulations on regional diversity and differentiation for greater sage-grouse (*Centrocercus urophasianus*). Molecular Ecology 25: 4424-4437.

Row, J. R., S. J. Oyler-McCance, J. A. Fike, M. S. O'Donnell, K. E. Doherty, C. L. Aldridge, Z. H. Bowen, and B. C. Fedy. 2015. Landscape characteristics influencing the genetic structure of greater sage-grouse within the stronghold of their range: a holistic modeling approach. Ecology and Evolution 15.

31. ASSESSING THE EFFICACY OF FATHEAD MINNOWS FOR MOSQUITO CONTROL IN NE WYOMING

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Principal Investigator

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West Nile virus (WNv) has become a significant and increasing threat to wildlife populations and human health throughout North America. Mosquito control is a significant and effective means of controlling the spread of WNv, as the virus is primarily spread between avian and mosquito vectors. This is of particular concern for avian host species such as the Greater sage-grouse (*Centrocercus urophasianus*), where WNv has been documented to negatively affect sage-grouse survival. So far, the most popular methods for controlling mosquito vectors have focused on controlling mosquitoes at their larval life stages. Our research tested the efficacy of using fathead minnows (*Pimephales promelas*) as a biological control for mosquito populations in northeastern Wyoming. Specifically, we addressed 2 main questions: 1) does the presence of fathead minnows influence mosquito larva density within reservoirs? 2) what pond and water quality characteristics support viable populations of fathead minnows? In 2013 and 2014, we introduced 2,500 minnows per surface acre into 7 of 15 monitored reservoirs. The presence of fathead minnows, mosquito larva density and adult mosquito populations were monitored at all sites on a weekly basis. Preliminary analysis suggests some sites were able to sustain minnow populations, which significantly reduced larva density at treated sites. Additionally, during our 2014 field season we used stable isotopes to assess whether minnows were consuming mosquito larva. Reservoirs were monitored during our final field season in 2015. The manuscript is currently in its first round of revisions with PLOS ONE.

Funding provided by: Northeast Sage-Grouse Local Working Group, Wolf Creek Charitable Foundation.

32. TEMPORAL-DAMPENING AND PERIOD-SHIFTING IN THE RANGE-WIDE CYCLIC DYNAMICS OF GREATER SAGE-GROUSE

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Global trends of dampening wildlife population cycles has increased interest in the spatial-temporal dynamics for cyclic species. However, most data and analyses are limited by data inconsistencies and geographic scope. We used wavelet analysis on a range-wide dataset of abundance and determined that most populations (11 of 15) of the greater sage-grouse have demonstrated cyclicity over the last 50 years. However, the patterns varied over both time and space with several peripheral populations demonstrating amplitude dampening or loss of cyclicity following population lows in the mid-1990s. Core populations demonstrated more consistent cyclic dynamics, but period length shortened from 10-12 to 6-8 years. Increased pairwise population synchrony was correlated with cycle intensity, except in core populations, which drifted out of phase following changes in period length. Our work represents the first comprehensive range-wide assessment of cyclic dynamics and revealed substantial variation in temporal and spatial trends of cyclic dynamics across populations.

Funding provided by: University of Waterloo and the Natural Sciences and Engineering Research Council of Canada; Data were provided by WAFWA.

Row, J.R. and B.C. Fedy. 2017. Spatial and temporal variation in the range-wide cyclic dynamics of greater sage-grouse. Oecologia. DOI 10.1007/s00442-017-3970-9

33. IMPROVING SUCCESS IN HABITAT RESTORATION FOR SAGEBRUSH-OBLIGATE WILDLIFE: ASSESSMENT OF AVIAN HABITAT USE AND VEGETATION COMPOSITION IN SAGEBRUSH STEPPE RECLAMATION ACTIVITIES

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To improve outcomes of habitat restoration for sage-grouse and other sagebrush obligate birds, we need to understand relationships between distribution and composition of plant communities on reclaimed sites in relation to habitat use and population fitness of sagebrush-obligates. Generally speaking, how can we best restore birds when restoring sagebrush habitat? We initiated research in the summer of 2016 to assess the influence of reclamation activities on habitat use and population fitness of sagebrush-obligate birds. Our study is in the Powder River Basin in an area that has undergone large-scale reclamation of coal bed natural gas infrastructure. This study area is ideal because it includes a gradient of disturbance types, representing different stages of energy development, from non-impacted sites, reclaimed sites, and active energy development sites. Our primary objectives are to assess the response of species across the gradient of energy development, reclaimed, and control areas in terms of habitat use and multiple fitness parameters. We have completed two field seasons in 2016 and 2017 and are planning for an additional season in 2018.

Funding provided by: BLM-Buffalo Field Office, Northeast Sage-Grouse Working Group, the Wyoming BLM-State Office, Canadian Foundation for Innovation, Natural Sciences and Engineering Research Council of Canada.

34. PROBABILITY OF LEK COLLAPSE INSIDE AND OUTSIDE SAGE-GROUSE CORE AREAS

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Greater sage-grouse (*Centrocercus urophasianus*) occupy sagebrush (*Artemisia* spp.) habitats in 11 western states and 2 Canadian provinces. In September 2015, the U.S. Fish and Wildlife Service announced the listing status for sage-grouse had changed from *warranted but precluded* to *not warranted*. The primary reason cited for this change of status was that the enactment of new regulatory mechanisms was sufficient to protect sage-grouse populations. One such plan is the 2008, Wyoming Sage Grouse Executive Order (SGEO), enacted by Governor Freudenthal. The SGEO identifies "Core Areas" that are to be protected by keeping them relatively free from further energy development and limiting other forms of anthropogenic disturbances near active sage-grouse leks. Using the Wyoming Game and Fish Department's sage-grouse lek count database and the Wyoming Oil and Gas Conservation Commission database of oil and gas well locations, we investigated the effectiveness of Wyoming's Core Areas, specifically: 1) how well Core Areas encompass the distribution of sage-grouse in Wyoming, 2) whether Core Area leks have a reduced probability of lek collapse, and 3) what, if any, edge effects intensification of oil and gas development adjacent to Core Areas may be having on Core Area populations. Core Areas contained 77% of male sage-grouse attending leks and 64% of active leks. Using Bayesian binomial probability analysis, we found an average 10.9% probability of lek collapse in Core Areas and an average 20.4% probability of lek collapse outside Core Areas. Using linear regression, we found development density outside Core Areas was related to the probability of lek collapse inside Core Areas. Specifically, probability of collapse among leks >4.83 km from inside Core Area boundaries was significantly related to well density within 1.61 km (1-mi) and 4.83 km (3-mi) outside of Core Area boundaries. Collectively, these data suggest that the Wyoming Core Area Strategy has benefited sage-grouse and sage-grouse habitat conservation; however, additional guidelines limiting development densities adjacent to Core Areas may be necessary to effectively protect Core Area populations.

Funding provided by: Wyoming Wildlife and Natural Resource Trust and Bowling Green State University.

Publication: Spence, E. S., J. L. Beck, and A. J. Gregory. *In press*. Probability of lek collapse is lower inside Sage-grouse Core Areas: Effectiveness of conservation policy for a landscape species. PLOS ONE

35. WYOMING SAGE-GROUSE CORE AREA HEALTH ASSESSMENT

Contact: Dr. Matt Holloran; E-mail: Holloran.matt@gmail.com; Phone: (307) 399-6885

Alison Holloran and Brian Rutledge: Audubon Rockies (project lead);
Dr. Curtis Burkhalter and Dr. Nicole Michel: National Audubon Society;
Holly Copeland: The Nature Conservancy;
Dr. Bradley Fedy: University of Waterloo;
Dr. Robert Crabtree and Steve Jay: Yellowstone Ecological Research Center;
Dr. Matt Holloran: Operational Conservation, LLC.

A comprehensive understanding of wildlife habitat suitability requires landscape-scale assessments that provide the framework for subsequent integration with local-scale relationships. In order to elucidate the functional role of habitat characteristics at large scales it is necessary to understand how abundance is related to important landscape characteristics. We estimated male Greater Sage-grouse (*Centrocercus urophasianus*) abundance on leks relative to sagebrush availability, landscape connectivity, and anthropogenic infrastructure densities within landscapes surrounding leks from 2006 to 2013 using binomial N-mixture models. We focused on Wyoming, as the state will play a critical role in the long-term persistence of Greater Sage-grouse due to its relatively robust populations, widespread sagebrush habitats, and innovative, large-scale conservation approaches. Landscapes associated with higher abundance of males on leks were characterized as highly-connected, sagebrush-dominated areas with limited energy development. These modeled relationships were used to evaluate spatial and temporal changes in the landscape-scale integrity of areas supporting the majority of the Greater Sage-grouse populations in Wyoming (i.e., core areas). By assessing relative changes in abundance over time, our models indicated that most of the habitat within core areas (86%) exhibited landscape conditions conducive to supporting medium or large Greater Sage-grouse populations that were stable or increasing through time. Larger populations were associated with larger, more centrally-located core areas. Conversely, core areas supporting relatively small or declining populations were located along range margins in the eastern portion of the state. The landscape-scale habitat relationships we developed can be used in combination with local-scale assessments to generate a more complete picture of Greater Sage-grouse habitat suitability.

Funding: Wyoming Governor's Office; the Bureau of Land Management Pinedale Field Office; and the Wind River/Sweetwater River, Upper Snake River, Southwest, Bates Hole/Shirley Basin, and Upper Green River Sage-grouse Local Working Groups.

Publication: Burkhalter, C., M. J. Holloran, B. C. Fedy, H. E. Copeland, R. L. Crabtree, N. L. Michel, S. C. Jay, B. A. Rutledge, and A. G. Holloran. *In Press*. Landscape-scale habitat assessment for an imperiled avian species. Animal Conservation.

36. USGS NEW SHRUBLAND COMPONENTS AVAILABLE IN WYOMING

Contact: Dr. Collin Homer[1], email, homer@usgs.gov, phone 208-426-5213

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The USGS in collaboration with the BLM has produced a new remote sensing-based quantification of Wyoming shrub lands. This circa 2015 database replaces the previous shrub component products produced by the USGS from circa 2006 data. For the new products, nine individual products have been produced with values representing the proportion (fractional vegetation) of each target component for every 30 m pixel. Component products include percent shrub, percent sagebrush, percent big sagebrush, percent herbaceous, percent annual herbaceous, percent litter, percent bare ground, shrub height and sagebrush height. This approach relies on creating training datasets using field measurements and high resolution satellite imagery at selected sites; extrapolating these training datasets to the landscape level using medium resolution satellite images, and then validating the final products with independent field measurements. New modeling improvements should result in an improved product over 2006. Similar work is being completed throughout the sagebrush ecosystems of the west so data will be comparable to other areas. Final products are now available for download from www.mrlc.gov. Second generation work is now being completed from these new base components to map historical component change every year back to 1984, providing users change and trend information across time. These products will be available June, 2018.

Funding provided by: U.S. Geological Survey, BLM – AIM program, and MRLC

Publication: Pending

37. SAGE-GROUSE HABITAT RESTORATION IN NORTHEASTERN WYOMING: EVALUATING REVEGETATION OUTCOMES

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Kristina M. Hufford and Sara Burns

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Greater sage-grouse conservation measures in Wyoming include large revegetation programs to restore landscapes disturbed by energy extraction. If we are to understand the effectiveness of current conservation practices, studies are needed of reclamation seeding outcomes. Few studies examine differences in the seed mix and established vegetation at reclamation sites. We are working to compare reclamation seed mixes with reclamation outcomes for vegetation in the Powder River Basin. To date, we have identified 30 sites representing undisturbed rangeland, reclaimed CBNG wells and active CBNG wells in the Powder River Basin. Seasonal surveys were completed in summer 2017 and we identified vegetation at each site using the Assessment, Inventory and Monitoring (AIM) strategy. Analysis is underway to compare species richness at reclaimed wells with species planted in the seed mix and vegetation present at undisturbed sites. We have found significant differences in species assemblages between reclaimed and undisturbed sites. Field brome (*Bromus arvensis*), cheatgrass (*B. tectorum*), and western wheatgrass (*Pascopyrum smithii*) dominate reclaimed well pads. Our ultimate goals are to quantify the outcome of revegetation for CBNG production sites in the Powder River Basin and to identify factors that may influence successful establishment of planted species and the quality of resulting habitat.

Funding provided by: Wyoming Game and Fish Department, Bureau of Land Management, and Wyoming Wildlife and Natural Resources Trust

38. EVALUATION OF THE RESPONSE OF GREATER SAGE-GROUSE TO WIND DEVELOPMENT ACTIVITIES ASSOCIATED WITH THE CHOKECHERRY AND SIERRA MADRE WIND ENERGY PROJECT, CARBON COUNTY, WYOMING

Contact: Jon Kehmeier; Email: jkehmeier@swca.com; Phone: (720) 951-0600

Jon Kehmeier and Nate Wojcik, SWCA Environmental Consultants; Josh Millspaugh, University of Montana; Chris Hansen, University of Missouri; Scott Gamo, Wyoming Game and Fish Department

Power Company of Wyoming (PCW) has proposed to construct the 1,000 turbine, 3,000 megawatt Chokecherry and Sierra Madre Wind Energy Project (CCSM Project) south of Rawlins, Wyoming. A before-after-control-impact (BACI) design is being used to evaluate the impacts of wind energy development on greater sage-grouse. The research area consists of 2 treatment areas where wind energy development will occur and 3 control areas without any wind energy development. Generally, the research effort will evaluate pre-construction habitat selection, population demographics, general movement and distribution patterns, and lek attendance trends and dynamics. Our design calls for maintaining 50 females and 50 males tagged with GPS PTTs and 75 males tagged with VHF transmitters. Since 2010, we have collected >525,000 locations on tagged hens and >180,000 locations on tagged males. Each spring, we conduct lek counts on 56 leks. During nesting and brood-rearing periods, we monitor survival and productivity of nests and broods to evaluate recruitment into the population. To evaluate microsite resource selection, we collect microsite vegetation characteristics at used and paired-random sites, using locations selected from the GPS data. Approximately 6 years of pre-construction data were collected for hens and 5 years of pre-construction data were collected for males prior to the initiation of wind development activities. Construction activities for the project began in fall 2016, and during-construction data are currently being collected. Subsequent years of research will begin to evaluate the response of sage-grouse to the construction and operations of the CCSM Project.

Funding provided by: Power Company of Wyoming, Wyoming Game and Fish Department, U.S. Forest Service Rocky Mountain Research Station, National Renewable Energy Laboratory, National Fish and Wildlife Foundation, Western Association of Fish and Wildlife Agencies, Bureau of Land Management, National Wind Coordinating Collaborative, University of Missouri, and SWCA Environmental Consultants

39. WHAT POTENTIAL MITIGATION AND RESTORATION SITES HAVE THE MOST POTENTIAL BENEFIT FOR GREATER SAGE-GROUSE?

Contact: Melanie A. Murphy; E-mail: melanie.murphy@uwyo.edu; Phone: (307) 766-5295
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To meet the management objective of long-term landscape-level sustainability of sage-grouse populations, both occupancy of habitat and functional connectivity through the landscape are required. Avoiding or reclaiming sage-grouse lek sites may influence population networks and can be used for making decisions regarding sage-grouse management. In order to prioritize landscape-level restoration efforts and plan for future development, we are addressing the following objectives in the Bighorn and Powder River basins:

Objective 1: Predict site-level sage-grouse occurrence in relation to energy development.
Objective 2: Estimate functional connectivity of sage-grouse.
Objective 3: Predict occurrence & connectivity of sage-grouse in future landscape scenarios.

Preliminary occurrence models show that sagebrush amount and configuration, and wetness influence probability of lek occurrence across the study area. Importance among these variables differ between basins; amount and configuration of development is more important to lek occurrence in the Powder River basin. Preliminary cluster analysis of the genetic data suggests two genetic groups separated by basin (n = 504 individuals). Within each basin there is strong support for genetic structuring (BHB: K = 2, n = 287; PRB: K = 3, n = 216); however, genetic structure in PRB does not appear to be spatially driven. Furthermore, longer dispersal distances in the Powder River basin are suggested by mantel's correlogram. Preliminary connectivity models suggest connectivity is influenced by climate parameters along edges (between leks) in both basins; however, development influences connectivity along edges in the bighorn basin whereas development directly surrounding lek locations influences gene flow at nodes (leks).

Funding by: Wyoming Reclamation and Restoration Center, Northeast Wyoming Sage-grouse Working Group, University of Wyoming, RM-URISA, Society for Integrative and Comparative Biology, Margaret and Sam Kelly Ornithology Fund, Sigma Xi GIAR, RM-URISA, NSF – UW Science Posse, Laramie Audubon Society, WRRC Reclamation Scholarship

40. ASSESSING AND REDUCING COMMON RAVEN IMPACTS ON GREATER SAGE-GROUSE NESTING ECOLOGY IN THE BIG HORN BASIN, WYOMING

Contact: Chad Olson; Email: chad@haydenwing.com; Phone: (307) 742-5440

Chad V. Olson[1], Seth M. Harju[1], and Steffen C. Cornell[2]

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Common ravens (*Corvus corax*) are known greater sage-grouse (*Centrocercus urophasianus*) nest and brood predators and baseline data within our project areas indicated high nest depredation rates by ravens, especially in the Polecat Bench area. As an alternative to large-scale poisoning at landfills, our intent was to test a more targeted approach involving raven nest removal and nest site management for reducing impacts by ravens on sage-grouse. Objectives included: (1) evaluate whether raven nest removal is correlated with increased grouse nest and brood success, (2) quantify spatio-temporal interactions between raven and mammalian predators and sage-grouse hens, and (3) monitor sage-grouse hen movement, spatial ecology, and nesting ecology in the Bighorn Basin. Project areas included the Polecat Bench and Sheets Flat areas near Powell and Meeteetse, respectively. Each area was divided into a control and a treatment portion and the goal was to remove all raven nests within 4 miles of GPS-tagged nesting sage-grouse in the treatment areas. Grouse were equipped with GPS/ARGOS transmitters (Microwave Telemetry) and ravens were equipped with GPS/GSM transmitters (CTT), divided equally between the two project areas. Between March 1st, 2016 and July 13th, 2017, when locations were extracted from the full data set for analysis, we recorded a total of 55,667 GPS locations among 25 grouse and 62,922 locations among 12 ravens. Grouse nest success was low in 2017; 5 of 19 nests successfully hatched. Five active raven nests were removed from the treatment portions of the project areas. Statistical analyses on the impacts of raven nest removal are partially completed and ongoing.

Funding provided by: Meeteetse Conservation District, Washakie County Conservation District, Wyoming Animal Damage Management Board, Big Horn Basin Local Working Group, Park County Farm Bureau, Wildlife Services Personnel and Supplies (in-kind; Park County Predator Management Board and Wyoming Wildlife Services), Wyo-Ben (in-kind), Vanguard Operating (in-kind), and Wyoming Wool Growers (in-kind)

41. MAPPING SAGE-GROUSE LEKS TO LINK HABITAT STRUCTURE AND BEHAVIOR

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Dr. Gail Patricelli, Dr. Alan Krakauer, Ryane Logsdon and Eric Tymstra, U of California Davis

Dr. Jennifer Forbey and Chelsea Merriman, Boise State University

The goal of this project is to understand how sage-grouse use their microhabitats on and off the lek and how those choices may affect survival and reproductive success. During the 2017 mating season, we have conducted multi-point TLS (Terrestrial LiDAR Scanning; a ground-based LiDAR – light detection and ranging) for 5 of our study leks in the Government Draw area near Hudson, Wyoming (Fremont County). These scans have provided us with highly accurate, three-dimensional maps of the topography and vegetation structure of the leks. These scans will be queried for the cover, horizontal concealment, and other relevant metrics to measure ecologically important features of the lek microhabitat. We also collected videos of the sage-grouse space use on the lek. These videos will be connected with the TLS scans to determine which microhabitat features are important for both male and female sage-grouse on their display grounds, which will help us determine which environmental characteristics are better and worse with respect to communication and riskiness on the lek. We are also examining sage-grouse dietary preferences off the lek using radio telemetry tags to find foraging and roost sites. At these sites, as well as random sites, we collect samples of browsed and unbrowsed sagebrush and habitat measures. Samples are currently being analyzed in the Forbey lab.

Funding provided by: Bureau of Land Management, State of Wyoming, National Science Foundation, University of California Davis, Boise State University

42. CHARACTERIZING GREATER SAGE-GROUSE NESTING HABITAT AT WYOMING'S EASTERN RANGE EDGE

Contact: Dave Pellatz; E-mail: dave.pellatz@tbgpea.org; Phone: (307) 359-1328

Dave Pellatz, Thunder Basin Grasslands Prairie Ecosystem Association; Laurel Vicklund, Peabody Energy; Gwyn McKee, Great Plains Wildlife Consulting, Inc.; Bill Vetter, Precision Wildlife Resources, LLC; Lauren Porensky, Agricultural Research Service; Matt Holloran, Operational Conservation LLC.

This proposal facilitates a cooperative effort among the Association, Peabody Energy, and other partners to investigate and pursue opportunities to pool existing and additional near-term data for collaboration on a peer-reviewed paper characterizing sage-grouse nesting habitat in northeastern Wyoming. Peabody Energy launched a voluntary, collaborative, multi-year sage-grouse project in northeastern Wyoming in 2001 and biologists were contracted to assist in this endeavor. The Association and ARS began systematic monitoring of sagebrush habitats in 2008 and 2014, respectively.

Work began in early 2017 to gather and standardize long-term datasets from 2001 to the present. Variables were identified that can effectively be pooled to characterize sage-grouse nesting habitat in northeastern Wyoming. Ongoing data collection and preliminary analysis continued on multiple fronts throughout the spring and summer. Coordinated field work included information on sage-grouse nest site locations and vegetation characteristics obtained by Peabody Energy and Precision Wildlife Resources. The Association and ARS continued gathering supporting vegetation information from multiple transects. With the completion of the field season, data sets are being prepared for final analysis. Submittal of a manuscript to a peer-reviewed scientific journal, along with presentation of results as a poster paper or oral presentation at one or more local and regional professional conferences, is expected to occur in 2018.

Funding/In-Kind: Peabody Energy, NE Wyoming Sage-grouse Working Group, Great Plains Wildlife Consulting, Inc., Thunder Basin Grasslands Prairie Ecosystem Association, USDA-Agricultural Research Service

43. USING GPS SATELLITE TRANSMITTERS TO ESTIMATE SURVIVAL, DETECTABILITY ON LEKS, LEK ATTENDANCE, INTER-LEK MOVEMENTS, AND BREEDING SEASON HABITAT USE OF MALE GREATER SAGE-GROUSE IN NORTHWESTERN COLORADO

Contact: Dr. Brett L. Walker, Colorado Parks and Wildlife, Grand Junction, Colorado. Phone: 970-255-6125. E-mail: brett.walker@state.co.us

Implementing effective monitoring and mitigation is crucial for conserving populations of greater sage-grouse (*Centrocercus urophasianus*). Despite relying on untested assumptions, lek-count data are widely used as an index of sage-grouse abundance by state and federal agencies to monitor sage-grouse populations. Buffers around lek locations are also commonly used to identify and protect important sage-grouse habitat. However, the reliability and effectiveness of current lek-based monitoring and management strategies has not been rigorously tested. It is unclear how closely lek-count data track actual year-to-year changes in male abundance, and the effectiveness of lek buffers at reducing disturbance to male sage-grouse and their habitat during the breeding season is poorly known. Colorado Parks and Wildlife conducted a multi-year study (fall 2010-spring 2014) to quantify variation in male breeding-season survival, lek attendance, inter-lek movements, detectability, and habitat use around leks to quantify the reliability of lek-count data and test the effectiveness of lek buffers in the Hiawatha Regional Energy Development project area in northwestern Colorado and southwestern Wyoming. Field work for the project concluded in June 2013, but we continued to monitor GPS males through June 2014 to obtain an additional year of data on survival, lek attendance, between-year inter-lek movements, and habitat use. Analyses for this project are ongoing.

Funding provided by: Colorado Parks and Wildlife. Logistical support was provided by Wyoming Game and Fish Department, Rock Springs and Little Snake Field Offices of the Bureau of Land Management, and private landowners.

Attachment E.
Wyoming Sage-Grouse Research Reports (through May 31, 2017)

Part I. Final research reports from Wyoming sage-grouse research or theses and dissertations from university research efforts. It does not include annual agency monitoring reports or popular press articles.

Part II. Wyoming sage-grouse research articles published in peer-reviewed journals or books.

Only research reports concerning Wyoming sage-grouse are included. Studies on related subjects, (e.g. sagebrush, cheatgrass, other geographical areas) are important, but too numerous to include in this attachment.

Part I. Research theses, dissertations and reports.

Bedrosian, B. and D Craighead. 2010. Jackson Hole sage grouse project completion report: 2007-2009. Craighead Beringia South. Kelly, Wyoming. Includes 4 appended reports:
A: Common raven activity in relation to land use in western Wyoming: Implications for greater sage grouse reproductive success.
B: Critical winter habitat characteristics of greater sage-grouse in a high altitude environment.
C: Sage grouse baseline survey and inventory at the Jackson Hole Airport. D: Sage-grouse chick survival rates in Jackson Hole, Wyoming.

Brooks, M.L., J.R. Matchett, D.J. Shinneman and P.S. Coates. 2015. Fire patterns in the range of greater sage-grouse, 1984–2013 - Implications for conservation and management: U.S. Geological Survey Open-File Report 2015-1167, 66 p., http://dx.doi.org/10.3133/ofr20151167.

Brown, K. G. and K. M. Clayton. 2004. Ecology of the greater sage-grouse (*Centrocercus urophasianus*) in the coal mining landscape of Wyoming’s Powder River Basin. Final Technical Report. Thunderbird Wildlife Consulting, Inc. Gillette, WY.

Bui, T.D. 2009. The effects of nest and brood predation by common ravens (*Corvus corax*) on greater sage-grouse (*Centrocercus urophasianus*) in relation to land use in western Wyoming. Thesis. University of Washington, Seattle.

Cagney J., E. Bainter, B. Budd, T. Christiansen, V. Herren, M. Holloran, B. Rashford, M. Smith and J. Williams. 2010. Grazing influence, objective development, and management in Wyoming’s greater sage-grouse habitat. University of Wyoming College of Agriculture Extension Bulletin B-1203. Laramie. Available on-line at: http://www.wyomingextension.org/agpubs/pubs/B1203.pdf

Chambers, J.C., J.L. Beck, S. Campbell, J. Carlson, T.J. Christiansen, K.J. Clause, J.B. Dinkins, K.E. Doherty, K.A. Griffin, D.W. Havlina, K.E. Mayer, J.D. Hennig, L.L. Kurth, J.D. Maestas, M. Manning, B.A. Mealor, C. McCarthy, M.A. Perea and D.A. Pyke. 2016. Using resilience and resistance concepts to manage threats to sagebrush ecosystems, Gunnison sage-grouse, and greater sage-grouse in their eastern range—A strategic multi-scale approach: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-356, 143p. https://www.fs.fed.us/rmrs/publications/using-resilience-and-resistance-concepts-manage-threats-sagebrush-ecosystems-gunnison.

Christiansen, T. 2006. Monitoring the impacts and extent of West Nile virus on sage-grouse in Wyoming – final report. Wyoming Game and Fish Department, Cheyenne.

Christiansen, T. 2010. Hunting and sage-grouse: a technical review of harvest management on a species of concern in Wyoming. Wyoming Game and Fish Department, Cheyenne.

Christiansen, T.J. (*in press*). Wyoming's approach to sage-grouse Conservation – a shotgun wedding of science and policy. Transactions of the 82nd North American Wildlife and Natural Resources Conference. Wildlife Management Institute.

Clarke, L. F., H. Rahn and M.D. Martin. 1942. Seasonal and sexual dimorphic variations in the so-called "air sacs" region of the sage grouse. Sage Grouse Studies Part II. Wyoming Game and Fish Department Bulletin No. 2. Wyoming Game and Fish Department, Cheyenne.

Courtemanch, A., G. Chong and S. Kilpatrick. 2007. A remote sensing analysis of sage-grouse winter habitat in Grand Teton National Park and Bridger-Teton National Forest, Wyoming.

Crist, M.R., S.T. Knick and S.E. Hanser. 2015, Range-wide network of priority areas for greater sage-grouse—A design for conserving connected distributions or isolating individual zoos?: U.S. Geological Survey Open-File Report 2015-1158, 34 p., http://dx.doi.org/10.3133/20151158.

Daniel, J. 2007. Spring precipitation and sage grouse chick survival. Thesis. Department of Statistics – University of Wyoming, Laramie.

Deibert, P. A. 1995. Effects of parasites on sage-grouse mate selection. Dissertation. University of Wyoming, Laramie.

Dinkins, J.B. 2013. Common raven density and greater sage-grouse nesting success in southern Wyoming: potential conservation and management implications. Dissertation. Utah State University, Logan.

Doherty, K.E. 2008. Sage-grouse and energy development: integrating science with conservation planning to reduce impacts. Dissertation. University of Montana, Missoula.

Doherty, M.K. 2007. Mosquito populations in the Powder River Basin, Wyoming: a comparison of natural, agricultural and effluent coal-bed natural gas aquatic habitats. Thesis. Montana State University, Bozeman.

Erickson, H.J. 2011. Herbaceous and avifauna responses to prescribed fire and grazing timing in a high-elevation sagebrush ecosystem. Thesis. Colorado State University, Ft. Collins.

Gamo, R.S. 2016. Effectiveness of Wyoming's Sage-Grouse Core Areas in conserving greater sage-grouse and mule deer and influence of energy development on big game harvest. Dissertation, University of Wyoming, Laramie.

Girard, G.L. 1935. Life history, habits, and food of the sage-grouse. Thesis. University of Wyoming, Laramie.

Girard, G.L. 1937. Life history, habits, and food of the sage-grouse. University of Wyoming Publication 3. University of Wyoming, Laramie.

Heath, B.J., R. Straw, S. Anderson and J. Lawson. 1996. Proceedings of the sage-grouse workshop, Pinedale, Wyoming, 6-7 September 1996. Wyoming Game and Fish Department. Cheyenne.

Heath, B. J., R. Straw, S.H. Anderson and J. Lawson. 1997. Sage-grouse productivity, survival and seasonal habitat use near Farson, Wyoming. Research Completion Report. Wyoming Game & Fish Dept., Cheyenne.

Heath, B.J., R. Straw, S.H. Anderson, J. Lawson and M. Holloran. 1998. Sage-grouse productivity, survival, and seasonal habitat use among three ranches with different livestock grazing, predator control, and harvest management practices. Research Completion Report. Wyoming Game & Fish Dept., Cheyenne.

Hess, J.E. 2010. Greater sage-grouse (*Centrocercus urophasianus*) habitat response to mowing and prescribed burning Wyoming big sagebrush and the influence of disturbance factors on lek persistence in the Bighorn Basin, Wyoming. Thesis. University of Wyoming, Laramie.

Hnilicka, P. and D. Skates. 2010. Movements and survival of sage-grouse on the Wind River Reservation, Wyoming. Completion Report. U. S. Fish and Wildlife Service Lander, Wyoming.

Holloran, M. J. 1999. Sage-grouse seasonal habitat use near Casper, WY. Thesis. University of Wyoming, Laramie.

Holloran, M.J. and S.H. Anderson. 2004. Greater Sage-grouse seasonal habitat selection and survival in Jackson Hole, Wyoming. Research Completion Report. University of Wyoming Cooperative Fish and Wildlife Research Unit, Laramie.

Holloran, M.J. 2005. Sage-grouse population response to natural gas field development in western Wyoming. Dissertation. University of Wyoming, Laramie.

Holloran, M.J. and S.H. Anderson. 2005a. Spatial distribution of Greater Sage-grouse nests in relatively contiguous sagebrush habitats. Attachment A in Holloran 2005 Dissertation. University of Wyoming, Laramie.

Holloran, M.J. and S.H. Anderson. 2005c. Greater Sage-grouse research in Wyoming: an overview of studies conducted by the Wyoming Cooperative Fish and Wildlife Research Unit between 1994 and 2005. Attachment C in Holloran 2005. Dissertation. University of Wyoming, Laramie.

Honess, R.F. and W.J. Allred. 1942. Structure and function of the neck muscles in inflation and deflation of the esophagus in the sage grouse. Sage Grouse Studies Part I. Wyoming Game and Fish Department Bulletin No. 2. Wyoming Game and Fish Department, Cheyenne.

Honess, R. F. and G. Post. 1968. History of an epizootic in sage-grouse. Science Monograph 14. University of Wyoming Agricultural Experiment Station, Laramie.

Jensen, B.M. 2006. Migration, transition range and landscape use by greater sage-grouse (*Centrocercus urophasianus*). Thesis, University of Wyoming, Laramie.

Johnson, G. 2010. Field evaluation of larvivorous fish for mosquito management in the Powder River Basin, Wyoming. Grant summary completion report. Montana State University, Bozeman.

Johnson, G.D. 1987. Effects of rangeland grasshopper control on sage-grouse in Wyoming. Thesis, University of Wyoming, Laramie.

Kaiser, R.C. 2006. Recruitment by greater sage-grouse in association with natural gas development in Western Wyoming. Thesis, Department of Zoology and Physiology, University of Wyoming, Laramie.

King, L. and J. Petty. 2008. Investigations of a gravity-fed supplemental irrigation system to enhance sagebrush seedling establishment on reclaimed bentonite mine lands in Wyoming's Big Horn Basin. Shell Valley Consulting Associates, Inc. Shell, WY.

King, L., E. Dunklee and J. Petty. 2009. Use of supplemental watering gels to enhance Wyoming big sagebrush establishment on Big Horn Basin bentonite reclamation. Shell Valley Consulting Associates, Inc. Shell, WY.

Kirol, C.P. 2012. Quantifying habitat importance for greater sage-grouse (*Centrocercus urophasianus*) population persistence in an energy development landscape. Thesis. University of Wyoming, Laramie.

Klott, J.H. 1987. Use of habitat by sympatrically occurring sage-grouse and sharptailed grouse with broods. Thesis. University of Wyoming, Laramie.

Kuipers, J.L. 2004. Grazing system and linear corridor influences on Greater Sage-grouse habitat selection and productivity. Thesis. University of Wyoming, Laramie.

LeBeau, C.W. 2012. Evaluation of greater sage-grouse reproductive habitat and response to wind energy development in South-Central, Wyoming. Thesis. University of Wyoming, Laramie.

LeBeau, C., G. Johnson, M. Holloran, J. Beck, R. Nielson, M. Kauffman, E. Rodemaker, and T. McDonald. 2016. Effects of a Wind Energy Development on Greater Sage-Grouse Habitat Selection and Population Demographics in Southeastern Wyoming. Unpublished report. Prepared for: National Wind Coordination Collaborative, Washington, DC. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.

Lyon, A.G. 2000. The potential effects of natural gas development on sage grouse near Pinedale, Wyoming. Thesis, University of Wyoming, Laramie.

Mabray, S.T. 2015. Microhabitat Selection by Greater Sage-Grouse Hens in Southern Wyoming. Thesis. Utah State University, Logan.

Mandich, C.A. 2011. Seasonal habitat distribution and parasite survey of greater sage-grouse in western Natrona County, Wyoming. Thesis. University of Wyoming, Laramie.

McDonald, D.B. 2006. Demographic population assessment of greater sage-grouse in Jackson Hole Wyoming. University of Wyoming Department of Zoology, Laramie.

Orning, E.K. 2013. Effect of predator removal on greater sage-grouse (*Centrocercus urophasianus*) ecology in the Bighorn Basin Conservation Area of Wyoming. Thesis. Utah State University. Logan.

Patricelli, G.L., J.L. Blickley and S.L. Hooper. 2012. The impacts of noise on greater sage-grouse: A discussion of current management strategies in Wyoming with recommendations for further research and interim protections. Prepared for: The Bureau of Land Management, Lander Field Office and Wyoming State Office, Cheyenne and Wyoming Game and Fish Department.

Patterson, R.L. 1952. The sage grouse in Wyoming. Sage Books.

Peebles, L.W. 2015. Winter ecology of common ravens in southern Wyoming and the effects of raven removal on greater sage-grouse populations. Paper 4617. Thesis. Utah State University, Logan, UT.

Postovit, B.C. 1981. Suggestions for sage grouse habitat reclamation on surface mines in northeastern Wyoming. Thesis. University of Wyoming, Laramie.

Rothenmaier, D. 1979. Sage-grouse reproductive ecology: breeding season movements, strutting ground attendance and site characteristics, and nesting. Thesis. University of Wyoming, Laramie.

Schmidtmann, E. 2007. Mosquitoes, West Nile virus and Wyoming Wildlife – Powder River Basin. Arthropod-Borne Animal Diseases Research Laboratory, USDA, ARS, Laramie, WY.

Schmidtmann, E. 2007. Mosquitoes, West Nile virus and Wyoming Wildlife – Fremont and

Sublette Counties. Arthropod-Borne Animal Diseases Research Laboratory, USDA, ARS, Laramie, WY.

Schreiber, L.A. 2013. Greater sage-grouse nest site selection, brood-rearing site selection and chick survival in Wyoming. Thesis, Univ. of Missouri, Columbia.

Slater, S.J. 2003. Sage-grouse use of different aged burns and the effects of coyote control in southwestern Wyoming. Thesis. University of Wyoming, Laramie.

Smith, K.T. 2016. Identifying habitat quality and population response of greater sage-grouse to treated Wyoming big sagebrush habitats. Dissertation. University of Wyoming, Laramie.

Spurrier, M.F. 1989. Courtship behavior in *Centrocercus urophasianus*. Thesis. University of Wyoming, Laramie.

Schulwitz, S.E. 2016. Informing conservation management using genetic approaches: greater sage-grouse and Galápagos short-eared owls as case studies. Dissertation. University of North Texas, Denton.

Taylor, R.L., D.E. Naugle and L.S. Mills. 2012. Viability analyses for conservation of sage-grouse populations: Buffalo Field Office, Wyoming Final Report 27 February 2012. BLM Contract 09-3225-0012 Number G09AC00013 (8/10/10). University of Montana, Missoula**.**

Thompson, K.M., M.J. Holloran, S.J. Slater, J.L. Kuipers and S.H. Anderson. 2005. Greater Sage-grouse early brood-rearing habitat use and productivity in Wyoming. Attachment B in Holloran 2005. Dissertation. University of Wyoming, Laramie.

Walker, B.L. 2008. Greater sage-grouse response to coal-bed natural gas development and West Nile virus in the Powder River Basin, Montana and Wyoming, U.S.A.. Dissertation. University of Montana, Missoula.

Watchorn, R. 2015. Biological control of disease vectors: a case study evaluating the efficacy of fathead minnows (*Pimephales promelas*) for mosquito control in northeast Wyoming. Thesis. University of Waterloo. Waterloo, Ontario, Canada.

Wetzel, W., G. Chong, A. Courtemanch and N. Pope. 2007. Composition and structure of sage grouse winter habitat in the Upper Snake River Basin, Wyoming.

Wiley, R.H. 1970. Territoriality and non-random mating in sage grouse *Centrocercus urophasianus*. Dissertation. The Rockefeller University, New York, New York.

Wilms, D. and A. Alexander. 2014. The North American model of wildlife conservation in Wyoming: understanding it, preserving it, and funding its future. Wyoming Law Review 14(2).

Wyoming Wildlife Consultants, LLC. 2012. Greater sage-grouse winter habitat selection relative to natural gas field infrastructure in northern portions of the Pinedale Anticline Project Area Sublette County, Wyoming. Final report. Prepared for*:* Shell Western Exploration and

Production, LP, QEP Energy Company and Ultra Petroleum.

Part II. Peer reviewed journal articles or book chapters.

Applegate, D.H. and N.L. Owens. 2014. Oil and gas impacts on Wyoming's sagegrouse: summarizing the past and predicting the foreseeable future. Commentary. Human–Wildlife Interactions 8(2):284–290.

Beck, J.L., J.W. Connelly and C.L. Wambolt. 2012. Consequences of treating Wyoming big sagebrush to enhance wildlife habitats. Rangeland Ecology & Management 65(5):444-455.

Beck, J.L., D.T. Booth and C.L. Kennedy. 2014. Assessing greater sage-grouse breeding habitat with aerial and ground imagery. Rangeland Ecology and Management 67(3):328-332.

Bergquist, E., P. Evangelista, T. J. Stohlgren and N. Alley. 2007. Invasive species and coal bed methane development in the Powder River Basin, Wyoming. Environmental Monitoring and Assessment 128:381-394.

Blickley, J.L. and G.L. Patricelli. 2010. Impacts of anthropogenic noise on wildlife: research priorities for the development of standards and mitigation. Journal of International Wildlife Law & Policy 13:274-292.

Blickley, J.L. and G.L. Patricelli. 2012. Potential acoustical masking of greater sage-grouse display components by chronic industrial noise. Ornithological Monographs 74:23-35.

Blickley, J.L., D. Blackwood and G.L. Patricelli. 2012. Experimental evidence for the effects of chronic anthropogenic noise on abundance of greater sage-grouse at leks. Conservation Biology 26: 461-471.

Blickley, J.L., K.R. Word, A.H. Krakauer, J.L. Phillips, S.N. Sells, J.C. Wingfield and G.L. Patricelli.. 2012. Experimental chronic noise is related to elevated fecal corticosteroid metabolites in lekking male greater sage-grouse (*Centrocercus urophasianus*). PLoS ONE 7(11): e50462. doi:10.1371/journal.pone.0050462

Boyce, M.S. 1990. The red queen visits sage-grouse leks. American Zoologist 30:263-270.

Boyd, C.S., J.L. Beck and J.A. Tanaka. 2014. Livestock grazing and sage-grouse habitat: impacts and opportunities. Journal of Rangeland Applications 1:58-77.

Bui, T-V. D., J.M. Marzluff and B. Bedrosian. 2010. Common raven activity in relation to land use in Western Wyoming: implications for greater sage-grouse reproductive success. The Condor 112(1):65-78.

Cardinal, C.J. and T.A. Messmer. 2016. Ecology of greater sage-grouse populations inhabiting the northwestern Wyoming Basin: Human-Wildlife Interactions 10(2):188–204.

Conover, M.R., J.S. Borgo, R.E. Dritz, J.B. Dinkins and D.K. Dahlgren. 2010. Greater sage-grouse select nest sites to avoid visual predators but not olfactory predators. The Condor 112(2):331-336.

Copeland, H.E., K.E. Doherty, D.E. Naugle, A. Pocewicz and J.M. Kiesecker. 2009. Mapping oil and gas development potential in the US intermountain west and estimating impacts to species. PLoS ONE 4(10): e7400. doi:10.1371/journal.pone.0007400. 7 pp.

Copeland, H.E., A. Pocewicz, D.E. Naugle, T. Griffiths, D. Keinath, et al. 2013. Measuring the effectiveness of conservation: a novel framework to quantify the benefits of sage-grouse conservation policy and easements in Wyoming. PLoS ONE 8(6): e67261.

Dahlgren, D.K., R.T. Larsen, R. Danvir, G. Wilson, E.T. Thacker, T. Black, D.E. Naugle, J.W. Connelly and T.A. Messmer. 2015. Greater sage-grouse response to range management: insights from a 25-year case study in Utah. Rangeland Ecology & Management: 68:375-382. (Corrigendum in Rangeland Ecology & Management 69:235).

Deibert, P.A. and M.S. Boyce. 1997. Heritable resistance to malaria and the evolution of lek behaviour in sage-grouse. Wildlife Biology 3:284.

Dinkins, J.B., M.R. Conover, C.P. Kirol and J.L. Beck. 2012. Greater sage-grouse (*Centrocercus urophasianus*) select nest-sites and brood-sites away from avian predators. The Auk 129:600–610.

Dinkins, J.B., M.R. Conover and S.T. Mabray. 2013. Do artificial nests simulate nest success of greater sage-grouse? Human–Wildlife Interactions 7(2):299–312.

Dinkins, J.B., M.R. Conover, C.P. Kirol, J.L. Beck and S.N. Frey. 2014. Greater sage-grouse (Centrocercus urophasianus) hen survival: effects of raptors, anthropogenic and landscape features, and hen behavior. Canadian Journal of Zoology. doi:10.1139/cjz-2013-0263

Dinkins, J.B., M.R. Conover, C.P. Kirol, J.L. Beck and S.N. Frey. 2014. Greater Sage-Grouse (Centrocercus urophasianus) select habitat based on avian predators, landscape composition, and anthropogenic features. The Condor 116 (4), 629-642.

Dinkins, J.B., K.T. Smith, J.L. Beck, C.P. Kirol, A.C. Pratt and M.R. Conover. 2016. Microhabitat conditions in Wyoming sage-grouse core areas: effects on selection and nest success. PLoS ONE 11:e0150798.

Dinkins, J.B., M.R. Conover, C.P. Kirol, J.L. Beck and S.N. Frey. 2016. Effects of common raven and coyote removal and temporal variation in climate on greater sage-grouse nesting success. Biological Conservation 202:50–58.

Doherty, K.E., D.E. Naugle and B.L. Walker. 2008. Sage-grouse winter habitat selection and energy development. Journal of Wildlife Management 72:187-195.

Doherty, K.E., D.E. Naugle and B.L. Walker. 2010. Greater sage-grouse nesting habitat: the importance of managing at multiple scales. Journal of Wildlife Management 74(7):1544-1553.

Doherty, K.E, D.E. Naugle and J.S. Evans. 2010. A currency for offsetting energy development impacts: horsetrading sage-grouse on the open market. PLoS ONE 5(4):e10339.

Doherty, K.E., J.L. Beck and D.E. Naugle. 2011. Comparing ecological site descriptions to habitat characteristics influencing greater sage-grouse nest site occurrence and success. Rangeland Ecology and Management 64(4):344-351.

Doherty, K.E., D.E. Naugle, J.D. Tack, B.L. Walker, J.M. Graham and J.L. Beck. 2014. Linking conservation actions to demography: grass height explains variation in greater sage-grouse nest survival. Wildlife Biology 20(6):320-325.

Dzialak, M.R., C.V. Olson, S.M. Harju, S.L. Webb, J.P. Mudd, J.B. Winstead and L.D. Hayden-Wing. 2011. Identifying and prioritizing greater sage-grouse nesting and brood rearing habitat for conservation in human-modified landscapes. PLoS ONE 6(10): e26273.

Dzialak, M.R., C.V. Olson, S.L. Webb, S.M. Harju and J.B. Winstead. 2012. Temporal and hierarchical spatial components of animal occurrence: conserving seasonal habitat for greater sage-grouse. Ecosphere 3:art30.

Dzialak, M.R., S.L. Webb, S.M. Harju, C.V. Olson, J.B. Winstead and L.D. Hayden-Wing. 2013. Greater sage-grouse and severe winter conditions: identifying habitat for conservation. Rangeland Ecology and Management 66:10-18.

Dzialak, M.R., C.V. Olson, S.L. Webb, S.M. Harju and J.B. Winstead. 2015. Incorporating within- and between-patch resource selection in identification of critical habitat for brood-rearing greater sage-grouse. Ecological Processes v.4 art. 5. https://doi.org/10.1186/s13717-015-0032-2.

Fedy, B.C. and K.E. Doherty. 2010. Population cycles are highly correlated over long time series and large spatial scales in two unrelated species: greater sage-grouse and cottontail rabbits. Oecologia 165:915-924.

Fedy, B.C. and C.L. Aldridge. 2011. The importance of within-year repeated counts and the influence of scale on long-term monitoring of sage-grouse. Journal of Wildlife Management 75(5): 1022-1033.

Fedy, B.C., C.L. Aldridge, K.E. Doherty, M. O'Donnell, et al. 2012. Interseasonal movements of greater sage- grouse, migratory behavior, and an assessment of the core regions concept in Wyoming. Journal of Wildlife Management 76:1062–1071.

Fedy, B.C., K.E. Doherty, C.L. Aldridge, M. O’Donnell, et al. 2014. Habitat prioritization across large landscapes, multiple seasons, and novel areas: an example using greater sage-grouse in Wyoming. Wildlife Monographs 190:1–39.

Fedy, B.C., C. P. Kirol, A.L. Sutphin and T.L. Maechtle. 2015. The influence of mitigation on sage-grouse habitat selection within an energy development field. PLoS ONE 10(4): e0121603. doi:10.1371/journal.pone.0121603

Fedy, B.C., M.S. O'Donnell and Z.H. Bowen. 2015. Large-scale control site selection for population monitoring - An example assessing sage-grouse trends: Wildlife Society Bulletin 39:700–712.

Fremgen, A.L., C.P. Hansen, M.A. Rumble, R.S. Gamo and J.J. Millspaugh. 2016. Male greater sage-grouse detectability on leks. Journal of Wildlife Management 80:266–274.

Gamo, R.S. and J.L. Beck. 2017. Effectiveness of Wyoming's sage-grouse core areas: Influences on energy development and male lek attendance: Environmental Management 59(2)189-203.

Green, A.W., C.L. Aldridge and M.S. O'Donnell. 2017. Investigating impacts of oil and gas development on greater sage-grouse: Journal of Wildlife Management 81:46-57.

Gregory, A.J. and J.L. Beck. 2014. Spatial heterogeneity in response of male greater sage-grouse lek attendance to energy development. PLoS ONE 9(6):e97132. doi:10.1371/journal.pone.0097132

Harju, S.M., M.R. Dzialak, R.C. Taylor, L.D. Hayden-Wing., J.B. Winstead. 2010. Thresholds and time lags in effects of energy development on greater sage-grouse populations. Journal of Wildlife Management 74:437-448.

Hansen, C.P., L.A. Schreiber, M.A. Rumble, J.J. Millspaugh, R.S. Gamo, J.W. Kehmeier and N. Wojcik. 2016, Microsite selection and survival of greater sage-grouse nests in south-central Wyoming: Journal of Wildlife Management 80:862–876.

Harju, S.M., C.V. Olson, M.R. Dzialak, J.P. Mudd, J.B. Winstead. 2013. A flexible approach for assessing functional landscape connectivity, with application to greater sage-grouse (*Centrocercus urophasianus*). PLoS ONE 8(12): e82271. doi:10.1371/journal.pone.0082271

Harju, S.M., C.V. Olson, L. Foy-Martin, S.L. Webb, M.R. Dzialak, J.B. Winstead and L.D. Hayden-Wing. 2013. Occurrence and success of greater sage-grouse broods in relation to insect vegetation community gradients. Human–Wildlife Interactions 7(2):214–229.

Harmon, L. and D. Hirchert. 2016, Managing safety and wildlife at Jackson Hole Airport: Journal of Airport Management 10:381–401.

Hess, J.E. and J.L. Beck. 2012. Disturbance factors influencing Greater Sage-grouse lek abandonment in north-central Wyoming. Journal of Wildlife Management 76:1625-1634.

Hess, J. E. and J. L. Beck. 2012. Burning and mowing Wyoming big sagebrush: do treated sites meet minimum guidelines for greater sage-grouse breeding habitats? Wildlife Society Bulletin

36:85–93.

Hess, J.E and J.L. Beck. 2014. Forb, insect, and soil response to burning and mowing Wyoming big sagebrush in greater sage-grouse breeding habitat. Environmental Management 53:813-822.

Holloran, M.J. and S.H. Anderson. 2003. Direct identification of Northern sage-grouse, *Centrocercus urophasianus*, nest predators using remote sensing cameras. Canadian Field-Naturalist 117:308-310.

Holloran, M.J., and S.H. Anderson. 2005. Spatial distribution of greater sage-grouse nests in relatively contiguous sagebrush habitats. Condor 107:742-752.

Holloran, M.J., B.J. Heath, A.G. Lyon, S.J. Slater, J.L. Kuipers and S.H. Anderson. 2005. Greater sage-grouse nesting habitat selection and success in Wyoming. Journal Wildlife Management 69:638-649.

Holloran, M.J., R.C. Kaiser and W.A. Hubert. 2010. Yearling greater sage-grouse response to energy development in Wyoming. Journal of Wildlife Management 74:65-72.

Holloran, M.J., B.C. Fedy and J. Dahlke. 2015. Winter habitat use of greater sage-grouse relative to activity levels at natural gas well pads. Journal of Wildlife Management 79:630-640.

Hopken, M.W., E.K. Orning, J.K. Young, and A.J. Piaggio. 2016, Molecular forensics in avian conservation—A DNA-based approach for identifying mammalian predators of ground-nesting birds and eggs: BMC Research Notes v.9, art.14, https://doi.org/10.1186/s13104-015-1797-1.

Johnson, G.D. and M.S. Boyce. 1990. Feeding trials with insects in the diet of sage-grouse chicks. Journal of Wildlife Management 54:89-91.

Juliusson, L.M. and K.E. Doherty. 2017. Oil and gas development exposure and conservation scenarios for greater sage-grouse: Combining spatially explicit modeling with GIS visualization provides critical information for management decisions. Applied Geography 80:98-111.

Kiesecker, J.M., J.S. Evans, J. Fargione, K. Doherty, K.R. Foresman, T.H. Kunz, D. Naugle, N.P. Nibbelink, N.D. Neimuth. 2011. Win-win for wind and wildlife: a vision to facilitate sustainable development. PLoS ONE 6(4): e17566. doi:10.1371/journal.pone.0017566

Kirol, C.P., J.L. Beck, J.B. Dinkins and M.R. Conover. 2012. Microhabitat selection for nesting and brood-rearing by the greater sage-grouse in xeric big sagebrush. The Condor 114:75-89.

Kirol, C.P., A.L. Sutphin, L. Bond, M.R. Fuller and T.L. Maechtle. 2015. Mitigation effectiveness for improving nesting success of greater sage-grouse influenced by energy development. Wildlife Biology 21: 98-109.

Kirol, C.P., J.L. Beck, S.V. Huzurbazar, M.J. Holloran, S.N. Miller. 2015. Identifying greater sage-grouse source and sink habitats for conservation planning in an energy development landscape. Ecological Applications 25:968–990.

Klott, J.H., and F.G. Lindzey. 1989. Comparison of sage and sharp-tailed grouse leks in south central Wyoming. Great Basin Naturalist 49:275-278.

Klott, J.H. and F.G. Lindzey. 1990. Brood habitats of sympatric sage grouse and Columbian sharp-tailed grouse in Wyoming. Journal of Wildlife Management 54:84-88.

Koch, R.E., A.H. Krakauer and G.L. Patricelli. 2015. Investigating female mate choice for mechanical sounds in the male greater sage-grouse. The Auk 132:349-358.

Krakauer, A. H., M. Tyrrell, K. Lehmann, N. Losin, F. Goller and G. Patricelli. 2009. Vocal and anatomical evidence for two-voiced sound production in greater sage-grouse *Centrocercus urophasianus*. Journal of Experimental Biology 212:3719-3727.

Krakauer, A.H., M.A. Blundell, T.N. Scanlan, M.S. Wechsler, E.A. McCloskey, J.H. Yu and G.L. Patricelli. 2016. Successfully-mating male sage-grouse show greater laterality in courtship and aggressive interactions. Animal Behaviour. 111: 261-267.

LeBeau. C.W., J.L. Beck, G.D. Johnson and M.J. Holloran. 2014. Short-term impacts of wind energy development on greater sage-grouse fitness. Journal of Wildlife Management 78:522-530.

LeBeau, C.W., J.L. Beck, G.D. Johnson, R.M. Nielson, M.J. Holloran, K.G. Gerow and T.L. McDonald. 2017. Greater sage-grouse male lek counts relative to a wind energy development. Wildlife Society Bulletin 41:17-26.

LeBeau, C.W., G.D. Johnson, M.J. Holloran, J.L. Beck, R.M. Nielson, M.E. Kauffman, E.J. Rodemaker and T.L. McDonald. 2017. Greater sage-grouse habitat selection, survival, and wind energy infrastructure. Journal of Wildlife Management 81:690–711.

Lyon, A.G. and S.H. Anderson. 2003. Potential gas development impacts on sage grouse nest initiation and movement. Wildlife Society Bulletin 31:486-491.

Mabray, S.T. and M.R. Conover. 2015, Microhabitat selection by greater sage-grouse hens during brood rearing: Human-Wildlife Interactions, 9(2)219–228.

McCaffery, R. and P.M. Lukacs. 2016. A generalized integrated population model to estimate greater sage-grouse population dynamics. Ecosphere 7(11) art. e01585. http://doi.org/10.1002/ecs2.1585.

Monroe, A.P., Edmunds, D.R. and Aldridge, C.L. 2016. Effects of lek count protocols on greater sage-grouse population trend estimates. Journal of Wildlife Management, 80:667–678.

Monroe, A.P., C.L. Aldridge, T.J. Assal, K.E. Veblen, D.A. Pyke and M.L. Casazza. 2017. Patterns in greater sage-grouse population dynamics correspond with public grazing records at broad scales: Ecological Applications 27:1096–1107, https://doi.org/10.1002/eap.1512.

Naugle, D.E., C.L. Aldridge, B.L. Walker, T.E. Cornish, B.J. Moynahan, et al. 2004. West Nile virus: pending crisis for Greater Sage-grouse. Ecology Letters 7:704-713.

Naugle, D. E., C. L. Aldridge, B. L. Walker, K. E. Doherty, M. R. Matchett, J. McIntosh, T. E. Cornish and M. S. Boyce. 2005. West Nile virus and sage-grouse: What more have we learned? Wildlife Society Bulletin 33:616-623.

Naugle, D.E., K.E. Doherty, B. Walker, M. Holloran and H. Copeland. 2011. Greater sage-grouse and energy development in western North America. Pp 489-503 in S.T. Knick and J.W. Connelly (editors). Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian biology (vol. 38). University of California Press, Berkeley, CA.

Naugle, D.E., K.E. Doherty, B.L. Walker, H.E. Copeland, M.J. Holloran, and J. D. Tack. 2011. Sage-grouse and cumulative impacts of energy development. Pp. 55-70 in D.E. Naugle, (editor). Energy development and wildlife conservation in western North America. Island Press, Washington, D.C., USA

Orning, E.K., and J.K. Young, 2016. Impacts of coyote removal on space use by greater sage-grouse: Human-Wildlife Interactions 10(2):144–156.

Oyler-McCance, S.J., S.E. Taylor and T.W. Quinn. 2005. A multilocus population genetic survey of Greater sage-grouse across their range. Molecular Ecology 14:1293-1310.

Oyler-McCance, S.J., R.S. Cornman, K.L. Jones, J.A. Fike. 2015. Genomic single-nucleotide polymorphisms confirm that Gunnison and greater sage-grouse are genetically well differentiated and that the Bi-State population is distinct: The Condor 117:217–227, https://doi.org/10.1650/CONDOR-14-174.1.

Patricelli, G.L. and A.H. Krakauer. 2010. Tactical allocation of effort among multiple signals in sage grouse: an experiment with a robotic female. Behavioral Ecology 21:97-106.

Patricelli, G.L., J.L. Blickley and S.L. Hooper. 2013. Recommended management strategies to limit anthropogenic noise impacts on greater sage-grouse in Wyoming. Journal of Human-Wildlife Interactions 7: 230–249.

Peebles, L.W. and M.R. Conover. 2016. Effectiveness of the toxicant DRC-1339 in reducing populations of common ravens in Wyoming: Wildlife Society Bulletin 40:281–287.

Post, G. 1951. Effects of toxaphene and chlordane on certain game birds. Journal of Wildlife Management 15:381-386.

Row, J.R., S.J. Oyler-McCance, J.A. Fike, M.S. O'Donnell, K.E. Doherty, C.L. Aldridge, Z.H. Bowen and B.C. Fedy. 2015. Landscape characteristics influencing the genetic structure of greater sage-grouse within the stronghold of their range: a holistic modeling approach. Ecology and Evolution 5(10): 1955–1969.

Row, J.R., S.J. Oyler-McCance and B.C. Fedy. 2016, Differential influences of local subpopulations on regional diversity and differentiation for greater sage-grouse (*Centrocercus urophasianus*): Molecular Ecology 25:4424–4437.

Schreiber, L. A. et al. 2015. Microhabitat selection of brood-rearing sites by greater sage-grouse in Carbon County, Wyoming. – Western North American Naturalist 75: 348–363.

Schreiber, L.A., C.P. Hansen, M.A. Rumble, J.J. Millspaugh, S. Gamo, J. Kehmeier and N. Wojcik. 2016. Greater sage-grouse apparent nest productivity and chick survival in Carbon County, Wyoming. Wildlife Biology 22:37-44.

Schulwitz, S., B. Bedrosian and J.A. Johnson. 2014. Low neutral genetic diversity in isolated Greater Sage-Grouse (*Centrocercus urophasianus*) populations in northwest Wyoming. The Condor 116:560-573.

Smith, J.T., J.S. Evans, B.H. Martin, S. Baruch-Mordo, J.M. Kiesecker and D.E. Naugle. 2016. Reducing cultivation risk for at-risk species—Predicting outcomes of conservation easements for sage-grouse: Biological Conservation 201:10–19.

Smith, K.T., J.L. Beck and A.C. Pratt. 2016. Does Wyoming's core area policy protect winter habitats for greater sage-grouse? Environmental Management 58:585–596.

Spurrier, M.F., M.S. Boyce and B.F. Manly. 1994. Lek behaviour in captive sage grouse *Centrocercus urophasianus*. Animal Behaviour 47:303-310.

Spurrier, M.F., M.S. Boyce and B.F. Manly. 1991. Effects of parasites on mate choice by captive Sage Grouse. Pages 389-398 *in* J. E. Loye and M. Zuk, editors. Bird-Parasite Interactions: Ecology, evolution, and behaviour. Oxford Ornithological Series 2.

Slater, S.S. and J.P. Smith. 2010. Effectiveness of raptor perch deterrents on an electrical transmission line in southwestern Wyoming. Journal of Wildlife Management 74:1080-1088.

Smith, K.T., C.P. Kirol, J.L. Beck and F.C. Blomquist. 2014. Prioritizing winter habitat quality for greater sage-grouse in a landscape influenced by energy development. Ecosphere 5(2):15.

Taylor, R.L., B.L. Walker, D.E. Naugle and L.S. Mills. 2012. Managing multiple vital rates to maximize greater sage-grouse population growth. Journal of Wildlife Management 76:336-347.

Taylor, R.L., J.D. Tack, D.E. Naugle, L.S. Mills. 2013. Combined effects of energy development and disease on greater sage-grouse. PLoS ONE 8(8): e71256. doi:10.1371/journal.pone.0071256

Thompson, K.M., M.J. Holloran, S.J. Slater, J.L. Kuipers and S.H. Anderson. 2006. Early brood-rearing habitat use and productivity of greater sage-grouse in Wyoming. Western North American Naturalist 66:332-342.

Walker, B.L., D.E. Naugle, K.E. Doherty and T.E. Cornish. 2004. Outbreak of West Nile virus in greater sage-grouse and guidelines for monitoring, handling, and submitting dead birds. Wildlife Society Bulletin 32:1000-1006.

Walker, B.L., D.E. Naugle and K.E. Doherty. 2007. Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management 71:2644-2654.

Walker, B.L., D.E. Naugle, K.E. Doherty and T.E. Cornish. 2007. West Nile virus and greater sage-grouse: estimating infection rate in a wild bird population. Avian Diseases 51:691-696.

Webb, S.L., C.V. Olson, M.R. Dzialak, S.M. Harju, J.B. Winstead and D. Lockman. 2012. Landscape features and weather influence nest survival of a ground-nesting bird of conservation concern, the greater sage-grouse, in human-altered environments. Ecological Processes 1:art4.

Wiley, R.H. 1973. The strut display of male Sage Grouse: A "fixed" action pattern. Behaviour 47:129-152.

Wiley, R.H. 1973. Territoriality and non-random mating in sage grouse, *Centrocercus urophasianus*. Animal Behavior Monographs 6:87-169.

Wiley, R.H. 1974. Evolution of social organization and life-history patterns among grouse. Quarterly Review of Biology 49:201-227.

Wiley, R.H. 1978. The lek mating system of the sage grouse. Scientific American 238:114-125.

Zabihi, K., G.B. Paige, A.L. Hild, S.N. Miller, A. Wuenschel and M.J. Holloran. 2017. A fuzzy logic approach to analyze the suitability of nesting habitat for greater sage-grouse in western Wyoming. Journal of Spatial Science 62:215–234.

Zou, L., S. Miller and E. Schmidtmann. 2006. Mosquito larval habitat mapping using remote sensing and GIS: implications of coal-bed methane development and West Nile virus. Journal of Medical Entomology 43:1034-1041.

Bates Hole – Shirley Basin
Sage-Grouse
Job Completion Report
2016

June 2016-May 2017

Justin Binfet
Wyoming Game & Fish Dept.
Casper Region

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Bates Hole

1. Lek Attendance Summary (Occupied Leks) (1)

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2008	209	62	30	2226	37.1
2009	210	60	29	1611	29.3
2010	213	109	51	2485	27.0
2011	216	103	48	1670	19.9
2012	216	77	36	1222	20.0
2013	221	77	35	969	16.4
2014	222	86	39	1261	19.4
2015	221	101	46	2857	33.2
2016	220	86	39	2893	40.2
2017	221	79	36	2207	35.6

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2008	209	102	49	2031	27.4
2009	210	98	47	1661	23.7
2010	213	63	30	852	17.8
2011	216	93	43	895	14.9
2012	216	90	42	779	13.0
2013	221	99	45	814	14.0
2014	222	121	55	928	13.4
2015	221	93	42	1677	26.6
2016	220	100	45	2269	32.4
2017	221	120	54	2137	29.3

1) Occupied - Active during previous 10 years (see official definitions)

2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

3) Inactive - Confirmed no birds/sign present (see official definitions)

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Bates Hole

1. Lek Attendance Summary (Occupied Leks) (1) Continued

c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2008	209	164	78	4257	31.8
2009	210	158	75	3272	26.2
2010	213	172	81	3337	23.8
2011	216	196	91	2565	17.8
2012	216	167	77	2001	16.5
2013	221	176	80	1783	15.2
2014	222	207	93	2189	16.3
2015	221	194	88	4534	30.4
2016	220	186	85	5162	36.4
2017	221	199	90	4344	32.2

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2008	135	17	12	152	88.8	11.2
2009	129	16	13	145	89.0	11.0
2010	142	12	18	154	92.2	7.8
2011	157	32	7	189	83.1	16.9
2012	131	25	11	156	84.0	16.0
2013	123	40	13	163	75.5	24.5
2014	138	49	20	187	73.8	26.2
2015	153	32	9	185	82.7	17.3
2016	143	23	20	166	86.1	13.9
2017	145	44	10	189	76.7	23.3

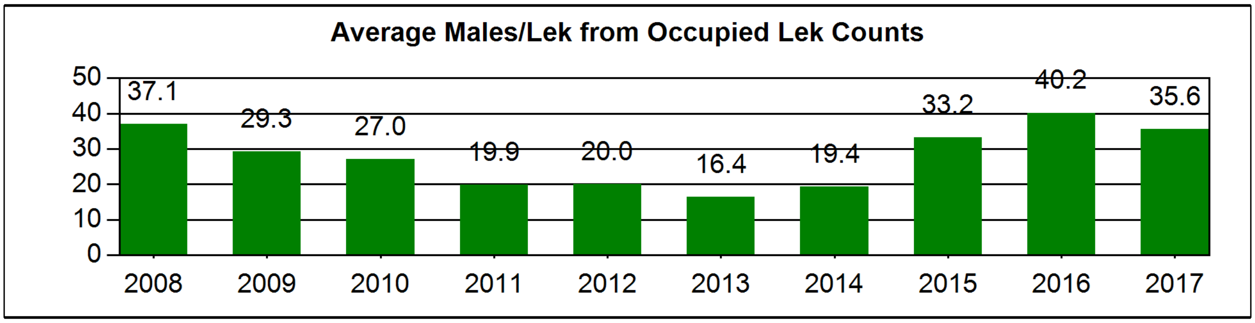
1) Occupied - Active during previous 10 years (see official definitions)

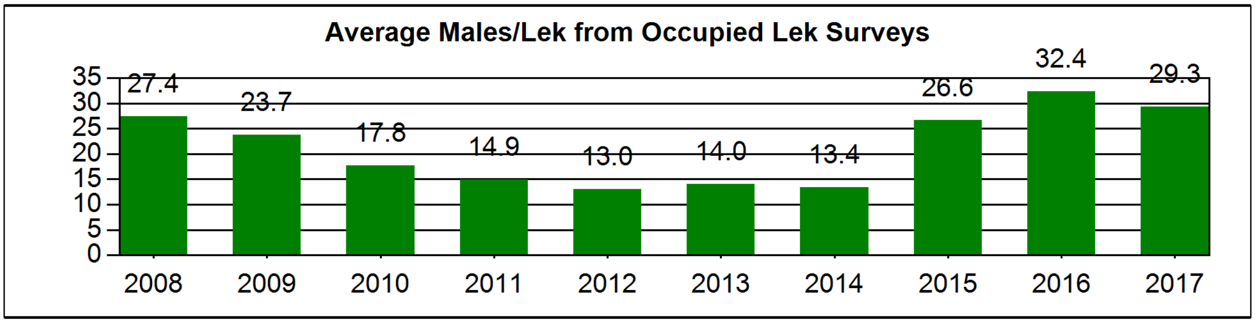
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

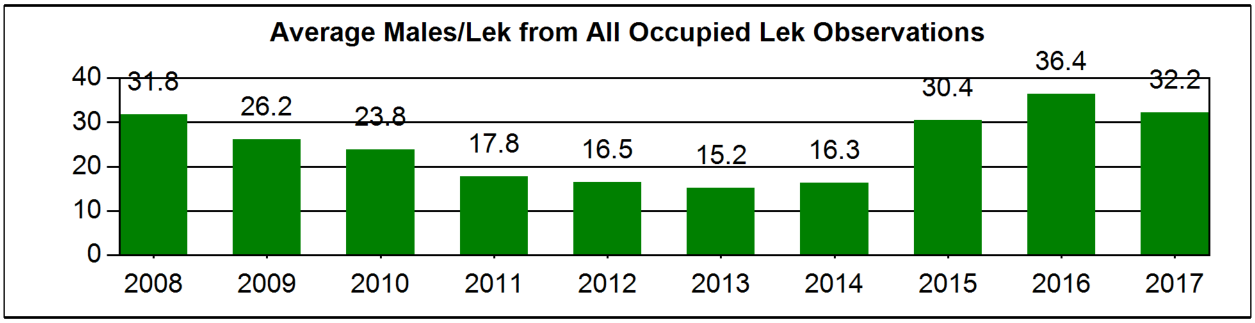
3) Inactive - Confirmed no birds/sign present (see official definitions)

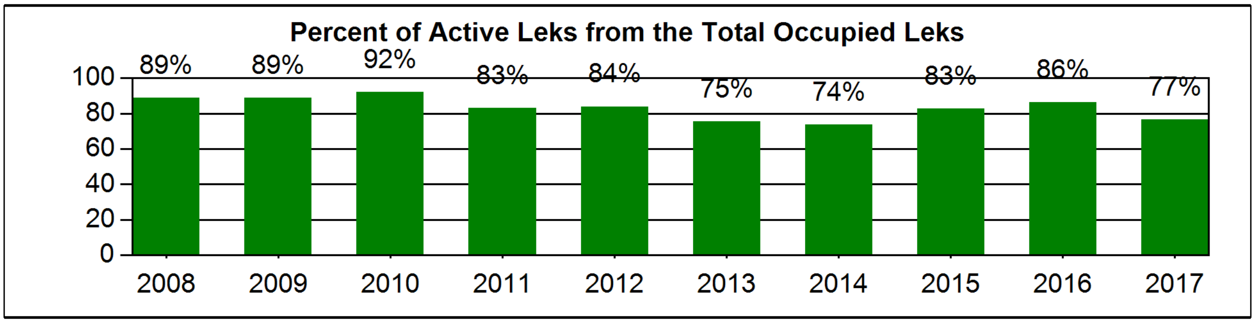
Sage Grouse Occupied Lek Attendance Summary

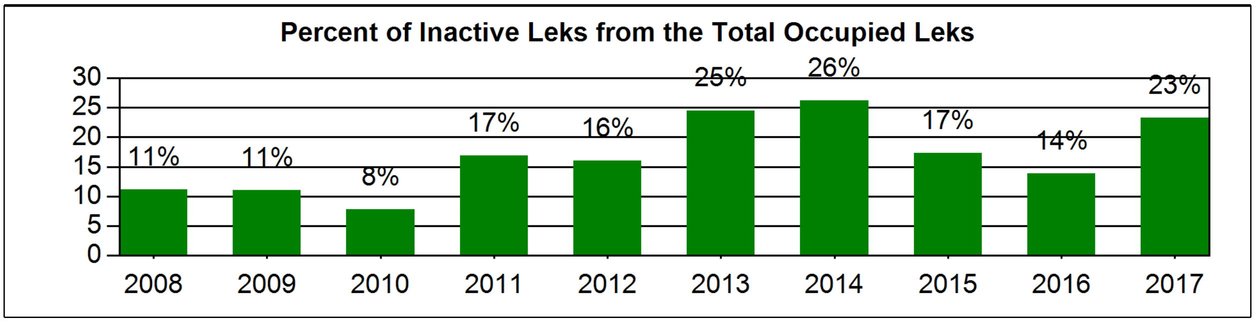
Year: 2008 - 2017, Working Group: Bates Hole











Sage Grouse Job Completion Report

Year: 2007 - 2016, Working Group: Bates Hole

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4
2011	Sep-17	Sep-30	14	2/4
2012	Sep-15	Sep-30	16	2/4
2013	Sep-21	Sep-30	10	2/4
2014	Sep-20	Sep-30	11	2/4
2015	Sep-19	Sep-30	12	2/4
2016	Sep-17	Sep-30	14	2/4

b. Harvest

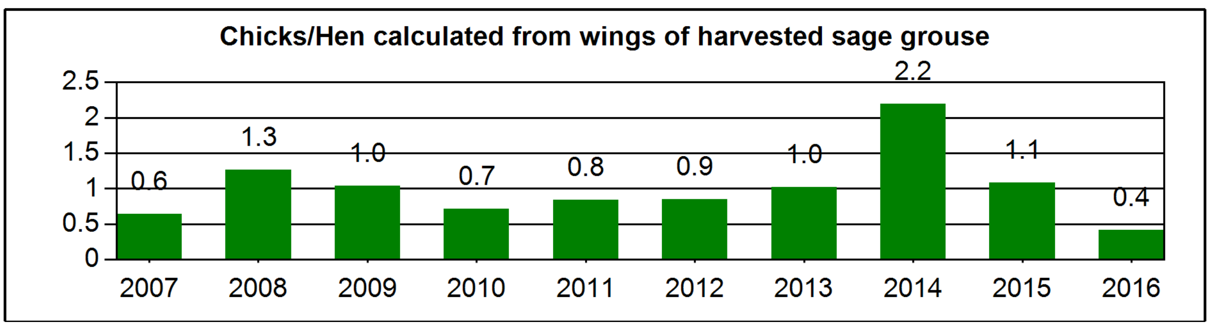
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2007	1365	655	1155	1.2	2.1	1.8
2008	1295	654	1161	1.1	2.0	1.8
2009	1026	532	956	1.1	1.9	1.8
2010	1027	480	1001	1.0	2.1	2.1
2011	1117	514	981	1.1	2.2	1.9
2012	688	415	852	0.8	1.7	2.1
2013	488	399	670	0.7	1.2	1.7
2014	588	352	804	0.7	1.7	2.3
2015	837	380	889	0.9	2.2	2.3
2016	869	466	869	1.0	1.9	1.9
Avg	930	485	934	1.0	1.9	2.0

Sage Grouse Job Completion Report

Year: 2007 - 2016, Working Group: Bates Hole

4. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult Male	Percent Adult Female	Percent Yearling Male	Percent Yearling Female	Percent Young Male	Percent Young Female	Chicks/ Hens
2007	329	25.2	38.9	4.3	4.0	11.9	15.8	0.6
2008	217	12.0	26.7	5.5	9.7	17.1	29.0	1.3
2009	314	12.7	26.1	9.2	12.1	17.8	22.0	1.0
2010	284	13.0	35.2	5.6	12.3	13.4	20.4	0.7
2011	224	17.9	34.8	4.9	7.1	15.6	19.6	0.8
2012	145	20.7	33.8	1.4	8.3	19.3	16.6	0.9
2013	187	9.1	26.2	4.3	16.6	24.1	19.8	1.0
2014	190	10.5	16.8	2.1	10.5	30.5	29.5	2.2
2015	253	14.6	31.6	5.5	6.7	22.9	18.6	1.1
2016	217	19.4	33.2	10.1	16.6	11.5	9.2	0.4



Introduction

Sage-grouse are found throughout the Bates Hole/Shirley Basin Local Working Group (BHSBLWG) area in the sagebrush/grassland habitats of Bates Hole, Shirley Basin, the South Fork of the Powder River Basin, foothills of the Laramie Range and Rattlesnake Hills, and in northern Platte/southern Niobrara Counties. Occupied habitat is fairly contiguous throughout much of Bates Hole and Shirley Basin. Habitats within the South Fork of the Powder River Basin are somewhat fragmented by changes in habitat type / sagebrush cover, transportation and utility corridors, and oil and gas development. Occupied sage-grouse habitat in the Laramie Range is primarily limited to the west slope including portions of the Laramie Plains. Large contiguous blocks of sagebrush/grassland communities east of the Laramie Range have been largely eliminated. Occupied habitat within the BHSBLWG area is nearly evenly split between private and public ownership. Approximately 51% of the known leks are found on private land with the remaining 49% found on Forest Service, Bureau of Land Management, Bureau of Reclamation, and Wyoming State Trust lands.

Sage-grouse management data collected by the WGFD focuses on lek counts and surveys, harvest statistics, brood surveys, and analysis of wings collected from harvested birds. Lek counts and surveys have been conducted within the BHSBLWG area since the 1950s. Lek counts are conducted in April and early May as per WGFD protocol (Christiansen 2012). Individual leks are counted 3 or more times at 7 – 10 day intervals. Lek counts are conducted to estimate population trend based on peak male attendance. Lek surveys are also conducted in the spring, but are typically conducted only one time per lek to determine general lek activity status (e.g., active, inactive, or unknown). More detailed lek definitions are attached to the Statewide JCR. Limited sage-grouse brood data is also collected during July and August. Brood counts provide some indication of chick production and survival, although their use is limited in estimating recruitment due to sampling design being neither systematic nor repeatable, with sample sizes typically being small. Where available, wing data from harvested sage-grouse provide a more reliable indicator of chick production and recruitment.

Past and current management of sage-grouse within the BHSBLWG area has focused mainly on the protection and/or enhancement of sagebrush habitats and protection of leks and nesting buffers from surface disturbing activities during the breeding/nesting season. Protection efforts have primarily occurred via controlled surface use or timing stipulations attached to state and federally permitted projects and through revision of BLM Resource Management Plans. Sage-grouse habitat protection has been increasingly important given the potential listing under the Endangered Species Act. As a result, the State of Wyoming adopted a core area management strategy through a series of Governor's Sage Grouse Executive Orders. This strategy enhances protections to sage-grouse within delineated core areas, which were further refined in 2015 (Wyoming Executive Order 2015-4). Core areas have been delineated to encapsulate important sage-grouse habitats throughout Wyoming thereby increasing protections for the majority of sage-grouse occurring in the State. Protections applied to sage-grouse habitats outside of core areas are less stringent than those within core areas in an attempt to incentivize natural resource development outside of the best remaining sage-grouse habitats.

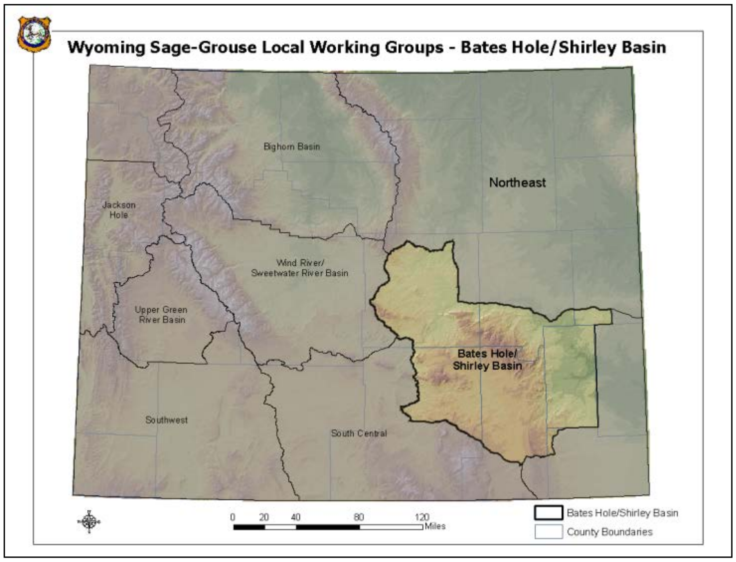
Most sage-grouse populations in Wyoming are hunted, though some portions of the state have been closed to sage-grouse hunting to protect small, isolated populations (i.e., in the southeast, northeast, and northwest portions of the state). A technical review of hunting seasons and harvest of sage-grouse in Wyoming was developed by the Wyoming Game and Fish Department (Christiansen 2010). This document details the role of hunting seasons and public use of sage-grouse populations, potential impacts, and management actions taken by the Department to implement more conservative harvest strategies dating back to the mid-1990's. Within sage-grouse populations having less than 100 males attending leks, hunting seasons should be closed to prevent additive mortality on small, isolated populations (BHSBLWG 2007). Hunting seasons have thus been closed in Niobrara, Platte, Goshen and Laramie Counties, and in the majority of Converse, Weston and Crook Counties. In addition, seasons were closed in the eastern portion of Natrona County including the Hat Six area southeast of Casper. Within these areas, sage-grouse populations occur in small, isolated patches of suitable habitat on the fringe of sage-grouse range. Harvest mortality within these small populations is far more likely to be additive and potentially detrimental. Within the remaining portion of the BHSBLWG area where robust sage-grouse populations occur, conservative hunting seasons continue to occur each year.

Historically, sage-grouse hunting seasons opened in early September. Research investigating the impacts of hunting on sage-grouse populations indicated a late September opening date resulted in reduced harvest pressure on hens compared to an early September season (Heath et al. 1997). In early September, hunters tend to disproportionately focus harvest pressure along drainages and near water sources, which is where successful hens with broods are most commonly found. In late September, hens (especially successful brood rearing hens) are typically more widely distributed across the landscape and occur in mixed flocks. Shifting hunting seasons to late September has not only reduced harvest pressure on females, but has also reduced hunter effort (Christiansen 2010). Sage-grouse seasons within most of the BHSBLWG area currently span two or three weekends, opening the third Saturday in September and closing September 30. From 1982 – 2001, bag and possession limits were 3 per day and 6 in possession. Since 2002, bag and possession limits have been reduced throughout the BHSBLWG area to 2 per day and 4 in possession.

Local Working Group Area

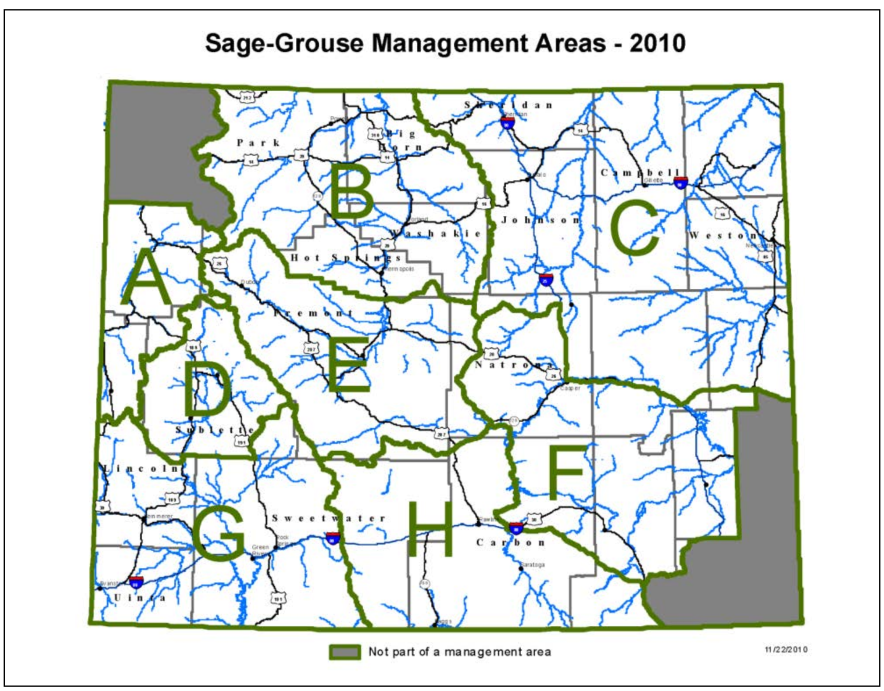
The BHSBLWG area includes Bates Hole, the Shirley Basin, the Rattlesnake Hills, the southern Bighorn Mountains, the Laramie Range, and isolated occupied habitats in southern Niobrara and Platte County (Figure 1). Political jurisdictions include Albany, Carbon, Converse, Laramie, Natrona, Niobrara, and Platte counties. This area is managed by the BLM (primarily the Casper and Rawlins Field Offices), the Bureau of Reclamation, the USDA Forest Service (Medicine Bow National Forest), the State of Wyoming, and private landowners. Major habitat types within the plan area include sagebrush/grassland, salt desert shrub, mixed mountain shrub, grasslands, mixed forests (conifers and aspen), agricultural crops, riparian corridors, and urban areas. Primary land uses within the BHSBLWG area include livestock grazing, wind energy development, oil and gas development, coal and uranium mining, and dry-land and irrigated crop production.

Figure 1. The Bates Hole/Shirley Basin Local Working Group Area.



The BHSBLWG area equates to WGFD Small/Upland Game Management Area F (Figure 2). Management areas do not correspond to sage-grouse population boundaries. Rather, management areas are used for general data collection (including harvest) and reporting for all small and upland game species. Sage-grouse are well distributed throughout most of the BHSBLWG area. Sage-grouse are largely absent from most of Platte County, some of the Laramie Plains, and higher elevation timbered areas in the Laramie Range and Shirley Mountains.

Figure 2. The Bates Hole/Shirley Basin Local Working Group area and WGFD sage-grouse management areas.



Leks

Sage-grouse, and therefore occupied leks, are well distributed throughout most of the BHSBLWG area (Figure 3). Much of the historic range in Platte County is no longer occupied due to large scale conversions of sagebrush grasslands to cultivated fields. The Wyoming Game and Fish Department summarizes lek monitoring data each year. As of spring 2017, there are 220 known occupied leks, 76 unoccupied leks, and 17 leks of an undetermined classification within the BHSBLWG area (Figure 4). Lek definitions are presented each year in the statewide Job Completion Report and are included in the monitoring protocol (Christiansen 2012). Undoubtedly, there are leks within the BHSBLWG area that have not yet been identified, while other un-discovered leks have been abandoned or destroyed. The majority of leks classified as "undetermined" lack sufficient data to make a valid status determination. In these cases, historic data indicates these leks were viable at one point, with the leks subsequently being either abandoned or moved. However, location data is either generic or suspect in many of these cases, further confounding the ability to determine the status of these leks.

Figure 3. Sage-grouse lek distribution and core areas within the BHSBLWG area, 2015.

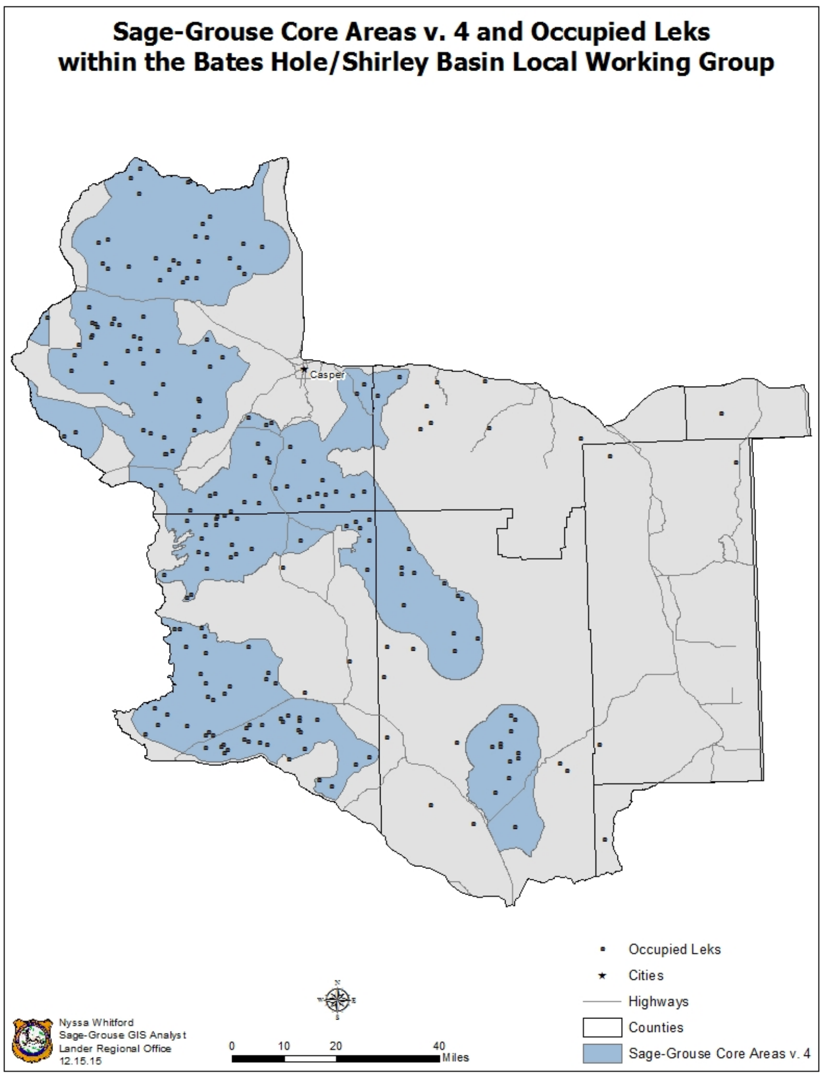


Figure 4. Sage-grouse lek demographics within the BHSBLWG area, 2017.

Sage Grouse Lek Characteristics

Working Group: Bates Hole

Region	Number	Percent
Casper	122	39.0
Lander	2	0.6
Laramie	189	60.4

Working Group	Number	Percent
Bates Hole	313	100.0

Classification	Number	Percent
Occupied	220	70.3
Undetermined	17	5.4
Unoccupied	76	24.3

BLM Office	Number	Percent
Casper	123	39.3
Lander	2	0.6
Newcastle	1	0.3
Rawlins	187	59.7

Biologist	Number	Percent
Casper	113	36.1
Douglas	8	2.6
Laramie	109	34.8
Saratoga	73	23.3
Sinclair	2	0.6
Wheatland	8	2.6

Warden	Number	Percent
Cheyenne	2	0.6
Douglas	3	1.0
East Casper	36	11.5
East Rawlins	2	0.6
Elk Mountain	69	22.0
Glenrock	7	2.2
Lusk	1	0.3
Medicine Bow	72	23.0
North Laramie	40	12.8
West Casper	75	24.0
Wheatland	6	1.9

County	Number	Percent
Albany	77	24.6
Carbon	108	34.5
Converse	10	3.2
Laramie	2	0.6
Natrona	109	34.8
Niobrara	1	0.3
Platte	6	1.9

Land Status	Number	Percent
BLM	103	32.9
BOR	1	0.3
Private	184	58.8
State	25	8.0

Management Area	Number	Percent
F	313	100.0

Lek Status	Number	Percent
Active	151	48.2
Inactive	121	38.7
Unknown	73	13.1

Lek counts and lek surveys have been conducted within the area since the late 1950's, although historically on only a small number of leks. Since 1998, lek monitoring effort has expanded significantly, resulting in increasing numbers of leks being monitored over time and enabling meaningful comparisons of current sage-grouse data to a running 10-year average. In 2017, WGFD personnel, BLM personnel, volunteers and consultants combined efforts to check 199 of the 221 (90%) known occupied leks in the BHSBLWG area. Seventy-nine leks were counted while 120 leks were surveyed in 2016. A total of 189 occupied leks were checked with annual status being confirmed. Of these, 145 (77%) were active and 44 (23%) were inactive.

It is important to consider trends in the numbers of active versus inactive leks in addition to average male lek attendance when analyzing population trend. During a period of population decline, male lek attendance decreases while the number of inactive leks typically increases. The converse occurs with an increasing population. The percent of active occupied leks (that were checked) generally decreased in the BHSBLWG area as sage-grouse numbers declined from 2006-2013. Conversely, the percentage of active occupied leks increased for three consecutive years from 2014-2016 as this population grew. In addition, some new leks were discovered during this timeframe while other smaller leks again became active after periods of inactivity. The decline in the percentage of active leks in 2017 may be attributed to the beginning of a downward trend in the population, or may be due to more marginal leks being checked in recent years, thus increasing the chances of smaller leks becoming inactive on an annual basis.

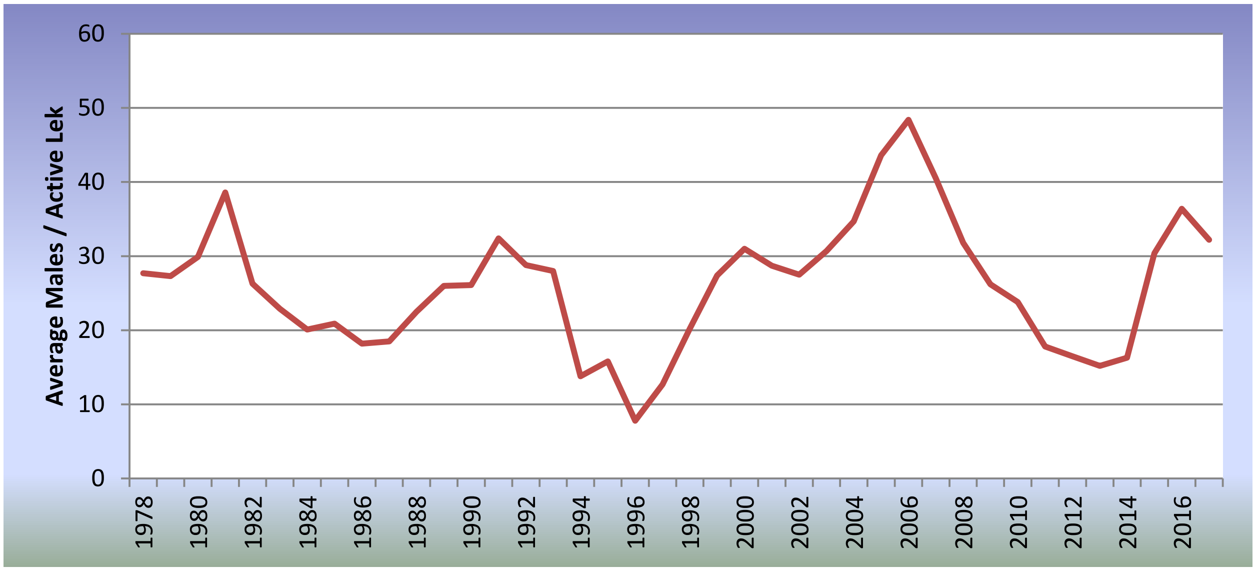
There is always some variation in the annual percentage of occupied leks being active. This variation can be attributed to both population fluctuations and survey effort. Survey effort has been relatively consistent over the past 10 years in the BHSBLWG area, with the total number of occupied leks checked ranging from 209 – 221. However, leks that are not checked in some years tend to be smaller, more difficult to access, or have been compromised in some manner (e.g. due to disturbance). Both disturbed and smaller leks have a higher probability of becoming inactive during a population nadir, such as that of 2013. Regardless, it is important to continue to monitor as many leks as possible, including smaller and marginal leks, to ensure they are classified appropriately (i.e. occupied, unoccupied or undetermined). Where sufficient monitoring data has shown a lek is no longer occupied, it is reclassified as unoccupied as per established protocol.

Population Trend

Monitoring male attendance on leks provides a reasonable index of sage-grouse population trend over time. Nevertheless, these data must be interpreted with caution for several reasons: 1) the survey effort and the number of leks surveyed/counted has varied over time; 2) it is assumed that not all leks in the area have been located; 3) sage-grouse populations exhibit cyclic patterns (Fedy and Doherty 2010); 4) the effects of unlocated or unmonitored leks that have become inactive cannot be quantified; and 5) lek sites may change over time. Both the number of active leks and the number of males attending these leks must be quantified over time to estimate population trend. Fluctuations in the number of grouse observed on leks over time are not exclusively a function of changing grouse numbers. These data also reflect changes in lek survey effort due to weather conditions dictating access to monitor leks.

Despite the aforementioned considerations regarding the interpretation of male lek attendance data, average peak male lek attendance obtained through surveys are strongly correlated with those obtained via lek counts in years when sample sizes exceed 50 leks (Fedy and Aldridge 2011). Since 1978, a minimum of 50 leks have been checked within the BHSBLWG area in all but 4 years (1992-1995) to determine annual population trend. The average number of males observed per active surveyed lek has fluctuated substantially over that time frame within the BHSBLWG area (Figure 5).

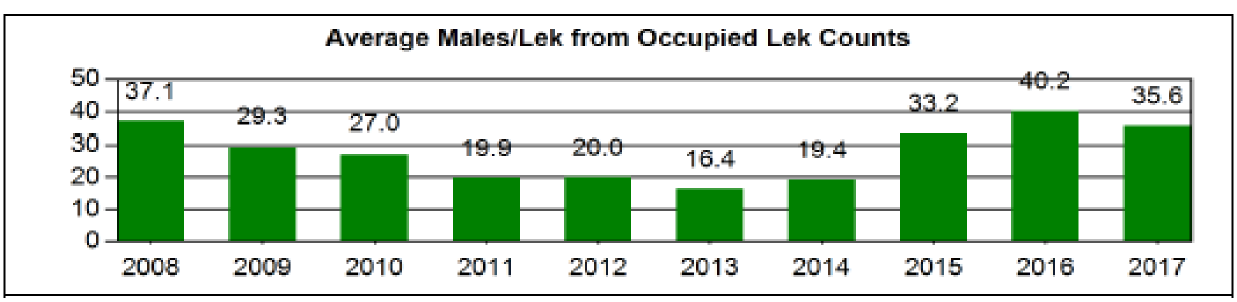
Figure 5. Mean number of peak males per active lek checked within the BHSBLWG area, 1978 – 2017.



*From 1978-1983, an average of 93 leks were checked each year.
*From 1984-1991, an average of 78 leks were checked each year.
*From 1992-1995, an average of 33 leks were checked each year.
*From 1996-2004, an average of 100 leks were checked each year.
*From 2005-present, an average of 175 leks were checked each year.

Based on the mean maximum number of males observed per counted lek, sage-grouse populations declined considerably through 2013 in the BHSBLWG area (Figure 6). In fact, the 2013 nadir was the lowest average recorded male lek attendance since intensive lek monitoring began in 1998. However, male lek attendance increased considerably through 2016, with a mean maximum number of males per counted lek increasing to 40.2. This figure declined somewhat in 2017, with an average of 35.6 males per counted lek. This decline in lek attendance was likely a function of declining sage-grouse chick production and/or survival in 2015 and 2016. It is unknown whether the decline in 2017 lek attendance will mark the beginning of a cyclical downturn in this population, or if it is simply due to short-term decline based on annual variation. Based on cyclical long-term trends in male lek attendance in the BHSBWLG area (and for sage-grouse populations in general), the recent decline in male lek attendance has likely marked the beginning of a downward trend in this population that will continue for the next few years.

Figure 6. Mean number of peak males per count lek within the BHSBLWG area, 2008 – 2017.



Productivity

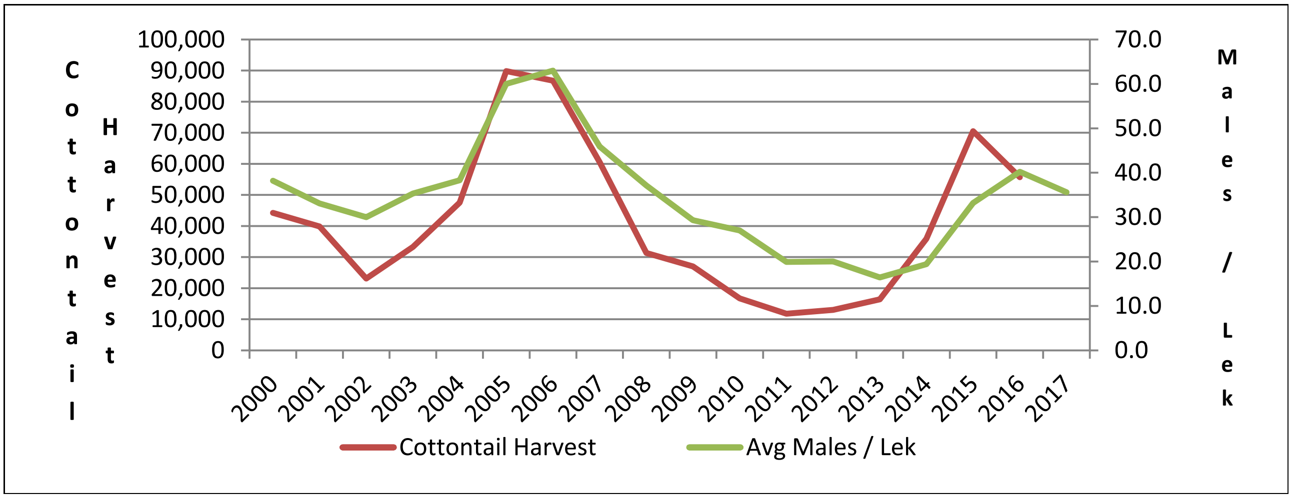
Classifying wings based on sex and age from harvested sage-grouse provides a meaningful indicator of annual sage-grouse chick productivity. During fall hunting seasons, hunters predominantly select for hens and chicks, and typically do not differentiate between the two. Sampling bias is therefore assumed to be minimal when analyzing the ratio of chicks per hen in hunter harvested sage-grouse wings. However, hunter selectivity and sage-grouse habitat use do result in adult and yearling males being under-represented in the harvest compared to their proportion of the population. Summer brood surveys are also conducted, but do not provide as reliable an indicator of chick productivity given they are not conducted in a systematic and repeatable manner and sample sizes are low. In addition, many observations of sage-grouse occur along riparian areas during summer brood surveys, which may under-represent the number of barren hens occurring on uplands, thus biasing the actual chick:hen ratio. Brood survey data will therefore not be discussed here.

Based on wing data within the BHSBLWG area, chick productivity/survival was excellent in 2014 with an observed 2.2 chicks per hen, which allowed for significant population increase. However, chick production has since declined (was 1.1 chicks per hen in 2015), and was extremely poor in 2016 with a ratio of 0.4. The 2016 ratio was the lowest ever chick/hen ratio recording using wing data within the BHSBLWG area (dating back to 1976). Such poor chick production/survival is likely the reason for the decline in the number of males observed per count lek in 2017.

In general, chick/hen ratios of about 1.5:1 result in relatively stable lek counts the following spring, while chick/hen ratios of 1.8:1 or greater result in subsequent increased lek attendance and ratios below 1.2:1 result in decline (WGFD 2007). These thresholds do not seem to directly apply in the BHSBLWG area as sage-grouse populations increased from 2013-2016 despite relatively poor chick production (as measured by wing data) in all but one year. Obviously, additional factors must be considered when assessing changes in population trend such as fluctuations in adult female survival, changes in predation, etc. In addition, as populations are increasing, relatively less chick production is needed to fuel continued population growth. Over the last 10 years, wing-barrel estimated productivity has fluctuated between 0.4 and 2.2 chicks per hen within the BHSBLWG area, although this ratio has only exceeded 1.5 in one of the past 10 years. Reasons for continued relatively low chick production (as measured by wing data) in the BHSBLWG area are unknown, especially considering the extremely low proportion of harvested chicks in the 2016 wing data. Weather conditions in the 2016 spring / early summer were relatively normal and did not experience any unusual cold, wet conditions that can lead elevated chick mortality following hatch.

The recent decline in sage-grouse chick production is correlated with the recent substantial downturn in cottontail rabbit populations throughout most of the BHSBLWG area. Sage-grouse population cycles are highly correlated with those of cottontail rabbits over a long period of time (Fedy and Doherty 2010). The only cottontail rabbit data now collected in Wyoming is the estimated annual statewide harvest, which is highly correlated with cottontail densities and therefore serves as a reasonable indicator of population trend. Within the BHSBLWG area, both sage-grouse populations and cottontail rabbit densities decreased through 2012-2013, subsequently increased through 2015, and began to again decrease over this past year (2017 cottontail harvest data is not yet available) (Figure 7). When comparing the cottontail harvest data to the following spring's lek attendance data, there is an 80% correlation. Anecdotal observations of rabbit densities from WGFD field personnel corroborate this, as there has been a noticeable decline in cottontail densities over this past year.

Figure 7. Statewide Wyoming Cottontail Harvest and Average Males/Lek (BHSBLWG), 2000 – 2017.

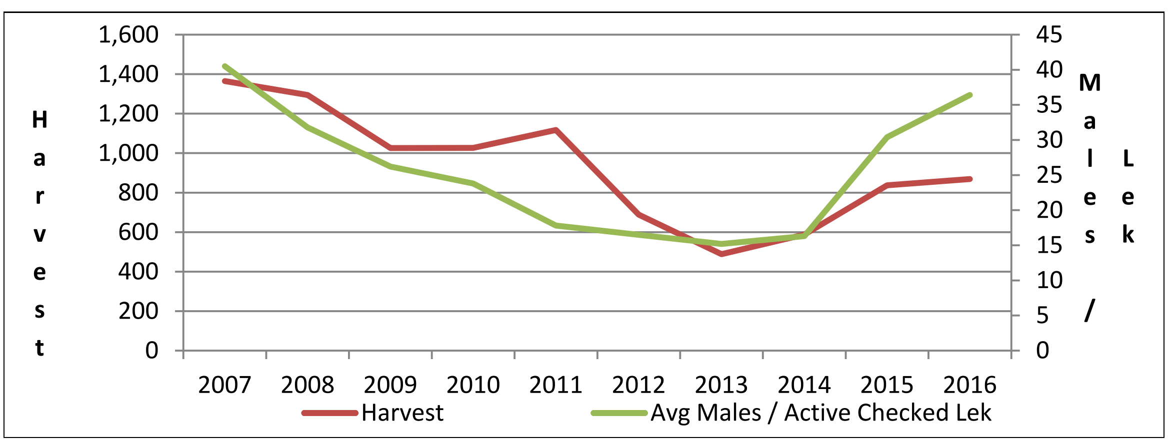


*Statewide cottontail harvest and male lek attendance the following spring are 80% correlated.

Harvest

Hunter and harvest statistics provide insight into trends in wildlife populations. Typical of upland game bird populations, there is usually a direct correlation between sage-grouse population levels and hunter effort and harvest when hunting seasons are consistent over time. As sage-grouse numbers decrease, hunter harvest generally declines. Conversely, when populations increase, sage-grouse hunting effort and harvest generally increases. Harvest data specific to the BHSBLWG area was obtainable starting in 1982. Prior to 1982, harvest data was recorded by county and not by management areas. Since 1982, overall sage-grouse harvest has declined considerably within the BHSBLWG area. Harvest peaked in 1983 at ~14,180 birds and subsequently declined to an historic low of 488 in 2013. In 2016, sage-grouse harvest increased for the third consecutive year in the BHSBLWG area as this population increased from 2013-2016, and was estimated to be 869. Over the last 10 years, trends observed in harvest data generally mirror those observed in male lek attendance within the BHSBLWG area (Figure 8).

Figure 8. Total sage-grouse harvested per year and the average number of males per active lek checked within the BHSBLWG area, 2007 – 2016.



Hunter participation and harvest declined dramatically in Wyoming when the Wyoming Game and Fish Commission reduced the bag limit and shortened the hunting season in 2002 (WGFD 2008). A similar reduction occurred in 1995 when the season was moved later into September. This decline occurred in spite of a concurrent population increase (based on males/lek), demonstrating the effects increasingly conservative hunting seasons have had on hunter participation in recent years. Managers are unable to quantify population response to changes in harvest levels within the BHSBLWG area. Research suggests harvest pressure can be an additive source of mortality within small isolated sage-grouse populations, but is generally compensatory at levels under 11% of the preseason population (Braun and Beck 1985, Connelly et al. 2000, Sedinger et al. 2010).

Habitat

Management of greater sage-grouse habitat in Wyoming is based on a "core area" strategy of limiting human disturbance in the most important sage-grouse habitats. This strategy is codified by a Governor's executive order. The current Executive Order (2015-4) was signed by Governor Matt Mead in July of 2015. The Executive Order and related materials are available at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management

In September 2015, the U.S. Fish and Wildlife Service issued a decision of "not warranted" for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. This means the State of Wyoming maintains management authority over sage-grouse in Wyoming and management emphasis focuses on implementation of the core area strategy. In its decision document, the Service specifically cited Wyoming's core area strategy as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude the need for a future listing. Federal land use planning documents are largely consistent with the Wyoming strategy.

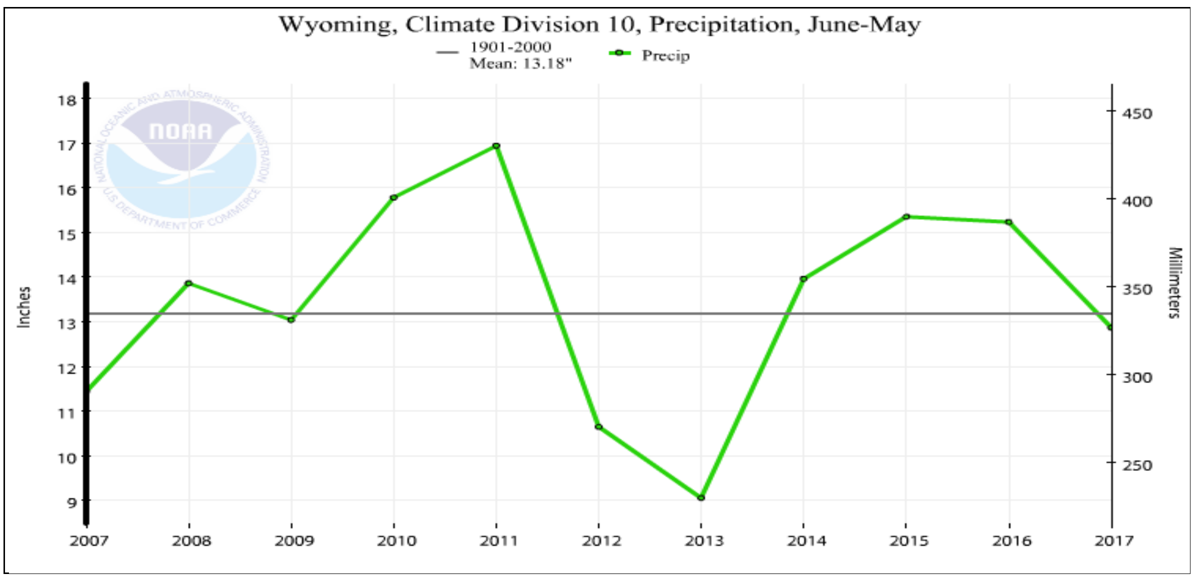
There is little doubt sage-grouse habitat quality has declined over the past several decades throughout the BHSBLWG area. Increased human-caused disturbance (i.e., oil/gas, coal, uranium, and wind energy development), improper grazing by livestock and wildlife, sagebrush eradication programs, and long-term drought have all combined to negatively impact sage-grouse and their habitats. As the level of concern for sage-grouse and sagebrush ecosystems has risen, large-scale sagebrush eradication programs have been largely abandoned, and significant portions of the landscape are now enrolled in grazing systems which are designed to be sustainable and promote healthy rangelands. In addition, various habitat improvement projects have been planned and/or implemented throughout the BHSBLWG area. However, there is much debate among wildlife managers, habitat biologists, researchers, and rangeland specialists as to the efficacy of various forms of habitat treatments within sagebrush ecosystems. Given the long timeline required to reestablish sagebrush following treatment and the difficulty in measuring sage-grouse population level response to such treatments, habitat projects designed to improve sagebrush ecosystem function should be conducted with extreme caution, especially in xeric sagebrush stands or in habitats containing isolated sage-grouse populations. Habitat treatments within the BHSBLWG area designed to improve sagebrush community health funded through the Governor's Sage-grouse Conservation Fund are detailed in Appendix I. Funding for all projects detailed in Appendix I was allocated via the BHSBLWG.

Of particular concern to sage-grouse within the BHSBLWG area is the strong likelihood of substantial expansion of large-scale industrial wind development within Shirley Basin. Several new projects are currently in various stages of permitting. Should all or most of these projects come to fruition, they could cumulatively result in the installation of several thousand new wind turbines throughout Shirley Basin. Some of the larger proposed developments (e.g. Viridis Eolia project) are slated to occur within sage-grouse habitat, and could pose significant cumulative impacts to sage-grouse over a large landscape depending upon project scale and siting. Although the current Executive Order (2015-4) prohibits wind development within core areas pending further research, some substantial sage-grouse habitats within Shirley Basin were not included within the most recent version (Version 4) of core areas (as per the recommendation of the BHSBLWG) as wind development was already in the permitting stage.

Weather

Based on data obtained from the National Oceanic and Atmospheric Administration (NOAA), the Upper North Platte climatic division experienced higher than normal precipitation in early 2016, but then relatively dry conditions during the summer (Figure 9). This resulted in moderate to good sagebrush leader growth and herbaceous vegetation production in 2016, although a relatively dry summer did result in early curing of key grasses and forbs within sagebrush communities. In general, rangeland conditions were moderate to good over the reporting period, which provided adequate habitat conditions for the annual requirements of sage-grouse. Prevailing climatic conditions cannot be quantitatively or anecdotally correlated to sage-grouse population trend or measured chick production over this reporting period.

Figure 9. NOAA Precipitation Data for the Upper North Platte drainage, Wyoming Climate Division 10, 2007-2016 (http://www.ncdc.noaa.gov/cag/time-series/us).



Special Studies

In addition to a 2016 Completion Report, Western EcoSystems Technology, Inc. provided two reports on the effects of wind energy development on sage-grouse habitat selection, survival and population demographics for the Simpson Ridge Wind Energy Project, Carbon County, Wyoming (LeBeau et al. 2016, LeBeau et al. 2017a, LeBeau et al. 2017b). In summary, the consulting firm was hired to conduct a long-term research project to evaluate the impacts to sage-grouse from wind energy development within a defined core area. A technical committee was assembled to define research methodology and objectives. The committee included representation from state and federal agencies as well as reputable sage-grouse researchers. This research was partially funded from local sage-grouse working group funds. Field work was initiated in 2009 and continued through 2015. In addition, a master's thesis was completed summarizing male lek attendance, seasonal habitat selection, and survival within this study area (LeBeau 2012). Some results from this thesis were also published in a peer-reviewed journal (LeBeau 2014) with additional publications in preparation.

Two studies are being conducted in the Jeffrey City area, with some marked sage-grouse occurring south of the Rattlesnake Hills which is within the BHSBLWG area, although the primary study area occurs within the Wind River / Sweetwater River LWG area. One study is evaluating the response of sage-grouse to various treatments in Wyoming big sagebrush by conducting a Before-After Impact-Control study comparing demographic rates and habitat selection patterns within treated and non-treated sites (Smith and Beck, *In press*). Sites were treated in 2014 with sagebrush mowing and application of Spike® (Tebuthiuron). Final results of this study are not yet available. The second research project is utilizing the same study area as the first, and is designed to assess the effects of mowing and herbicide treatments on the nutritional quality of sagebrush in central Wyoming (Smith et al., *In Review*).

Diseases

There were no confirmed cases of West Nile virus (WNv) in sage-grouse within the BHSBLWG area during this reporting period. Normal monitoring efforts were in place. These consisted of requesting researchers with radio-marked birds to monitor for mortality in late summer and attempt to recover and submit carcasses of dead birds to the Wyoming State Vet Lab for necropsy. WGFD field personnel, other agency personnel and the public (via press release), especially ranchers and hay farmers, were also asked to report dead sage-grouse in a timely fashion. The extent of WNv infection and its effects on sage-grouse populations throughout the BHSBLWG area is unknown, but potentially significant in years when outbreaks occur.

Bates Hole / Shirley Basin LWG Conservation Plan Addendum

The BHSBLWG Conservation Plan was updated to reflect major state and federal policy changes in 2013. A Conservation Plan Addendum was completed in July 2013 and is available on the Wyoming Game and Fish Department website at:

https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Sage%20Grouse/SG_BSBASIN_CONSVPLAN.pdf.

Recommendations

1. Enhance understanding of *long-term* impacts to sage-grouse from large-scale industrial wind through continued research in addition to the research that was conducted within the 7-Mile Hill / Simpson Ridge wind development areas (LeBeau et al., 2016).

2. Continue efforts to document seasonal habitat use throughout the BHSBLWG area, with emphasis on nesting, early-brood rearing, and winter habitats.

3. Enhance efforts to document sage-grouse use in ephemeral / mesic drainages where sagebrush has been removed to enhance herbaceous grass and forb production for the benefit of early and late brood rearing habitats.

4. The BHSBLWG should continue to solicit conservation projects that will benefit sage-grouse. These include but are not limited to projects designed to enhance sagebrush understory herbaceous vegetation production, riparian corridor protection, wind energy related research, water development, livestock grazing management planning, etc.

5. Ensure monitoring of all count leks is conducted properly and consistently as per WGFD protocol on an annual basis (WGFD 2010). In addition, maximize overall lek monitoring efforts (including lek surveys) each year to ensure lek sample sizes are significant enough to adequately detect population change.

6. If possible, attempt to survey all leks each year while maintaining counts on all designated count leks. Encourage the public, volunteers, and especially landowners to report lek activity and assist with lek surveys and counts.

7. Continue to monitor inactive or unoccupied leks to adjust classification designation as appropriate.

8. Continue to update and refine UTM coordinates (using NAD83) of leks and map lek perimeters where needed.

9. Continue to inventory abandoned leks to ensure they are appropriately classified and determine whether or not they should continue to remain in the database as per protocol.

Literature Cited

Bates Hole/Shirley Basin Local Working Group (BHSBLWG). 2007. Bates Hole/Shirley Basin Sage-grouse Conservation Plan. January, 2007.

Braun, C. E., and T.D.I. Beck. 1985. Effects of changes in hunting regulations on sage-grouse harvest and populations. Pages 335-344 in S.L. Beasom and S. F. Roberson, editors. Game harvest management. Caesar Kleberg Wildlife Research Institute, Kinsville, Texas, USA.

Christiansen, T. 2010. Hunting and Sage-grouse: A Technical Review of Harvest Management on a Species of Concern in Wyoming. Revised September, 2010. Wyoming Game and Fish Department. Cheyenne, WY.

Christiansen, T. 2012. Chapter 12: Sage Grouse (*Centrocercus urophasianus*). Pages 12-1 to 12-55 in S. A. Tessmann and J. R. Bohne (eds). Handbook of Biological Techniques: third edition. Wyoming Game and Fish Department. Cheyenne, WY.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage-grouse populations and their habitats. Wildl. Soc. Bull. 28(4): 967-985.

Fedy, B. C. and K. E. Doherty. 2010. Population cycles are highly correlated over long time series and large spatial scales in two unrelated species: greater sage-grouse and cottontail rabbits. Oecologia 165:915-924.

Fedy, B. C. and C. L. Aldridge. 2011. The Importance of Within-Year Repeated Counts and the Influence of Scale on Long-Term Monitoring of Sage-Grouse. Journal of Wildlife Management 75(5):1022–1033.

Heath, B., R. Straw, S. Anderson, and J. Lawson. 1997. Sage-grouse productivity, survival, and seasonal habitat use near Farson, Wyoming. Wyoming Game and Fish Department, Completion Report. Cheyenne, WY. USA.

LeBeau, C. W. 2012. Evaluation of Greater Sage-Grouse Reproductive Habitat and Response to Wind Energy Development in South-Central, Wyoming. Thesis. Department of Ecosystem Science and Management. University of Wyoming, Laramie.

LeBeau. C. W., J. L. Beck, G. D. Johnson, M. J. Holloran. 2014. Short-term impacts of wind energy development on greater sage-grouse fitness. Journal of Wildlife Management 78:522-530.

LeBeau, C., G. Johnson, M. Holloran, J. Beck, R. Nielson, M. Kauffman, E. Rodemaker, and T. McDonald. 2016. Effects of a Wind Energy Development on Greater Sage-Grouse Habitat Selection and Population Demographics in Southeastern Wyoming. Prepared for: National Wind Coordination Collaborative, Washington, DC. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY. January 2016.

LeBeau, C.W., Beck, J.L., Johnson, G.D., Nielson, R.M., Holloran, M.J., Gerow, K.G., and McDonald, T.L., 2017a, Greater sage-grouse male lek counts relative to a wind energy development: Wildlife Society Bulletin 41(1): 17-26.

LeBeau, C.W., Johnson, G.D., Holloran, M.J., Beck, J.L., Nielson, R.M., Kauffman, M.E., Rodemaker, E.J., and McDonald, T.L., 2017b, Greater sage-grouse habitat selection, survival, and wind energy infrastructure: Journal of Wildlife Management 81(4): 690-711.

Mandich, Cheryl, A., Seasonal Habitat Distribution and Parasite Survey of Greater Sage-Grouse in Western Natrona County, Wyoming, M.S., Zoology and Physiology, May, 2011.

Naugle, D. D. 2005. West Nile Virus and sage-grouse: What more have we learned? University of Montana. Missoula, MT. 27 pp.

Sedinger, J.S., G.C. White, S. Espinosa, E.T. Partee, C.E. Braun. 2010. Assessing compensatory versus additive harvest mortality: An example using greater sage-grouse. Journal of Wildlife Management 74(2): 326-332.

Smith, K. T. and J.L. Beck. *In press*. Sagebrush treatments influence annual population change for greater sage-grouse. Restoration Ecology DOI: 10.1111/rec.12589.

Smith, K. T., J.S. Forbey, and J.L. Beck. *In Review*. Effects of mowing and tebuthiuron treatments on the nutritional quality of Wyoming big sagebrush.

Appendix I. Conservation Projects within the BHSBLWG area funded since inception through the Wyoming Governor's Sage-grouse Conservation Fund.

Project Name	Budget Biennium	Conservation Funding	Project Description	Partners
Martin Ranch Range Improvement (Phase I)	2005-06	$19,501 requested/ approved; $19,633 spent	Fence construction to implement 3 pasture rotation grazing system and mosaic prescribed fire in mountain big sagebrush to improve forage including forbs and insects	Martin Ranch, NRCS
7E Ranch Grazing Mgt	2005-06	$44,990 requested/ approved; $44,990 spent	Fence construction and water development to implement a 4-pasture rest-rotation grazing system	NRCS, 7E Ranch, BLM
SG Education and Community Outreach	2007-08	$13,000 requested/ approved	Develop and administer sage-grouse conservation educational programs in the Casper area	Audubon Wyoming
Western Natrona County Sage-Grouse Study	2007-08	$7,210 requested/ approved	Seasonal distribution and habitat use for land use planning along with parasite/disease assay	BLM, WGFD, University of Wyoming, Casper College
M&D Land Company Water Development	2007-08	$7,425 requested/ approved; $4,000 spent	Water development to facilitate grazing plan implementation (dry hole - unsuccessful)	M&D Land Co., NRCS
Shook Ranch Range Improvement	2007-08	$10,000 requested/ approved	Prescribed fire in mountain big sage, developing and protecting water sources, installing a cross fence and implementing rotational grazing system	Shook Ranch, NRCS
Hat-Six Ranch Riparian Buffer	2007-08	$11,600 requested/ approved; $9,936 spent	Fencing riparian buffer to enhance riparian habitat, reduce erosion and improve brood-rearing use by sage-grouse	Hat-Six Ranch, NRCS
Martin Ranch Range Improvement (Phase II)	2007-08	$14,000 requested/ approved; $10,825 spent	Fence construction to implement 3 pasture rotation grazing system and mosaic prescribed fire	Martin Ranch, NRCS

3-Man Ranch Upland Habitat Improvement	2007-08	$13,944 requested/ approved	Water development and fencing to facilitate rest-rotation grazing system	3-Man Ranch, WGF LIP, WWNRT
L3 Cattle Co. fence and spring development	2007-08	$5,297 requested/ approved; $5,194 spent	Water development and fencing to facilitate deferred-rotation grazing system	L3 Cattle Co, NRCS
M&D Land Wildlife Inventory	2007-08	$10,500 requested/ approved; $10,302 spent	Wildlife surveys, range surveys & management consultation	NRCS
Schnoor/Flat Top Big Sagebrush Restoration	2007-08	$18,305 requested/ approved	LWG $ to apply Plateau herbicide to cheatgrass infested areas. Other mechanical, chemical and RX fire to be used to restore big sage communities.	Mule Deer Foundation, WY Gov's Big Game License Coalition, WWNRT, WGFD, NRCS
Water trough escape ramps, spring protection and fence markers*	2007-08	$36,000 requested/ approved	Provide pre-fab wildlife escape ramps, fence collision deterents and spring protection fencing to private landowners throughout the state.	WWNRT, Landowners, WGFD
Impacts of wind energy development in SE WY*	2009-10	$22,750 requested/ approved	Research to determine impacts of wind energy development to sage-grouse	Horizon Wind Energy, Iberdrola Renewables
Grazing Management Assistance	2009-10	$5,000 requested/ approved; $4,600 spent	Small group or 1:1 grazing management assistance from Dr. Roy Roath to landowners	Natrona Conservation District, NRCS, WGFD
Seasonal Habitat Mapping*	2009-10	$155,000 requested/ approved; $141,000 spent	Use predictive habitat models to produce sage-grouse seasonal habitat maps	U.S. Fish & Wildlife Service, BLM, Various energy companies
Fence markers and spring protection fencing*	2009-10	$64,800 requested/ approved; $62,628 spent	Purchase fence markers and Steel Jack spring protection for statewide distribution	Niobrara Conservation District, numerous private landowners, BLM, TNC

Impacts of wind energy development in SE WY*	2011-12	$110,000 requested; $85,000 approved	Research to establish the short-term effects of wind development to sage-grouse	National Wind Coordinating Collaborative, Western Assoc. of Fish & Wildlife Agencies
Henderson Draw cheatgrass treatment	2011-12	$50,000 requested/ approved	Cheatgrass control	BLM - Casper F.O.
Audubon Community Naturalist (see also #53)	2011-12	$10,000 requested/ approved	Sagebrush ecosystem education program for schools	various foundations and grants
North Laramie Range cheatgrass control	2011-12	$26,000 requested/ approved	Cheatgrass control	WWNRT, WGFD, Gov's Big Game Lic. Coalition
Response of sage-grouse to sagebrush treatment in Fremont County*	2011-12	$189,800 requested/ approved	Research to determine sage-grouse demographic and habitat use response to sagebrush treatments	Univ. of Wyoming, WGFD
Estimating noise impacts for habitat selection modeling*	2011-12	$49,335 requested/ approved	Research to develop a noise model and determine noise exposure thresholds	Univ. California-Davis
Audubon Community Naturalist (see also #53)	2013-14	$10,000 requested/ approved	Sagebrush ecosystem education program for schools	various foundations and grants
North Natrona cheatgrass treatment	2013-14	$60,000 requested/ approved	Cheatgrass control northwest of Casper in the Natrona Core Area	BLM - Casper F.O.
Impacts of wind energy development in SE WY*	2013-14	$50,000 requested/ approved	Research to establish the short-term effects of wind development to sage-grouse	National Wind Coordinating Collaborative, Western Assoc. of Fish & Wildlife Agencies
Impacts of wind energy development in SE WY*	2015-16	$18,000 approved	Research to establish the short-term effects of wind development to sage-grouse	National Wind Coordinating Collaborative, Western Assoc. of Fish & Wildlife Agencies
Audubon Community Naturalist (see also #53)	2015-16	$10,000 requested/ approved	Sagebrush ecosystem education program for schools	various foundations and grants
Response of sage-grouse to sagebrush treatment in Fremont County*	2015-16	$15,000 approved	Research to determine sage-grouse demographic and habitat use response to sagebrush treatments	Univ. of Wyoming

Audubon statewide sage-grouse habitat modeling	2015-16	$17,000 approved	Use various remote imaging and GIS mapping techniques to map sage-grouse habitat throughout Wyoming	Unknown
Bates Creek cheatgrass treatment	2015-16	$15,000 approved	Treat cheatgrass in sage-grouse habitat to promote rangeland health and restore perennial grass cover and forb production	WGFD, WWNRT
Mud Springs sagebrush thinning	2015-16	$35,000 approved	Mechanically treat dense high canopy coverage sagebrush in snow accumulation zones to open canopy and promote brood rearing habitat	WGFD, WWNRT
Statewide 0.5 meter resolution NAIP imagery for core areas	2015-16	$10,000 approved	Assist in statewide effort to obtain high resolution aerial imagery for all core areas in Wyoming	Various entities
50-Mile Flat restoration	2015-16	$30,000 approved	Restore vegetation including sagebrush to 50-Mile Flat (which is a monoculture of crested wheatgrass adjacent to sage-grouse habitat)	WGFD, BLM, others
GSG Educational Exhibit	2017-18	$3,325 approved	Sagebrush ecosystem education program for schools	Audubon
Audubon Sagebrush Explorers Education	2017-18	$17,500 approved	Sagebrush ecosystem education program for schools and museums	Audubon
Response of GSG to Treatments*	2017-18	$40,000 approved	Research to determine sage-grouse demographic and habitat use response to sagebrush treatments	University of Wyoming (Dr. Jeff Beck)
Habitat Quality Relative to Predators*	2017-18	$20,000 approved	Research to determine sage-grouse demographic and habitat use response to differing predator densities	University of Wyoming (Dr. Jon Dinkins)
Stonehouse Cheatgrass Treatment	2017-18	$2,500 approved	Experimentally treat cheatgrass with bio-control (bacteria) in sage-grouse habitat to promote rangeland health and restore perennial grass cover and forb production	WGFD

Schnoor Cheatgrass Treatment	2017-18	$2,500 approved	Experimentally treat cheatgrass with bio-control (bacteria) in sage-grouse habitat to promote rangeland health and restore perennial grass cover and forb production	WGFD
Sandhills Cheatgrass Treatment	2017-18	$2,500 approved	Experimentally treat cheatgrass with bio-control (bacteria) in sage-grouse habitat to promote rangeland health and restore perennial grass cover and forb production	WGFD
Seepie Springs Sagebrush Thinning	2017-18	$19,750 approved	Mechanically treat dense high canopy coverage sagebrush in snow accumulation zones to open canopy and promote brood rearing habitat	WGFD
Natrona County Cheatgrass Treatment	2017-18	$17,925 approved	Treat cheatgrass in sage-grouse habitat to promote rangeland health and restore perennial grass cover and forb production	BLM
Bates Juniper Treatment	2017-18	$20,000 approved	Mechanically (with some fire) thin juniper to enhance watershed function and promote herbaceous forage production in key sage-grouse habitats	BLM

* Other local working groups collaborated on funding these projects with Sage-grouse Conservation Funds

Big Horn Basin
Sage-Grouse
Job Completion Report
2016

June 2016-May 2017

Leslie Schreiber
Wyoming Game & Fish Dept.
Cody Region

Cody Region Sage-Grouse Job Completion Report

Conservation Plan Area: **Big Horn Basin**
Period Covered: **6/1/2016 – 5/31/2017**
Prepared by: **Leslie Schreiber**

INTRODUCTION

During the late 1990s, concerns increased over degradation and fragmentation of sagebrush ecosystems and declines in greater sage-grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) populations. Wyoming Game & Fish Department (WGFD) increased monitoring efforts for sage-grouse across the state and also formed an internal working group in 1997 to focus on sage-grouse management issues. In addition, a state-wide citizens working group was formed in 2000 consisting of representatives from government agencies (state and federal), agriculture, extractive industries, environmental groups, hunting groups, and Native American tribal interests. This citizens' group produced the *Wyoming Greater Sage-grouse Conservation Plan (The State Plan)*, which was approved and adopted by the WGF Commission in 2003. The State Plan called for creation of local working groups (LWG) to formulate strategies at a local level to address sage-grouse conservation; eight local working groups were formed in 2004 (Figure 1).

Similar to the state-wide working group, the Big Horn Basin LWG (BHBLWG), in north-central Wyoming (Figure. 1), consisted of representatives from agriculture, mining, oil/gas production, conservation and hunting interests, a citizen at-large, local (county) government, local Conservation Districts, Bureau of Land Management (BLM), Natural Resources Conservation Service (NRCS), and WGFD. BHBLWG produced the *Sage-grouse Conservation Plan for the Big Horn Basin, Wyoming* in 2007 and updated it in 2013 which can be found at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management.

Management of greater sage-grouse habitat in Wyoming is based on a "core area" strategy of limiting human disturbance in the most important sage-grouse habitats. This strategy is codified by a Governor's executive order. The current Executive Order (2015-4) was signed by Governor Matt Mead in July of 2015. The Executive Order and related materials are available at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management

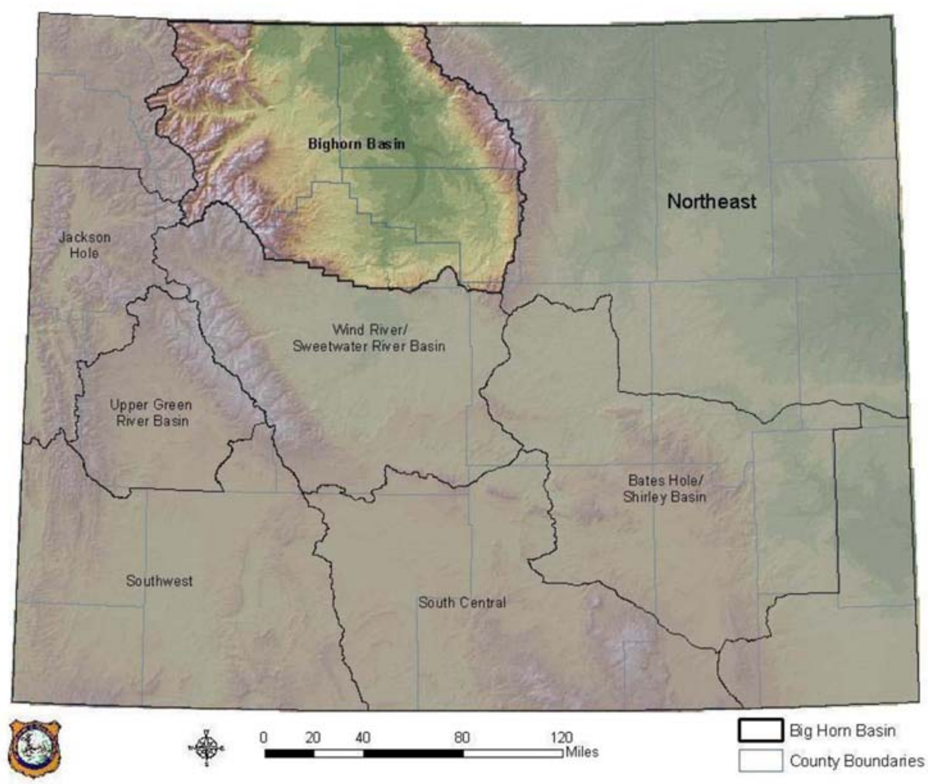
In September 2015, the U.S. Fish and Wildlife Service issued a decision of "not warranted" for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. This means the State of Wyoming maintains management authority over sage-grouse in Wyoming and management emphasis focuses on implementation of the core area strategy. In its decision document, the Service specifically cited Wyoming's core area strategy as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude the need for a future listing. Federal land use planning documents are largely consistent with the Wyoming strategy.

This report summarizes conservation efforts and data collected on sage-grouse in the Big Horn Basin during the 2016 biological year (1 June 2016 – 31 May 2017), including lek surveys conducted during the 2017 breeding season.

STUDY AREA

The Big Horn Basin Conservation Area (hereafter, Basin) encompasses over 12,300 square miles and is mostly public land managed by the BLM (40%), Forest Service (25%), State "school sections" (5%), or other government agencies (>1%; Bureau of Reclamation, National Park Service). Over 3,100 square miles of the Basin are private land (25%). Counties within the Basin include Big Horn, Hot Springs, Park, and Washakie. Historically, WGFD divided the state into management areas for data collection and reporting of small and upland game species. Sage-grouse specific management areas were created in 2010 with the Basin as Area B (Figure 1). Primary land uses in the Basin include livestock grazing, farming, oil and gas development, bentonite mining, urban and suburban developments, recreation, and wildlife habitat.

Figure 1. Big Horn Basin Conservation Area in Wyoming.



Vegetation communities within the Basin are diverse and vary according to soil type, annual precipitation, and elevation. Major vegetation communities in the Basin include sagebrush/grassland, salt desert shrub, agricultural crops, pasture lands, cottonwood riparian corridors, mixed mountain shrub, and mixed conifer forests with interspersed aspen stands at higher elevations.

Connelly et al. (2004) recognized sage-grouse in the Basin as a distinct sub-population (Figure 2). Mountain ranges to the east and west restrict most sage-grouse movement due to unsuitable habitat. There are several leks near the Wyoming/Montana state line with movement between states occurring. Copper Mountain, the Owl Creek Mountains, and the southern Bighorn Mountains provide suitable habitat serving as travel corridors to adjacent populations.

In 2017, 309 sage-grouse leks are known to occur in the conservation area with 249 leks known to be occupied and 29 leks known to be unoccupied (Table 1). Undetermined leks (n=31) need additional observations before being reclassified as occupied or unoccupied. A majority of leks (66%) occur on BLM managed land and 27% of leks occur on private land (Table 1). There are most likely other leks in the Basin not yet discovered.

Figure 2. Discrete populations and subpopulations of sage-grouse in western North America, with the Big Horn Basin sub-population surrounded by the red rectangle. (Adapted from Connelly et. al. 2004).

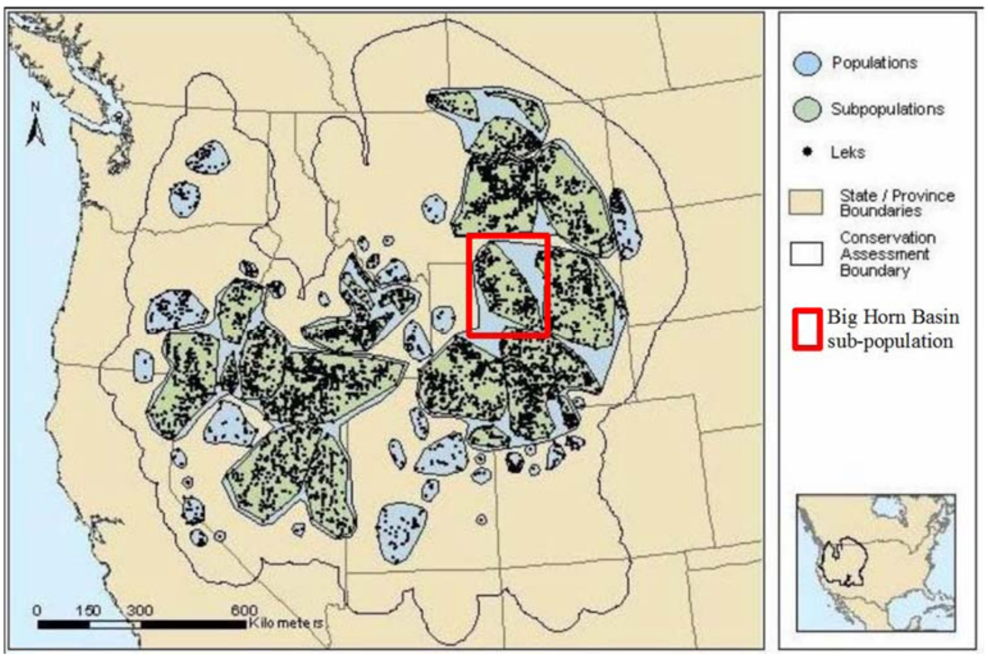


Table 1. Lek classifications in the Big Horn Basin by activity, ownership and geopolitical boundaries,2017.

Region	Number	Percent
Cody	309	100.0

Working Group	Number	Percent
Big Horn Basin	309	100.0

Classification	Number	Percent
Occupied	249	80.6
Undetermined	31	10.0
Unoccupied	29	9.4

BLM Office	Number	Percent
Cody	114	36.9
Worland	195	63.1

Biologist	Number	Percent
Cody	85	27.5
Greybull	52	16.8
Worland	172	55.7

Warden	Number	Percent
Greybull	23	7.4
Lovell	31	10.0
Meeteetse	32	10.4
North Cody	24	7.8
Powell	13	4.2
South Cody	28	9.1
Ten Sleep	52	16.8
Thermopolis	48	15.5
Worland	58	18.8

County	Number	Percent
Big Horn	48	15.5
Hot Springs	61	19.7
Park	104	33.7
Washakie	96	31.1

Land Status	Number	Percent
BLM	205	66.3
BOR	3	1.0
Private	82	26.5
State	19	6.1

Management Area	Number	Percent
B	309	100.0

Lek Status	Number	Percent
Active	179	57.9
Inactive	70	22.7
Unknown	60	19.4

METHODS

Data on the number of male sage-grouse attending leks are collected in two ways: lek *surveys* and lek *counts*. Lek surveys inform us if the lek is active and require at least 1 visit to the lek during the breeding season from mid-March to mid-May. Whereas, lek counts document the maximum number of male sage-grouse in attendance and require 3 or more visits to a lek, with each visit separated by about 7-10 days, during the peak of strutting activity from early April to early May. For an in-depth review of lek survey methods, see the Handbook of Biological Techniques (Christiansen 2012). Lek surveys in the Basin are performed by WGFD wardens and biologists, BLM personnel, and volunteers. After completing their surveys, observers send lek datasheets to Greybull Biologist Leslie Schreiber for entry into the sage-grouse database.

In 2012, WGFD changed how lek data were calculated and reported. Prior to 2012, leks with fresh sign (feathers, droppings), but with 0 males were included in calculating average male lek attendance. Average male lek attendance is now calculated using only leks with ≥1 observation of strutting males, while leks with only sign (feathers, droppings) are excluded.

No consistent methodology has been established for brood surveys. Sage-grouse brood data is opportunistically collected by field personnel while doing other field work during July and August. Data on the number of chicks, adult hens, and adult males along with location (UTM coordinates) and habitat type, are recorded and then entered into the Wildlife Observation System (WOS).

Harvest information is obtained through a mail questionnaire of bird hunters who provide data on number of birds harvested, days hunted, and areas hunted. Hunter survey data was compiled by county prior to 1982; by small and upland game management area from 1982 to 2009; and then in 2010, sage-grouse management areas were consolidated into 8 conservation areas with the Basin designated as Management Area B (Figure 1).

RESULTS AND DISCUSSION

Lek Monitoring In spring 2017, 56 leks were counted in the Basin, resulting in an average of 34.8 males per lek (Table 2a). We surveyed 176 leks (2008-17 average=122; Table 2b), for a total of 232 leks checked during the 2017 season (2008-17 average=189; Table 2c). More leks were *surveyed* and less were *counted* in 2017 compared to 2016 in an effort to visit more leks overall. To evaluate long-term population trends, we combine and average survey and count lek data since the count protocol was not used during the late 1980s and early 1990s. Fortunately, long-term data sets from Wyoming and neighboring states indicate similar trends from both counts and surveys (Fedy and Aldridge 2011; Figure 3).

The average number of male sage-grouse on both counted and surveyed leks dipped in 2017 to 23.6 males, after rising for the previous 3 years (Table 2c), indicating a downswing in the population (Figure 4). Sage-grouse populations cycle on approximate 7 to 10-year intervals (Fedy and Doherty 2010; Figure 4). During a downswing in the population, we would expect an increase in the number of inactive leks. The number of inactive leks jumped from 26 in 2016 to 34 in 2017. The number of leks with a known status (n=205) is the highest in the last 10 years (Table 2d). After 3 years of increasing sage-grouse abundance, the data suggests abundance is starting its downward cycle (Figure 4).

Table 2 (a-d). Lek attendance summary of occupied[1] leks in the Big Horn Basin, 2008-2017.

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2008	217	96	44	2083	24.8
2009	218	74	34	1717	25.6
2010	223	74	33	1495	21.7
2011	231	64	28	905	16.2
2012	234	53	23	816	16.7
2013	236	42	18	501	12.5
2014	233	68	29	824	14.2
2015	243	53	22	1108	26.4
2016	250	87	35	2260	30.1
2017	252	56	22	1636	34.8

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2008	217	79	36	1120	17.0
2009	218	95	44	1244	18.6
2010	223	109	49	1243	15.0
2011	231	121	52	989	12.8
2012	234	126	54	777	8.8
2013	236	148	63	749	8.2
2014	233	90	39	517	9.2
2015	243	139	57	2265	20.4
2016	250	140	56	2053	23.3
2017	252	176	70	2284	19.2

c. Leks Checked

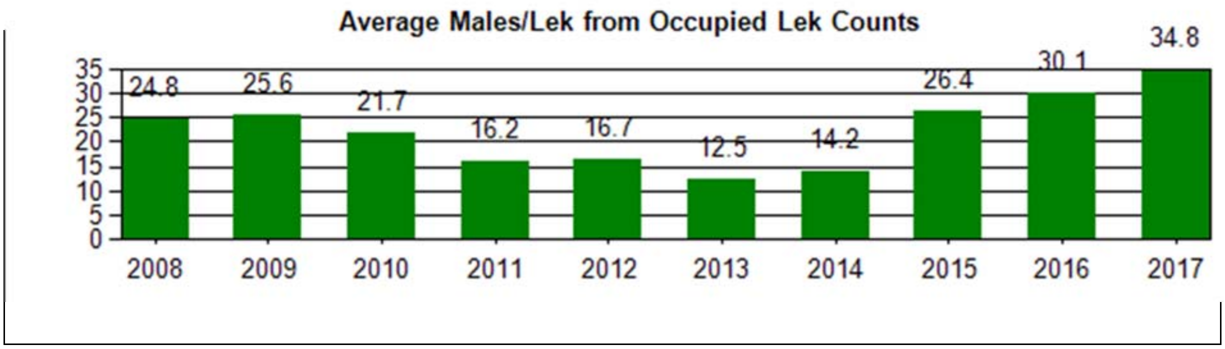
Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2008	217	175	81	3203	21.4
2009	218	169	78	2961	22.1
2010	223	183	82	2738	18.0
2011	231	185	80	1894	14.2
2012	234	179	76	1593	11.6
2013	236	190	81	1250	9.5
2014	233	158	68	1341	11.8
2015	243	192	79	3373	22.0
2016	250	227	91	4313	26.5
2017	252	232	92	3920	23.6

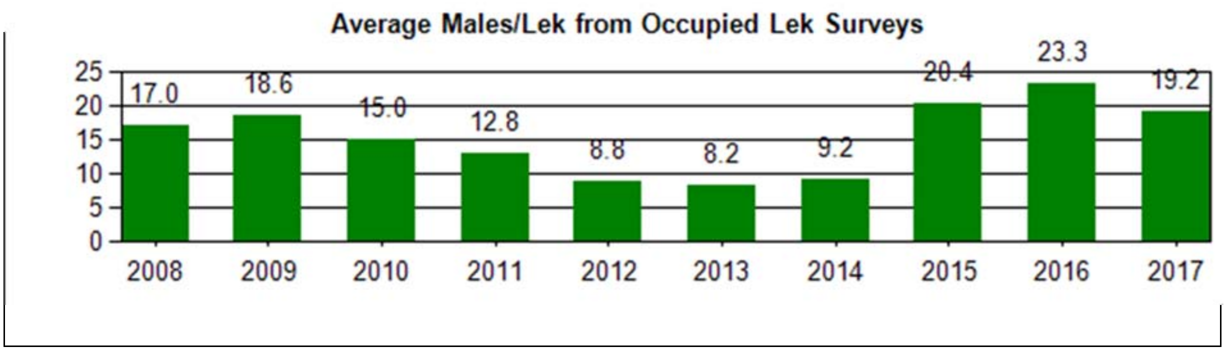
d. Lek Status

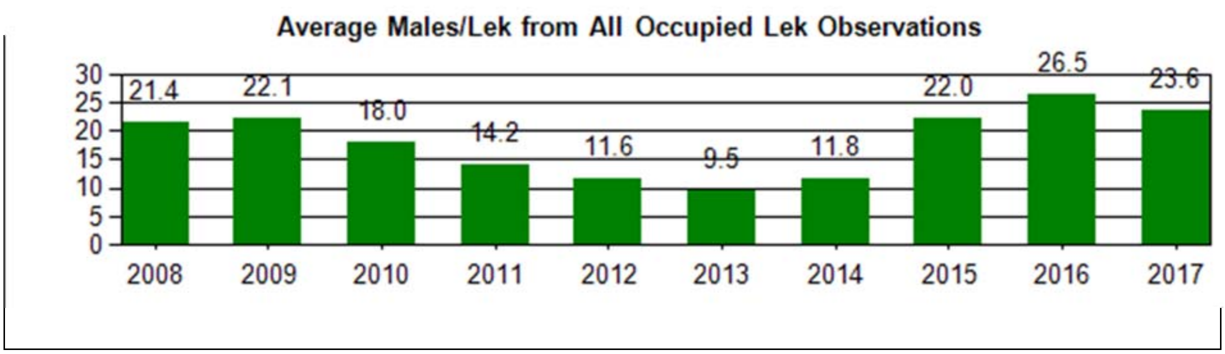
Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2008	147	8	20	155	94.8	5.2
2009	130	11	28	141	92.2	7.8
2010	146	8	29	154	94.8	5.2
2011	130	9	46	139	93.5	6.5
2012	144	7	28	151	95.4	4.6
2013	132	8	50	140	94.3	5.7
2014	116	22	20	138	84.1	15.9
2015	154	26	12	180	85.6	14.4
2016	175	26	26	201	87.1	12.9
2017	171	34	27	205	83.4	16.6

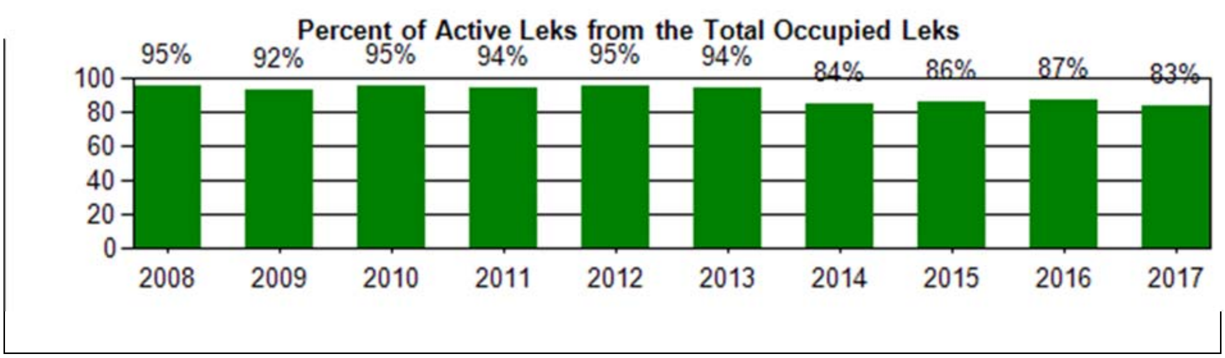
[1]Occupied – Active during previous 10 years (see official definitions in Christiansen 2012)
[2]Avg Males/Active Lek – Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.
[3]Inactive – Confirmed no birds/sign present (see official definitions in Christiansen 2012)

Figure 3. Average number of male sage-grouse observed per lek in the Big Horn Basin by counts, surveys and all observations, and percent active and inactive leks from total leks checked, 2008-17.









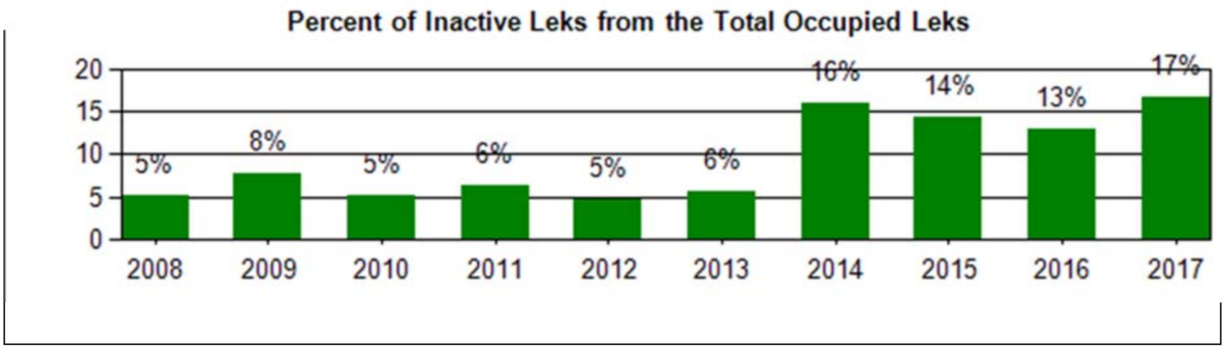
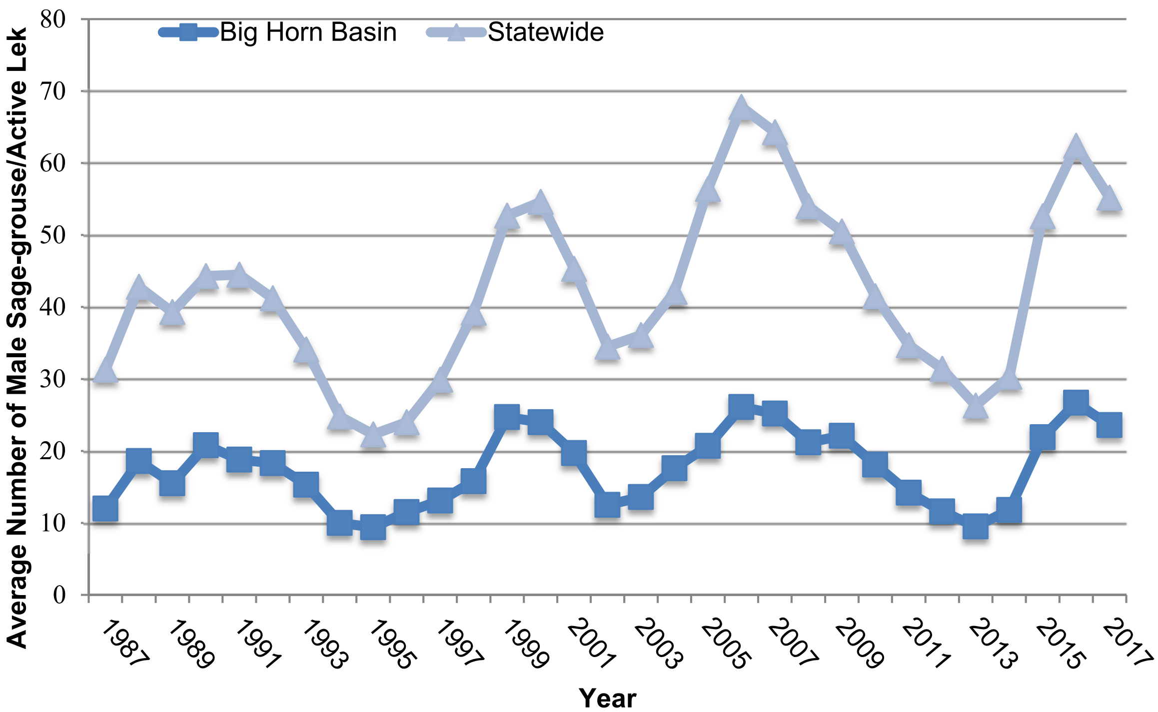


Figure 4. Trends in average male attendance for all lek observations in the Big Horn Basin and statewide, 1985-2016.



<u>Production surveys</u> Five sage-grouse broods were documented in 2017 (Table 3). Sample sizes (number of groups observed) from 2011-2017 were too small to estimate chick production (chicks/brood or chicks/hen) in the Bighorn Basin management area. Low sample sizes are likely a product of lack of effort by field personnel, because sage-grouse brood data is opportunistically collected while performing other duties during July and August. A direct connection between effort (time spent surveying for broods) and number of broods observed was presented in previous Job Completion Reports (JCR). In other portions of Wyoming, wings from harvested grouse are analyzed to estimate chick production; however, we collect an insufficient number of wings in the Basin to draw meaningful conclusions, thus this technique was discontinued by the Cody Region.

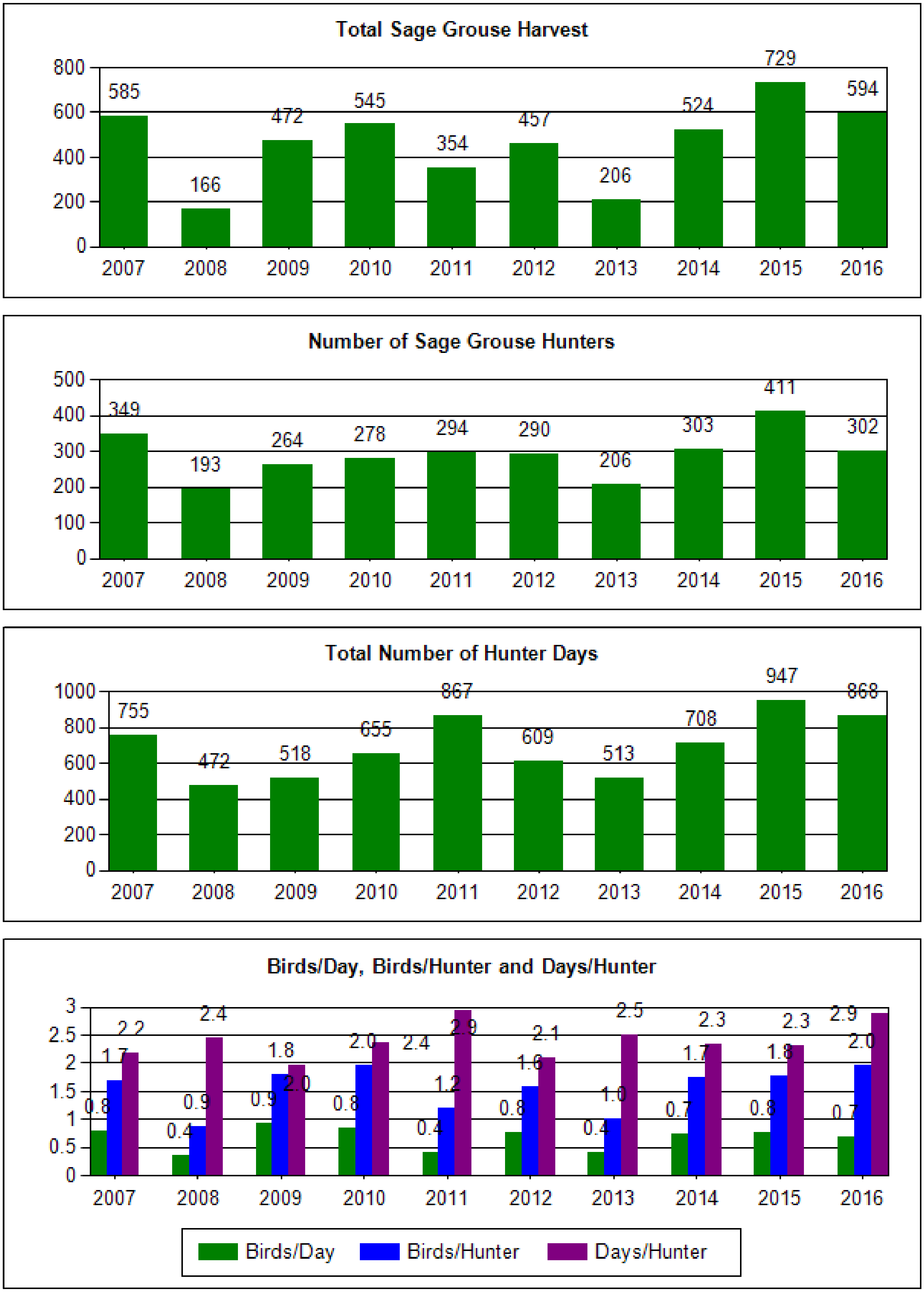
Table 3. Brood survey data collected by Wyoming Game & Fish Department personnel in the Bighorn Basin, 2008-17.

Year Observed	Broods	Chicks	Hens	Chicks/brood	Chicks/hen
2008	18	88	29	4.6	3
2009	26	104	33	4	3.2
2010	17	64	17	3.8	3.8
2011	0	0	18	0	0
2012	8	26	8	3.3	3.3
2013	8	30	9	3.8	3.3
2014	6	31	27	5.2	1.1
2015	13	69	24	5.3	2.9
2016	8	21	5	2.6	4.2
2017	5	32	7	6.4	4.6
2008-17 average	***10.9***	***46.5***	***17.7***	***3.9***	***2.9***

Hunting season and harvest The opening day of the sage-grouse hunting season was moved from 1 September to the third Saturday in September in 1995. Research suggests that hens and broods are more dispersed and less vulnerable to hunting later in the fall. Hunting seasons averaged 25 days long (range 16-31 days) from 1982-94 and about 15 days from 1995-2001. Due to concerns over low populations, the hunting season was again shortened in 2002 and daily bag limit decreased from 3 to 2 sage-grouse. Hunting seasons have averaged 12 days since 2002.

Changing the season and decreasing the bag limit reduced sage-grouse harvest and hunters in the Basin. Average (1982-1994) annual harvest in the Basin was 3,756 sage-grouse taken by 1,300 hunters during 3,118 hunter days (2.8 birds/hunter, 2.4 days/hunter). During 1995-2001 an average of 549 hunters took 1,056 sage-grouse during 1,567 days of hunting (1.9 birds/hunter, 2.8 days/hunter). During the most recent period (2002-2016), hunters averaged 1.5 birds/hunter and 2.4 days/hunter. In 2016, 302 hunters in the Big Horn Basin harvested 594 sage-grouse (2.0 birds/hunter); spending 868 hunter-days afield (2.9 days/hunter) during the 14-day hunting season. The decrease in sage-grouse harvest observed in 2016 is likely a result of decreasing sage-grouse populations. Less sage-grouse in the population equates to hunters harvesting less sage-grouse, with hunters expending more effort in 2016 than the prior 4 years.

Figure 5. Sage-grouse hunting statistics for the Big Horn Basin, 2007-16.



CONSERVATION PLANNING

The BHBLWG was formed in September 2004 to develop and implement a local conservation plan for sage-grouse and sagebrush habitats. The BHBLWG's mission statement is, "*Through the efforts of local concerned citizens, recommend management actions that are based on the best science to enhance sagebrush habitats and ultimately sage-grouse populations within the Big Horn Basin*."

The BHBLWG's local plan identifies factors and impacts that may influence sage-grouse populations in the Basin, and outlines goals and objectives to address habitats, populations, research and education. Strategies and commitments in the local plan are designed to improve sage-grouse habitats and populations in the Basin (Table 4). The local plan was updated in 2013 and highlights completed and ongoing projects in the Basin in addition to summarizing state- and nation-wide policy and programs. The updated plan can be viewed at the WGFD website: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management.

Most recently, the BHBLWG met in March 2015 to discuss proposed changes to sage-grouse core area boundaries. The group provided recommendations to the Sage Grouse Implementation Team who reviewed the recommendations from local working groups statewide and developed Wyoming's sage-grouse core areas, version 4, available at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management. Details on Wyoming's Core Area Policy are also available at this website.

In May 2015, the BLM and the U.S. Forest Service released 14 Environmental Impact Statements that will help conserve greater sage-grouse habitat and support sustainable economic development on portions of public lands in 10 states across the West including the Big Horn Basin. The plans contain 3 common approaches: minimizing new or additional surface disturbance, improving sage-grouse habitat condition, and reducing the threat of rangeland fire.

RESEARCH

Sage-grouse research in the Basin has historically been limited, but recent projects are shedding light on sage-grouse habitat, movements, and survival. Hess (2010) and Hess and Beck (2012a) evaluated the relative influence of prescribed burning and mowing treatments on sage-grouse nesting and early brood-rearing habitats. Hess and Beck (2012b) evaluated landscape characteristics that explain differences between occupied and unoccupied leks using Basin lek data from 1980 to 2009.

In 2010, two research projects on sage-grouse were begun in the Basin. Pratt and Beck (2012) are evaluating possible effects of bentonite mining on sage-grouse near Hyattville and field work was completed in 2015. Data analysis and writing took place in 2016, and the dissertation defense was in November 2017. Orning and Young (2012, 2012a) started a multiphase sage-grouse predation project focusing on coyote predation. This completed project documented predation levels on nests, broods, and adult hens at several sites in the Basin (Orning 2013). Next, Dr. James Taylor (USDA-APHIS) investigated raven predation in the Basin, resulting in a publication (Taylor et al. 2017). HWA Wildlife Consulting conducted raven predation research in 2017 (HWA 2017; Appendix A). Other research projects approved for funding at the July 2016 meeting of the Bighorn Basin Local Working Group included "Habitat Quality of Core Areas Relative to Avian and Mammalian Predators" by Dr. John Dinkins, and a cheatgrass control study by Dr. Brian Mealor (Table 4).

Table 4. Sage-grouse conservation projects funded by the Big Horn Basin Local Working Group in bio-year 2016, Wyoming.

Grantee	Project Description	Amount Allocated
University of Wyoming	Cheatgrass thresholds for treatment research	$87,000
University of Wyoming	Response of sage-grouse demographics to habitat treatments research	$34,000
Oregon State University	Habitat quality in and out of Core Areas relative to predator presence and abundance research	$47,000
Meeteetse Conservation District	Sage-grouse distribution and habitat use (portion of raven/sg interactions research)	$20,000

CONCLUSIONS & RECOMMENDATIONS

Sage-grouse populations in the Basin experienced a high in the population cycle from 2014-16, but 2017's data suggests that populations are on a downswing, possibly due to decreased spring precipitation. Sage-grouse in the Basin face threats, but are not in danger of foreseeable extirpation, and on-going conservation efforts are intended to mitigate some anthropogenic impacts. Research and monitoring are important to help identify limiting factors, important habitats, and to track populations.

- Continue to improve the number and intensity of lek surveys, especially visiting previously unoccupied leks.
- Update all lek observers on WGFD survey protocols, and familiarize them with standardized datasheets.
- Conduct brood surveys whenever work schedules allow, and enlist volunteers where practical.
- Formalize winter use area mapping in coordination with Worland and Cody BLM offices
- Continue to be WGFD liaison for ongoing and new research projects, as much as possible.
- Work closely with local ranchers, farmers, energy companies, and other landowners whenever possible on sage-grouse habitat (especially early brood-rearing) and water development projects.
- Assist the Bighorn National Forest with prescribed burning plans targeting sage-grouse habitats on the Bighorn National Forest.

LITERATURE CITED

Christiansen, T. 2012. Chapter 12: Sage-grouse (*Centrocercus urophasianus*). Pages 12-1 to 12-55 in S.A. Tessmann (ed). Handbook of Biological Techniques: third edition. Wyoming Game and Fish Department. Cheyenne, WY.

Connelly, J. W., S. T. Knick, M. A. Schroeder, and S. J. Stiver. 2004. Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, Wyoming.

Fedy, B. C. and C. L. Aldridge. 2011. The importance of within-year repeated counts and the influence of scale on long-term monitoring of sage-grouse. Journal of Wildlife Management 75:1022-1033.

Fedy, B. C. and K. E. Doherty. 2010. Population cycles are highly correlated over long time series and large spatial scales in two unrelated species: greater sage-grouse and cottontail rabbits. Oecologia 165:915-924.

Hess, J. E. 2010. Greater sage-grouse (*Centrocercus urophasianus*) habitat response to mowing and prescribed burning Wyoming big sagebrush and the influence of disturbance factors on lek persistence in the Big Horn Basin, Wyoming. Thesis, University of Wyoming, Laramie, USA.

Hess, J. E. and J. L. Beck. 2012a. Burning and mowing Wyoming big sagebrush: Do treated sites meet minimum guidelines for greater sage-grouse breeding habitats? Wildlife Society Bulletin 36:85-93.

Hess, J. E., and J. L. Beck. 2012b. Disturbance factors influencing greater sage-grouse lek abandonment in north-central Wyoming. Journal of Wildlife Management 76:1625-1634.

HWA Wildlife Consulting. 2017. Assessing and reducing common raven impacts on greater sage-grouse nesting ecology. Unpublished report, Laramie, Wyoming, USA.

Orning, E. K. 2013. Effect of predator removal on greater sage-grouse (Centrocercus urophasianus) ecology in the Bighorn Basin conservation area. Thesis, Utah State University, Logan, USA.

Orning, E. K. and J. K. Young. 2012. Bighorn Basin greater sage-grouse project. Annual Report, Utah State University, Logan, USA.

Orning, E. K. and J. K. Young. 2012a. Bighorn Basin greater sage-grouse project. Summary report for Major Basin, Utah State University, Logan, USA.

Pratt, A. C. and J. L. Beck. 2012. Greater sage-grouse migration ecology and response to bentonite mining in the Bighorn Basin, Wyoming. Annual Report, University of Wyoming, Laramie, USA.

Taylor, J. D., R. D. Holt, E. K. Orning, and J. K. Young. 2017. Greater sage-grouse nest survival in northwestern Wyoming. Journal of Wildlife Management 81:1219-1227.

Other regional literature:

Harrell, D. 2008. Peak lek attendance for greater sage-grouse within the northern Bighorn Basin, Wyoming. Technical Note 424. U.S. Department of the Interior, Bureau of Land Management, Cody Field Office, Wyoming, USA.

Tarasoff, C. 2015. Using assisted succession to improve sage-grouse habitat in high conflict areas of the Big Horn Basin, WY. Report prepared for the Wyoming Game and Fish Department and Big Horn Basin Local Sage-Grouse Working Group. Michigan Technological University, Houghton, Michigan, USA.

Taylor, J. D. 2016. Monitoring causes of mortality, predation rates, and space use of greater sage-grouse in the Bighorn Basin. Final report to the Meeteetse Conservation District, USDA APHIS Wildlife Services, National Wildlife Research Center, Oregon Field Station, Corvallis, USA.

Taylor, J. D. and R. D. Holt. 2016. An assessment of greater sage-grouse (Centrocercus urophasianus) population demographics in the Bighorn Basin, Wyoming, 2011-2014. Report to the Wyoming Wildlife and Natural Resources Trust, Oregon State University, Corvallis, USA.

Appendix A

Assessing and Reducing Common Raven Impacts on Greater Sage-grouse Nesting Ecology

Final statistical analysis and report – November 20, 2017

prepared by

HWA Wildlife Consulting

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EXECUTIVE SUMMARY

This report describes the field activities, statistical analysis, and results of the Meeteetse Conservation District research project titled 'Assessing and reducing common raven impacts on greater sage-grouse nesting ecology'. Field methods included capturing and attaching GPS units to greater sage-grouse hens (*Centrocercus urophasianus*) and breeding and nonbreeding common ravens (*Corvus corax*). We established two field sites in the Bighorn Basin, Wyoming (Polecat Bench and YU Bench), to explicitly incorporate some geographic variability in measured avian metrics and in response to treatments. We monitored nesting success and movement activity of sage-grouse and ravens in 2016 and 2017. We also conducted a field experiment by destroying all discoverable raven nests within 4.0 km of a GPS-tagged sage-grouse nest within half of each study area and monitored breeding raven movement patterns and sage-grouse nest success in response to raven nest treatments. The total dataset from this study contains a total of 62,922 GPS-tagged raven locations, 55,667 GPS-tagged sage-grouse locations, 24 active raven nests located, 16 raven nests treated, and 43 monitored sage-grouse nests. We found that spatio-temporal use of the landscape was fundamentally different for breeding ravens and nonbreeding ravens, with breeding ravens showing diurnal variation in movement and rapid travel and nonbreeding ravens showing minimual diurnal variation in their slow and steady travel rates. We found that treating raven nests resulted in a significant change in how treated breeding ravens used the landscape, causing them to range widely, similar to nonbreeding ravens. We also found higher sage-grouse nest success in treated compared to untreated areas in the Polecat Bench study area but not in the YU Bench study area. Together, these results suggest that treating raven nests may be an effective way to improve sage-grouse nest success, but only in landscapes where ravens are a primary nest predator.

INTRODUCTION

In 2016, with funding support for a sixth consecutive year from the Animal Damage Management Board (ADMB), the Meeteetse Conservation District (MCD) continued with an agreement with Laramie-based HWA Wildlife Consultants, LLC (HWA, formerly Hayden-Wing Associates, LLC) to continue the joint research project on raven impacts on greater sage-grouse in the Bighorn Basin. This research project was a new phase of an ongoing project initially begun by MCD and the National Wildlife Research Center in Logan, UT and Corvallis, OR in 2011. Beginning in the 2016 field season, the ongoing study shifted from *Evaluation of causes of mortality and predation rates of sage-grouse in the Big Horn Basin* to *Assessing and reducing common raven impacts on greater sage-grouse nesting ecology.* We tested a novel approach to reducing raven impacts on sage-grouse and evaluated it effectiveness, including the mechanism by which it worked.

BRIEF DESCRIPTION OF PROJECT

Current raven management usually involves lethal bait, which often kills nonbreeding ravens that frequent landfills (Coates 2007). However this method of control has had either spatially-dependent or no detectable effect on sage-grouse nesting success in the larger surrounding landscape (Coates 2007, Bui et al. 2010, Dinkins 2013). This is likely because breeding ravens usually forage exclusively within a few kilometers of the nest and rarely visit poison bait stations (Rösner and Selva 2005, HWA unpublished data). Further, as-yet unpublished data from GPS-tagged ravens in southcentral Wyoming suggests that breeding raven pairs whose nests failed for natural reasons switched to a spatially wide-ranging behavioral pattern whereas nesting and post-successful nesting pairs continued to intensively use the landscape surrounding the nest site (HWA *manuscript in prep*). Together these studies suggest that an alternative nest-focused breeding raven control method, where breeding ravens are induced to switch behavioral and space-use patterns, and reduce energetic demands to those of nonbreeding ravens, may prove successful in improving greater sage-grouse nest success.

In 2016 we began a new study to better understand raven ecology, greater sage-grouse nesting ecology, and interactions between the two. Study components included:

1) <u>Determine spatial use of the landscape by breeding and nonbreeding ravens</u> – Determining how ravens use the landscape equivalently or differently depending on breeding status will provide information on how specific management actions are likely to impact different components of the raven population.

2) <u>Evaluate a targeted lethal/non-lethal method for reducing raven impacts on sage-grouse nesting success</u> – We proposed a combination non-lethal (raven nest removal) and lethal (raven egg removal) treatment method for two reasons. First, broadly-applied lethal control of juvenile and adult ravens largely impacts transient individuals and has minimal impact on nesting pairs, but nesting raven pairs appear to be the raven population component that has the largest impact on sage-grouse nest success (Bui et al. 2010, Dinkins 2013). Second, targeted lethal control of nesting pairs involves permit complications, locating and killing two mobile birds (rather than destroying the stationary nest), and results in an open nesting territory that can be immediately occupied by another pair of breeding ravens. A targeted non-lethal/lethal option has the potential to effectively improve sage-grouse nest success while also being feasible to apply over large landscapes. Expected outcomes include an assessment of whether destroying raven nests alters raven space use and whether this alteration in space-use is associated with improved greater sage-grouse nest success.

Due to time and budget constraints, additional research objectives have not been analyzed and are therefore not discussed in this report. This report contains statistical analyses pertaining to movement behavior of nonbreeding ravens, breeding ravens, and sage-grouse, raven space-use responses to raven nest treatment, and sage-grouse nest fate in response to raven nest treatments.

STUDY AREA AND FIELD METHODS

We used two study areas in northwest Wyoming (Figure 1) in 2016 and 2017. The Polecat Bench (PB) study area is located just north of Powell, Wyoming, and the YU Bench (formerly known as Sheets Flat) study area is located just east of Meeteese, Wyoming. Each study area was split into a treatment and non-treatment side for the targeted raven nest removals. Due to difficulty in accessing raven nests in rugged terrain in the southern half of the YU study area, this portion was removed from the study in 2017.

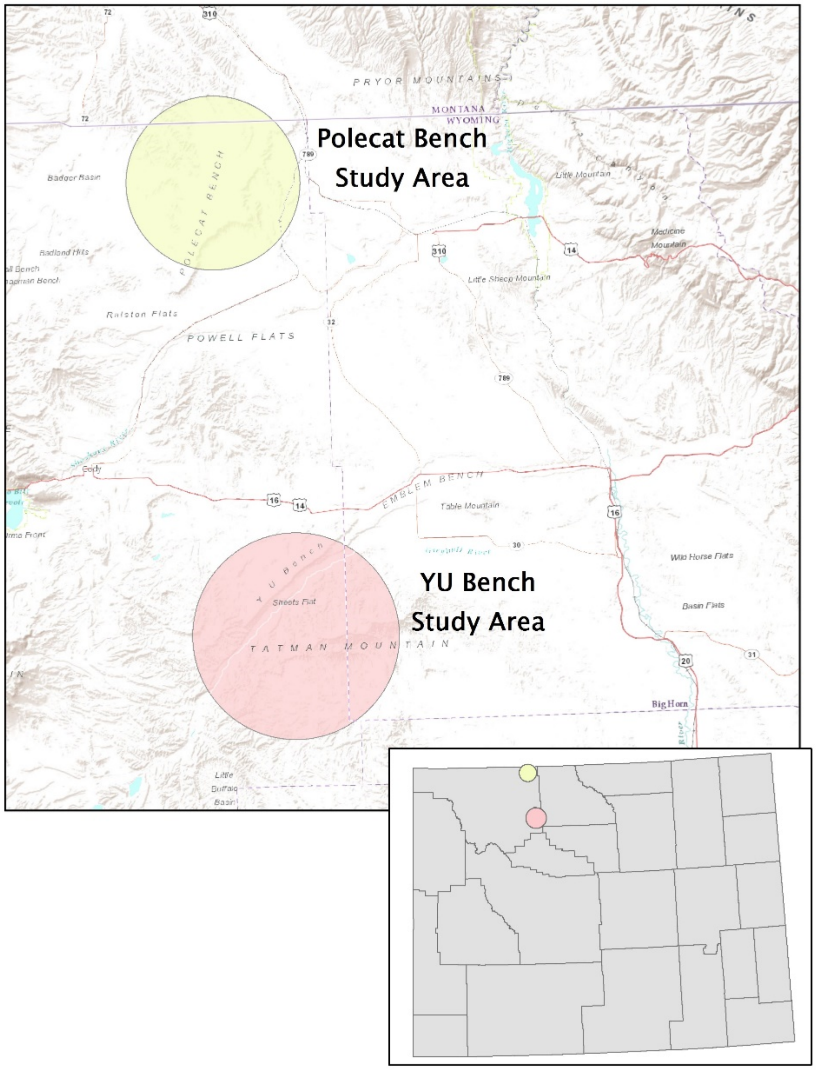


Figure 1. Study areas for raven and greater sage-grouse capture and nesting locations that were part of the study. The southern half of the YU Bench study area was dropped after 2016 due to difficulty in accessing raven nests in rugged terrain. All capture locations and nests were within these study areas, although individual ravens and greater sage-grouse traveled outside of these areas. Study area boundaries include data from 2016 and 2017.

Based on previous field studies by HWA in Wamsutter, WY, we noted that ravens forage within 2 miles of their nests, most heavily within 1.5 miles of their nests (Rösner and Selva 2005, HWA *manuscript in prep*). The majority of greater sage-grouse tend to nest within 3 miles of known leks (Holloran and Anderson 2005, HWA unpublished data). Following this knowledge, we focused raven capture within 4 miles of sage-grouse leks. We then established 4 km boundaries around GPS-tagged sage-grouse nests within the treatment side of each study area within which to conduct raven nest treatments. We altered the official delineation of each study area's boundaries where necessary to ensure that the treatment and non-treatment sides of each study area encompassed the associated GPS-tagged sage-grouse.

For the treatment side of each study area, MCD employees conducted the treatment actions. This included extensive searches for raven nests. Once located, raven nests and/or associated eggs or chicks were removed or destroyed as approved by the Wyoming Game and Fish Department (permit ID: 1056) and the

U.S. Fish and Wildlife Service (permit # MB85114B-0). Treatment of raven nests took place throughout the overlap between the sage-grouse and raven nesting seasons within the treatment side of each study area. All known discoverable raven nests in treatment portions were treated regardless of whether or not a member of the breeding pair was GPS-tagged. On the non-treatment portions of each study area, we did not treat raven nests to allow for comparison of treatment to non-treatment.

In 2016, a variety of trapping methods were tried for capturing ravens, including: padded leg-hold traps, net-launchers, and hoop-netting at night. Padded leg-hold traps were the only trapping method employed during 2017 for ravens. Unfortunately, very difficult field conditions prevented successful captures of new ravens in 2017. Several ravens captured and GPS-tagged in 2016 were still active and contributed GPS locations. Ravens captured in 2016 were outfitted with 30-gram solar powered CTT-1000-BT3 Series GPS-GSM transmitters (Cellular Tracking Technologies). These transmitters allowed for much faster sampling intervals and allowed us to measure raven movement patterns more accurately during the grouse nesting season. Raven transmitters were set to record GPS-quality (±3 meters) locations at 30 minute time intervals when stationary and 5 minute time intervals when flying during the greater sage-grouse nesting season (April 1 – June 30). The high frequency location fixes were only activated when birds were inside the study areas; hence the study areas were used as geofences and the programming defaulted to the 30 minute intervals when birds were outside the pre-programmed study area boundaries. After the nesting season, we increased the time interval to a static 30 minute interval independent of geofences in order to save battery power (July 1 – August 31). During the fall, winter, and early spring (September 1 – March 31), the transmitters were programmed to record locations every 3 hours. All raven programming was for daylight hours only and GPS locations from the raven CTT transmitters were downloaded via cellular technology. CTT transmitters were fitted to ravens using standard backpack harnesses constructed with ¼" Teflon ribbon (Bally Ribbon).

Greater sage-grouse captured in 2016 were captured almost exclusively on leks using rocket-nets, although one grouse was captured opportunistically using spot-lighting and a hoop-net during the 2016 field season. In 2017, all sage-grouse were captured using the spot-lighting and hoop-net method. Because sage-grouse were more stationary during the nesting season, we outfitted hens with 30-gram solar-powered GPS/ARGOS PTT transmitters (Microwave Telemetry, Inc.). Transmitters were programed to record 5-15 GPS-quality (±18 meters) locations per day for each grouse hen, depending on the time of year. The programming varied slightly among transmitters, but generally transmitters were programmed to record 16 GPS locations per day between April 15 and June 30, and 6 GPS locations per day the remainder of the year (July 1 – April 14). The greater sage-grouse ARGOS PTT location data were received via the ARGOS satellite system (CLS America, Inc.) every three days. ARGOS PTT transmitters were fitted to sage-grouse using rump-mounted harnesses constructed with ¼" Teflon ribbon (Bally Ribbon).

Sage-grouse nest success was monitored from GPS-outfitted hens by MCD staff. Nest locations were determined by identifying clusters of GPS locations once nesting activity was detected (i.e., movement patterns indicative of incubation). We estimated the incubation date using the GPS data then forecast the hatch date using an average incubation period of 27 days. A hen departing from a nest >2 days prior to the expected hatch data indicated a nest failure. Nests were checked immediately after hens departed the area to confirm nest fate. Nests were considered successful if hens incubated for $\geq$24 days and a ground visit verified $\geq$1 egg hatched. Hatched eggs were identified by hatching pattern (i.e., eggs split into halves) and detached membranes. Nests were classified as unsuccessful if hens vacated the nest >3 days prior to the expected hatch date and a ground visit confirmed a nest failure.

RESULTS

RAW DATA

Greater sage-grouse

Three sage-grouse hens had working GPS units that were attached in earlier years of this study and were subsumed into this study's sample of hens. Seventeen sage-grouse hens were captured in late March / early April, 2016, and outfitted with ARGOS GPS units. Eleven greater sage-grouse hens captured and outfitted in 2016 were still alive and had functioning units in 2017. We captured five additional hens in April 2017 to re-deploy GPS units recovered from hen mortalities in 2016. The 20 captures in 2016 were equally split between the two study areas. Three of the 2017 captures were in PB, two captures were in YU Bench.

As of July 12, 2017 (the end of data collection for this analysis), we had collected 55,667 GPS locations from tagged sage-grouse. The mean number of locations per individual hen was 1,104.4 (SD 562.4) with a minimum of 78 locations and a maximum of 1,934 locations per hen.

In the PB study area, 3 of 11 nests and 4 of 12 nests were successful in 2016 and 2017, respectively. In YU Bench, 2 of 12 nests and 1 of 7 nests were successful in 2016 and 2017, respectively.

Six hen carcasses were recovered in 2016 and three in 2017. One transmitter was recovered in 2016 without evidence of a carcass. Four additional hens did not transmit locations in the two weeks prior to July 12, 2017 (the end of data collection for this analysis) and may have died, dropped the GPS unit, or had GPS unit malfunction.

Common raven

Twelve ravens were captured in 2016, three males and three females in each study area. Raven capture efforts were unsuccessful in 2017 due to poor weather and field logistics. However, six ravens captured and GPS-tagged in 2016 were still alive with active CTT units in 2017, providing additional GPS location and movement data.

As of July 12, 2017 (the end of data collection for this analysis), we had collected 62,922 GPS locations from tagged ravens. The mean number of locations per individual raven was 5,243.5 (SD 3,863.0) with a minimum of 255 locations and a maximum of 11,633 locations per raven.

Six of the 12 ravens were active breeders in 2016. Four of these breeders were in the non-treatment side of the two study areas; two breeders were in treatment sections. In 2017, only one of the six surviving and tagged ravens was a breeder and it was in the treatment section of YU Bench. An additional nine raven nests were located in treatment areas and one additional raven nest was located in the non-treatment areas in 2016. Nine raven nests from untagged ravens were located and treated and five untagged raven nests were located and not treated in 2017.

STATISTICAL ANALYSES

Temporal movement patterns of ravens and sage-grouse

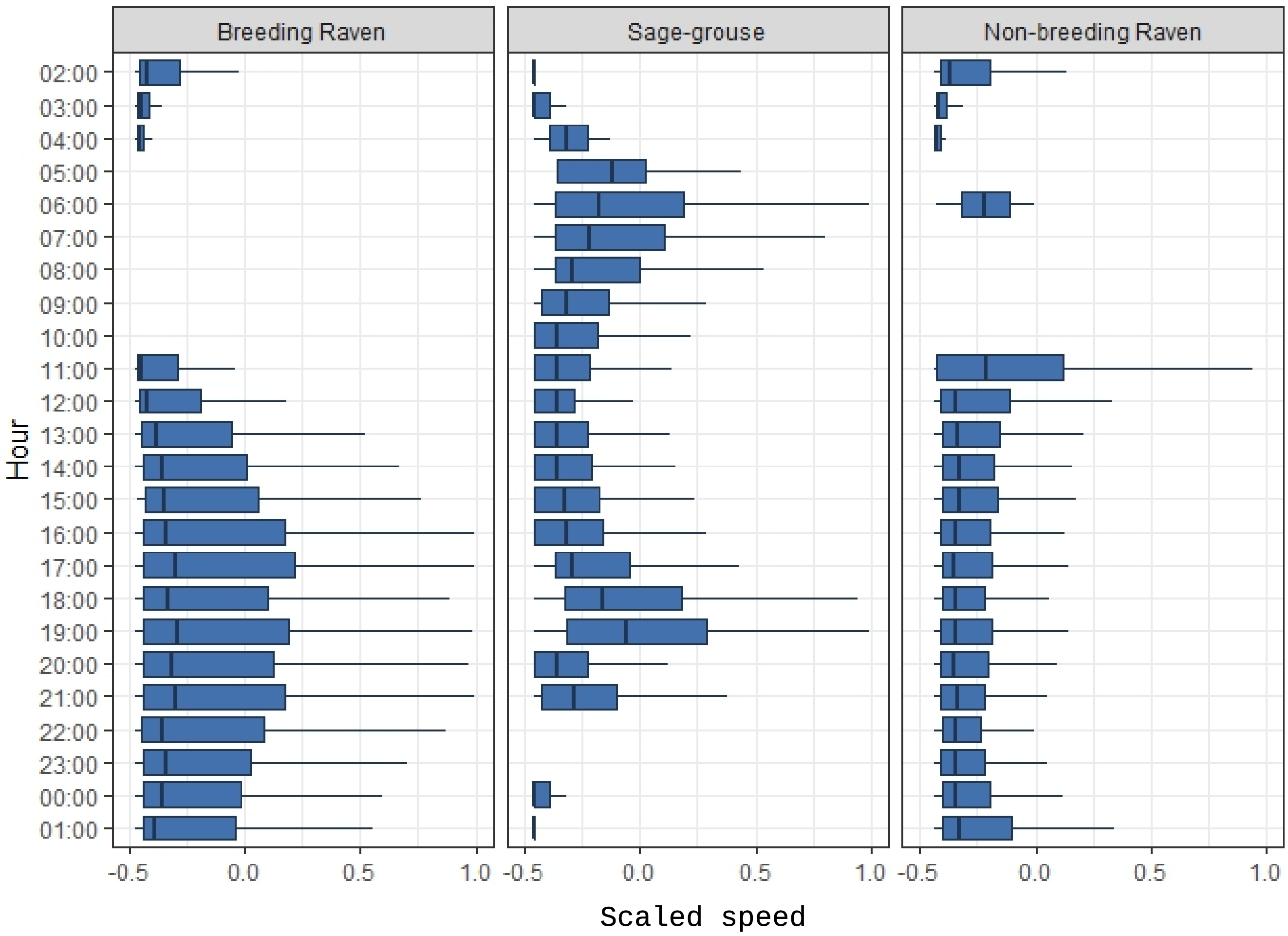
Understanding how different groups of animals use the same space is crucial to understanding when and where individuals from those groups interact. For ravens and sage-grouse this means identifying how they use the landscape in a spatiotemporal context to identify times or places of interaction, particularly during sage-grouse nesting. Of further interest is comparing and contrasting how breeding versus nonbreeding ravens use space as part of this study's goal of establishing a baseline for how breeding ravens use the landscape and whether they use the landscape different than nonbreeding ravens.

To achieve this comparison among nonbreeding ravens, breeding ravens, and breeding sage-grouse during the breeding season, we focused on diurnal patterns of movement rates. For diurnal patterns we wanted to see if there are periods of peak activity when a raven is more likely to encounter a sage-grouse, whether breeding ravens had the same activity patterns as nonbreeding ravens, and whether sage-grouse had times of peak activity when they most often left the nest temporarily unattended. We defined the sage-grouse breeding season as April 1st through June 15th, which was approximately one week prior to the earliest sage-grouse nest initiation date (April 7th) and approximately one week later than the latest nest hatch date and nest failure date (both June 10th). We restricted this analysis to only include raven and sage-grouse movement metrics from within this window.

The GPS units for ravens and sage-grouse were from different manufacturers and therefore had fundamentally different location recording schedules. As detailed in the Methods section above, raven locations were recorded every 5 minutes while actively moving and every 30 minutes when stationary. Sage-grouse GPS units generally recorded ~16 locations per day (hourly, during daytime) during breeding. Distances between successive locations within an individual raven or sage-grouse were not directly comparable because longer time periods between successive locations can also result in longer (or shorter) distances recorded traveled (e.g., an incubating hen may leave the nest to forage briefly, then return, and be recorded as having traveled a distance of 0 m during the encompassing GPS location recording interval). Further, GPS units on both ravens and sage-grouse sometimes temporarily malfunctioned or failed to achieve sufficient satellite coverage and could not record a location. To deal with unequal intervals between successive GPS locations, we calculated rate of movement (km/hr) between successive locations as a standardized metric across individuals. Then, to accommodate dramatically different calculated rates of movement between ravens and sage-grouse, we scaled movement rates within each group: breeding ravens, nonbreeding ravens, and sage-grouse hens. After scaling, each group has mean = 0 and standard deviation = 1. Finally, we rounded movement rate timestamps to the nearest hour for plotting and analysis purposes. Statistical analysis was a generalized linear model using a quasipoisson distribution. The first simple model was simply a fixed effect of Group (i.e., breeding raven, nonbreeding raven, etc.) and BirdID as a nuisance variable to account for each individual bird's inherent behavioral pattern. The second full model also included Hour and Hour*Group to test for temporal differences in movement rates among groups.

We found that both breeding ravens and sage-grouse showed strong cyclical patterns in movement rates throughout the 24-hour period (Figure 2). Sage-grouse showed prominent increases in movement rate early in the morning and in the evening, peaking at 06:00 and 19:00. Breeding ravens were missing data from early in the morning, but showed a gradual increase and then decrease in movement rates over the day, with a gentle peak between ~17:00 – 21:00. Nonbreeding ravens were also missing morning data, but at first location showed the highest movement rates at 11:00, suggesting the possibility of unobserved high movement rates earlier in the morning. During the remainder of the day nonbreeding ravens showed consistent low movement rates. The simple statistical model found that breeding ravens had significantly higher movement rates than nonbreeding ravens ($p<0.001$) or sage-grouse ($p<0.001$) across all hours combined. Breeding ravens on average traveled 1.40 times faster than nonbreeding ravens and 1.22 time faster than sage-grouse hens. The full statistical model looking for hourly differences in movement rates among groups found no difference in scaled movement rates between sage-grouse and breeding ravens at any time (all p-values > 0.307). However, breeding ravens showed significantly lower movement rates than nonbreeding ravens at 01:00, 02:00, 04:00, and 12:00 and significantly higher movement rates than nonbreeding ravens at each hour from 14:00 to 23:00 (all p-values <0.05).

Figure 2. Boxplots of movement rates for breeding ravens, sage-grouse, and nonbreeding ravens in Bighorn Basin, WY, USA during sage-grouse breeding season in 2016-2017. X-axis (speed.grp.scale) is movement rate in km / hr scaled for each group. Some time periods were completely missing observations due to GPS unit scheduling and/or failure to record location due to GPS unit or satellite issues (e.g., too few satellites, power failures, physical barrier between GPS unit and satellites, etc.).



Together, Figure 2 and the statistical analyses suggest that breeding ravens and sage-grouse have strong crepuscular patterns of movement, with longer and faster movements in early morning and early evening. In contrast, nonbreeding ravens showed no evening spike in activity but rather constant movement rates. In light of breeding ecology, the differences in raven movement make sense. Breeding ravens need to forage to sustain energy for incubation and feeding, but need to balance foraging food with attending the nest and therefore would move quickly when they foraged. Engel and Young (1992) also observed that during spring, breeding ravens increase the proportion of time spent moving or flying in the afternoon and evening compared to morning. In contrast, without a nest to attend, nonbreeding ravens are free to forage at a steady pace over a wide area (Heinrich et al. 1994, Webb et al. 2012, Loretto et al. 2016). In terms of interactions between breeding ravens and sage-grouse, ravens may be leveraging hen foraging periods to find unattended sage-grouse nests. While few published data are available to inform timing of raven nest depredation, Coates (2007) found that eight out of nine video-recorded raven depredations of sage-grouse nests occurred between ~6:30-9:30 and 18:00-19:00, the peak periods of sage-grouse off-nest movement in our study.

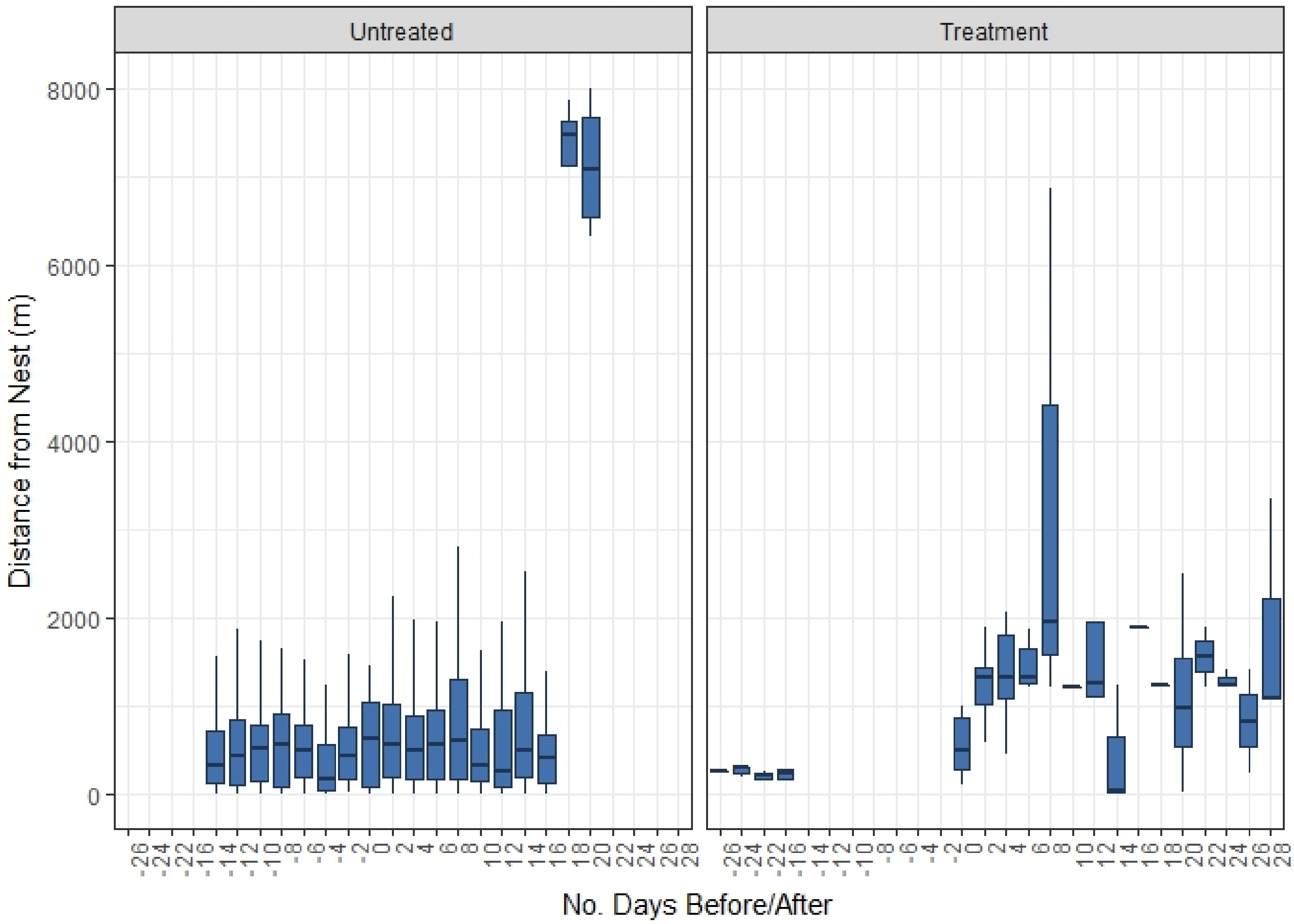
Raven space-use response to nest treatment

The notion that ravens would alter space use when incubating a nest and tending to young is logical and widely supported by field data. Breeding ravens often stay within 2 km of the nest (Rösner and Selva 2005). They establish non-shared territories to defend local food opportunities (Webb et al. 2012). Even after the raven chicks fledge, the adults and chicks can occupy the same territory for up to six weeks while the adults teach the chicks how to forage (Stiehl 1985). Given that the act of attending a nest alters raven space use, it stands to reason that removing the need to attend a nest (e.g., destroy the nest) would induce a behavioral shift back to that of nonbreeding ravens. For example, in southcentral Wyoming, ravens whose nests failed due to natural causes quickly switched to a space use pattern similar to nonbreeding ravens, traveling significantly further between successive locations and ranging over much larger portions of the landscape than breeding ravens or than breeding ravens who successfully hatched (HWA *manuscript in prep*).

In this study we treated active raven nests and then monitored the space use response of GPS-tagged ravens in those nests. Sample size was small, given the difficulty in capturing known breeding ravens and the fact that treated and untreated portions of the landscape were largely determined by the spatial distribution of our GPS-tagged sage-grouse. Nonetheless, we were able to monitor space use of three GPS-tagged ravens whose nests were treated and four GPS-tagged ravens whose nests were untreated. Treatment consisted of regular nest searches in treated areas. When a nest was located, it was destroyed along with any eggs. Follow-up surveys were conducted by MCD to determine if the breeding pair attempted to re-nest in the same territory. The time period for analysis was set as 30 days prior- and 30 days post-treatment for treated ravens. For untreated ravens, the time period was set as 30 days prior to and post June 15th, which was the center date for treatment of the three treated nests. We analyzed whether the distance a raven was from the nest depended on treatment status. GPS locations were not recorded when the raven was stationary, therefore this analysis reflects distance from the nest when off of the nest. Statistical analysis was a linear regression on log-transformed distance-to-nest for each breeding raven GPS location, with a single predictor variable reflecting whether a breeding raven was untreated, prior to treatment, or after treatment.

We found that the average distance from the nest for untreated breeding ravens was 368.5 m (95% CI 354.0 – 383.7 m), for pre-treatment ravens was 231.7 m (95% CI 91.7 – 585.7 m), and for post-treatment ravens was 833.3 m (95% CI 635.7 – 1092.3 m). Distance from nest was not significantly different for untreated and pre-treatment ravens ($p = 0.327$), but the distance from nest for post-treatment ravens was 3.6 times higher than the distances of the same ravens pre-treatment, which was statistically significantly farther from the nest than pre-treatment ($p = 0.009$) or untreated ravens ($p < 0.001$; Figure 3). This finding indicated that nest treatment was effective at inducing a significant difference in space use of breeding ravens, causing them to range widely and no longer be tied to the nest location.

Figure 3. Distance from nest for GPS-tagged breeding ravens as a function of days before and after raven nest treatment in northwest WY, USA, 2016-2017. Untreated ravens showed constant distances from the nest until ~17 days after June 15th, likely reflecting fully fledged and mobile young. Treated ravens showed low motility prior to treatment, then dramatic and sustained variable movements away from the nest beginning on the day of treatment.



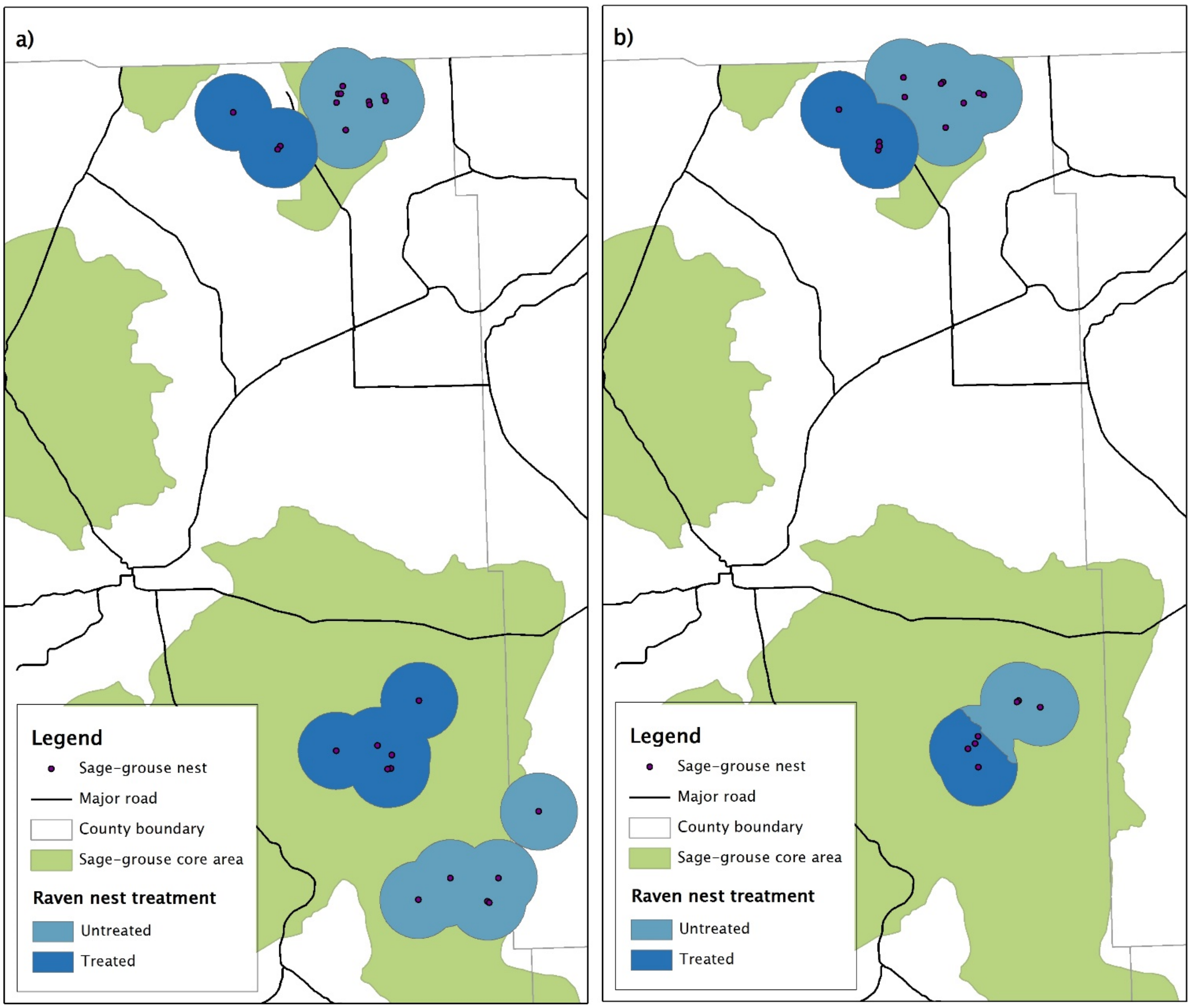
<u>Sage-grouse nest success in response to raven nest treatment</u>

Sage-grouse nesting success is one of the primary drivers of sage-grouse population dynamics (Taylor et al. 2012). Because raven predation can be a major component of sage-grouse nest failure, and because breeding ravens appear to be the raven population component that most frequently encounters sage-grouse nests, a key goal of this project was to determine whether destroying raven nests improved nesting success of sage-grouse (Coates 2007, Bui et al. 2010, Dinkins 2013).

We designed the study to try and test the raven nest hypothesis in spite of the spatiotemporal variability in other factors that influence sage-grouse nest success, such as weather, other predators, hen nutrition, etc. This included maximizing sample size of GPS-tagged sage-grouse, creating two separate landscape-level study areas, and conducting the experiment over two years. We then carried out the raven nest treatment portion of the study as thoroughly as possible (i.e., we conducted comprehensive raven nest searches in treatment areas; Figures 4a and 4b). We used logistic regression, with sage-grouse nest fate classified as a '1' if successfully hatching ≥1 chick and as a '0' if a nest failed, to determine whether sage-grouse in landscapes subject to raven nest control had higher success than sage-grouse nesting in natural untreated landscapes. We discuss the results in light of small sample sizes and without using a rigid definition of a specific p-value determining that a result was "significant".

Sample sizes were limited. In PB, there were 7 and 16 sage-grouse nests in treated and untreated areas, respectively, pooling both years. In YU Bench there were 10 and 9 sage-grouse nests in treated and untreated areas, respectively, pooling both years.

Figure 4. Treated and untreated areas for raven nest removal experiment in 2016 (a) and 2017 (b). Boundaries were set as a 4 km radius around nests of GPS-tagged sage-grouse. Boundaries shifted between years because they were defined by movement of free-ranging GPS-tagged sage-grouse. The southern portion of the southern study area (YU Bench) was dropped after 2016 due to logistical access issues.



Sage-grouse nest success was not statistically different in treated versus untreated areas when study areas were pooled together ($p = 0.484$; Figure 5). However, when differentiating between sage-grouse nest success in the PB study area versus YU Bench, in both years sage-grouse nesting in the treated portion of PB had considerably higher success than nests located in the untreated portion of PB (p = 0.0785, Figure 6a). Nest success was ~5x higher in 2016 and ~2x higher in 2017. The same pattern did not hold for YU Bench, where in 2016 sage-grouse nest success was equivalent in treated and untreated areas and in 2017 showed the opposite relationship to what we expected, where nest success was lower in treated areas (Figure 6b).

Figure 5. Sage-grouse nest success in landscapes with and without lethal treatment of raven nests in northwest Wyoming, USA, 2016-2017. PB and YU Bench study areas were combined in this graph.

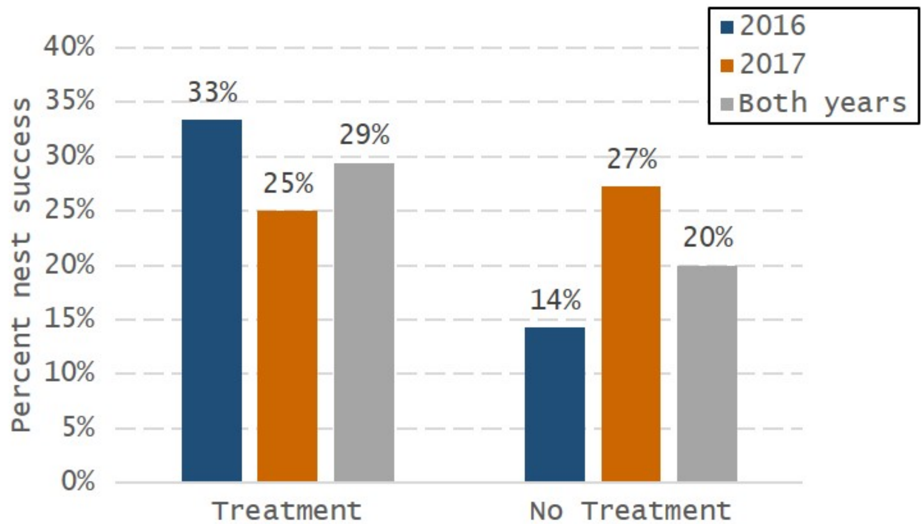
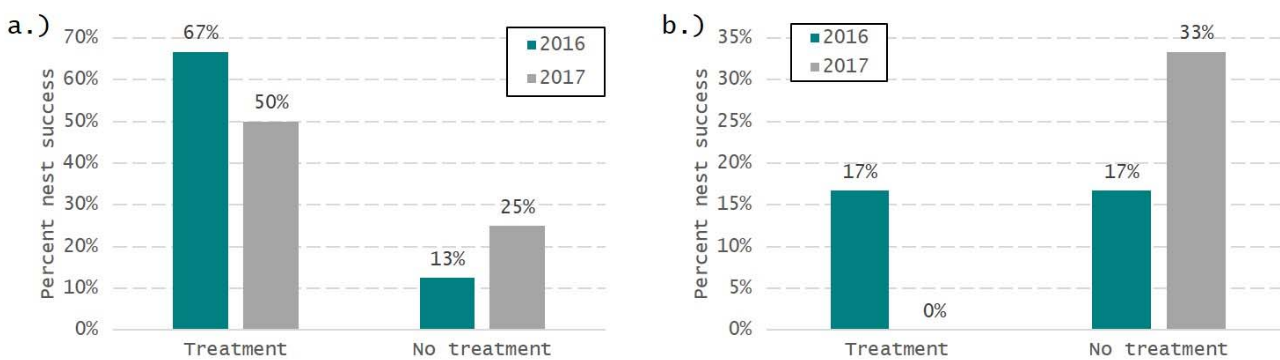


Figure 6. Sage-grouse nest success in response to raven nest lethal treatments at PB study area (a) and YU Bench study area (b) in northwest Wyoming, USA, 2016-2017. Sage-grouse nest success was notably higher in treated areas within PB in both years, but not in YU Bench.



Ultimately, sample size was limited by the number of GPS units available to be deployed on sage-grouse hens. This resulted in single-digit samples once split into treated and untreated portions in both study areas in both years. Nonetheless, the results are informative. First, raven nest treatment was associated with higher nest success in the PB study area. Earlier components of this study (2011 – 2015) found the highest rate of sage-grouse nest depredation was in the PB area and that ravens depredated nearly as many nests as coyotes (Taylor 2015). In contrast, Taylor (2015) found that the more southern study areas in the vicinity of our YU Bench study area had sage-grouse nest depredation driven primarily by coyotes. This could explain why the raven nest treatment was not effective at increasing sage-grouse nesting success in YU Bench, because coyotes were the main nest predators. Combining the results from this study and the recent predator research in these study areas supports the conclusion that raven nest control may be effective at raising sage-grouse nest success, but only in areas where ravens are a primary component of nest depredation.

Conclusion

This study tested three sequential hypotheses: 1) whether breeding ravens use space differently from nonbreeding ravens, 2) whether treating raven nests changes breeding raven space use to resemble nonbreeding raven space use, and 3) whether the change in breeding raven space use following nest treatment results in changes in sage-grouse nest success. The results from this project suggest that the answer to all three questions is 'yes'. The first section showed that breeding ravens use the landscape fundamentally differently than nonbreeding ravens, with respect to time and movement. Nonbreeding ravens showed minimum diurnal variation in movement rates, and in general moved at comparatively slow speeds. In contrast, breeding ravens and sage-grouse showed clear crepuscular increases in movement rate, with peaks for both groups occurring in late afternoon/evening. So, yes, breeding ravens had different spatiotemporal space use patterns than nonbreeding ravens.

The second section found that, after a raven nest was destroyed, the attending adults immediately shifted into a wide-ranging, erratic movement pattern and started using locations that were on average 3.6 times further away from the nest than prior to nest treatment. Untreated breeding ravens showed no such change in pattern during the same window, until a clear dispersal event likely coinciding with full fledging and dispersal of the young. So, yes, treating raven nests changed the way that breeding ravens used the landscape.

The third section found that raven nest treatment was strongly associated with improved sage-grouse nest success, but only in the PB study area. This may be explained by earlier research in these same areas that found a high level of raven predation in PB but low level of raven predation in YU Bench. The fact that the raven nest treatment didn't uniformly improve sage-grouse nest success, combined with independent knowledge of the suite of local predators, provides more evidence that the treatment may be successful in landscapes with large raven depredation issues.

In spite of a probable answer of 'yes' to the three research questions, caution is warranted due to the small sample size. Due to funding constraints we had a limited number of GPS units that could be deployed on both ravens and sage-grouse. In addition, ravens are notoriously difficult to capture, and in particular breeding ravens were very wary of humans in the capture phases of this study (C. Olson, pers. comm.). Add in field site access issues, and dealing with free-ranging animals that might die during the study or disperse out of the study area, and it becomes difficult to conclusively assess the effectiveness of any landscape-level field experiment. Nonetheless, all study results are consistent with hypotheses that breeding ravens use the landscape different than nonbreeding ravens, that destroying raven nests immediately changes how formerly breeding ravens use the landscape, and, in one of our study areas with a known high level of raven predation, that raven nest treatments were associated with marked improvements in sage-grouse nest success. Thus, while preliminary, these findings are promising.

Future research is crucial to determine if these findings hold up over time. Pertinent research questions are: Is raven nest treatment effective for long-term sage-grouse population uplift? Or does compensatory nest predation from coyotes and badgers ultimately negate any effectiveness of raven predation? Is raven nest treatment a useful short-term tool, but only applicable to areas with relative high raven and low coyote abundance? Or would it function in the long-term to ameliorate other human subsidies to raven populations that artificially increase raven impacts on sage-grouse populations? The answers to these questions, perhaps obtained through further experimental management, could lead to another useful tool in the toolbox of sage-grouse and land managers.

LITERATURE CITED

Bui, T. D., J. M. Marzluff, and B. Bedrosian. 2010. Common raven activity in relation to land use in western Wyoming: implications for greater sage-grouse reproductive success. Condor 112:65-78.

Coates, P.S. 2007. Greater sage-grouse (*Centrocercus urophasianus*) nest predation and incubation behavior. Dissertation, Idaho State University.

Dinkins, J. B. 2013. Common raven density and greater sage-grouse nesting success in southern Wyoming: potential conservation and management implications. PhD Dissertation, Utah State University.

Engel, K.A., and L.S. Young. 1992. Daily and seasonal activity patterns of common ravens in southwestern Idaho. Wilson Bulletin 104:462-471.

Heinrich, B., D. Kaye, T. Knight, and K. Schaumburg. 1994. Dispersal and association among common ravens. Condor 96:545-551.

Holloran, M. J., and S. H. Anderson. 2005. Spatial distribution of greater sage-grouse nests in relatively contiguous sagebrush habitats. The Condor 107:742-752.

Loretto, M.C., S. Reimann, R. Schuster, D.M. Graulich, and T. Bugnyar. 2016. Shared space, individually used: spatial behavior of non-breeding ravens (*Corvus corax*) close to a permanent anthropogenic food source. Journal of Ornithology 157:439-450.

Rösner, S. and N. Selva. 2005. Use of the bait-marking method to estimate the territory size of scavenging birds: a case study on ravens *Corvus corax*. Wildlife Biology 11:183-191.

Stiehl, R.B. 1985. Brood chronology of the common raven. Wilson Bulletin 97:78-87.

Taylor, J.D. 2015. An assessment of greater sage-grouse (*Centrocercus urophasianus*) population demographics in the Bighorn Basin, Wyoming, 2011-2014. Report to Wyoming Wildlife and Natural Resources Trust, unpublished.

Taylor, R. L., B. L. Walker, D. E. Naugle, and L. S. Mills. 2012. Managing multiple vital rates to maximize greater sage-grouse population growth. Journal of Wildlife Management 76:336-347.

Webb, W.C., J.M. Marzluff, and J. Hepinstall-Cymerman. 2012. Differences in space use by common ravens in relation to sex, breeding status, and kinship. Condor 114:584-594.

Northeast
Sage-Grouse
Job Completion Report
2016

June 2016-May 2017

Dan Thiele
Wyoming Game & Fish Dept.
Sheridan Region

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Northeast

1. Lek Attendance Summary (Occupied Leks) (1)

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2008	405	127	31	1933	20.6
2009	407	147	36	1133	11.0
2010	405	177	44	1561	13.7
2011	412	173	42	1134	11.7
2012	416	240	58	1860	13.0
2013	408	107	26	713	10.5
2014	405	197	49	932	9.7
2015	397	190	48	1945	16.2
2016	392	168	43	1953	20.3
2017	374	165	44	1845	20.1

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2008	405	235	58	2190	15.8
2009	407	218	54	1346	11.8
2010	405	177	44	635	7.9
2011	412	189	46	652	8.2
2012	416	148	36	476	9.5
2013	408	249	61	940	8.5
2014	405	162	40	705	9.9
2015	397	145	37	1059	16.3
2016	392	177	45	1704	19.4
2017	374	149	40	1325	16.6

1) Occupied - Active during previous 10 years (see official definitions)

2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

3) Inactive - Confirmed no birds/sign present (see official definitions)

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Northeast

1. Lek Attendance Summary (Occupied Leks) (1) Continued

c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2008	405	362	89	4123	17.7
2009	407	365	90	2479	11.4
2010	405	354	87	2196	11.3
2011	412	362	88	1786	10.1
2012	416	388	93	2336	12.1
2013	408	356	87	1653	9.3
2014	405	359	89	1637	9.8
2015	397	335	84	3004	16.2
2016	392	345	88	3657	19.9
2017	374	314	84	3170	18.4

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2008	234	83	45	317	73.8	26.2
2009	219	82	64	301	72.8	27.2
2010	198	108	48	306	64.7	35.3
2011	183	111	68	294	62.2	37.8
2012	199	115	74	314	63.4	36.6
2013	180	120	56	300	60.0	40.0
2014	170	133	56	303	56.1	43.9
2015	188	91	56	279	67.4	32.6
2016	190	110	45	300	63.3	36.7
2017	174	96	44	270	64.4	35.6

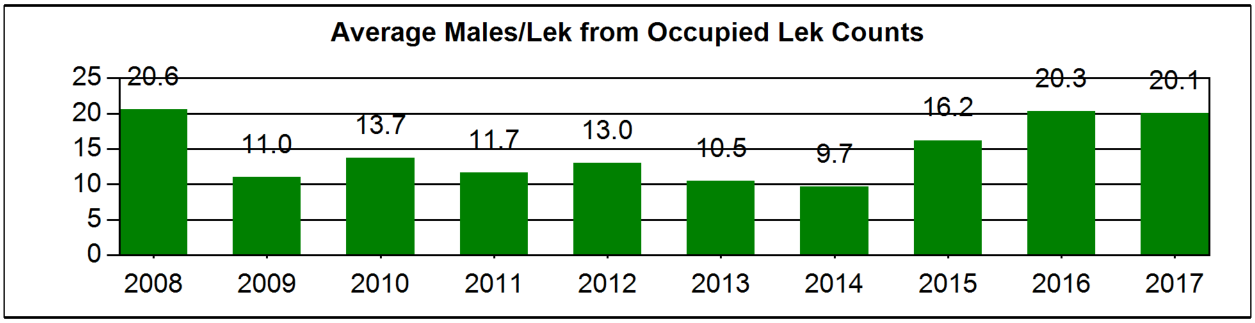
1) Occupied - Active during previous 10 years (see official definitions)

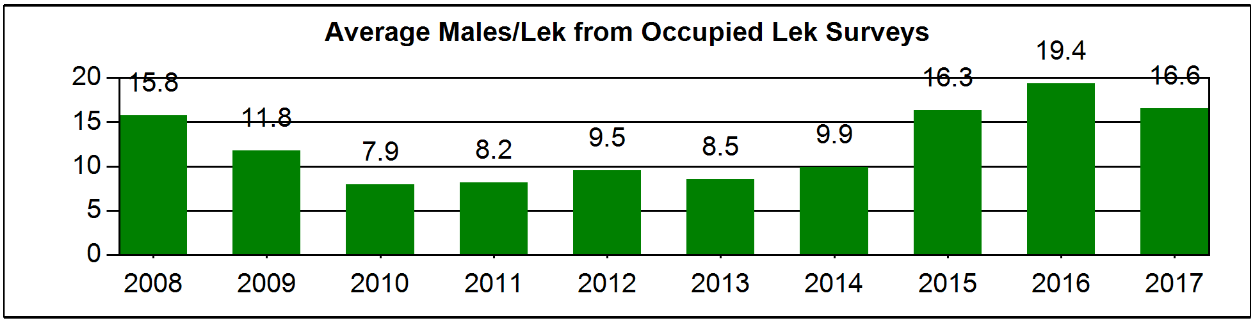
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

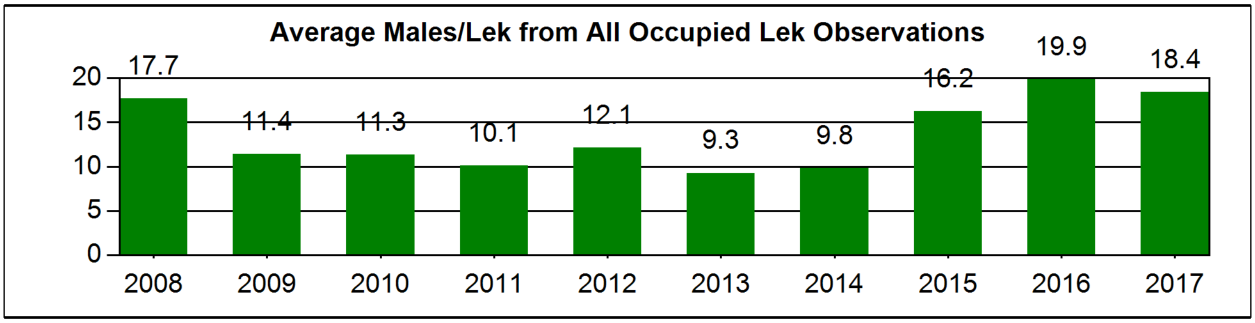
3) Inactive - Confirmed no birds/sign present (see official definitions)

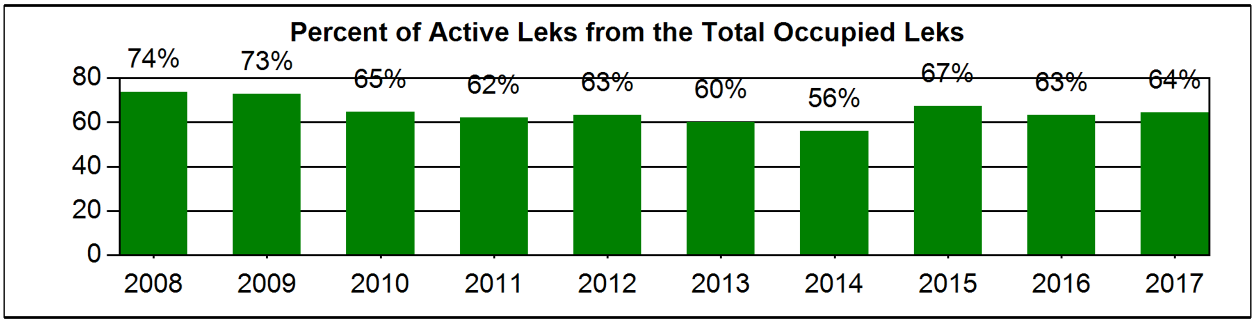
Sage Grouse Occupied Lek Attendance Summary

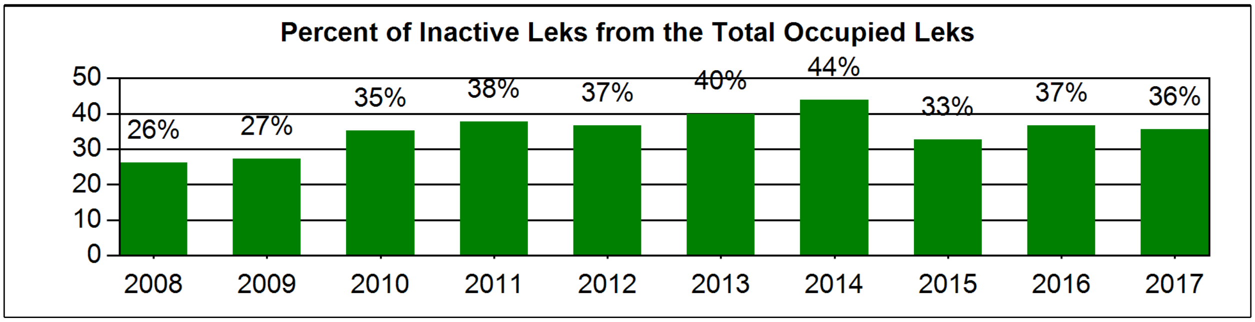
Year: 2008 - 2017, Working Group: Northeast











Sage Grouse Job Completion Report

Year: 2007 - 2016, Working Group: Northeast

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4
2011	Sep-17	Sep-30	14	2/4
2012	Sep-15	Sep-30	16	2/4
2013	Sep-21	Sep-30	10	2/4
2014	Sep-20	Sep-30	11	2/4
2015	Sep-19	Sep-30	12	2/4
2016	Sep-17	Sep-30	14	2/4

b. Harvest

Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2007	532	297	632	0.8	1.8	2.1
2008	101	186	295	0.3	0.5	1.6
2009	311	230	559	0.6	1.4	2.4
2010	129	117	202	0.6	1.1	1.7
2011	158	124	173	0.9	1.3	1.4
2012	405	218	404	1.0	1.9	1.9
2013	27	82	249	0.1	0.3	3.0
2014	123	137	242	0.5	0.9	1.8
2015	314	228	400	0.8	1.4	1.8
2016	89	129	265	0.3	0.7	2.1
Avg	219	175	342	0.6	1.1	2.0

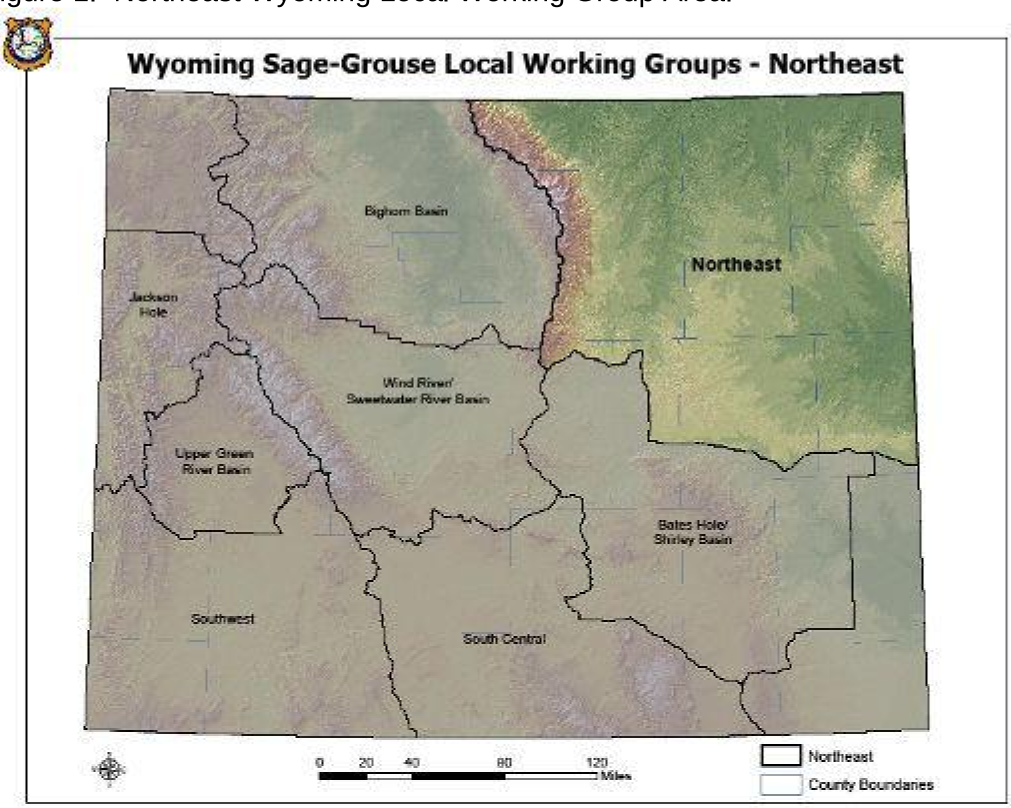
2016 JOB COMPLETION REPORT

Narrative
SPECIES: **Sage-grouse**
DAU NAME: **Northeast Wyoming Working Group**
Period Covered: **6/1/2016 – 5/31/2017**
Prepared by: **Dan Thiele, Wildlife Management Coordinator**

INTRODUCTION

Sage-grouse data are reported for the area encompassed by the Northeast Wyoming Local Working Group Area (NEWLWGA) which formed in 2004 to develop and facilitate implementation of a local conservation plan for the benefit of sage-grouse, their habitats, and whenever feasible, other wildlife species that use sagebrush habitats. The NEWLWGA covers Wyoming from the Bighorn Mountain divide to South Dakota and from Montana to Interstate Highway 25 and U.S. Highway 20/26 (Figure 1). The Area boundary encompasses the WGFD Sheridan Region and a portion of the Casper Region. In 2010, the Department revised sage-grouse management areas by eliminating the numbered upland and small game management areas and created management areas corresponding to working group area boundaries. The NEWLWGA now corresponds to Management Area C.

Figure 1. Northeast Wyoming Local Working Group Area.



Sage-grouse are found throughout sagebrush grassland habitats of northeast Wyoming. Occupied habitat is fairly contiguous east of the Bighorn Mountains to the Black Hills and the Wyoming-Nebraska state line with the exception of forested, grassland and highly developed agricultural habitats. Sagebrush habitats are less continuous than in western Wyoming, which contributes to lower sage-grouse densities.

Sage-grouse data collection efforts have focused on lek counts and surveys, which have been conducted each spring within the area since at least 1967. Lek monitoring may have been conducted earlier; however, no records exist for data verification. Lek counts include those lek observations conducted three to four times each spring, about a week to 10 days apart. Lek counts are conducted to provide population trends based on the average peak male attendance. Lek surveys include lek attendance observations not following the count protocol, and are intended to determine general lek status (active, inactive or unknown).

Historically, management of sage-grouse habitat within the NEWLWGA focused mainly on the protection of lek and nesting areas during the breeding and nesting season. Protection efforts primarily occurred through the environmental commenting process and, since 2008, the formation of core areas combined with the issuance of Governor's executive orders guiding development. Although more than 75% of the area's leks are found on private land, the split estate nature of the surface and mineral ownership provides for greater management influence by the BLM for oil and gas resource development.

In 2015, the U.S. Fish and Wildlife Service issued a decision of "not warranted" for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. This means the State of Wyoming maintains management authority over sage-grouse in Wyoming and management emphasis focuses on implementation of the core area strategy. In its decision document, the Service specifically cited Wyoming's Core Area Strategy as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude the need for a future listing. The Service plans to reexamine the issue after five years (2020) to ensure planned conservation efforts are implemented and the status of the species remains unwarranted for listing. The decision document can be viewed at: https://www.fws.gov/greatersagegrouse/ .

WEATHER

Weather during the 2016 biological year (June 2016 – May 2017) was wetter and warmer than average due to above average September and April precipitation and above average June, October, November, February and March temperatures (Figures 2 and 3). Precipitation was 10% above average resulting from September precipitation at 122% of average and April precipitation 144% above average, compensating for below average precipitation in June, July and May. Summer and fall temperatures were well above average whereas winter temperatures were 6.7° and 5.8° below average for December and January, respectively. The severe winter ended in late January with the remainder of winter being mild. February and March temperatures were 3.7° and 6.3° above average.

Weather data was obtained from the National Climate Data Center/National Oceanic and Atmospheric Administration (NCDC/NOAA) for Wyoming Climatic Division 5 which includes the Powder River, Little Missouri River and Tongue River drainages. Weather data from this area are provided as a general indication of weather patterns over the entire working group area.

Figure 2. 2016 Bio-Year: Monthly Precipitation Data (in), Wyoming Climate Division 5.

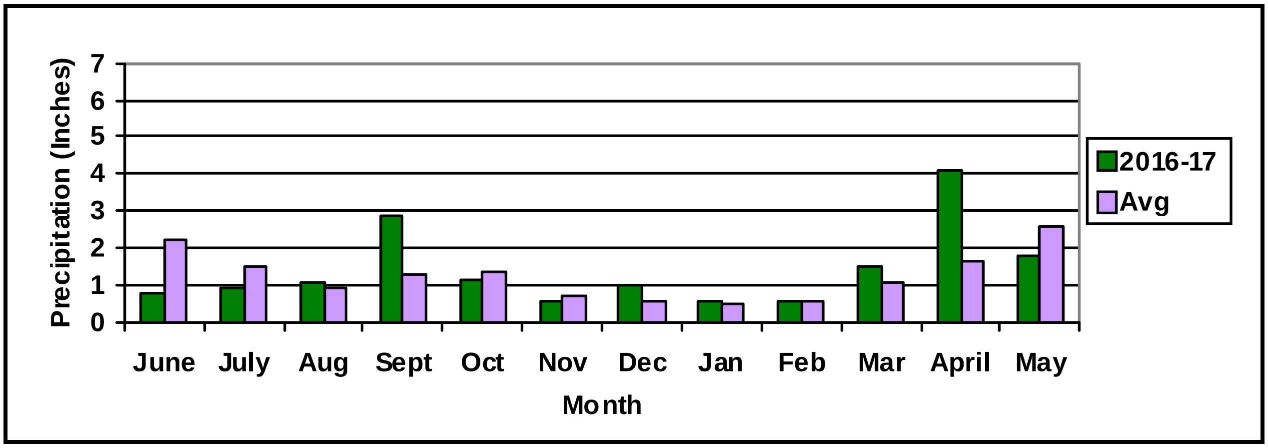
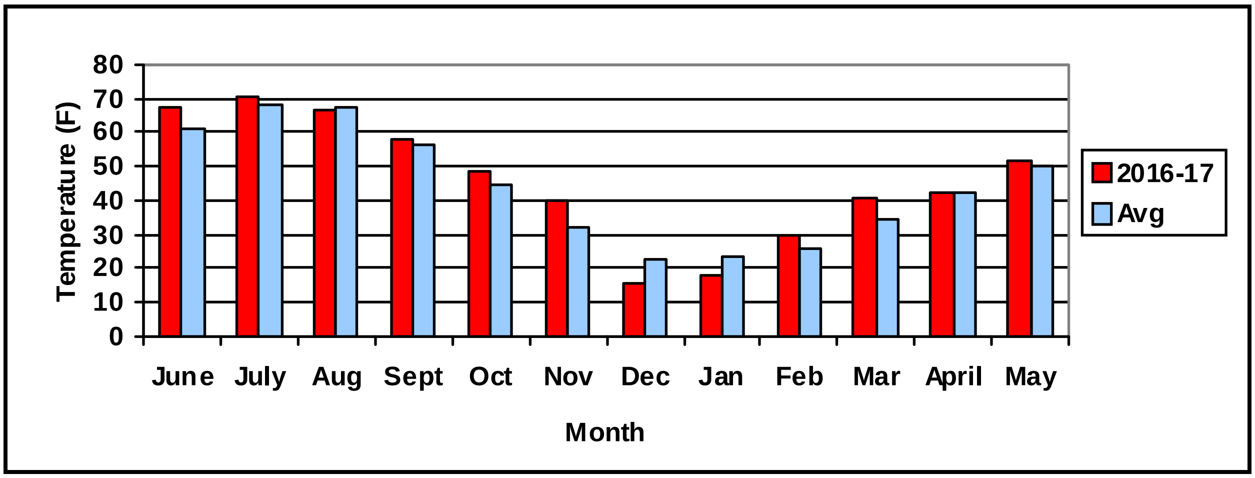


Figure 3. 2016 Bio-Year: Monthly Temperature Data (^{o}F), Wyoming Climate Division 5.



MONITORING METHODS

Methods for collecting sage-grouse data are described in the sage-grouse chapter of the WGFD Handbook of Biological Techniques (Christiansen 2012), which is largely based on Connelly et al (2003).

RESULTS

Variation in this report from previous years' reports is expected because of new data added to the lek database. Old records are added each year as data become available and newly discovered leks are added to the database. New lek count routes may also be added. Data adjustments should be taken into consideration when the current report and tables are compared to previous editions.

West Nile Virus

No West Nile virus (WNv) mortality was reported for northeast Wyoming in 2016 and no major mortality events have been documented since 2003. However, there are fewer radio marked sage-grouse being monitored by researchers which decreases the likelihood of finding mortalities. Based on human diagnosed cases of WNv, outbreaks occurred in 2003 and 2007. Sage-grouse in North and South Dakota were reported to have suffered large losses to WNv in 2007 and there may have been undetected impacts in Wyoming.

Taylor et al. (2012) predicted that the low elevation population of northeast Wyoming is susceptible to West Nile virus outbreaks which can decrease a population by more than 50%. Furthermore, even with no additional energy development the authors predict that some local populations may be one outbreak year away from extirpation.

Harvest

The Northeast Working Group area is comprised of Hunt Area 4 and portions of Hunt Areas 1 and 2 (Figure 4). A very small amount of Hunt Area 1 occurs in the southwestern most extent of the Area while Hunt Area 2 is closed to hunting. In Hunt Area 4, a very conservative hunting season was implemented beginning in 2010 due to continuing concerns of decreasing lek attendance trends.

Although sage-grouse numbers have decreased long-term, an adequate population exists to support the conservative hunting season. Nearly 3,200 males were observed during 2017 lek monitoring efforts with most of these birds in the portion of the Northeast Working Group Area included in Hunt Area 4. This number far exceeds the 100 male minimum threshold recommended to support a hunting season in the sage-grouse management guidelines (Connelly, et. al 2000). In 2010, the Department produced a white paper on the implications of harvest strategies on sage-grouse in Wyoming, *Hunting and Sage-grouse: A Technical Review of Harvest Management on a Species of Concern in Wyoming* (Christiansen 2010).

The 2016 harvest survey indicated that 89 sage-grouse were harvested by 129 hunters who spent a total of 265 days hunting during the Hunt Area 4 three day season. The average number of birds harvested per hunter day was 0.3. The average number of sage-grouse harvested per hunter was 0.7 and the average number of days hunted was 2.1.

The 2016 sage-grouse harvest was down 72% from the 314 birds harvested in 2015 but was similar to the 123 birds harvested in 2014. The 2016 harvest was the lowest harvest since 27 birds were harvested in 2013 and was the second lowest harvest of the 10 year period. The low harvest likely reflects the poor upland bird productivity for all species this year due a wet April and extremely dry early brood rearing period. Recent low harvest levels have been attributed to the three day season, private land access and publicity about lower bird numbers and the bird's plight which likely reduces hunter interest. The ten-year average (2007-2016) is 219 birds, with harvest ranging from a low of 27 birds in 2013 to a high of 532 birds in 2007. More than 2,500 birds were harvested as recently as 2000 when a 16 day season was in place. Hunter numbers over the last ten years have ranged from 82 hunters in 2014 to 297 hunters in 2007. Hunter days decreased 34% from 2015 to 265 days and remain well below the 1,649 days logged in 2005. It should be noted that statistical variance for harvest data is likely high given the limited number of hunters in this hunt area and varying response rates.

Figure 4. Northeast Wyoming Sage-grouse Hunt Areas.

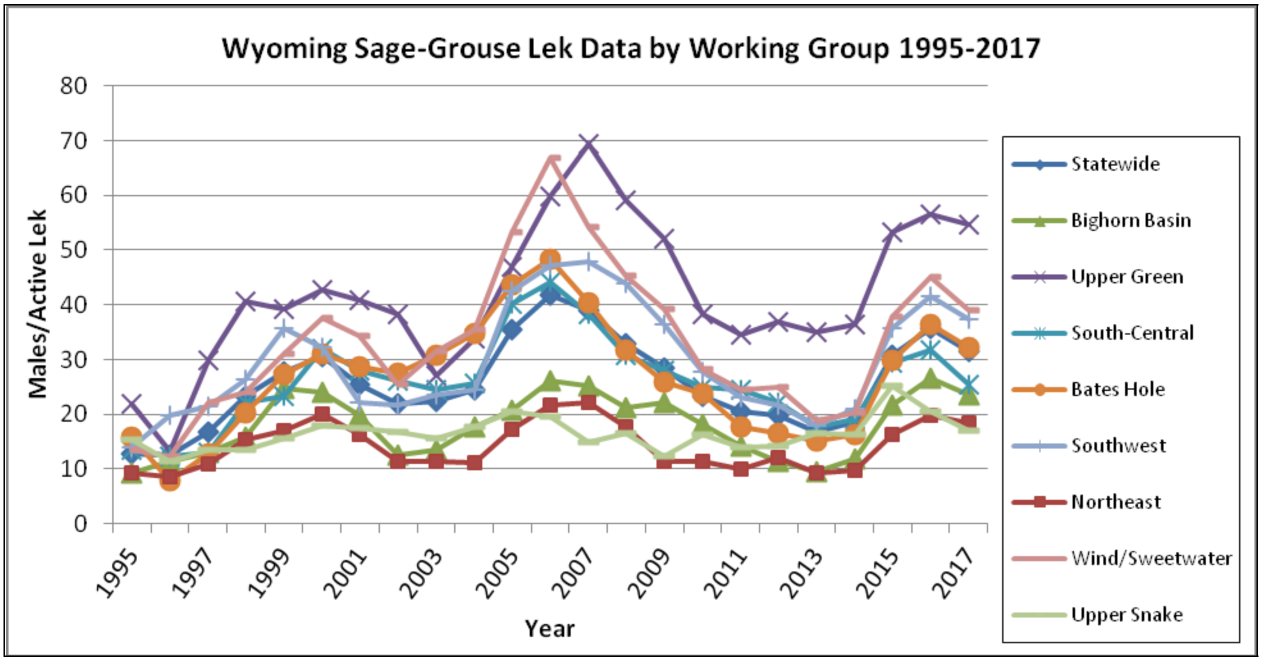
In past years a limited number of sage-grouse wings were collected during the hunting season, primarily in the eastern portion of the Area. Sample sizes were small due to the low harvest and the difficulty to strategically place enough collection barrels along the many roads and highways within the Area. Composition of the harvest as determined by analysis of wings deposited by hunters in wing barrels can provide insight into current year's chick production, although in most years the sample is too small to allow for reliable interpretation of the sample. No wings were collected during the 2016 hunting season.

<u>Lek Monitoring</u>

Northeast Wyoming has the lowest average male lek attendance in the state, averaging 18 males per active lek in 2017 compared to the statewide average of 32 males per active lek (Figure 5). Most leks in northeast Wyoming are small with less than 20 males. In years when grouse are at the peak of their population cycle less than 10% of the active leks have greater than 50 males at peak count. Twelve leks exceeded 50 males in 2017 with the largest being 86 males.

Average male lek attendance in northeast Wyoming has decreased significantly over the years. Figure 6 shows the average number of males per active lek by decade since monitoring efforts began. Average male attendance has decreased by more than one-half over the last thirty years. A slight upswing occurred from 2000-2009, however, the long-term trend remains a concern.

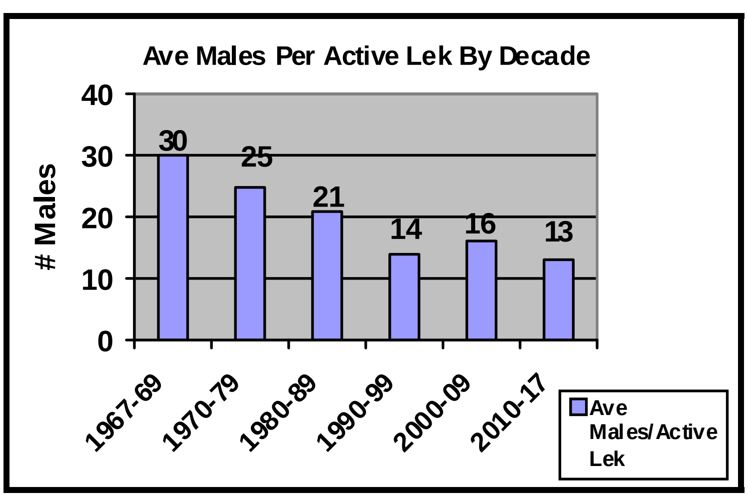
Figure 5. Wyoming Statewide and Local Working Group Area Lek Attendance Trends.



Lek monitoring efforts increased substantially beginning in 2000 due to concerns over range wide declines in sage-grouse populations. Additionally, coalbed natural gas (CBNG) development in the Powder River Basin resulted in extensive survey work to meet federal permitting requirements. The WGFD, BLM, U.S. Forest Service, private consultants, landowners and volunteers participated in ground and aerial monitoring of leks.

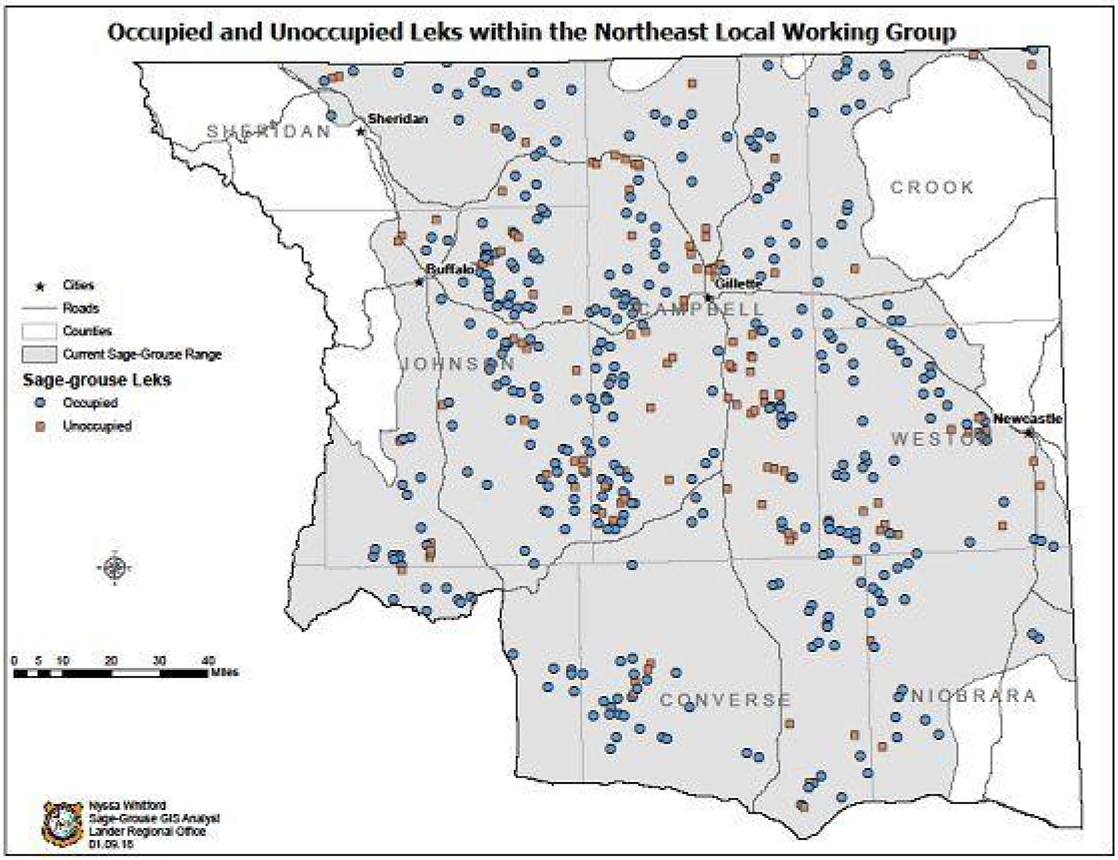
Sage-grouse lek monitoring efforts are accomplished through lek counts, lek surveys and searches for new leks. The Sheridan Region received additional funds from the Bureau of Land Management for sage-grouse surveys for the sixteenth consecutive year. This funding was used for aerial surveys to monitor known leks and fly grid searches for new leks in those areas with seemingly adequate habitat, but no previously known leks.

Figure 6. Average Number of Males per Active Lek by Decade for Northeast Wyoming Leks.



Following the 2017 lek monitoring period there are 566 documented leks in the NEWLWGA distributed over various land ownership and management authority boundaries (Figure 7 and Table 1). Of this total, 374 are classified as occupied leks. The 374 occupied leks is less than the 566 total leks because unoccupied leks (abandoned or destroyed) are not considered potentially active and undetermined leks have had no documented activity in the past 10 years. During the 2017 breeding season 165 leks were counted, representing 44% of known occupied leks (JCR Table 1a). The average number of males per active lek from lek counts was 20.1. This is essentially unchanged from the 20.3 males/active lek in 2016 and 16.2 males/active lek in 2015. The 2017 lek count suggests the sage-grouse population remained stable near the peak of the most recent cycle peak. The previous cycle peaked at 28.0 males/active lek in 2006.

Figure 7. Sage-grouse Leks in the Northeast Wyoming Working Group Area.



Lek count routes were established in 2000 to better document the actual number of male sage-grouse attending a lek or complex of leks. Lek counts consist of at least three ground visits to a lek following a stringent protocol to ensure accurate counts of male sage-grouse at lek sites. Department lek count data, along with the lek counts from the private consultants and volunteers significantly improve the opportunity to better evaluate population trends.

The number of known occupied leks checked by lek counts and lek surveys combined was 314 leks or 84% of the known occupied leks (JCR Table 1c). The average number of males/active lek was 18.4 compared to 19.9 males/active lek in 2016. The 2017 average attendance represents a 7% decrease from last year. For the 10-year period, 2008-2017, the number of males/active lek has ranged from 9.3 in 2013 to 19.9 in 2007. These numbers and trends are comparable to the lek count data but suggest a slight decrease (7%) in lek attendance. One-hundred-seventy-four leks were documented as active with peak male attendance ranging from 1 to 78 males. The three leks with the highest number of males were the Kaufman Draw Lek with 78 males, Watsabaugh I Lek with 78 males and the Cooper Lek with 70 males. No lek has exceeded 100 males since 2007. The median peak male attendance was 15 males, unchanged from 2016.

Table 1. Northeast Wyoming Working Group Area Sage-grouse Lek Site Characteristics for the 566 known leks in 2017.

Region	Number	Percent
Casper	152	26.9%
Sheridan	414	73.1%

Classification	Number	Percent
Occupied	367	64.8%
Unoccupied	127	22.4%
Undetermined	72	12.7%

Biologist	Number	Percent
Buffalo	73	12.9%
Casper	14	2.5%
Douglas	60	10.6%
Gillette	252	44.5%
Newcastle	78	13.8%
Sheridan	89	15.7%

County	Number	Percent
Bighorn, MT	1	0.2%
Campbell	197	34.8%
Carter, MT	1	0.2%
Converse	57	10.1%
Crook	27	4.8%
Johnson	138	24.4%
Natrona	16	2.8%
Niobrara	21	3.7%
Powder River, MT	1	0.2%
Sheridan	35	6.2%
Weston	72	12.7%

Management Area	Number	Percent
C	566	100.0%

Working Group	Number	Percent
Northeast	566	100.0%

BLM Office	Number	Percent
Buffalo	372	65.7%
Casper	73	12.9%
Newcastle	121	21.4%

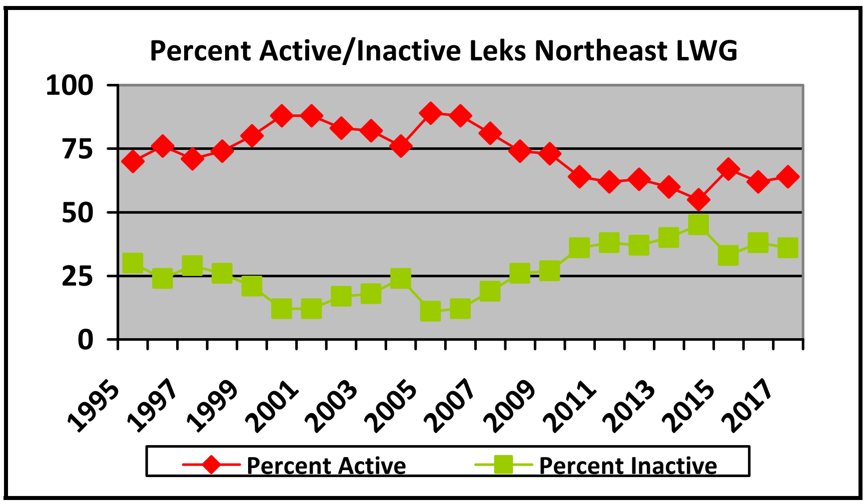
Game Warden	Number	Percent
Buffalo	73	12.9%
Dayton	24	4.2%
Douglas	26	4.6%
East Casper	5	0.9%
Glenrock	30	5.3%
Kaycee	59	10.4%
Lusk	21	3.7%
Moorcroft	73	12.9%
Newcastle	63	11.1%
North Gillette	67	11.8%
Sheridan	13	2.3%
South Gillette	105	18.6%
Sundance	6	1.1%
West Casper	1	0.2%

Land Status	Number	Percent
BLM	52	9.2%
Private	442	78.1%
State	37	6.5%
US Forest Service	35	6.2%

In total, there were 1,101 recorded observations of sage-grouse lek visits in 2017. This was over 150 fewer lek visits than 2016 and over 950 fewer lek visits than were recorded in 2008. The decline is due to reduced survey effort resulting from decreased CBNG development activity and a coordinated effort of agencies and consultants to reduce excessive visits to leks. The Buffalo BLM Field Office sponsored data sharing website on WYGIS was not used this year. Rather, coordination between agencies and consultants prior to the survey season helped to reduce duplication of effort. In areas of energy development where companies are required to conduct wildlife surveys, a large number of leks were being surveyed more than the required number of times because one or more companies with neighboring leases would survey the same leks due to monitoring buffers extend beyond their respective leases. This problem was most prevalent in the CBNG fields where monitoring buffers of Plan of Development (POD) boundaries overlap adjacent leases resulting in multiple visits to leks. Although some leks still experience more lek visits than necessary, the frequency has been greatly reduced. Likewise, aerial monitoring of leks counted or surveyed from the ground has been discouraged to minimize disturbance.

Since only “occupied” leks are being reported in JCR Table 1, it is important to consider trends in the numbers of active versus inactive leks in addition to the average size of active leks. During a period of population decline, the size of active leks typically declines and the number of inactive leks increases. The converse is typically true of an increasing population. Therefore the magnitude of both increases and decreases is usually greater than what is indicated by average lek size alone.

Figure 8. Trends in Active and Inactive Leks, 1995-2017.



Lek status as determined from lek counts and lek surveys shows 270 leks with confirmed lek status. Sixty-four percent of the leks (n=174) with confirmed status were determined to be active (JCR Table 1d), meaning strutting males or sign of leking activity (feathers/droppings) were observed at the lek site. Ninety-six leks (36%) were determined to be inactive based on multiple ground visits and/or checks for sign (feathers/droppings) late in the strutting season. The number of leks monitored annually has remained relatively stable since 2006, which was the last peak in the male lek attendance cycle. Until 2015, both the average number of males per active lek and the percentage of active leks have trended down, suggesting a notable decrease in the population (Figure 8). In 2017, the percentage of active leks remained relatively stable along with the average number of males per active lek suggesting a stable population. The increase in 2015 was the first notable increase in lek activity for the last 10 years. A large number of monitored leks (n=44) have an unknown activity status. This category includes leks that were surveyed but had no strutting activity. For a lek to be considered inactive, two ground visits separated by 7 days and conducted under ideal conditions, or a ground check of the exact lek site late in the strutting season that fails to find sign is needed. Many leks were checked one or more times but protocol to confirm inactivity was not met. A list of sage grouse definitions is available in the statewide JCR and the Biological Techniques Manual (Christiansen 2012).

Comparisons of core and non-core area lek monitoring results shows that core areas have a similar number of males per active lek (19.3 vs 17.4) but confirmed lek activity is notably higher in core areas (72% vs. 57%). This suggests the core area policy may be successful at maintaining lek persistence. However, it should be noted that core areas in Northeast Wyoming do not encompass all priority habitats which likely contributes to the discrepancy in average male lek attendance figures. Furthermore, in 2017, only 46% of occupied leks were in core areas. Some inconsistencies remain in complying with monitoring protocol and monitoring some leks on a regular basis. Some leks have not been documented as active in many years which may be due to inaccurate locations based on legal descriptions. Continued efforts at determining the exact location and status of these leks are needed. As birds on a lek are observed, UTM coordinates are recorded using GPS. GPS locations for lek sites should make future surveys more efficient even with changes in personnel. Furthermore, with the high amount of activity around leks in areas of energy development, caution must be taken to ensure that strutting activity represents an actual lek and not birds displaced from established leks.

North Gillette Connectivity Area Infrared Lek Survey

An infrared lek survey of the North Gillette Connectivity Area was flown by Owyhee Air of Nampa, ID on April 14 - 17, 2017. The area encompasses approximately 130,000 acres. Flights were conducted during early morning hours from an altitude of at least 1,500 feet and at a line interval spacing to ensure complete coverage. Survey cost including ferry time, survey time and document preparation was $21,957 and was funded through the BLM Buffalo Field Office wildlife survey agreement and Wyoming Game and Fish sage-grouse funds.

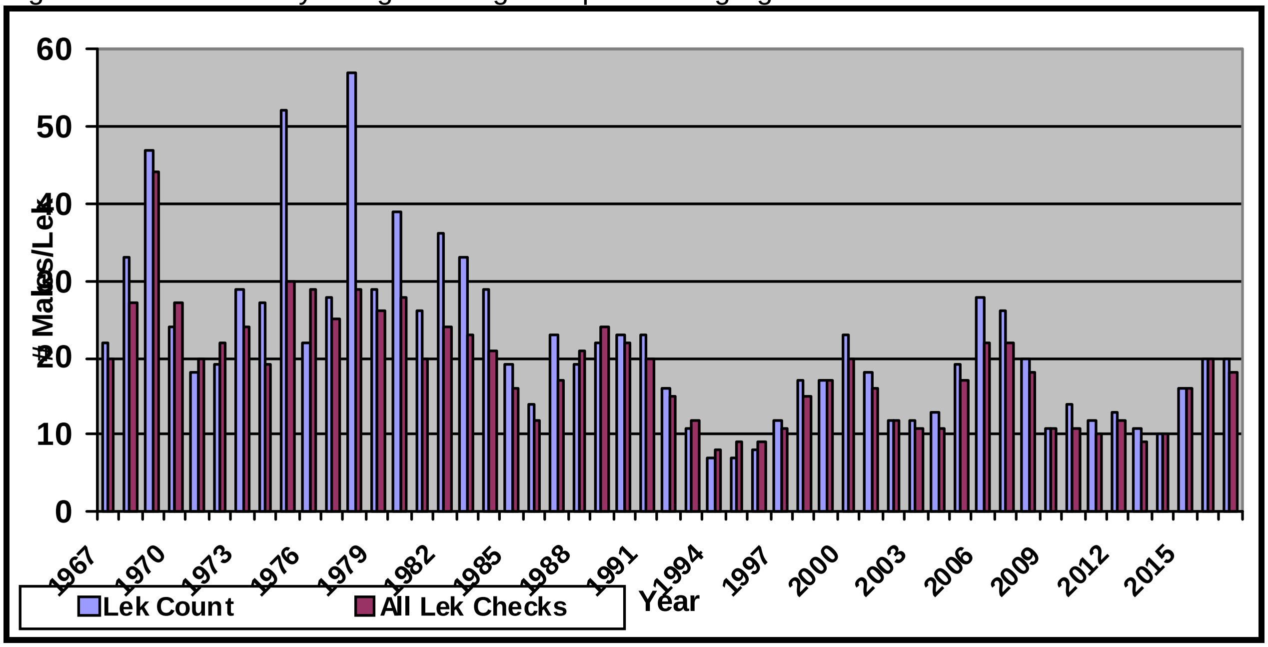
Six lek detections were made with infrared technology with identification to species made with a high definition camera. Final survey analysis identified five sage-grouse leks, including two previously known leks, and one sharp-tailed grouse lek. Total sage-grouse numbers on the three new sage-grouse leks was 3, 6 and 22 birds indicating that even low numbers of birds are possible to detect.

Population Trends

No reliable or cost effective method for estimating the sage-grouse population for the NEWLWGA exists at this time. However, the number of males/active lek provides a reasonable index of abundance of sage-grouse populations over time in response to environmental conditions and other influences. However, it must be noted that lek data must be interpreted with caution for several reasons: 1) the survey effort and the number of leks surveyed/counted has varied over time, 2) it is assumed that not all leks in the area have been located, 3) sage-grouse populations can exhibit cyclic patterns over approximately a decade, 4) the effects of unlocated or unmonitored leks that have become inactive cannot be quantified or qualified, and 5) lek sites may change over time. Both the number of leks and the number of males attending these leks must be quantified in order to estimate population size.

Figure 9 shows the average number of males/active lek for lek counts and all lek monitoring (counts and surveys) combined from 1967 to 2017 for the NEWLWGA. If the average number of males/active lek is reflective of the sage-grouse population, the trend suggests about a 10-year cycle of periodic highs and lows. Of concern, however, is that with the exception of the most recent cycle, subsequent peaks in the average male lek attendance are usually lower than the previous peak. Additionally, periodic lows in the average male attendance are generally lower than the previous low. The long term trend suggests a steadily declining sage-grouse population.

Figure 9. Northeast Wyoming Working Group Male Sage-grouse Lek Attendance 1967- 2017.



It appears that sage-grouse numbers reached a new peak in 2006 and 2007, exceeding the previous peak in 2000. In fact, the trends suggest sage-grouse may have been at their highest numbers since 1991. However, the percentage of active leks was nearly ten percentage points higher in 1991. The 2008 - 2014 data reflect the declining phase of the cycle, rivaling that observed from 1994 through 1997. The increased male lek attendance documented 2015 through 2017 has ended the decline, however, the percentage of active leks remains below that observed during previous cycle peaks.

The number of total known leks increased from 2000 - 2010 primarily due to increased survey effort associated with CBNG activities. However, even with the increased lek activity level the past three years, the percentage of active leks remains well below that observed in the past. While the number of leks present historically cannot be known, recent monitoring confirms the number and proportion of active leks has declined.

HABITAT

Habitat Conditions

Habitat conditions in 2016 were very good following above normal spring precipitation. Timely precipitation in March compensated for below normal precipitation in May and June. The Palmer Drought Index, a measure of long-term meteorological conditions, showed climate divisions in northeast Wyoming were mid-range to moderately moist in April and May 2016. Drought was prevalent the remainder of 2016 and into 2017, however, the excellent spring 2016 forage production provided for very good residual vegetation into 2017. Spring 2017 showed improvement with excellent March and April precipitation, again providing for very good herbaceous forage production.

Habitat Impacts

Most occupied habitat for sage-grouse is held in private ownership. Approximately 75 percent of known leks are found on private land with the remaining 25 percent found on Bureau of Land Management, U.S. Forest Service, and State owned lands. Because most sage-grouse are found on private land, little direct control exists to protect important habitats, including breeding and nesting areas, brood rearing areas, and major wintering areas.

The primary economic uses of lands currently or historically providing sage-grouse habitat are agriculture and energy. Livestock grazing, mainly cattle along with limited sheep production, is the primary agriculture use. Some crop production occurs as irrigated and dry land hay and some small grains. Historically, large parcels of sagebrush habitat were converted either to grasslands or crops. Limitations of remote sensing technology have prevented quantifying and mapping these conversions.

Vast coal reserves are being developed with surface pit mines in eastern Campbell County and northern Converse County.

Oil and natural gas production has occurred in portions of the area since the early 20th century. An unprecedented energy boom began in the Powder River Basin in the late 1990's with the exploration and development of CBNG reserves. The BLM predicted 51,000 wells could be drilled in the Powder River Basin Oil and Gas Project Record of Decision (BLM 2003). At the peak of the CBNG play, more than 18,300 wells were in production (August 2008) with production peaking in January 2009 at 49,459,629 Mcf of methane gas (WOGCC 2017). Much of the development in the energy play involves federal minerals with private surface. Wells, roads, power lines, produced water, activity and dust are components of development which affect sage-grouse habitat at a broad scale. Since 2009, development and production has declined as CBNG leases have been drilled and natural gas prices remain low. In May 2017, the Wyoming Oil and Gas Conservation Commission reported that 6,093 producing wells yielded 11,621,897 Mcf of methane gas (WOGCC 2017). Federal mineral leases provided for 73% of the production while fee leases accounted for 19% and State leases 6%. In addition to producing wells there are 6,340 shut in wells. This compares to May 2016 when 6,123 producing wells yielded 13,146,505 Mcf of methane gas. More than 72,000 permits to drill have been issued, although many have expired. Many wells drilled early in the play have completed the production phase of development and are now being plugged and abandoned. Furthermore, low gas prices currently hamper the economic viability of CBNG production operations. Drilling new wells is occurring primarily to hold existing leases.

Deep well oil and gas development has increased in recent years with new technologies enabling horizontal and directional drilling. While CBNG activity decreased, the interest in deep drilling increased until low oil prices reduced the economic viability of oil exploration. In 2016, counties comprising the NEWLWG had 76 oil wells started (spud) including 56 horizontal wells, 5 directional wells and 15 conventional wells (WOGCC 2017). Drilling for natural gas was limited to 5 wells, one of which was a horizontal well. Exploration utilizing horizontal drilling has increased markedly from 10 wells in 2007 to 365 wells in 2014 after which activity decreased to 118 wells in 2016. Most development is occurring in the Douglas area. Deep wells require large well pads and enormous amounts of truck traffic to deliver water, sand, etc for drilling and fracking.

Considerable debate occurred on the effects of energy development on sage-grouse. Peer reviewed research findings show significant impacts (Walker et al. 2007, Doherty et al. 2008, Doherty et al. 2010, Harju et al. 2010 and others). These findings have yet to be accepted by some people and this has contributed to uncertainty in the public and political arenas as to the real effects of energy development. Furthermore, many continue to blame predation while some in the energy industry point to continued hunting of the species given that they are being asked for increased mitigation measures in areas of development.

A population viability analysis by Taylor et al. (2012) found that energy development had the greatest influence on male grouse lek attendance within 12.4 miles of a lek. At 8 wells per section (80 acre spacing), only 39% of males persisted while the number of large leks significantly decreased. Subjecting suppressed populations in developed areas to West Nile virus outbreaks or other stressors threatens local populations with extirpation.

Northeast Local Working Group Threats Identification

Sage-grouse are influenced by many factors, both individually and cumulatively. Habitat loss and fragmentation, direct mortality and disturbance affect sage-grouse populations. In 2006, the NEWLWG identified and ranked those factors believed to be most influencing the northeast Wyoming sage-grouse population, as well as those factors that might most effectively be addressed to provide the greatest benefit for sage-grouse conservation in northeast Wyoming. Nearly all top ranking factors were directly related to, or indirectly related to, habitat. The working group felt oil, gas, and CBNG development, weather, vegetation management, invasive plants, and parasites and diseases were the most important influences on the northeast Wyoming sage-grouse population. In the opinion of the group, conservation efforts targeting oil, gas and CBNG development, vegetation management, invasive plants, local residential land use, and livestock grazing would be most effective in benefiting sage-grouse.

Wyoming Core Area Strategy

The Wyoming Sage-Grouse Core Area Strategy (CAS) is based on a series of Executive Orders issued by former Governor Dave Freudenthal and current Governor Matt Mead. The CAS is designed to coordinate sage grouse conservation efforts across the State of Wyoming and directs state agencies to work to maintain and enhance greater sage grouse habitat in Wyoming with the goal of precluding the need to list sage-grouse under the Endangered Species Act. The current Executive Order (2015-4) was signed by Governor Mead in July of 2015. The Executive Order is available at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management .

Core areas (Figure 10) were designated with the objective of identifying habitats that supported most of Wyoming's sage-grouse. Statewide, core areas account for approximately 36% of the current sage-grouse range while encompassing leks with 78% of the 2012-2014 peak males. However, in the NEWSGLWGA, core areas were designated based on CBNG development patterns along with lek density data thereby encompassing leks supporting only 49% of the 2012-2014 peak males.

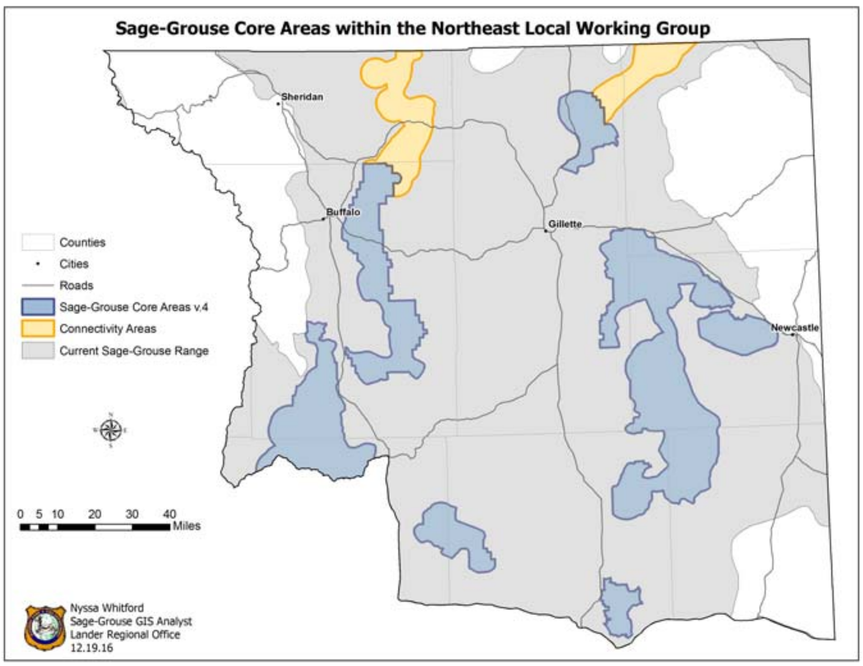
Gamo and Beck (2017) determined 72% of development projects located within Wyoming core areas were in compliance with the executive order. Non-compliant projects were generally operating under valid, existing rights and therefore not subject to provisions of the executive order. Those projects were reviewed further, and operators often agreed to implement mitigation practices that included locating structures within previously disturbed sites, site-specific avoidance of sage-grouse habitat, and habitat restoration. Gamo and Beck's analysis demonstrated that the CAS has been generally effective at conserving sage-grouse populations by managing anthropogenic disturbances. However, it also indicated additional actions are needed to conserve sage-grouse in northeast Wyoming where many developments were in place or permitted prior to the implementation of the CAS (Gamo and Beck 2017).

Powder River Basin Restoration Program

For the reporting period, the program reported the following accomplishments within northeast Wyoming core areas:

- 410 acres of conifer encroachment removed by the Montana Conservation Corp.
- Two unpermitted reservoirs were reclaimed to help manage mosquito habitat/West Nile virus for a total of eight reservoirs reclaimed.
- Planted about 2,000 sagebrush seedlings in the Buffalo Core Area
- 2,100 acres of cheat-grass treatment in the Buffalo Core Area as part of a joint fuels management and greater sage-grouse habitat improvement project.
- Assisted the NRCS Gillette Field Office and Campbell County Conservation District with a riparian project on the Little Powder River.

Figure 10. Northeast Wyoming Sage-grouse Core Area and Connectivity Areas (version 4).



Douglas Core Area

Sage-grouse peak lek attendance within the Douglas Core Area (DCA) totaled 43 males in 2017. This was a decrease from the 50 males in 2016 and 53 males in 2015, but well above the 31 and 11 males in 2014 and 2013, respectively. There have been no changes in lek classification and status since 2016; there are three active leks of the five leks that are occupied in the DCA.

The DCA has experienced a substantial increase in energy development over the past several years. Due to the high density of oil and gas development coupled with a large wildfire that eliminated sagebrush cover over the landscape, all permitted disturbance within the DCA exceeds thresholds established by the Governor's 2011-5 E.O.. Because the majority of the permitted activities are being developed under valid and existing rights secured prior to core area designation, development has continued to occur despite exceeding disturbance thresholds. To mitigate this, the Wyoming Governor's Office, the Department and other partners have worked closely with industry to identify a plan of development and establish a large industry funded restoration effort guided by a multi-faceted restoration team. The plan of development includes practices such as avoiding key habitat areas, minimizing disturbance and significantly reducing traffic during breeding and nesting seasons. The Restoration Team has identified, and is currently implementing, multiple projects beneficial to sage-grouse within the DCA including sagebrush restoration, cheatgrass control and a West Nile virus management program. Additionally, the team has sponsored multiple research projects through two graduate research students with the goal of developing best management practices for sagebrush restoration. To date the team has planted over 100,000 sagebrush plants and is currently working to leverage additional partner funds to continue sagebrush restoration, cheatgrass management and mesic habitat improvement work. Lastly, the team refined the WyGIS disturbance data layer for the DCA by documenting suitable habitat per the 2015 Executive Order guidelines.

NRCS Sage-grouse Conservation Initiative

NRCS contracts for FY2017 within counties comprising the NEWSGLWG area consisted of six contracts totaling 26,872 acres.

- Campbell County – 1 contract for 3,200 acres
- Converse County – 1 contract for 4,230 acres
- Crook County – no contracts
- Johnson County – 1 contract for 18,409 acres
- Niobrara County – no contracts
- Natrona County - 3 contract for 1,033 acres
- Sheridan County – no contracts
- Weston County – no contracts

Information on the Sage-grouse Initiative is available at http://www.sagegrouseinitiative.com.

SPECIAL PROJECTS

Conservation Planning

The Local Working Group schedule was scaled back following completion of the conservation plan addendum in 2013. The plan and other LWG information is available on the WGFD website at http://gf.state.wy.us/wildlife/wildlifemanagement/sagegrouse/index.asp.

Projects funded with the NEWSGLWG allocation of the FY 2017-18 Wyoming Sage-grouse Conservation Fund dollars included four projects, all based in northeast Wyoming (Table 2).

The Working Group held two meetings during the reporting period. The group received updates on completed research and issues related sage-grouse conservation including invasive weeds and the captive rearing legislation. One working group position was filled. The Group also reviewed and allocated Wyoming Sage-grouse Conservation Fund dollars.

Projects funded with the NEWSGLWG allocation of the FY 2017-18 Wyoming Sage-grouse Conservation Fund dollars included four projects, all entirely located in northeast Wyoming (Table 2).

This report is dedicated to the memory of Tom Maechtle, chair of the Northeast Wyoming Local Sage-Grouse Working Group from its first meeting in 2004 until his death in 2016. Tom was dedicated to sage-grouse conservation and donated much of his time and talent to this cause.

U.S. Fish and Wildlife Service Candidate Conservation Agreements With Assurances (CCAA)

A CCAA is a voluntary agreement between the U. S. Fish and Wildlife Service (USFWS) and a non-federal landowner(s) on non-federal lands that provides assurances that landowners covered by a CCAA will not be subject to additional restrictions if the sage-grouse is listed under the Endangered Species Act. Landowners must agree to implement agreed upon conservation actions on their property to remove or reduce threats to the sage-grouse.

For the reporting period, no additional sign-ups were made. The USFWS has 12 participants with 187,178 acres in five counties within the NEWLWGA enrolled into CCAA's (Table 3). The agreements include 122,878 acres of core area habitat and 20,348 acres of connectivity area habitat.

Table 3. U.S. Fish and Wildlife CCAA Sign-ups.

County	Sign-ups	Total Acres	Core Acres	Connectivity Acres	Core and Connectivity Area
Campbell	3	11,298	2,920	0	North Gillette Core
Converse	1	2,000	1,880	0	North Glenrock Core
Crook	1	24,196	0	20,348	North Gillette Connectivity
Johnson	4	72,659	53,223	0	Buffalo Core
Natrona	4	77,025	64,855	0	Natrona Core
Niobrara	0	0	0	0	
Sheridan	0	0	0	0	
Weston	0	0	0	0	
TOTAL	**12***	**187,178**	**122,878**	**20,348**	

*Sign-ups can cover more than one county.

Table 2. Northeast Wyoming sage-grouse projects supported with 2017-18 Wyoming General Fund Appropriation.

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
Improving success in habitat restoration for greater sage-grouse and other sagebrush birds	2017-18	Northeast	$130,637	$75,219 requested/approved	Quantify relationships between distribution and composition of plant communities on reclaimed sites in relation to habitat use and population fitness of sagebrush-obligate birds, including sage-grouse.	University of Waterloo	Approved and On-going
Characterizing SG nesting habitat at Wyoming's eastern edge range	2017-18	Northeast	$25,000	$25,000 requested/approved	Pool data for collaboration on a peer reviewed paper characterizing sage-grouse nesting habitat in northeast Wyoming	Thunder Basin Grasslands Prairie Ecosystem Assoc., Peabody Energy, ICF International, Thunderbird Wildlife Consulting	Approved and on-going
Sage-Grouse Habitat Restoration in Northeastern Wyoming: Evaluating Revegetation Outcomes	2017-18	Northeast	$22,781	$22,781 requested/approved	Evaluate reclamation seeding success at CBNG well sites in the Powder River Basin	University of Wyoming	Approved and on-going
Douglas Core Area burn restoration project	2017-18	Northeast	$382,700	$25,000 requested/approved	Enhance seasonal habitat within the north burn area with sagebrush plantings and cheat grass control	Converse County Conservation District, DCA Restoration Team	Approved and on-going

Research

The following publications have been authored relative to research conducted in the Powder River Basin of Wyoming and Montana.

Copeland, H.E., K.E. Doherty, D. E. Naugle, A. Pocewicz, and J.M. Kiesecker. 2009. Mapping Oil and Gas Development Potential in the US Intermountain West and Estimating Impacts to Species. PLoS ONE 4(10): e7400. doi:10.1371/journal.pone.0007400.

Doherty, K. E., D. E. Naugle and B. L. Walker. 2010. Greater sage-grouse nesting habitat: The importance of managing at multiple scales. Journal of Wildlife Management 74(7):1544–1553.

Doherty, K. E. 2008. Sage-grouse and Energy Development: Integrating Science with Conservation Planning to Reduce Impacts. Ph.D. Dissertation. Fish and Wildlife Biology, University of Montana. 125 pp.

Doherty, K. E., D. E. Naugle, B. L. Walker, and J. M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management 72:187–195.

Doherty, K. E, D. E. Naugle and J. S. Evans. 2010. A currency for offsetting energy development impacts: horse trading sage-grouse on the open market. PLoS ONE 5(4):e10339.

Doherty, K. E., J. L. Beck and D. E. Naugle. 2011. Comparing ecological site descriptions to habitat characteristics influencing greater sage-grouse nest site occurrence and success. Rangeland Ecology and Management 64(4):344-351.

Doherty, M.K. 2007. Comparison of Natural, Agricultural and Effluent Coal Bed Natural Gas Aquatic Habitats. Master of Science. Montana State University. Boseman, MT.

Fedy, B. C. and K. E. Doherty. 2010. Population cycles are highly correlated over long time series and large spatial scales in two unrelated species: greater sage-grouse and cottontail rabbits. Oecologia 165:915-924.

Fedy, B.C. and C.L. Aldridge. 2011. The importance of within-year repeated counts and the influence of scale on long-term monitoring of sage-grouse. Journal of Wildlife Management 75(5): 1022-1033.

Foster, M. A.. J. T. Ensign, W. N. Davis, and D. C. Tribby. 2014. Monitoring Greater Sage-Grouse in the Southeast Montana Sage-grouse Core Area. Final Report. February 2014. Montana Fish Wildlife and Parks *in partnership* with the Bureau of Land Management. Miles City, MT. 108 pp.

Gregory, A. J. and J. L. Beck. 2014. Spatial Heterogeneity in Response of Male Greater Sage-Grouse Lek Attendance to Energy Development. PLoS ONE 9(6): e97132. doi:10.1371/journal.pone.0097132

Harju, S.M., M.R. Dzialak, R.C. Taylor, L.D. Hayden-Wing, and J.B. Winstead. 2010. Thresholds and Time Lags in Effects of Energy Development on Greater Sage-Grouse Populations. Journal of Wildlife Management 74:437-448.Naugle, D. E., C. L. Aldridge, B. L. Walker, T. E. Cornish, B. J. Moynahan, M. J. Holloran, K. Brown, G. D. Johnson, E. T. Schmidtmann, R. T. Mayer, C. Y. Kato, M. R. Matchett, T. J. Christiansen, W. E. Cook, T. Creekmore, R. D. Falise, E. T. Rinkes, M. S. Boyce. 2004. West Nile virus: pending crisis for Greater Sage-grouse. Ecology Letters. Volume 7, Issue 8, p. 704-713.

Kirol, C. 2014. Powder River Basin Radio-Marked Greater Sage-Grouse Study—Mammal Nest Predator DNA Identification. Project Report *prepared for the* Northeast Wyoming Sage-grouse Local Working Group. 13 pp.

Kirol, C.P., Sutphin, A.L., Bond, L.S., Maechtle, T.L., Fuller, M.R., 2015, Mitigation effectiveness for improving nesting success of greater sage-grouse influenced by energy development. DOI- 10.2981/wlb.00002: Wildlife Biology, v. 21, p. 98-109.

Naugle, D. E., C. L. Aldridge, B. L. Walker, K. E. Doherty, M. R. Matchett, J. McIntosh, T. E. Cornish, and M. S. Boyce. 2005. West Nile virus and sage-grouse: What more have we learned? Wildlife Society Bulletin, 33(2):616-623.

Naugle D. E., K. E. Doherty, B. L. Walker, M. J. Holloran, and H. E. Copeland. 2011. Energy development and greater sage-grouse. Pages 489-529 in Greater sage-grouse: ecology and conservation of a landscape species and its habitats, S. T. Knick, J. W. Connelly, C. E. Braun (editors). Studies in Avian Biology, Number 38, University of California Press, Berkeley, CA, USA.

Taylor, R. L., D. E. Naugle, and L. S. Mills. 2010. Viability analyses for conservation of sage-grouse populations. Completion report, Miles City Field Office, Montana, USA.

Taylor, R. L., D. E. Naugle, and L. Scott Mills. 2012. Viability analyses for conservation of sage-grouse populations: Buffalo Field Office, Wyoming Final Report 27 February 2012. BLM Contract 09-3225-0012 Number G09AC00013 (8/10/10). University of Montana, Missoula**.**

Taylor, R. L., B. L. Walker, D. E. Naugle, and L. Scott Mills. 2012. Managing multiple vital rates to maximize greater sage-grouse population growth. Journal of Wildlife Management 76:336-347.

Walker, B. L., D. E. Naugle, K. E. Doherty, and T. E. Cornish. 2004. Outbreak of West Nile Virus in Greater Sage-grouse and Guidelines for Monitoring, Handling, and Submitting Dead Birds. Wildlife Society Bulletin 32(3): 1000–1006.

Walker, B. L., D. E. Naugle, and K. E. Doherty. 2007a. Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management 71:2644-2654.

Walker, B.L. D.E. Naugle, K.E. Doherty, and T.E. Cornish. 2007b. West Nile Virus and greater sage-grouse: estimating infection rate in a wild bird population. Avian Diseases 51:691-696.

Walker, B. L. 2008. Greater Sage-grouse Response to Coalbed-Natural Gas Development and West Nile Virus in the Powder River Basin, Montana and Wyoming, USA. Dissertation. University of Montana. Missoula, MT.

Zou, L., S.N. Miller, and E.T. Schmidtmann. 2006. Mosquito larval habitat mapping using remote sensing and GIS: Implications of coalbed methane development and West Nile virus. Journal of Medical Entomology 43:1034–41.

RECOMMENDATIONS

1. Continue to participate in the Northeast Wyoming Local Working Group. The Group has developed a conservation plan for the species and designed and implemented projects that benefit sage-grouse. The Department representative will continue to assist with implementing projects to benefit sage-grouse.
2. Continue to assist the BLM with developing and implementing the sage-grouse monitoring program as prescribed by the Powder River Basin CBNG EIS Record of Decision (April 2003).
3. Continue to coordinate with the BLM and industry to minimize the number of visits to leks during lek monitoring efforts.
4. Continue WNv monitoring.
5. Continue to assist the BLM with coordinating sage-grouse population monitoring efforts with the private consultants doing work for energy development companies.
6. Use any additional flight money from the BLM in 2018 for lek searches and surveys. All leks should be checked at least once every three years. All leks should be recorded in UTMs (NAD 83) using GPS.
7. The sage-grouse database should be maintained and used to store and report sage-grouse data. Any old records that have not been included should be added to the database. Current records should be reviewed to eliminate leks without adequate documentation to support a lek designation.
8. The Working Group should continue to solicit habitat projects on private lands that will have benefit for sage-grouse.
9. The WGFD Regions should continue to recommend protection of occupied sage-grouse leks during environmental commenting and promote their protection on private land projects.
10. Additional effort is needed to document the status of undetermined leks. Encourage reporting of lek activity from the public and in particular landowners.
11. Better document wintering sage-grouse locations and develop a seasonal range map for sage-grouse for the Working Group Area.
12. Continue to map lek perimeters to ensure adequate buffer distance in protecting leks.

LITERATURE CITED

BLM 2003. Record of Decision and Resource Management Plan Amendments for the Powder River Basin Oil and Gas Project. U.S. Department of Interior, Bureau of Land Management. Wyoming State Office/Buffalo Field Office. WY-070-02-065.

Christiansen, T. 2010. Hunting and sage-grouse: a technical review of harvest management on a species of concern in Wyoming. Wyoming Game and Fish Department, Cheyenne.

Christiansen, T. 2012. Chapter 12: Sage Grouse (*Centrocercus urophasianus*). Pages 12-1 to 12-55 in S.A. Tessmann and J.R. Bohne (eds). Handbook of Biological Techniques: third edition. Wyoming Game and Fish Department. Cheyenne, WY.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to Manage Sage-grouse and Their Habitats. Wildlife Society Bulletin 28(4): 967–985

Connelly, J. W., K. P. Reese and M. A. Schroeder. 2003. Monitoring of greater sage-grouse habitats and populations. Station Bulletin 80. University of Idaho College of Natural Resources Experiment State. Moscow, ID.

Doherty, K. E. 2008. Sage-grouse and Energy Development: Integrating Science With Conservation Planning to Reduce Impacts. Dissertation. University of Montana. Missoula, MT.

Doherty, K. E., D. E. Naugle, B. L. Walker, and J. M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management 72:187-195.

Doherty, K. E., D. E. Naugle, and J. S. Evans. 2010. A currency for offsetting energy development impacts: horse-trading sage-grouse on the open market. PLoS One 5:e10339.

Gamo, R. S., and J. L. Beck. 2017. Effectiveness of Wyoming's sage-grouse core areas: influences on energy development and male lek attendance. Environmental Management 59:189–203.

Knick, S.T., and J.W. Connelly, editors. 2011. Ecology and Conservation of Greater Sage-Grouse: A Landscape Species and its Habitats. Volume 38. Studies in Avian Biology. Cooper Ornithological Society. University of California Press.

Naugle, D. E., B. L. Walker, and K. E. Doherty. 2006a. Sage-grouse Population Response to Coal-bed Natural Gas Development in the Powder River Basin: Interim Progress Report on Region-wide Lek-count Analyses. Wildlife Biology Program, College of Forestry and Conservation, University of Montana. 10 pp.

Naugle, D. E., K. E. Doherty and B. L. Walker. 2006b. Sage-grouse Winter Habitat Selection and Energy Development in the Powder River Basin: Completion Report. June 2006. Unpublished Report, University of Montana, Missoula, MT. 23 pp.

Taylor, R. L., D. E. Naugle and L. S. Mills. 2012. Viability Analysis for Conservation of Sage-grouse Populations: Buffalo Field Office, Wyoming. Wildlife Biology Program, University of Montana, Missoula, MT. 46 pp.

Walker, B. L. 2007. Personnel Communication. November 5, 2007. E-mail. CO Division of Wildlife.

Walker, B. L. 2007. Greater Sage-grouse Population Response to Energy Development and Habitat Loss. Journal of Wildlife Management. 71(8):2644–2654.

Wyoming Oil and Gas Conservation Commission (WOGCC). 2016. Website at www.wogcc.state.wy.us. Accessed December, 2016.

South-Central
Sage-Grouse
Job Completion Report 2016

June 2016-May 2017

Will Schultz
Wyoming Game & Fish Dept.
Laramie Region

South Central Conservation Area Job Completion Report

Species: **Sage-grouse** Conservation Plan Area: **South Central**

Period Covered: **June 1, 2016 – May 31, 2017** Sage-Grouse Mgmt Area: **H**

Prepared by: **Will Schultz**

Introduction

The South Central Local Conservation Area (SCCA) generally includes The Platte Valley, Laramie Plains, Great Divide Basin, North Ferris, south Sweetwater and Little Snake River Valley in the counties of Carbon, Sweetwater, Albany, Fremont and Natrona in southern Wyoming (Figure 1).

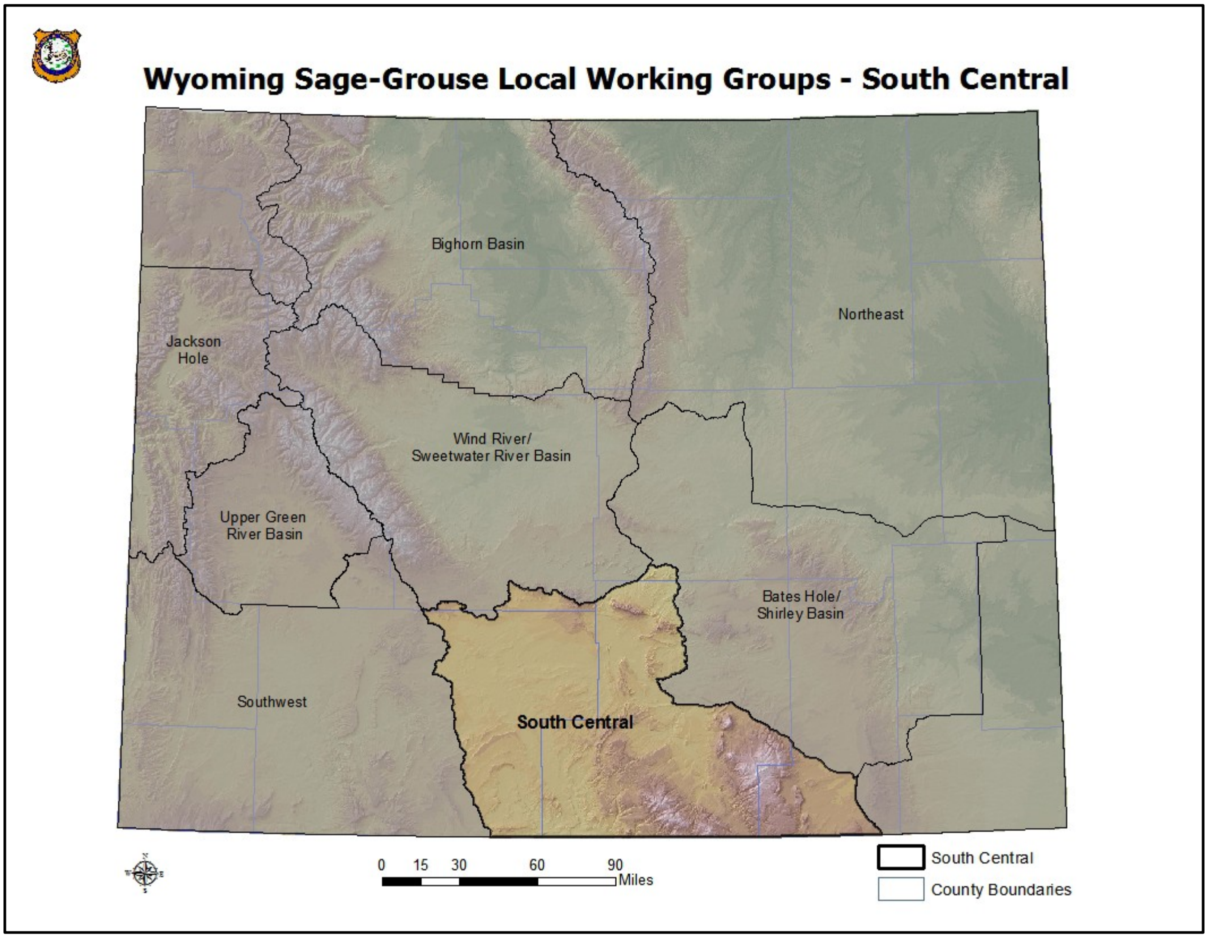


Figure 1. South Central Conservation Area in Wyoming.

Sage-grouse habitat in the SCCA is comprised of public land administered by the Bureau of Land Management (BLM), Wyoming State Land and Investments Board, and private land. A very minor portion of sage-grouse habitat is located on the fringe of the US Forest Service's (USFS) Medicine Bow National Forest (Figure 2). A major portion of the SCCA is "checkerboard" land ownership (alternating public and private lands) within 20 miles of the Union Pacific Railroad corridor in the center of the area. Major habitat types include sagebrush/grassland, salt desert shrub, short-grass prairie, mixed mountain shrub, mixed forest types, agricultural, riparian, and urban types. Transportation corridors include Interstate 80 (I-80), Union Pacific Railroad (mostly parallel to I-80), and State Highways 70, 789, 287, 230/130. Major cities and towns found in the area are Rawlins, Laramie, Saratoga, Encampment, Baggs, and Wamsutter.

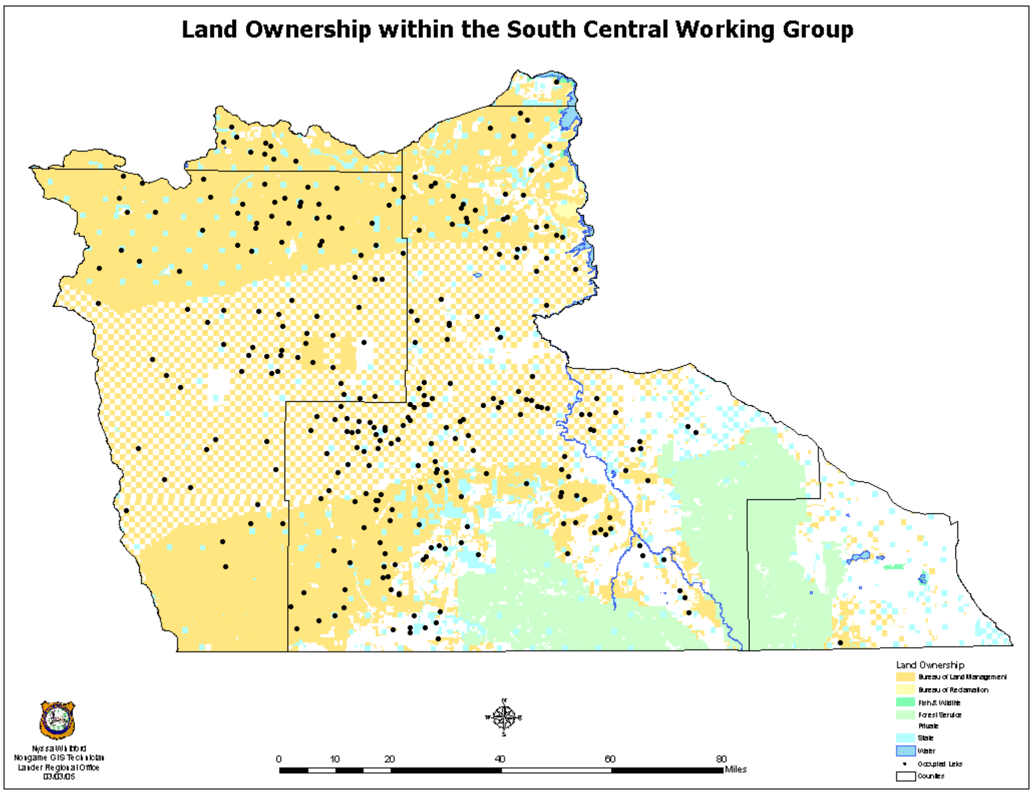


Figure 2. Landownership and sage-grouse leks locations within the South Central Conservation Area of Wyoming.

The South Central Sage-Grouse Local Working Group (SCLWG) was initiated in September of 2004 to address local sage-grouse conservation in the SCCA. The SCLWG completed their Sage-grouse Conservation Plan (Plan) in 2007. Much has changed since 2007 with regard to our knowledge about this species and the conservation efforts which have been implemented at both the state and range-wide level. The SCLWG completed an addendum to their Plan in 2014.

In bio-year 2016 (June 1, 2016 – May 31, 2017), there were 288 occupied leks in the SCCA. Of these, 257 were monitored. From these monitoring efforts it was determined 187 leks were active; producing an average peak males/lek ratio of 25.4 males.

The 2016 upland harvest survey indicated 477 hunters spent 1,162 days to harvest 911 sage-grouse in the SCCA. Analyses of wing data from hunter harvested sage-grouse indicated the proportion of chicks in the harvest was 1.3 chicks/hen in the SCCA.

Weather

The National Climate Data Center/National Oceanic and Atmospheric Administration (NCDC/NOAA) has divided Wyoming into 10 climatic divisions for the purpose of weather data collection (Figure 3). These divisions correspond to major watersheds within the state. Wyoming's Climatic Division 10, the Upper Platte, covers much of the SCCA.

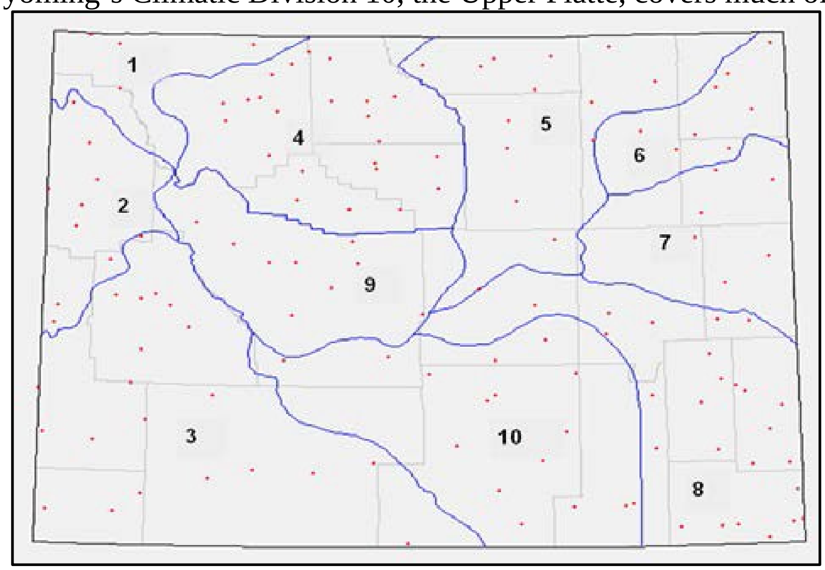


Figure 3. NCDC/NOAA, State of Wyoming Climate Division Map.

Temperature and precipitation data was obtained for Division 10 from NCDC/NOAA's website, https://www.ncdc.noaa.gov/cag/ to illustrate weather conditions during bio-year 2016 (Figures 4 and 5). These figures also include data from April and May of bio-year 2015 to describe the weather conditions immediately preceding bio-year 2016 during the strutting and nesting season. Monthly mean temperatures in bio-year 2015 were similar to the 50-year monthly means. Precipitation in April and May of 2016, primarily received in the form of very moist snow, was 169% and 132% of their respective 50-year monthly means. The monthly precipitation during brood rearing season, June – August, was well below their respective 50-year monthly means. Some sage-grouse hens likely had to re-nest or they may have abandoned nesting activities entirely. The dryer summer conditions may have cause food sources such as insects and forbs to relatively less abundant. Mediocre chick survival indicated by the analysis of sage-grouse wings collected from hunters in the fall of 2016 was considered to have been caused by this combination of wetter spring and dryer summer weather conditions. Otherwise, relatively favorable weather conditions were experienced in Division 10 throughout the remainder of bio-year 2016.

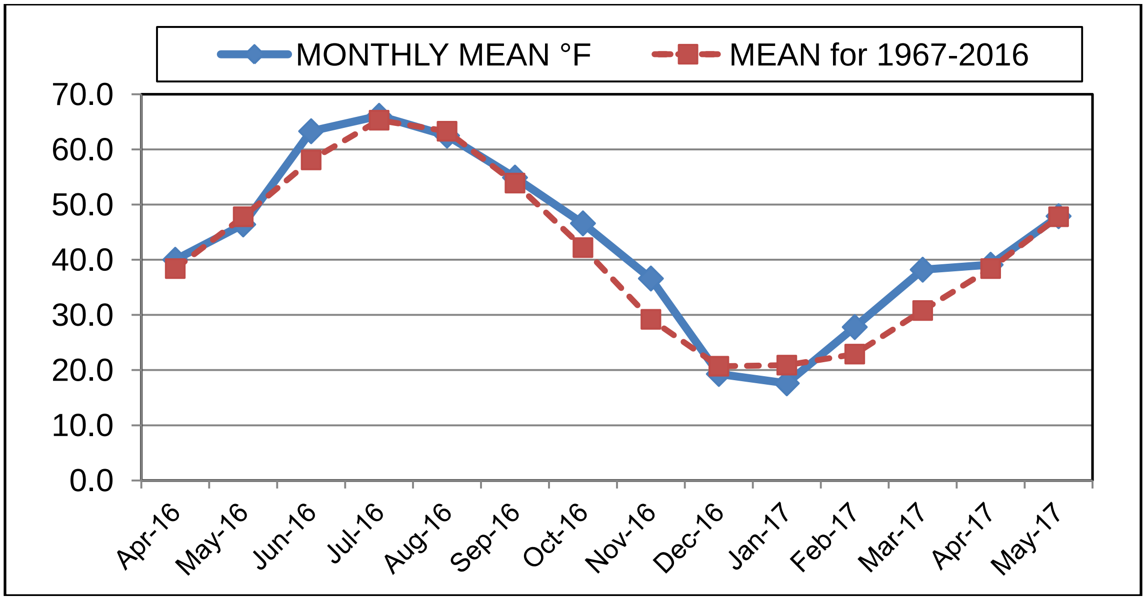


Figure 4. Mean monthly temperatures compared to the 50-year monthly mean temperatures for Wyoming’s climate Division 10.

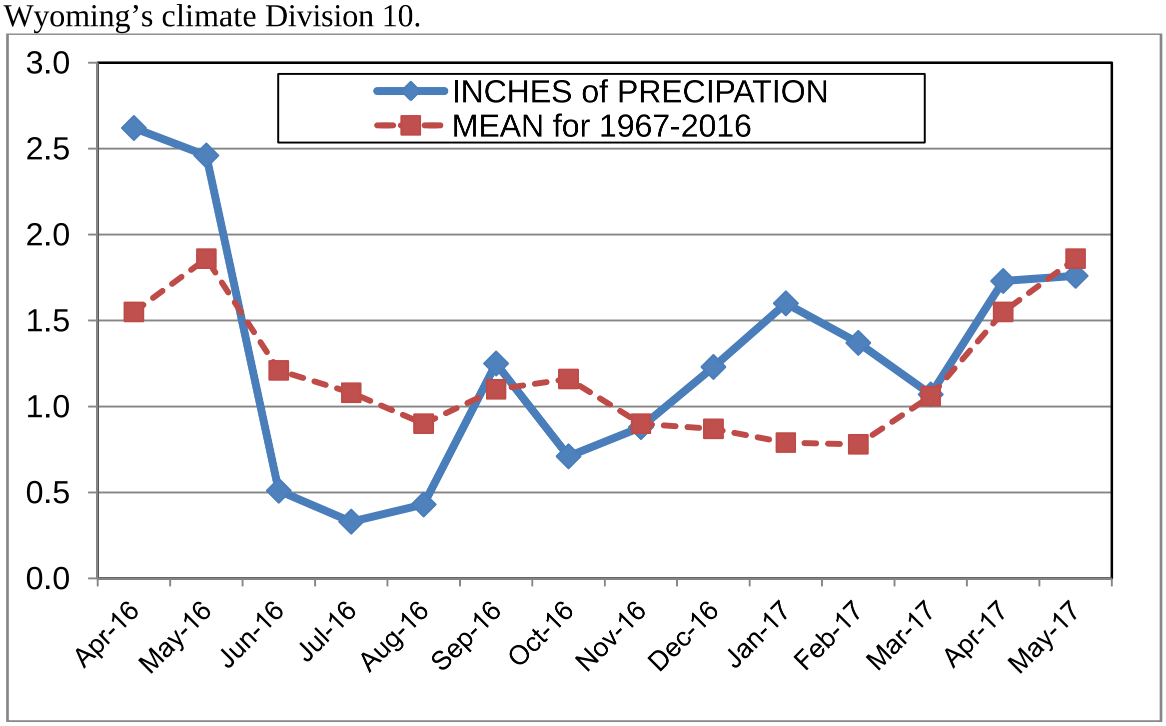


Figure 5. Monthly precipitation compared to the 50-year monthly mean precipitation rates for Wyoming’s climate Division 10.

Habitat

Much of the sage-grouse habitat in the SCCA is comprised of a relatively intact sagebrush ecosystem. The health of this ecosystem is predominately dependant on the type, amount, and timing of annual precipitation.

Livestock grazing is a predominate use of sage-grouse habitat in the SCCA. In the first half of the 20th century, much of the sage-grouse habitat in the SCCA provided winter grazing for hundreds of thousands of both domestic sheep and cattle. In the later part of the last century, sheep numbers declined dramatically while cattle became to primary species of livestock using the SCCA. Improved grazing management on both public and private lands during the last few decades has generally led to improved habitat for sage-grouse and other sagebrush obligates.

Energy development and mineral extraction are secondary uses of sage-grouse habitat within the SCCA. A majority of the energy development is associated with producing natural gas from both deep gas and coal bed methane sources. Energy development has directly or indirectly reduced the functionality of sage-grouse habitat in portions of the SCCA. Past and present uranium mining has also contributed to reducing sage-grouse habitat in the SCCA. The Interstate 80/UPRR transportation corridor bisects the SCCA east to west and is a major cause of habitat fragmentation.

Lek Monitoring and Population Trend

Tables and graphs describing annual lek monitoring efforts, observations, and lek characteristics are provided in Appendix A. Lek monitoring techniques are described in Christiansen (2012). Wyoming Game and Fish Department (WGFD) and BLM personnel, environmental consultants, and volunteers monitored 257 leks in the spring of 2017. This represented checking 89% of the occupied status leks in the SCCA. This rate of effort was 2% less than in 2016. The 2008-2017 mean of leks checked annually was 87%. The proportion of leks checked in the spring of 2016 was 2% greater than the 10-year average.

Since only occupied leks were reported on Table 1 in Appendix A., it is important to consider trends in the numbers of active versus inactive leks in addition to the average size of active leks. The proportion of occupied leks which were considered inactive remained at 22% in 2017. The average peak male/lek for active leks decreased 6.3% from 31.7 in 2016 to 25.4 in 2017. During periods of population increase the size of active leks typically increases and the number of inactive leks decreases. The converse is typically true of a decreasing population. In 2017, the management status for 8 leks in the SCLWG was changed from occupied to unoccupied because they no longer met the criteria for an occupied lek.

In 2017, the peak male lek attendance totaled 4,629 males in the SCCA. This was a 23% decrease from 2016. The males/lek average was 25.4. The 2017 males/lek average was equal to the 10-year average. Count monitored leks averaged 29.6 males/lek, compared to 22.6 males/lek for survey monitored leks. The current decrease in male attendance is within the observed rates since 1996, and most likely attributable to normal cyclic variation in populations and to weather conditions; at least within habitats least impacted by human disturbance. Figure 6 illustrates the trends in average peak males/lek for all sage-grouse conservation areas in Wyoming, as well as the statewide average.

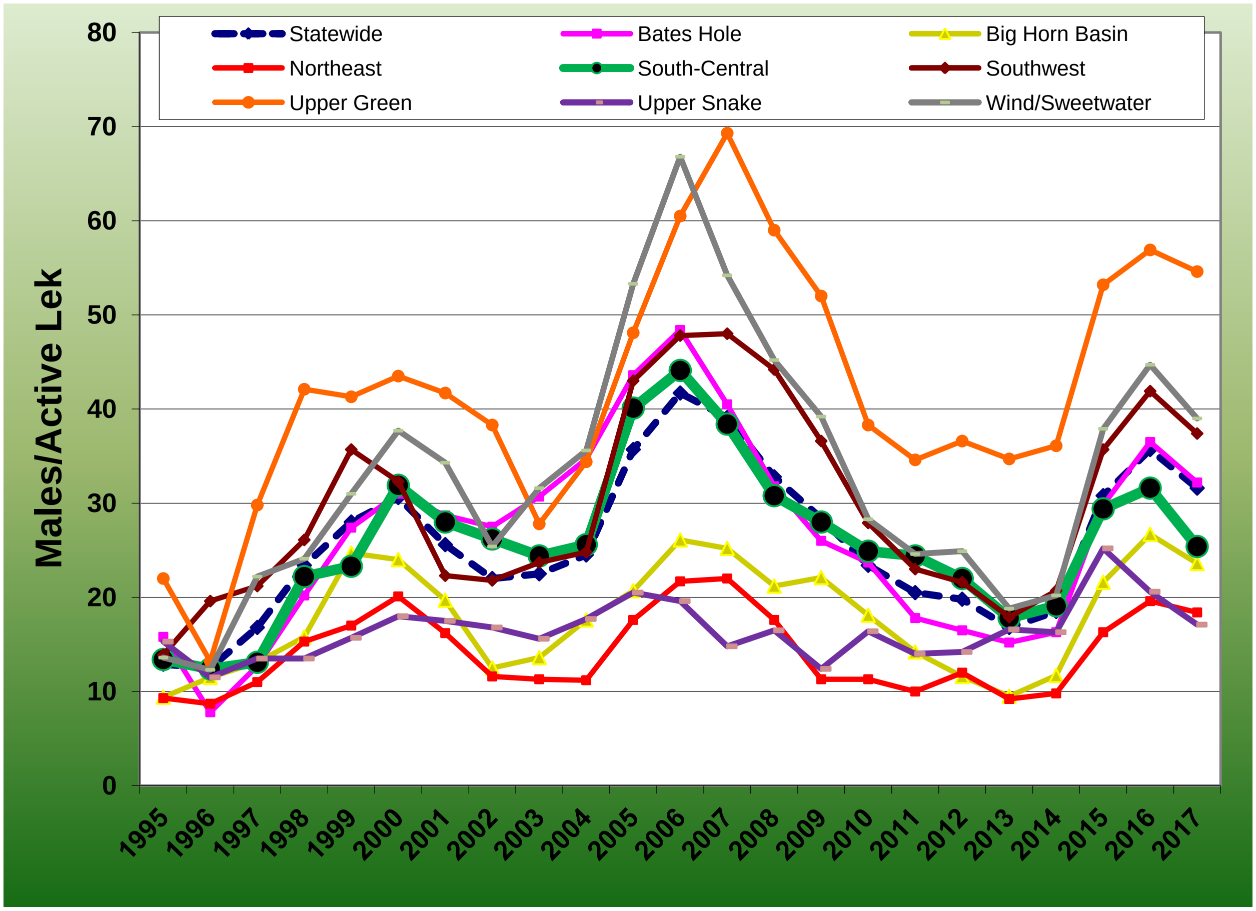


Figure 6. 1995-2017 Average peak male sage-grouse lek attendance, by Conservation Area and statewide, Wyoming.

Harvest

Weather conditions during the 2016 hunting season were conducive to hunters being able to access sage-grouse habitat within the SCCA. Tables and graphs describing hunting season structure, annual harvest and subsequent wing survey analyses are provided in Appendix A. The 2016 sage-grouse hunting season was from September 17 to September 30, and allowed for the harvest of 2 sage-grouse/day and 4 in possession. The 2016 upland harvest survey indicated 477 hunters spent 1,162 days to harvest 911 sage-grouse in the SCCA. This equals approximately 0.8 birds/day, 1.9 birds/hunter, and 2.4 days/hunter. Birds/hunter rates increased slightly from the 2015 hunting season indicating hunters were generally more successful. Compared to the 2015 season results, when hunting regulations were similar with the exception of 2 less days in the 2015 season length; 2016 hunter numbers increased by 21%, the birds/day stayed the same, and the days/hunter increased by 14%. Generally, during the past 10 years, overall harvest appeared be correlated to hunter numbers and sage-grouse abundance.

Hunter-harvested sage-grouse wings have been collected annually and used for estimating productivity. Wings were collected in barrels set out at major road junctions where hunters are most likely to pass, and can provide a relatively consistent source of productivity data. Wings are gathered and then aged/sexed by molt patterns, and numbers of chicks/hen are calculated and used as a measure of productivity. While there are biases associated with the hunter selectivity of different age/sex groups of sage-grouse, trends still provide yearly comparisons of relative chick production.

During the 2016 hunting season WGFD collected 174 wings from wing barrels within the SCCA, which was 19% of the estimated harvest of 911. This was a 10% decrease in wings when compared to the 192 wings collected in 2015, while harvest was estimated to have increased 17% in 2016. Age and sex composition of the wings indicated the proportion of chicks/hen decreased from 1.4 in 2015 to 1.3 in 2016. This difference is not statistically meaningful. . Statewide analyses of wing data from harvested sage-grouse have suggested chick/hen ratios of 1.4-1.7 typically results in relatively stable populations as determined by lek counts the following year. Given the continued declining ratio for chicks in the harvest, we believe we will see a continued decline in male lek attendance rates for next few strutting seasons.

Disease

There were no cases of West Nile Virus in sage-grouse, or other diseases detrimental to sage-grouse documented within the SCCA in bio-year 2016.

Special Studies

Several long term sage-grouse research projects related to the development of wind energy continued in the immediate vicinity of the SCCA. In conjunction with development of the proposed Chokecherry/Sierra Madre Wind Farm, located south of Rawlins, a multi-faceted sage-grouse research project has continued since 2010. The principal investigators include the consulting firm SWCA, University of Missouri, and US Forest Service.

During the spring of 2017, 60 greater sage-grouse were captured near Stewart Creek, in the northern portion of the SCLWG area, and translocated to southwest North Dakota. This was done in an effort to supplement North Dakota’s remnant sage-grouse population. Translocation success, as well as impacts to the Stewart Creek source population, is being studied by Utah State University researchers. See Appendix B for an interim report for this project.

A bibliography of research conducted in the SCCA or supported by the SCLWG is listed following the Literature Cited section of this JCR.

State and Federal Conservation Strategies

Wyoming continued to manage sage-grouse and sagebrush habitats under the guidance of the

Governor's Executive Order 2015-4 (EO 2015-4). During the 2017 Wyoming Legislative session, lawmakers chose to discontinue the funding of the WGFD sage-grouse program. This program will now be funded entirely by WGFD through a recently adopted increase to license fees. Lawmakers also passed legislation to allow for commercial bird farms to collect eggs from wild sage-grouse and begin the rearing of sage-grouse in captivity.

The BLM and the USFS began implementation of their respective revised land use plans as they related to sage-grouse habitat conservation. The US Department of Agriculture's Natural Resource Conservation Service (NRCS) continued to implement their national Sage-Grouse Initiative program (SGI) in the SCCA. This program was revised and re-tooled in 2015 under the name of "Sage Grouse Initiative 2.0." U.S. Fish and Wildlife Service (FWS) is still on track to review the status of greater sage-grouse in 2020. The FWS also continued to offer landowners an opportunity for enrollment in the sage-grouse Candidate Conservation Agreement with Assurances (CCAA) program. The CCAA program is a voluntary agreement whereby private landowners agree to manage their lands to remove or reduce threats to sage-grouse being listed under the ESA. However, landowner participation in the CCAA program waned after the, "Not Warranted," listing decision was announced in 2015.

Local Working Group Conservation Plan Implementation

The SCLWG was initiated in September of 2004 and completed their Sage-grouse Conservation Plan (Plan) in 2007. In 2014, the SCLWG adopted an addendum to their Plan which is available at https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management. This addendum documented conservation action such as research and habitat projects the LWG had supported since their Plan was completed, as well as how these projects addressed the goals and action items identified in the Plan.

In bio-year 2016, the SCLWG held one meeting during this reporting period for the purpose of allocating funds provided by the Wyoming Sage-Grouse Conservation Fund (Table 1). Funds available for SC LWG allocation was $148,000.

Applicant	Conservation Project	Amount Allocated
University of Wyoming	Identification of Winter Concentration Areas in SC Wyoming	$100,000
University of Wyoming	Response of SG to habitat treatments	$30,000
Bureau of Land Management	Rankin Creek exclosure rebuild	$10,000
Bureau of Land Management	Standard Allotment guzzler	$8,300

Table 1. Sage-grouse conservation projects funded by the South Central Sage-Grouse Local Working Group in bio-year 2016, Wyoming.

Management Recommendations for the SCCA

1. Continue to monitor a minimum of 80% of the occupied leks in the SCCA.

2. Support WGFD and BLM efforts to address mitigation and reclamation issues.

3. Support research efforts to identify seasonal habitats, especially winter concentration habitat.

4. Coordinate with BLM and USFS to ensure habitat treatments in sage-grouse Core area comply with WY-EO-2015-4.

5. Continue to build partnerships with private landowners to maintain or improve sage-grouse habitat on private lands through mutually beneficial habitat projects.

Literature Cited

Christiansen, T. 2012. Chapter 12: Sage Grouse (Centrocercus urophasianus). Pages 12-1 to 12-55 in S.A. Tessmann and J. R. Bohne (eds). Handbook of Biological Techniques: third edition. Wyoming Game and Fish Department. Cheyenne.

Wyoming Game and Fish Department (WGFD). 2007. South Central Sage-Grouse Conservation Plan. 74pp.

Bibliography of sage-grouse research conducted in the SCCA or funded by the SCLWG:

Dinkins, J.B. 2013. Common raven density and greater sage-grouse nesting success in southern Wyoming: potential conservation and management implications. Dissertation. Utah State Univ., Logan.

Dinkins, J. B., M. R. Conover, C. P. Kirol, and J. L. Beck. 2012. Greater sage-grouse (Centrocercus urophasianus) select nest-sites and brood-sites away from avian predators. The Auk 129:600–610.

Dinkins, J.B., M.R. Conover and S.T. Mabray. 2013. Do artificial nests simulate nest success of greater sage-grouse? Human–Wildlife Interactions 7(2):299–312.

Dinkins, J.B., M.R. Conover, C.P. Kirol, J.L. Beck, and S.N. Frey. 2014. Greater sage-grouse (Centrocercus urophasianus) hen survival: effects of raptors, anthropogenic and landscape features, and hen behavior. Canadian Journal of Zoology 92:319-330

Dinkins, J.B., M.R. Conover, C.P. Kirol, J.L. Beck and S.N. Frey. 2014. Greater Sage-Grouse (Centrocercus urophasianus) select habitat based on avian predators, landscape composition, and anthropogenic features. The Condor 116 (4), 629-642.

Dinkins, J. B., K. T. Smith, J. L. Beck, C. P. Kirol, A. C. Pratt, and M. R. Conover. 2016. Microhabitat conditions in Wyoming sage-grouse core areas: effects on selection and nest success. PLoS ONE 11:e0150798.

Dinkins, J. B., M. R. Conover, C. P. Kirol, J. L. Beck, and S. N. Frey. 2016. Effects of common raven and coyote removal and temporal variation in climate on greater sage-grouse nesting success. Biological Conservation 202:50–58.

Dzialak, M. R., S. L. Webb, S. M. Harju, C. V. Olson, J. B. Winstead, and L. D. Hayden-Wing. 2013. Greater sage-grouse and severe winter conditions: identifying habitat for conservation. Rangeland Ecology and Management 66:10-18.

Fremgen, A.L., Hansen, C.P., Rumble, M.A., Gamo, R.S., and Millspaugh, J.J., 2016, Male greater sage-grouse detectability on leks: Journal of Wildlife Management, v. 80, no. 2, p. 266-274.

Erickson, H. J. 2011. Herbaceous and avifauna responses to prescribed fire and grazing timing in a high-elevation sagebrush ecosystem. Thesis. Colorado State Univ., Ft. Collins.

Fremgen, A. L., C. P. Hansen, M. A. Rumble, R. S. Gamo, and J. J. Millspaugh. 2016. Male greater sage-grouse detectability on leks. Journal of Wildlife Management 80:266–274.

Heath, B. J., R. Straw, S. H. Anderson, J. Lawson, M. Holloran. 1998. Sage-grouse productivity, survival, and seasonal habitat use among three ranches with different livestock grazing, predator control, and harvest management practices. Research Completion Report. Wyoming Game & Fish Dept., Cheyenne.

Kirol, C. P. 2012. Quantifying habitat importance for greater sage-grouse (Centrocercus urophasianus) population persistence in an energy development landscape. Thesis. Univ. of Wyoming, Laramie.

Kirol, C. P., Beck, J. L., J. B. Dinkins, and M. R. Conover. 2012. Microhabitat selection for nesting and brood-rearing by the greater sage-grouse in xeric big sagebrush. The Condor 114:75-89.

Kirol, C. P., Beck, J. L., Huzurbazar, S. V., Holloran, M. J., Miller, S. N. 2015. Identifying greater sage-grouse source and sink habitats for conservation planning in an energy development landscape. Ecol Apps 25:968–990.

Klott, J. H. 1987. Use of habitat by sympatrically occurring sage-grouse and sharptailed grouse with broods. Thesis. Univ. of Wyoming, Laramie.

Klott, J. H., and F. G. Lindzey. 1989. Comparison of Sage and Sharp-tailed Grouse leks in south central Wyoming. Great Basin Naturalist 49:275-278.

Klott, J. H. and F. G. Lindzey. 1990. Brood habitats of sympatric sage grouse and Columbian sharptailed grouse in Wyoming. Journal of Wildlife Management 54:84-88.

LeBeau, C.W. 2012. Evaluation of Greater sage-grouse reproductive habitat and response to wind energy development in south-central Wyoming. Thesis, Univ. of Wyoming, Laramie.

LeBeau. C. W., J. L. Beck, G. D. Johnson, M. J. Holloran. 2014. Short-term impacts of wind energy development on greater sage-grouse fitness. Journal of Wildlife Management 78:522-530.

LeBeau, C.W., Beck, J.L., Johnson, G.D., Nielson, R.M., Holloran, M.J., Gerow, K.G., and McDonald, T.L., 2017a, Greater sage-grouse male lek counts relative to a wind energy development: Wildlife Society Bulletin, v. 41, no. 1, p. 17-26.

LeBeau, C.W., Johnson, G.D., Holloran, M.J., Beck, J.L., Nielson, R.M., Kauffman, M.E., Rodemaker, E.J., and McDonald, T.L., 2017b, Greater sage-grouse habitat selection, survival, and wind energy infrastructure: Journal of Wildlife Management, v. 81, no. 4, p. 690-711.

LeBeau, C., G. Johnson, M. Holloran, J. Beck, R. Nielson, M. Kauffman, E. Rodemaker, and T. McDonald. 2016. Effects of a Wind Energy Development on Greater Sage-Grouse Habitat Selection and Population Demographics in Southeastern Wyoming. Unpublished report. Prepared for: National Wind Coordination Collaborative, Washington, DC. Prepared by: Western EcoSystems Technology, Inc., Cheyenne, WY.

Peebles, L. W. 2015. Winter ecology of common ravens in southern Wyoming and the effects of raven removal on greater sage-grouse populations. Paper 4617. Thesis. Utah State Univ., Logan.

Schreiber, L. A. 2013. Greater sage-grouse nest site selection, brood-rearing site selection and chick survival in Wyoming. Thesis. Univ. of Missouri, Columbia.

Schreiber, L.A., Hansen, C.P., Rumble, M.A., Millspaugh, J.J., Gamo, R.S., Kehmeier, J.W., and Wojcik, N., 2015a. Microhabitat selection of brood-rearing sites by greater sage-grouse in Carbon County, Wyoming: Western North American Naturalist, v. 75, no. 3, p. 348-363.

Schreiber, L.A., C.P. Hansen, M.A. Rumble, J.J. Millspaugh, S. Gamo, J. Kehmeier, and N. Wojcik. 2015.. Greater sage-grouse apparent nest productivity and chick survival in Carbon County, Wyoming. Wildlife Biology 22:37-44.

Smith, K. T., C. P. Kirol, J. L. Beck, and F. C. Blomquist. 2014. Prioritizing winter habitat quality for greater sage-grouse in a landscape influenced by energy development. Ecosphere 5(2):15

Southwest

Sage-Grouse
Job Completion Report
2016

June 2016-May 2017

Patrick Burke
Wyoming Game & Fish Dept.
Green River Region

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Southwest

1. Lek Attendance Summary (Occupied Leks) (1)

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2008	266	69	26	4284	63.0
2009	282	71	25	2651	40.2
2010	288	77	27	2214	30.8
2011	298	73	24	1855	26.9
2012	304	81	27	1719	23.5
2013	311	116	37	1955	19.4
2014	313	96	31	1613	19.9
2015	319	70	22	2197	34.9
2016	329	94	29	3744	44.0
2017	336	97	29	2950	34.3

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2008	266	149	56	4021	33.5
2009	282	188	67	5485	35.4
2010	288	183	64	3753	26.6
2011	298	166	56	2893	21.3
2012	304	184	61	2880	20.9
2013	311	178	57	2254	16.9
2014	313	192	61	3177	21.2
2015	319	225	71	6256	35.5
2016	329	214	65	6435	40.2
2017	336	202	60	5923	39.2

1) Occupied - Active during previous 10 years (see official definitions)

2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

3) Inactive - Confirmed no birds/sign present (see official definitions)

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Southwest

1. Lek Attendance Summary (Occupied Leks) (1) Continued

c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2008	266	218	82	8305	44.2
2009	282	259	92	8136	36.8
2010	288	260	90	5967	28.0
2011	298	239	80	4748	23.2
2012	304	265	87	4599	21.8
2013	311	294	95	4209	18.0
2014	313	288	92	4790	20.7
2015	319	295	92	8453	35.4
2016	329	308	94	10179	41.5
2017	336	299	89	8873	37.4

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2008	196	13	9	209	93.8	6.2
2009	230	19	10	249	92.4	7.6
2010	225	13	22	238	94.5	5.5
2011	219	6	14	225	97.3	2.7
2012	227	25	13	252	90.1	9.9
2013	243	29	22	272	89.3	10.7
2014	236	25	24	261	90.4	9.6
2015	252	22	21	274	92.0	8.0
2016	264	28	16	292	90.4	9.6
2017	250	32	17	282	88.7	11.3

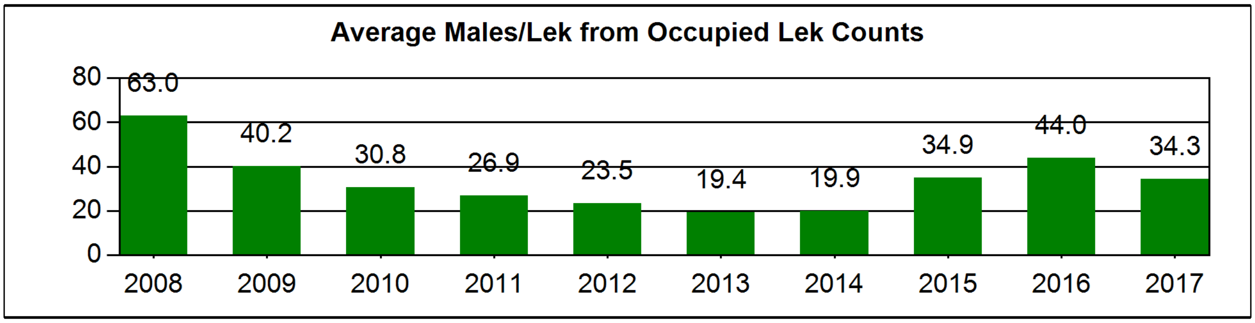
1) Occupied - Active during previous 10 years (see official definitions)

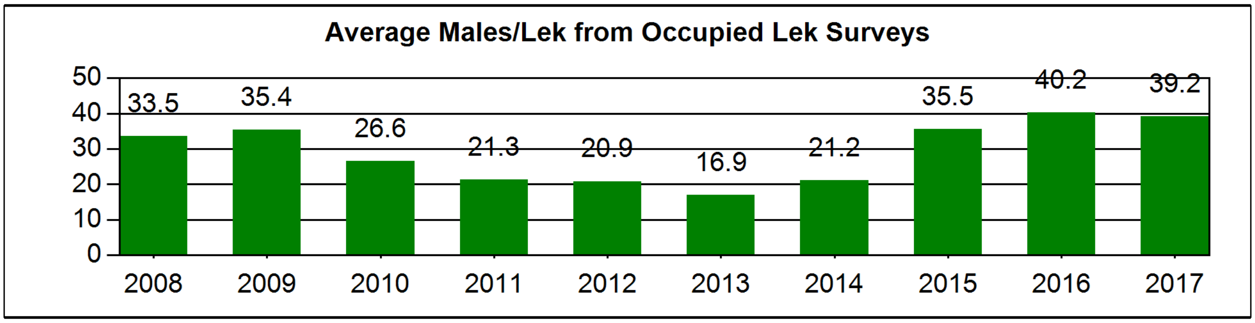
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

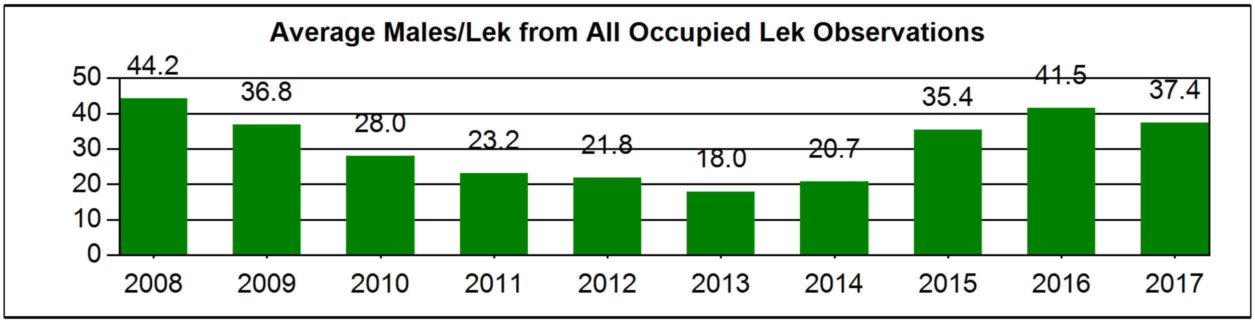
3) Inactive - Confirmed no birds/sign present (see official definitions)

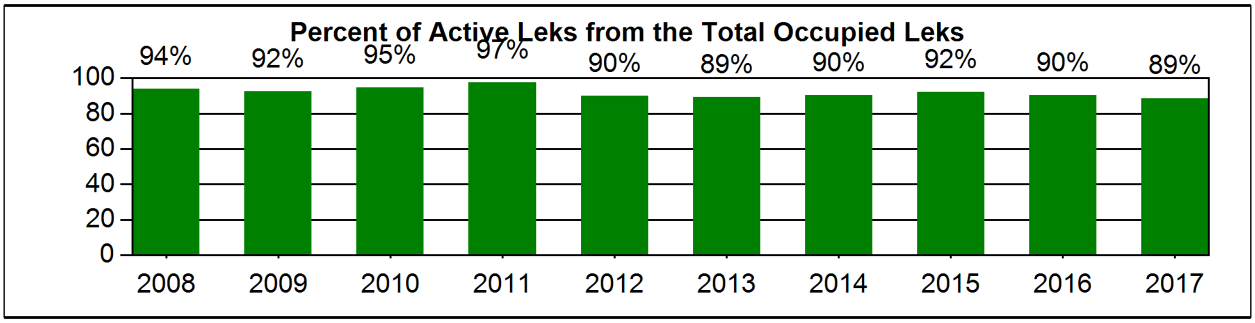
Sage Grouse Occupied Lek Attendance Summary

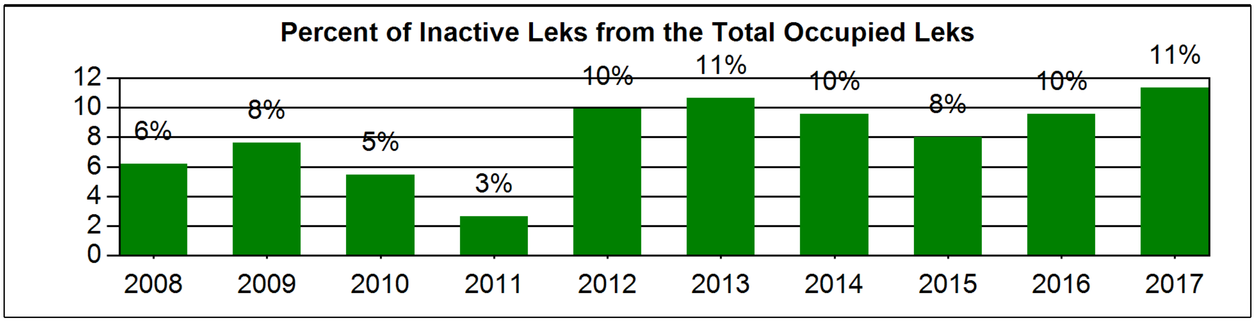
Year: 2008 - 2017, Working Group: Southwest











Sage Grouse Lek Characteristics

Working Group: Southwest

Region	Number	Percent
Green River	395	88.0
Pinedale	54	12.0

Working Group	Number	Percent
Southwest	449	100.0

Classification	Number	Percent
Occupied	332	73.9
Undetermined	7	1.6
Unoccupied	110	24.5

BLM Office	Number	Percent
Kemmerer	197	43.9
Pinedale	11	2.4
Rawlins	4	0.9
Rock Springs	237	52.8

Biologist	Number	Percent
Green River	168	37.4
Mountain View	227	50.6
Pinedale	53	11.8
South Lander	1	0.2

Warden	Number	Percent
Cokeville	55	12.2
Evanston	35	7.8
Green River	74	16.5
Kemmerer	68	15.1
Mountain View	51	11.4
Rock Springs	112	24.9
South Pinedale	54	12.0

County	Number	Percent
Fremont	4	0.9
Lincoln	133	29.6
Sublette	34	7.6
Sweetwater	212	47.2
Uinta	66	14.7

Land Status	Number	Percent
BLM	310	69.0
BOR	15	3.3
National Park	2	0.4
Private	106	23.6
State	15	3.3
USFS	1	0.2

Management Area	Number	Percent
G	449	100.0

Lek Status	Number	Percent
Active	279	62.1
Inactive	71	15.8
Unknown	99	22.0

Sage Grouse Job Completion Report

Year: 2007 - 2017, Working Group: Southwest

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

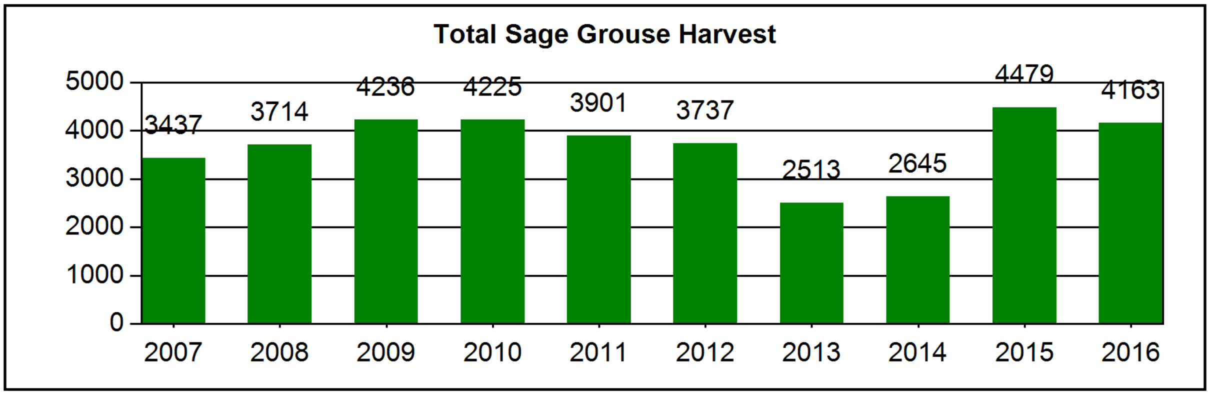
Year	Season Start	Season End	Length	Bag/Possesion Limit
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4
2011	Sep-17	Sep-30	14	2/4
2012	Sep-15	Sep-30	16	2/4
2013	Sep-21	Sep-30	10	2/4
2014	Sep-20	Sep-30	11	2/4
2015	Sep-19	Sep-30	12	2/4
2016	Sep-17	Sep-30	14	2/4

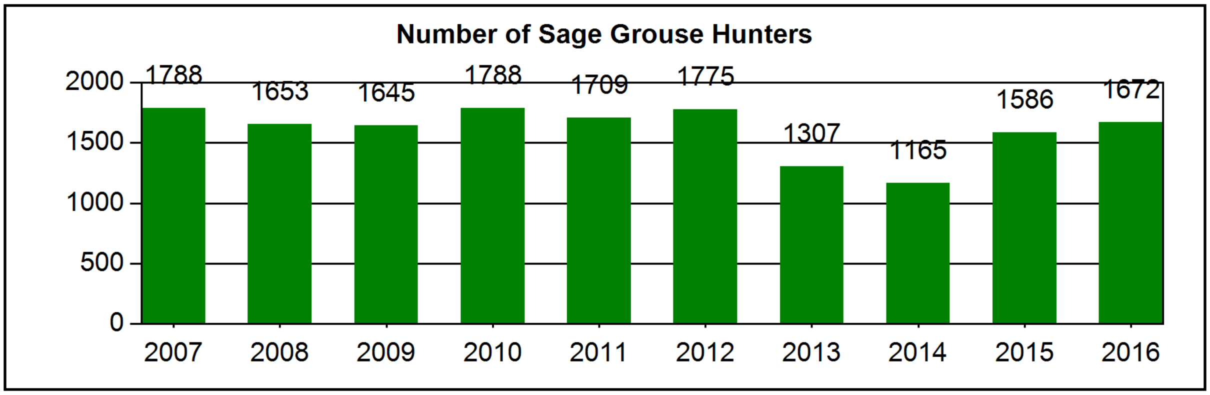
b. Harvest

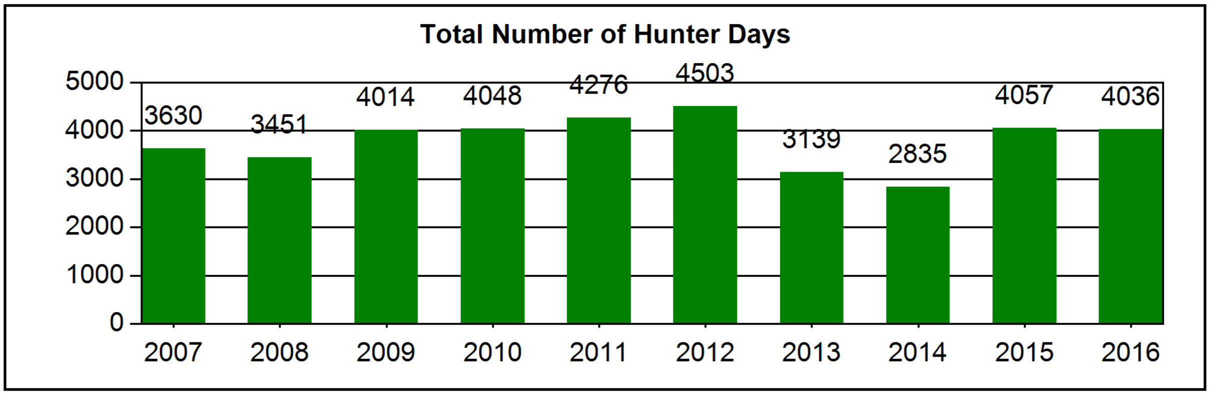
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2007	3437	1788	3630	0.9	1.9	2.0
2008	3714	1653	3451	1.1	2.2	2.1
2009	4236	1645	4014	1.1	2.6	2.4
2010	4225	1788	4048	1.0	2.4	2.3
2011	3901	1709	4276	0.9	2.3	2.5
2012	3737	1775	4503	0.8	2.1	2.5
2013	2513	1307	3139	0.8	1.9	2.4
2014	2645	1165	2835	0.9	2.3	2.4
2015	4479	1586	4057	1.1	2.8	2.6
2016	4163	1672	4036	1.0	2.5	2.4
Avg	3,705	1,609	3,799	1.0	2.3	2.4

Sage Grouse Harvest Summary

Working Group: Southwest

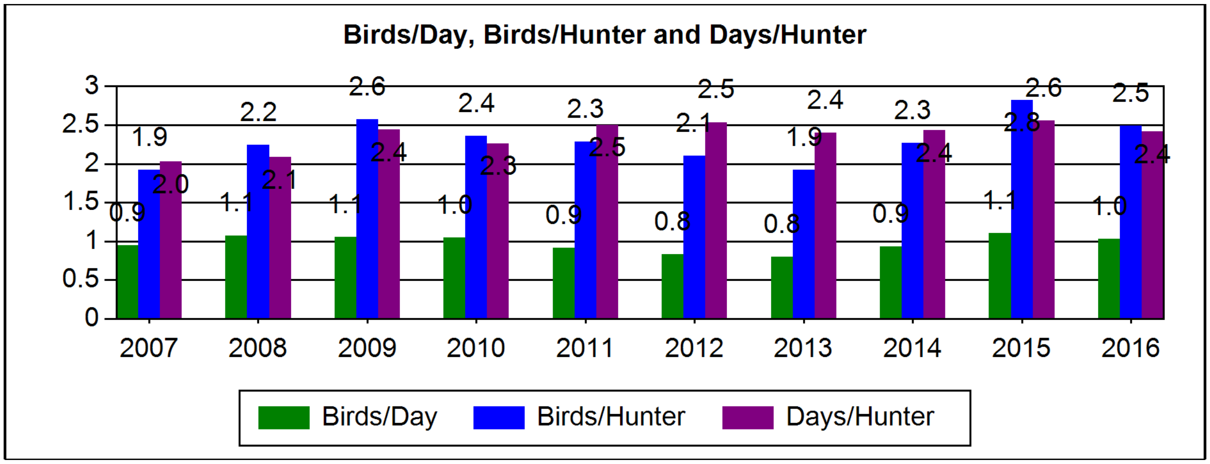






Sage Grouse Harvest Summary

Working Group: Southwest

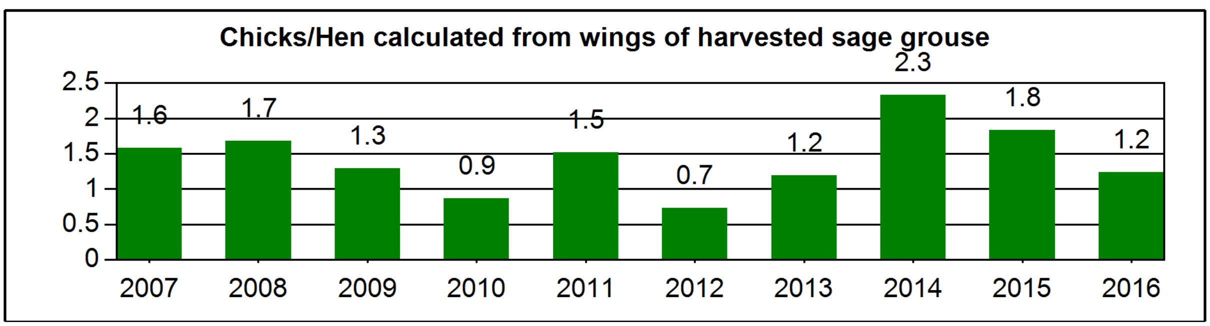


Sage Grouse Job Completion Report

Year: 2007 - 2016, Working Group: Southwest

4. Composition of Harvest by Wing Analysis

Year	Sample	Percent Adult		Percent Yearling		Percent Young		Chicks/
	Size	Male	Female	Male	Female	Male	Female	Hens
2007	509	18.5	26.5	3.3	3.7	22.6	25.3	1.6
2008	666	12.9	24.6	5.0	6.0	20.1	31.4	1.7
2009	887	11.7	30.0	4.4	6.7	20.0	27.3	1.3
2010	696	2.6	51.0	0.6	0.9	2.9	3.6	0.9
2011	998	6.1	31.9	2.9	4.3	23.9	30.9	1.5
2012	581	10.0	38.9	4.6	10.3	16.5	19.6	0.7
2013	390	9.2	38.5	1.5	2.3	20.5	27.9	1.2
2014	517	5.6	20.7	2.3	7.0	33.5	30.9	2.3
2015	860	13.5	25.1	3.1	4.3	27.4	26.5	1.8
2016	949	15.2	30.5	4.2	5.6	19.9	24.7	1.2



2016 Annual Sage-Grouse Job Completion Report

Conservation Plan Area: **Southwest**
Biological Year: **June 1, 2016 – May 31, 2017**
Prepared by: **Patrick Burke**

INTRODUCTION

The Southwest Wyoming Sage-Grouse Conservation Area (SWSGCA) is one of eight in Wyoming (Figure 1). The local working groups were created in 2004 and charged with developing and implementing plans to promote sage-grouse conservation for their respective areas. The conservation plan put together by the Southwest Local Working Group for the SWSGCA was completed in July 2007 and an updated version was completed during the 2013 reporting period. This report focuses on analysis of data for the biological year June 1, 2016-May 31, 2017, with comparisons made to the previous ten years of data.

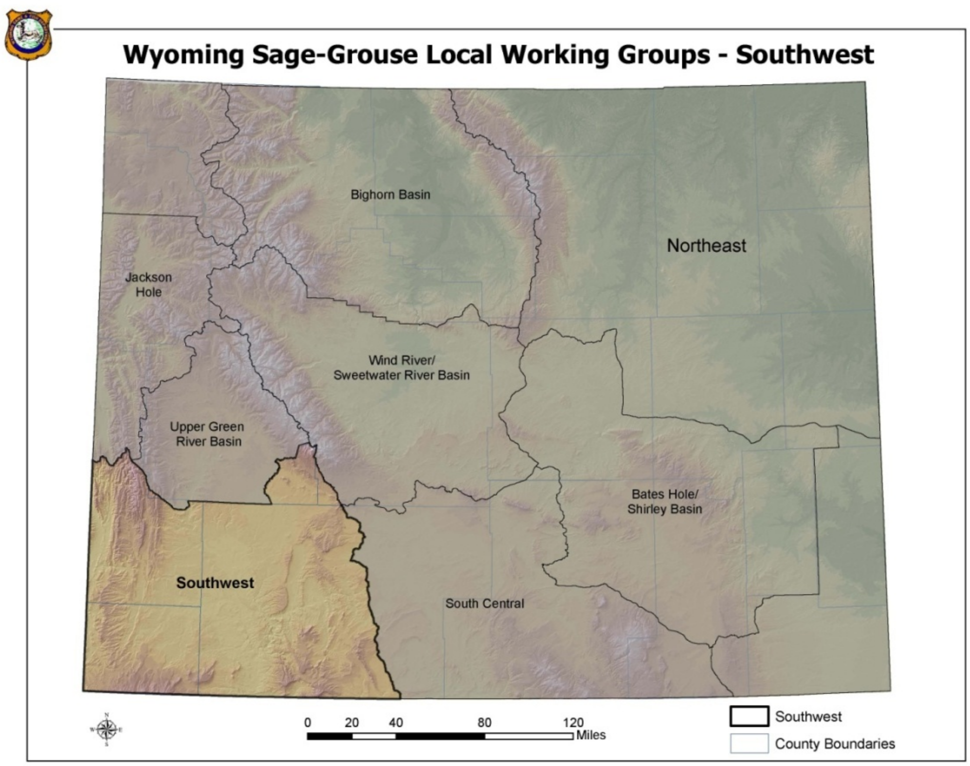


Figure 1. Wyoming Local Sage-Grouse Working Group Boundaries

Range-wide sage-grouse populations have experienced declines and loss of sagebrush habitats upon which they depend. In response, there has been an increased emphasis on sage-grouse data collection over the last couple of decades. These monitoring efforts have suggested that sage-grouse populations in the SWSGCA were at their lowest levels ever recorded in the mid-1990s. Since that low point, grouse numbers then responded to increased precipitation during the late 1990's with some individual leks seeing three fold increases in the number of males counted between 1997 and 1999. The return of drought conditions in the early 2000's led to decreases in chick production and survival and therefore population declines; although the populations never fell back to their mid-1990s levels. Well-timed precipitation in 2004-05 increased chick survival and later lek attendance, however drought conditions from 2006-08 appear to have caused the population in the southwest part of the state to decline. Increased springtime precipitation in 2009-2011 did not result in increased sage-grouse numbers. We suspect the moisture arrived with cold temperatures during the peak of hatching which may have reduced hatching success and early chick survival. Drought conditions again returned in 2012 and 2013, which resulted in decreased chick to hen ratios, suggesting a continuation of overall population declines. However, in 2014 much improved chick production and survival, evidenced by higher proportions of chicks to adult hens in hunter submitted wings resulted in higher lek attendance numbers in throughout the SWSGCA in 2015 and 2016. The spring of 2016 saw much better than average precipitation levels in southwest Wyoming, but similar to 2009-2011, the higher observed moisture levels did not result in increased chick recruitment.

In addition to the impacts that drought have on sage-grouse, some of the other causes of concern for sage-grouse populations in the SWSGCA include continued pressure from natural gas development, livestock grazing practices and vegetation treatment practices. In addition to the aforementioned threats, the recent interest in wind energy and solar development is a cause for concern and could potentially have measurable negative impacts on sage-grouse populations throughout Wyoming and the west. While most of the proposed wind energy projects in the SWSGCA are no longer being actively pursued, the potential for negative impacts to sage-grouse populations still exists if these projects are reinitiated.

The issues of hunting and predation and the potential impacts of hunting are concerns that have often raised by the public. There is little evidence suggesting that hunting has any population level impacts on sage-grouse in Wyoming (Christiansen 2010). Research in the Upper Green River Basin area suggests raven populations are heavily subsidized by human activities and raven predation may be impacting grouse in that area (Bui 2009). Other raven impact studies are continuing in the SWSGCA and South-Central SGCA with several resulting publications (Conover et al. 2010, Dinkins et al. 2012, Dinkins 2013, Dinkins et al. 2013, Dinkins et al. 2014a/b, Peebles 2015, Dinkins et al. 2016a/b).

WYOMING CORE AREA STRATEGY

Management of greater sage-grouse habitat in Wyoming is based on a “core area” strategy of limiting human disturbance in the most important sage-grouse habitats. This strategy is codified by a Governor’s executive order. The current Executive Order (2015-4) was signed by Governor Matt Mead in July of 2015. The Executive Order and related materials are available at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management

In 2015 the U.S. Fish and Wildlife Service issued a decision of “not warranted” for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. This means the State of Wyoming maintains management authority over sage-grouse in Wyoming and management emphasis focuses on implementation of the core area strategy. In its decision document, the Service specifically cited Wyoming’s core area strategy as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude the need for a future listing. Federal land use planning documents are largely consistent with the Wyoming strategy. The current core areas are shown in Figure 2.

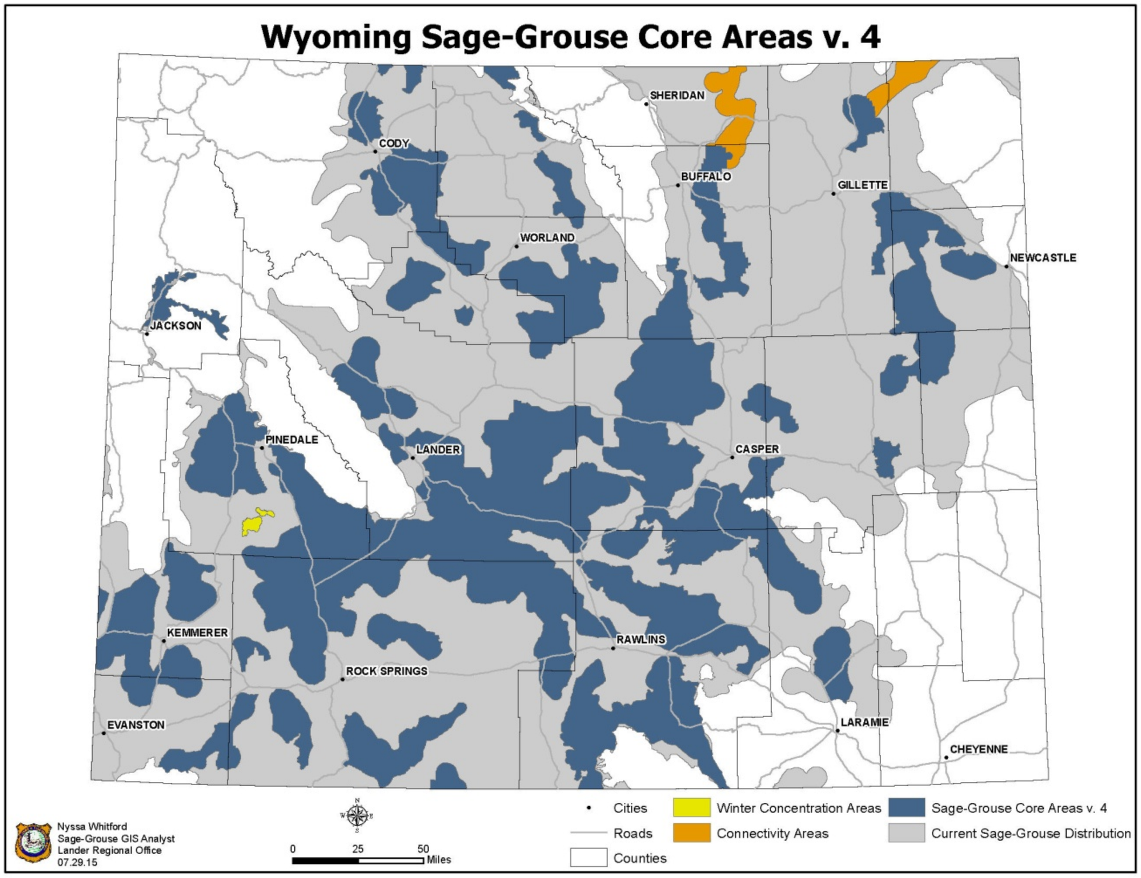


Figure 2. Wyoming sage grouse core areas Version 4.

METHODS

Data on numbers of sage-grouse males attending leks are collected in two ways: lek surveys and lek counts. Lek surveys are defined as at least one visit to a lek during the breeding season to determine if the lek is active or inactive. A lek is considered to be active if one or more males were observed strutting on the lek during one of the lek visits. Lek counts consist of three or more visits (separated by about 7-10 days) to a lek during the peak of strutting activity (late March-mid May) to more precisely estimate the maximum number of males attending that lek. Average male attendance is calculated as the maximum number of males observed on each lek divided by the number of leks checked, using only those leks that were known to be active that year.

Harvest information is obtained through a mail/internet questionnaire of Wyoming game bird license holders. From 1982 to 2009 sage-grouse harvest data were compiled by Upland Game Management Area. Management Areas in the SWSGCA included Areas 4, 5, 6, and a portion of Area 7 (Figure 3). The remainder of Management Area 7 was included in the Upper Green River Basin Conservation Planning Area (UGRBCA). Since 2010, sage-grouse harvest data have been reported by Sage-Grouse Management Area. The Sage-Grouse Management Areas were created to correspond to the local working group boundaries, which allow for harvest data to be more accurately attributed to each conservation planning area. The Sage-Grouse Management Area for the SWSGCA is Management Area G.

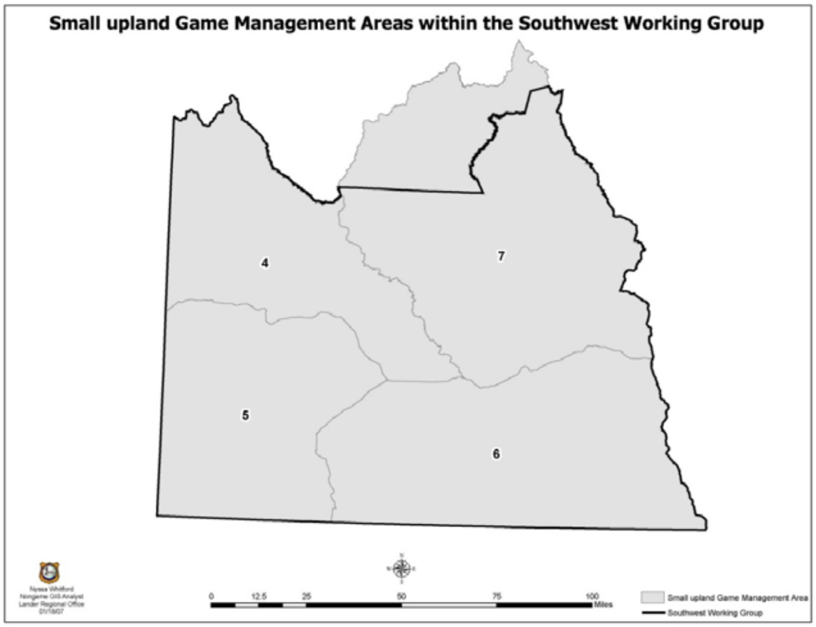


Figure 3. Small Game Management Areas within the Southwest Wyoming Sage-Grouse Conservation Planning Area that were used to report sage-grouse harvest prior to 2010.

In addition to the mailed/on-line questionnaire, wings are collected on a voluntary basis from harvested sage-grouse in order to determine the proportions of adults, juveniles, males, and females in the harvest. Wings were submitted by successful hunters at wing collection barrels distributed throughout the SWSGCA. Of primary interest is the chick to hen ratio, a statistic that provides an index of annual chick productivity and survival.

More specific methods for collecting sage-grouse data are described in the sage-grouse chapter of the WGFD Handbook of Biological Techniques (Christiansen 2012), which is largely based on Connelly et al (2003).

RESULTS

Lek Monitoring

A total of 336 occupied leks were known to exist in the SWSGCA during the 2017 lekking season. Of these 336 occupied leks, 299 of them were checked, with 97 of those checks being lek counts with three or more visits during the breeding season, with the remaining 202 checks consisting of lek surveys where less than three lek visits were made during the breeding season. In 2016, 94% of the known leks were checked at least once during the lekking season; in 2017, however only 89% of the known leks were checked. This lower visitation rate was caused largely by the above average snow that the region received during the 2016-2017 winter. This increased snow pack resulted in many leks being inaccessible during the spring months because of persistent snow and muddy roads caused by melting snow.

Of the 299 lek visits to known lek sites in the SWSGCA conducted in 2017, 250 of them were documented as being active, 32 were classified as being inactive and 17 leks were of unknown or undetermined status. All lek monitoring data from 2017, along with data from the past ten years for comparison are summarized in Appendix B Tables 1 a-d and JCR Data Figures 2 a-e.

Because of the quantity of leks in the SWSGCA, data collection efforts have focused on lek surveys, which involved at least one visit to the lek during the breeding season over lek counts, which are more labor intensive and involve three or more visits during the breeding season. Fedy and Aldridge (2011) determined that population trends demonstrated by lek surveys are the same as those indicated by lek counts as long as the number of leks surveyed exceeds 50 leks in an area.

Since only "occupied" leks are being reported on Appendix B Tables 1 a-d, it is important to consider trends in the numbers of active versus inactive leks in addition to the average size of active leks. During a period of population decline, the size of active leks typically declines and the number of inactive leks increases. The converse is typically true of an increasing population. Therefore the magnitude of both increases and decreases is usually greater than what is indicated by the average lek size alone. The proportion of known status leks that were active in the SWSGCA has remained relatively steady over the 10-year reporting period varying from 88-98% active, with the proportion active for the 2017 lekking season being at the lower end of the range at 89% active.

Monitoring the total number of males on a lek is used as an index of trend, but these data should be viewed with caution for several reasons: 1) the survey effort and the number of leks surveyed/counted has varied over time, 2) it can be safely assumed that not all leks in the area have been located, 3) sage-grouse populations can exhibit cyclic patterns over approximately a decade long period, 4) the effects of un-located or un-monitored leks that have become inactive cannot be quantified or qualified, and 5) lek sites may shift over time. Both the number of leks and the number of males attending these leks must be quantified in order to estimate population trend.

The average number of males per active lek for all leks checked (both counted and surveyed) during the 2017 lekking season was 37.4 males per active lek. This is a 10% decrease from the 41.5 males per active lek observed in 2016, but still above the 10 year average of 31.8 males per active lek; but well below the 48 males per lek observed in 2007. The average number of males in attendance on the 97 count leks in 2017 was 34.3 males per lek. This number is better than the low numbers seen in 2013 and 2014, but it is below last year's observed number of 44 males per active lek, and below the 10-year average of 36.1 males per count lek. For the 202 leks that were surveyed in 2017, the average lek had 39.2 males in attendance, which is above the recent average of 29.5, but down from 2016's observed value of 40.2.

It is important to note that data collection efforts have increased considerably since the early 2000's. In 2000, only 63% of known occupied leks were checked, but in recent years, the number annually checked is usually above 90% of the known occupied leks. In addition, efforts by WGFD personnel, volunteers, and other government and private industry biologists have led to increased numbers of known leks.

Currently, no method exists to estimate total sage-grouse population size in a statistically significant way. However, the recent male per lek averages along with the observed chick per hen ratios in hunter submitted wings indicate that the sage-grouse population in southwest Wyoming had been slightly decreasing during this reporting period.

Harvest

The 2016 hunting season for sage-grouse in the SWSGCA ran from September 17 to September 30 and allowed for a daily take of 2 birds with a limit of 4 grouse in possession (Appendix B Table 2 a). The 2016 season was consistent with how the season has been run since 2002 when the season opening date was moved to the third Saturday in September and the daily bag limit was reduced to 2 birds and a possession limit of 4 birds. The sage-grouse season had historically started as early as September first and ran for 30 days; during this time the daily limit was 3 grouse with a possession limit of up to 9 birds. Over time, the season was gradually shortened and the daily bag and possession limits reduced because of concern over declining sage-grouse populations. The opening date was moved back from the first of September to the third weekend because research suggested that hens with broods were concentrated near water sources earlier in the fall and therefore more susceptible to harvest. The later opening date allowed more time for those broods to disperse and therefore reduced hunting pressure on those hens that were successful breeders and on young of the year birds.

The data for grouse harvested in the SWSGCA are reported under Sage-Grouse Management Area G for the 2011 through 2016 hunting seasons. Note that for 2007-2009 the data for all birds harvested in Management Areas 4, 5, 6, and 7 were included in the SWSGCA report even though a portion of Area 7 was located in the UGRBSGCA (Figure 3). Since the majority of Area 7 resided within the boundaries of the SWSGCA, the decision was made to include all of the data from Area 7 in SWSGCA report.

Based on harvest survey estimates, 1,672 hunters harvested 4,163 sage-grouse during the 2016 hunting season (Appendix B Table 2 b and Figures 2 a-d). This is down slightly from the 4,479 birds reported harvested in 2015, but it is above the 10 year average harvest of 3,791 birds. The trends in harvest statistics over the last 10 years are not well correlated with average male lek attendance due to changes in hunting season structure, weather conditions, and hunter participation levels over that period.

Wings are collected each hunting season via voluntary hunter submission to allow for the determination of the sex and age of harvested birds. Successful hunters submitted 949 grouse wings from the 2016 hunting season (Appendix B Table 3). This represents just over 23% of the estimated total harvest for 2016, which is slightly about the average submission rate of around 18%-19%, but it is down from the 2011 submission rate, when over one-quarter of the estimated harvest was submitted for age analysis.

The most important ratio obtained from the wing analysis is the chick to hen ratio; this ratio provides a general indication of chick recruitment. Assuming that hen and chick harvest is proportional to the actual makeup of the population, chick production for that year can be estimated. Even if the rate of harvest between age/sex groups is not random, the information can be used as a tool for looking at population trends as long as any biases are relatively consistent across years.

In general it appears that chick:hen ratios of about 1.3:1 to 1.7:1 result in relatively stable lek counts the following spring, while chick:hen ratios of 1.8:1 or greater result in increased lek counts and ratios below 1.2:1 result in subsequent declines. The chick:hen ratio as determined from hunter submitted wings for the 2016 hunting season was 1.2 chicks/hen (Appendix B Table 3 and Figure 3). This ratio suggests a slightly decreasing grouse population. This observed chick:hen ratio corresponds well with the decreased male lek attendance seen in the spring of 2017.

Weather

Spring habitat conditions are one of the most important factors in determining nesting success and chick survival for sage-grouse. Specifically, shrub height and cover, live and residual grass height and cover, and forb production, all have a large impact on sage-grouse nesting and brood rearing success. The shrubs and grasses provide screening cover from predators and weather while the forbs provide forage and insects that reside in the forbs, which are an important food source for chicks. Spring precipitation is an important determinant of the quality and quantity of these vegetation characteristics. Residual grass height and cover depends on the previous year's growing conditions and grazing pressure while live grass and forb cover are largely dependent on the current year's precipitation.

Winter weather has not been shown to be a limiting factor to sage-grouse except in areas with persistent snow cover that is deep enough to limit sagebrush availability. This condition is rarely present in the SWSGCA even during the above average winter of 2010-2011.

The spring (March-June) precipitation and fall chick:hen ratios (as determined by hunter submitted wings) are given in Table 1 and Figure 4. Generally speaking, when spring precipitation is at or above 90% of average, chick to hen ratios are above average, but when spring precipitation is below average, chick:hen ratios also tend to be below average. However, periods of prolonged cold, wet weather may have adverse effects on hatching success, plant and insect phenology and production and chick survival.

The below average precipitation observed in 2012 and 2013 coincides with the below average chick ratio observed in the 2012 and 2013 wing submissions. Precipitation increased in the fall of 2013 and weather conditions heading into the 2014 nesting season were favorable and even though the spring precipitation in 2014 was only 86% of normal it was enough moisture to result in improved chick survival in 2014. The better than average spring time precipitation observed in 2015 of 169% of average did not, however result in as high of chick to hen ratios as would have been expected. Many areas of the state experienced heavy precipitation and even flooding in May 2016 potentially reducing nesting success and chick survival. The spring of 2016 saw even higher moisture levels in the SWSGCA with the March to June precipitation level being 190% of average; this however, again did not result in increased chick recruitment. This may have been one of those years when the high precipitation levels resulted in cold, wet conditions that negatively impacted chick survival.

Table 1. Spring precipitation compared to fall chick:hen ratios in the SWSGCA 2005-2015. Precipitation data from: http://www.wrcc.dri.edu/index.html (Click on Monitoring – under Monitoring click on Drought Monitoring then click on Monthly divisional precipitation or temperature – click on the map in the relevant portion of Wyoming, in this case division #3 Green and Bear Drainage Division – set up the plot as desired including "List the data for the points plotted?" Option – add the percentages listed under March through June of the year of interest and divide by four).

Year	% of Average March-June Precipitation	Chicks:Hen
2006	50%	1.1
2007	57%	1.8
2008	64%	2.1
2009	144%	1.4
2010	110%	0.9
2011	116%	1.5
2012	54%	0.7
2013	84%	1.2
2014	105%	2.3
2015	169%	1.8
2016	190%	1.2

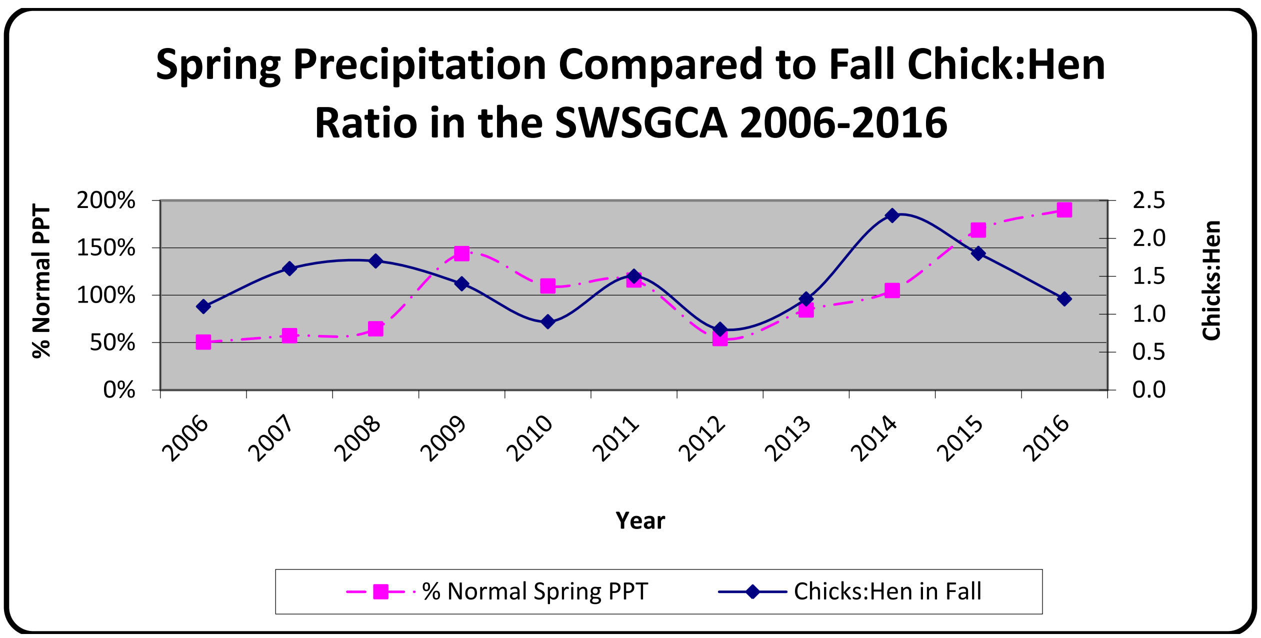


Figure 4. Percent of normal spring precipitation compared to fall chick to hen ratios in the Southwest Wyoming Sage-Grouse Conservation Planning Area

HABITAT AND SEASONAL RANGE MAPPING

While new leks are still being located in the SWSGCA, we believe that the majority of the currently occupied leks have been documented, however important other seasonal habitats such as winter concentration areas and especially nesting/early brood-rearing areas have not yet been adequately identified.

CONSERVATION PLANNING/IMPLEMENTATION

Since 2005, Local Working Groups have supported implementation of local sage-grouse conservation projects with funding appropriated from State of Wyoming General Fund as requested by the governor and approved by the legislature. In early 2017 funding of the sage-grouse program was transferred from the legislature back to the WGFD. A license fee increase was passed by the legislature to fund this change. See Table 2 for a list of the projects implemented in, or on behalf of, the SWSGCA during the reporting period.

Table 2. Projects funded in part by the SWSGLWG, 2016.

Project Name	Project Description	Partners
Albert Creek Allotment wet meadow restoration	Restoring historic creek flows and riparian vegetation in an area impacted by old non-functioning, and eroded stock dams.	USFWS, Uinta Co. Conservation Dist., grazing permittees, SW LWG
Geophagy and greater sage-grouse	Continuing research to determine why sage-grouse consume soil and how this behavior influences survival and productivity.	UGRB LWG, SW LWG, WLCI Ruby Pipeline mitigation, BLM, Encana, WY Dept of Ag, Teton Raptor Center
Identification of winter concentration areas: abundance and resource selection	Identity winter concentration of sage-grouse though use of infrared videography and evaluating habitat characteristics and climate variables associated with abundance and selection.	Univ. of WY, SC LWG, SW LWG, Oregon State Univ., Governor's SG Implementation Team
Response of SG to sagebrush treatments Phase IV	Continuing research to determine sage-grouse demographic and habitat use response to sagebrush treatments	University of Wyoming, Kelly Ornith. Research Fund, BLM, WY Reclamation & Restoration Center, WWNRT, multiple LWGs
Habitat quality of core areas relative to avian and mammalian predators	Research to compare avian and mammalian predator abundance in and out of core areas. Map predator densities. Evaluate predator removal activities.	BHB LWG, BHSB LWG, SW LWG, Oregon State Univ.

PAST RESEARCH/STUDIES IN THE SWSGCA

Conover, M. R., J. S. Borgo, R. E. Dritz, J. B. Dinkins and D. K. Dahlgren. 2010. Greater sage-grouse select nest sites to avoid visual predators but not olfactory predators. The Condor 112(2):331-336.

Dinkins, J. B., M. R. Conover, C. P. Kirol, and J. L. Beck. 2012. Greater sage-grouse (*Centrocercus urophasianus*) select nest-sites and brood-sites away from avian predators. The Auk 129:600–610.

Dinkins, J.B., M.R. Conover and S.T. Mabray. 2013. Do artificial nests simulate nest success of greater sage-grouse? Human–Wildlife Interactions 7(2):299–312.

Dinkins, J.B. 2013. Common raven density and greater sage-grouse nesting success in southern Wyoming: potential conservation and management implications. Dissertation. Utah State Univeristy, Logan.

Dinkins, J.B., M.R. Conover, C.P. Kirol, J.L. Beck, and S.N. Frey. 2014a. Greater sage-grouse (Centrocercus urophasianus) hen survival: effects of raptors, anthropogenic and landscape features, and hen behavior. Canadian Journal of Zoology 92:319-330.

Dinkins, J.B., M.R. Conover, C.P. Kirol, J.L. Beck and S.N. Frey. 2014b. Greater Sage-Grouse (Centrocercus urophasianus) select habitat based on avian predators, landscape composition, and anthropogenic features. The Condor 116 (4), 629-642.

Dinkins, J. B., K. T. Smith, J. L. Beck, C. P. Kirol, A. C. Pratt, and M. R. Conover. 2016. Microhabitat conditions in Wyoming sage-grouse core areas: effects on selection and nest success. PLoS ONE 11:e0150798.

Dinkins, J. B., M. R. Conover, C. P. Kirol, J. L. Beck, and S. N. Frey. 2016. Effects of common raven and coyote removal and temporal variation in climate on greater sage-grouse nesting success. Biological Conservation 202:50–58.

Heath, B. J., R. Straw, S. H. Anderson and J. Lawson. 1997. Sage-grouse productivity, survival, and seasonal habitat use near Farson, Wyoming. Completion Report. Wyoming Game and Fish Department. Cheyenne.

Patterson, R. L. 1952. The sage-grouse in Wyoming. Wyoming Game and Fish Department. Sage Books.

Peebles, L. W. 2015. Winter ecology of common ravens in southern Wyoming and the effects of raven removal on greater sage-grouse populations. Paper 4617. Thesis. Utah State University, Logan.

Slater, S. J. 2003. Sage-grouse *(Centrocercus urophasianus)* use of different-aged burns and the effects of coyote control in southwestern Wyoming. M.S. Thesis. University of Wyoming, Department of Zoology and Physiology. Laramie.

Slater, S. J. and J. P. Smith. 2010 Effectiveness of raptor perch deterrents on an electrical transmission line in southwestern Wyoming. Journal of Wildlife Management 74:1080-1088.

RECOMMENDATIONS

1) Identify important seasonal habitats, especially brood rearing areas.

2) Continue to implement provisions of the Governor's executive order for sage-grouse core area management.

3) Continue implementation of the SWSGCA Conservation Plan.

4) Continue expanded lek searches to ensure that all active leks within the SWSGCA have been identified.

LITERATURE CITED

Bui, T.D. 2009. The effects of nest and brood predation by common ravens (*Corvus corax*) on greater sage-grouse (*Centrocercus urophasianus*) in relation to land use in western Wyoming. M.S. Thesis. University of Washington, Seattle.

Christiansen, T. 2012. Chapter 12: Sage Grouse (*Centrocercus urophasianus*). Pages 12-1 to 12-55 in S.A. Tessmann and J.R. Bohne (eds). Handbook of Biological Techniques: third edition. Wyoming Game and Fish Department. Cheyenne.

Christiansen, T. 2010. Hunting and sage-grouse: a technical review of harvest management on a species of concern in Wyoming. Wyoming Game and Fish Department, Cheyenne.

Conover, M. R., J. S. Borgo, R. E. Dritz, J. B. Dinkins and D. K. Dahlgren. 2010. Greater sage-grouse select nest sites to avoid visual predators but not olfactory predators. The Condor 112(2):331-336.

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Dinkins, J.B., M.R. Conover and S.T. Mabray. 2013. Do artificial nests simulate nest success of greater sage-grouse? Human–Wildlife Interactions 7(2):299–312.

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Dinkins, J. B., K. T. Smith, J. L. Beck, C. P. Kirol, A. C. Pratt, and M. R. Conover. 2016a. Microhabitat conditions in Wyoming sage-grouse core areas: effects on selection and nest success. PLoS ONE 11:e0150798.

Dinkins, J. B., M. R. Conover, C. P. Kirol, J. L. Beck, and S. N. Frey. 2016b. Effects of common raven and coyote removal and temporal variation in climate on greater sage-grouse nesting success. Biological Conservation 202:50–58.

Fedy, B.C. and C.L. Aldridge. 2011. The importance of within-year repeated counts and the influence of scale on long-term monitoring of sage-grouse. Journal of Wildlife Management 75(5): 1022-1033.

Peebles, L. W. 2015. Winter ecology of common ravens in southern Wyoming and the effects of raven removal on greater sage-grouse populations. Paper 4617. Thesis. Utah State University, Logan.

Upper Green River Basin Sage-Grouse Job Completion Report 2016

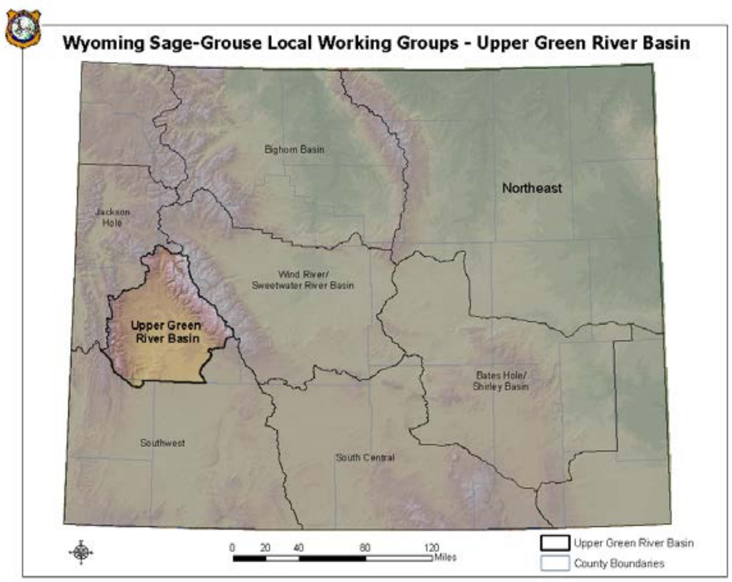
June 2016-May 2017

Dean Clause
Wyoming Game & Fish Dept.
Pinedale Region

Narrative
Conservation Plan Area: **Upper Green River Basin**
Period Covered: **6/1/2016 – 5/31/2017**
Prepared by: **Dean Clause**

Introduction

The Upper Green River Basin Working Group Area (UGRBWGA) covers Sage-grouse Management Area (SGMA) D that lies within Sublette County. All lek data and harvest data from SGMA D is included in this 2015 JCR. Prior to 2010, only harvest data from UGBMA 3 was included in the report while that portion of UGBMA 7 that lies with UGRBWGA was reported in the Southwest WG JCR.



Sage-grouse are found in suitable sagebrush uplands throughout the Upper Green River Basin. Sage-grouse habitats within Sublette County are expansive and relatively intact outside of developing natural gas fields. Habitats for sage-grouse within Sublette County occur throughout mixed land ownership jurisdictions. Most sage-grouse leks are found on Bureau of Land Management (BLM) lands (82%), with fewer leks found on private (12%), and state (6%) ownership. Nesting and early brood rearing habitats are also found predominantly on BLM lands, while many birds move to moist meadow habitat located on private or public/private interfaces during late brood rearing and/or summer. Fall movements away from these moist areas to sagebrush-dominated uplands on BLM lands occur in late September/early October. As winter progresses, birds concentrate on sagebrush upland habitats. These winter concentration areas are also located primarily on BLM lands.

Traditionally, sage-grouse data collection within the Pinedale Region has focused on lek surveys, with a secondary emphasis on collecting information from harvested birds. Prior to 1994, relatively few leks were monitored and prior to 2000, standardized efforts were not used to collect sage-grouse lek information. Since 2000, efforts have been made to standardize lek data collection methods and increase lek monitoring efforts (i.e. collect data on more leks along with increasing the number of site visits per lek). Current lek monitoring has shifted from "lek surveys" to "lek counts" as described below.

Information presented in this report includes data and trend analysis for lek monitoring, population trends, harvest rates, productivity rates, winter distribution surveys, and weather data. Other categories covered in this report include special projects/research, management summaries, and recommendations.

Data Collection Efforts and Methods

Lek monitoring consists of inventory methods called "lek counts" or "lek surveys". A lek count consists of at least 3 site visits during the strutting season, with each visit conducted at least 7 days apart. Lek counts are used to determine annual status (active or inactive) along with determining population trends. A lek count can also be a census technique that documents the actual number of male sage-grouse observed on a lek complex. A lek complex is defined as a group of leks in close proximity between which male sage-grouse may be expected to interchange from one day to the next. In order to be classified as an accurate lek count (or census), a lek observation must include all leks within a complex on the same morning. These simultaneous observations must be performed at least 3 times during the strutting season, with at least 7 days separating each lek observation. Lek complex counts have not routinely been conducted due to manpower and logistical restraints; although most leks within close proximity to one another typically get visited on the same morning and therefore probably do meet the requirements for lek complex counts. Besides arbitrary delineation of lek complexes in the past base on geographic area, efforts have not been using actual male movements to map lek complexes, and therefore individual lek complexes are unknown at this time.

A lek survey consists of only 1 or 2 site visits during the strutting season. Lek surveys are primarily important to identify annual status (active or inactive) of a particular lek or lek complex and not for estimating population trends. However, population trends are essentially the same between counts and surveys when over 50 leks are sampled (Fedy and Aldridge 2011). Overall, lek counts are preferred over surveys and recent emphasis has been placed on collecting lek counts.

Based on the findings at each lek, the lek is assigned an annual status of "Active" (attended by more than one male sage-grouse), "Inactive" (it was known that there was no strutting activity during the breeding season), and "Unknown" (either active or inactive status has not been determined). Based on the past and current status, leks are assigned one of the three categories for management purposes. The category "Occupied" is a lek that has been active during at least one strutting season within the last ten years. Management protection will be afforded to occupied leks. An "Unoccupied" lek has not been active during the past 10 years, although there must be sufficient data to justify placing a lek into this category. A lek survey or count must have been conducted 4 out of 10 years during non-consecutive years (i.e. every other year) without activity to be placed in the "Unoccupied" category. Unoccupied leks are also broken down into two subcategories ("Destroyed" – habitat no longer exists or "Abandoned" – habitat still exists). Management protection is not afforded to unoccupied leks. The third category is "Undetermined" which is a lek that has not documented grouse activity in the past 10 years, but doesn't have sufficient data to be classified as unoccupied (as mentioned above). Management protection is not afforded to undetermined leks.

Information on the sex/age composition of harvested birds is collected through the use of wing barrels distributed throughout Sublette County each fall. Productivity information is estimated from this data set, as the number of chicks/hen can be derived. Wing collections can also provide valuable harvest trend data. Harvest estimates for each Sage-Grouse Management Area are obtained through a hunter harvest questionnaire that is conducted annually.

With declining long-term sage-grouse populations, both locally and range-wide, increased effort has been placed on collecting sage-grouse data. In addition, the increase in natural gas exploration and development within Sublette County raised concerns regarding the impact of such large-scale landscape developments on sage-grouse populations. In response, several sage-grouse research projects were initiated in this region. Local research indicated that habitat protection measures (stipulations) being implemented during the studies were not sufficient to protect sage-grouse and their habitats. The results of this research have been important in the revision of some stipulations, the development of the Wyoming Core Area Strategy (discussed below) and revisions to BLM and Forest Service planning documents.

Prior to the winter of 2003, sage-grouse winter distribution information had only been collected opportunistically during other winter surveys (deer, elk, and moose composition counts) and ground observations that were documented in the Wildlife Observation System (WOS). Some data had also been collected by private wildlife consultants conducting ground surveys directed by the BLM for clearance associated with gas development. Since 2004, most areas within the Upper Green River Basin have been surveyed to document important sage-grouse wintering areas. These surveys have been conducted aerially with a helicopter during January/February using stratified transects at approximately 1 minute (~1 mile) intervals or less to document sign and live observations of grouse. These aerial surveys, along with other existing data, are very useful baseline information to identify important winter grouse habitats for future management decisions.

Weather data (particularly precipitation data) is helpful in understanding the effects of environmental conditions on sage-grouse population dynamics. Lower than normal precipitation can affect sage-grouse by reducing the amount of herbaceous vegetation necessary for successful nesting, reduce insect and forb production for early brood success, and reduce the quantity and quality of sagebrush. Not only the amount of annual precipitation, but the timing of precipitation events can be a very significant influence on sage-grouse populations. Temperatures during nesting and early brood rearing periods (April – June) can also influence nest success and chick survival. A National Climatic Data Center (NOAA Satellite and Information Service) weather site has been utilized to gather moisture and temperature data. Wyoming is split into 10 different weather reporting Divisions. Division 3 covers the entire southwestern portion of Wyoming and is used in this UGRB Sage-grouse JCR to report precipitation and temperature trends. Climatic data for Division 3 can be found at the NCDC/NOAA web site: http://www.ncdc.noaa.gov/cag/time-series/us .

More specific methods for collecting sage-grouse data are described in the sage-grouse chapter of the WGFD Handbook of Biological Techniques (Christiansen 2012) located on the WGFD website (http://wgfd.wyo.gov/).

Results

Lek Monitoring

A total of 158 leks are currently documented in the UGRBWGA. These leks are classified as follows; 136 occupied, 22 unoccupied, and 0 undetermined. During 2017, a total of 126 occupied leks (93%) were checked (survey or count). Lek monitoring efforts in 2017 primarily focused on counts (71%) over surveys (21%). Compared to previous years, the proportion of overall leks monitored and lek counts in 2017 were lower due to difficult access from persistent snow accumulation this past winter, in particular those leks along foothill habitats. Results from the counts and surveys showed that 77% of the leks were active and 23% were inactive. The average number of males/lek for all active leks decrease slightly to 55 in 2017, compared to the past three years of 57 in 2016, 53 in 2015, and 36 in 2014. This results in nearly a 4 decrease compared to 2016 and a 58% increase compared to 2014 (Figure 1).

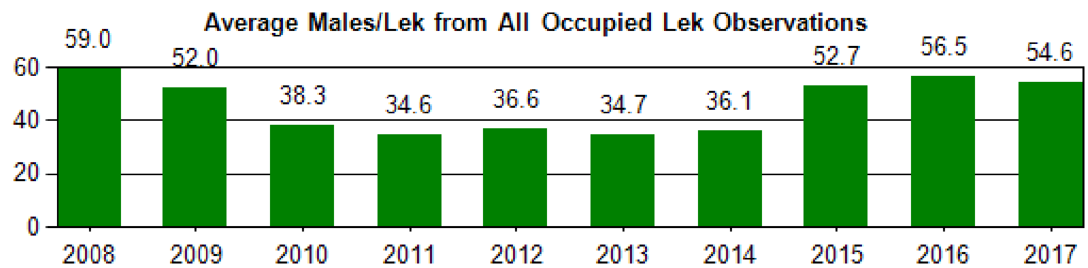


Figure 1. Average Peak Male Sage-grouse Lek Attendance 2008-2017, UGRBWG Area.

The last peak in male attendance occurred in 2007 and was the highest level ever recorded for the area. Since 2007, the observed average peak male has declined through 2010, stabilized from 2011-2014, and increased in 2015-2016 (Figure 1). The 2017 male lek attendance is 20% lower compared to the peak in 2007 using all occupied leks within the UGRBWGA. This trend is likely a combination of the cyclic nature of sage-grouse populations (Fedy and Doherty 2010) and drought combined with documented influences from habitat fragmentation in the Upper Green River Basin. Caution is warranted when analyzing long-range data sets (20+ years) within the UGRBWG area as the number of known (documented) leks have more than doubled during the past 17 years. Since many of these newly documented leks probably existed but were not monitored, there is some speculation in regards to what the average number of males/lek actually was prior to the mid 1990's.

The proportion of leks checked that are confirmed “active” has stayed relatively stable during the past 10 years, ranging from 77% to 84%. Although, there has been increased lek inactivity and abandonment in areas associated with gas development activity. Additional lek monitoring efforts and searches have resulted in locating new or undiscovered leks (57 new leks since 2004) mathematically negating the downward trend in the proportion of active leks in the UGRBWGA.

An analysis was performed and reported in the 2015 JCR (covering the period from June 2015 – May 2016) to assess longer range population trends in the UGRBWG. Overall, trends are similar when comparing all lek data within the UGRBWGA and a sub-set of leks that were monitored since 1997 or earlier (Figure 2). See the 2015 UGRB Sage-Grouse Job Completion Report for further detailed analysis.

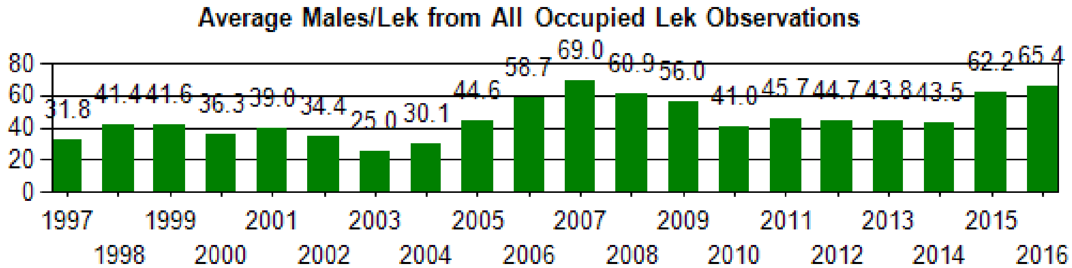


Figure 2. Average Peak Male Sage-grouse Lek Attendance 1997-2016 using only leks known in 1997, UGRBWG Area.

Also in the 2015 UGRB Sage-Grouse Job Completion Report, a lek analysis to assess natural gas development impacts in the Pinedale area was performed that showed higher rates of decline on leks (males) near or within gas field development compared to leks away from gas development. Two data sets were derived from all the known leks within the UGRBWGA using the most current aerial imagery. The group of leks referred to as “Disturbed Leks” were those leks within or near (roughly within one mile) active gas field development within the Pinedale Anticline Project Area (PAPA) and the Jonah. The other group of leks referred to as “Undisturbed Leks” used all the remaining leks not included in the Disturbed Leks data set. In comparing the two data sets (Disturbed Leks vs. Undisturbed Leks), the average number of peak males/lek for occupied leks reveal similar trends (Figures 3 & 4).

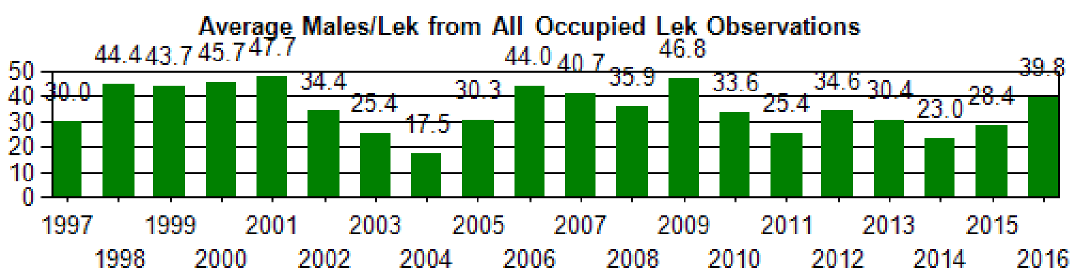


Figure 3. Average Peak Male Sage-grouse Lek Attendance 1997-2016, Disturbed Leks.

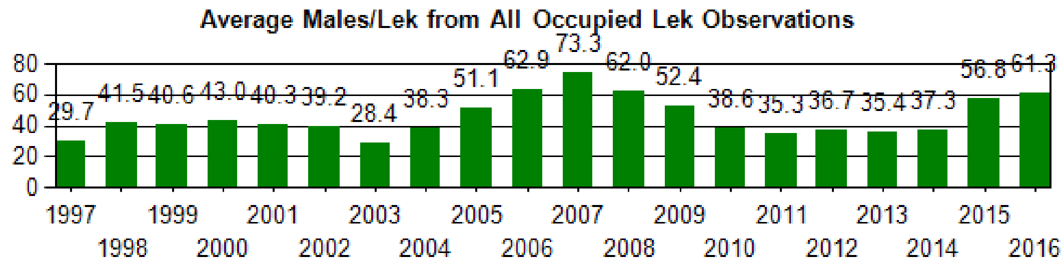


Figure 4. Average Peak Male Sage-grouse Lek Attendance 1997-2016, Undisturbed Leks.

The difference documented between the two data sets is associated with the proportion of active and occupied leks. The Disturbed Leks show activity levels declining from an average of 86% (1997-2001) to 45% by 2016 (occupied leks only). The Undisturbed Leks show activity levels changing very little with an average of 81% (1997-2001) to 84% by 2016, see Figure 5. In addition, a much higher proportion of leks are currently unoccupied (abandoned or destroyed) within or near the PAPA and Jonah gas fields (Disturbed Leks) at 42% compared to 10% outside the PAPA and Jonah as fields (Undisturbed Leks). Please see the 2015 UGRB Sage-Grouse JCR for further details associated with this gas development analysis.

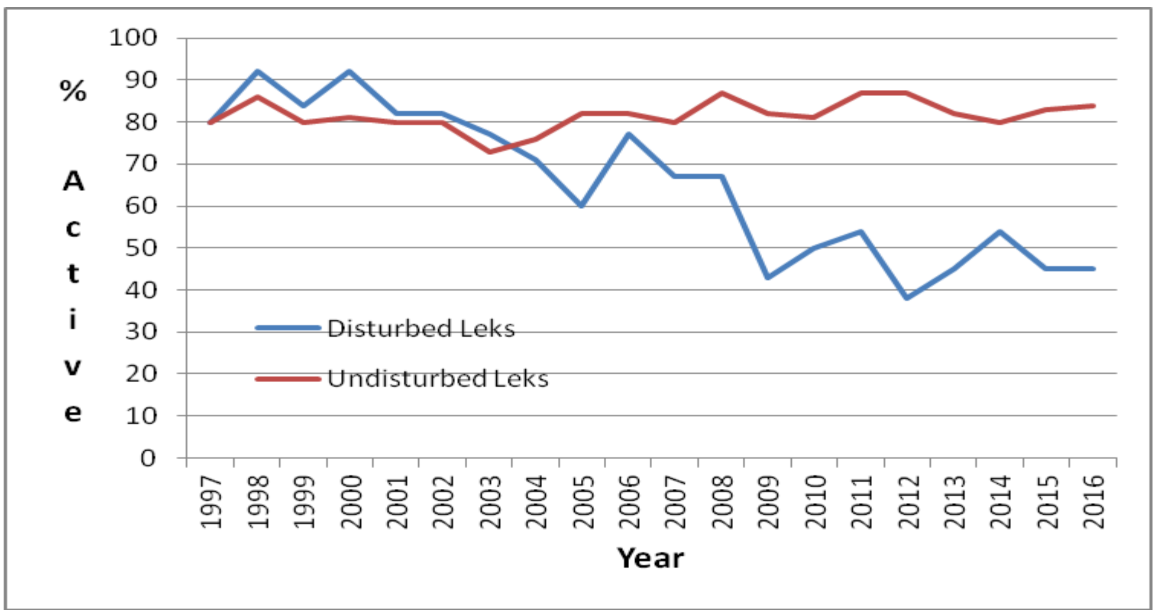


Figure 5. Proportion of active leks 1997-2016, Disturbed Leks verses Undisturbed Leks.

<u>Population Trends and Estimates</u>

No reliable population estimate have be made from data collected during 2017 (or any of the previous years), due in part to unknown male:female sex ratios and since it is unknown if all active leks have been located within the UGRBWGA. An increasing population trend during 2004-2007 is indicated by an increase in the average number of males/lek since 2003. While 2008-2010 lek monitoring indicate a declining trend, with population stabilization during 2011-2014. A significant increase in male lek attendance during 2015 was followed by a slight increase in 2016 and a slight decline in 2017. With the exception of the disturbed leks noted above, the proportion of active leks in the UGRBWGA has remained relatively stable at 77% to 84% over the last ten years. Thus the average males/lek is a reasonable indicator of population trend over that time.

Harvest

The 2016 sage-grouse season was September 17 through September 30, a 14-day hunting season, similar seasons since 2004. Hunting seasons since 2002 have allowed the season to remain open through two consecutive weekends. From 1995 – 2001 hunting seasons were shortened to a 15-16 day season that typically opened during the third week of September and closed in early October. Prior to 1995, the sage-grouse seasons opened on September 1 with a 30 day season. Seasons have been shortened with later opening dates to increase survival of successful nesting hens (as they are usually more dispersed later in the fall) and to reduce overall harvest.

Bag limits from 2003 to 2016 have been 2 per day and 4 in possession. 2003 was the first year that bag/possession limits had been this conservative. Bag limits traditionally (prior to 2003) were 3 birds/day with a possession limit 9 (changed to 6 birds from 1994-2002). Prior to 2010, harvest estimates in the UGRBWGA were only reported from UGBMA 3 and not in that portion of UGBMA 7 that lies within the UGRBWGA. New Sage-grouse Management Areas (SGMA) was developed in 2010, where SGMA D covers all of the UGRBWGA and has been reported that way since 2010.

The 2016 harvest survey estimated that 706 hunters bagged 1990 sage grouse and spent 2012 days hunting, an increase over any year since 2010. The average number of birds per day was 1.0, the average number of birds per hunter was 2.8, and the number of days spent hunting per hunter was 2.8 during 2016. Harvest survey data indicates there had been an increase in hunter participation since 2013, most likely attributed to improved grouse numbers and possibly more opportunity (slightly longer seasons). Prior to 2010, only a portion (UGBMA 3) of the UGRBWGA was included in the harvest statistics, and that portion of UGBMA 7 was left out of the reported harvest. Starting in 2010, all harvest within the UGRBWGA is now reported in Sage-grouse Management Area D. Harvest rates (# birds/day, # birds/hunter, and # days/hunter) have remained somewhat similar since 2010, with the exception of lower harvest rates during 2013 (Figure 6). From 1995 to 2002, overall harvest and harvest rates significantly declined following altered seasons (shortened and moved to a later date). Since 2010, hunter participation has varied from 387 to706 hunters per year.

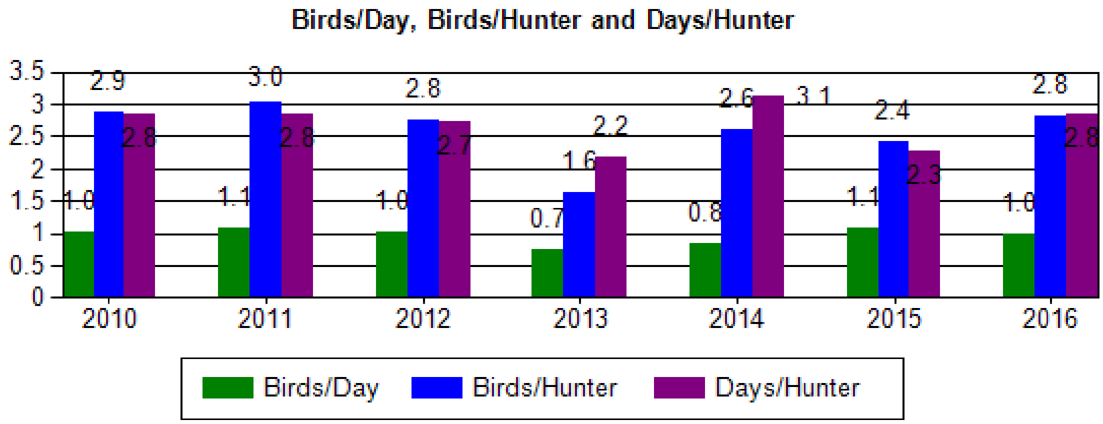


Figure 6. Sage grouse harvest rates 2010-2016 in SGMA D.

Wing Collections

Eighteen sage-grouse wing barrels were distributed throughout Sublette County in 2016 within Sage-grouse Management Area D. Barrels were placed prior to the sage-grouse hunting season opener and were taken down following the closing date. Wing collections were typically made following each weekend of the hunting season (collected twice). The wings are used to determine age and sex based on molting patterns and feather characteristics.

A total of 450 sage-grouse wings were collected from barrels in the UGRBWGA during 2016, slightly low than the 482 wings in 2015, and higher than the 337 wings collected during 2014. The number of wings collected during 2013 and 2014 is the lowest sample during the past 10-year period, ranging from 337 to 547. Of the 450 wings collected in 2015, 30% were juvenile birds, indicating a lower proportion of harvest on juveniles compared to most years. The overall composition of wings in 2016 indicated a ratio of 0.6 chicks/hen (adult and yearling females), the lowest during the past 10-year period (same as in 2007). Conversely, wing collections during 2015 showed 1.6 chicks/hen, resulting in the highest production during the past 10-year period. The combination of low and high chick production during the past two years can be credited with keeping grouse number somewhat stable in the 2017 spring lek counts. This chick/hen ratio derived from wing collections has been a relatively good indicator to predict future population trends, as male lek attendance trends have broadly correlated with chick production in the UGRBWGA.

Winter Distribution Surveys

No winter sage grouse surveys were conducted during the 2016-2017 winter within the UGRBWG Area. Winter surveys were initially conducted in 2004 and continued through 2013 within portions of the Upper Green River Basin. This winter data has been used to develop winter concentrations area maps (first map developed in 2008). Additional analysis methods such as Resource Selection Function (RSF) models have recently been utilized with this winter survey data to help refine previously identified winter concentration areas (WCA). Although, WCA have been identified throughout the UGRBWG Area, the Sage Grouse Implementation Team (SGIT) has only recognized one area located in the Alkali Draw & Alkali Creek Area as of 2017.

Weather Data

Wyoming Climatic Division 3 (Green and Bear Drainage Basin) monthly temperature and precipitation data were obtained from: http://www.ncdc.noaa.gov/cag/time-series/us. A graph was generated comparing 3-month (April-June) average precipitation for years 2013-2016 (Figure 7) and should correlate to forage production during that year. A graph comparing 3-month (April-June) average temperatures (Figure 8) for years 2013-2016 might provide some insight on nest and early brood-rearing success. A 30-year average was also plotted on these graphs to indicate a long range average.

The average precipitation for the 3-month period of April - June was below average during 2014 and 2017 and above average during 2015 and 2016 (Figure 7). The above average precipitation reported in 2015 during this 3-month period is attributed to nearly 4 inches of precipitation in May, significantly higher than the 30-year average near 1.6 inches of precipitation for May. Temperatures have remained at or above average for the 3-month period of April-June for 2014-2017 (Figure 8). Overall, this reported precipitation and temperature data from Climatic Division 3 trends appear to reflect conditions documented within the UGRBWGA. The higher than normal temperatures and precipitation recorded during the spring of 2015 is suspected to have resulted in improved nest success and chick survival during 2015 and improved male lek counts in 2016. However, similar conditions during 2016 seem to have contributed to poor nest success and similar male lek counts in 2017.

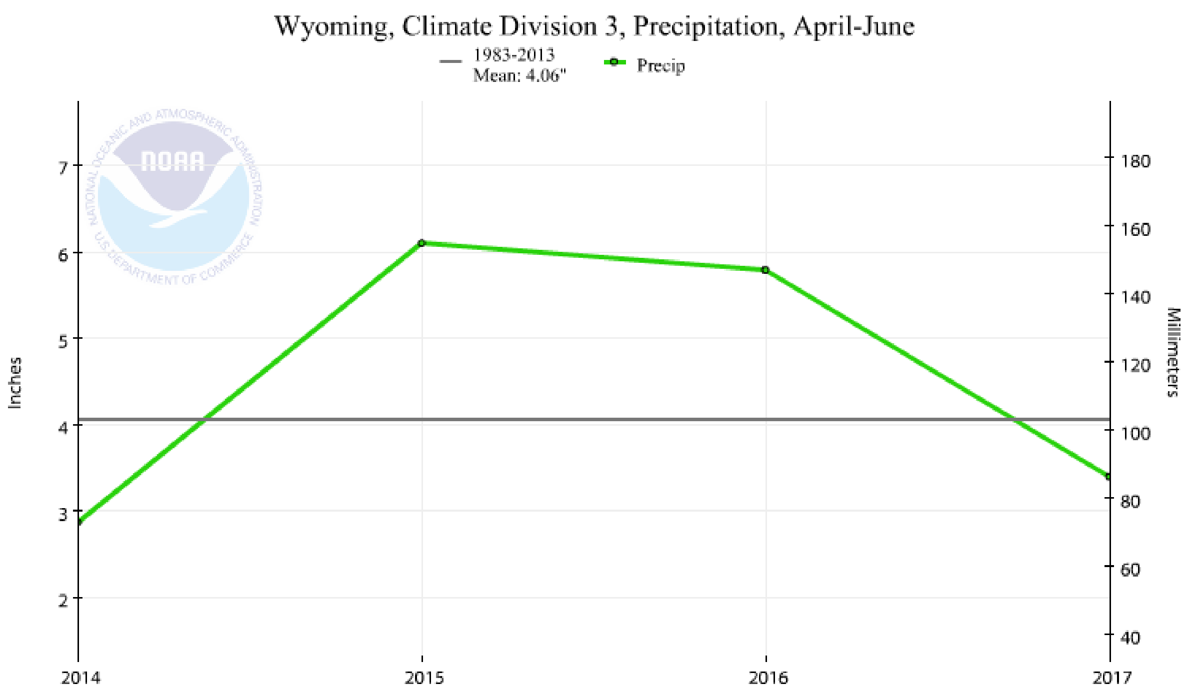


Figure 7. 3-month average (April-June) precipitation for years 2014-2017.

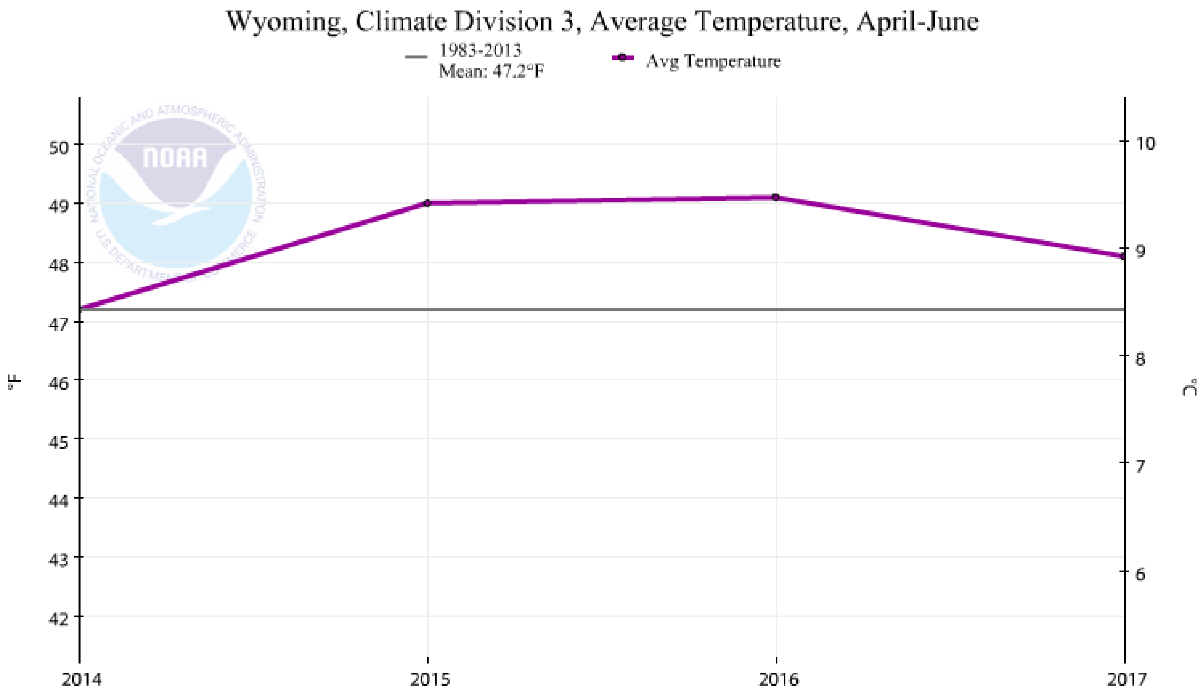


Figure 8. 3-month average (April-June) temperature for years 2014-2017.

Habitat Protection and Core Area Policy

Management of greater sage-grouse habitat in Wyoming is based on a "core area" strategy of limiting human disturbance in the most important sage-grouse habitats. This strategy is codified by a Governor's executive order. The current Executive Order (2015-4) was signed by Governor Matt Mead in July of 2015. The Executive Order and related materials are available at: https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management

In September 2015, the U.S. Fish and Wildlife Service issued a decision of "not warranted" for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. This means the State of Wyoming maintains management authority over sage-grouse in Wyoming and management emphasis focuses on implementation of the core area strategy. In its decision document, the Service specifically cited Wyoming's core area strategy as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude the need for a future listing. Federal land use planning documents are largely consistent with the Wyoming strategy.

Special Projects

Sage-grouse Research Projects

From 1998-2009 there were several research projects initiated and completed that have provided information on sage-grouse demographics and effects of natural gas development on sage-grouse populations. See UGRBWGA 2010 JCR for a summary of past sage-grouse research in the Pinedale area.

There is an on-going study (initiated in 2013) looking into the significance of geophagy (consumption of soil) by sage grouse within the UGRBWGA. Sage-grouse geophagy, or intentional ingestion of soil, was documented in Sublette County Wyoming during the winter of 2012 – 2013. While it is well-known for a variety of other birds and mammals, it represents a behavior that has never before been described for sage-grouse. The goal of this project is to assess the importance of "soil-eating" areas in describing winter habitat selection by sage-grouse. Currently, within the Upper Green River Basin researchers have identified 24 confirmed locations of geophagy behavior. An additional 20 potential locations have also been identified. Coordinated tracking, GPS downloading of grouse on winter range, and site verification efforts involving BLM, Teton Raptor Center, Wyoming Wildlife Consultants, and Sublette County Conservation District are underway. Soil has been collected and tested at each confirmed location and compared to soil at random locations in order to identify the potential target mineral or compound responsible for the behavior. Soil tests indicate higher sodium, pH, and clay content at the documented geophagy sites. Using the spatial data collected from this project, future plans involve development of a resource selection model in order to assess the importance of available soil-eating sites on selection of winter habitat by sage-grouse in Wyoming. A graduate student from the Utah State University will be continuing the research and data collection efforts for this geophagy project during 2017 and 2018.

Sage-Grouse Working Group

The Upper Green River Basin Sage-grouse Working Group was formed in March of 2004. The group is comprised of representatives from agriculture, industry, sportsmen, public at large, conservation groups, and government agencies (federal and state). The purpose of the UGRB Working Group is to work towards maintaining or improving sage-grouse populations in the Upper Green River basin. The group is directed to formulate plans, recommend management actions, identify projects, and allocate available funding to support projects that will benefit sage-grouse. A local sage-grouse plan (Upper Green River Basin Sage-Grouse Conservation Plan) was finalized in May of 2007 and can be found on the WGFD website https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management). This Plan identified past, proposed, and ongoing projects; recommended management activities; funding sources; and other relevant sage-grouse information within the UGRBWGA intended to maintain and/or increase sage-grouse populations. The Working Group recently completed an addendum to this 2007 Conservation Plan (Upper Green River Basin Sage-Grouse Conservation Plan Addendum – 2014) that provides updated information on activities, projects, and management strategies within the UGRBWGA, which can also be found at https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management. A new appropriation of State monies was approved for sage grouse projects during 2016 to be allocated by UGRB Working Group on local conservation measures that benefit sage grouse. Raven control, water windmill to solar pump conversion, and cheatgrass inventory/control projects continue to account for the majority of allocated funds granted to the UGRB Working Group in recent years.

Management Summary

Data collected and reported in this 2016 Sage-Grouse Job Completion Report (June 2016 thru May 2017) gives insight to population trends. Analysis of the past years of data indicates that the sage-grouse populations steadily increased from 2003 to 2007, dropped slightly in 2008, continued to decline through 2011, stabilized through 2014, increased significantly in 2015, and followed by a relatively stable population in 2016 and 2017. Lek trend data indicate grouse populations were at the lowest level in 2003 and highest level in 2007.

Lek monitoring in the UGRBWGA showed a 146% increase in the peak number of males per lek from 2003 to 2007 as males increased from 28 males/lek to 69 males/lek. This trend reversed after 2007, as the number of males/lek declined by 48% dropping to 36 males/lek by spring of 2014. During 2015, lek counts showed a 47% (53 males/lek) increase followed by an 8% increase in 2016 and 4% decrease in 2017. Sage-grouse leks within developing gas fields continue to show declines and lek abandonment regardless of lek trends outside of gas development, indicating negative impacts to leks and populations in and near natural gas fields. Several leks exist within non-core habitats and within identified and exiting gas development fields that will be subject to further impacts.

Sage-grouse hunting season dates, season length, and bag limits have remained similar since 2002, running from late September to early October for 9-15 days with a daily bag limit of 2 birds and a possession limit of 4 birds. Although season length and bag limits have remained similar since 2002, overall harvest and hunter participation has varied somewhat, while harvest rates (# birds taken/day, #birds taken/hunter, and # days/hunter) have remained similar on most years. With grouse numbers steadily increasing from 2003-2007, declining from 2007-2014, and increasing in 2015-2016, the progression of hunter participation was expected to show similar trends. Variation in hunter participation can be affected by hunting season structure, weather conditions, especially during the current short seasons, as well as hunter perceptions of sage-grouse populations.

Wing collection from wing barrels (drop locations) continue to provide good sample sizes to determine overall chick survival trends within the UGRBWGA. During 2008-2015 wing collections ranged from 31% to 45% of the reported harvest. The sample size of 450 wings in 2016 accounted for 23% of the reported harvest, the lowest proportion in the last 10-years. These annual wing samples can vary significantly based on weather conditions affecting hunter participation, especially during the weekend days of hunting season. Overall, some correlation exists between trends in wing sample sizes and harvest, and provides managers the most reliable data for determining annual reproductive rates and population trends in the UGRBWGA.

Trends in chicks/hen derived from wing collections continue to show a correlation with following year lek trends. An increase (or decrease) in the number of chicks/hen in the harvest typically results in similar trends documented on leks the following year(s). In general, a chick/hen ratio below 1.1 has shown declines in overall male lek attendance the following spring, 1.1 to 1.3 chicks/hen has shown stable attendance, and a chick/hen ratio greater than 1.3 has shown increases in lek attendance in the UGRBWGA. During the past 5 years (2012-2016) the chicks/hen ratio has varied from 0.6 to 1.6 and averaging 1.0 chicks/hen. The improved chick survival documented during 2015 has resulted in an overall male lek attendance increase of 53% since 2014.

Above normal precipitation during 2004 and 2005 during key periods (specifically in the spring and early summer) contributed to increased sage-grouse numbers due to enhanced production and juvenile survival in the Upper Green River Basin. Declining chick survival was documented in 2006 and 2007 caused by spring and summer drought conditions in the Upper Green River Basin. Male sage-grouse lek numbers declined from 2007-2014. Good to above average spring precipitation during 2008-2011 led to good herbaceous production, which should have helped turn around the recent declining trends in the UGRBWGA. It appears the cold temperatures during the spring of 2009 and 2010 impacted reproduction resulting in further declines in lek numbers in 2010. Spring moisture in 2011 resulted in very good habitat production, and most likely contributing to the slight increase in bird numbers documented during the spring of 2012. Drought conditions in 2012 and 2013 most likely attributed to poor chick survival as spring temperatures were near normal, resulting in little change on spring lek counts in 2014. In 2014, good forage production was the result of good precipitation during the fall of 2013 and spring of 2014 which likely contributed to increased male lek counts in 2015. Although the winter of 2014-15 was mild with low precipitation, the spring of 2015 had above average precipitation, primarily attributed to a very wet May, apparently resulting in very good chick production. The 2015-2016 winter and 2016 spring conditions were very similar to the previous year with dry winter and wet spring conditions, but resulted in poor chick production and similar lek counts. The 2016-17 winter conditions were severe with heavy snow loads and cold temperatures followed by a dry and spring, yet lek counts in 2017 were similar to those recorded in 2016. The predictability of factors that determine nest success and chick survival remains complex, as indicate above, and more dynamic than just climate conditions such as precipitation and temperature trends.

The sage-grouse population in the UGRBWGA appears to be showing some fluctuation attributed to natural influences, such as spring precipitation and temperature. On a more localized level, the current amount and rate of natural gas development in the Upper Green River Basin has and will continue to impact sage-grouse habitat and localized populations. Lek monitoring data has shown lower male attendance and in several cases total bird abandonment on leks within and adjacent to developing gas fields. Sage-grouse studies and research in the UGRBWGA has also documented impacts to grouse from gas development. Direct, indirect, and cumulative impacts to sage-grouse from gas and residential development will continue to challenge managers to maintain current grouse numbers.

Recommendations

1. Continue to monitor sage-grouse leks and look for new and previously undocumented ones.
2. Continue to monitor and provide input on natural gas development/sage-grouse projects being conducted.
3. Continue to place wing barrels in enough locations to obtain an adequate and representative sample to derive sex/age and harvest trend information.
4. Continue existing efforts and encourage new efforts to document and identify important sage-grouse areas (breeding, brood rearing, and winter).
5. Continue to work with GIS personnel and land managers to create and update seasonal range maps (breeding, summer/fall, and winter) to aid land managers in protecting and maintaining important sage-grouse habitats. Delineation of winter concentration areas will be a priority.
6. Continue to identify needed sage-grouse research, data collection efforts, project proposals, development mitigation, and funding.
7. Implement proposals and management recommendations identified in the Upper Green River Basin Sage-Grouse Working Group Conservation Plan and Plan Addendum where possible.

Literature Cited

Christiansen, T. 2012. Chapter 12: Sage Grouse (*Centrocercus urophasianus*). Pages 12-1 to 12-55 in S.A. Tessmann and J. R. Bohne (eds). Handbook of Biological Techniques: third edition. Wyoming Game and Fish Department. Cheyenne.

Fedy, B. C., and K. E. Doherty. 2010. Population cycles are highly correlated over long time series and large spatial scales in two unrelated species: greater sage-grouse and cottontail rabbits. Oecologia 165:915-924.

Fedy, B. C. and C. L. Aldridge. 2011. The importance of within-year repeated counts and the influence of scale on long-term monitoring of sage-grouse. Journal of Wildlife Management 75(5): 1022-1033.

Upper Snake River Basin Sage-Grouse Job Completion Report 2016

June 2016-May 2017

Aly Courtemanch
Wyoming Game & Fish Dept.
Jackson Region

Species: Sage-Grouse
Period Covered: June 1, 2016 – May 31, 2017
Management Areas: A
Working Group Area: Upper Snake River Basin
Prepared by: Alyson Courtemanch

Summary

The Upper Snake River Basin Sage-Grouse Area includes the entire Snake River drainage basin in Wyoming including the major tributaries of the Gros Ventre, Hoback, and Salt River drainages. The area encompasses almost all of Teton County and small portions of Sublette and Lincoln Counties. The boundaries of the core areas were revised in 2015 by the Governor's Sage-Grouse Implementation Team, with input from the local working groups. The Upper Snake River Basin Core Area expanded to include portions of the Gros Ventre drainage.

Sage-grouse in this area are non-migratory and genetically isolated from surrounding populations. In recent years, 16 occupied and historical sage-grouse leks have been monitored annually to track population trends. The majority of these leks are within Grand Teton National Park (n=11) with an additional 2 on the National Elk Refuge and 3 on Bridger-Teton National Forest in the Gros Ventre drainage and Hoback Basin areas. This population may follow a cyclical trend. The average peak males per lek declined in the early 1990's, then increased from 2002-2006, declined from 2007-2011, and has been increasing again during the past 5 years. The average peak males per lek in 2015 and 2016 were the highest recorded since 1994 (25.2 and 22.3, respectively). However, the average dropped in 2017 to 18.3 average peak males per lek.

This drop was influenced by lower male counts at the RKO, Breakneck, and Bark Corral leks in 2017. In 2016, male attendance at the RKO lek increased substantially with a high count of 48, compared to 21 in 2015 and 8 in 2014. In 2017, the count dropped to 15 males. The Breakneck Flats lek dropped from 34 males in 2016 to 22 in 2017. The largest lek, Moulton, did not change significantly from 70 males in 2016 to 76 in 2017.

This decrease in 2017 could have been influenced by severe winter conditions in 2016/2017, which likely impacted over-winter survival. Snowpack was 150-200% above average in the Snake River Basin from January 2016 through May 2017. In addition, several freeze/thaw events occurred in the Jackson Hole and Gros Ventre valley areas during the winter, which created a hard and thick snow crust. In late February 2017, several days of rain caused snow to melt in some lower elevation areas near Jackson, opening up sagebrush in some areas. Spring and summer precipitation was above average in 2017, which should have contributed to good chick production and survival for next year. While winter is not limiting to most sage-grouse populations, persistent deep snow is the norm in Jackson Hole during winter. These more extreme conditions can severely limit access to sagebrush cover and food in some years.

Introduction

With establishment of eight sage-grouse working groups throughout the state in 2004, sage-grouse Job Completion Reports (JCR) were revised to Working Group Areas and not Wyoming Game and Fish Department Regions. Until 2010, the Upper Snake River Basin Working Group

(USRBWG) included Game Bird Management Areas (GBMA) 1 (Gros Ventre and Jackson Hole) and 2 (Hoback Basin and Star Valley). However upland game management areas were revised in 2010 and the Upper Snake River Basin Conservation Area (USRBCA) was designated as Area A, which is covered in this report

The initial role of the USRBWG was to develop and facilitate implementation of a local working group plan for the benefit of sage-grouse and, whenever feasible, other species that use sagebrush habitats. The 2008 Conservation Plan identified management practices for the purposes of improving sage-grouse numbers and maintaining a viable population in entire Snake River Basin in Teton, Lincoln, and Sublette counties in Wyoming. Specifically the plan addressed management of four small, isolated populations in Jackson Hole, the Gros Ventre Drainage, Hoback Basin, and an interstate population shared by Wyoming and Idaho in the Salt River drainage. The 2008 Plan was revised in 2014 to reflect current policy for sage-grouse conservation under Wyoming Executive Order 2011-5 and other relevant information. The 2014 Plan was approved by the Wyoming Game and Fish Commission in February 2014. The plan is available at: https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Sage%20Grouse/SG_USR_CONSERVPLAN.pdf

Plan Area

The USRBCA includes the entire Snake River drainage basin in Wyoming including the major tributaries of the Gros Ventre, Hoback and Salt River drainages. The area boundary encompasses almost all of Teton County and small portions of Sublette and Lincoln Counties (Figure 1).

The occupied sage-grouse habitat in the plan area is primarily sagebrush grassland habitat in the valley floor and foothills of Jackson Hole, Hoback Basin, Gros Ventre River Drainage, and in the western foothills of Star Valley. Much of the remainder of the working group area is forested habitat that is not occupied by sage-grouse. The sage-grouse distribution map was updated in this reporting period (Figure 2). A more fine scale review of the habitats underlying the former map of occupied range resulted in the changes shown in Figure 2. The core population in Jackson Hole is found primarily in Grand Teton National Park (GTNP) and on the National Elk Refuge (NER). Sage-grouse also use some of the foothill areas on the Bridger-Teton National Forest and private land on East and West Gros Ventre Buttes. The Jackson population was designated as a core area by the Governor’s Sage-Grouse Implementation Team (SGIT) in August 2008. The boundaries of the core areas were revised in 2015 by the SGIT, with input from the local working groups (Figure 3). The Jackson Core Area expanded to include portions of the Gros Ventre drainage.

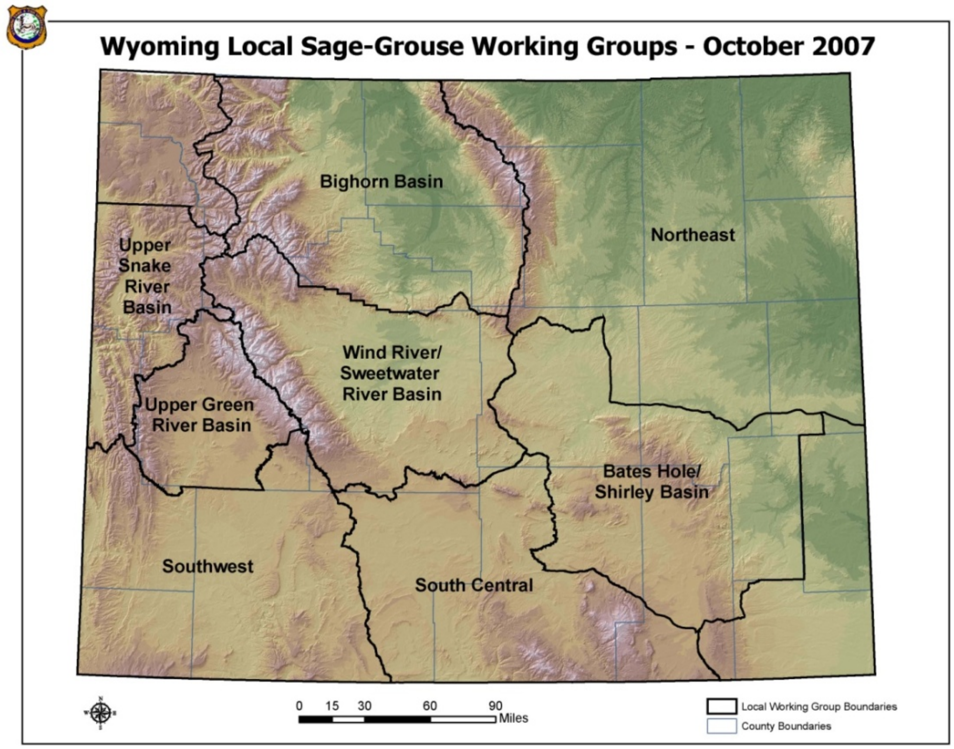


Figure 1. Wyoming local sage-grouse working group boundaries.

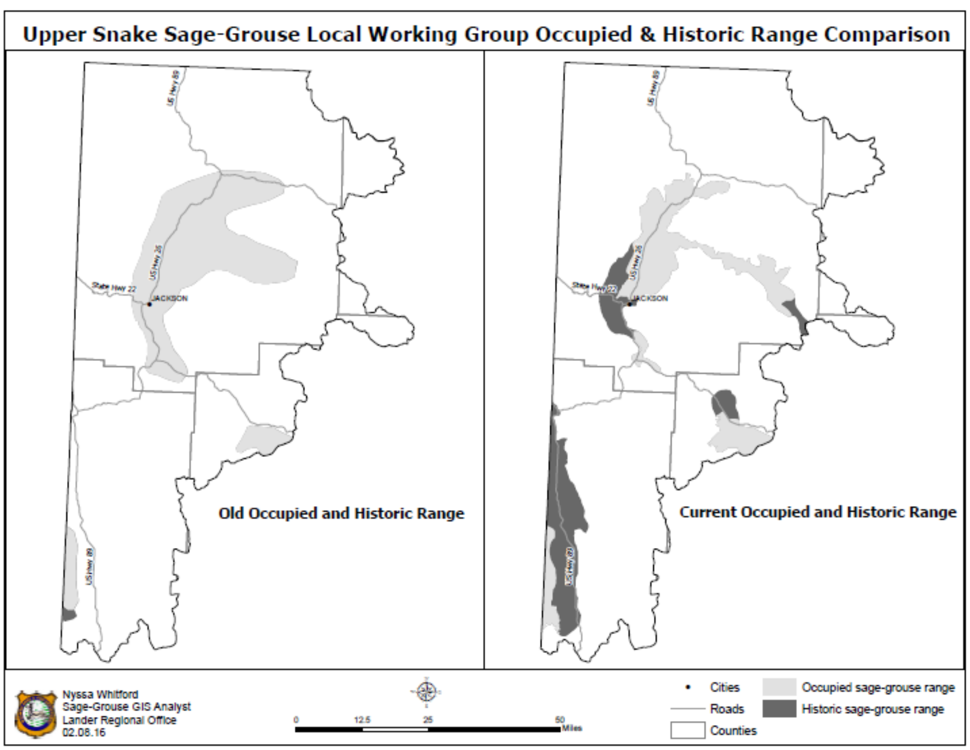


Figure 2. Comparison of the former and the revised occupied and historical range maps for the Upper Snake River Basin, WY.

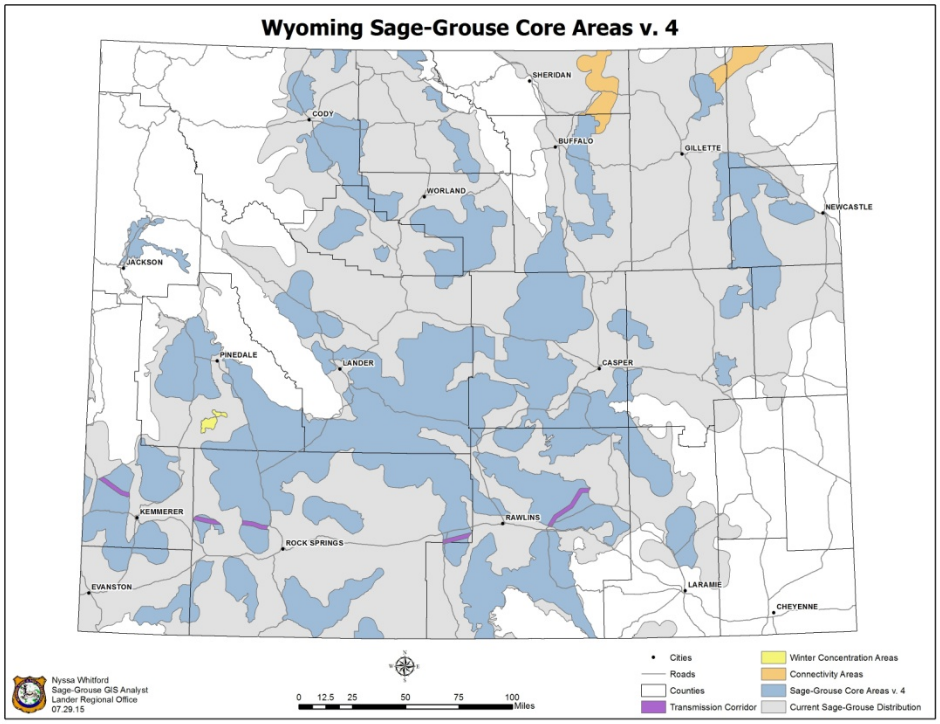


Figure 3. Wyoming Sage-Grouse Core and Connectivity Areas, revised in 2015.

Sage-grouse in Jackson Hole are non-migratory and genetically isolated from surrounding populations (Schulwitz et al. 2014). There is evidence of one-way genetic interchange from the Jackson Hole segment to the Gros Ventre Drainage segment, but very little interchange with Pinedale populations (Schulwitz et al. 2014). In the Hoback Basin, a lek was discovered in the Clark Draw area in April 2010. Birds telemetered on this lek have been shown to migrate to winter range near Big Piney in the Upper Green River Basin. A small population of sage-grouse use habitat associated with the Gannet Hills in Wyoming and Idaho along the western edge of Star Valley. There are three leks located in Idaho in the Crow Creek and Stump Creek drainages near the Wyoming-Idaho state line.

Lek Monitoring

Sage-grouse data collection within the USRBCA focuses on lek surveys. Prior to 1994, relatively few leks were monitored and since 2000, efforts have been made to increase data collection on leks and standardize data collection methods. Starting in 2005, lek counts in GTNP, and to some extent on the NER, were coordinated to occur on the same days when it was logistically possible. This presumes that all leks in Jackson Hole constitute a sub-population and the leks in the Gros Ventre drainage constitute a second sub-population. No marked birds from the Gros Ventre leks have appeared on the Jackson Hole leks (Holloran and Anderson 2004, Bryan Bedrosian *pers. comm.*) and there is no evidence of genetic flow from the Gros Ventre to Jackson Hole (Schulwitz et al. 2014).

Lek counts and lek surveys have been conducted within the area since 1948; however, the most consistent data sets occur from 1989 to the present. Sage-grouse leks within the USRBCA are summarized in Table 1 from 1990 through 2017. In some years it is uncertain from the data provided by GTNP if leks that were recorded as inactive were actually checked. Since the status of these leks is uncertain they are noted in the lek database report as not checked (undetermined). It is likely most of these leks are inactive in these years but occasionally some birds do appear to use leks that have been inactive for several years.

There are 12 occupied and 4 historical sage-grouse leks in the Upper Snake River Basin Area (Table 1, Figure 4). Twelve leks are considered to be occupied (active at least one year during the past 10 years) and four appear to be unoccupied historical leks (3 Bar H/Circle EW, Antelope Flats, McBride, and Beacon). The Beacon lek switched to unoccupied in 2016 since no birds were observed since 2006. In recent years the Simpson lek, formerly called Poverty Flats lek on the NER was considered to be unoccupied but 3 males were sighted there in 2012. It is unclear if the Airport Pit lek is really a lek, a satellite lek or a sporadic activity center for birds displaced off the airport lek by airport operations. The Bark Corral lek has 2 activity centers (East and West) or the West lek may be a satellite of the Bark Corral East lek. The Moulton lek also has two activity centers.

There is some movement of males between leks, particularly from the North Gap lek on the NER to leks in GTNP and between leks in the lower valley with leks in the upper valley as the spring progresses and snow melt occurs. As a result, the total of the high counts on all leks in each year may represent an inflated estimate of total males in the population.

Moulton East and Moulton West leks were combined in 2007 (reported as separate leks in previous reports) and reported as the Moulton lek (one lek with two activity centers) in 2008. In some years it appears the total birds counted on the same day for both activity centers were reported as the high count and in other years a high count for each activity center was reported, but not necessarily on the same date (GTNP Database). We have attempted to correct what may have been double counts by taking the highest count for a particular date on both activity centers and reporting that number for the Moulton lek.

The Spread Creek lek was located in 2007 near the east end of Wolff Ridge in the sagebrush flat between the ridge and Spread Creek. In 2010, birds were also seen strutting on the bare ridge top of Wolff Ridge where there is considerable grouse sign. The lek was reported by other observers in the past but its location was never confirmed. The Spread Creek lek has been active from 2008 - present.

During research activities in 2008, a lek was located in the Potholes area of GTNP (RKO Road lek). Birds were located on the RKO Road lek on a number of occasions in 2008 and one male was trapped and fitted with radio transmitters near this new lek. The lek has been active every year since its discovery, with the most recent count of 15 males in 2017.

There are currently 12 occupied and 4 historical leks in the USRBCA that are monitored on an annual or semi-annual basis. In 2017, 12 occupied leks and one historical lek (McBride) were monitored. Nine of the occupied leks were active with sage grouse observed, three were inactive (no grouse observed) (Airport Pit, Simpson, and Dry Cottonwood) and the one historical lek was inactive (McBride). Beacon, 3 Bar H/Circle EW, and Antelope Flats leks were not checked in 2017. These leks are not checked on an annual basis because they have been unoccupied for many years.

Table 1. Maximum male counts at sage-grouse leks in the Upper Snake River Basin Conservation Area, 1990-2017. NC denotes “not checked”.

Year	Airport	Beacon	Airport Pit	3 Bar H/ Circle EW	McBride	Antelope Flats	Moulton	Spread Creek	Bark Corral	Timbered Island	North Gap	Simpson	Breakneck Flats	Dry Cottonwood	RKO Road	Clark Draw	Total	Average # males/ active lek
1990	52			NC	10	10	63		8		22	NC					214	35.7
1991	63			NC	15	10	48		16		29	NC					207	34.5
1992	51			NC	12	8	37		16		21	NC					168	28.0
1993	37	21		NC	16	5	24		8		9	54					198	24.8
1994	NC	NC		NC	27	NC	50		NC		7	NC					84	28.0
1995	18	15		NC	6	4	63		10		6	NC					122	17.4
1996	18	8		NC	4	2	33		8		19	NC					92	13.1
1997	15	1		NC	6	0	48		1		10	NC					81	13.5
1998	14	0		NC	4	0	33		0		7	NC					58	14.5
1999	17	0		NC	0	0	21		0		9	NC					47	15.7
2000	18	NC		NC	0	NC	28		NC		5	NC	21				72	18.0
2001	15	NC		NC	NC	NC	30		NC		6	NC	19				70	17.5
2002	19	24		NC	NC	NC	28		NC		4	NC	9				84	16.8
2003	25	NC		NC	NC	NC	35		NC	8	3	NC	7				78	15.6
2004	17	NC		NC	NC	NC	54		2	15	4	NC	14				106	17.6
2005	17	NC		NC	NC	NC	49		NC	17	18	0	16	6			123	20.5
2006	26	4	6	0	0	NC	44		0	20	30	0	21	9			157	19.6
2007	23	NC	0	0	1	0	41	4	1	20	9	0	30	4			133	14.8
2008	16	0	0	0	0	0	38	5	10	26	23	NC	22	13	12		165	18.3
2009	10	0	2	NC	0	NC	33	4	5	22	11	0	21	1	15		124	12.4
2010	10	0	0	NC	0	NC	40	5	24	18	13	0	24	4	13	13	151	15.1
2011	11	0	0	0	0	0	27	15	10	0	21	0	5	0	10	12	111	13.9
2012	17	0	0	0	0	0	44	0	3	7	18	3	14	0	8	14	128	14.2
2013	17	NC	0	NC	NC	0	46	24	0	16	8	0	14	5	6	13	149	16.6
2014	11	NC	3	NC	NC	0	61	8	10	16	21	0	18	0	8	7	163	16.3
2015	12	NC	0	NC	0	NC	103	15	11	11	10	0	27	0	21	17	227	25.2
2016	7	0	0	NC	0	0	70	6	13	18	7	0	34	8	48	12	223	22.3
2017	10	NC	0	NC	0	NC	76	5	4	16	4	0	22	0	15	13	165	18.3

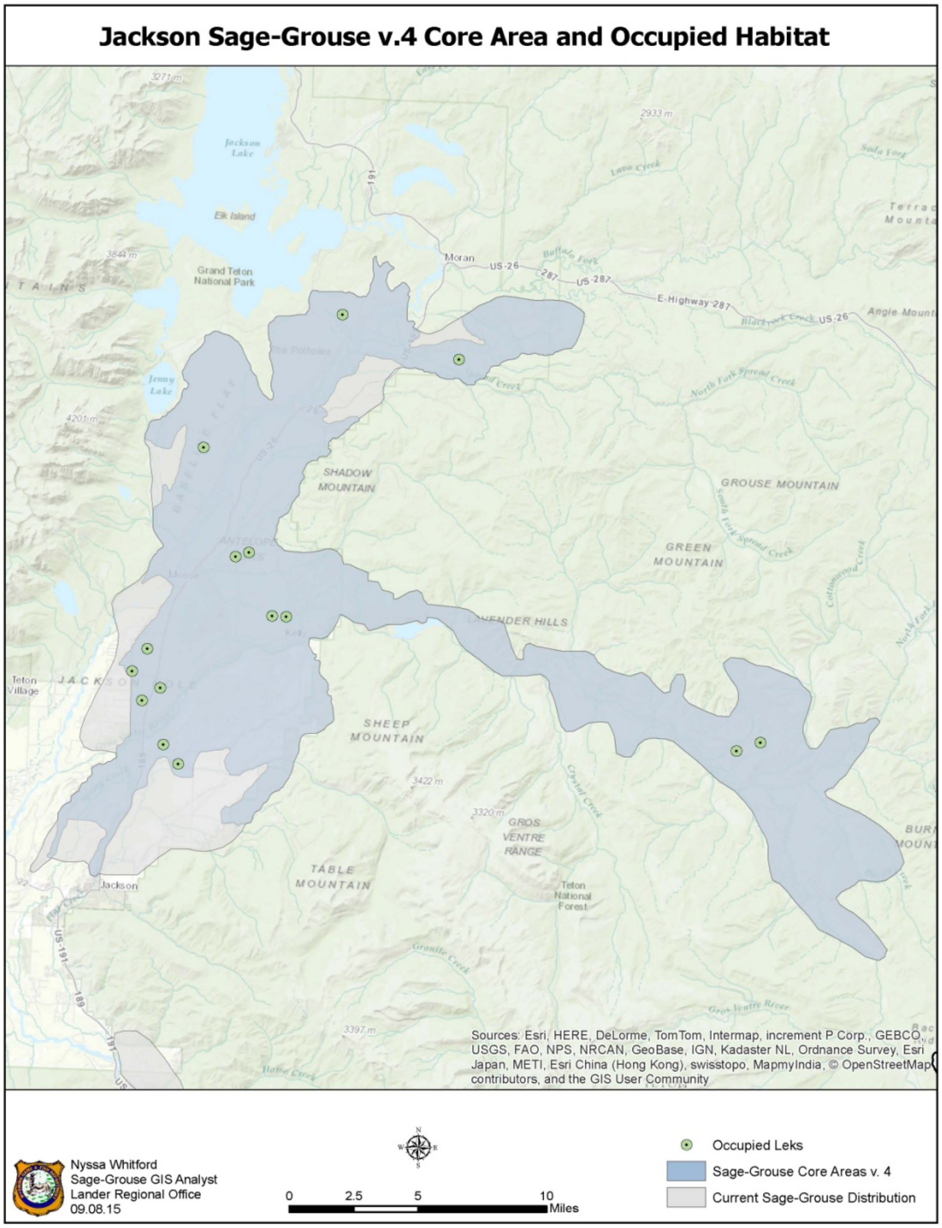


Figure 4. Sage-grouse core area, occupied habitat, and occupied leks in the Upper Snake River Basin Area (does not show Clark's Draw lek).

Population Trends and Estimates

No reliable method for estimating the sage-grouse population for the USRBCA exists at this time. However, the peak number of males per lek provides a reasonable index of abundance of sage-grouse populations over time in response to environmental conditions. The average number of males per active lek counted each year may be a more reliable index of population trends over time. Average peak number of males per active lek declined in the early 1990's (Figure 5). Counts from the past 8 years have showed a generally increasing trend, however there was a substantial decrease in 2017

(Figure 5). The average peak males per lek in 2015 and 2016 were the highest recorded since 1994. The average peak males per lek dropped to 18.3 in 2017. This decrease could have been influenced by severe winter conditions in 2016/2017, which likely impacted over-winter survival.

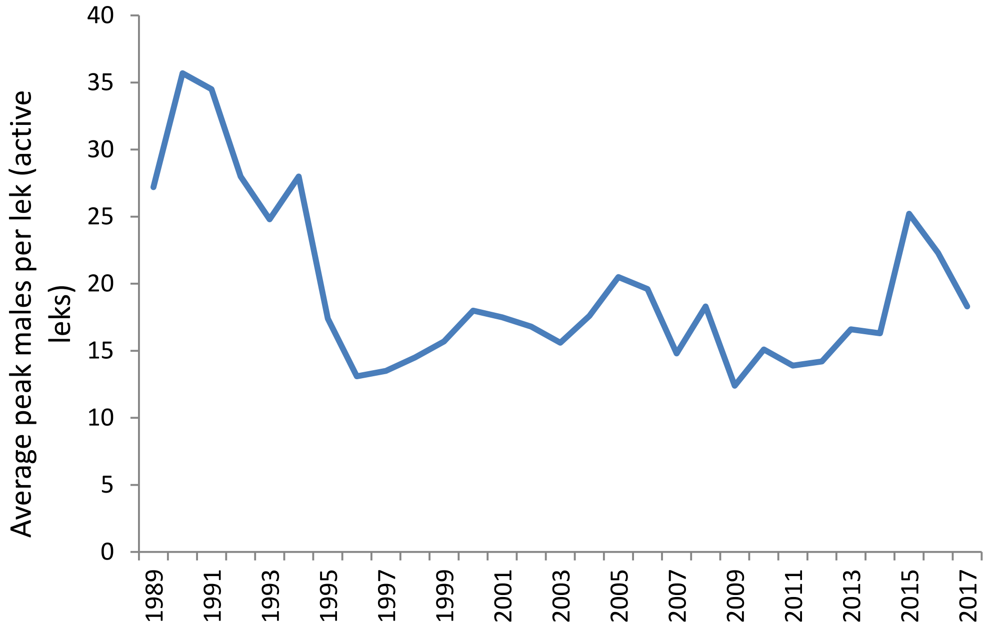


Figure 5. Average peak male counts for active leks in the Upper Snake River Basin Conservation Area, 1989-2017.

Data from the most recent 10 year period suggests that the population has been slowly increasing with a notable jump in 2015. However, 2017 counts were down from the last two years. In 2015 and 2016, the peak number of males were 227 and 223, respectively. However, peak males dropped in 2017 to 165 (Table 1). The 10-year average is currently 161 peak males (2008-2017). Despite increases in recent years, the drop in 2017 is concerning, though still within the range of variability observed in recent years. The long term persistence of this population continues to be of paramount concern to the local working group and resource managers.

Winter Survey

Above average snowpack and winter conditions in winter 2016/2017 caused sage-grouse to concentrate into small areas of open habitat (Bryan Bedrosian, *pers. comm.*). Therefore, there was interest among the Upper Snake River Basin Working Group members to conduct a sage-grouse winter aerial survey to obtain total numbers of grouse. Funding was provided by Teton Conservation District and WGFD managers conducted the survey in conjunction with the annual big game classification surveys. Bryan Bedrosian (Teton Raptor Center) provided recommended search polygons in GIS based on GPS-marked grouse movements and past knowledge of wintering areas (Figure 6). The survey was flown over three days with two WGFD observers plus the helicopter pilot in a Bell 47. Transects were flown approximately ¼ mile apart in sage-grouse search areas at < 200 feet AGL, except where not feasible (in the Jackson Hole Airport airspace). Portions of polygons in the Kelly Hayfields area and near the Fish Hatchery were skipped due to bad weather conditions.

A total of 91 sage-grouse were observed during the survey. Most grouse were found in very small groups with only one larger flock of 43 observed. Despite severe winter conditions leading up to the survey, several days of rain and above-freezing temperatures right before the survey caused large areas of sagebrush to become snow-free. Several GPS-marked sage-grouse also moved outside of the search areas a few days before the survey (Bryan Bedrosian, *pers. comm.*). Snow-free areas of sagebrush made visibility of sage-grouse very difficult unless they flushed from the helicopter. Of the 12 groups of sage-grouse observed, five were found opportunistically well outside of the search polygons, which suggests that many more birds were likely missed (Figure 6). These factors contributed to poorer survey results than expected.

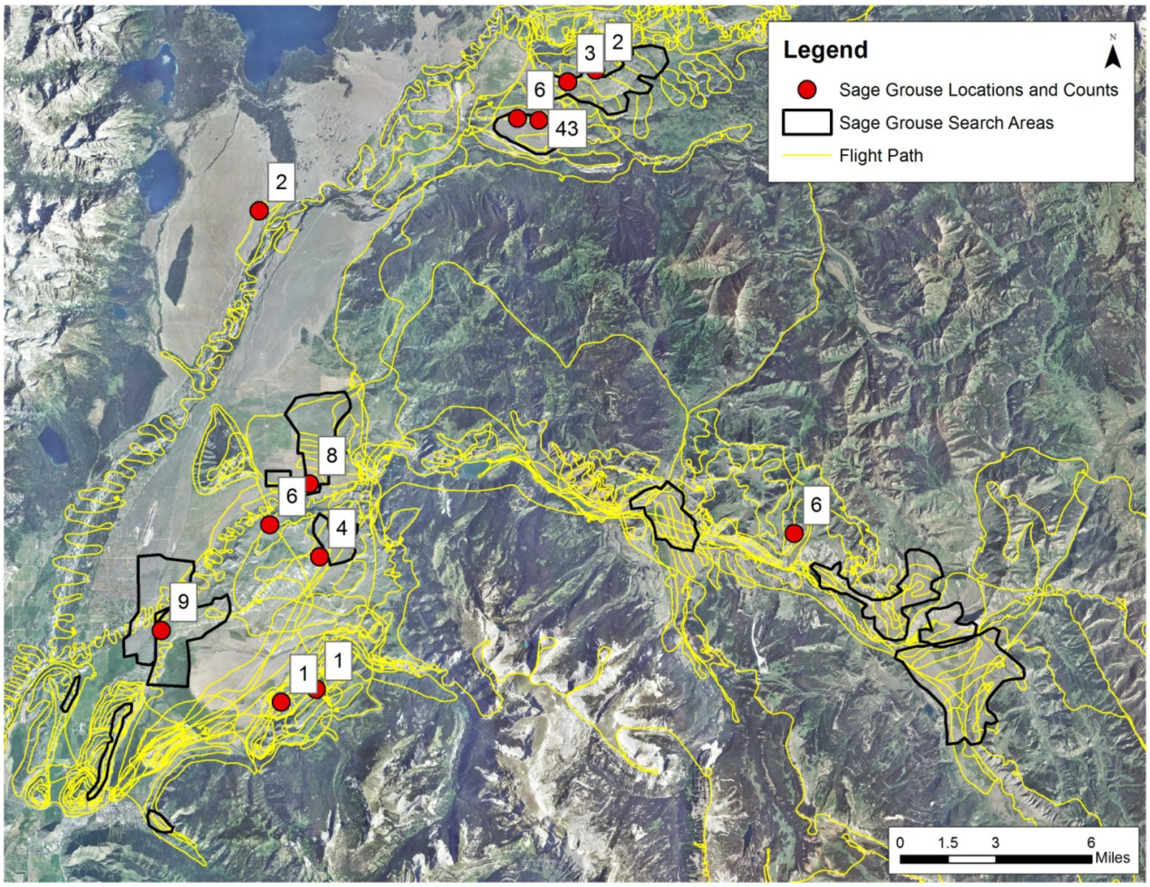


Figure 6. Locations of sage-grouse groups (red circles) and counts (white squares) observed during a helicopter flight in February 2017. Black polygons depict sage-grouse wintering areas and yellow lines are helicopter flight path (includes both sage grouse and big game surveys).

Productivity

No productivity data were collected on this population in 2017.

Harvest

Most of the USRBCA has been closed to hunting since the establishment of GTNP in 1929. No sage-grouse hunting e has been allowed on lands under the jurisdiction of GTNP or the NER. In 2000, the hunting season was closed in the entire WSRBWGA and remains so today.

Habitat Protection

Management of greater sage-grouse habitat in Wyoming is based on a “core area” strategy of limiting human disturbance in the most important sage-grouse habitats. This strategy is codified by a Governor’s executive order. The current Executive Order (2015-4) was signed by Governor Matt Mead in July of 2015. The Executive Order and Core Area Policy can be found on the WGFD website and attached to the Statewide JCR.

In September 2015, the U.S. Fish and Wildlife Service issued a decision of “not warranted” for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. This means the State of Wyoming maintains management authority over sage-grouse in Wyoming and management emphasis focuses on implementation of the core area strategy. In its decision document, the Service specifically cited Wyoming’s core area strategy as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude the need for a future listing. Federal land use planning documents are largely consistent with the Wyoming strategy.

No wildfires or prescribed burns occurred in significant areas of sagebrush habitat in sage-grouse core areas within the USRBCA this year. There were no significant human developments or surface disturbances in core areas during this reporting period.

Special Projects

<u>Sage-Grouse Movements, Productivity, and Habitat Use in the Spread Creek Area</u>
Bryan Bedrosian, Teton Raptor Center
John Stephenson, Grand Teton National Park
Jason Wilmot, Bridger-Teton National Forest

SUMMARY
Spread Creek is an important area in Grand Teton National Park for sage-grouse leking and nesting. There is also an active gravel extraction facility in the area (on Bridger-Teton National Forest) that operates at differing levels of use annually. There is potential for disturbance from the gravel pit operations to sage-grouse movements and demography in the area. The gravel pit is expected to have low levels of activity in 2016 and 2017, but increase operations in 2018 and 2019. The project will investigate the movements, habitat use, and nesting demography of sage-grouse from 2016-2019 to evaluate the effects of differing levels of disturbance. Sage-grouse will be captured and fitted with solar-powered, rump-mounted GPS transmitters. Transmitters will gather a minimum of hourly locations during daylight and an additional roost location. Any suspected nesting attempts or mortality events will be investigated. Home range sizes, distances to gravel pit, and other movement metrics will

be compared in a pre/post design framework. Also, nest locations, clutch sizes, success, and brood sizes among years will be assessed. This project applied for and received funding from the Upper Snake River Basin Sage-Grouse Working Group for 2017-2018.

Sagebrush Restoration in an Abandoned Hayfield in the Upper Gros Ventre Watershed
Kerry Murphy, Bridger-Teton National Forest

SUMMARY
The project area is located on the Dew Place Ranch in the Upper Gros Ventre watershed, which was homesteaded 1899 and brought into the National Forest System through a land exchange in 1997. The Forest Service and partners have identified the ranch for several habitat improvement projects in wetland, riparian, and upland areas. Located near the confluence of Fish Creek and the Gros Ventre River—and within 3 miles of the Breakneck Flat sage grouse lek—the property is uniquely situated to provide critical, high value habitat for upland and riparian-dependent wildlife, including sage-grouse. The area is within core sage-grouse habitat identified under the Wyoming Executive Order. Telemetry data collected during the last two decades suggest that sage grouse use the ranch and vicinity throughout the year (Holloran and Anderson 2004, Bedrosian 2010). However, sage-grouse apparently make little use of the abandoned agricultural field.

This project proposes to establish the methodology needed to re-establish sagebrush steppe on an abandoned hayfield on the Dew Place Ranch, with the net effect of increasing the availability of winter, nesting, and late brooding rearing habitats for sage grouse in the upper Gros Ventre watershed. About 88 acres on the south end of the Dew Place Ranch currently stands as an abandoned hayfield and irrigation ditches located on a terrace above the Gros Ventre River. The hayfield is dominated by non-native, smooth brome (*Bromus inermis*) interspersed with patches of Kentucky bluegrass (*Poa pratensis*), and supports few noxious weeds. Our treatment methods will generally follow currently in use by Grand Teton National Park Science and Resource Management personnel to restore the Kelly Hayfields, a successful and ongoing 4,500-acre effort in a similar ecological setting. Methodology developed from the test plots will be subsequently applied to the entire hayfield, and likely to similar Forest Service lands in the area. This project applied for and received funding from the Upper Snake River Basin Sage-Grouse Working Group for 2017-2018.

Jackson Hole Airport Wildlife Hazard Management Plan

SUMMARY
Concern has been expressed by the Federal Aviation Administration (FAA) and the Jackson Hole Airport Board over the presence of sage-grouse around the airport and the potential for collisions between aircraft and sage-grouse, which has implications for human safety and economic losses resulting from damaged aircraft. Thirty-two plane strikes with sage-grouse are reported in the FAA's national database at Jackson Hole Airport between 1994 and 2012. Five of these reported strikes occurred in March, 24 occurred from June through September during the brood rearing period, and three occurred from October through December.

Safety issues related to the potential for sage-grouse strikes with airplanes arriving or leaving the airport has prompted the FAA to require the Jackson Hole Airport to create a Wildlife Hazard

Management Plan. This plan creates an action plan and mitigation measures for the Jackson Hole Airport to reduce airplane strike risk with all wildlife, but emphasis is placed on sage-grouse given the lek proximity and historical strikes. The FAA is tasked with managing all wildlife risks within 10 miles of the airport perimeter, but GTNP also has jurisdiction over wildlife within that region. This led to a highly collaborative project between many stakeholders, including the local working group, to create a management plan for the Jackson Hole Airport. Grand Teton National Park recently completed a Jackson Hole Airport Wildlife Hazard Management and Sage-Grouse Restoration Plan Environmental Assessment in fall 2017, which is planned to be released for public comment in 2018.

Sage steppe plant community restoration in abandoned smooth brome dominated hayfields in Grand Teton National Park

Daniel Reinhart, Grand Teton National Park

SUMMARY

The sagebrush steppe vegetation within GTNP forms the core habitat for sage-grouse within the Upper Snake River Basin. While the Park contains 47,000 acres of big sagebrush, it has nearly 9,000 acres of abandoned hayfields that were once sagebrush. These hayfields are now dominated by a nearly shrubless monoculture of smooth brome (*Bromus inermis*). In the 30-50 years that these hayfields have been abandoned, sagebrush has re-established in only a limited area. However, where the sagebrush has returned, the native bunchgrass/forb understory hasn't always. Since 2006, Craighead Beringia South has been collecting GPS points from collared sage-grouse and has demonstrated that grouse do not utilize the hayfields nearly frequently as the intact sagebrush nearby. These abandoned hayfields are within 4 miles of the Moulton lek. Clearly, for these hayfields to ever be prime habitat for sage-grouse and other sagebrush obligates, they must be restored to their former sagebrush-steppe vegetation.

For the benefit of sage-grouse and many other species, the park has begun to restore these hayfields to native sagebrush-steppe vegetation. This work has been initiated with funds from the Wyoming Sage-Grouse Conservation Fund and the National Park Service. During 2015 and 2016, Grand Teton National Park staff have treated additional acres for smooth brome removal, continued to monitor and conduct noxious weed treatments as necessary, collected native seeds, and seeded treated areas with native seeds. Fencing was also constructed on some treatment units to reduce native ungulate grazing pressure. In total, there are 1,263 acres in various stages of restoration treatment. The goal is to restore 4,500 acres to ecological function, which will require many more years of work.

Geophagy and movements of sage-grouse in the Hoback and Upper Green River drainages

Bryan Bedrosian, Teton Raptor Center
Dale Woolwine, Bureau of Land Management – Pinedale Office
Josh Hemenway, Bureau of Land Management
Matt Holloran, Wildlife Management Research Support
Dave Dahlgren, Utah State University

SUMMARY

During the 2012-13 winter, managers working for the BLM in Pinedale documented sage-grouse congregating in several areas and pecking at the dirt. Motion-activated cameras were placed at several of these locations and consistent use by large numbers of sage-grouse during the second half of the winter was documented. This geophagy ("dirt-eating") behavior has also been documented in several areas in Jackson Hole (B. Bedrosian, unpublished data). Geophagy is usually attributed to an animal's search for minerals that are otherwise missing in their diets (e.g., sodium, calcium, iron – with sodium the most commonly cited). Sage-grouse in Wyoming may be seeking the nutrients needed to prepare for breeding and nesting by consuming soil. Conversely, sage-grouse eat predominantly sagebrush throughout the winter, and sagebrush leaves contain terpenoids, tannins and other volatile oils. Therefore, sage-grouse may be consuming soils to aid in detoxification of their winter diet.

This study was initiated in 2014 and is ongoing. In 2017, a Master's student from Utah State University will take over the data analysis. Data from GPS-marked sage-grouse are being compiled to investigate geophagy on winter ranges in Pinedale/Big Piney regions of the Upper Green River drainage. Long-term questions on geophagy behavior include where the sites are, frequency of use, why the behavior occurs, and how it affects movement and fitness. To date, 27 geophagy sites have been identified and a preliminary 22 soil samples from verified sites paired with random sites have been collected. Initial results from soil analysis indicate higher pH, electrical connectivity, sodium, and sodium absorption ratio at the use sites compared to paired random sites.

Secondly, GPS data are also being used to help define occupied breeding and brood rearing habitat in the Hoback and Upper Green areas on Bridger-Teton National Forest. These areas may be key connectivity corridors between the large core sage-grouse populations in the Pinedale region to the genetically isolated core population in the Jackson region. In total, data from 36 sage-grouse were collected from 2014-2016. These data have helped mapped several sage-grouse migrations, including the longest known migration of any sage-grouse (about 95 miles one-way from the Upper Green to west of Farson). Additional sage-grouse have been captured and fitted with GPS transmitters to extend the study through 2019.

Invasive species control in occupied sage-grouse habitat

Amy Collett, Teton County Weed and Pest District
Kerry Murphy, Bridger-Teton National Forest
Mark Daluge, Teton County Weed and Pest District

SUMMARY
This project is designed to address the issue of noxious weeds out-competing the natural habitat in such a way that sage-grouse suffer from lack of cover and inadequate forage. By employing Early Detection/Rapid Response tactics we will be more efficiently managing our resources. Over time this method can greatly conserve cost because it targets small problems while they are still manageable before they become too expensive and extensive to treat. Our project would benefit the grouse in preserving their natural habitat and keeping their habitat free of large noxious weed infestations. Well established noxious weed infestations will be controlled so they do not continue their spread.

Sage-grouse in the Upper Gros Ventre watershed have very limited winter range and are vulnerable to loss of habitat due to noxious weed infestations. The core winter ranges (Breakneck Flats and the

Cottonwood-Fish Creek) on Bridger-Teton National Forest support a large percentage (> 60%) of the high quality foraging and thermal cover in the entire watershed. Thus, little other habitat is available to displaced birds. This is an ongoing project that has received financial support numerous times by the Upper Snake River Basin Sage-Grouse Working Group. In 2016, crews treated noxious weeds on approximately 81.5 acres and surveyed and mapped 765 acres in the Gros Ventre watershed. This project applied for and received funding from the Upper Snake River Basin Sage-Grouse Working Group for 2017-2018.

Management Summary

The trend of average peak number of males per lek suggests relatively high populations in the early 1990s with a sharp decline through 1999 and several small rebounds and declines since. It appears that the population has been rebounding in recent years, but the lower count in 2017 represents a set-back for the population. Continued coordination between agencies to monitor this population is essential.

Lek data suggest the population has declined over the long term (1989-present) (Table 1, Figure 5). The long-term viability of this population probably can be assured only if mortality factors currently affecting adult and juvenile hens do not increase. Based on this assumption, reinstituting the hunting season in Management Area A (formerly Areas 1 and 2) is not warranted at this time.

Monitoring sagebrush habitats used by sage-grouse are a priority. Additional documentation of sage-grouse distribution would be helpful to confirm seasonal distribution, movements, and habitat use. Key areas on public lands used by sage-grouse should be protected from management actions which could have adverse impacts on that habitat. Wildfire suppression should be considered in occupied sage-grouse habitat in Jackson Hole and the Gros Ventre drainage. Restoration of native sagebrush habitats on lands formerly hayed in GTNP and the Gros Ventre drainage appears to have the greatest potential to expand and enhance habitat used by sage-grouse in the USRBCA. Protecting sagebrush habitat on private lands from future residential development is also important. Sagebrush restoration on private lands may also be an option in the future.

The impact of the Jackson Hole Airport on the sage-grouse population is an ongoing issue. Management options that do not adversely affect the sage-grouse population should be considered in any risk assessment and wildlife plan associated with safe aircraft operations at the Jackson Hole Airport. Efforts to reduce the risks that sage-grouse may pose to airport operations should be carefully evaluated to avoid negative impacts to this population.

Past and current sage-grouse research by local researchers provides essential information to manage this sage-grouse population and its habitat in Jackson Hole. Managers should continue to prioritize funding and in-kind support to these research efforts.

Recommendations

1. Continue to help coordinate lek surveys across jurisdictional boundaries using the lek survey protocols adopted by the WGFD.

2. Continue coordinating with other agencies to ensure periodic monitoring of historic, unoccupied or inactive leks. Continue to coordinate with other agencies to search for new leks.

3. Continue to document sage-grouse observations to improve occupied habitat mapping.

4. Cooperate with the National Park Service and Jackson Hole Airport to complete the hazard plan and environmental assessment, and assist with designing projects to minimize risks of sage-grouse strikes to aircraft.

5. Support GTNP's sagebrush habitat restoration projects in the Mormon Row and Hayfields areas which could be used as winter, nesting, and brood-rearing habitats for sage-grouse.

6. Continue to work with land management agencies during the implementation of habitat improvement projects to minimize impacts to sage-grouse occupied habitats.

7. Implement the USRBWG Sage-Grouse Conservation Plan (2014). Work to implement the strategies and projects identified in the plan.

8. Support implementation of the most current version of the Governor's Executive Order for Greater Sage-Grouse Core Area Protection.

Relevant References

Bedrosian, B. and S. Walker. 2010. Sage-grouse baseline survey and inventory at the Jackson Hole Airport. Completion Report. Craighead Beringia South, P.O. Box 147, Kelly, WY 83011.

Bedrosian, B., R. Crandall, and D. Craighead. 2010. Jackson Hole Sage-grouse Project Completion Report: 2007-2009. Craighead Beringia South, P.O. Box 147, Kelly, WY 83011.

Bridger-Teton National Forest. 2007. DEIS Eagle Prospect and Noble Basin Master Development Plan. Plains Exploration and Development Company. Bridger Teton National Forest, Jackson WY 83001.

Courtemanch, A., Chong, G., and S. Kilpatrick. 2007. A remote sensing analysis of sage-grouse winter habitat in Grand Teton National Park and Bridger-Teton National Forest, Wyoming. Completion Report. Available in Appendix 3 in Upper Snake River Basin Sage-Grouse Working Group Plan: http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/SG_USR_CONSERVPLAN0005529.pdf

Garton, E.O., J.W. Connelly, J.S. Horne, C.A. Hagen, A. Moser, and M.A Schroeder. 2011. Pages 293-381 *in* S.T. Knick and J.W. Connelly, editors. Greater sage-grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology 38. University of California Press, Berkeley, California.

Holloran, M. J. and S.H. Anderson. 2004. Greater sage-grouse seasonal habitat selection and survival in Jackson Hole, Wyoming. Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, USA.

Patterson, R.L. 1952. The sage grouse in Wyoming. Sage Books, Denver, Colorado, USA.

Schulwitz, S., B. Bedrosian, and J.A. Johnson. 2014. Low neutral genetic diversity in isolated Greater Sage-Grouse (*Centrocercus urophasianus*) populations in northwest Wyoming. The Condor 116:560-573.

Upper Snake River Basin Sage-Grouse Working Group. 2014. Upper Snake River Basin Sage-Grouse Conservation Plan. 137 pp. Available at:
https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Sage%20Grouse/SG_USR_CONSERVPLAN.pdf

Wind River - Sweetwater River Basins
Sage-Grouse
Job Completion Report
2016

June 2016 - May 2017

Stan Harter
Wyoming Game & Fish Dept.
Lander Region

Wind River/Sweetwater River Conservation Area
Job Completion Report

Species: **Greater Sage Grouse**
Mgmt. Areas: **E & WR**
Period Covered: **June 1, 2016 – May 31, 2017**
Prepared by: **Stan Harter, South Lander Wildlife Biologist**

Introduction

The Wind River/Sweetwater River Conservation Area (WRSRCA) encompasses just over 10,000 mi^2, including a diverse array of vegetation communities in central Wyoming (Figure 1). Greater sage-grouse (*Centrocercus urophasianus*) are found throughout the sagebrush/grassland habitats of Wind River and Sweetwater River drainages. Occupied habitat is fairly contiguous throughout much of the conservation area, with principal differences in sagebrush species and associated plant communities related to elevation, precipitation, and soil type diversity. Habitats within the Gas Hills and Badwater Creek areas appear to be the most fragmented by changes in habitat type and energy development. Migrant populations of sage-grouse occur within portions of the conservation area, with some overlap among more stationary resident populations. Large, contiguous blocks of sagebrush/grassland communities have been eliminated in most of the Bureau of Reclamation's (BOR) Withdrawal Area near Riverton and converted into agricultural croplands, as well as near most developed urban areas.

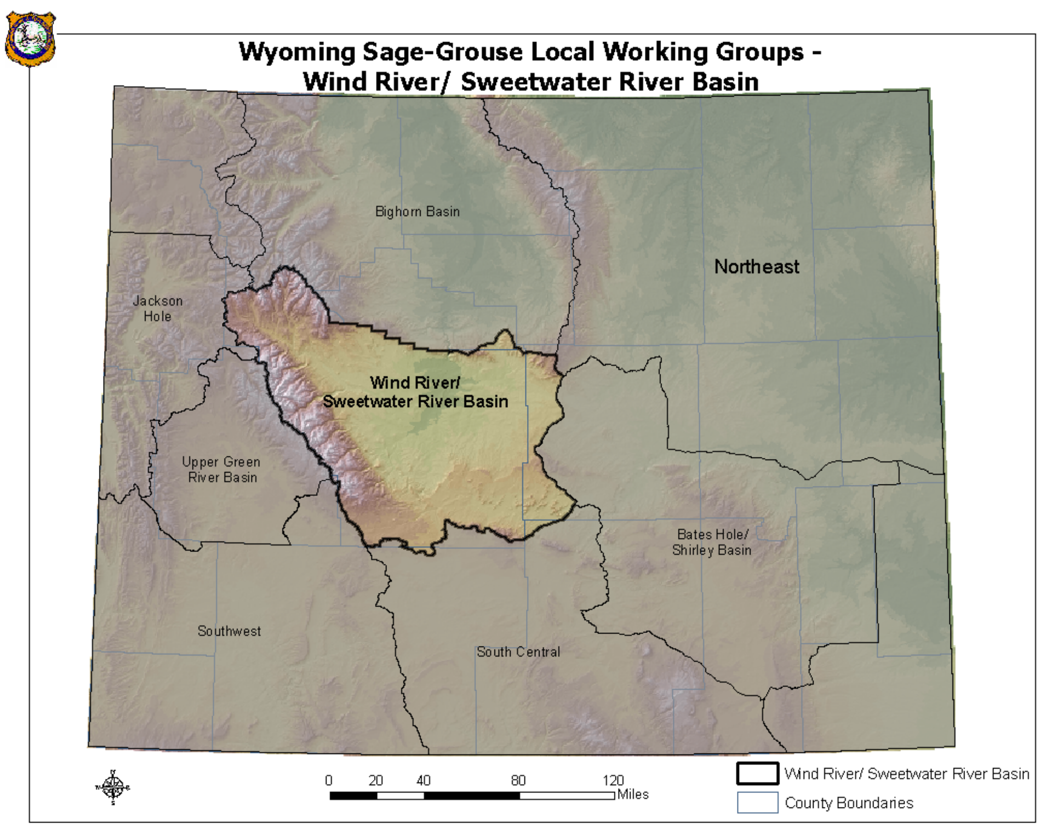


Figure 1. The Wind River/Sweetwater River Conservation Area within Wyoming.

Conservation Area

The Wind River/Sweetwater River Conservation Area features the Wind River and Sweetwater River drainages. The area generally extends from Dubois in the northwest to Muddy Gap and Waltman in the east and from South Pass and Cyclone Rim, Crooks & Green Mountains in the south to the Owl Creek Mountains and South Bighorns in the north. The WRR is also included in the local planning area. Known occupied sage-grouse leks within the WRSRCA are predominantly located on public lands (Bureau of Land Management (BLM) – 57.6% and Bureau of Reclamation (BOR) – 1.6%), or tribal lands on the Wind River Reservation (WRR) – 23.3%. Private lands contain 11.7% of known occupied leks, with the remaining 5.8% located on Wyoming State Trust lands (Figure 2 and Appendix 1).

Major habitat types within the plan area include: sagebrush/grassland, salt desert shrub, mixed mountain shrub, grasslands, mixed forests (conifers and aspen), agricultural crops, riparian corridors, and urban areas. Primary land uses within the WRSRCA include: livestock grazing, oil/gas development, mining, dryland and irrigated crop production, recreation, and urban expansion.

The Wind River/Sweetwater River Local Working Group was organized in fall 2004 to develop and implement a local conservation plan to benefit sage-grouse and other species that use sagebrush habitats. This conservation plan identifies management practices to improve sage-grouse habitat and populations. The mission statement of the Wind River/Sweetwater River Local Sage-grouse Working Group is "to identify issues and implement strategies to enhance sage-grouse and their habitats". The Wind River/Sweetwater River Local Sage-Grouse Conservation Plan was completed in 2007, with an Addendum to the Plan completed in March 2014. The plan, addendum, and other Wyoming sage-grouse information are located on the WGFD website at https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management

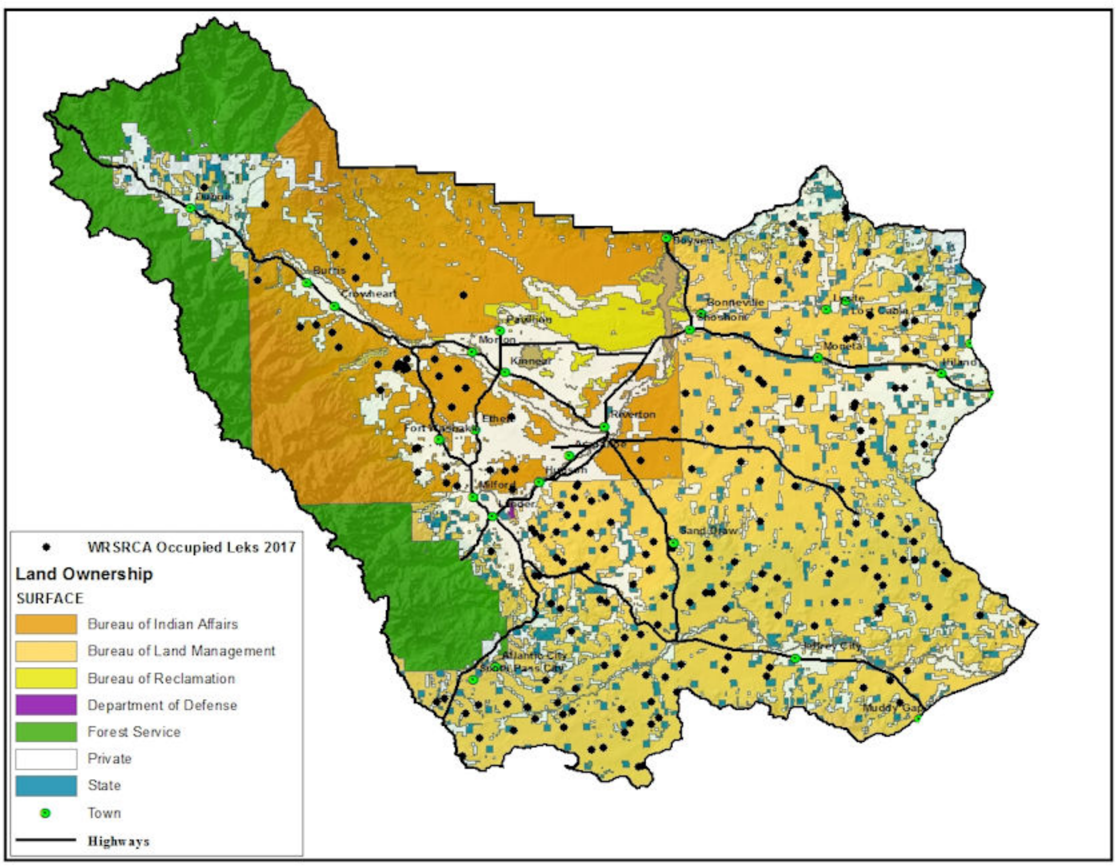


Figure 2. Land ownership within the WRSRCA (dots = 2017 occupied leks). Source: WGFD, BLM.

The WRSRCA encompasses all of the WGFD's Sage Grouse Management Areas E and WR (Figure 3). Management recommendations and conservation efforts apply to all tribal lands within the WRR in both Fremont and Hot Springs Counties. These management areas do not directly correspond to sage-grouse population boundaries, but are used for general data collection and reporting.

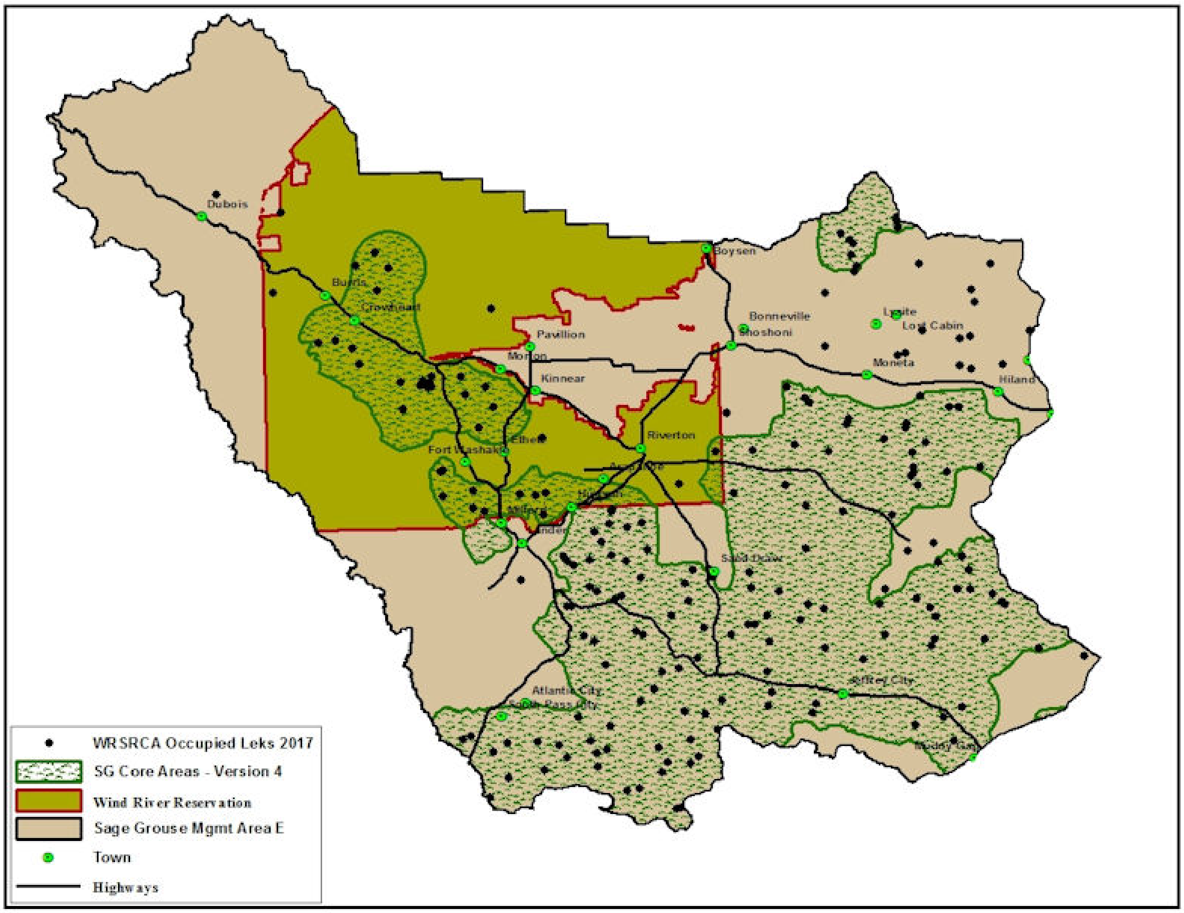


Figure 3. WGFD upland game bird management areas, core areas, and occupied leks within WRSRCA (dots=leks). Source WGFD.

Wyoming Governors' Executive Orders and Greater Sage-Grouse Core Areas

In July 2015, Governor Mead signed Executive Order 2015-4 (replacing 2011-5 and 2013-3) which included Version 4 of the Core Area strategy (Figure 3), which guided management actions during the period covered in this report. The Wyoming Game and Fish Department and Commission maintain management authority over greater sage grouse and management emphasis will continue to focus on implementation of Wyoming's Core Area Strategy. Additional information about the Wyoming Executive Orders, Core Area Strategy, and other relevant sage-grouse information may be found at https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management.

Federal Agency Actions Regarding Greater Sage-Grouse

U.S. Fish and Wildlife Service (USFWS)

The U.S. Fish and Wildlife Service issued a 12-month finding that greater sage-grouse was warranted for listing in 2010 (75 FR 13910, March 23, 2010). In 2015, the U.S. Fish and Wildlife Service issued a decision of "not warranted" for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. This means the State of Wyoming maintains management authority over sage-grouse in Wyoming and management emphasis focuses on implementation of the core area strategy. In its decision document, the Service specifically cited Wyoming's core area strategy as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude the need for a future listing. The Service plans to reexamine the issue after five years (2020) to ensure planned conservation efforts are implemented and the status of the species remains unwarranted for listing. The decision document can be viewed at: https://www.fws.gov/greatersagegrouse/ .

Bureau of Land Management (BLM)

With over 80% of core areas occurring on lands administered by the BLM, that agency initiated a series of state and national Instructional Memoranda (IMs) designed to provide guidance to their field offices on sage-grouse habitat management for proposed activities and resource management planning. These memoranda incorporated the core area concept and executive orders initiated by the Governors. A new Wyoming IM and several national IMs were issued in September 2016. (Table 1).

Table 1. BLM Instruction Memoranda issued in August and September 2016

Wyoming BLM IM

24	August 15, 2016	Greater Sage-grouse Habitat Management Policy on Bureau of Land Management (BLM) Wyoming Administered Public Lands Including the Federal Mineral Estate

BLM Washington Office Instruction Memoranda (IM)

IM 2016-144	September 1, 2016	Gunnison and Greater Sage-Grouse (including the Bi-State Distinct Population Segment) Habitat Assessment Policy
IM 2016-143	September 1, 2016	Implementation of Greater Sage-Grouse Resource Management Plan Revisions or Amendments – Oil & Gas Leasing and Development Sequential Prioritization
IM 2016-142	September 1, 2016	Incorporating Thresholds and Responses into Grazing Permits/Leases
IM 2016-141	September 1, 2016	Setting Priorities for Review and Processing of Grazing Authorizations in Greater Sage-Grouse Habitat; DD: February 1, 2017
IM 2016-140	September 1, 2016	Process for Assessing, Coordinating, and Implementing Greater Sage-Grouse Land Use Plan Adaptive Management Hard and Soft Triggers; DD: February 1 of each year
IM 2016-139	September 1, 2016	Policy for Resource Management Plan Effectiveness Monitoring for Renewable Resources with Additional Guidance for Plans Implementing the Greater Sage-Grouse Conservation Strategy

The WRSR LWG area lies predominantly within the BLM's Lander Field Office but also overlaps into the Casper, Rock Springs and Worland Field Offices. The Lander and Worland Field Offices have revised their resource management plans (RMP) which incorporate measures to enhance sage-grouse and sagebrush management, patterned after and including the state and national IMs. The Record of Decision (ROD) for the Lander RMP revision was released on June 26, 2014 and the Worland RMP revision was signed on September 21, 2015, and the Casper RMP amendment was signed August 3, 2016. The Rock Springs Field Office has initiated efforts to revise the Green River RMP (August 1997) with anticipation of a ROD in 2019.

The new federal administration may decide to alter these decisions.

Natural Resources Conservation Service (NRCS)

The NRCS has implemented its Sage-Grouse Initiative (SGI) across Wyoming and 10 other sage-grouse states. Details of this initiative can be obtained from the NRCS Wyoming State Office or from the Sage-Grouse Initiative website. http://www.sagegrouseinitiative.com

From 2013 through 2016, SGI projects were implemented on a total of just over 341,000 acres (280,482 BLM; 60,546 private and Wyoming State Trust Lands) in Fremont County, including prescribed grazing management/rest rotation, upland wildlife habitat management, herbaceous weed control, critical area plantings, wildlife friendly fencing, fence removal, and livestock water developments.

Summary – Management direction and projects implemented or funded by the WRSR LWG have been, and will be, influenced by the guidance provided in the Wyoming Greater Sage-Grouse Conservation Plan (2003), Governor's executive orders, BLM's instructional memorandum and other programs discussed above. As these directives are updated, the WRSR LWG will continue to consult their guidance.

Sage-grouse Data Collection Methods

Data collection methods and definitions can be found in the Wyoming Game and Fish Department Handbook of Biological Techniques sage-grouse chapter (Christiansen 2012).

Results

Lek Monitoring

Data for "occupied" leks are reported on in Tables 1a-d of Appendix 1. Accordingly, it is important to consider trends in the numbers of active versus inactive leks in addition to the average size of active leks. During a period of population decline, the size of active leks typically declines and the number of inactive leks increases. The opposite is typically true of an increasing population. Therefore, the magnitude of both increases and decreases is usually greater than what is indicated solely by average lek size.

Average female lek attendance is not reported since data collection techniques are not designed to accurately capture these data, and is therefore not useful in assessing population trend.

WGFD, federal agencies, and volunteers have conducted lek counts and surveys each spring within the WRSRCA for over 40 years, providing some of the best long-term management data currently available for sage-grouse. Lek counts include those lek observations conducted 3–4 times each spring, about 7–10 days apart. Lek counts are a census technique that document the actual number of male sage-grouse observed attending a particular lek or lek complex. Lek surveys usually consist of only one spring visit and are intended to determine general lek status, although trends reflected by lek surveys are adequately similar to lek counts when sample sizes exceed 50 leks (Fedy and Aldridge 2011). Known leks indicate sage-grouse distribution within the WRSRCA as represented previously in Figures 2 and 3.

Lek Attendance - 2017

Sage-grouse are generally found throughout the WRSRCA, except in heavily forested, agriculturally developed, or urbanized areas. Sage-grouse leks in the WRSRCA are located within the Lander WGFD Region, 4 BLM Resource Areas, 5 Wyoming counties, and the WRR. There were 205 known occupied leks within the conservation area in 2017, along with 37 unoccupied and 15 undetermined leks. It is highly probable there are leks within the WRSRCA that have not yet been documented, as evidenced by at least 131 (average 6 per year) new or newly discovered leks being documented in the WRSRCA through intensive monitoring and search efforts since 1995. Similarly, there are leks that have been abandoned or destroyed that are undocumented.

Lek attendance generally increased between 1995 and 2006, declined until 2013, increased again for 3 years, only to decline in 2017, mimicking Wyoming's statewide trends, but with generally higher numbers than the Wyoming average (Figures 4, 5).
Of the 207 known occupied leks in the WRSRCA, 189 were checked in 2016 by WGFD, BLM, USFWS, and Shoshone-Arapahoe Tribal Fish and Game (SATFG), assisted by several researchers, consultants, and volunteers. Of those checked, 88 were counted and 101 were surveyed. Weather and road conditions prevented access to some leks in 2016 and 2017, causing an unintended decrease in number of leks counted compared with 2014 and 2015. Of the 164 leks where status was confirmed, 156 (95.1%) were active and 8 (4.9%) were inactive, with a greater proportion in active status than the average since 2007.

Average male lek attendance for all leks checked dropped from 45.1 in 2016 to 39.0 in 2017. Average maximum male attendance at count leks also dropped from 53.6 in 2016 to 44.0 in 2017, which is still nearly 18% above the average since 2008 (37.4), but 42% below the peak in 2006 (76.0).

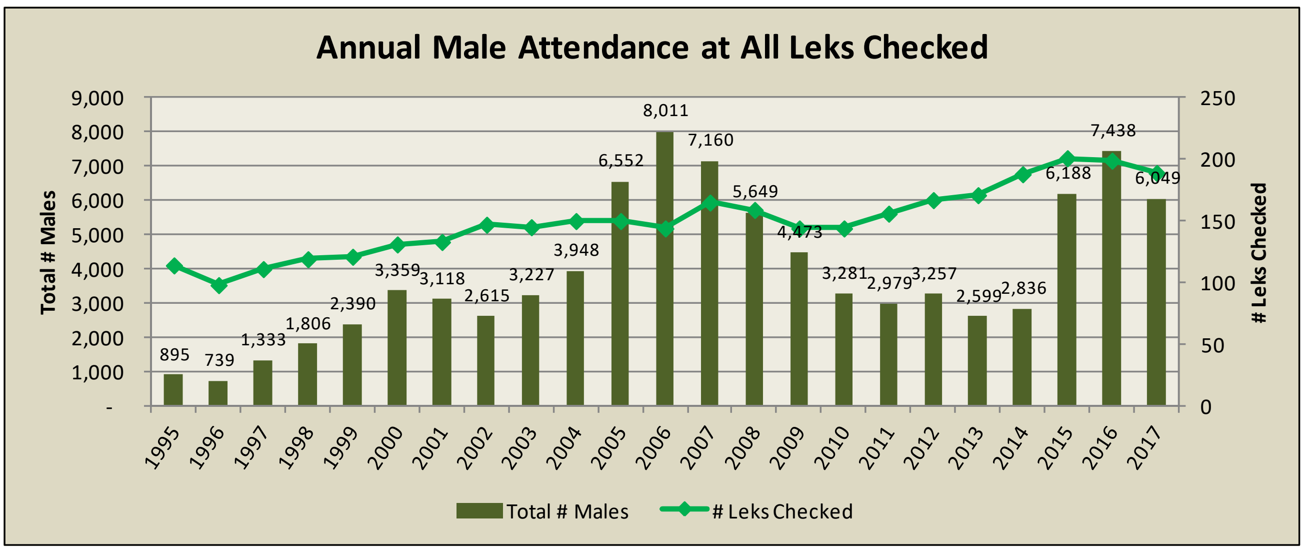


Figure 4. Total male attendance at all leks within the Wind River/Sweetwater River Conservation Area, 1995–2017.

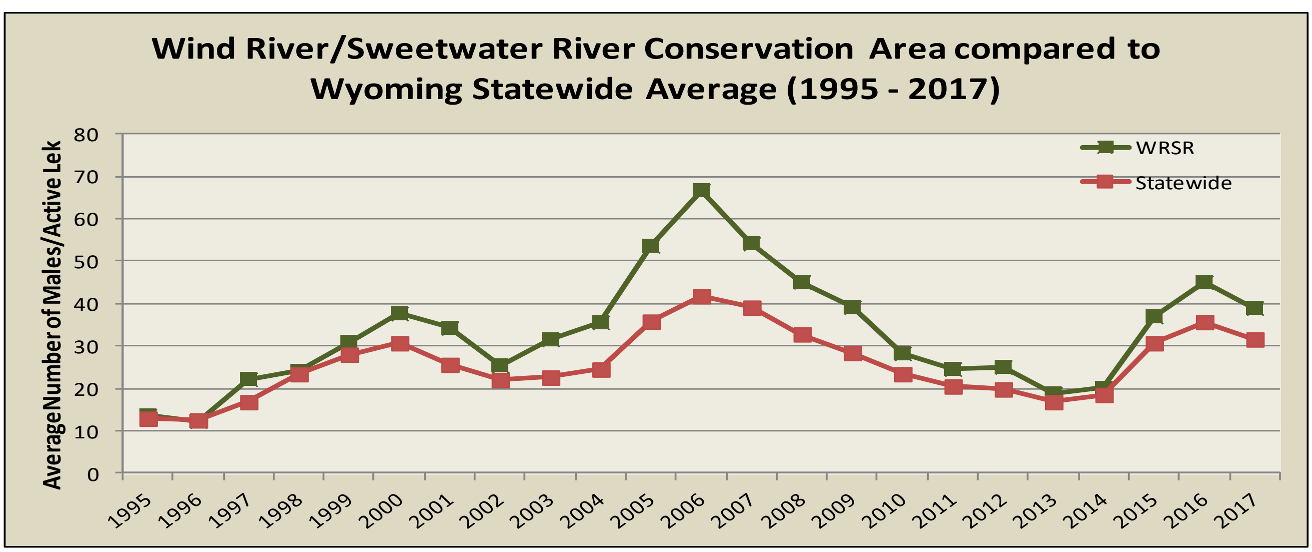


Figure 5. Average male lek attendance (all leks checked) in WRSRCA relative to Wyoming statewide trends, 1995 –2017.

Lek Perimeter Mapping

With increased interest in developing Wyoming's energy resources, emphasis has arisen to map all known sage grouse leks, complete with perimeters outlining the extent of strutting activity on each lek. As of 2017, nearly all lek perimeters were mapped in the WRSRCA. Distance and timing stipulations for developments are applied to the perimeter of each mapped lek, rather than a centralized point. This is a significant difference for many large leks with some total lek perimeter areas reaching 100 acres or larger.

Productivity

Since summer brood data are very limited in the WRSRCA, wing data collected from harvested birds provide a more reliable indicator of recruitment than do brood survey data. Harvested wings are collected from hunters at 7 wing barrels placed annually along major hunting area exit roads in Sage Grouse Management Area E and at the Lander Game Check Station, and typically provide significant wing data, due to a relatively high number of sage-grouse hunters in the area. Wing data are summarized for the WRSRCA for hunting seasons 2007 – 2016 and reported in detail for 2016 (Appendix 1). Wings collected from hunter harvested birds during the 2016 hunting season yielded an average brood size of 0.9 chicks per hen, 31% below the average of 1.3 chicks per hen over the last 10 years. This was the second lowest average brood size since 2007, indicating chick survival was quite poor when compared with 2.0 chicks per hen in 2016. Population growth typically requires 1.7 chicks/hen or more based on historic statewide averages. As such, the low chick survival in 2016 was followed by a 14% decline in male lek attendance as reported above.

Hunting Season and Harvest

Regulated hunting is the cornerstone of the North American Model of Wildlife Conservation, a system that keeps wildlife a public and sustainable resource, and scientifically managed by professionals. Many greater sage-grouse populations can, and do, support hunting under this model (WGFD - Hunting and Sage Grouse, 2010). The Wind River/Sweetwater River Conservation Area has some of the most robust habitats in the entire sage grouse range. As outlined in the hunting season tables in Appendix 1, bag limits, season lengths, and harvest levels appear to be within acceptable levels for the "population" of sage grouse within the WRSRCA. Wings are collected from harvested birds annually at barrels placed at major exits from hunting spots within the WRSRCA. Data gathered from these wings are used to calculate age and sex ratios, and chick survival. Hunting seasons and harvest from the WRR is minimal and are not included in these data.

Sage-grouse hunting season in Management Area E has been "standardized" since 2009, keeping opening day on the 3rd Saturday in September, and was 14 days long in 2016 (Sept. 17 – 30). Hunter numbers rose by 25% and sage grouse harvest increased by 11.5% in 2016 compared with 2015. Hunter effort (days/bird) and (birds/hunter) statistics have been relatively stable since 2006 (Appendix 1, Table 3b).

Weather

Sage-grouse nest success and chick survival have been linked to habitat condition, specifically shrub height and cover, live and residual (remaining from the previous year) grass height and cover, and forb cover. The shrubs (primarily sagebrush) and grasses provide screening cover from predators and weather while the forbs provide food in the form of the plant material itself and in insects that use the forbs for habitat. Spring precipitation is an important determinant of the quantity and quality of these vegetation characteristics. Residual grass height and cover depends on the previous year's growing conditions and grazing pressure while live grass and forb cover are largely dependent on the current year's precipitation.

Weather and climate have been linked to sage-grouse population trends (Heath et al. 1997, Blomberg et al. 2014a/b, Caudill et al. 2014). In general, spring precipitation is positively linked to chick:hen ratios, which are in turn, linked to the following year's lek counts of males. However, periods of prolonged cold, wet weather may have adverse effects on hatching success, plant and insect phenology and production and chick survival.

Following a period of intense drought that began in summer 2006, precipitation has improved substantially since fall 2013, leading to improved habitat conditions, increased chick survival, and subsequent increases in lek attendance in 3 of the past 4 years as seen in Appendix 1. April and May were very wet months in 2016, with precipitation in the WRSRCA ranging from 1.6 to 2.2 times above the average amounts at 4 weather stations within Fremont County. Ordinarily, a wet spring translates to good habitat conditions that summer, but the timing of the rain and snow in spring 2016 overlapped badly with nesting and early brood-rearing periods. This resulted in nests and young chicks being lost to cold, wet conditions. Consequently, chick survival was low, as measured by means of wing data collected during the 2016 hunting season, and was followed by a 14% decline in male sage grouse attendance at leks in spring 2017.

Habitat (Current and Historic)

Long-term sage-grouse habitat conditions have been affected by long-term drought throughout the WRSRCA. Disturbance (i.e., localized energy development, season-long grazing by livestock and wildlife, etc.) combined with lengthy drought periods and sagebrush eradication programs in many areas have negatively impacted sage-grouse and their habitats. In an effort to improve conditions for sage-grouse, habitat improvement projects are being planned and/or implemented throughout the WRSRCA to address declining sage-grouse habitat condition. In addition, research projects in the WRSRCA are continuing to provide more insight to sage-grouse movements and habitat use. Habitat conditions vary greatly within the WRSRCA, due to climatic differences, soil types, land use, and elevation.

Habitat Monitoring/Inventory

No habitat monitoring transects were measured in 2016. Habitat monitoring is discussed in past WRSRCA JCRs, and in the 2007 WRSRCA Local Sage Grouse Conservation Plan and 2014 Addendum. Implementation of "Rapid Habitat Assessments" has begun, to develop a baseline from which to gauge overall habitat condition across the landscapes of the WRSRCA. At least 2 sites were assessed in 2016, one in Hall Creek, another near Red Canyon.

Winter Habitat Survey

Limited winter observations were collected in 2016-17, mostly as opportunistic observations during deer, elk, and moose classifications flights or random ground surveys. Winter habitat use has been obtained via GPS location data from University of Wyoming research in the Jeffrey City/Beaver Rim area. These data were compared with WGFD's Wildlife Observation System (WOS) data and historic winter use maps dating back to the 1960s. Maps of winter use areas were prioritized in May 2015 by BLM Lander Field Office and WGFD wildlife biologists, with additional GPS and VHF winter use data being collected by the University of Wyoming in the Jeffrey City project area, and we await direction as to how to designate these winter use areas.

Habitat Treatments

Since adoption of the WRSR LWG plan in 2007, a number of vegetation treatments have been implemented with the intention of improving habitats for sage grouse, mule deer, and other wildlife. Summaries of these treatments are reported in past JCRs and in the 2007 WRSRCA Local Sage Grouse Conservation Plan and 2014 Addendum. Reports for current year activities follow.

University of Wyoming - "Response of Greater Sage-grouse to Treatments in Wyoming Big Sagebrush"

No new treatments occurred during 2016, however post-treatment monitoring is ongoing, as summarized in the research section later in this report and in their annual report.

South Hudson-Government Draw Noxious Weed Survey and Treatment

Fremont County Weed and Pest (FCWP) staff successfully treated, mapped, and monitored invasive weeds in the project treatment area. Within the areas effected totaling over 12,500 acres, 600 acres of invasive weeds were treated with herbicide. Approximately 100 new locations of invasive Canada thistle, leafy spurge, musk thistle, Russian knapweed, Russian olive, saltcedar, whitetop, field bindweed, black henbane, and perennial pepperweed were identified. FCWP treatment efforts in 2016 were focused on areas north and east of the Hudson-Atlantic City Road where weed pressure is relatively low, but there is a high degree of importance to limit spread north and east of the Hudson-Atlantic City Rd just southeast of Hudson, WY. FCWP crews also treated other known infestations, high priority weed infestations, and spread corridors within the project area.

Conservation Easements

Within the WRSRCA, several privately owned properties have been placed under conservation easements with deed restrictions ranging from minimal to no new construction of houses, barns, or other buildings. Conservation easements are mostly located in the Lander Foothills, Sweetwater River, Twin Creek, Dubois, and Ervay Basin areas. No new conservation easements were completed in 2016. However, a few properties are being considered for easements within the WRSRCA. Presently, nearly 30,000 acres of private lands are permanently protected by conservation easements within the WRSRCA, and provide protection of crucial wildlife habitat, water quality, maintain migration routes, and continue traditional agricultural land uses.

Research

A number of research projects have been conducted in the WRSRCA since 2000. Studies conducted prior to 2016 were reported in past JCRs and in the 2007 WRSRCA Local Sage Grouse Conservation Plan and 2014 Addendum, which contains the most complete bibliography of sage grouse research for the WRSRCA through March 2014. A collection of current sage-grouse research being conducted in Wyoming is compiled annually by Dr. Jeff Beck at the University of Wyoming and is included in the annual statewide sage-grouse JCR. Abstracts for studies conducted in or directly pertaining to the WRSRCA in 2016-17 follow. Citations for published works are included at the end of this report.

Response of Greater Sage-grouse to Treatments in Wyoming Big Sagebrush –
Leonard, Smith, Beck, et al - University of Wyoming (Ongoing Research)

ABSTRACT: Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) has been treated through chemical application, mechanical treatments, and prescribed burning to increase herbaceous forage species released from competition with sagebrush over story. Originally intended to provide more forage for livestock, these techniques have been applied to improve habitat for sagebrush wildlife species including greater sage-grouse (*Centrocercus urophasianus*). Treatments are intended to rejuvenate sagebrush plants and increase herbaceous production. Studies evaluating habitat treatments have reported varied results and generally lack the replication necessary for evaluation of demographic rates and fine-scale habitat use of sage-grouse in response to treatments. Our study, centered near Jeffrey City, Wyoming is designed as a Before-After Impact-Control study with 3 years of pre-treatment and at least 5 years of post-treatment data comparing demographic rates and habitat selection patterns within treated and non-treated sites.

We initiated our study in spring 2011 by capturing female sage-grouse and affixing VHF necklace-mounted or GPS rump-mounted transmitters to measure nest and brood-rearing success, and adult female survival. During winter 2014, we mowed 489 ha (1,208 acres) of sagebrush habitats across 2 mowing treatment areas and applied Spike® 20P on 607 ha (~1,500 acres) across 2 herbicide treatments areas in May 2014. To date, we have monitored demographic parameters from n = 507 marked females. Identifying sage-grouse demographic and habitat use responses will aid in determining the efficacy of habitat treatments intended to enhance habitat for sage-grouse and other species associated with the sagebrush biome.

Effects of Mowing and Herbicide Treatments on the Nutritional Quality of Sagebrush in south-central, Wyoming *– Smith, et al – University of Wyoming; Forbey, et al. – Boise State University (Publication in Review)*

ABSTRACT: Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) is the most abundant subspecies of big sagebrush and has been treated through chemical application, mechanical treatments and prescribed burning to improve habitat conditions for greater sage-grouse (*Centrocercus urophasianus*). Although the response of structural attributes of sagebrush communities to treatments is well understood, there is a need to identify how treatments influence the quality of sagebrush as winter food for wildlife. Our purpose was to identify how mowing and tebuthiuron treatments intended to reduce sagebrush canopy cover influenced dietary quality of Wyoming big sagebrush in central Wyoming. Two study areas were mowed in January and February 2014 and tebuthiuron was applied in two study areas in May 2014. We constructed 6 exclosures in each of these four study areas (24 total), which encompassed 30 m x 30 m areas of treated and untreated sagebrush within each exclosure. Samples of current annual growth were collected from 18 sagebrush plants from treatment sites and 12 plants from control sites within each exclosure during November 2013–2015. Samples were analyzed for crude protein and plant secondary metabolites known to influence dietary selection of sagebrush by sage-grouse and other sagebrush occurring herbivores. Our results suggest mowing and tebuthiuron treatments may slightly increase crude protein concentrations directly after treatments without immediate changes in plant secondary metabolites. Future work should evaluate not only how treatments influence sage-grouse habitat use and reproductive success, but how treatments influence other wildlife species in fragile sagebrush ecosystems.

Effectiveness of Sage-Grouse Core Areas as an Umbrella for Non-Game Sagebrush Species of Greatest Conservation Need *– Carlisle, Chalfoun. University of Wyoming (Carlisle, 2017)*

ABSTRACT: We investigated how effective Greater Sage-Grouse is as an umbrella species for the conservation of non-game wildlife, specifically sagebrush-associated wildlife designated as Species of Greatest Conservation Need (SGCN). Our findings will be useful to managers interested in indirectly conserving SGCN under the streamlined approach of the sage-grouse umbrella. We addressed the following objectives at differing spatial scales to rigorously test sage-grouse as an umbrella species: 1) quantify overlap statewide between sage-grouse core areas and the habitat of 52 SGCN using GIS data; 2) determine whether high sage-grouse abundance corresponds with high abundance of sagebrush-obligate SGCN songbirds in the field; 3) evaluate whether sage-grouse nest-site quality and selection match those of sagebrush-obligate SGCN songbirds in the field; and 4) examine the responses of sagebrush-obligate SGCN songbirds (abundance, nesting success, etc.) to sagebrush-reducing habitat treatments implemented to improve sage-grouse brood-rearing habitat. We have completed field work near Jeffrey City, WY (4 seasons, 2012-2015). Preliminary findings by objective: 1) Core areas covered 0-63% of associated SGCN's suitable habitat; 2) Sage-grouse abundance was a generally poor indicator of sagebrush-obligate songbird abundance; 3) Sage-grouse nest-site quality and selection did not match those of sagebrush-obligate songbirds; and 4) SGCN songbirds nested in the vicinity of mowed areas, but did not appear to use the mowed footprint, or benefit from habitat treatments. Full results appear in Jason Carlisle's dissertation (Carlisle 2017, University of Wyoming) and are in the process of peer-reviewed publication.

Fitness Consequences of Migration Strategy and Seasonal Habitat Protections for Greater Sage-Grouse - *Dinkins, et al – University of Wyoming (Publication in Review)*

ABSTRACT: Our study aimed to delineate seasonal habitats and assess differential fitness related to migration strategy and seasonal habitat use of greater sage-grouse (*Centrocercus urophasianus*: hereafter "sage-grouse"). In addition, we evaluated benefits gained for sage-grouse through the implementation of the Wyoming Core Area Strategy relative to protection of habitat and differences in nest, brood, and annual female survival. We compared the proportion of seasonal habitats that were within or outside Core Areas as delineated with 75% and 95% kernel density contours (KDE). The proportion of summer and winter habitats (95% KDE) that overlapped Core Areas was 0.69 of summer and 0.50 of winter habitat within a Core Area. We found no

differences in nest or brood survival among migration strategies or within and outside Core Areas. However, females that did not migrate out of their respective winter habitat had lower risk of death, which highlighted year-round benefits of winter habitat. Females had lower risk of death during winter with the lowest risk occurring during winter in Core Areas. Higher temperature and lower snow water equivalent during the breeding season and fall were detrimental to female survival; whereas, neither had an effect on winter survival. Although Core Areas encompassed a large proportion of winter habitat, our results indicate that Core Areas (as delineated) were not the most direct way to protect winter habitat for sage-grouse. During winter, sage-grouse gathered within habitat conducive to winter survival, indicating that disturbances within these winter habitats may have broad consequences for sage-grouse populations.

Wyoming Sage-grouse Core Area Health Assessment – *Burkhalter, Holloran, et al (2017)*

ABSTRACT: A comprehensive understanding of wildlife habitat suitability requires landscape-scale assessments that provide the framework for subsequent integration with local-scale relationships. In order to elucidate the functional role of habitat characteristics at large scales it is necessary to understand how abundance is related to important landscape characteristics. We estimated male Greater Sage-grouse (*Centrocercus urophasianus*) abundance on leks relative to sagebrush availability, landscape connectivity, and anthropogenic infrastructure densities within landscapes surrounding leks from 2006 to 2013 using binomial N-mixture models. We focused on Wyoming, as the state will play a critical role in the long-term persistence of Greater Sage-grouse due to its relatively robust populations, widespread sagebrush habitats, and innovative, large-scale conservation approaches. Landscapes associated with higher abundance of males on leks were characterized as highly-connected, sagebrush-dominated areas with limited energy development. These modeled relationships were used to evaluate spatial and temporal changes in the landscape-scale integrity of areas supporting the majority of the Greater Sage-grouse populations in Wyoming (i.e., core areas). By assessing relative changes in abundance over time, our models indicated that most of the habitat within core areas (86%) exhibited landscape conditions conducive to supporting medium or large Greater Sage-grouse populations that were stable or increasing through time. Larger populations were associated with larger, more centrally-located core areas. Conversely, core areas supporting relatively small or declining populations were located along range margins in the eastern portion of the state. The landscape scale habitat relationships we developed can be used in combination with local-scale assessments to generate a more complete picture of Greater Sage-grouse habitat suitability.

Mapping Sage-grouse Leks to Link Habitat Structure and Behavior – *Patricelli, et al. - University of California-Davis and Forbey, et al. – Boise State University (Ongoing Research)*

ABSTRACT: The goal of this project is to understand how sage-grouse use their microhabitats on and off the lek and how those choices may affect survival and reproductive success. During the 2017 mating season, we have conducted multi-point TLS (Terrestrial LiDAR Scanning; a ground-based LiDAR – light detection and ranging) for 5 of our study leks in the Government Draw area near Hudson, Wyoming (Fremont County). These scans have provided us with highly accurate, three-dimensional maps of the topography and vegetation structure of the leks. These scans will be queried for the cover, horizontal concealment, and other relevant metrics to measure ecologically important features of the lek microhabitat. We also collected videos of the sage-grouse space use on the lek. These videos will be connected with the TLS scans to determine which microhabitat features are important for both male and female sage-grouse on their display grounds, which will help us determine which environmental characteristics are better and worse with respect to communication and riskiness on the lek. We are also examining sage-grouse dietary preferences off the lek using radio telemetry tags to find foraging and roost sites. At these sites, as well as random sites, we collect samples of browsed and unbrowsed sagebrush and habitat measures. Samples are currently being analyzed in the Forbey lab.

Diseases

No new cases of West Nile Virus (WNv) or other avian diseases are known to have occurred in sage grouse in the WRSRCA in 2016.

Management Recommendations

1. Incorporate recommendations outlined in Wyoming Governor's Executive Orders and associated "Stipulations for Development in Core Sage-Grouse Population Areas".
2. Implement the Wind River/Sweetwater River Local Sage-Grouse Conservation Plan and 2014 Addendum and work to incorporate recommended management practices.
3. Continue to collect age and sex composition of the harvest via wing collection and analyses.
4. Continue intensive lek counts in the Government Draw area south of Hudson.
5. Continue ground checks of all non-intensively monitored leks.
6. Continue to search for new or undiscovered leks in remote areas of WRSRCA.
7. Continue to cooperate with private landowners and Federal/State land managers to reduce negative impacts to crucial sage-grouse habitats.
8. Continue to coordinate research projects with University of Wyoming, University of California-Davis, and others within or applicable to the WRSRCA.

Literature Cited

Blomberg, E.J., D. Gibson, M. T. Atamian, and J.S. Sedinger. 2014a. Individual and environmental effects on egg allocations of female greater sage-grouse. Auk 131:507–523.

Blomberg, E.J., J.S. Sedinger, D. Gibson, P.S. Coates, and M.L. Casazza. 2014b. Carry-over effects and climatic conditions influence the post fledging survival of greater sage-grouse. Ecology and Evolution doi: 10.1002/ece3.1139

Burkhalter, C., M. J. Holloran, B. C. Fedy, H. E. Copeland, R. L. Crabtree, N. L. Michel, S. C. Jay, B. A. Rutledge, and A. G. Holloran. *In Press*. Landscape-scale habitat assessment for an imperiled avian species. Animal Conservation.

Carlisle, J.D. 2017. The effect of sage-grouse conservation on wildlife species of concern: implications for the umbrella species concept. Dissertation. University of Wyoming, Laramie, WY.

Caudill, D., M. R. Guttery, B. Bibles, T.A. Messmer, G. Caudill, E. Leone, D. K. Dahlgren, and R. Chi. 2014. Effects of climatic variation and reproductive trade-offs vary by measure of reproductive effort in greater sage-grouse. Ecosphere 5(12):154. http://dx.doi.org/10.1890/ES14-00124.

Christiansen, T. 2012. Chapter 12: Sage Grouse (*Centrocercus urophasianus*). Pages 12-1 to 12-55 in S.A. Tessmann and J. R. Bohne (eds). Handbook of Biological Techniques: third edition. Wyoming Game and Fish Department. Cheyenne.

Dinkins, J. B., K. J. Lawson, K. T. Smith, J. L. Beck, C. P. Kirol, A. C. Pratt, M. R. Conover, and F. C. Blomquist. *In press*. Quantifying overlap and fitness consequences of migration strategy with seasonal habitat use and a conservation policy. Ecosphere

Fedy, B.C. and C.L. Aldridge. 2011. The importance of within-year repeated counts and the influence of scale on long-term monitoring of sage-grouse. Journal of Wildlife Management 75(5): 1022-1033.

Heath, B. J., R. Straw, S.H. Anderson, J. Lawson. 1997. Sage-grouse productivity, survival and seasonal habitat use near Farson, Wyoming. Research Completion Report. Wyoming Game & Fish Dept., Cheyenne.

Smith, K.T., J.S. Forbey, and J.L. Beck. *In Review*. Effects of mowing and tebuthiuron treatments on the nutritional quality of Wyoming big sagebrush.

Smith, K.T., and J.L. Beck. *In press*. Sagebrush treatments influence annual population change for greater sage-grouse. Restoration Ecology DOI: 10.1111/rec.12589

Wind River/Sweetwater River Local Working Group. August 2007. Wind River/Sweetwater River Local Sage-Grouse Conservation Plan. Wyoming Game and Fish Department, Cheyenne.

Wind River/Sweetwater River Local Working Group. March 2014. Addendum for the Wind River/Sweetwater River Local Sage-Grouse Conservation Plan. Wyoming Game and Fish Department, Cheyenne.

Sage Grouse Lek Characteristics (2017)

Working Group: Wind River/Sweetwater River

Region	Number	Percent
Casper	2	0.8
Lander	194	75.5
WRIR	61	23.7

Working Group	Number	Percent
Wind River/Sweetwater River	257	100.0

Classification	Number	Percent
Occupied	205	79.8
Undetermined	15	5.8
Unoccupied	37	14.4

BLM Office	Number	Percent
Lander-WRR	61	23.7
Casper	12	4.7
Lander	175	68.1
Rock Springs	7	2.7
Worland	2	0.8

Biologist	Number	Percent
WRR-USFWS	61	23.7
Casper	2	0.8
North Lander	69	26.8
Sinclair	1	0.4
South Lander	123	47.9
Worland	1	0.4

Warden	Number	Percent
Shoshone-Arapahoe Tribal	61	23.7
Dubois	1	0.4
Lander	72	28.0
North Riverton	27	10.5
South Riverton	61	23.7
West Casper	2	0.8
West Rawlins	33	12.8

County	Number	Percent
Carbon	1	0.4
Fremont	227	88.3
Hot Springs	4	1.6
Natrona	24	9.3
Sweetwater	1	0.4

Land Status	Number	Percent
BLM	148	57.6
BOR	4	1.6
Private	30	11.7
Reservation	60	23.3
State	15	5.8

Management Area	Number	Percent
E	196	76.3
WR	61	23.7

Lek Status	Number	Percent
Active	164	63.8
Inactive	24	9.3
Unknown	69	26.8

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Wind River/Sweetwater River

1. Lek Attendance Summary (Occupied Leks) (1)

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2008	179	72	40	3367	51.0
2009	177	65	37	2444	45.3
2010	179	54	30	1621	36.0
2011	187	70	37	1668	26.9
2012	193	78	40	1899	28.8
2013	196	81	41	1543	22.4
2014	199	101	51	1860	21.6
2015	215	117	54	4614	43.9
2016	212	99	47	4770	53.6
2017	207	88	43	3523	44.0

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2008	179	84	47	2282	39.3
2009	177	79	45	2029	33.8
2010	179	90	50	1660	23.4
2011	187	86	46	1311	22.6
2012	193	89	46	1358	21.2
2013	196	90	46	1056	15.3
2014	199	87	44	976	17.7
2015	215	84	39	1570	25.3
2016	212	100	47	2668	35.1
2017	207	101	49	2526	33.7

1) Occupied - Active during previous 10 years (see official definitions)

2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

3) Inactive - Confirmed no birds/sign present (see official definitions)

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Wind River/Sweetwater River

1. Lek Attendance Summary (Occupied Leks) (1) Continued

c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2008	179	156	87	5649	45.6
2009	177	144	81	4473	39.2
2010	179	144	80	3281	28.3
2011	187	156	83	2979	24.8
2012	193	167	87	3257	25.1
2013	196	171	87	2599	18.8
2014	199	188	94	2836	20.1
2015	215	201	93	6184	37.0
2016	212	199	94	7438	45.1
2017	207	189	91	6049	39.0

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2008	127	11	18	138	92.0	8.0
2009	114	14	16	128	89.1	10.9
2010	119	9	16	128	93.0	7.0
2011	121	10	25	131	92.4	7.6
2012	131	16	20	147	89.1	10.9
2013	139	14	18	153	90.8	9.2
2014	142	22	24	164	86.6	13.4
2015	167	17	17	184	90.8	9.2
2016	167	11	21	178	93.8	6.2
2017	156	8	25	164	95.1	4.9

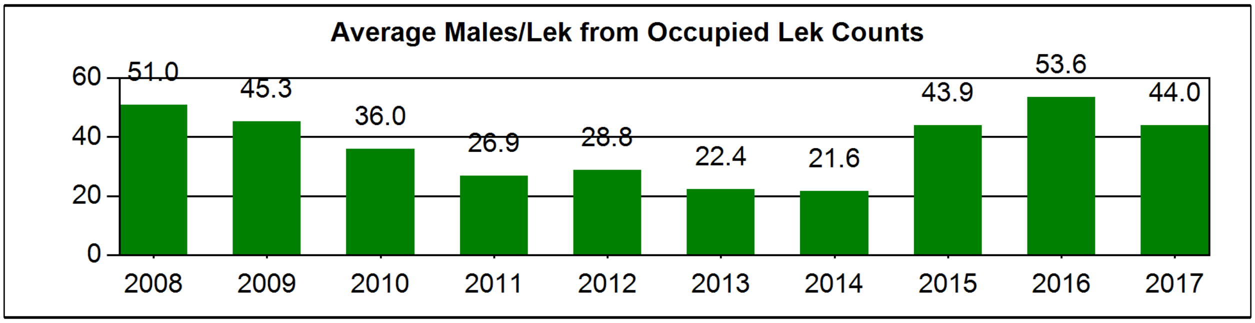
1) Occupied - Active during previous 10 years (see official definitions)

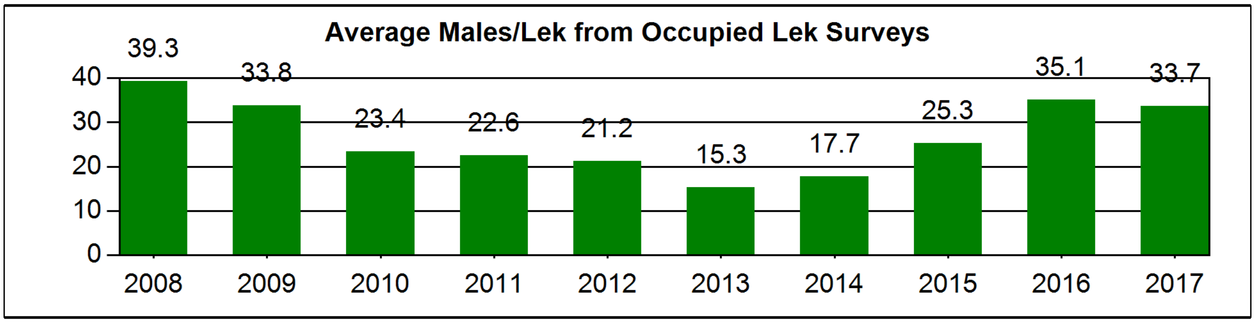
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

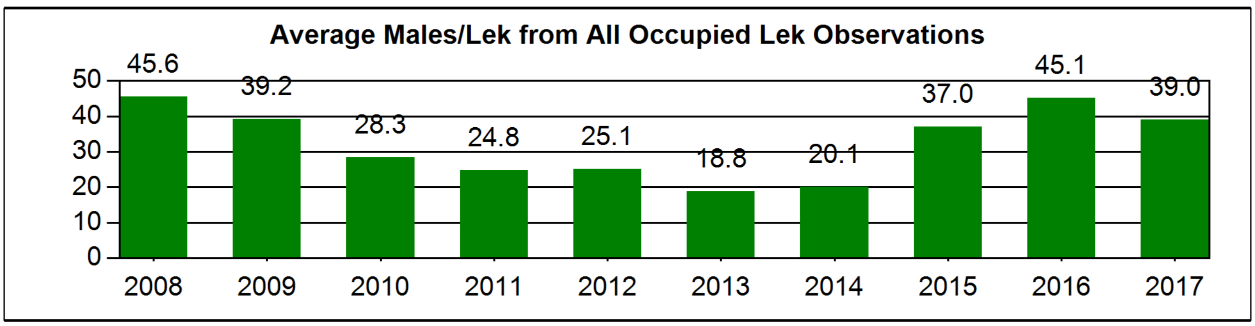
3) Inactive - Confirmed no birds/sign present (see official definitions)

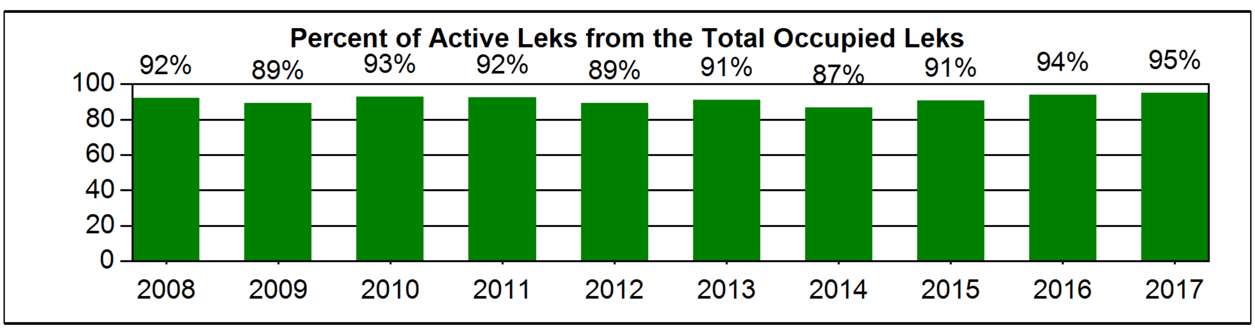
Sage Grouse Occupied Lek Attendance Summary

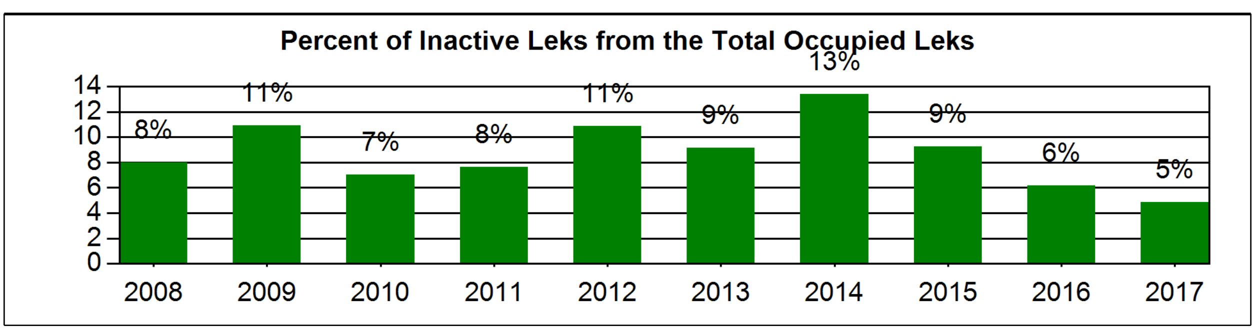
Year: 2008 - 2017, Working Group: Wind River/Sweetwater River











Sage Grouse Job Completion Report

Year: 2007 - 2016, Working Group: Wind River/Sweetwater River

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4
2011	Sep-17	Sep-30	14	2/4
2012	Sep-15	Sep-30	16	2/4
2013	Sep-21	Sep-30	10	2/4
2014	Sep-20	Sep-30	11	2/4
2015	Sep-19	Sep-30	12	2/4
2016	Sep-17	Sep-30	14	2/4

b. Harvest

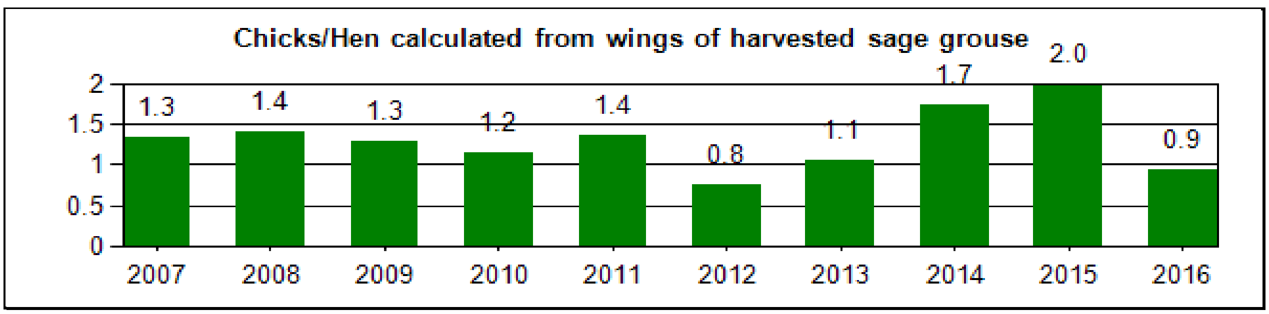
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2007	1,776	788	1,696	1.0	2.3	2.2
2008	2,144	863	2,059	1.0	2.5	2.4
2009	2,295	875	2,114	1.1	2.6	2.4
2010	2,495	1,056	2,866	0.9	2.4	2.7
2011	1,779	771	1,801	1.0	2.3	2.3
2012	2,068	890	2,296	0.9	2.3	2.6
2013	1,240	565	1,325	0.9	2.2	2.3
2014	1,546	772	1,853	0.8	2.0	2.4
2015	2,158	737	1,846	1.2	2.9	2.5
2016	1,910	922	2,264	0.8	2.1	2.5
Avg	1,941	824	2,012	1.0	2.4	2.4

Sage Grouse Job Completion Report

Year: 2007 - 2016, Working Group: Wind River/Sweetwater River

4. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult Male	Percent Adult Female	Percent Yearling Male	Percent Yearling Female	Percent Young Male	Percent Young Female	Chicks/ Hens
2007	397	23.9	29.2	1.0	3.0	17.1	25.7	1.3
2008	538	21.6	24.5	5.6	5.6	17.8	24.7	1.4
2009	598	16.7	24.6	6.9	8.9	14.7	28.3	1.3
2010	476	16.0	30.3	4.4	6.7	15.1	27.5	1.2
2011	376	9.0	27.1	6.9	8.5	14.4	34.0	1.4
2012	443	18.5	36.1	6.3	6.8	11.1	21.2	0.8
2013	202	18.8	29.7	0.5	9.4	14.9	26.7	1.1
2014	343	10.5	23.3	2.3	8.5	30.3	25.1	1.7
2015	513	11.3	21.2	5.3	6.6	21.4	34.1	2.0
2016	307	16.9	29.6	3.9	11.1	16.9	21.5	0.9



Sage Grouse Wing Analysis Summary

Year: 2016, Working Group: Wind River/Sweetwater River

Adult Males:	52	% of All Wings:	16.9
Adult Females:	91	% of All Wings:	29.6
Adult Unknown:	0	% of All Wings:	0.0
Total Adults:	143		
Yearling Males:	12	% of All Wings:	3.9
Yearling Females:	34	% of All Wings:	11.1
Yearling Unknown:	0	% of All Wings:	0.0
Total Yearlings:	46		
Chick Males:	52	% of All Wings:	16.9
Chick Females:	66	% of All Wings:	21.5
Chick Unknown:	0	% of All Wings:	0.0
Total Chicks:	118		
Unknown Sex/Age:	0		
Total for all Sex/Age Groups:	**307**		

Chick Males:	52	% of All Chicks	44.1
Yearling Males:	12	% of Adult and Yearling Males	18.8
Adult Males:	52	% of Adult and Yearling Males	81.3
Adult and Yearling Males:	64	% of Adults and Yearlings	33.9
Total Males:	116	% of All Sex/Age Groups	37.8
Chick Females:	66	% of All Chicks	55.9
Yearling Females:	34	% of Adult and Yearling Females	27.2
Adult Females:	91	% of Adult and Yearling Females	72.8
Adult and Yearling Females:	125	% of Adults and Yearlings	66.1
Total Females:	191	% of All Sex/Age Groups	62.2

Chicks:	118	% of All Wings:	38.4
Yearlings:	46	% of All Wings:	15.0
Adults:	143	% of All Wings:	46.6
Chicks/Hen	0.9