Wyoming

Sage-Grouse
Job Completion Report
2017

June 2017-May 2018

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Wyoming Game & Fish Dept.

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Wyoming Sage-Grouse Job Completion Report

Conservation Plan Area: **Statewide Summary**
Period Covered: **6/1/2017– 5/31/2018**
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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 88% of these leks in the spring of 2018. Results of the survey indicate 1,174 leks were confirmed active, 304 confirmed inactive, and 131 unknown or unchecked. The average number of males observed on leks was 26/active lek, 6 percent fewer than the 32/active lek observed in the spring of 2017, 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.

Since the mid-2000's, the Wyoming Legislature biennially appropriated over $1 million of General Funds to the sage-grouse program for the state's 8 local sage-grouse working groups (LWGs) (Figure 2) to allocate to local projects. 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. The last of biennial legislative funds were allocated in FY 2017-2018.

The 2017 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 promulgated regulations in Chapter 60 to permit this activity. However, no sage-grouse eggs have been collected from the wild for this purpose as of May 2018.

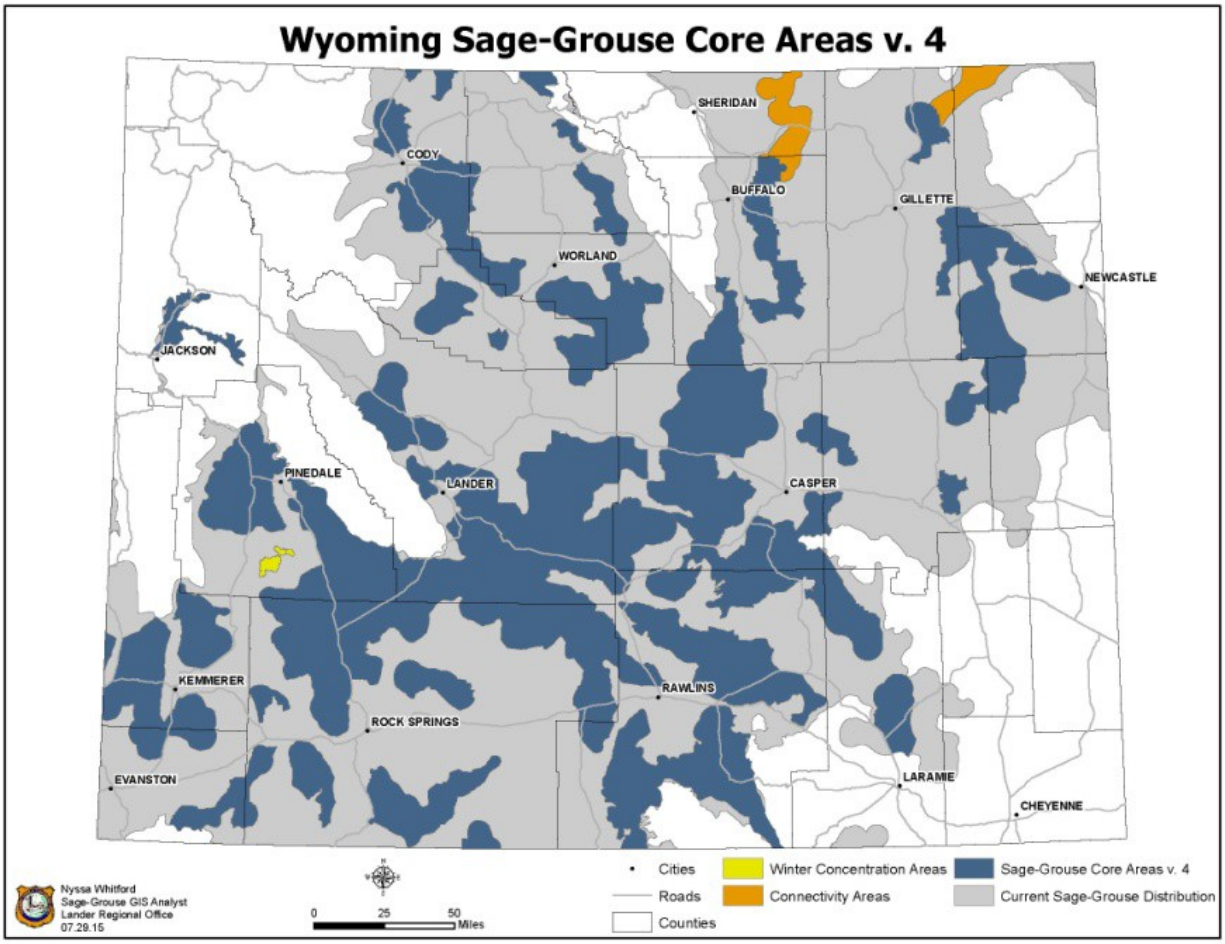


Figure 1. Wyoming Core Areas (version 4).

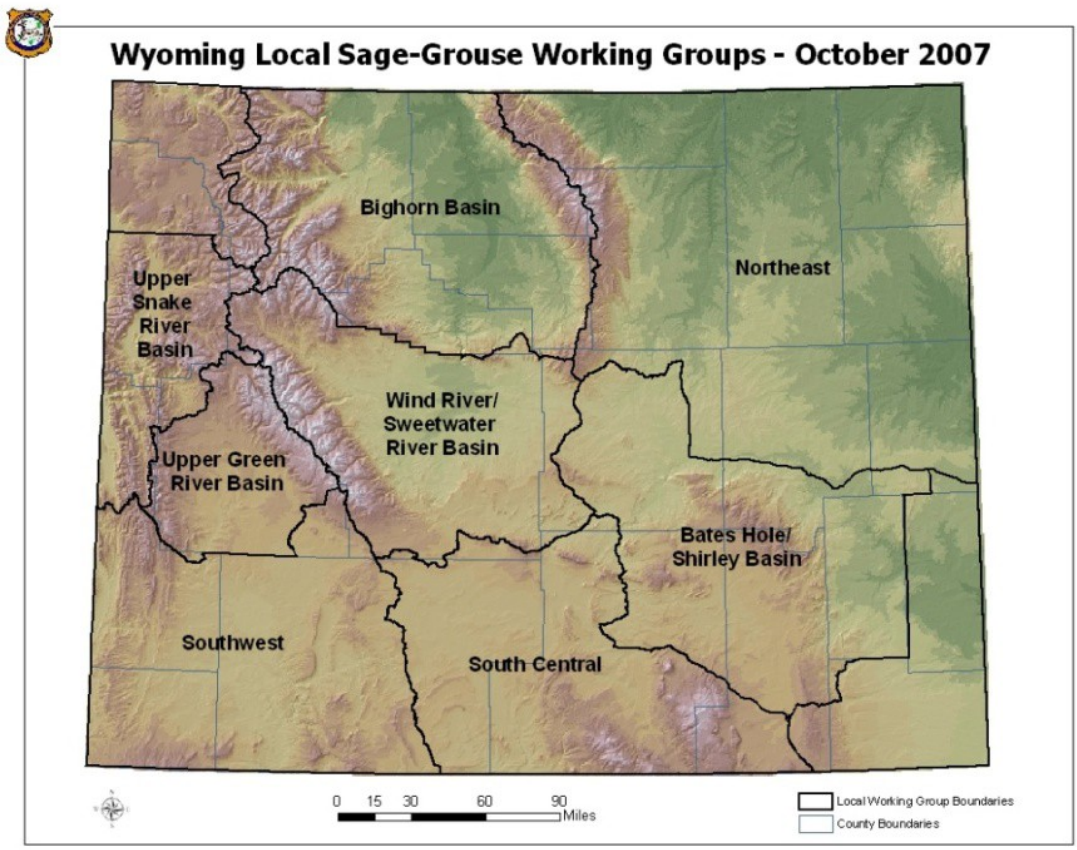


Figure 2. Wyoming Local sage-grouse working group boundaries.

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 28% from 2016 to 2018.

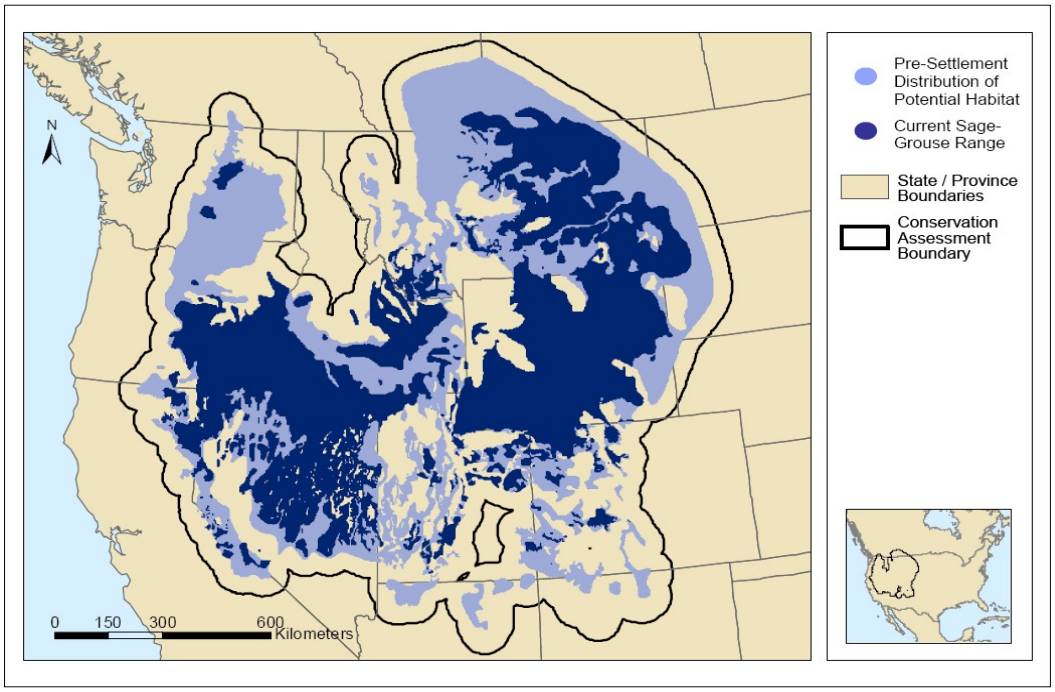


Figure 3. Current distribution of sage-grouse and pre-settlement distribution of potential habitat in North America (Schroeder 2004). For reference, Gunnison sage-grouse in SE Utah and SW Colorado are shown.

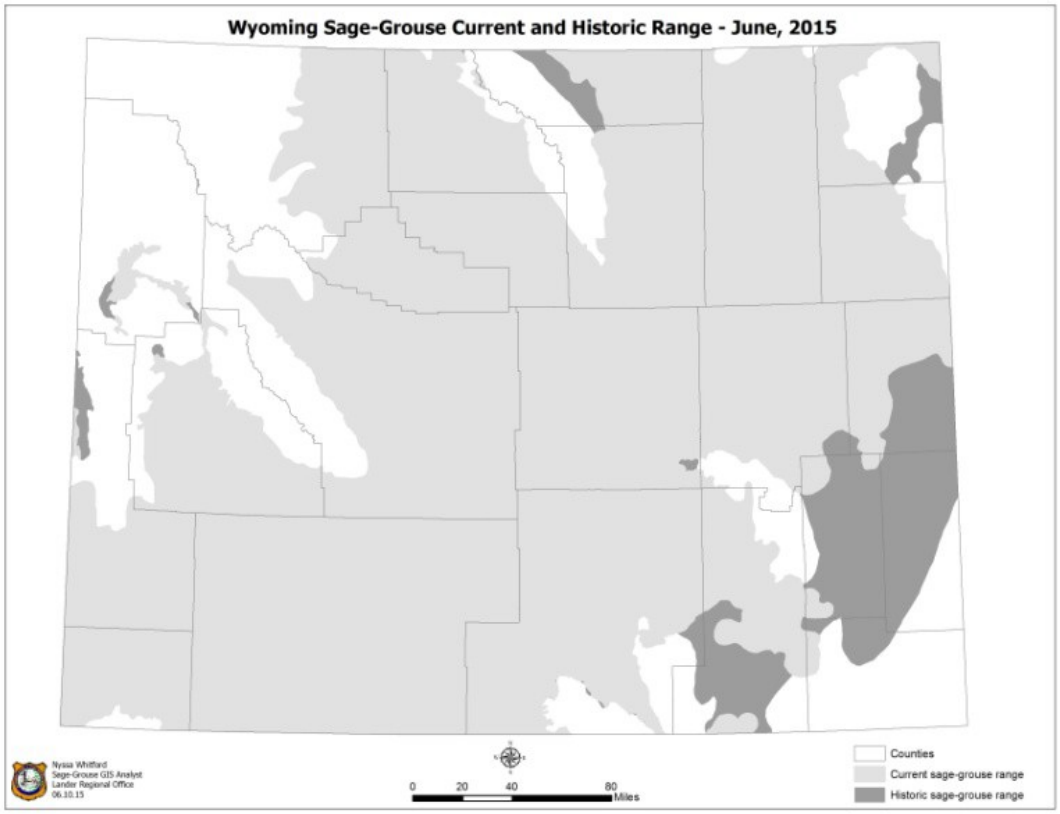


Figure 4. Sage-grouse range in Wyoming (updated 2015).

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 males 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%, then declined another 18% in 2018 to nearly equal the 10-year (2008-2017) average of 25.9 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 2018 breeding season are summarized in Tables 1a-d and Figures 6-11. Department personnel and others checked 88% (1,609/1,820) of the known occupied leks in 2018 (Table 1-c). Male attendance at all leks visited (counts and surveys) averaged 25.7 males per lek during spring 2018, an 18% decrease from the 31.4 males/lek observed in 2017 and 38% below the 41.7 males/lek observed in 2006. For the 10-year period (2009-2018), average male lek attendance ranged from 16.8 males/lek in 2013, the lowest average males per lek since 1997, to a high of 35.6 males/lek in 2016.

The proportion of active, occupied leks remained stable at 82% in 2016, 80% in 2017, and 79% in 2018.

In 2018, 7,052 fewer male sage-grouse were observed on 27 fewer active leks checked. Cumulatively, the lek attendance data suggest there were fewer grouse in bio-year 2017 than in 2016. 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.

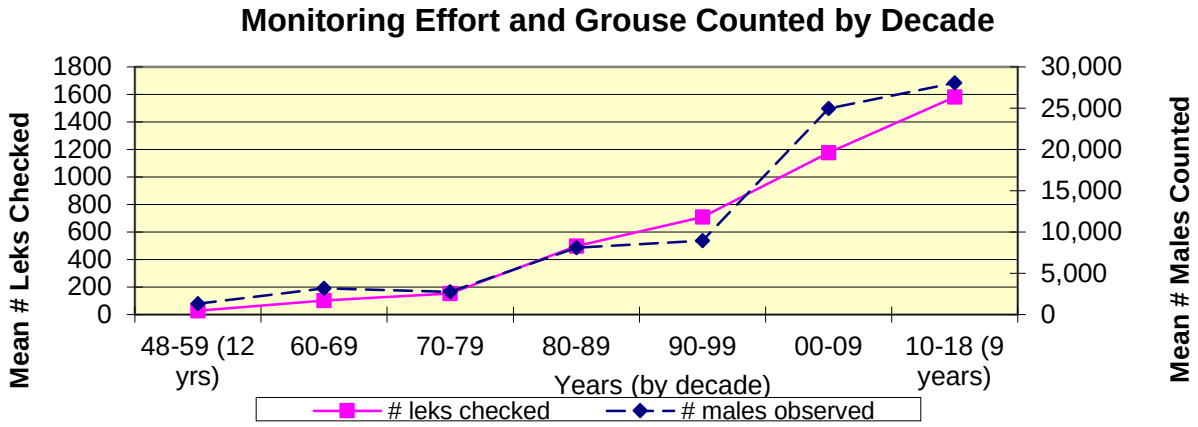


Figure 5. Mean annual numbers of leks checked (monitoring effort) and male grouse counted in Wyoming 1948-2018 by decade.

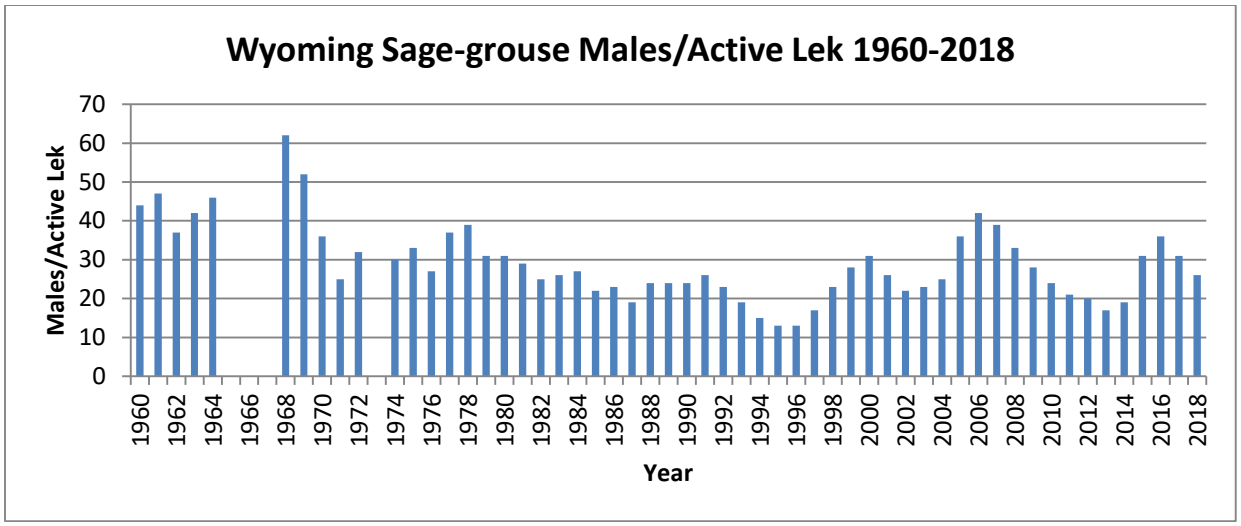


Figure 6. Average number of males per lek counted in Wyoming from 1960-2018 with a minimum of 100 leks checked each year.

Table 1a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2009	1683	580	34	15550	32.1
2010	1714	647	38	14154	27.2
2011	1750	646	37	11308	22.5
2012	1783	716	40	12661	23.0
2013	1795	646	36	10617	20.7
2014	1798	772	43	11466	20.6
2015	1827	742	41	19505	34.2
2016	1843	733	40	23388	40.3
2017	1833	689	38	18690	35.5
2018	1820	788	43	17025	28.5

Table 1b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2009	1683	857	51	15032	25.5
2010	1714	824	48	11578	20.1
2011	1750	836	48	10143	18.7
2012	1783	821	46	8624	16.6
2013	1795	930	52	7657	13.4
2014	1798	841	47	8604	16.5
2015	1827	880	48	17005	27.7
2016	1843	950	52	19884	31.3
2017	1833	951	52	17877	28.1
2018	1820	821	45	12490	22.8

Table 1c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2009	1683	1437	85	30582	28.5
2010	1714	1471	86	25732	23.5
2011	1750	1482	85	21451	20.5
2012	1783	1537	86	21285	19.9
2013	1795	1576	88	18274	16.8
2014	1798	1613	90	20070	18.6
2015	1827	1622	89	36510	30.8
2016	1843	1683	91	43272	35.6
2017	1833	1640	89	36567	31.4
2018	1820	1609	88	29515	25.7

Table 1d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2009	1093	189	155	1282	85.3	14.7
2010	1116	194	161	1310	85.2	14.8
2011	1081	219	182	1300	83.2	16.8
2012	1119	248	170	1367	81.9	18.1
2013	1116	286	174	1402	79.6	20.4
2014	1105	352	153	1457	75.8	24.2
2015	1215	272	135	1487	81.7	18.3
2016	1260	276	147	1536	82.0	18.0
2017	1201	302	137	1503	79.9	20.1
2018	1174	304	131	1478	79.4	20.6

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)

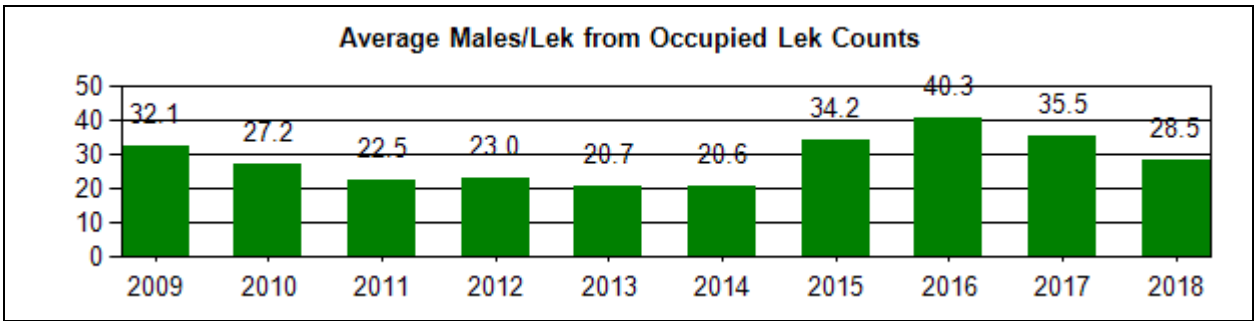


Figure 7. Average males/lek from occupied lek counts.

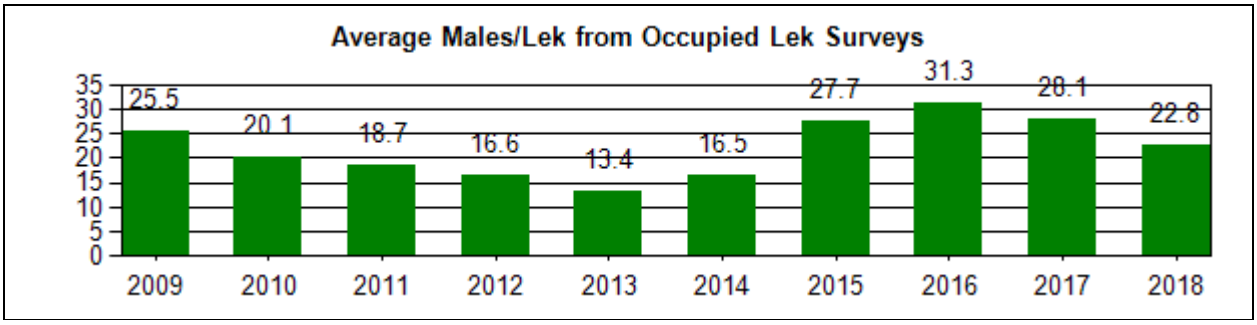


Figure 8. Average males/lek from occupied lek surveys.

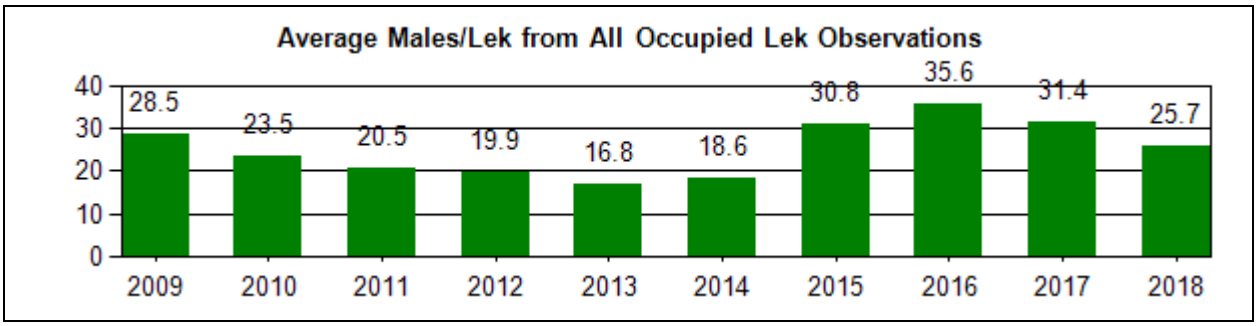


Figure 9. Average males/lek from all occupied leks checked (counts+surveys).

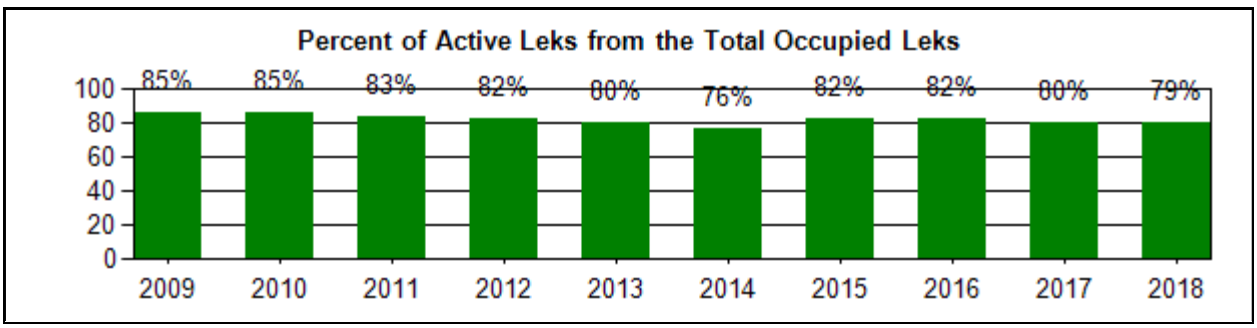


Figure 10. Percent active leks from the occupied leks checked with known status.

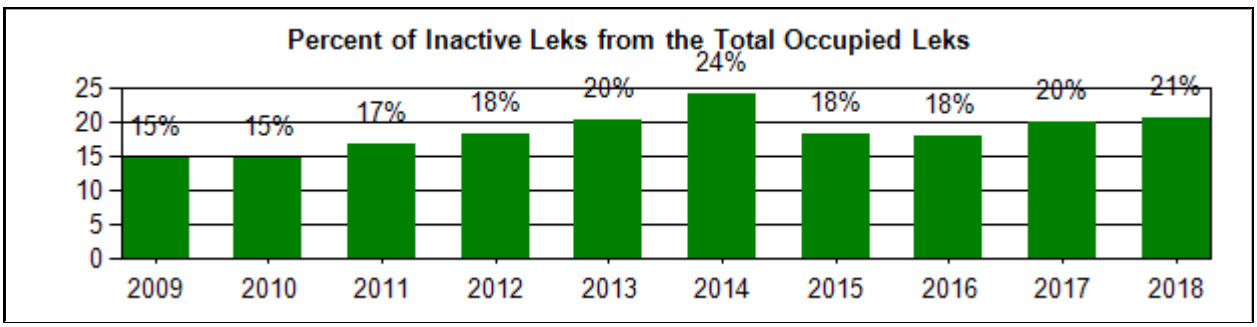
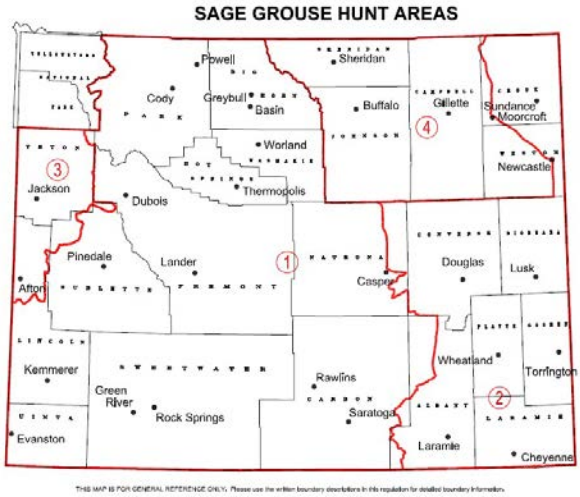


Figure 11. Percent inactive leks from the occupied leks checked with known status.

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 2017 hunting season (Figure 12, Table 2) for most of the state (Area 1) was 1 day longer than 2016 due to the calendar effect of opening the season on the third Saturday of September. In 2016 the third Saturday was September 17, but in 2017 it was September 16.



Area	Season Dates	Daily/Poss. Limits	Falconry
1	Sept. 16-Sept. 30	2/4	Sept. 1-Mar. 1
2, 3	Closed	Closed	Closed
4	Sept. 16-Sept. 18	2/4	Sept. 1-Mar. 1

Figure 12 and Table 2. 2017 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 decreased between 2016 (4,674 hunters/10,526 birds) and 2017 (3,576 hunters/7,817 birds). The trend in the number of birds harvested is generally correlated with lek attendance trends. The number of birds harvested is estimated from a voluntary hunter survey.

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

Year	Season Start	Season End	Length	Bag/Possesion Limit
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
2017-1	Sep-16	Sep-30	15	2/4
2017-4	Sep-16	Sep-18	3	2/4

Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
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
2017	7817	3576	8646	0.9	2.2	2.4
Avg	9,434	4,294	10,151	0.9	2.2	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
2017						
Avg	9,690	4,454	10,356	0.9	2.2	2.3

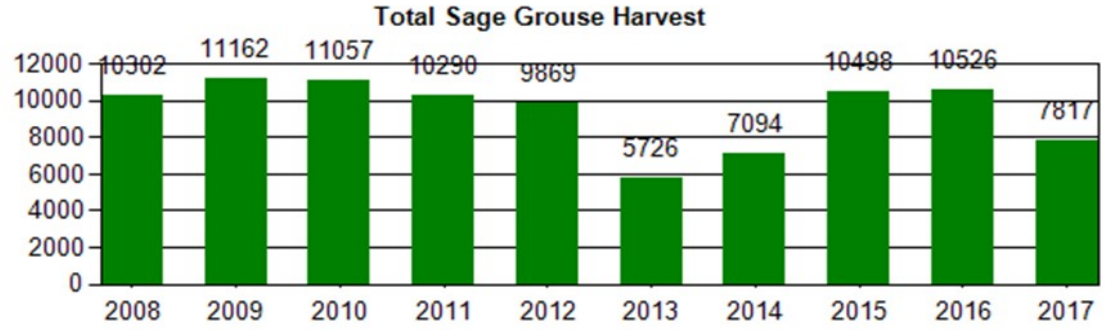


Figure 13. Wyoming statewide sage-grouse harvest 2008-2017.

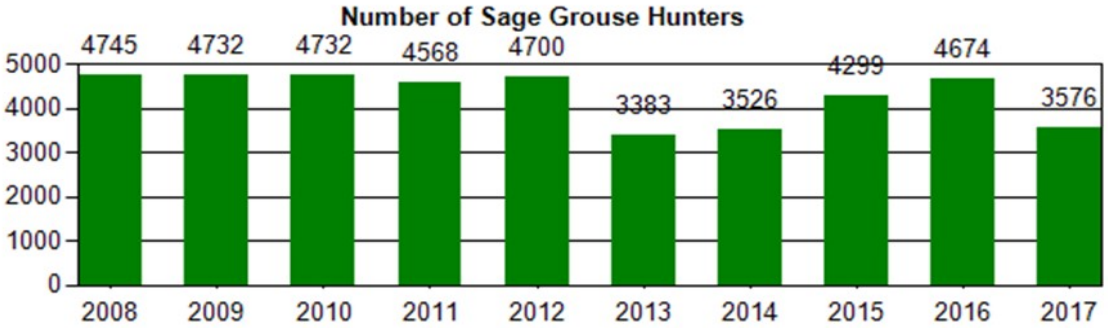


Figure 14. Wyoming statewide sage-grouse hunter numbers 2008-2017.

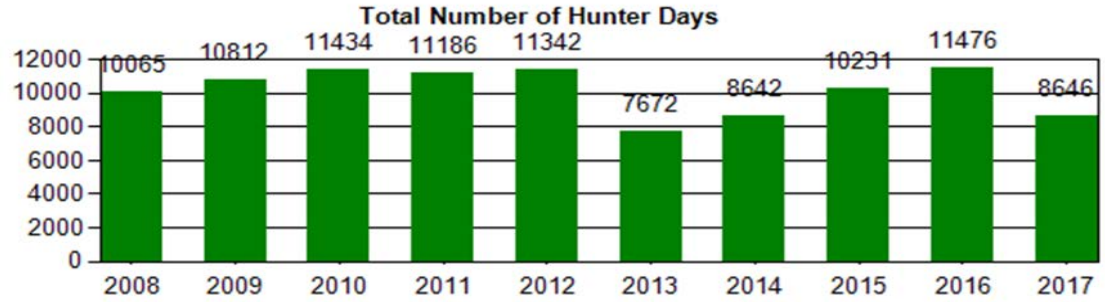


Figure 15. Wyoming statewide number of hunter days 2008-2017.

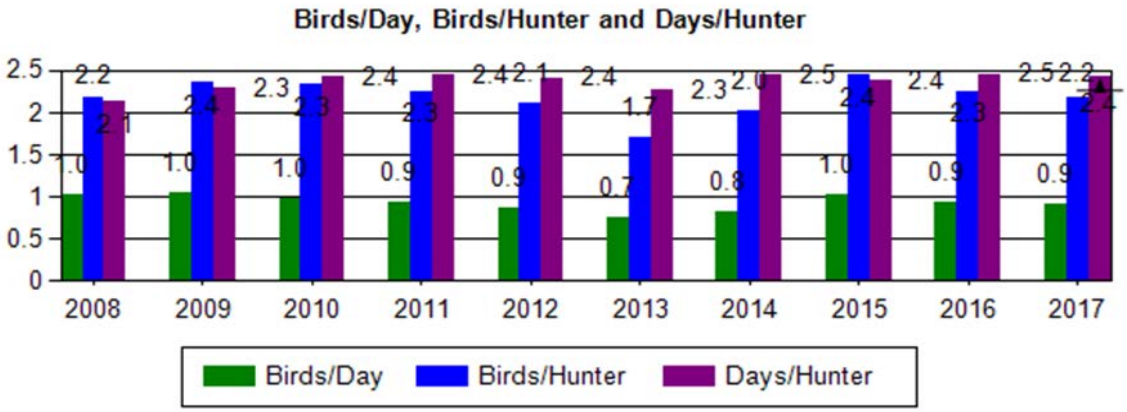


Figure 16. Wyoming statewide birds/day, birds/hunter and days/hunter 2008-2017.

The number of sage-grouse wings collected from hunters decreased by 2% in 2017. In 2017, 2,047 wings were recorded (Table 4), which is 26% of the estimated harvest. This is slightly above the 10-year average of 20% with most changes between years being minor.

The 2017 chick:hen ratio (based on harvested wing analysis) was 1.2 chicks per hen (Table 4 and Figure 17). This level of productivity is typically associated with a declining population. This is consistent with the 2018 lek data (all lek checks), which indicated an 18% decrease in the average numbers of males on leks (Table 5). When 1997-2017 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	Percent Adult		Percent Yearling		Percent Young		Chicks/
	Size	Male	Female	Male	Female	Male	Female	Hens
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
2017	2047	13.8	31.7	3.3	6.0	20.7	24.6	1.2

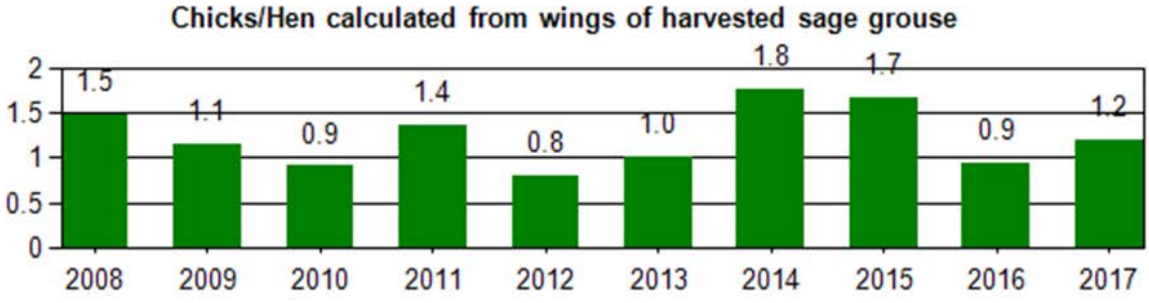


Figure 17. Chicks/Hen 2008-2017 based on wings from harvested grouse.

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%
2017	1.2	-18%

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.

Habitat and seasonal range mapping.

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 (Attachment B). 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.

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 2005-2017, 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-eight (28) projects (Attachment C) were funded. Most of the projects are supported by multiple cost-sharing partners. Cumulatively, two-hundred-twenty-four (224) 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.

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

Wyoming to North Dakota Translocation Project

In 2017, 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 females, 20 males) from Wyoming to North Dakota in an effort to prevent extirpation of the North Dakota population. The effort was repeated in 2018 (20 females, 20 males, 6 females with broods) 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. Some translocated sage-grouse moved long distances shortly after release, including into Montana and South Dakota, hence the team is moving toward translocating females with young chicks to suppress long-distance movements.

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 promulgated regulations in Chapter 60 to permit this activity. One permit contingent upon completion of infrastructure was issued to a facility in January 2018. However, the permittee did not collect sage-grouse eggs from the wild as of May 2018.

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 2017 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. 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.

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) Continuously evaluate participation in the North Dakota translocation project.

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:

MATTHEW H. MEAD
GOVERNOR

THE STATE OF WYOMING

STATE CAPITOL
CHEYENNE, WY 82002

Office of the Governor

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.

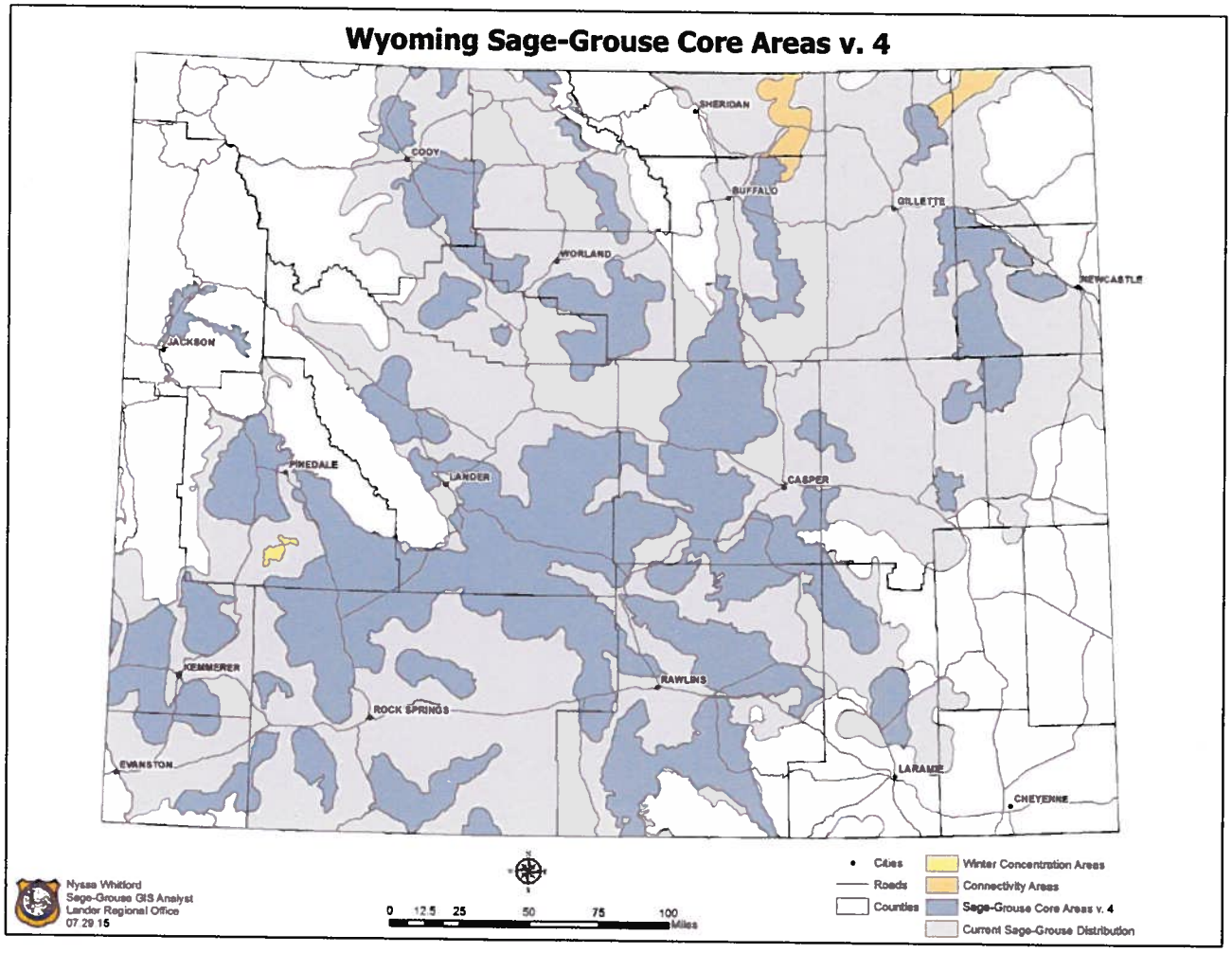
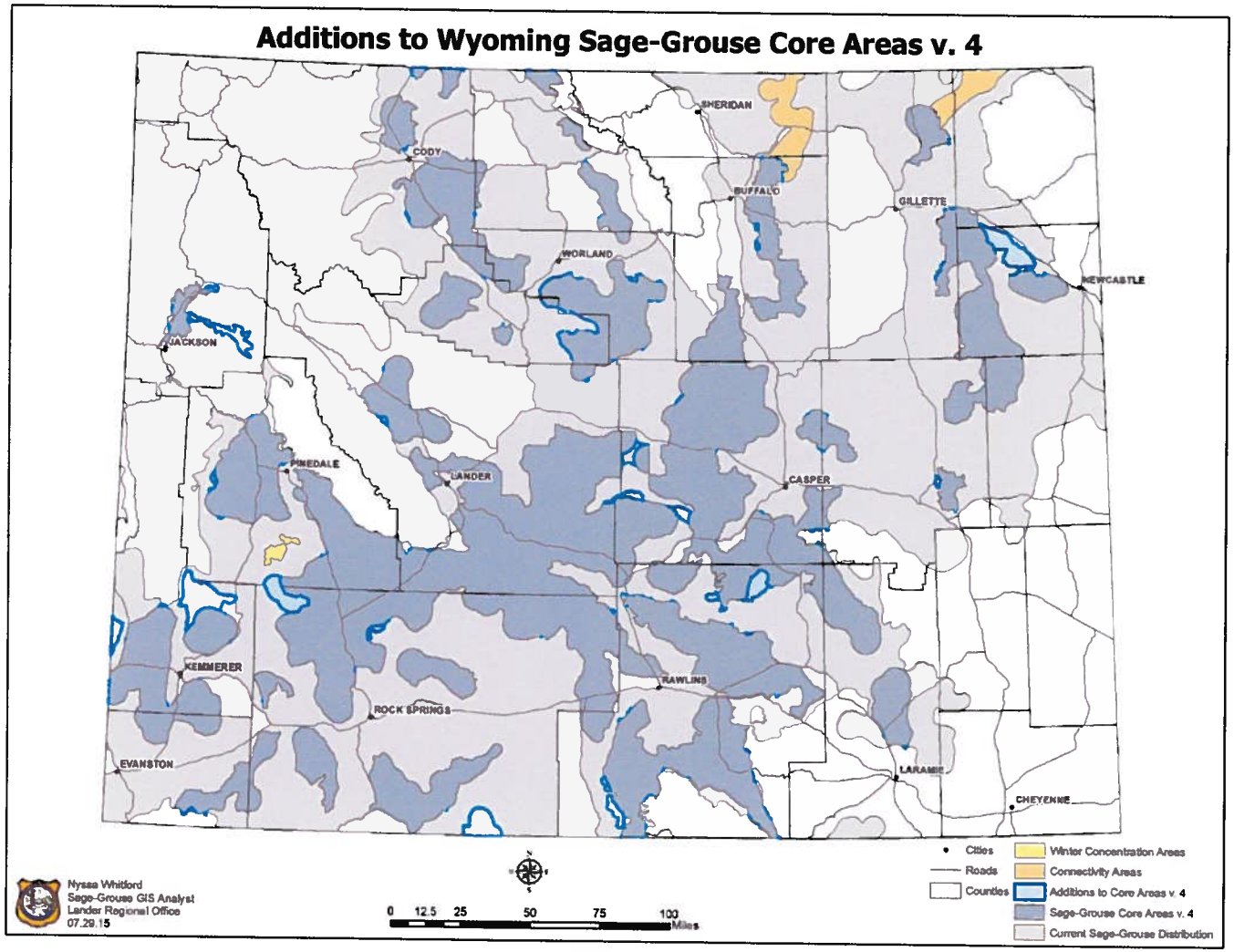


Figure 2.


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
Nyssa Whitford
Sage-Grouse GIS Analyst
Lander Regional Office
07.29.15
0 12.5 25 50 75 100
Miles
Cities
Roads
Counties
Winter Concentration Areas
Connectivity Areas
Additions to Core Areas v. 4
Sage-Grouse Core Areas v. 4
Current Sage-Grouse Distribution

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.

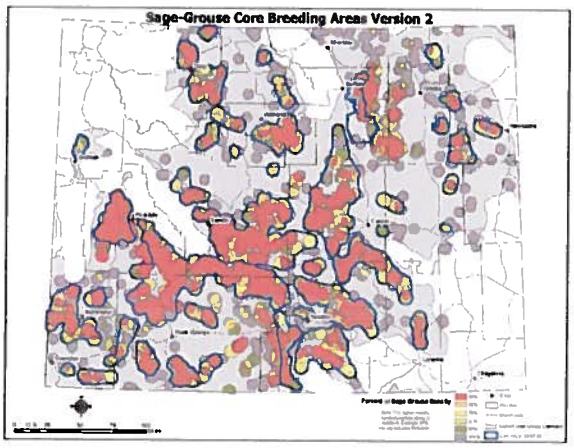


Figure 3. Greater sage-grouse breeding density and Core Population Areas (Version 2) associated with Executive Order 2008-2.

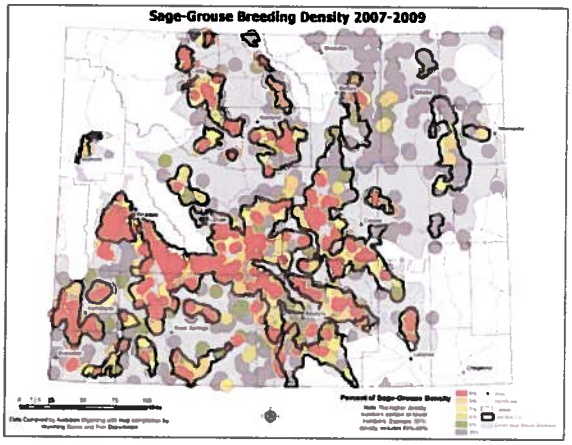


Figure 4. Greater sage-grouse breeding density and Core Population Areas (Version 3) associated with Executive Orders 2010-4 and 2011-5.

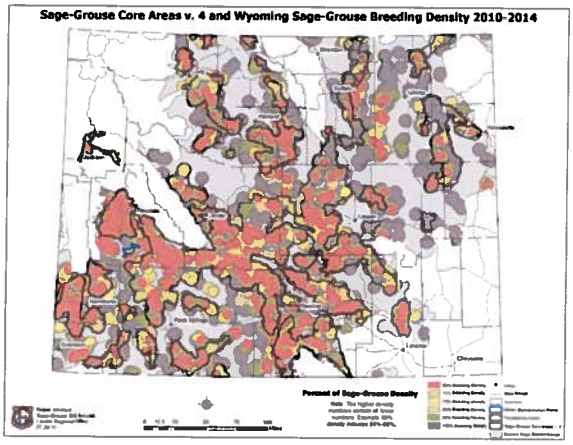


Figure 5. Greater sage-grouse breeding density and Core Population Areas (Version 4) associated with Executive Order 2015-4.

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 $\geq$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.

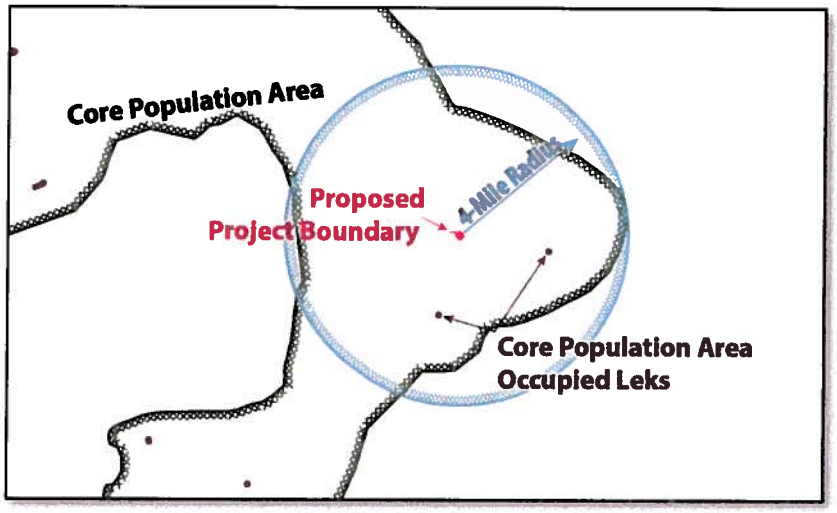


Figure 1 – DDCT assessment area step 1, proposed project boundary.

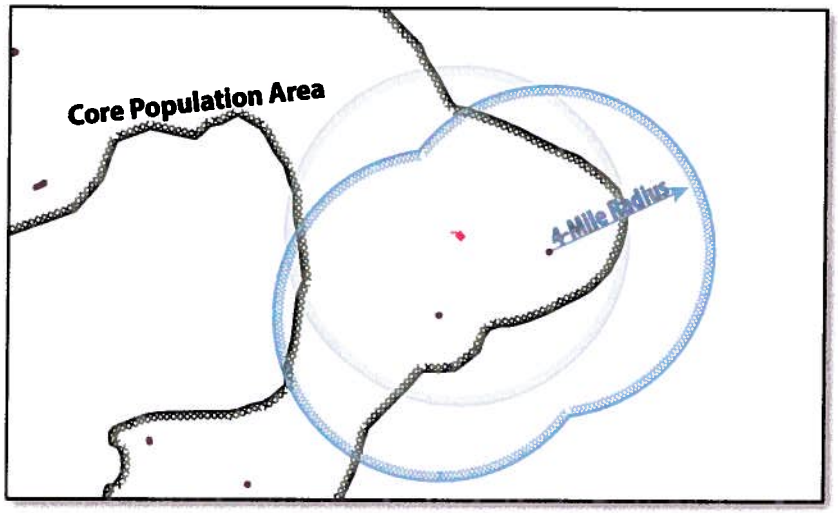


Figure 2 - DDCT assessment area step 2, lek boundaries.

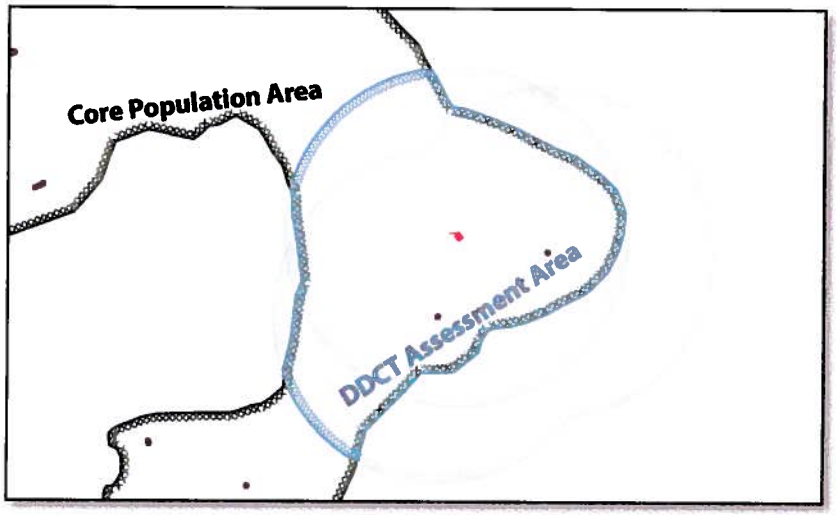


Figure 3 - DDCT assessment area step 3, remove non-core population areas.

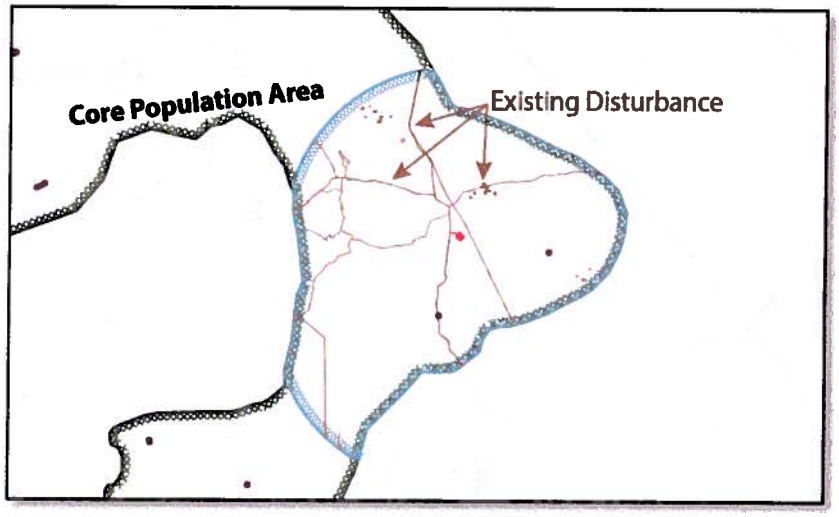


Figure 4 - Existing and proposed disturbance in the DDCT assessment area.

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

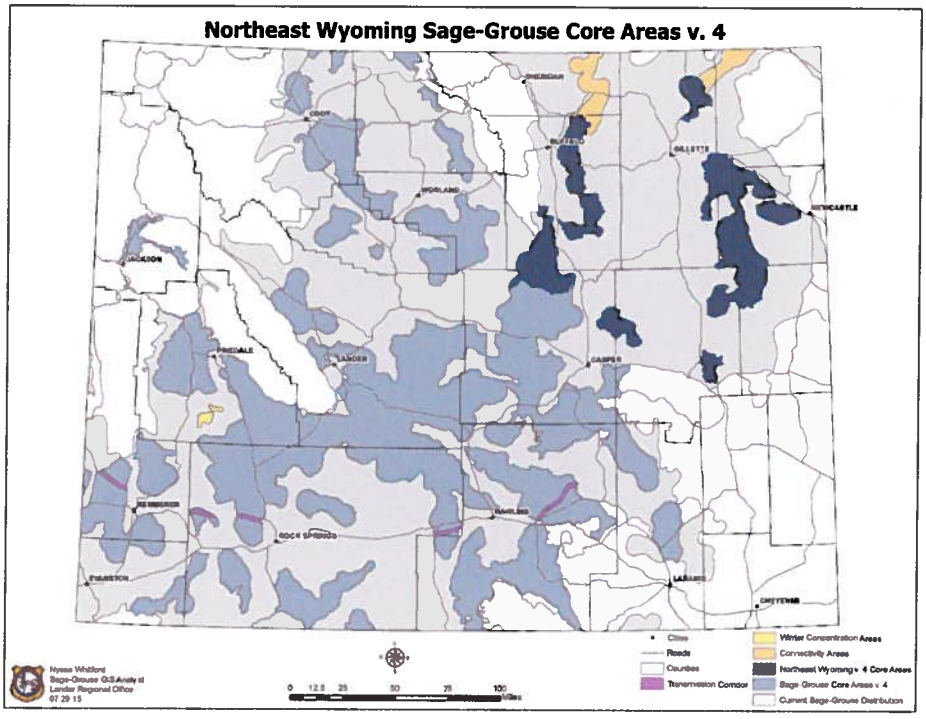
Vegetation removal should be limited to the minimum disturbance required by the project. All topsoil stripping and vegetation removal in suitable habitat is limited to between July 1 and March 14 in areas that are within 4-miles of an occupied lek. Production and maintenance activities (surface mining) 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.

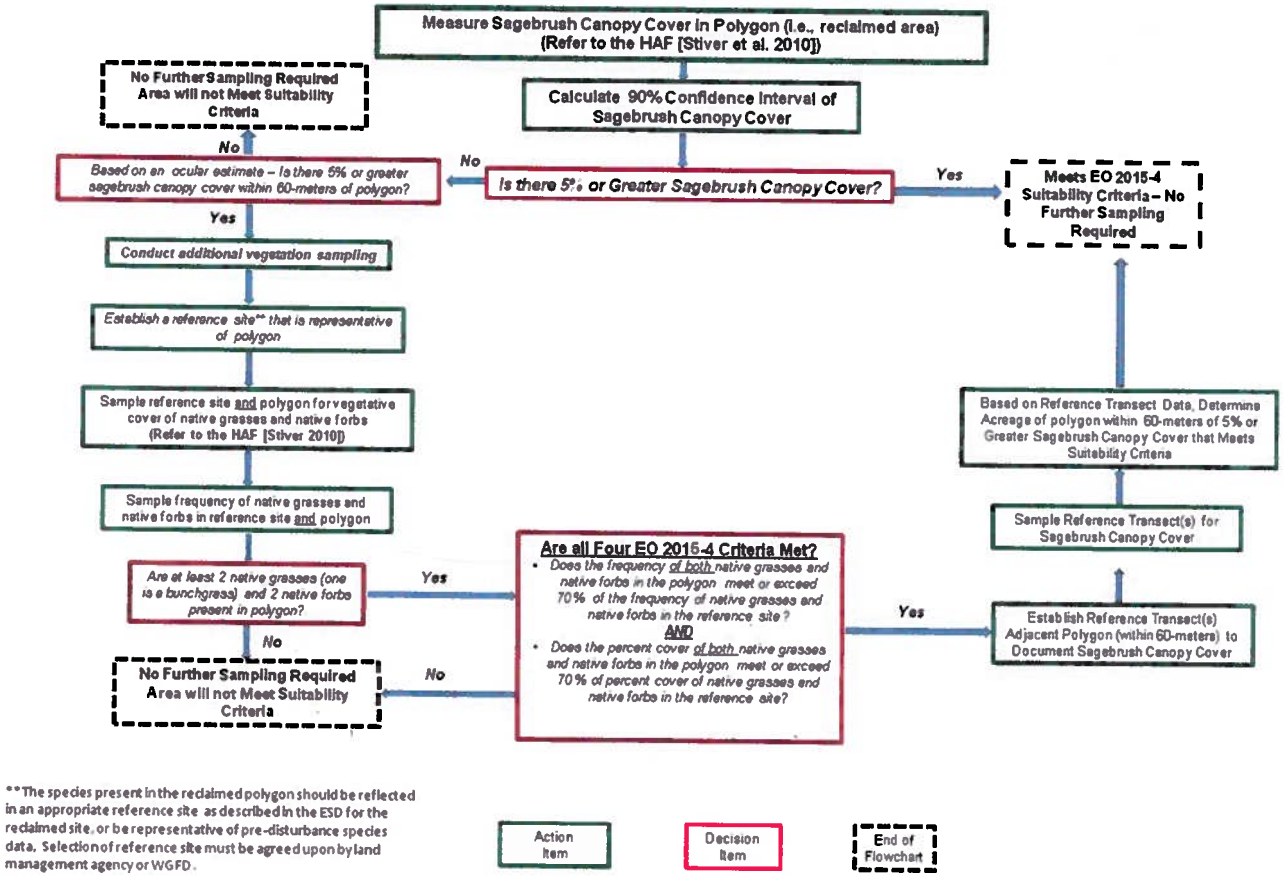
- The **frequency** of occurrence of forbs is expected to meet or exceed 70% of the frequency of forbs as measured on the reference site, as described in the ESD for the reclaimed sites(s), or as represented in the pre-disturbance species data.
- Forbs **canopy cover** is expected to meet or exceed 70%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

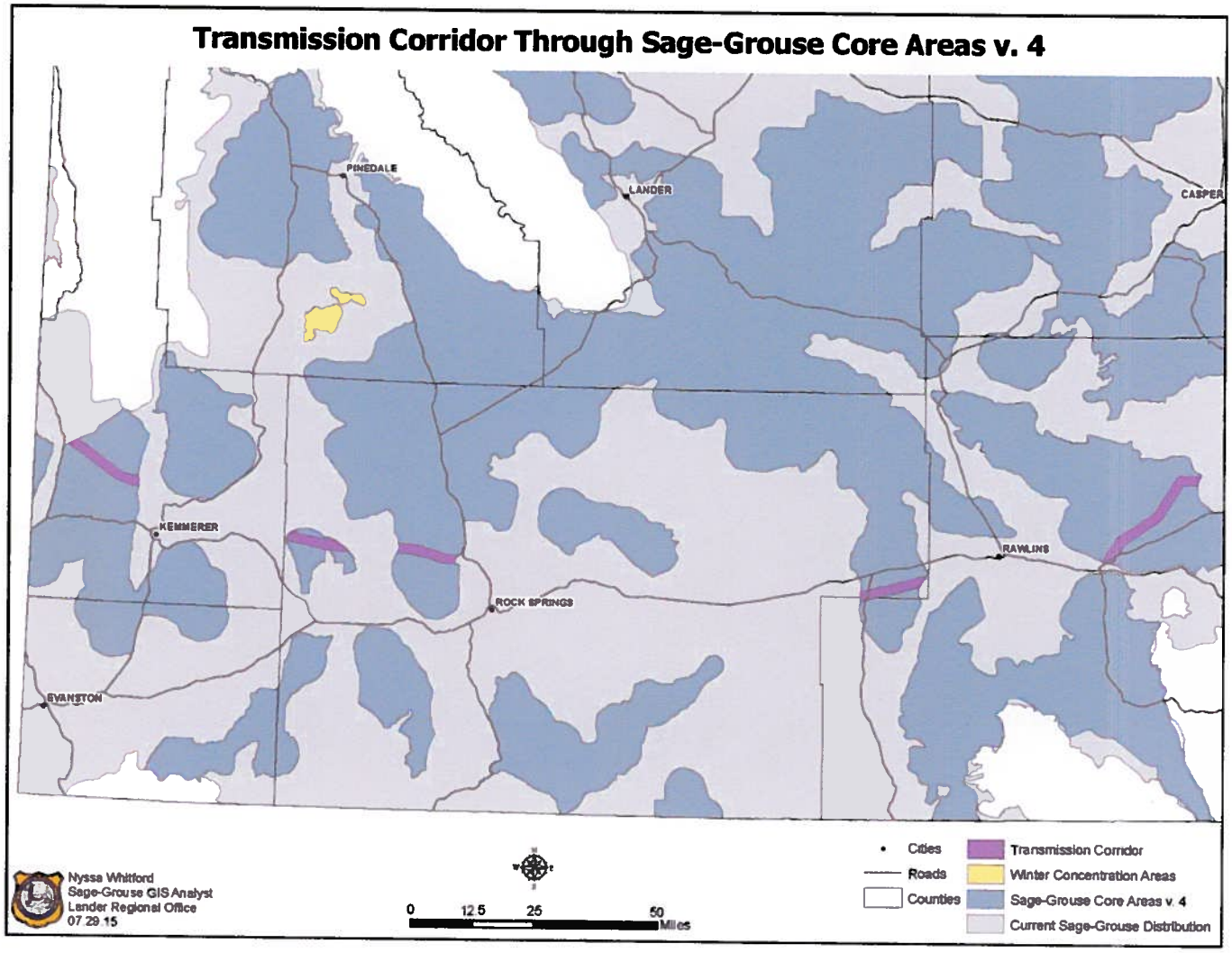
Compensatory Mitigation

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



Executive Order 2015-4
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/spent	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	Complete
200 – Bates juniper treatment	2017-18	Bates Hole/ Shirley Basin	$150,000	$20,000 requested/approved/spent	Mechanical juniper removal from sage-grouse habitat	BLM, RMEF, National Wild Turkey Federation	Complete
201 – Seppie Springs sagebrush thinning	2017-18	Bates Hole/ Shirley Basin	$45,600	$20,000 requested/approved/spent	Fine-scale strip mowing in mountain big sagebrush to enhance native grasses and forbs	WGFD, WWNRT, private landower	Complete
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/spent	Riparian exclosure	BLM, WWNRT, RMEF, Permittee	Complete
205 – Standard Allotment guzzler	2017-18	South-Central	$9,800	$8,300 requested/approved/spent	Wildlife water guzzler installation	BLM; Water for Wildlife	Complete

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/spent	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	Complete
208 – Douglas Core Area wildfire restoration	2017-18	Northeast	$382,700 (multi-year)	$25,000 requested/approved/spent	Restoration of a wildfire area within the Douglas Core Area	DCA Restoration Team, private landowners	Complete
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/spent	Research to determine sage-grouse and songbird response to gas field restoration	University of Waterloo, University of Wyoming, BLM, Anadarko, private landowners	Complete
211 – Albert Creek wet meadow restoration	2017-18	Southwest	$41,000	$10,000 requested/approved/spent	Restore channelized and degraded streambed to historic channel	USFWS Partners, Uinta County CD, Anadarko, grazing permittees	Complete
212 – Sage-grouse geophagy	2017-18	Upper Green River Basin, Southwest	$327,000	$20,000 requested/approved/spent	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	Complete

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; $37,814.40 spent	Research to determine sage-grouse movements, productivity and habitat use relative to a gravel mine	Grand Teton National Park, Teton Raptor Center, USFS	Complete
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/spent	Rapid detection and early response weed control on BTNF lands	USFS, Teton Weed & Pest, YCC/JHWMA, RMEF	Complete
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/spent	Noxious weed surveys and treatment	WWNRT, BLM, Private Landowners, WYDOT, WSLB, Fremont Weed & Pest	Complete
218 – SGI support	2017-18	Wind River-Sweetwater River	$1,500	$1,500 requested/approved; $1,239.34 spent	Travel/training support for NRCS SGI personnel	NRCS, Popo Agie CD	Complete

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; $20,816 spent	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	Complete
220 – Linking lek habitat structure to grouse behavior	2017-18	Wind River – Sweetwater River	$63,807	$33,614 requested $15,000 approved/spent	Research to determine if micro-habitat influences lekking behavior	University of California-Davis	Complete
221-Windmill Conversion	2017-18	Upper Green River Basin	$22,000	$22,000 requested/approved; $400 spent	Remove raven nesting substrate by removing 3 windmills, however suitable sites were not found	Sublette County Conservation District	Complete
222- Sublette Cheatgrass Mapping and Control in Core	2017-18	Upper Green River Basin	$133,000	$133,000 requested/approved; $132,983.54 spent	Hired a contractor to develop the Bridger-Teton Invasive species EIS; treated cheatgrass	Sublette County Weed and Pest, Sublette Invasive Species Taskforce	Complete
223- South LaBarge Common Designated Weed Control	2017-18	Southwest	$10,000	$10,000 requested/approved; $9,924.54 spent	Survey and treat for Musk thistle, Canada thistle, Black henbane, etc.	Sublette County Weed and Pest	Complete
224-Bone Draw Fence Marking	2017-18	Southwest	$5,500	$5,500 requested/approved/spent	Installed 7000 high-visibility fence markers near Eden, WY	Utah's Hogle Zoo	Complete

GREATER SAGE-GROUSE RESEARCH CONDUCTED IN WYOMING IN 2018

Presented to State of Wyoming and Wyoming Game and Fish Department

Compiled by:

Dr. Jeff Beck
Department of Ecosystem Science and Management
University of Wyoming
Laramie, WY 82071

November 11, 2018

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 Chicks in central, Wyoming, Summer 2015
Photo by ©Noppadol Paothong

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

Cameron Aldridge[1], D. Joanne Saher[1], Steven E. Hanser[2], Julie Heinrichs[1], Adrian Monroe[1], and Matthias Leu[3]

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[3]Biology Department, College of William and Mary, Williamsburg, VA

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 area. 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 nevadansis*), 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 late 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

Contact: Dr. David Edmunds; E-mail: Dave.Edmunds@rams.colostate.edu; Phone: (970) 226-9180 or Dr. Cameron Aldridge; E-mail: Cameron.Aldridge@colostate.edu; Phone: (970) 226-9433

David R. Edmunds[1], Cameron L. Aldridge[2], Michael S. O'Donnell[3], and Adrian P. Monroe[1], Peter S. Coates[4], and Brian S. Cade[3]

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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 evaluate density-independent (DI) and density-dependent (DD) models to estimate 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 than other population demarcations. We developed our suite of models and applied them by Working Group and Core Areas; we finalized the development of lek clusters and applied the PVA across cluster scales using lek count data (1993-2017). We published our management areas-based PVA and a correction to our publication in 2018 and we will submit a manuscript for peer-review assessing sage-grouse population viability by clusters in early 2019.

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

Publications: Edmunds, D.R., C.L. Aldridge, M.S. O'Donnell, A.P. Monroe, P.S. Coates, and B.S. Cade. *In Prep.* Greater sage-grouse trends across nested hierarchical spatial scales in Wyoming. Target Journal: *Journal of Wildlife Management*.

Edmunds, D.R., C.L. Aldridge, M.S. O'Donnell, and A.P. Monroe. 2018. Erratum: Greater sage-grouse population trends across Wyoming. *Journal of Wildlife Management* 82(8): 1808-1808. doi:10.1002/jwmg.21560.

Edmunds, D.R., C.L. Aldridge, M.S. O'Donnell, and A.P. Monroe. 2018. Greater sage-grouse population trends across Wyoming. *Journal of Wildlife Management* 82(2): 397-412. doi:10.1002/jwmg.21386.

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

Contact: Dr. Julie Heinrichs; E-mail: Julie.Heinrichs@colostate.edu; Phone: (970) 226-9149 or Dr. Cameron Aldridge; E-mail: Cameron.Aldridge@colostate.edu; Phone: (970) 226- 9433

Julie A. Heinrichs[1,2] Cameron L. Aldridge[1], Michael S. O'Donnell[3], Steve Garman[4], Collin Homer[5]

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[5]US Geological Survey/ EROS Data Center, Sioux Falls, SD

The abundance and distribution 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 habitats and populations. We developed a series of future landscape maps for the Wyoming Landscape Conservation Initiative (WLCI) 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 in southwestern Wyoming. Climate change scenarios were incorporated as climate-induced changes in vegetation. Future landscape maps were used to update seasonal habitat selection maps and influence future Sage-grouse habitat use. In oil and gas scenarios, avoidance of infrastructure and fitness consequences were enacted for some life stages within a spatially explicit individual-based model. We quantified a possible range of impacts of climate and development stressors on sage-grouse distribution, abundance, and persistence. Results indicate that long-term changes in climate or development could substantively re-shape existing Sage-grouse populations. Consideration of only one stressor could underestimate expected population changes. Analysis has been completed and the manuscript was submitted for peer review in 2018.

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

Publications: Heinrichs, J.A, M.S. O'Donnell, C.L. Aldridge, S.L. Garman, C.G. Homer, and N.H. Schumaker. *In Review*. Simulating the influences of future climate and oil and gas development on Sage-grouse population outcomes. *Ecological Applications*.

4. 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 were 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 most 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

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

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Population monitoring is vital to conservation and management of wildlife; yet, population survey data are commonly limited to single geographic extents and rarely account for processes occurring across spatial and temporal scales. To support a statistically repeatable and hierarchical framework for long-term monitoring, we developed a method to construct hierarchically nested groupings of similar habitats represented as spatial boundaries of population structures. Our approach relied on a clustering algorithm (Spatial "K"luster Analysis by Tree Edge Removal) where we explicitly included habitat selection at multiple scales surrounding leks (breeding grounds) and we modified the process to include constraint-based rules of connectivity between habitat. We applied this framework to Greater sage-grouse (*Centrocercus urophasianus*) in two disparate ecological contexts (Nevada and Wyoming). The connectivity rules consisted of inter-lek movement distances (isolation-by-distance; 15 km) and resistance to movements (barriers) between leks, increasing the biological realism of connectedness. The selection of habitat type and habitat scales varied across the geographic extents as well as across cluster levels. In Nevada, the finest-scaled cluster level captured ~90% of sage-grouse movements, where each bird was assigned to a home cluster, while mid-level scales captured ~97%–99% of movements. In Wyoming, where we lacked telemetry data, we suspect similar or better performance because a recent study suggests a mean inter-lek movement distance of ~6 km in Wyoming compared to the observed ~15 km in Nevada. This approach can support scale-dependent management and research needs including population and habitat monitoring and inform conservation and adaptive management practices.

Funding provided by: U.S. Geological Survey and the Bureau of Land Management
Publication: O'Donnell, Michael S., David R. Edmunds, Cameron L. Aldridge, Julie A. Heinrichs, Peter S. Coates, Brian G. Prochazka, and Steve E. Hanser. *In Review.* Designing hierarchically nested and biologically relevant monitoring frameworks to study populations across scales. *Ecosphere*.

6. 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 lek counts. Because of the importance of these data and repetitive use by researchers and managers for population trend monitoring, we developed program R code to use these data for long-term monitoring based on policies defined in the WGFD Handbook of Biological Techniques (Chapter 12; Christiansen 2012; p. 12-8). Although these standards did not apply to data collected prior to the mid-1990s, we apply them across all years for the trend analyses. 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]). Our code extracts observations meeting the four main criteria for counts as defined in the handbook: 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 speeds ≤10 mph. While these criteria are often not explicitly identified in the database, our code searches fields, such as "comments". The WGFD 2017 database (1948-2017) included 131,084 records and we identified records that did not meet the defined protocols: 44,610 with missing time or incorrect format; 114 with missing date or incorrect format; 6,927 that exclude survey methods; 35,080 not defined as a "count;" 3,391 that did not meet time since sunrise; and 526 that did not meet proper weather conditions. From these results, we removed 69.2% of available observations, but notably, the reduction was mostly associated with observations before WGFD established standard protocols.

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

7. PREDICTING POST-DISTURBANCE RECOVERY OF SAGEBRUSH ECOSYSTEMS USING REMOTE SENSING PRODUCTS

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The historic loss of vegetation and subsequent recovery trajectories after disturbances in sagebrush ecosystems are not well understood at broad spatial and temporal scales. Establishing rates of sagebrush recovery and estimating time to recovery will aid in characterizing restoration and management efforts and inform effective sagebrush restoration strategies. Recently, we have assembled spatial datasets characterizing disturbance-specific information from energy development, fire, mechanical, and chemical treatments within Wyoming. 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 recovery (relative to current sagebrush cover). We demonstrate this approach by examining variation in recovery rates among 375 former well pads in WLCI, evaluating the contribution of weather, soils, and other factors on sagebrush recovery rates. We then used model estimates to predict recovery rates and times across the WLCI. The resulting prediction surfaces will aid in identifying sagebrush and habitat recovery expectations and directly inform management efforts outlined within the Secretarial Order 3336 and within the recently revised BLM and USFS resource management plans. We have submitted a manuscript for peer review in October 2018. We received support to extend this approach to a suite of other disturbance types and vegetation treatments across Wyoming.

Funding provided by: U.S. Geological Survey, the Bureau of Land Management, and the Wyoming Landscape Conservation Initiative through USGS

Publication: Monroe, A.P., C.L. Aldridge, M.S. O'Donnell, D.J. Manier, C.G. Homer, and P.J. Anderson. *In Review*. Using remote sensing to quantify recovery of vegetation across space and time following energy development. *Ecological Indicators*

8. 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. We assembled a reference genome and performed whole-genome sequencing across sage-grouse from both species and six populations, including Jackson Hole, WY. 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. We have also accumulated additional tissue samples and conducted a restriction associated DNA sequencing study (RAD-Seq) of additional samples including a group from southwestern WY to evaluate variation in these candidate genes across the range. We have submitted a peer-reviewed manuscript summarizing this work in 2018.

Funding provided by: U.S. Geological Survey

Publications: Oh, K.P., C.L. Aldridge, J.S. Forbey, C.Y. Dadabay, and S.J. Oyler-McCance. *In Review*. Conservation genomics in the sagebrush sea: population divergence and adaptive metabolic variation in sage-grouse. Science Advances.

9. SOUND LEVELS AT GREATER SAGE-GROUSE LEKS, PINEDALE ANTICLINE PROJECT AREA, WYOMING, APRIL 2013-2018

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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 15524 hours of acoustic data were collected at 23 leks in and near the PAPA from 2013-2018. Sound levels at leks were directly related to the distance to the nearest pad with gas field activity, the number of pads near the lek, and the type of activity at that pad. Sound levels at leks varied little among years except in situations where gas field activity changed significantly.

Distance to Pad:	>1600 m	<1600 m
$L_{eq,0\text{-}24}$	28 dBA	32 dBA
$L_{50,0\text{-}24}$	23 dBA	29 dBA
$L_{90,0\text{-}24}$	20 dBA	26 dBA

Funding provided by: Pinedale Anticline Project Office, Bureau of Land Management, Pinedale, Wyoming

10. MANAGEMENT GUIDELINES FOR GREATER SAGE-GROUSE WINTER CONCENTRATION AREAS

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During 2018, we initiated a project with an overall goal to generate management recommendation guidelines for greater sage-grouse winter concentration areas in Wyoming using a 2-phase approach. Phase 1 will utilize currently-available data from sage-grouse equipped with GPS transmitters throughout Wyoming to address 3 main objectives: 1) identify the timing of sage-grouse presence on winter range, 2) identify the interaction between snow cover/depth and sagebrush cover/height relative to sage-grouse winter habitat selection, and 3) identify thresholds of sage-grouse response to anthropogenic disturbance in winter. During 2018, we acquired existing datasets from multiple sage-grouse research projects across Wyoming that utilized GPS transmitters to obtain location data. We also began digitizing anthropogenic surface disturbance and started acquiring snow data for these study areas. The study areas our investigations occur in consist of a range of anthropogenic infrastructure and surface disturbance. Results from Phase 1 will form the basis from which disturbance management guidelines can be developed. Phase 2 will assess the management effectiveness of these guidelines applied to a novel area located in the southern Red Desert and Sierra Madre region of Wyoming. This novel area is ideal because it contains areas of heavy disturbance, areas of little disturbance, and areas of proposed new disturbance. This area also has documented sage-grouse winter concentration areas outside Core Area used by grouse that breed inside Core Area. For Phase 2, during 2018, we captured and equipped 12 adult female sage-grouse with GPS transmitters with plans to capture an additional 40 during winter/spring 2018/2019.

Funding provided by: Wyoming State Office of the Bureau of Land Management; Sublette County Conservation District; Wyoming Game and Fish Department; and South-Central, Southwest, and Wind River/Sweetwater River Local Sage-Grouse Working Groups

11. RESOURCE SELECTION OVERLAP BETWEEN GREATER SAGE-GROUSE AND CO-OCCURRING SPECIES

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Our project aims to address how resource selection and space use of greater sage-grouse compares with three co-occurring species: feral horses (*Equus ferus caballus*), pronghorn (*Antilocapra americana*), and sharp-tailed grouse (*Tympanuchus phasianellus*) in southern Wyoming. This information will elucidate how these species partition resources and identify potential areas of conservation concern for sage-grouse populations. Our sage-grouse, feral horse, and pronghorn investigation is focused around the BLM-administered wild horse Adobe Town Herd Management Area in Carbon and Sweetwater counties. Our sage-grouse and sharp-tailed grouse investigation is focused along the western slope of the Sierra Madre range in Carbon County. During 2017, we captured and equipped 37 adult female feral horses and 35 adult female pronghorn with GPS transmitters. During 2017 and 2018, we captured and equipped 191 adult female and male sharp-tailed grouse with VHF transmitters. During 2018, we captured and equipped 12 adult female sage-grouse with GPS transmitters with plans to capture an additional 40 during winter/spring 2018/2019. Our project will help clarify whether management actions for these other important species will benefit or adversely impact sage-grouse conservation, and vice-versa. Our study is in collaboration with other research projects investigating the ecology and management of feral horses; genetic relationships, demography, and resource selection of sharp-tailed grouse; and the winter ecology of sage-grouse.

Funding provided by: Bureau of Land Management; University of Wyoming–Agricultural Experiment Station; Wyoming Game and Fish Department; South-Central, Southwest, and Wind River/Sweetwater River Local Sage-Grouse Working Groups; Wyoming Governor's Big Game License Coalition; Wyoming Wildlife Federation; and U.S. Forest Service.

12. 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; 2011–2015) 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. Our second study objective was to describe 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 was migratory, timing, distance, duration, destination, and differences among seasons. We are currently conducting final analyses and manuscript writing relative to our research objectives.

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

Publications:

Pratt, A.C., and J.L. Beck. *In review*. Greater sage-grouse response to bentonite mining. *Journal of Wildlife Management*

Pratt, A.C., K.S. Smith, and J.L. Beck. *In review*. Comprehensive habitat requirements of a partial migrant. *Global Ecology and Conservation*

13. RESPONSE OF GREATER SAGE-GROUSE TO TREATMETNS 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 Control-Impact study with 3 years of pre-treatment and at least 6 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 tebuthiuron to 607 ha (~1,500 acres) across 2 herbicide treatment areas in May 2014. To date, we have monitored demographic parameters from n = 567 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. Our study is currently funded through the 2019 field season.

Funding provided by: Wyoming Game and Fish Department, Wyoming Sage-grouse Conservation fund; Bates Hole/Shirley Basin, Bighorn Basin, South-Central, Southwest, Upper Green River, Upper Snake River and Wind River/Sweetwater River Local Sage-grouse Work

Groups; Wyoming Reclamation and Restoration Center; Wyoming Wildlife and Natural Resource Trust; Land Field Office-Bureau of Land Management; and Margaret and Sam Kelly Ornithological Research Fund.

Publications:

Smith, K. T., A. C. Pratt, J. L. LeVan, A. M. Rhea, and J. L. Beck. 2019. Reconstructing greater sage-grouse chick diets: diet selection, body condition, and food availability at brood-rearing sites. *The Condor: Ornithological Applications* 121:In press..

Smith, K. T., J. S. Forbey, and J. L. Beck. 2018. Effects of mowing and tebuthiuron treatments on the nutritional quality of Wyoming big sagebrush. *Rangeland Ecology and Management* 71:417–423.

Smith, K. T., J. L. Beck, and C. P. Kirol. 2018. Reproductive state leads to intraspecific habitat partitioning and survival differences in greater sage-grouse: implications for conservation. *Wildlife Research* 45:119–131.

Smith, K. T., and J. L. Beck. 2018. Sagebrush treatments influence annual population change for greater sage-grouse. *Restoration Ecology* 26:497–505.

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.

14. 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 relative to 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 (n = 951) and fecal (n = 73) samples from these same leks. Genetic lab analyses are completed in conjunction with Beth Fitzpatrick and Melanie Murphy (University of Wyoming) and are scheduled to be completed this year. Our second study objective is to investigate the feasibility of using stable isotope methods to classify migration behavior to help investigate if there are any survival or reproductive consequences between grouse that make farther inter-seasonal movements (associated with montane sagebrush summer habitat) and those that make shorter movements (associated with hayfield summer habitat). Differences in 13C, 15N, 18O, and 2H isotope values between the 2 groups 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 data analyses and manuscript preparation are being 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.

15. FACTORS DRIVING GREATER SAGE-GROUSE TRENDS IN THE EASTERN PORTION OF THEIR RANGE: ANTHROPOGENIC, FIRE, HABITAT, HUNTING, RAVENS, AND WEATHER

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Degradation of sagebrush (*Artemisia* spp.) habitat has occurred throughout the range of greater sage-grouse (*Centrocercus urophasianus*; hereafter "sage-grouse"). Areas with greater loss of sagebrush habitat are avoided by sage-grouse and congruent with lower demographic rates and lek extirpation. We evaluated the effects of habitat and potential predation, including anthropogenic, fire, habitat, hunting regulations, weather, and common raven (*Corvus corax*; hereafter "raven") numbers, on lek trends of sage-grouse populations in the Powder River and Wyoming Basins from 1995–2014. Instantaneous growth rate (r) was positively associated with precipitation and negatively with hunting season length in the Powder River Basin population, and r was positively associated with precipitation but negatively with raven numbers for the Wyoming Basin population. Oil and gas well density was negatively associated with initial lek counts (Λ) and time-varying carrying capacity (K) for both populations. In addition, the Powder River Basin population had a negative association of human density with K, and the Wyoming Basin population had negative associations with tree proportion and major road density on Λ and major road density and fire, tree, and cropland proportions on K. Our results expand knowledge on how spatiotemporal factors related to Λ, r, and K influence sage-grouse populations. However, we could not discern whether longer hunting seasons in the Powder River Basin were associated with lower r or collinear with general trend or another factor (e.g., West Nile virus could also explain lower r rather than hunting), because spatial variability in hunting exposure could not be designated.

Funding provided by: Anadarko Petroleum Corporation, Oregon State University, Wyoming Wildlife and Natural Resource Trust

16. 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). In 2018, we collected data on a subset of these transects to track avian response to plague (*Yersina pestis*) in prairie dogs. We have published one paper examining the effect of disturbance on birds (Duchardt et al. 2018), but will continue to use these data 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, and compare these responses with sagebrush passerines including Brewer's sparrow (*Spizella breweri*) and sage thrasher (*Oreoscoptes montanus*).

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Publications – Peer-reviewed:

Duchardt, C. J., L. M. Porensky, D. J. Augustine, and J. L. Beck. 2018. Disturbance shapes avian communities on a grassland–sagebrush ecotone. *Ecosphere* 9(10):e02483. 10.1002/ecs2.248

Publications – Extension

Duchardt, C.J. and Connell, L.C. 2018. Sharing Fences. Western Confluence Magazine (in press)

Duchardt, C.J. and Scasta, J. D. 2017. Welcome to Thunder Basin. Thunder Basin Ecology Factsheet Series. University of Wyoming Extension. B-1288.1.

Duchardt, C.J. and Scasta, J. D. 2017. Birds of Thunder Basin: Sagebrush specialists. Thunder Basin Ecology Factsheet Series. University of Wyoming Extension. B-1288.2.

17. EXPLORING DISTURBANCE THRESHOLDS: GREATER SAGE-GROUSE REPRODUCTIVE RATES AND PATTERNS OF HABITAT USE RELATED TO THE PHYSICAL FOOTPRINT OF ENERGY DEVELOPMENT

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Energy infrastructure and associated habitat loss, has been shown to negatively affect reproductive rates across a variety of species including the greater sage-grouse (*Centrocercus urophasianus*). The goal of our research was to refine our understanding of how the physical "footprint" of energy development, quantified as surface disturbance, relates to nest and brood survival and to evaluate space use relative to different surface disturbance levels during the nesting and brood-rearing life stages. We utilized data from 6 study areas in Wyoming that contained several types of renewable and nonrenewable energy development. We used nest (n = 1,049), brood-rearing (n = 2,827), and random (to represent available habitat; n = 19,320) locations from VHF- and GPS-marked females compiled from 6 distinct study areas across Wyoming including from 2008–2011. We quantified surface disturbance for each study area with the Wyoming Density and Disturbance Calculation Tool and explored different functional relationships between nest and brood survival and disturbance using mixed-effects Cox proportional survival analyses. Our results suggest exposure to press disturbance during the nesting and brood-rearing life stages contributed to lower nest success and brood survival, however, the relationships between press disturbance and these reproductive rates were expressed differently and at different spatial scales. Space use by nesting and brood-rearing females suggested a strong preference for habitats with lower disturbance levels. Approximately 90% of the nest and brood-rearing locations, across all energy types, were in habitats with less than 3% surface disturbance. Our research informs better understanding of biological tradeoffs related to different levels of energy disturbance.

Funding provided by: A variety of resources contributed to funding of data collection. Funding for this analyses was provided by Wyoming Wildlife and Natural Resource Trust

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

Contact: Dr. David Dahlgren; Email: dave.dahlgren@usu.edu; Phone: 435-881-1910

David Dahlgren[1], Jesse Kolar[2], Rodney J. Gross[2], Peter Coates[3], Mark Ricca[3]

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[2] Upland Game Program, North Dakota Game and Fish Department, Bismarck, ND 58501
[3] Western Ecological Research Center, U.S. Geological Survey, Dixon, CA, 95620

Wildlife translocations and population augmentations continue to occur and are an important management option for wildlife managers. Many grouse populations are imperiled and managers have used translocation techniques for various species and populations. Past efforts have often lacked monitoring 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 with monitoring 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 translocated 40 female and 20 male sage-grouse during the spring of 2017. In 2018, we translocated 20 females and 20 males in the spring and captured and released 20 additional hens in the source population that were recaptured if they nested successfully and had a brood that was at least a few days old. All translocated birds were 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 were radio-marked and monitored for survival and reproductive rates. In addition to birds that were translocated or were released at the capture site with the potential to be translocated as brood hens, we also maintained a sample of 20 radio-marked female sage-grouse within the source population and monitored survival and reproduction. For spring translocated females, we used artificial insemination (AI) techniques on a treatment group, with sham and control samples as well, to see if AI influences reproductive rates of females. These same techniques are being used in the Bi-State population in California and a population in west-central Utah. During June and July of 2018 we translocated 6 brood hens and 26 chicks. All brood hens and chicks were radio-marked. We used a soft-release method by containing the chicks and brood hen in a specially designed brood box, which separated the hen from the chicks with a removable divider, but allowed vocalizations to occur. Once in North Dakota, the brood box was put in a release pen approximately 8 x 6 feet and 20 inches tall and the divider was removed and a door opened on the chick's side of the brood box into the release pen. To go into the release pen the brood hen was forced to move through her chicks. To release the brood into their new natural environment, one entire 8-foot side of the release pen was raised once the hen and chicks had acclimated to each other again within the release pen. We constructed drift fences in a V-shape using chicken wire to guide the brood into sagebrush cover at the release site and reduce the risk of separation occurring between the chicks

and hen. Three broods, with 7 chicks total between all broods, successfully fledged with at least one chick surviving to 50 days. However, for one of these broods the adult female was found positive for Avian TB and we were required to dispatch the brood hen and her 3 chicks. We are currently processing data and preparing analyses 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 publications for peer-review based on this research.

Funding provided by: North Dakota Game and Fish Department and Wyoming Game and Fish Department

19. GREATER SAGE-GROUSE GEOPHAGY DURING THE WINTER

Contact: Dr. David Dahlgren; Email: dave.dahlgren@usu.edu; Phone: 435-881-1910

David Dahlgren[1], Bryan Bedrosian[2], Joshua Hemenway[3]

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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 each year for the winters of 2017-18 and 2018-19. We will monitor their movements and habitat selection. We are also collecting soil samples at geophagy sites and at random sites across the study area 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 fecal 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. In December 2017 we radio-marked 20 sage-grouse with store-on-board GPS radios. We also had an additional 10 or more VHF radio-marked grouse. As of January 1, 2018 16 of the 20 GPS radios had a software glitch that caused the GPS units to fail. We were not able to replace this sample of birds until late February 2018. All GPS units had a paired VHF radio, and we attempted to use VHF data loggers at known geophagy sites to record visitation rates. We receive funding to order 18 additional GPS-PTT ARGOS enabled units for the 2018-19 winter field season. This sample of GPS radios, combined with our existing sample from February 2018, should provide a large amount of location and movement data for this upcoming field season. We collected ~ 20 samples of vegetation and pellets last field season, and will continue this effort this coming winter. By the end of the 2018-19 field season all known geophagy sites will have soil samples recorded. The current graduate student, Scott Fox, will begin analyses and writing of his thesis in March 2019 with a projected defense in December 2019 and a thesis publication shortly after. We also plan on having the next graduate student begin in the spring of 2019 to monitor the reproductive rates of the female sage-grouse in our sample for the 2019 and 2020 breeding seasons. We plan on 2 or more peer-reviewed publications concerning this research following the publication of theses.

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

20. 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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Claire L. Revekant[1] and Jonathan B. Dinkins[1]
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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. In addition, sage-grouse avoid areas with higher avian predator densities. 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 within Core Areas. Core Areas have maintained higher sage-grouse trends compared to Non-Core Areas, which could be partially explained by reduced predation rates. However, we lack a study comparing predator abundance within and outside Core Areas. We performed avian point counts along 8.05-km transects during summers 2017 and 2018. This information will be added to BBS data and human disturbance data previously calculated. We deployed trail cameras at scent stations and performed 500-m scat/badger burrow transects to survey for mammals during the 2018 summer. Scent stations and transects (avian, scat, burrow) were stratified between Core and Non-Core Areas in the Wyoming Basin. 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, South-Central, Southwest, and Wind River/Sweetwater River Wyoming Sage-Grouse Local Working Groups; and Oregon State University

Table 1. Sample sizes of data collection completed 2017 and 2018

Avian Predator Transects/Point Counts	400 transects/2,293 point counts
Deployed Scent Stations	117
Scat and Badger Burrow Transects	176 (98 were repeated)

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

Contact: Dr. Brad Fedy; E-mail: bfedy@uwaterloo.ca; Phone: (519) 888-4567 ext. 32706

Principal Investigators

Dr. Brad Fedy, School of Environment, Resources and Sustainability, University of Waterloo, Waterloo, Ontario, Canada
Dr. Sara Oyler-McCance, U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO 80526, USA

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.

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

Contact: Dr. Brad Fedy; E-mail: bfedy@uwaterloo.ca; Phone: (519) 888-4567 ext. 32706

Principal Investigator

Dr. Brad Fedy, School of Environment, Resources and Sustainability, University of Waterloo, Waterloo, Ontario, Canada

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 was published this year.

Watchorn, R. T., T. Maechtle, and B. C. Fedy. 2018. Assessing the efficacy of fathead minnows (*Pimephales promelas*) for mosquito control. PLoS ONE 13:e0194304.

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

23. 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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Dr. Brad Fedy, School of Environment, Resources and Sustainability, University of Waterloo, Ontario, Canada

To improve outcomes of habitat restoration for sage-grouse (Centrocercus urophasianus) and other sagebrush dependent 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 species. 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, movements and population fitness of sagebrush-obligate/associate birds. Our study is in the Powder River Basin in an area that has undergone large-scale reclamation of coal bed natural gas infrastructure. Our focal species include sage-grouse and passerines using sagebrush habitats during the breeding season. This study area is ideal because it contains 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 these species across the gradient of energy development, reclaimed, and control areas. We have completed three field seasons (2016, 2017 and 2018) and are planning for an additional season in 2019.

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.

24. USING EMERGING HOTSPOT ANALYSIS TO IDENTIFY SAGE-GROUSE SOURCE-SINK DYNAMICS IN WYOMING

Contact: Dr. Andrew J. Gregory, Email: agregor@bgsu.edu, Phone: (989) 400-3492

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Greater sage-grouse (*Centrocercus urophasianus*) have been subject to land-use change/habitat destruction throughout the Intermountain West, contributing to long-term population declines. However, recent evidence suggests that some sage-grouse populations might be stabilizing. We investigated population variability in sage-grouse productivity across Wyoming using hotspot/coldspot analysis to identify spatially varying patterns of where sage-grouse lek attendance is higher than average and lower than average (putatively sources verses sinks) across Wyoming to answer three questions: (1) Are there spatial regions across Wyoming that have consistently high sage-grouse populations?; (2)What factors influence the persistence and stability of areas with consistently high sage-grouse populations?; and (3) What, if any, contribution do Core Areas have in maintaining higher than average sage-grouse counts? We first evaluated the suitability of Wyoming Game and Fish Department's lek count data for these questions ensuring that there was no systematic bias (spatial and male count) to evaluate these questions. We then conducted hotspot/coldspot analysis for 30 years, independently, from 1986–2015, across Wyoming. We observed an ~6,165 km²/year increase in hotspotedness and an average of 8±1 males/hotspot. Additionally, we found that oils/gas well density and highway density were negatively correlated with hotspottendess; however, spatial dependencies and variabilities still need to be further investigated. Regardless, our ongoing hotspot analysis suggests a set of non-linear landscape dynamics impacting sage-grouse population trajectory throughout Wyoming.

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

Publication: In prep.

25. USGS NEW HISTORICAL SHRUBLAND COMPONENTS AVAILABLE IN WYOMING

Contact: Dr. Collin Homer, email, homer@usgs.gov, Phone (208) 426-5213

U.S. Geological Survey, 970 Lusk Street, Boise, Idaho

The USGS in collaboration with the BLM produced a new remote sensing-based quantification of Wyoming shrub lands last year. This circa 2015 database replaces the previous shrub component products produced by the USGS from circa 2006 data. Nine individual products were 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. A new follow-on effort has taken this 2015 database of mapped components back in time to 1984 for every year cloud free imagery is available. This results in a historical perspective of how and where component change is occurring across most of Wyoming. These new back in time products are being analyzed to understand trend analysis, especially in regard to climate change. Base component products are available for download from www.mrlc.gov. For back in time change products, contact Collin Homer directly.

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

Publication: Pending

26. 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

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 current design calls for maintaining 50 females tagged with GPS PTTs. Approximately 6 years of pre-construction data were collected prior to the initiation of construction. Construction activities for the project began in fall 2016 and are ongoing. Currently we are analyzing and characterizing pre-construction demographics, space use, and resource selection. 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

27. SPATIAL VARIABILITY OF SOIL CLIMATE AND MOISTURE BUDGETS WITHIN SAGEBRUSH ECOSYSTEMS: AN ENHANCEMENT OF RESISTANCE AND RESILIENCE TO IMPROVE CONSERVATION

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United States Geological Survey, Fort Collins Science Center, Fort Collins, CO

Understanding the drivers defining sagebrush ecosystem distributions and dynamics is important for habitat management, restoration and mitigation. Resistance and resilience concepts (R&R), based on the Natural Resources Conservation Service's soil temperature and moisture classifications, provide a useful framework for understanding and applying this information. Our objective was to improve the spatial discrimination of the R&R classification and enhance the information available for management of sagebrush habitats in Wyoming. Within the Wyoming Landscape Conservation Initiative (WLCI) area, we developed a spatially explicit model of soil conditions using the Newhall Simulation Model (NSM). We used the NSM for evaluating the interactions of temperature and moisture conditions with soils by simulating monthly evapotranspiration and movement of water in surface soils. We incorporated continuous, gridded soils data to define soil water capacity and gridded climate data to represent spatial variability in these drivers of ecosystem conditions. We also adjusted monthly climate data to account for temporal lags of water release via snow depletion rates. This approach resulted in detailed spatial discrimination of variability in temperature and moisture regimes and estimation of seasonal soil moisture budgets. These results improve our understanding of growing conditions related to the distribution and dynamics of sagebrush, disturbance effects and recovery rates, distribution of invasive plants and invasion risk, site potential for state-and-transition simulations, climate effects, and site quality for landscape mitigation. We intend to expand these efforts range-wide with annual and forecasted data products, release all data products, and produce a journal publication (expected in 2019).

Funding provided by: U.S. Geological Survey, Ecosystems Program, science support for the Wyoming Landscape Conservation Initiative

28. MAPPING SAGE-GROUSE LEKS TO LINK DIET, HABITAT STRUCTURE, AND BEHAVIOR

Contact: Dr. Gail Patricelli; Email: gpatricelli@ucdavis.edu

Dr. Gail Patricelli, Dr. Alan Krakauer, Ryane Logsdon and Eric Tymstra, University 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 health and reproductive success. During the 2017 mating season, we conducted multi-point TLS (a ground-based Terrestrial LiDAR Scanning) for 5 study leks in the Government Draw area near Hudson, Wyoming (Fremont County). These scans are being 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 in experimental interactions with robotic female sage-grouse. These videos are being analyzed to connect relative to TLS scans to determine which microhabitat features are important for both male and female sage-grouse on leks. We are also examining sage-grouse dietary preferences off the lek. From 2014-2017 we used radio telemetry tags to find foraging and roost sites, and we conducted transects around leks. At these sites, and random sites, we collect samples of browsed and unbrowsed sagebrush and habitat measures. This will help us to assess preferred habitat and forage at the chemical level. Fecal samples collected from leks are being analyzed for a byproduct of detoxification (glucuronic acid) and metabolites of stress-associated hormones (corticosterone); this will allow us to link dietary toxin intake to lek position and behavior. Samples are currently being analyzed in the Forbey lab. Sage-grouse dietary studies are ongoing in the Bi-State population in California for comparison.

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

29. 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. Final data sets were prepared for analysis throughout 2018. Initial analysis of paired "nearby random site" data from 2016 and 2017 revealed that nest sites are clearly associated with certain vegetation parameters. Shrubs near nests were almost twice as tall as shrubs at random points, grasses near nests were 40% taller than grasses at random points, and nest sites had more than twice as much sagebrush canopy cover as random points. Other vegetation parameters did not differ significantly between nest sites and random sites. Analysis is continuing to compare nest sites to a broader range of random sites. 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 2019.

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

Attachment E:
Wyoming Sage-Grouse Research Reports (through May 31, 2018)

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.

LeVan, J.R. 2018. Habitat selection and short-term demographic response of greater sage-grouse to habitat treatments in Wyoming big sagebrush. Thesis, University of Wyoming, Laramie.

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.

Pratt, A.C. 2017. Partial migration, habitat selection, and the conservation of greater sage-grouse in the Bighorn Basin of Montana and Wyoming. Dissertation, University of Wyoming, Laramie.

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.

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. 2018. Landscape-scale habitat assessment for an imperiled avian species. Animal Conservation 21:241-251.

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.

Christiansen, T.J. and L.R. Belton. 2017. Wyoming sage-grouse working groups: Lessons learned. Human-Wildlife Interactions 11:274-286.

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.

Cross, T.B., M.K. Schwartz, D.E. Naugle, B.C. Fedy, J.R. Row, S.J. Oyler-McCance. 2018. The genetic network of greater sage-grouse: Range-wide identification of keystone hubs of connectivity. Ecology and Evolution 8:1-19.

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).

Decker, K.L., A. Pocewicz, S. Harju, M. Holloran, M.M. Fink, T.P. Toombs, and D.B. Johnston. 2017. Landscape disturbance models consistently explain variation in ecological integrity across large landscapes. Ecosphere 8(4):e01775. 10.1002/ecs2.1775.

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.

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 82:397-412.

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.

Fedy, B.C., J.R. Row, and S.J. Oyler-McCance. 2017. Integration of genetic and demographic data to assess population risk in a continuously distributed species. Conservation Genetics 18:89-104.

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.

Fremgen, A.L., C.T. Rota, C.P. Hansen, M.A. Rumble, R.S. Gamo, and J.J. Millspaugh. 2017. Male greater sage-grouse movements among leks. Journal of Wildlife Management 81:498-508.

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.

Heinrichs, J.A., C.L. Aldridge, M.S. O'Donnell, and N.H. Schumaker. 2017. Using dynamic population simulations to extend resource selection analyses and prioritize habitats for conservation. Ecological Modelling 359:449-459.

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.

Orning, E.K., and J.K. Young. 2017. Coyote removal: can the short-term application of a controversial management tool improve female greater sage-grouse survival or nest success? Wildlife Biology:wlb.00345. doi: 10.2981/wlb.00.45.

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.

Peebles, L.W., M.R. Conover, and J.B. Dinkins. 2017. Adult sage-grouse numbers rise following raven removal or an increase in precipitation. Wildlife Society Bulletin 41:471-478.

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

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

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.

Row, J.R. and B.C. Fedy. 2017. Spatial and temporal variation in the range-wide cyclic dynamics of greater sage-grouse. Oecologia 185:687-698.

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, 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.

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.

Smith, K.T. and J.L. Beck. 2017. Sagebrush treatments influence annual population change for greater sage-grouse. Restoration Ecology 26:497-505.

Smith, K.T., J.L. Beck, C.P. Kirol. 2018. Reproductive state leads to intraspecific habitat partitioning and survival differences in greater sage-grouse: implications for conservation. Wildlife Research 45:119-131.

Spence, E.S, J.L. Beck, and A.J. Gregory. 2017. Probability of lek collapse is lower inside sage-grouse Core Areas: Effectiveness of conservation policy for a landscape species. PLos ONE 12(11): e0185885. https://doi.org/10.1371/journal.pone.0185885.

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.

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.

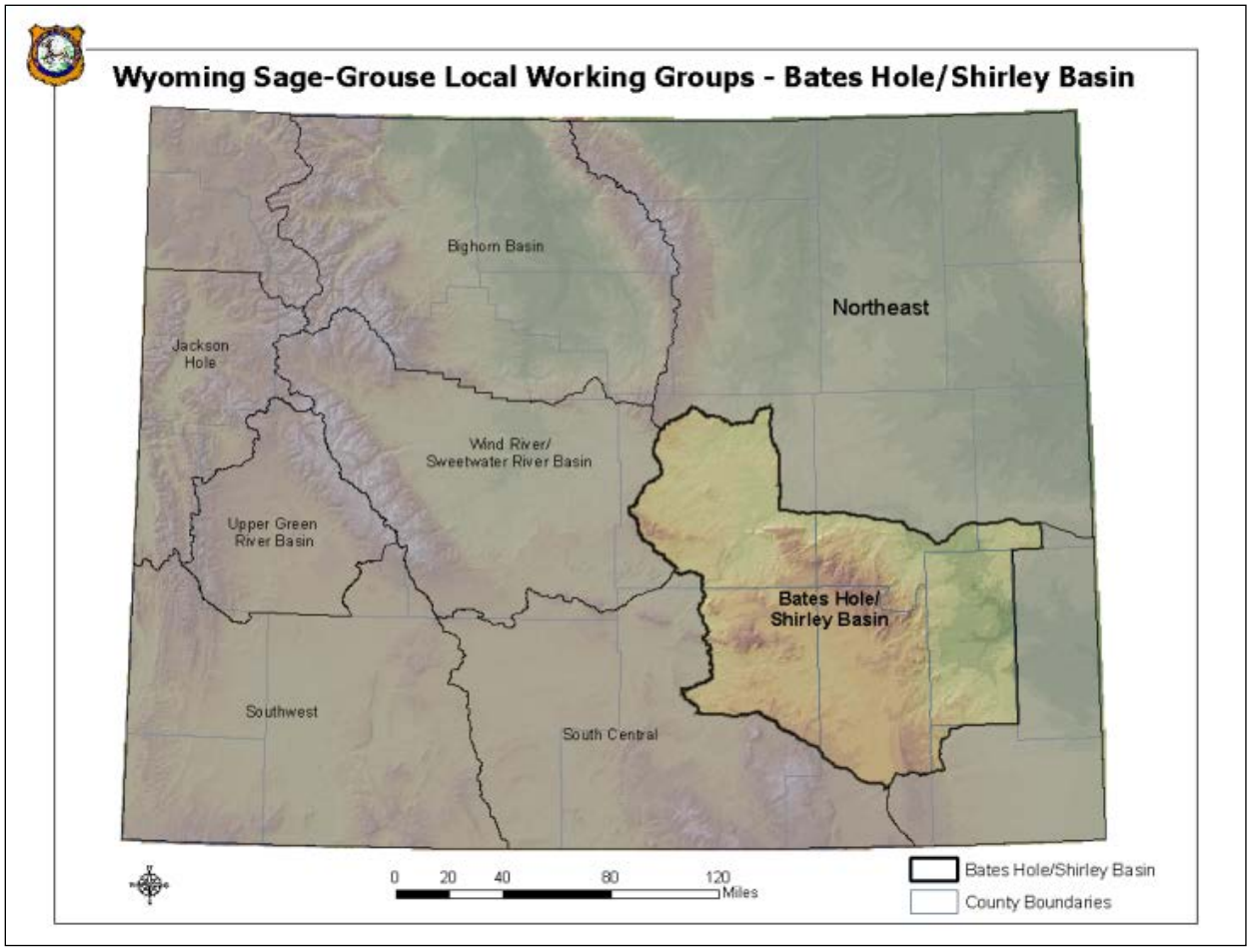
Wiley, R.H. 1978. The lek mating system of the sage grouse. Scientific American 238:114-125.

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 Conservation Area
Job Completion Report

Species: Greater Sage-grouse
Management Area(s): F – (portions of Casper and Laramie Regions)
Period Covered: June 1, 2017 – May 31, 2018
Prepared By: Justin Binfet, Casper Wildlife Management Coordinator



Sage Grouse Lek Characteristics

Working Group: Bates Hole

Region	Number	Percent
Casper	125	39.6
Lander	2	0.6
Laramie	189	59.8

Working Group	Number	Percent
Bates Hole	316	100.0

Classification	Number	Percent
Occupied	216	68.4
Undetermined	17	5.4
Unoccupied	83	26.3

BLM Office	Number	Percent
Casper	126	39.9
Lander	2	0.6
Newcastle	1	0.3
Rawlins	187	59.2

Biologist	Number	Percent
Casper	116	36.7
Douglas	8	2.5
Laramie	109	34.5
Saratoga	73	23.1
Sinclair	2	0.6
Wheatland	8	2.5

Warden	Number	Percent
Cheyenne	2	0.6
Douglas	3	0.9
East Casper	36	11.4
East Rawlins	2	0.6
Elk Mountain	69	21.8
Glenrock	7	2.2
Lusk	1	0.3
Medicine Bow	72	22.8
North Laramie	40	12.7
West Casper	78	24.7
Wheatland	6	1.9

County	Number	Percent
Albany	77	24.4
Carbon	108	34.2
Converse	10	3.2
Laramie	2	0.6
Natrona	112	35.4
Niobrara	1	0.3
Platte	6	1.9

Land Status	Number	Percent
BLM	107	33.9
BOR	1	0.3
Private	181	57.3
State	27	8.5

Management Area	Number	Percent
F	316	100.0

Lek Status	Number	Percent
Active	156	49.4
Inactive	123	38.9
Unknown	37	11.7

Report Date: December 31, 2018

Sage Grouse Job Completion Report

Year: 2009 - 2018, 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)
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	222	102	46	2869	33.0
2016	223	86	39	2893	40.2
2017	224	79	35	2207	35.6
2018	219	109	50	1944	24.0

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
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	222	93	42	1677	26.6
2016	223	103	46	2298	31.9
2017	224	123	55	2143	29.0
2018	219	79	36	1090	20.6

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: 2009 - 2018, 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)
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	222	195	88	4546	30.3
2016	223	189	85	5191	36.0
2017	224	202	90	4350	32.0
2018	219	188	86	3034	22.6

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
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	48	21	186	74.2	25.8
2015	154	32	9	186	82.8	17.2
2016	146	22	21	168	86.9	13.1
2017	147	45	10	192	76.6	23.4
2018	137	43	8	180	76.1	23.9

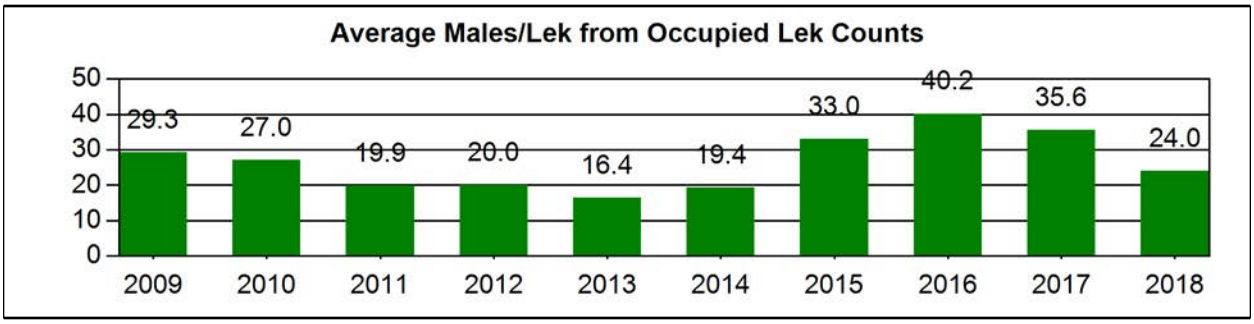
1) Occupied - Active during previous 10 years (see official definitions)

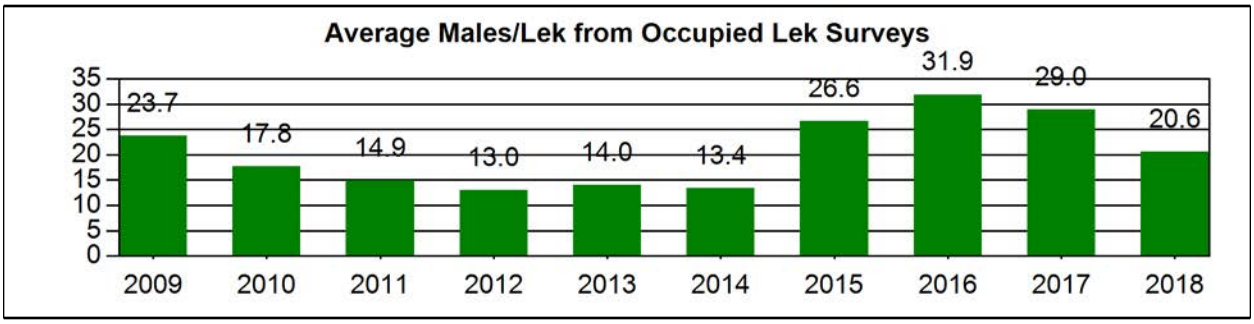
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

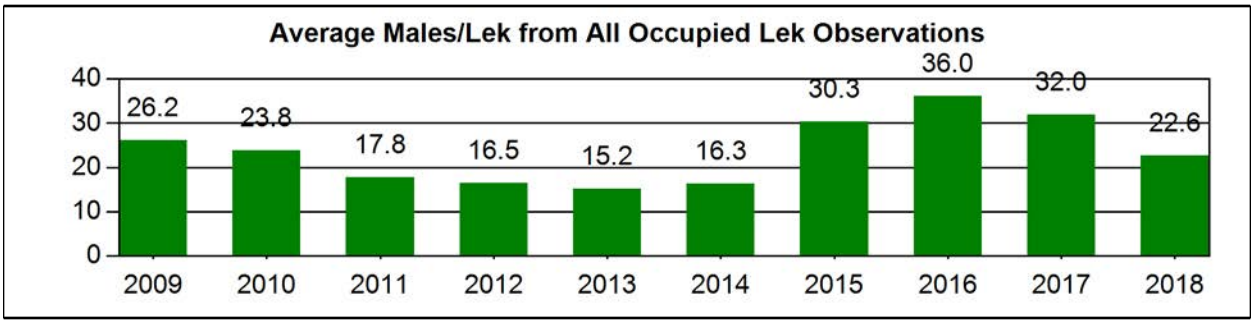
3) Inactive - Confirmed no birds/sign present (see official definitions)

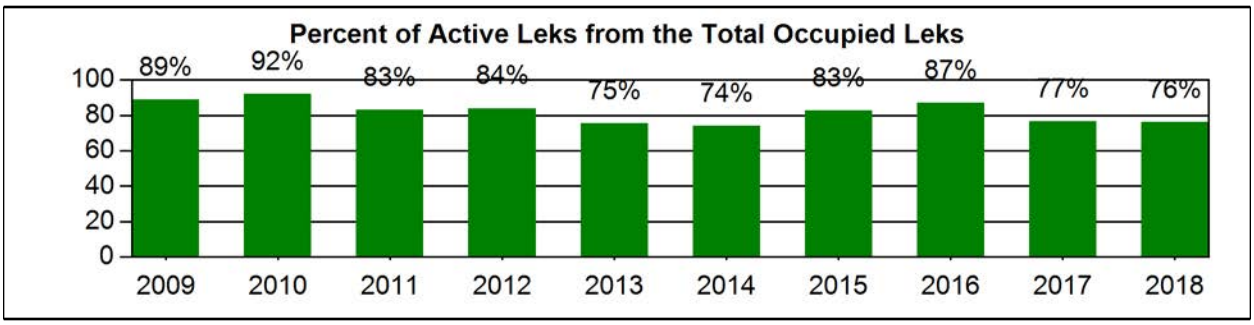
Sage Grouse Occupied Lek Attendance Summary

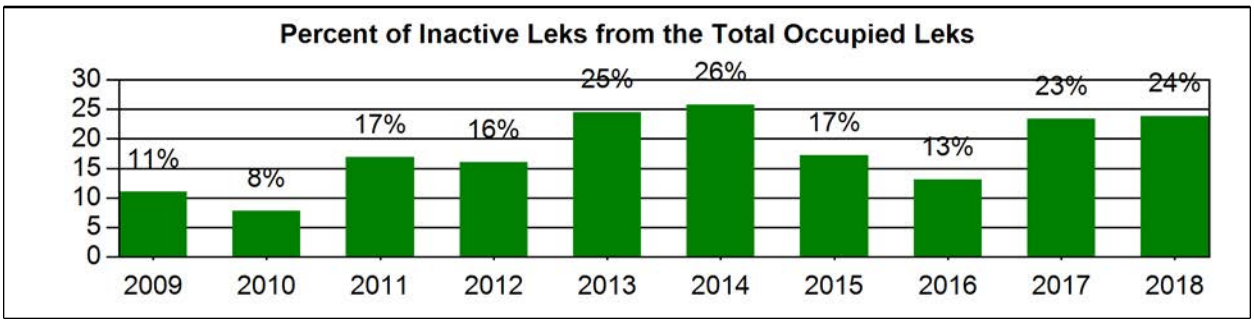
Year: 2009 - 2018, Working Group: Bates Hole











Sage Grouse Job Completion Report

Year: 2009 - 2018, Working Group: Bates Hole

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
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
2017	Sep-16	Sep-30	15	2/4

b. Harvest

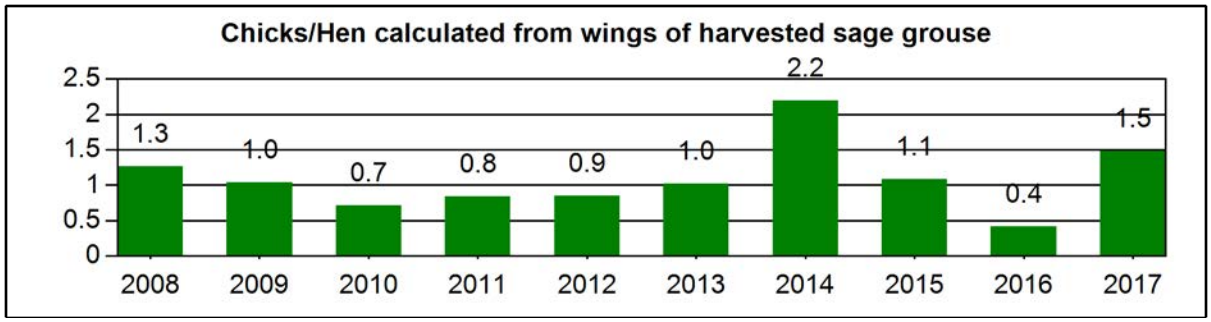
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2009	1026	532	956	1.1	1.9	1.8
2010	1027	480	1001	1.0	2.1	2.1
2011	1117	514	981	1.1	2.2	1.9
2012	688	415	852	0.8	1.7	2.1
2013	488	399	670	0.7	1.2	1.7
2014	588	352	804	0.7	1.7	2.3
2015	837	380	889	0.9	2.2	2.3
2016	869	466	869	1.0	1.9	1.9
2017	621	315	688	0.9	2.0	2.2
Avg	807	428	857	0.9	1.9	2.0

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Bates Hole

4. Composition of Harvest by Wing Analysis

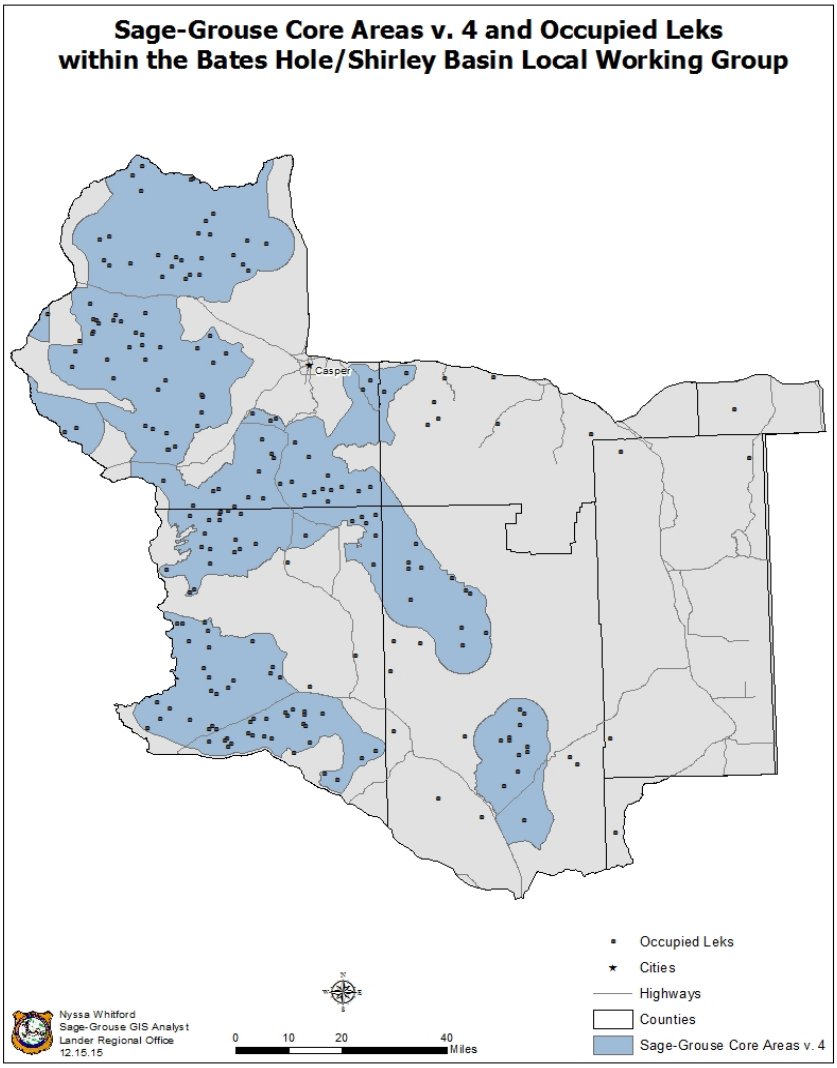
Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
2008	217	12.0	26.7	5.5	9.7	17.1	29.0	1.3
2009	314	12.7	26.1	9.2	12.1	17.8	22.0	1.0
2010	284	13.0	35.2	5.6	12.3	13.4	20.4	0.7
2011	224	17.9	34.8	4.9	7.1	15.6	19.6	0.8
2012	145	20.7	33.8	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
2017	145	20.0	23.4	4.8	6.9	20.0	24.8	1.5



Lek Monitoring

Sage-grouse, and therefore occupied leks, are well distributed throughout most of the BHSBLWG area (Figure 1). 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 2018, there are 216 known occupied leks, 83 unoccupied leks, and 17 leks of an undetermined classification within the BHSBLWG area. 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 1. Sage-grouse lek distribution and core areas within the BHSBLWG area, 2015.



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 2000, 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 2018, WGFD personnel, BLM personnel, volunteers and consultants combined efforts to check 188 of the 219 (86%) known occupied leks in the BHSBLWG area. One hundred and nine occupied leks were counted while 79 were surveyed in 2018. A total of 180 occupied leks were checked with annual status being confirmed. Of these, 137 (76%) were active and 43 (24%) 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 percentage 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 percentage of active occupied leks has declined over the past two years as overall sage-grouse lek attendance has declined, which may be signifying the beginning of a downward trend in this sage-grouse population. However, this may also 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 210 – 224. 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.

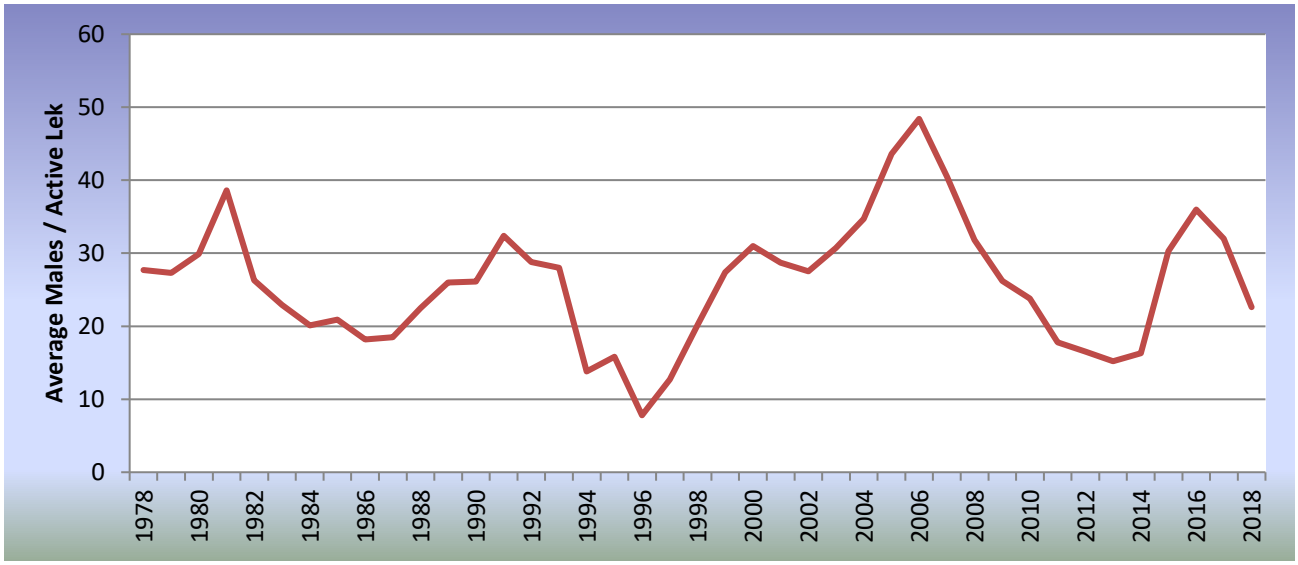
Population Trend

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 2).

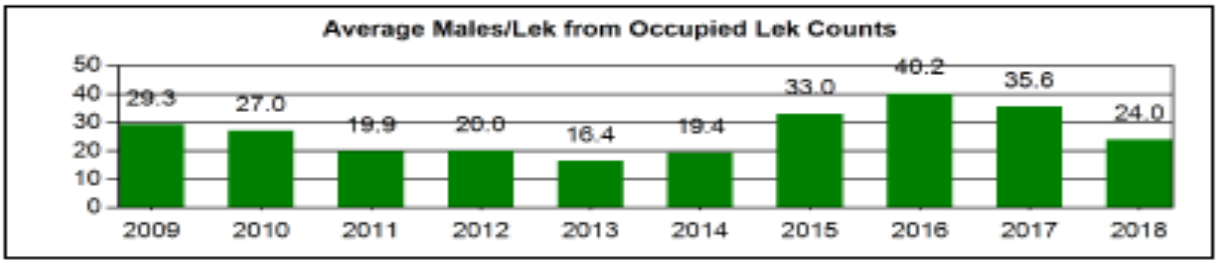
Figure 2. Mean number of peak males per active lek checked within the BHSBLWG area, 1978 – 2018.



*From 1978-1990, an average of 86 leks were checked each year.
*From 1991-1999, an average of 54 leks were checked each year.
*From 2000-present, an average of 163 leks were checked each year.

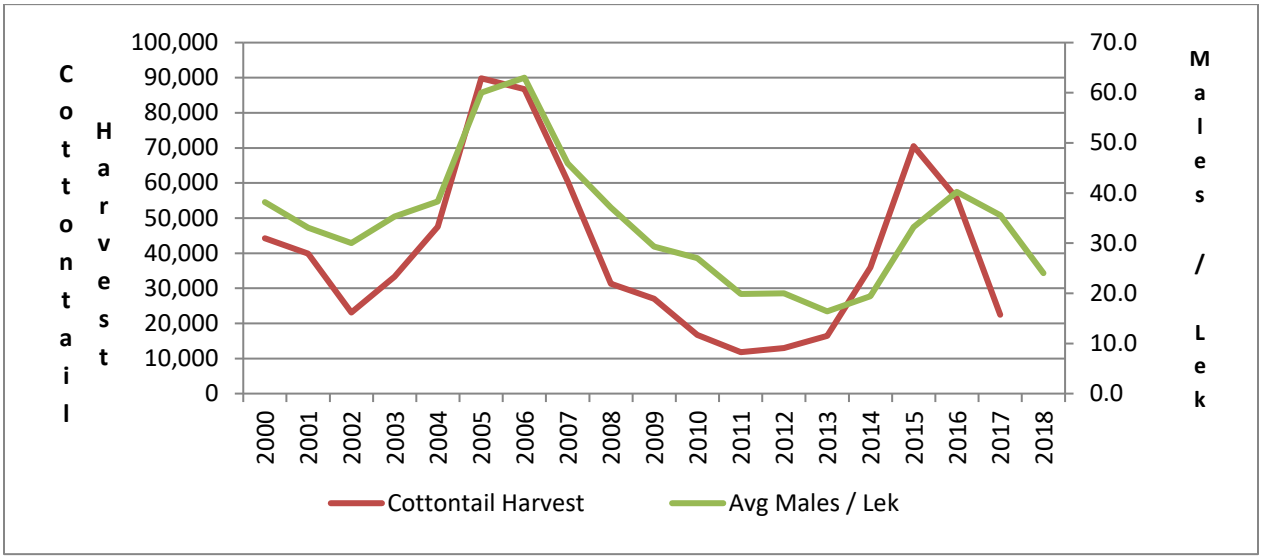
Based on the mean maximum number of males observed per counted lek, sage-grouse populations declined considerably through 2013 in the BHSBLWG area (Figure 3). In fact, the 2013 nadir was the lowest average recorded male lek attendance since intensive lek monitoring began in 2000. However, male lek attendance increased considerably through 2016, with a mean maximum number of males per counted lek increasing to 40.2. Male lek attendance has since declined sharply over the past two years, with an average of 35.6 males per counted lek in 2017 and an average of 24.0 in 2018. This steep decline is likely a function of declining chick production and/or survival in 2015 and 2016, followed by only moderate chick production in 2017. 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 3. Mean number of peak males per count lek within the BHSBLWG area, 2009 – 2018.



The recent decline in sage-grouse lek attendance is also strongly correlated with the substantial downturn in cottontail rabbit populations throughout most of the BHSBLWG area. There is a strong likelihood that some prey shifting occurs whereby predation pressure on sage-grouse increases during cottontail population downturns and decreases during periods of high cottontail densities. 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. When comparing statewide cottontail harvest data to the following spring's lek attendance data in the BHSBLWG area, there is an 80% correlation. Within the BHSBLWG area over the past ten years, both sage-grouse populations and cottontail rabbit densities (inferred through statewide cottontail harvest) increased through 2015-2016, but subsequently declined through 2018 (2018 cottontail harvest data is not yet available) (Figure 4). Anecdotal observations of rabbit densities from WGFD field personnel corroborate this, as there has been a noticeable decline in cottontail densities over the past two years.

Figure 4. Statewide Wyoming Cottontail Harvest and Average Males/Lek (BHSBLWG), 2000 – 2018.



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

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.

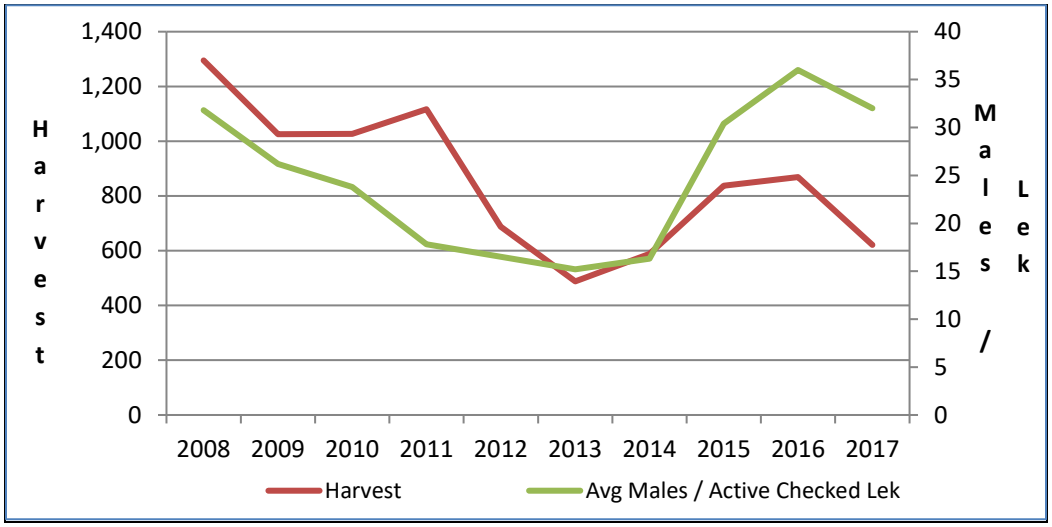
In general, chick/hen ratios of about 1.5:1 result in relatively stable lek counts the following spring, while chick/hen ratios of 1.8:1 or greater result in subsequent increased lek attendance and ratios below 1.2:1 result in decline (WGFD 2007). These thresholds do not seem to directly apply in the 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. Spring / early summer weather conditions have been relatively normal, and have not experienced any unusual cold, wet conditions that can cause widespread elevated chick mortality following hatch.

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, and was extremely poor in 2016 with a ratio of 0.4. The 2016 ratio was the lowest chick/hen ratio ever recorded using wing data within the BHSBLWG area (dating back to 1976). While chick production/survival increased in 2017 to moderate levels (1.5 chicks/hen), the improved productivity was not enough to offset continued population decline. In fact, even with improved chick survival in 2017, male lek attendance continued to sharply decline in 2018.

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 ~14,200 birds and subsequently declined to an historic low of 488 in 2013. Following a period of steadily increasing harvest from 2013-2016, sage-grouse harvest declined to an estimated 621 birds in the BHSBLWG area in 2017. This decline in harvest further indicates this population has declined over the past two years. Over the last 10 years, trends observed in harvest data generally mirror those observed in male lek attendance within the BHSBLWG area (Figure 5).

Figure 5. Total sage-grouse harvested per year and the average number of males per active lek checked within the BHSBLWG area, 2008 – 2017.



Hunter participation and harvest declined dramatically in Wyoming when the Wyoming Game and Fish Commission moved the hunting season to later in September in 1995, and then reduced the bag limit and shortened the hunting season in 2002 (WGFD 2008). This reduced hunter harvest occurred in spite of a concurrent sage-grouse 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).

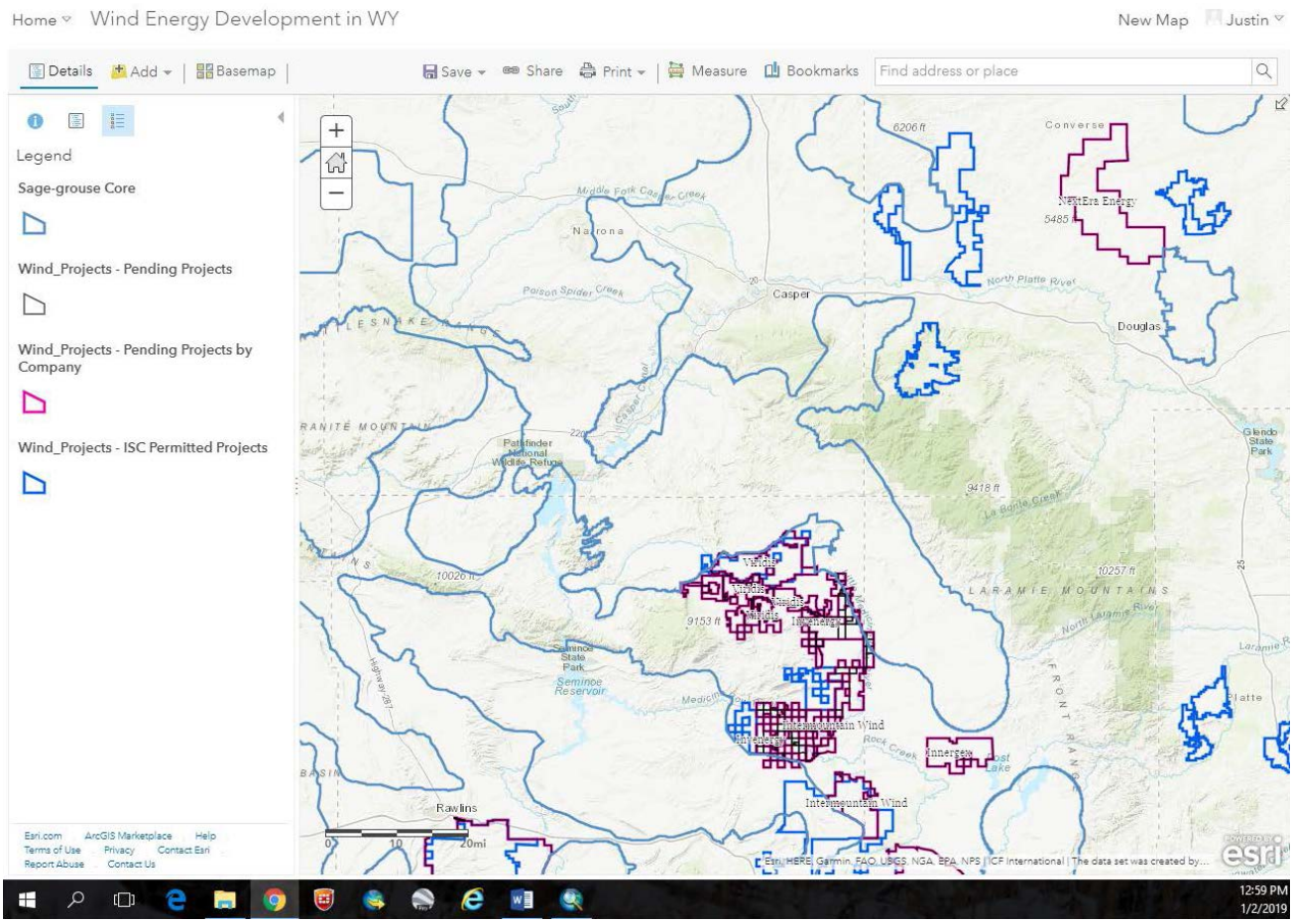
Habitat

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.

Of particular concern to sage-grouse within the BHSBLWG area is the substantial expansion of large-scale industrial wind development within Shirley Basin. Several new projects are currently in various stages of permitting, with construction being planned on multiple new wind farms over the next two

years (Figure 6). 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 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 wind development was already in the permitting stage. Much of the proposed development is immediately adjacent to core areas.

Figure 6. Existing and proposed (in permitting process) wind development within the BHSBLWG area, 2018.



Disease

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.

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 that followed.

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*). Here, researchers indicate that mowing and Tebuthiuron treatments may slightly increase sagebrush crude protein directly after treatments without significantly altering secondary metabolites. However, the researchers concluded the slight increase in dietary quality of sagebrush coupled with the trade-off of loss of biomass resulting from prescriptive treatments further indicates treating Wyoming big sagebrush may yield little benefit to sage-grouse (Smith et al., 2018).

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. Continue 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.

Relevant Research

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.

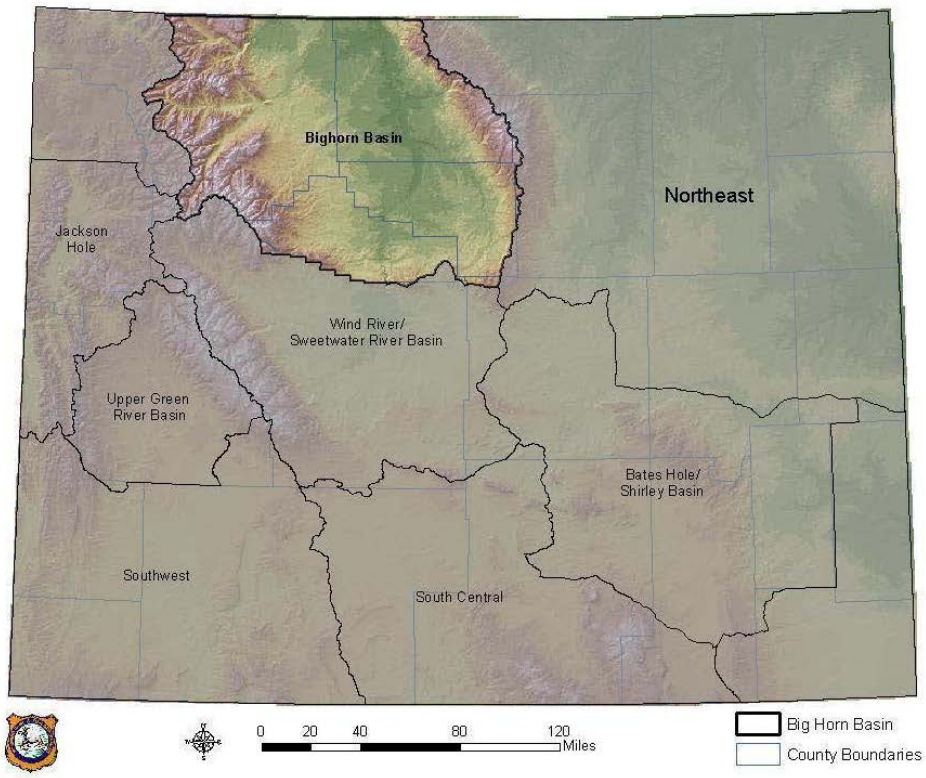
Sedinger, J.S., G.C. White, S. Espinosa, E.T. Partee, C.E. Braun. 2010. Assessing compensatory versus additive harvest mortality: An example using greater sage-grouse. Journal of Wildlife Management 74(2): 326-332.

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. 2018. Effects of mowing and tebuthiuron treatments on the nutritional quality of Wyoming big sagebrush. Rangeland Ecology & Management 71 (2018) 417-423.

Bighorn Basin Conservation Area
Job Completion Report

Species: Greater Sage-grouse
Mgmt. Areas: B; Cody Region
Period Covered: 6/1/2017 – 5/31/2018
Prepared by: Leslie Schreiber, Greybull Biologist



Sage Grouse Lek Characteristics

Management Area: B

Region	Number	Percent
Cody	309	100.0

Working Group	Number	Percent
Big Horn Basin	309	100.0

Classification	Number	Percent
Occupied	239	77.3
Undetermined	35	11.3
Unoccupied	35	11.3

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	177	57.3
Inactive	74	23.9
Unknown	58	18.8

Sage Grouse Job Completion Report

Year: 2009 - 2018, Management Area: B

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

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
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	815	17.0
2013	236	42	18	501	12.5
2014	233	68	29	823	14.4
2015	243	53	22	1108	26.4
2016	249	86	35	2258	30.5
2017	251	56	22	1636	34.8
2018	242	60	25	1115	24.2

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
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	249	140	56	2053	23.3
2017	251	175	70	2286	19.2
2018	242	153	63	1434	14.2

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: 2009 - 2018, Management Area: B

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

c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
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	1592	11.7
2013	236	190	81	1250	9.5
2014	233	158	68	1340	11.9
2015	243	192	79	3373	22.0
2016	249	226	91	4311	26.6
2017	251	231	92	3922	23.6
2018	242	213	88	2549	17.3

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2009	130	11	28	141	92.2	7.8
2010	146	9	28	155	94.2	5.8
2011	130	12	43	142	91.5	8.5
2012	143	10	26	153	93.5	6.5
2013	132	9	49	141	93.6	6.4
2014	115	23	20	138	83.3	16.7
2015	154	27	11	181	85.1	14.9
2016	173	26	27	199	86.9	13.1
2017	171	35	25	206	83.0	17.0
2018	152	34	27	186	81.7	18.3

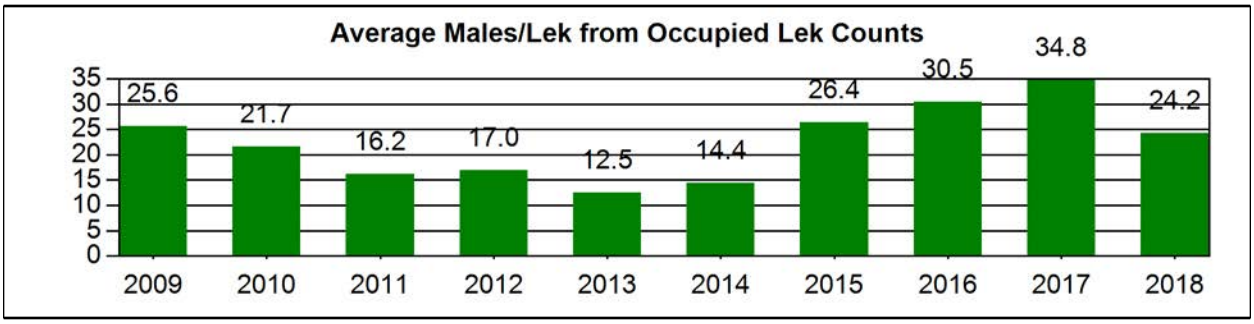
1) Occupied - Active during previous 10 years (see official definitions)

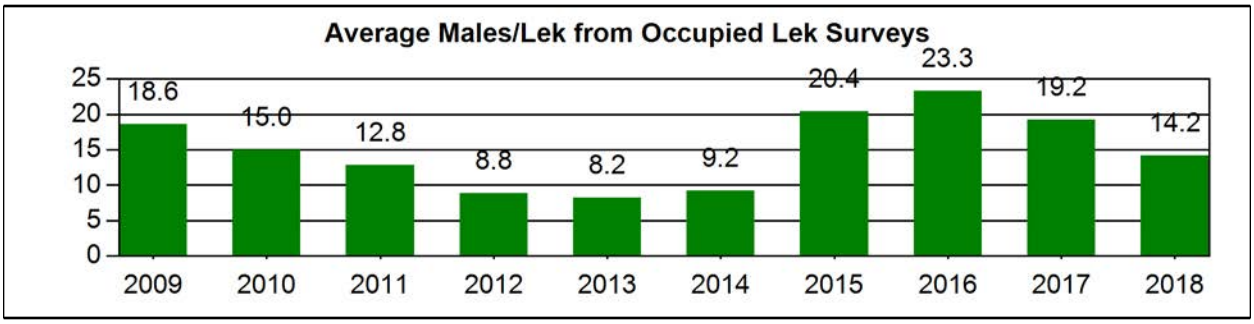
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

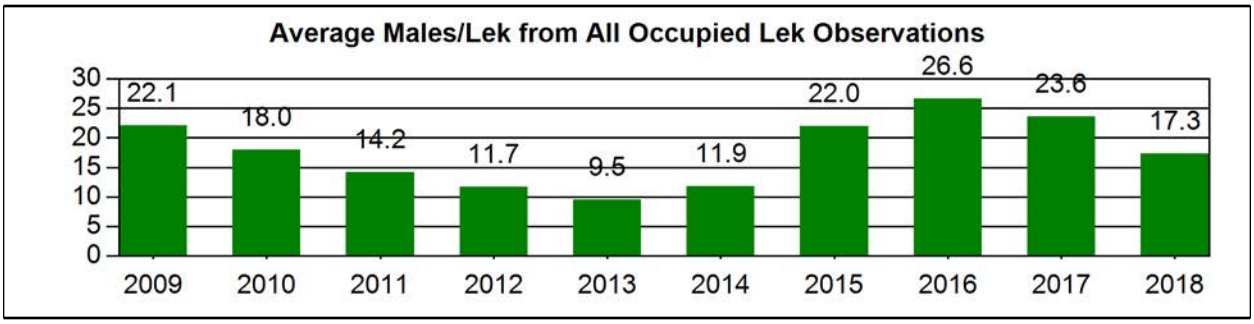
3) Inactive - Confirmed no birds/sign present (see official definitions)

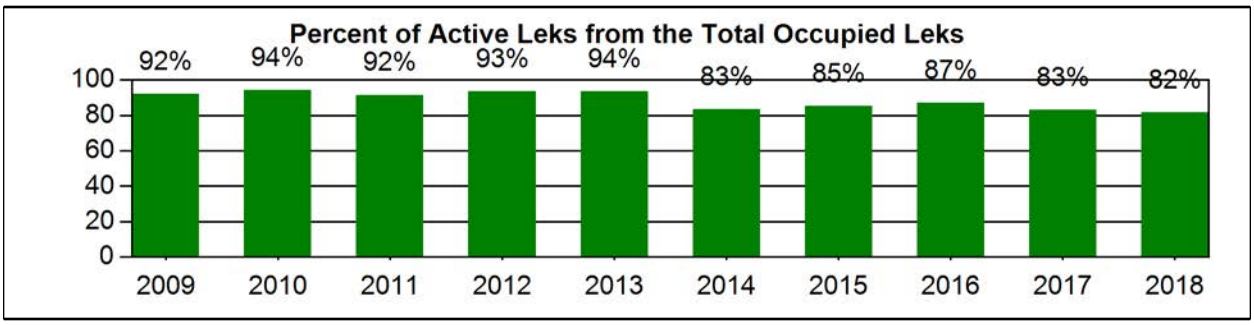
Sage Grouse Occupied Lek Attendance Summary

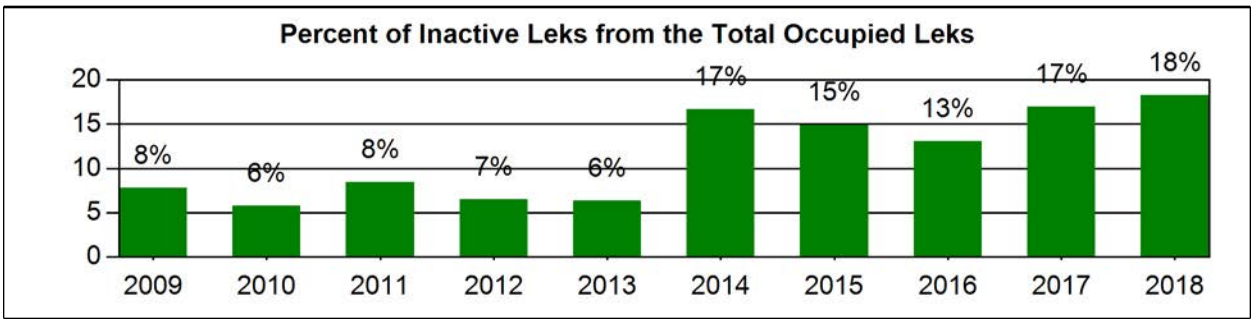
Year: 2009 - 2018, Management Area: B











Sage Grouse Job Completion Report

Year: 2009 - 2018, Management Area: B

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
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
2017	Sep-16	Sep-30	15	2/4

b. Harvest

Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2009	472	264	518	0.9	1.8	2.0
2010	545	278	655	0.8	2.0	2.4
2011	354	294	867	0.4	1.2	2.9
2012	457	290	609	0.8	1.6	2.1
2013	206	206	513	0.4	1.0	2.5
2014	524	303	708	0.7	1.7	2.3
2015	729	411	947	0.8	1.8	2.3
2016	594	302	868	0.7	2.0	2.9
2017	635	300	745	0.9	2.1	2.5
Avg	502	294	714	0.7	1.7	2.4

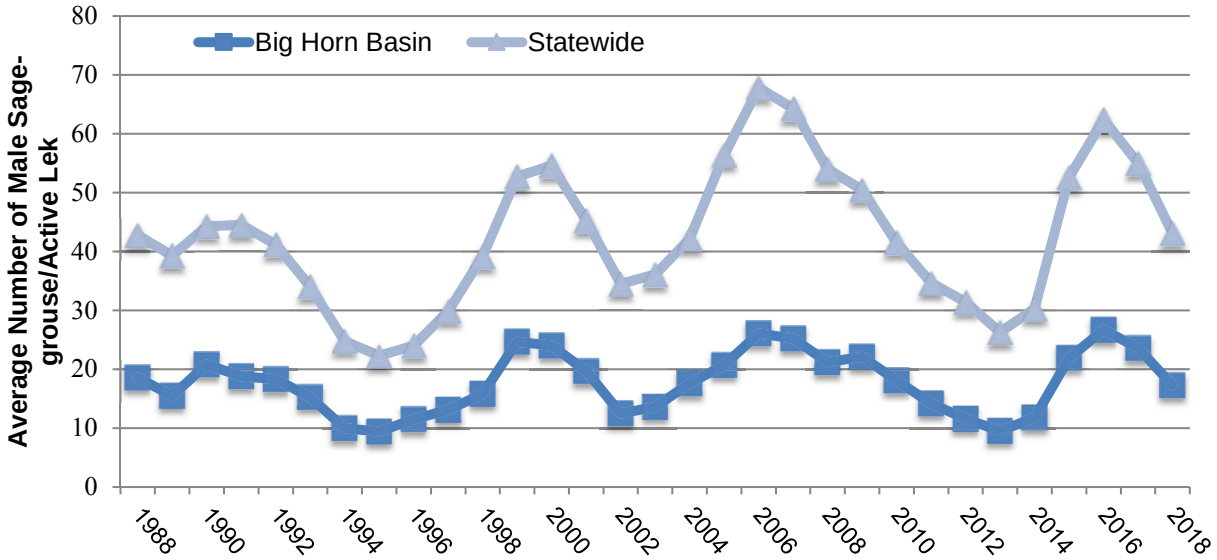
Lek Monitoring

For biological year 2017, 309 sage-grouse leks are known to occur in the Bighorn Basin Conservation Area (hereafter; Basin) with 239 leks known to be occupied, and 35 leks known to be unoccupied. Undetermined leks (*n*=35) 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. There are likely other leks in the Basin not yet discovered. Leks in the Basin are checked by WGFD wardens and biologists, BLM personnel, and volunteers. After lekking season is over, observers send standardized lek datasheets to the Greybull Biologist for entry into the Wyoming Game & Fish Department's sage-grouse database.

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). In spring 2018, we *counted* 60 leks in the Basin, resulting in an average of 24.2 males per lek. We *surveyed* 153 leks (2009-18 average=130), for a total of 213 leks checked during the 2018 season (2009-18 average=193).

To evaluate long-term population trends, we combine and average lek survey and count data, because the more stringent 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). The average number of male sage-grouse on both counted and surveyed leks continued its downward trend in 2018 to 17.3 males, indicating a downswing in the population (Figure 1). Sage-grouse populations in Wyoming cycle on approximately 6 to 8-year intervals (Row and Fedy 2017). During a downswing in the population, we would expect an increase in the number of inactive leks. The proportion of inactive leks increased from 17% in 2017 to 18.3% in 2018.

Figure 1. Trends in average male attendance for all lek observations in the Bighorn Basin Conservation Area and statewide for the last 30 years, 1988-2018.



Production surveys

Five sage-grouse broods were documented in 2018 (Table 1). Sample sizes (number of groups observed) from 2011-2018 were too small to estimate chick production (chicks/brood or chicks/hen) in the Basin. 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. 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 Game and Fish personnel in the Cody Region.

Table 1. 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	3.0
2009	26	104	33	4.0	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
2018	5	22	6	4.4	3.7
2008-18 average	**10**	**44**	**17**	**3.9**	**3.0**

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.

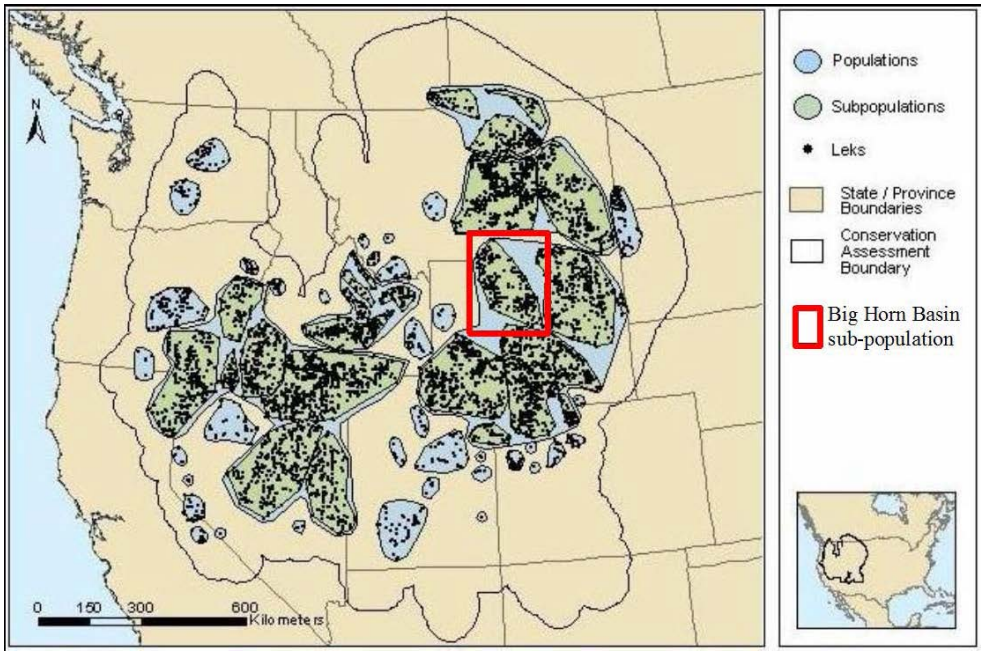
Changing the season and decreasing the bag limit reduced sage-grouse harvest and hunters in the Basin. Average (1982-1994) annual harvest in the Basin was 3,756 sage-grouse taken by 1,300 hunters during 3,118 hunter days (2.8 birds/hunter, 2.4 days/hunter). During 1995-2001 an average of 549 hunters took 1,056 sage-grouse during 1,567 days of hunting (1.9 birds/hunter, 2.8 days/hunter). During the most recent period (2002-2017), hunters averaged 1.6 birds/hunter and 2.4 days/hunter. In September 2017, 300 hunters in the Big Horn Basin harvested 635 sage-grouse (2.1 birds/hunter); spending 745 hunter-days afield (2.5 days/hunter) during the 15-day hunting season. Sage-grouse harvest metrics in the Basin have remained fairly steady for the last 10 years, indicating that a specialized group of bird hunters go afield regardless of sage-grouse population size.

Habitat

Vegetation communities within the Bighorn Basin Conservation Area 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. The area 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 privately-held land (25%). Primary land uses in the Basin include livestock grazing, farming, oil and gas development, bentonite mining, urban and suburban developments, recreation, and wildlife habitat. Compared to the rest of Wyoming, oil and gas development is minor and is located in the center (ex. Oregon Basin oil field) and along the western rim of the Basin. Bentonite mining occurs around the Basin mostly in salt-desert scrub vegetation communities.

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. To the north, several leks near the Wyoming/Montana state line host documented movement between states. To the south, Copper Mountain, the Owl Creek Mountains, and the southern Bighorn Mountains provide suitable habitat serving as travel corridors to adjacent populations.

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).



Conservation Planning

The Bighorn Basin Local Working Group (BHBLWG) was formed in September 2004 to develop and implement a local conservation plan for sage-grouse and sagebrush habitats. The BHBLWG 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 https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management/Sage-Grouse-Local-Working-Groups.

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, and allocate Game and Fish Commission funding.

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. Members are working on filling two vacant positions. The Group also reviewed and allocated Wyoming Sage-grouse Conservation Fund dollars. Projects funded with BHBLWG allocation in FY 2019 included four projects, three habitat treatments in the Basin and one continuing research project near Jeffrey City, WY.

Recommendations

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. Management recommendations include:

- 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.
- Work through winter range mapping in coordination with Worland and Cody BLM offices while statewide efforts map Winter Concentration Areas
- 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.

Area Specific Research and 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.

Hayden-Wing Associates Wildlife Consulting. 2017. Assessing and reducing common raven impacts on greater sage-grouse nesting ecology. Unpublished report, Laramie, Wyoming, USA.

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.

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. 2016. Impacts of coyote removal on space use by greater sage-grouse. Human-Wildlife Interactions 10:144-156.

Orning, E. K. and J. K. Young. 2017. Coyote removal: can the short-term application of a controversial management tool improve female greater sage-grouse survival or nest success? Wildlife Biology doi: 10.2981/wlb.00345.

Pratt, A. C., and J. L. Beck. 2019. Greater sage-grouse response to bentonite mining. Journal of Wildlife Management, *In press*.

Pratt, A. C., K. T. Smith, and J. L. Beck. *In revision*. Prioritizing seasonal habitats for comprehensive conservation of a partial migrant. Global Ecology and Conservation.

Pratt, A. C., K. T. Smith, and J. L. Beck. 2017. Environmental cues used by Greater Sage-grouse to initiate altitudinal migration. Auk 134: 628-643.

Pratt, A. C. 2017. Partial migration, habitat selection, and the conservation of greater sage-grouse in the Bighorn Basin of Montana and Wyoming. Dissertation, University of Wyoming, Laramie, 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. 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.

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.

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.

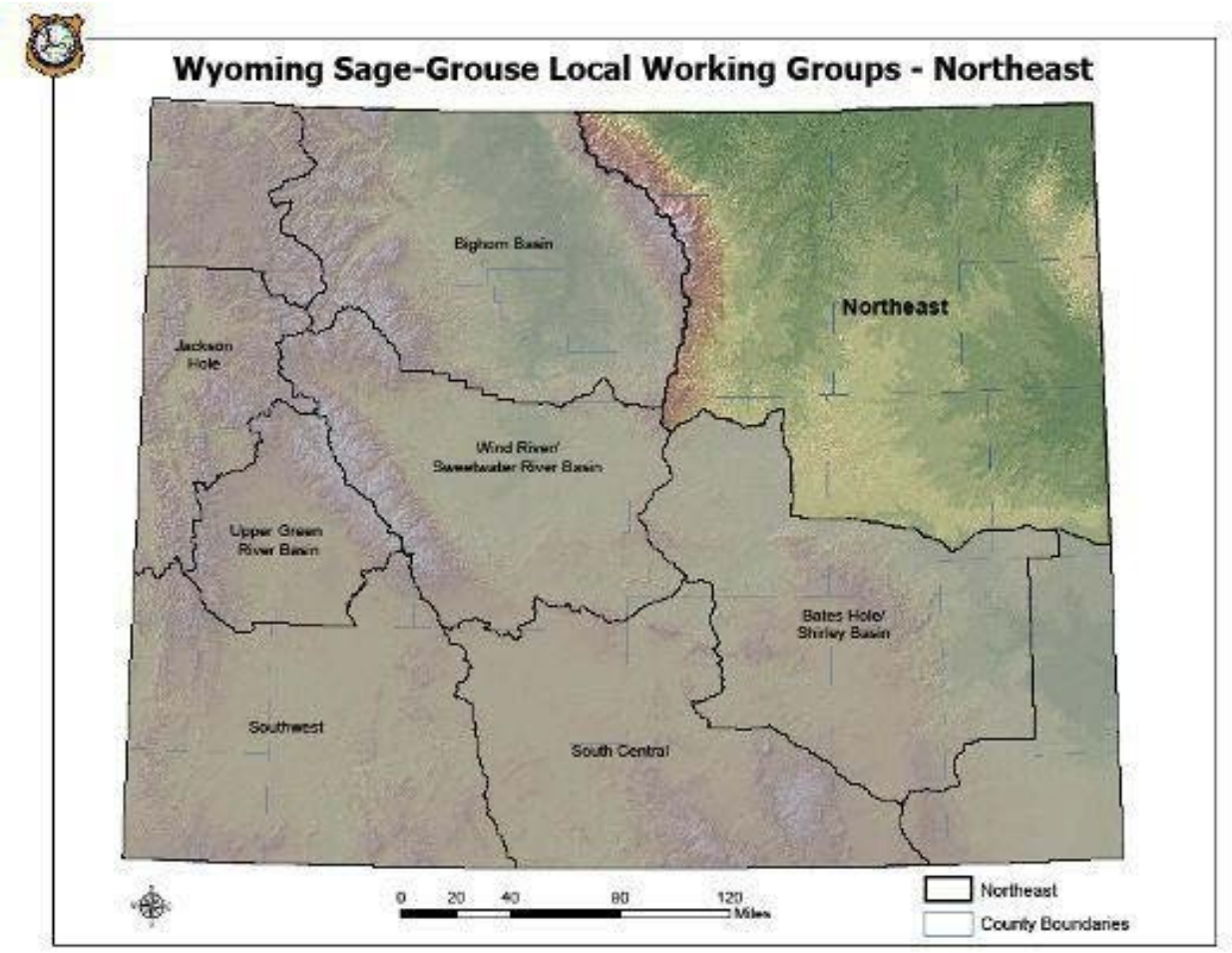
Fedy, B. C. and C. L. Aldridge. 2011. The importance of within-year repeated counts and the influence of scale on long-term monitoring of sage-grouse. Journal of Wildlife Management 75:1022-1033.

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.

Northeast Conservation Area

Job Completion Report

SPECIES: **Sage-grouse**
DAU NAME: **Northeast Wyoming Working Group**
Period Covered: **6/1/2017 – 5/31/2018**
Prepared by: **Dan Thiele, Wildlife Management Coordinator**



Sage Grouse Job Completion Report

Year: 2009 - 2018, 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)
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	189	48	1933	16.2
2016	393	168	43	1962	20.2
2017	377	165	44	1845	20.1
2018	371	177	48	1376	13.8

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
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	700	10.0
2015	397	147	37	1065	16.1
2016	393	179	46	1708	19.2
2017	377	152	40	1354	16.5
2018	371	107	29	648	12.5

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: 2009 - 2018, 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)
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	1632	9.8
2015	397	336	85	2998	16.2
2016	393	347	88	3670	19.7
2017	377	317	84	3199	18.4
2018	371	284	77	2024	13.3

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2009	219	83	63	302	72.5	27.5
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	168	134	57	302	55.6	44.4
2015	188	92	56	280	67.1	32.9
2016	192	109	46	301	63.8	36.2
2017	176	97	44	273	64.5	35.5
2018	156	99	29	255	61.2	38.8

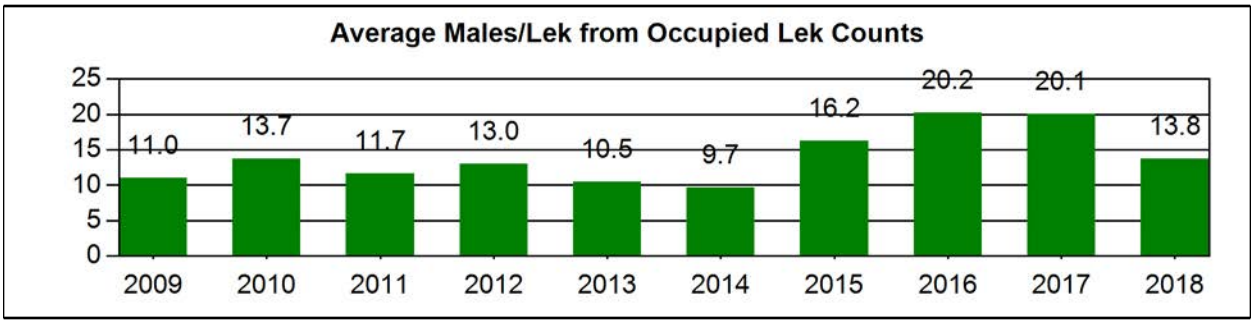
1) Occupied - Active during previous 10 years (see official definitions)

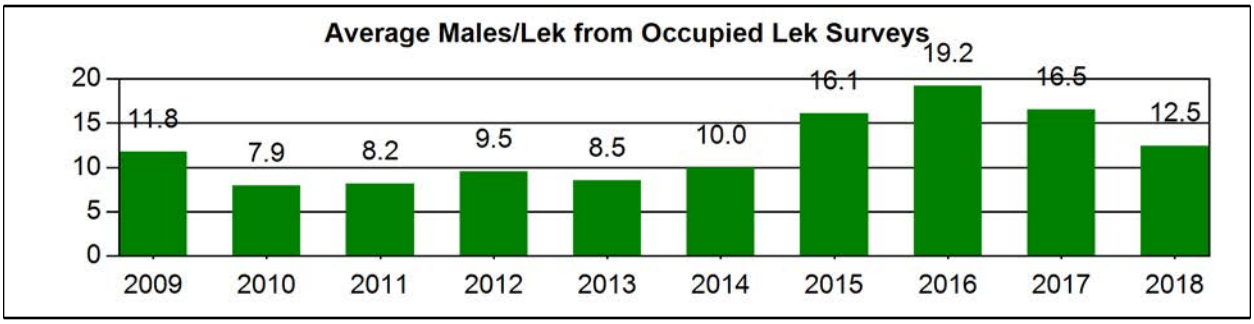
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

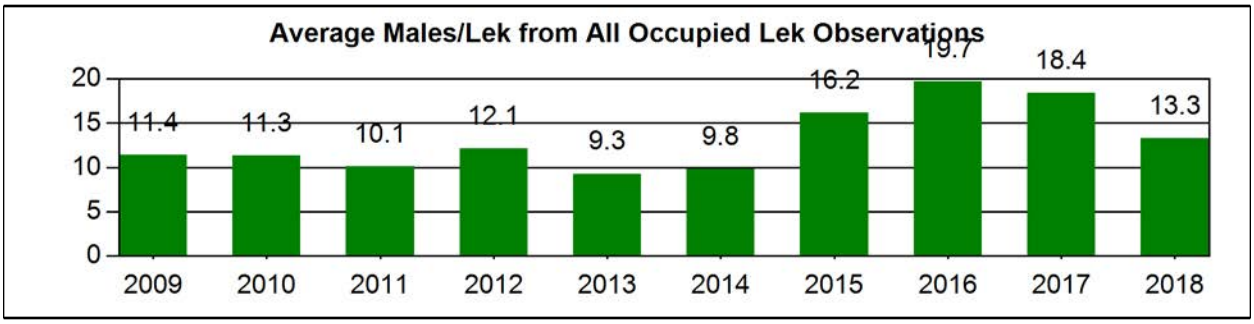
3) Inactive - Confirmed no birds/sign present (see official definitions)

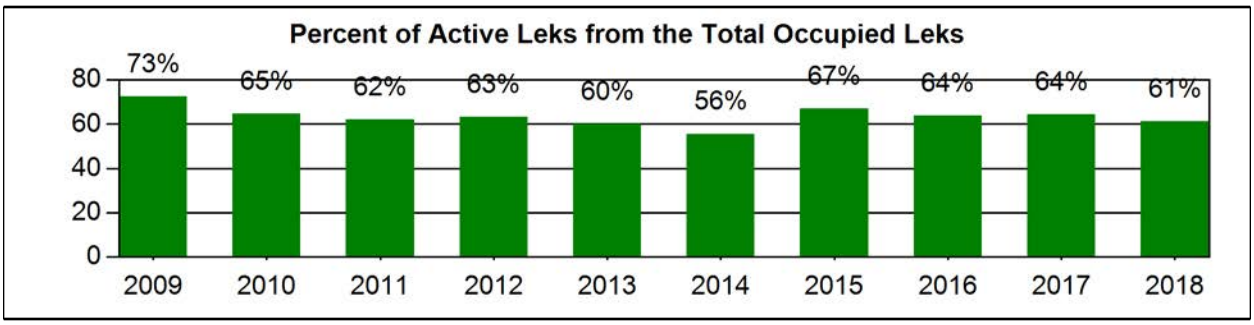
Sage Grouse Occupied Lek Attendance Summary

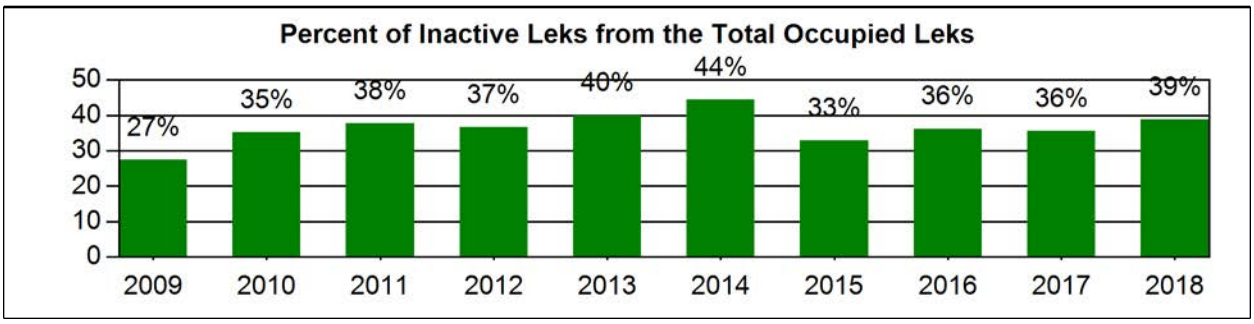
Year: 2009 - 2018, Working Group: Northeast











Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Northeast

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
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
2017	Sep-16	Sep-30	15	2/4

b. Harvest

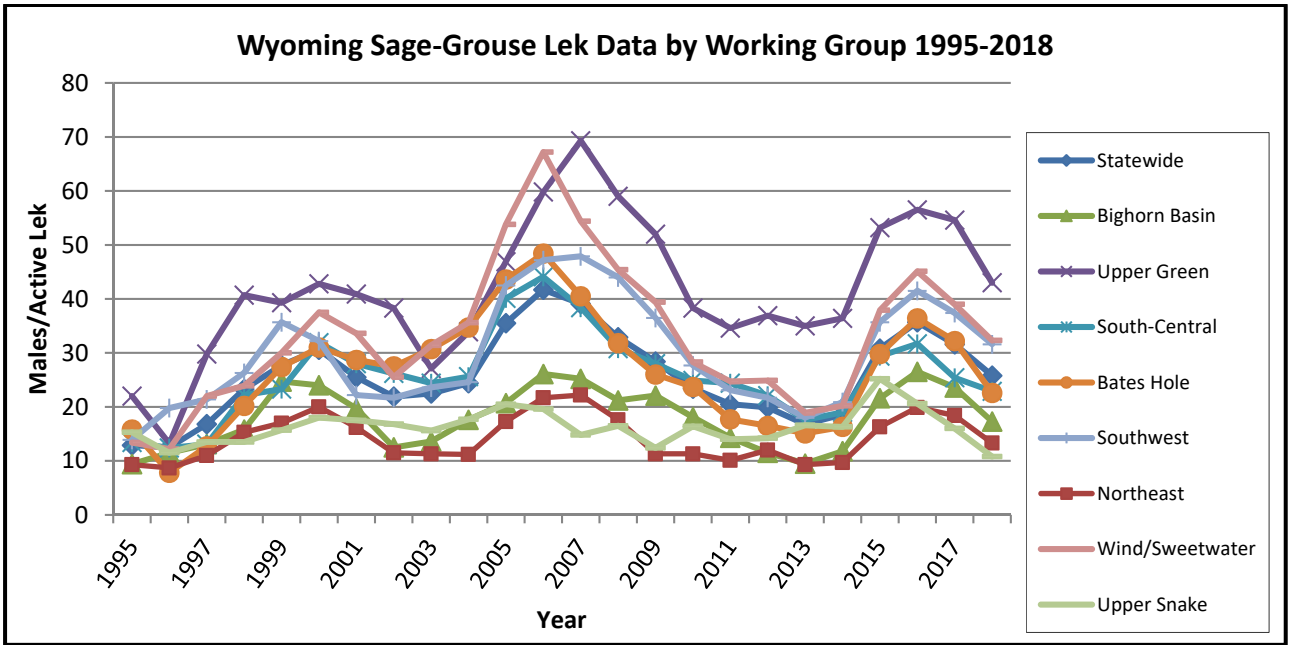
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2008	101	186	295	0.3	0.5	1.6
2009	311	230	559	0.6	1.4	2.4
2010	129	117	202	0.6	1.1	1.7
2011	158	124	173	0.9	1.3	1.4
2012	405	218	404	1.0	1.9	1.9
2013	27	82	249	0.1	0.3	3.0
2014	123	137	242	0.5	0.9	1.8
2015	314	228	400	0.8	1.4	1.8
2016	89	129	265	0.3	0.7	2.1
2017	118	145	344	0.3	0.8	2.4
Avg	178	160	313	0.6	1.0	2.0

Lek Monitoring

Northeast Wyoming has one of the lowest average male lek attendance rates in the state, averaging 13 males per active lek in 2018 compared to the statewide average of 26 males per active lek (Figure 1). 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. No leks exceeded 50 males in 2018 with the largest being 45 males.

Average male lek attendance in northeast Wyoming has decreased significantly over the years. Figure 2 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 2015-2017, however, the long-term trend remains a concern.

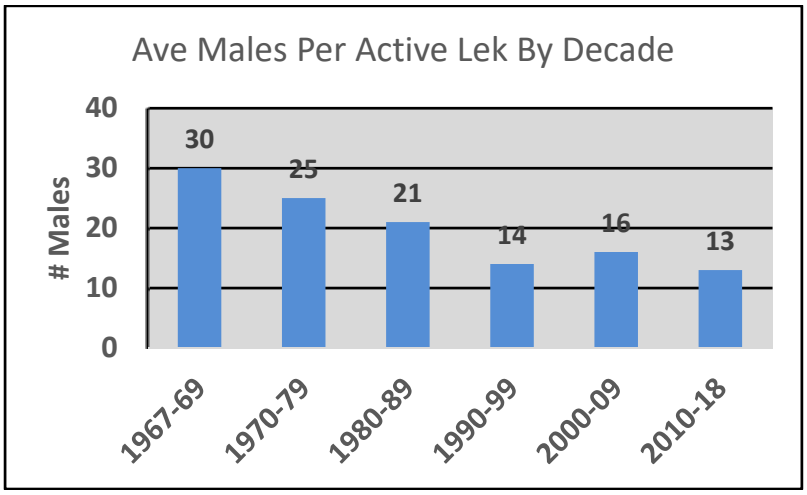
Figure 1. Wyoming Statewide and Local Working Group Area Lek Attendance Trends.



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 participate in ground and aerial monitoring of leks.

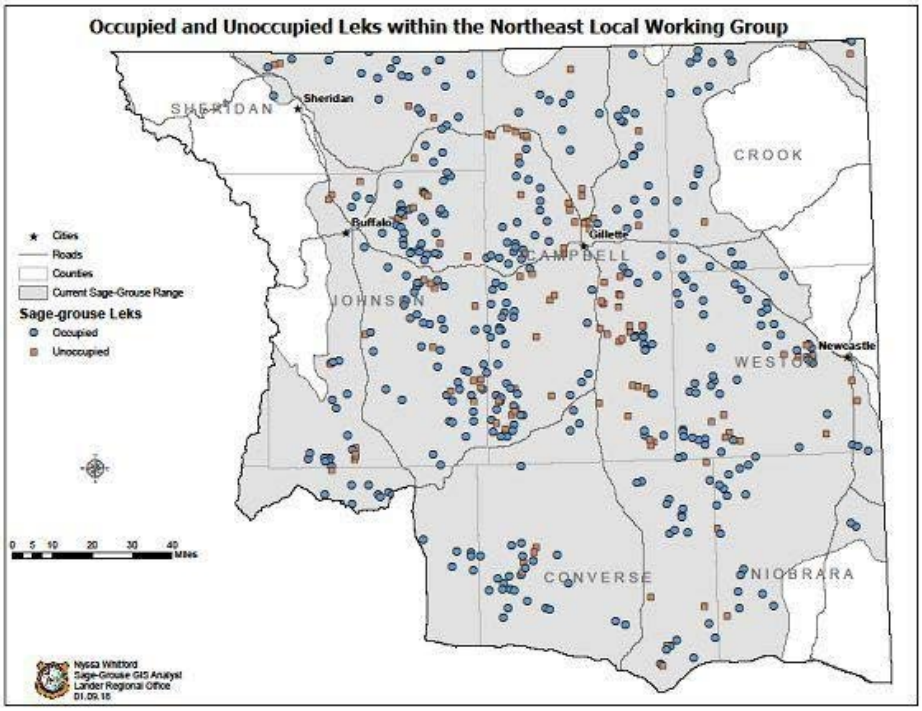
Sage-grouse lek monitoring efforts are accomplished through lek counts, lek surveys and searches for new leks. The Sheridan Region received additional funds from the Bureau of Land Management for sage-grouse surveys for the 17th consecutive year. This funding was used for aerial surveys to monitor known leks and fly grid searches for new leks in those areas with seemingly adequate habitat, but no previously known leks.

Figure 2. Average Number of Males per Active Lek by Decade for Northeast Wyoming Leks.



Following the 2018 lek monitoring period there are 571 documented leks in the NEWLWGA distributed over various land ownership and management authority boundaries (Figure 3 and Table 1). Of this total, 360 are classified as occupied leks. The 360 occupied leks is less than the 571 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 2018 breeding season, 177 leks were counted, representing 48% of known occupied leks (JCR Table 1a). The average number of males per active lek from lek counts was 13.8, well below the 20.1 males/active lek in 2017 and 20.2 males/active lek in 2016. The 2018 lek count suggests the sage-grouse population decreased after peaking the last two years. The previous cycle peaked at 28.0 males/active lek in 2006.

Figure 3. 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.

Table 1. Northeast Wyoming Working Group Area Sage-grouse Lek Characteristics for the 571 known leks in 2018.

Region	Number	Percent
Casper	154	27.0%
Sheridan	417	73.0%

Classification	Number	Percent
Occupied	360	63.0%
Unoccupied	135	23.6%
Undetermined	76	13.3%

Biologist	Number	Percent
Buffalo	72	12.6%
Casper	14	2.5%
Douglas	62	10.9%
Gillette	256	44.8%
Newcastle	78	13.7%
Sheridan	89	15.6%

County	Number	Percent
Bighorn, MT	1	0.2%
Campbell	200	35.0%
Carter, MT	1	0.2%
Converse	57	10.0%
Crook	27	4.7%
Johnson	138	24.2%
Natrona	15	2.6%
Niobrara	23	4.0%
Powder River, MT	1	0.2%
Sheridan	35	6.1%
Weston	73	12.8%

Management Area	Number	Percent
C	571	100.0%

Working Group	Number	Percent
Northeast	571	100.0%

BLM Office	Number	Percent
Buffalo	375	65.7%
Casper	72	12.6%
Newcastle	124	21.7%

Game Warden	Number	Percent
Buffalo	73	12.8%
Dayton	24	4.2%
Douglas	26	4.6%
East Casper	5	0.9%
Glenrock	30	5.3%
Kaycee	58	10.2%
Lusk	23	4.0%
Moorcroft	74	13.0%
Newcastle	63	11.0%
North Gillette	68	11.9%
Sheridan	13	2.3%
South Gillette	107	18.7%
Sundance	6	1.1%
West Casper	1	0.2%

Land Status	Number	Percent
BLM	51	8.9%
Private	446	78.1%
State	39	6.8%
US Forest Service	35	6.1%

Land Status	Number	Percent
Active	192	33.6%
InActive	220	38.5%
Unknown	159	27.8%

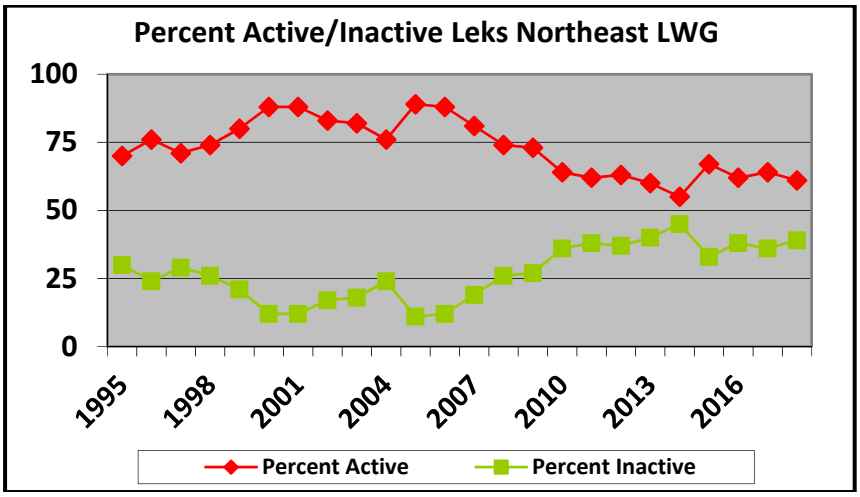
The number of known occupied leks checked by lek counts and lek surveys combined was 284 leks, or 77% of the known occupied leks (JCR Table 1c). The percentage of leks checked was below the 80% objective due to Bighorn Air being unavailable to conduct

aerial surveys. The average number of males/active lek was 13.3 compared to 18.4 males/active lek in 2017. The 2018 average attendance represents a 28% decrease from last year. For the 10-year period, 2009-2018, the number of males/active lek has ranged from 9.3 in 2013 to 19.7 in 2016. These numbers and trends are comparable to the lek count data. One-hundred-fifty-six leks were documented as active with peak male attendance ranging from 1 to 45 males. The three leks with the highest number of males were the Boxelder Draw and ZV Creek 1 Leks with 45 males and the Cooper Lek with 43 males. No lek has exceeded 100 males since 2007. The median peak male attendance was 11 males, down from 15 males in 2017.

In total, there were 1,140 recorded observations of sage-grouse lek visits in 2018. Visits were up slightly from 2017 but nearly 900 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. 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 4. Trends in Active and Inactive Leks, 1995-2018.



Lek status as determined from lek counts and lek surveys shows 255 leks with confirmed lek status. Sixty-one percent of the leks (n=156) 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-nine leks (39%) were determined to be inactive based on multiple ground visits and/or checks for sign (feathers/droppings) late in the strutting season. 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 4). In 2018, the percentage of active leks decreased slightly while the number of males per active lek decreased notably suggesting a lower population. A number of monitored leks (n=29) 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 (14.5 vs 12.1) but confirmed lek activity is notably higher in core areas (70% vs. 54%). 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 2018, only 47% 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 Core Area Infrared Lek Survey

An infrared lek survey of the North Gillette Core Area was flown by Owyhee Air of Nampa, ID on April 28-30, 2018. The area encompassed approximately 121,000 acres and required 19.3 hours of survey time. Flights were conducted during early morning hours from an altitude of at least 1,500 feet and at a line interval spacing of ¼ mile to ensure complete coverage. Survey cost including ferry time, survey time and document preparation was $18,569 and was funded through the BLM Buffalo Field Office wildlife survey agreement.

Twelve known leks were surveyed with three active leks confirmed with infrared technology and identification to species made with a high definition camera. Male attendance on the three active leks was 30, 24 and 23 males. No new sage-grouse or sharp-tailed grouse leks were found.

Niobrara County Infrared Lek Survey

An infrared lek survey of an area of Niobrara County was flown by Owyhee Air of Nampa, ID on April 23-27, 2018. The area was prioritized for the IR survey because of recent development activity, lack of ground access, sage-

grouse observations and increasing sharp-tailed grouse observations on sage-grouse leks. The area encompassed approximately 150,000 acres requiring 21 hours of survey time. Flights were conducted during early morning hours from an altitude of at least 1,500 feet and at a ¼ mile line interval spacing to ensure complete coverage. Survey cost including ferry time, survey time and document preparation was $20,642 and was funded through the BLM Buffalo Field Office wildlife survey agreement.

Ten known leks were surveyed with five leks found to be active with male attendance ranging from 4 to 21. One new lek was found near Lance Creek with 17 males. Lek detections were confirmed with infrared technology and identification to species made with a high definition camera. Male attendance on the six active leks was 21, 20, 17, 17, 4 and 4 males. No new sharp-tailed grouse leks were found.

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 the sage-grouse population 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 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 5. Northeast Wyoming Working Group Male Sage-grouse Lek Attendance 1967- 2018.

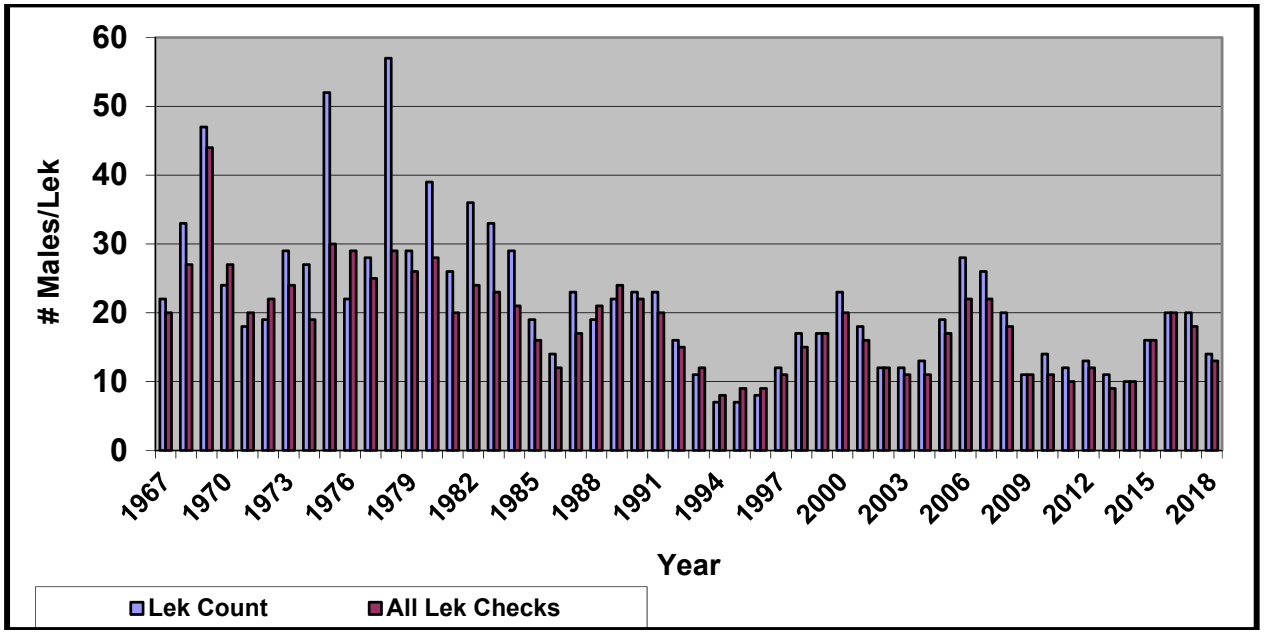


Figure 5 shows the average number of males/active lek for lek counts and all lek monitoring (counts and surveys) combined from 1967 to 2018 for the NEWLWGA. If the average number of males/active lek is reflective of the sage-grouse population, the trend suggests about a 10-

year cycle of periodic highs and lows. Of concern, however, is that with the exception of the 2006 peak, subsequent peaks in the average male lek attendance are usually lower, or similar, to previous peaks. Likewise, periodic lows in the average male attendance are generally lower, or similar, to the previous low. The long term trend suggests a steadily declining sage-grouse population through the late 1980's followed by a more stable population. Sage-grouse numbers most recently peaked in 2016 and 2017, followed by a decrease in 2018. This trend reflects the trends in other working group areas (Figure 1).

The number of known leks increased from 2000 to 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.

Harvest

The Northeast Working Group area is comprised of Hunt Area 4 and portions of Hunt Areas 1 and 2 (Figure 6). 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. Over 2,000 males were observed during 2018 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 2017 harvest survey estimated 118 sage-grouse were harvested by 160 hunters who spent a total of 313 days hunting during the Hunt Area 4 three day season. The average number of birds harvested per hunter day was 0.6. The average number of sage-grouse harvested per hunter was 1.0 and the average number of days hunted was 2.0.

The 2017 sage-grouse harvest was up 33% from the 89 birds harvested in 2016. 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 (2008-2017) is 178 birds, with harvest ranging from a low of 27 birds in 2013 to a high of 405 birds in 2012. 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 230 hunters in 2009. Hunter days increased 30% from 2016 to 344 days, but remains 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 6. 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 was too small to allow for reliable interpretation of the sample. No wings were collected during the 2017 hunting season.

Weather

Weather during the 2017 biological year (June 2017–May 2018) was slightly drier and warmer than average due to below average June and July precipitation and above average early summer, winter and May temperatures (Figures 7 and 8). Precipitation was 5% below average resulting from low June, July and May precipitation (67% of average). Early summer (June +1.4° and July +5°) and winter (November +3.5°, December +1.0° and January +1.2°) temperatures were well above nomal as was the average May (+5.4°) temperature. The northern portion of the area experienced above average winter conditions with persistent snow cover and cold temperatures in February and March with temperatures -9.9° and -1.0° below average. Even though precipitation was below normal early in the biological year, forage production was very good due to April rainfall at 144% 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 division is provided as a general indication of weather patterns over the entire working group area.

Figure 7. 2017 Bio-Year: Monthly Precipitation Data (in), Wyoming Climate Division 5.

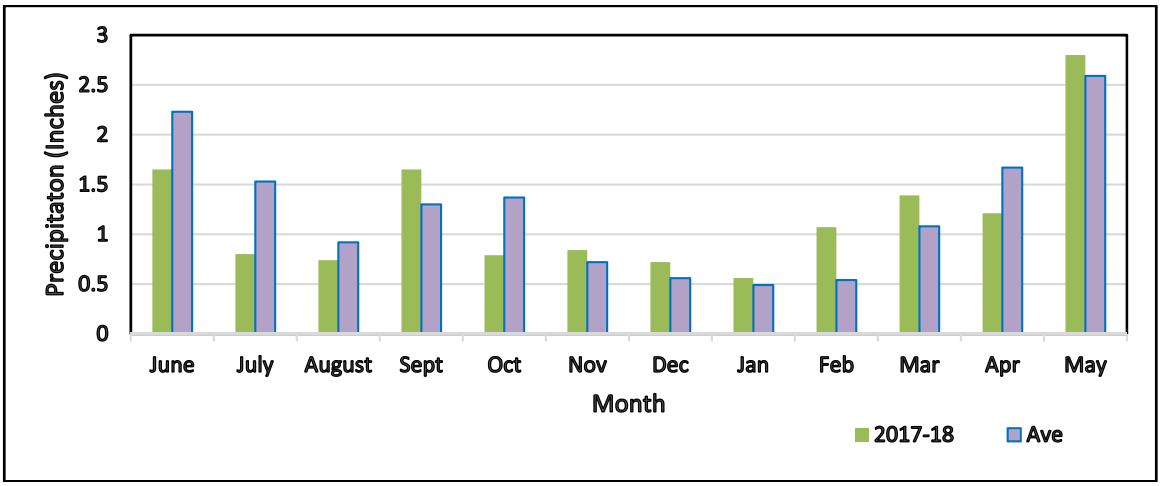
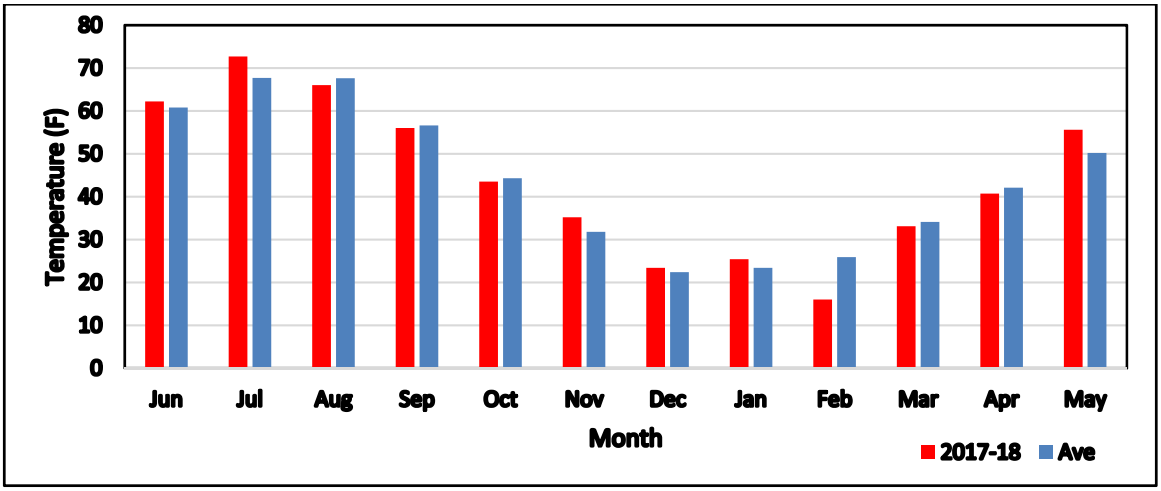


Figure 8. 2017 Bio-Year: Monthly Temperature Data (°F), Wyoming Climate Division 5



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.

Disease

No West Nile virus (WNv) mortality was reported for northeast Wyoming in 2017 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.

Habitat

Habitat conditions in 2017 were very good following above normal spring precipitation. Abundant April precipitation (+144%) 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 generally mid-range for the biological year, although moderate drought was noted in August and September. The excellent spring 2017 forage production provided for very good residual vegetation into 2018. Spring 2018 precipitation was near normal although a drier April dampened herbaceous forage production in many areas. Crook, Weston and Niobrara Counties received above normal precipitation extending spring green-up well into summer.

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 2018). 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 decreased. In May 2018, the Wyoming Oil and Gas Conservation Commission reported that 5,349 producing wells yielded 9,881,365 Mcf of methane gas (WOGCC 2018). Federal mineral leases provided for 73% of the

production while fee leases accounted for 20% and State leases 7%. In addition to producing wells there are 4,276 shut in wells. This compares to May 2017 when 6,093 producing wells yielded 11,621,897 Mcf of methane gas. Nearly 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 has fluctuated with inconsistent oil prices. In 2017, counties comprising the NEWLWGA had 248 oil wells started (spud) including 175 horizontal wells, 21 directional wells and 52 conventional wells (WOGCC 2018). No drilling for natural gas occurred. 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 9) 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).

BLM Powder River Basin Restoration Program

For the reporting period, the program reported the following accomplishments within northeast Wyoming core areas:

Unauthorized Reservoirs

- Two unpermitted public land reservoirs in Johnson County were reclaimed to help manage mosquito habitat/West Nile virus for a total of eight reservoirs reclaimed.
- Three additional reservoirs were evaluated and will be permitted for livestock use.

Noxious and Invasives

All work was accomplished through appropriate county weed and pest districts through an assistance agreement.

- Re-treated 1,100 acres of a cheatgrass mitigation project.
- Treated 2,150 acres at Long Office Draw. Project was planned and completed in cooperation with the Buffalo Field fuels program (planning and funding). This project is in priority sage-grouse habitat adjacent to the 2012 Cato Fire.
- Treatment of noxious weeds on previously reclaimed reservoirs.

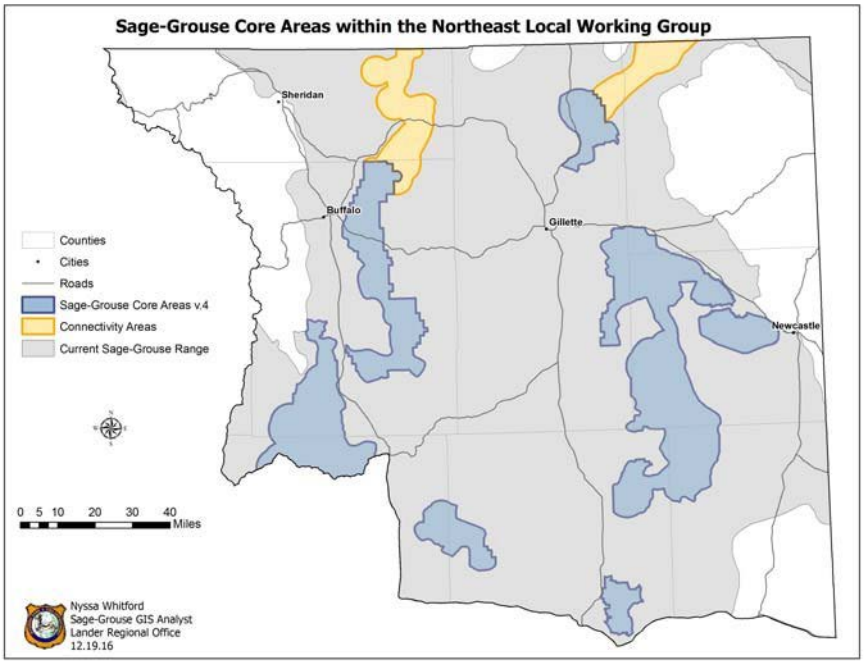
Conifer Removal

- Conifers were removed from 410 acres of public land by the Montana Conservation Corp.

Partnerships

- Developed an assistance agreement with the Campbell County Conservation District. Currently working on a Little Powder River riparian fencing project with the NRCS and BLM grazing lessee. Drilled a well to provide an additional water source for livestock and wildlife since stream water is no longer available. The American Bird Conservancy and the Wyoming Game & Fish are involved in habitat improvement projects on this ranch.
- A second project is in the planning stage and is a partnership between the Spring Creek Grazing Association (15 members), NRCS, Wyoming Game & Fish and the Forest Service (Thunder Basin Grasslands). The initial project involves replacing woven-wire fence with wildlife friendly fence.
- The Northeast Wyoming Invasive Grasses Working Group was formed and is working to inventory and treat two new invasive annual grasses in Sheridan County. The Buffalo Field Office range program and PRBR contributed funding to this project. Coordination is through the Sheridan County Weed & Pest and partners including the University of Wyoming Sheridan Research & Experiment Center, Wyoming Game & Fish, Forest Service, Wyoming Office of State Lands and Investments, Johnson and Campbell County Weed & Pest Districts, county conservation districts and others.

Figure 9. 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 19 males in 2018. This was the lowest peak male count since 2013, and a significant reduction from the 2017 count of 43 males. Two of the five occupied leks were active, which is one less than in 2017. There have been no changes in lek classifications since 2016.

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-disciplinary restoration team. The plan of development, which was renewed in 2018 and is valid until 2022, 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. The team has recently been working to disseminate results from these projects. To date, the team has planted over 100,000 sagebrush plants and has leveraged additional partner funds to continue sagebrush restoration, cheatgrass management and mesic habitat improvement work. Lastly, the team refined the disturbance data layer for the DCA by documenting suitable habitat per the 2015 Executive Order guidelines.

NRCS Sage-grouse Conservation Initiative

No information was provided on the SGI.

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.

The Working Group held one meeting during the reporting period. The group received updates on on-going research and management of the Douglas Core Area restoration project. Adaptive management options for the Buffalo Connectivity Area were discussed. The Group also reviewed and allocated Wyoming Sage-grouse Conservation Fund dollars.

Projects funded with the NEWSGLWG allocation of the FY 2019 Wyoming Sage-grouse Conservation Fund dollars included three projects, all entirely located in northeast Wyoming (Table 2).

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, there were no additional sign-ups. However, one CCAA totaling 8,363 acres was withdrawn from Johnson County in January 2016.

Table 2. Northeast Wyoming sage-grouse projects supported with 2019 Wyoming Game & Fish Commission Funding.

Project Name	Budget Fiscal Year	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
Improving success in habitat restoration for greater sage-grouse and other sagebrush birds	2019	Northeast	$500,089	$47,189 / $40,000 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 BLM	Approved and On-going
Habitat restoration in NE Wyoming: evaluating revegetation outcomes	2019	Northeast	$30,367	$18,640 / $15,000 Requested / approved	Evaluate CBNG seeding success on reclaimed sites. Compare species composition to original reclamation seed mixes.	University of Wyoming	Approved and on-going
Douglas Core Area burn restoration project 2	2019	Northeast	$551,000	$25,000 / $20,000 Requested / approved	Enhance seasonal habitat within the north burn area with sagebrush plantings and cheat grass control	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. Annually monitor 80% of the occupied leks in the local working group area.
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.

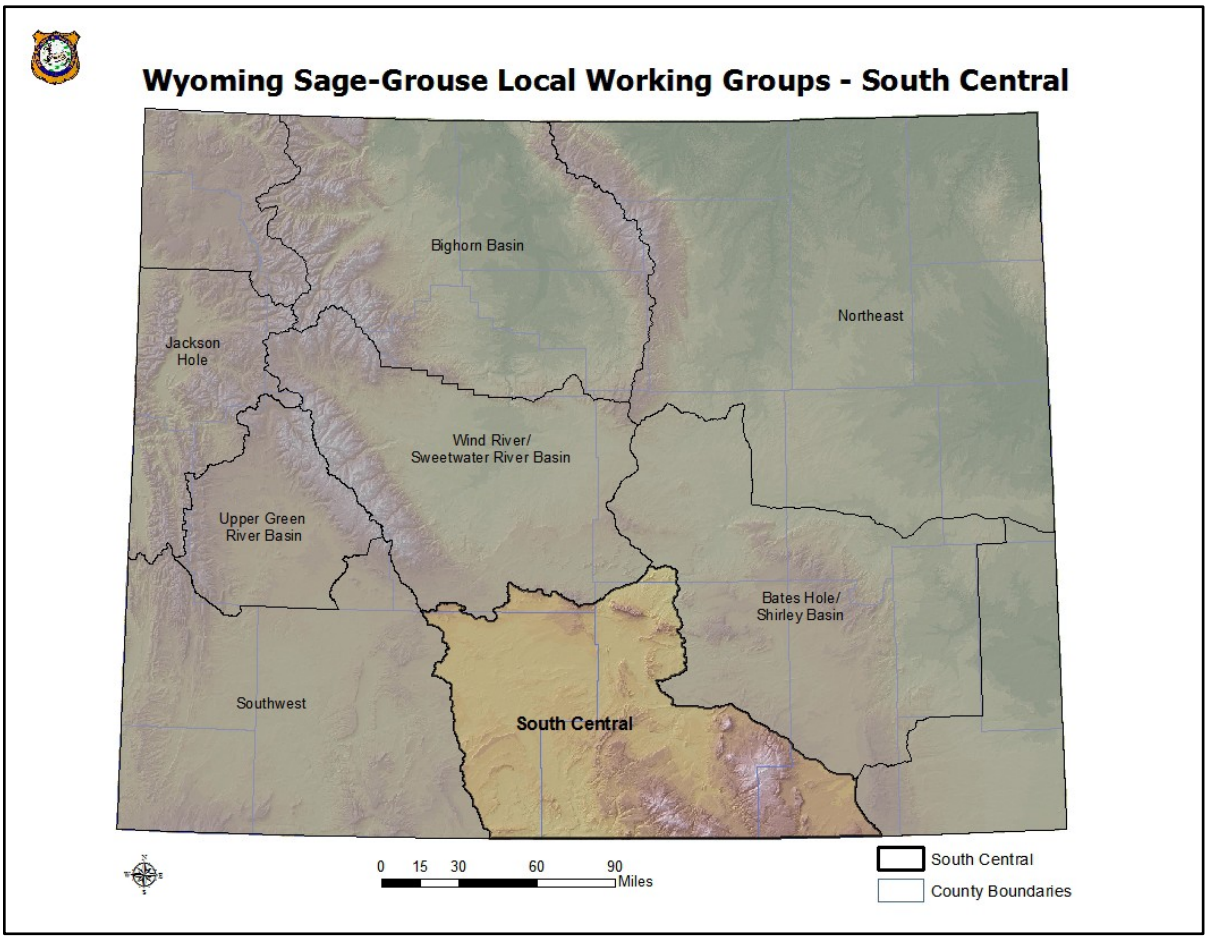
Walker, B. L. 2007. Personnel Communication. November 5, 2007. E-mail. CO Division of Wildlife.

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 Conservation Area
Job Completion Report

Species: Greater Sage-Grouse
Sage-Grouse Mgmt Area: H
Period Covered: June 1, 2017 – May 31, 2018
Prepared by: Will Schultz, Biological Services Staff Biologist



Sage Grouse Lek Characteristics

Management Area: H, Working Group: South Central

Region	Number	Percent
Green River	135	33.7
Lander	210	52.3
Laramie	56	14.0

Working Group	Number	Percent
South Central	401	100.0

Classification	Number	Percent
Occupied	264	65.8
Undetermined	69	17.2
Unoccupied	68	17.0

BLM Office	Number	Percent
Casper	2	0.5
Lander	26	6.5
Rawlins	356	88.8
Rock Springs	17	4.2

Biologist	Number	Percent
Baggs	122	30.4
Green River	14	3.5
Laramie	6	1.5
Saratoga	50	12.5
Sinclair	194	48.4
South Lander	15	3.7

Warden	Number	Percent
Baggs	121	30.2
East Rawlins	105	26.2
Elk Mountain	6	1.5
Lander	2	0.5
Rock Springs	14	3.5
Saratoga	45	11.2
South Laramie	5	1.2
West Rawlins	103	25.7

County	Number	Percent
Albany	5	1.2
Carbon	264	65.8
Fremont	13	3.2
Natrona	2	0.5
Sweetwater	117	29.2

Land Status	Number	Percent
BLM	226	56.4
LocalGov	1	0.2
Private	145	36.2
State	28	7.0
USFWS	1	0.2

Management Area	Number	Percent
H	401	100.0

Lek Status	Number	Percent
Active	200	49.9
Inactive	149	37.1
Unknown	52	13.0

Sage Grouse Job Completion Report

Year: 2009 - 2018, Management Area: H, Working Group: South Central

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

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2009	261	67	26	2020	34.2
2010	265	52	20	1528	33.2
2011	262	49	19	1272	31.0
2012	273	55	20	1490	28.1
2013	278	94	34	1662	21.9
2014	281	100	36	1607	21.4
2015	282	89	32	1915	32.5
2016	286	72	25	2381	39.0
2017	286	95	33	2176	29.4
2018	285	113	40	2210	24.6

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2009	261	152	58	2648	24.7
2010	265	170	64	2849	21.9
2011	262	157	60	2460	22.0
2012	273	179	66	2214	19.3
2013	278	159	57	1564	14.9
2014	281	176	63	2016	17.8
2015	282	170	60	3224	27.8
2016	286	192	67	3707	28.1
2017	286	162	57	2465	22.6
2018	285	153	54	2005	21.3

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: 2009 - 2018, Management Area: H, Working Group: South Central

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

c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2009	261	219	84	4668	28.1
2010	265	222	84	4377	24.9
2011	262	206	79	3732	24.4
2012	273	234	86	3704	22.0
2013	278	253	91	3226	17.8
2014	281	276	98	3623	19.3
2015	282	259	92	5139	29.4
2016	286	264	92	6088	31.5
2017	286	257	90	4641	25.4
2018	285	266	93	4215	22.9

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2009	175	20	24	195	89.7	10.3
2010	181	13	28	194	93.3	6.7
2011	160	24	22	184	87.0	13.0
2012	177	32	25	209	84.7	15.3
2013	193	44	16	237	81.4	18.6
2014	198	71	7	269	73.6	26.4
2015	185	53	21	238	77.7	22.3
2016	198	53	13	251	78.9	21.1
2017	188	54	15	242	77.7	22.3
2018	192	53	21	245	78.4	21.6

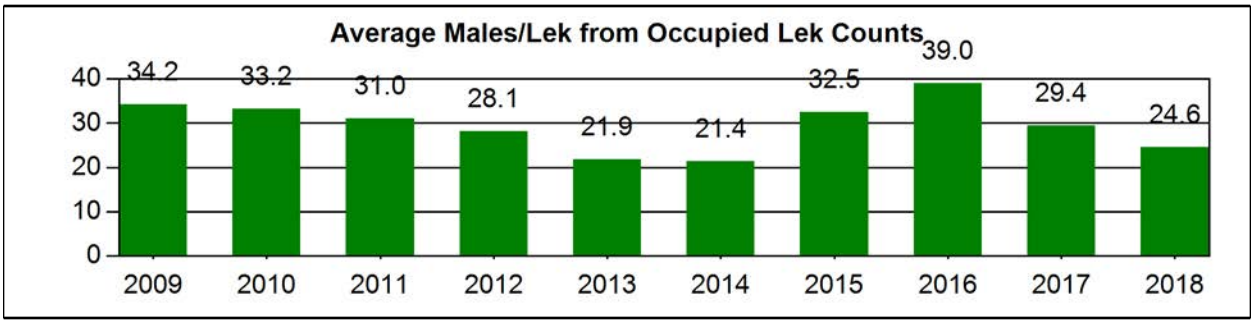
1) Occupied - Active during previous 10 years (see official definitions)

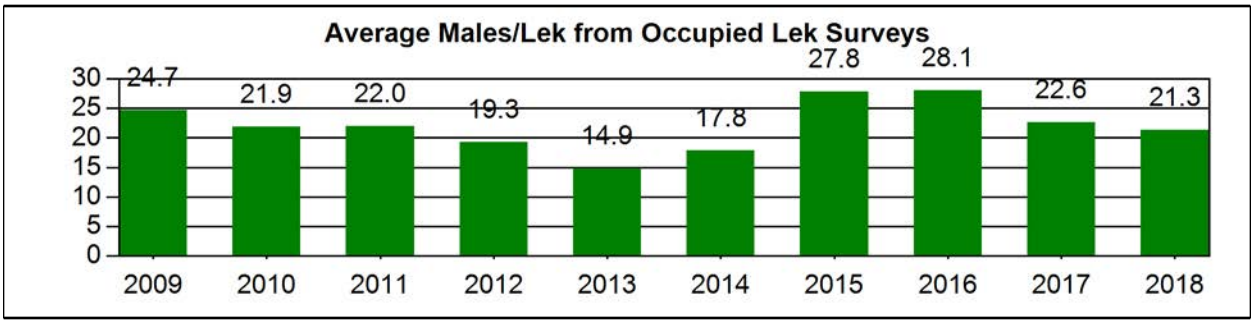
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

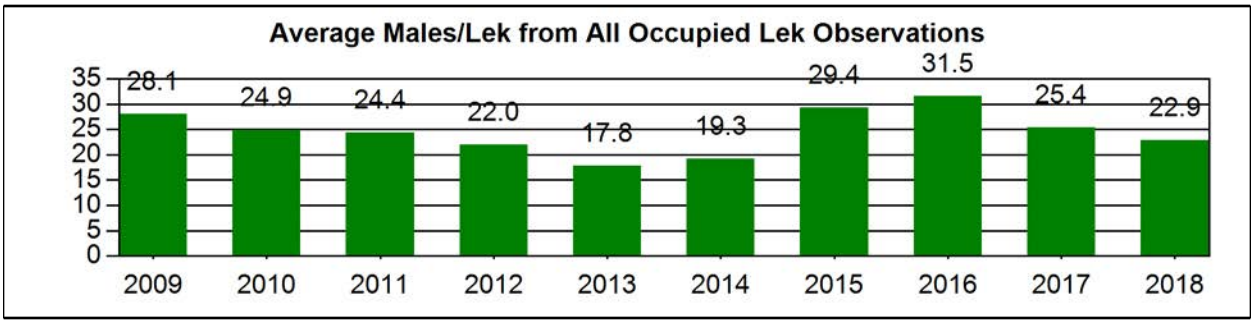
3) Inactive - Confirmed no birds/sign present (see official definitions)

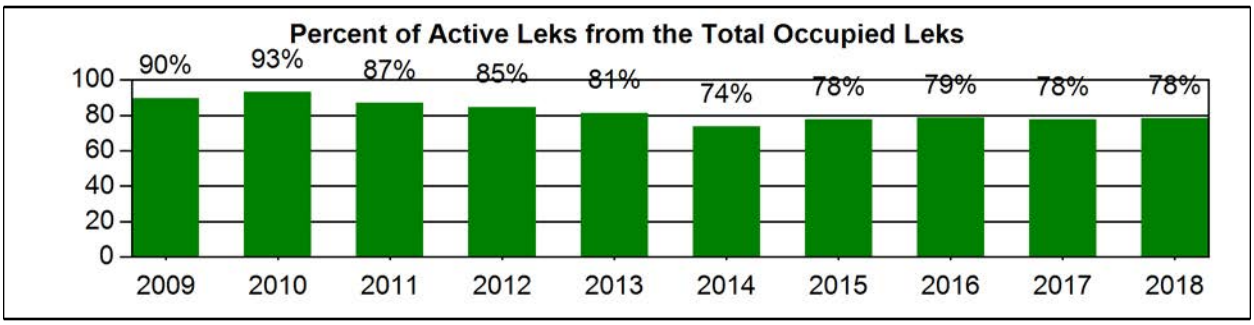
Sage Grouse Occupied Lek Attendance Summary

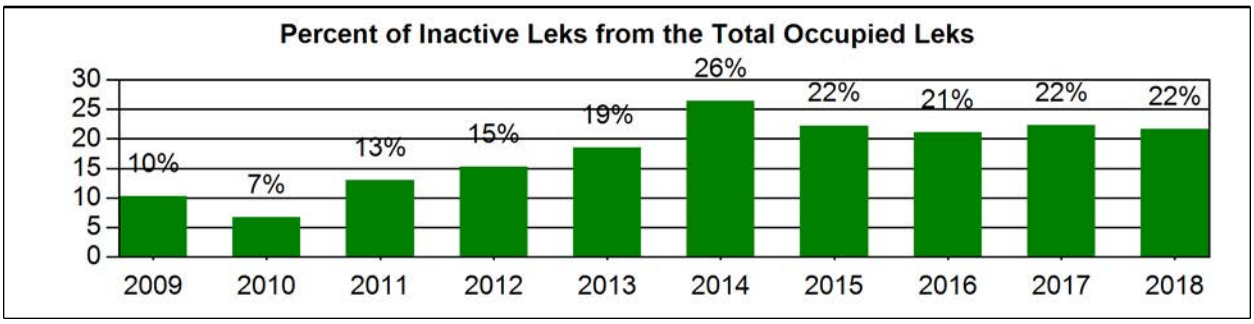
Year: 2009 - 2018, Management Area: H, Working Group: South Central











Sage Grouse Job Completion Report

Year: 2008 - 2017, Management Area: H, Working Group: South Central

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

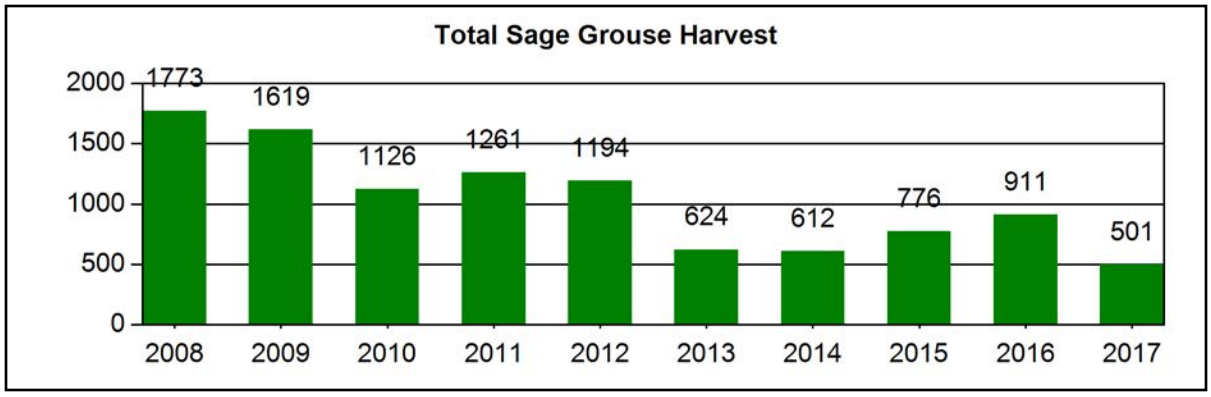
Year	Season Start	Season End	Length	Bag/Possesion Limit
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4
2011	Sep-17	Sep-30	14	2/4
2012	Sep-15	Sep-30	16	2/4
2013	Sep-21	Sep-30	10	2/4
2014	Sep-20	Sep-30	11	2/4
2015	Sep-19	Sep-30	12	2/4
2016	Sep-17	Sep-30	14	2/4
2017	Sep-16	Sep-30	15	2/4

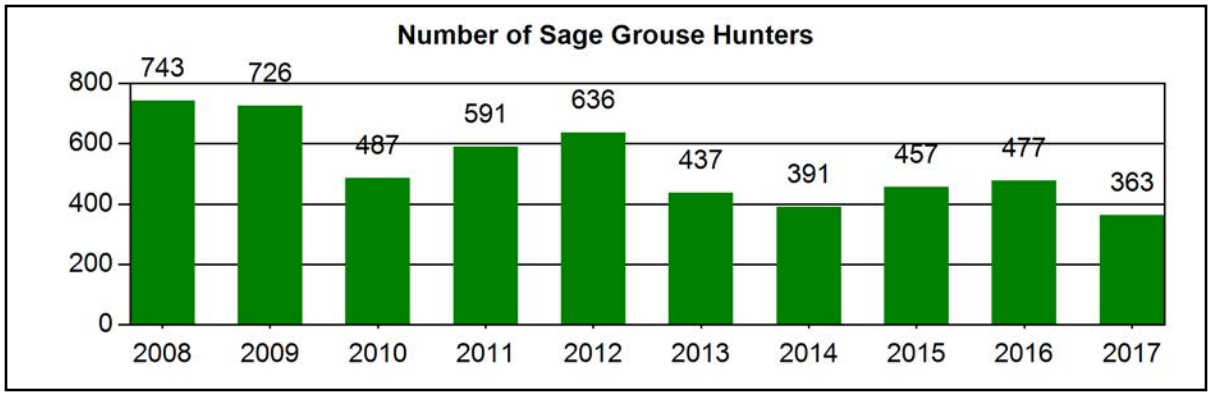
b. Harvest

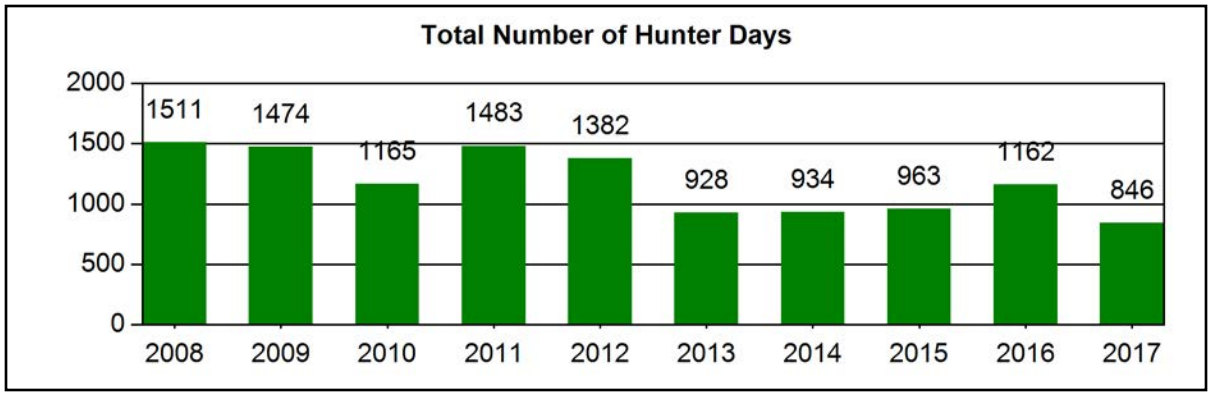
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2008	1773	743	1511	1.2	2.4	2.0
2009	1619	726	1474	1.1	2.2	2.0
2010	1126	487	1165	1.0	2.3	2.4
2011	1261	591	1483	0.9	2.1	2.5
2012	1194	636	1382	0.9	1.9	2.2
2013	624	437	928	0.7	1.4	2.1
2014	612	391	934	0.7	1.6	2.4
2015	776	457	963	0.8	1.7	2.1
2016	911	477	1162	0.8	1.9	2.4
2017	501	363	846	0.6	1.4	2.3
Avg	1,040	531	1,185	0.8	1.9	2.3

Sage Grouse Harvest Summary

Management Area: H, Working Group: South Central

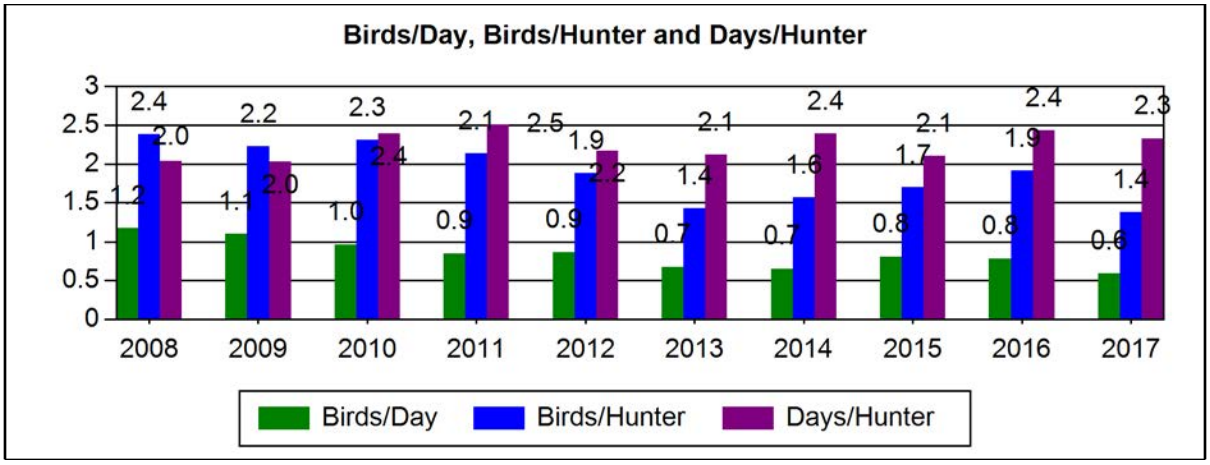






Sage Grouse Harvest Summary

Management Area: H, Working Group: South Central

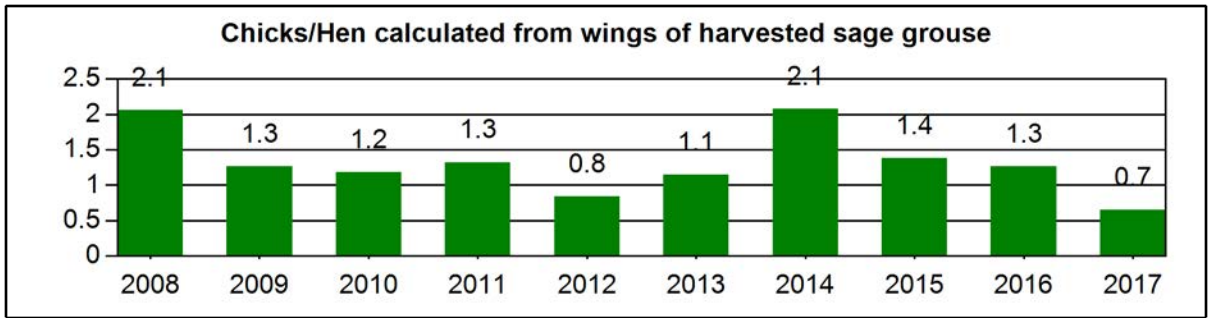


Sage Grouse Job Completion Report

Year: 2008 - 2017, Management Area: H, Working Group: South Central

4. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
2008	233	8.2	24.5	2.1	4.7	26.2	33.9	2.1
2009	282	15.2	23.8	8.5	9.9	15.6	27.0	1.3
2010	230	10.4	33.9	1.3	6.5	13.0	22.2	1.2
2011	271	11.8	29.2	3.0	7.4	20.7	27.7	1.3
2012	220	10.0	38.2	5.5	7.7	15.5	23.2	0.8
2013	107	14.0	36.4	1.9	1.9	15.9	27.1	1.1
2014	146	10.3	23.3	3.4	4.8	30.8	27.4	2.1
2015	192	10.4	30.7	2.6	5.7	24.5	26.0	1.4
2016	174	21.8	27.0	4.0	5.7	16.1	25.3	1.3
2017	123	13.8	39.8	5.7	8.9	16.3	15.4	0.7



Lek Monitoring

Tables and graphs describing annual lek monitoring efforts, observations, and lek characteristics were included immediately prior to this section. Lek monitoring techniques are described in Christiansen (2012). Wyoming Game and Fish Department (WGFD) and Bureau of Land Management (BLM) personnel, environmental consultants, and volunteers monitored 266 leks in the spring of 2018. This represented checking 93% of the occupied status leks in the South Central Conservation Area (SCCA). This rate of effort was 3% greater than in 2017. The 2008-2017 mean of leks checked annually was 89%. The proportion of leks checked in the spring of 2016 was 4% greater than the 10-year average.

Since only occupied leks were reported in 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. The proportion of occupied leks which were considered inactive remained at 22% in 2018. The average peak male/lek for active leks decreased 2.5% from 25.4 in 2017 to 22.9 in 2018. 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 2018, the management status for 21 leks (8%) in the SCCA was unknown because they were not monitored.

Population Trend

In 2018, the peak male lek attendance totaled 4,215 males in the SCCA. This was a 9% decrease from 2017. The males/lek average was 22.9. The 2018 males/lek average was 2% less than the 10-year average. Count monitored leks averaged 24.6 males/lek, compared to 21.3 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 1 illustrates the trends in average peak males/lek for all sage-grouse conservation areas in Wyoming, as well as the statewide average.

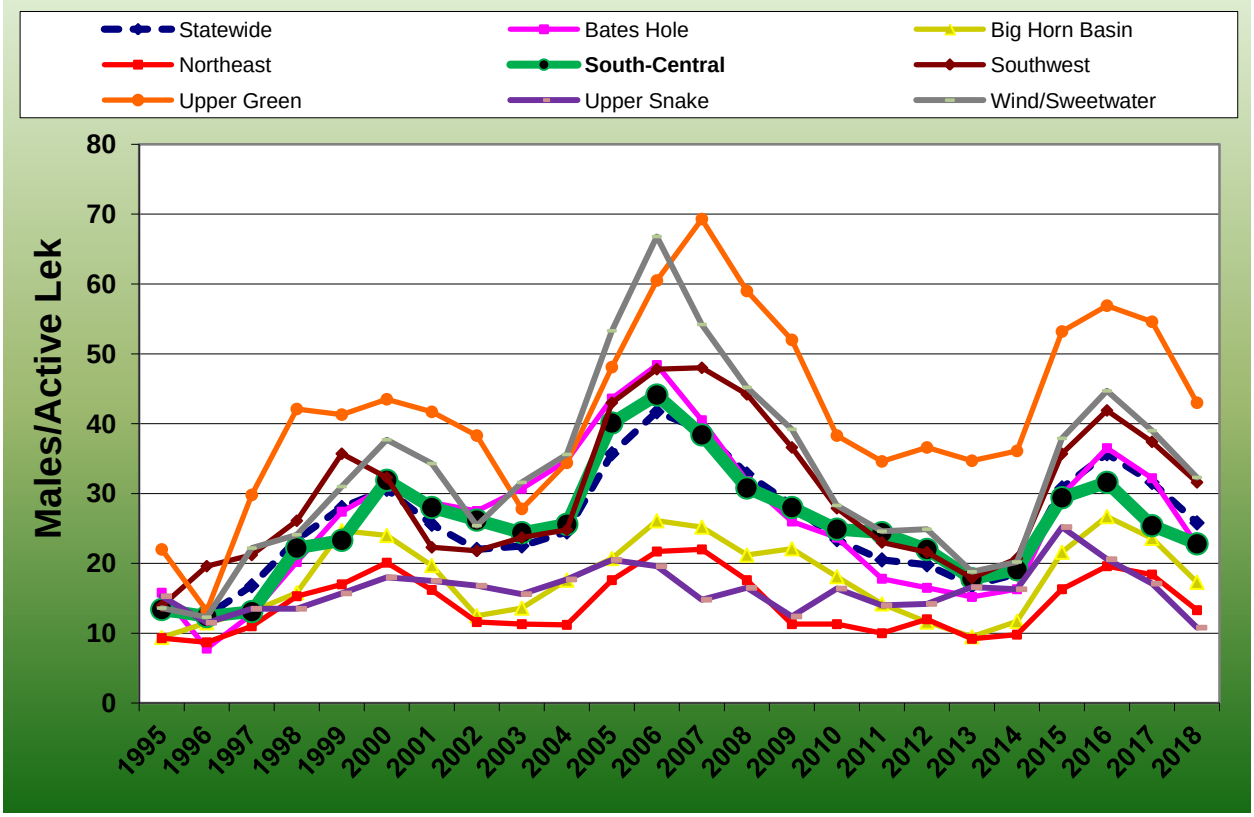


Figure 1. 1995-2018 Average peak male sage-grouse lek attendance, by Conservation Area and statewide, Wyoming.

Harvest

Weather conditions during the 2017 hunting season were conducive to hunters being able to access sage-grouse habitat within the SCCA, although some areas experienced high winds during the opening weekend. Tables and graphs describing hunting season structure, annual harvest and subsequent wing survey analyses are provided earlier in this report. The 2017 sage-grouse hunting season was from 16 September to 30 September, and allowed for the harvest of 2 sage-grouse/day and 4 in possession. The 2017 upland harvest survey indicated 363 hunters spent 846 days to harvest 501 sage-grouse in the SCCA. This equals approximately 0.6 birds/day, 1.4 birds/hunter, and 2.3 days/hunter. Birds/hunter rates decreased slightly from the 2016 hunting season indicating hunters were generally less successful. Compared to the 2016 season results, when hunting regulations were similar with the exception of 1 less day in the 2016 season length; 2017 hunter numbers decreased by 24%, the birds/day decreased by 25%, and the days/hunter decreased by 26%. Generally, during the past 10 years, overall harvest appeared be correlated to both 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 2017 hunting season WGFD collected 123 wings from wing barrels within the SCCA, which was 25% of the estimated harvest of 501 birds. This was a 29% decrease in the total number of wings when compared to the 174 wings collected in 2016, while harvest was estimated to have decreased 23% in 2017. Age and sex composition of the wings indicated the proportion of chicks/hen decreased from 1.3 in 2016 to 0.7 in 2017.

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 during the next few strutting seasons.

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. Feral horses continue inhabit the western and northern portions of the SCCA.

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. Development of the first phase for the Chokecherry/Sierra Madre wind energy facility (500 wind turbines) began in 2016.

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 2017.

Conservation Planning

The South Central Local Working Group (SCLWG) was established in September of 2004 and they 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 SCLWG 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 2017 the SCLWG held one meeting. Two new industry representatives, Jack Engstrom and Josh Verner, were selected to replace Randy Phipps and Tom Clayson, who had both recently retired. The SCLWG also allocated funds provided by the Wyoming Sage-Grouse Conservation Fund towards sage-grouse conservation projects. The SCLWG awarded all of their allocated $75,000 towards three conservation projects.

Special Projects

The North Dakota Greater Sage-Grouse Translocation Project continued in bio-year 2017. During the spring of 2017, researchers captured sage-grouse near Stewart Creek, in the northern portion of the SCLWG area and translocated them to southwest North Dakota. This was done in an effort to supplement North Dakota's remnant sage-grouse population. Translocation success and the impacts to the Stewart Creek source population are being studied by Utah State University and U.S. Geological Survey researchers. See Appendices A and B for progress reports generated during this reporting period.

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 development and 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.

Bibliography of sage-grouse research relevant to 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

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.

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In Cooperation with: Great Basin Bird Observatory and Utah State University

Annual Data Summary 2017: Monitoring and Research on Translocated Greater Sage-Grouse Populations in North Dakota

ANNUAL DATA SUMMARY

21 December 2017

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Cover photograph: A brood rearing female at the Bowman study site in North Dakota; photo courtesy of Kade Lazenby.

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Annual Data Summary 2017: Monitoring and Research on Translocated Greater Sage-Grouse Populations in North Dakota

DATA SUMMARY

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1.0 Abstract

In 2017, we initiated the first year of an experimental translocation program designed to restore viable populations of greater sage-grouse (*Centrocercus urophasianus*) to North Dakota. Following an outbreak of West Nile Virus, only 15 males were observed across six leks in 2016. In 2017, we translocated 60 grouse (n = 40 F, n = 20 M) from populations outside of Rawlings, WY, to western North Dakota. Upon release, grouse were closely monitored to determine probabilities of nest, brood, and adult survival, and we conducted habitat and predator surveys to help understand the variation within these probabilities. To increase the probability of nest initiation of translocated females, we employed novel artificial insemination techniques within a subsample of translocated females. Here, we present preliminary estimations of nest, brood, and adult survival of translocated grouse. Habitat selection by translocated grouse, predator composition across the study site, and the efficacy of artificial insemination are not reported in this first year data summary, but results will be provided upon completion of those analyses.

2.0 Background

Greater sage-grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) distribution and abundance has declined substantially throughout western North America (Connelly and others, 2004). Accordingly, sage-grouse have been evaluated for listing multiple times under the Endangered Species Act (ESA) of 1973. Most recently; the U.S. Fish and Wildlife Service (USFWS) determined that sage-grouse do not require protection under the ESA (CFR, 2015). Sage-grouse are thought to be an important management indicator species for the health of sagebrush ecosystems based on their specific needs for healthy sagebrush habitats at different life-stages (Patterson, 1952). The species has been classified as an umbrella species because management of sage-grouse can benefit other species of conservation concern (Rowland and others, 2006), including sagebrush obligates such as pygmy rabbit (*Brachylagus idahoensis*) and sagebrush sparrow (*Artemisiospiza nevadensis*).

North Dakota (ND) is on the northeastern fringe of the species distribution. Historically, sage-grouse have been documented throughout the southwestern portion of the state including Bowman, Slope, and Mercer counties (Johnson and Knue, 1989; Smith and others, 2004). Until the mid-2000s, male lek count data indicated that populations in ND were fairly stable and oscillated on a roughly 10-year cycle of population highs and lows (Robinson and others, 2016). In 2007, populations declined by 60% in response to a severe outbreak of West Nile Virus (WNV). From 2008 – 2016, populations continued to decline (average of 5% decline per year) and now exist at critically low abundances (Robinson and others, 2016).

Vital rates describing survival and reproduction of sage-grouse in ND prior to the WNV outbreak are relatively normal in comparison to rates from other areas of the species range (Herman-Brunson, 2007, 2009; Swanson, 2009), and suggest that habitat in ND can support a

self-sustaining population of greater sage-grouse. Translocations have become a useful tool in wildlife management (Armstrong and Seddon, 2008) and are often utilized to establish or augment populations of species of conservation concern (Griffith and others, 1989). There have been multiple translocation attempts of prairie (*Tympanuchus* sp.) and sage-grouse since the mid-20th century (Snyder and others, 1999; Coates and others, 2006), with mixed results.

Frequently, there is a lack of post-release monitoring to assess the causes of translocation success or failure (Reese and Connelly, 1997; Snyder and others, 1999). However, previous translocation of sage and sharp-tailed grouse have been plagued with low survival and reproduction by translocated individuals (Snyder and others, 2009; Coates and Delehanty, 2006; Mathews and others, 2016). Poor reproduction following translocation may be due to a combination of factors including the inability to find mates and chronic stress (Dickens and others, 2009). Previous studies indicate that females that are naturally inseminated prior to translocation are more likely to nest post-release, and females captured late in the breeding season were more likely to be naturally inseminated compared with those captured early in the breeding season (Coates and Delehanty, 2006). Additionally, novel artificial insemination (AI) techniques have proven successful in the production of offspring in a number of endangered and wild avian species (Blanco and others, 2009). Therefore, our secondary objective was to test the effectiveness of AI as a viable tool to promote reproduction in translocated female sage-grouse.

This annual data summary represents the first year of study in an ongoing research effort between the U.S. Geological Survey (USGS), Utah State University (USU), and North Dakota Game and Fish (NDGF). These preliminary findings should be used only to monitor the progress of the research project.

3.0 Study Area

North Dakota's core habitat is separated into two general areas of Slope and Bowman County. Slope County is naturally fragmented by rough terrain and historically had relatively low sagebrush densities with no energy development. Bowman County contains 80% of the sage-grouse population and has the majority of sagebrush habitat. Landownership across these counties is mixed with private and federal land.

To select a release site, NDGF developed a resource selection model (Manly and others, 2002) to characterize nesting habitats within the core sage-grouse range of ND (A. Robinson, unpub. data). Random locations were generated across the core area to represent the variation in habitat availability, and were compared with nest locations from recent telemetry studies. Results from this preliminary habitat suitability model were used to create an RSF model of predicted nesting habitat in ND. Following suggestions by Coates and Delehanty (2006), we released translocated grouse into nesting habitat in western ND.

4.0 Methods

4.1 Capture and Handling of Sage-Grouse

Sage-grouse were captured at nocturnal roosting locations using spotlights and nets attached to 3 m extension handles, and were fitted with battery powered necklace-style Very High Frequency (VHF) transmitters (< 3% body mass, 1 – 1.8 kg, Schroeder and others, 1999; Advanced Telemetry Systems, Isanti, MN) equipped with a mortality sensor. Males were fitted with a rump-mounted VHF transmitter. A subsample of female (50%), and were fitted with a Global Positioning System (GPS), Platform Transmitter Terminal (PTT; < 5% body mass, Northstar Science and Technology LLC, King George, VA) and a VHF transmitter.

After capture, each grouse was placed in a cardboard box lined with wood shavings to absorb fecal matter and keep their plumage clean. Sage-grouse were transported in cardboard boxes from their capture locations to a processing station for all measurements and transmitter placement prior to translocation, wherein a subsample of females were artificially inseminated. Processed grouse were weighed, sexed, aged, banded, and evaluated for general health. Multiple morphometric measurements were taken from each individual to calculate a body condition score, including the metatarsal bone, flattened wing cord, and culmen length. Sage-grouse were classified as yearling (first year breeding) or adult (> 1 breeding year) based on plumage characteristics of the 9^{th} and 10^{th} primaries (Ammann 1944).

4.2 Artificial Insemination

To obtain semen for artificial insemination (AI), we captured male sage-grouse on leks at geographically distinct locations using capture methods described in Section 4.1. After transport to the processing station, male sage-grouse were aged, weighed, and given leg bands with unique ID numbers. Semen was collected via the massage method (Quinn and Burrows, 1936), which has recently been used with success in other grouse translocations (Fischer and others, 2016). After semen was collected, an assessment of semen volume and sperm density was made and samples were buffered according to quality. The purpose of semen buffer is to provide sperm cells with energy so that they remain alive and active for potentially several hours prior to artificial insemination of a female. After semen collection, donor males were released back onto their respective capture leks. From time of capture to release, male semen donors were held in captivity ≤8 h, but most were held less than ≤6 h.

Buffered semen samples were inserted into the female's vagina through the oviductal opening using a 1 mL syringe with a flexible rubber tip. To evaluate the effectiveness of AI,

translocated females were divided into three groups, AI, SHAM, and Control. SHAM females were inseminated with a buffer-only solution, and control females were not inseminated. The purpose of three treatment groups is to fully understand the effects of additional handling and stimulation upon translocated female grouse. Significant differences between treatment groups in regards to nest initiation, nest survival, and grouse survival will be tested using linear mixed models when appropriate sample sizes have been met.

4.3.3 Soft-release of Translocated Sage-grouse

After processing, all translocated grouse were placed into new transport boxes and flown to the release site. Grouse were released at dawn, during natural lekking hours, approximately 30 hours after capture. All sage-grouse were placed in a compartmentalized release box (Figure 2) to facilitate the soft-release of several individuals, together, as outlined by Musil (1989), using a modified soft-release strategy. Sage-grouse silhouettes, along with playback of lek sounds were placed near the release site based on design of Rodgers (1992); the purpose of this was to 1) create an "artificial lek" to release sage-grouse into in the event resident males at ND were absent, and 2) to enhance the appearance of the existing lek to released sage-grouse. The release box was placed at the release site before light and opened remotely by an observer in a blind at 150 ft. Observational data was collected on behavior of birds upon release, including flushing behavior and whether released sage-grouse interacted with silhouettes or resident males. Release behavior will be formatted into covariates and included in all relevant analyses when sample sizes have been met.

4.3 Post-Release Monitoring

4.3.1 Radio Telemetry

We conducted intensive on-the-ground monitoring of sage-grouse movement, survivorship, and

reproduction following release of marked birds during the spring. All telemetry procedures were conducted according to the USGS sage-grouse telemetry protocol (USGS 2015) for VHF transmitters. We used a three-element Yagi antenna (Advanced Telemetry Systems Inc., Isanti, MN) and portable receiver (Communication Specialist Inc., Orange, CA) to track radio-marked sage-grouse and confirmed a visual when locating a bird. Throughout the nesting and brood-rearing period, we attempted to locate female sage-grouse at least twice per week, although this was difficult given the extreme dispersal abilities of translocated sage-grouse. Aerial fixed-wing telemetry flights were conducted to locate sage-grouse that could not otherwise be located from the ground. Additional flights were conducted following the field season to identify fall and winter use areas and seasonal mortality rates.

4.4 Estimating Adult Survival, Nest Survival, and Brood Survival

We employed maximum likelihood techniques to estimate survival probabilities for sage-grouse nests, broods, and adults. All model parameters were estimated using the statistical package 'RMark' (Laake and Rexstad, 2008) within program R (R Development Core Team, 2008) and program MARK (White and Burnham, 1999). For each survival analysis, we developed a daily encounter history for individuals (nests, broods, or adults) that included the date of initiation (nests), hatch (broods), or capture (adult), last date known to be alive, and fate (confirmed failure or success/censored). A censored bird is either still alive or its fate is unknown. Daily survival estimates were then exponentiated by the appropriate number of exposure days to estimate cumulative (nest and brood), monthly (adult), and annual (adult) survival probabilities. For survival analyses in this report, we included the yearling age class with adults. We will investigate the effect of age and other covariates on survival rates in subsequent analyses.

After confirming a nest-attempt by a marked female, each nest was monitored every three days until its fate was determined (i.e., successful, depredated or abandoned). A nest was considered successful if ≥ 1 chick hatched, determined by visual assessment of eggshell remains or observing ≥ 1 chick in the nest bowl. Nests were considered unsuccessful when the entire clutch failed to hatch. Failed nests were scored as depredated, partially depredated (≥ 1 intact egg), or abandoned.

We monitored broods every 10 days for up to 50 days after hatch. Each brood check consisted of two locations, a day location and a nocturnal roost location. We determined a successful brood if it survived 50 days post-hatch. During most surveys, we counted the number of surviving chicks in the brood if possible, but we took caution to ensure that we did not flush a brood rearing female. Because of our caution, we generally could not obtain accurate chick counts until the 50-day check, where the female was intentionally flushed.

We will conduct a more intensive investigation of factors that influence vital-rate estimates by fitting environmental and anthropogenic covariates after sufficient data has been collected during subsequent years of study.

4.5 Nest and Brood-Rearing Microhabitat Surveys

We followed USGS WERC protocol for measuring nest vegetation variables in the field for microhabitat analyses (USGS, 2015), with slight alterations. To examine microhabitat selection, defined as habitat use disproportionate to availability (Manly and others, 2002), we compared means and standard errors of vegetation measurements at used (e.g., nest or brood) locations to those at random locations. To characterize available vegetation, we generated one dependent random (hereafter, DR) point within the boundaries of the study site for each nest. The same

habitat measurements conducted at used locations were also conducted at DR locations, with the center of DR locations at a random shrub capable of concealing a sage-grouse nest.

Shortly following nest fate, we conducted microhabitat surveys at Used and DR points. We waited until the estimated hatch date (when the nest would have hatched) before conducting habitat surveys at failed nests to facilitate unbiased comparisons with successful nests. Accordingly, the used and DR vegetation surveys were conducted within three days of each other to account for temporal variation of vegetation measurements across the growing season.

At each survey location, we measured habitat characteristics along four 15-m transects for each location. Orientation of the first transect was randomly assigned using a random number generator, and the remaining transects were sequentially oriented 90° from the previous transect. Along each transect, we measured understory cover by use of a Jones Coverboard (hereafter, VO Board; Jones 1968) and a modified Daubenmire frame (20 x 50 cm; Daubenmire 1959), and used the line-intercept method (Canfield, 1941) to quantify shrub canopy-cover (hereafter, shrub-cc). We measured shrub-cc continuously along the entire length of the transect, but quantified canopy cover at the 1, 5, 10, and 15 m (cumulative) interval. We measured understory cover with VO boards located at the nest bowl, and at 5 and 10 m from the nest along each transect line. We used Daubenmire frames at the nest bowl, and at 0, 2.5, 5, 7.5, and 10 m from the nest, along all four transects.

For brood rearing females, we completed microhabitat surveys every 10 days. Surveys were conducted at day, night, and DR point locations. We conducted vegetation measurements at 10 day intervals to evaluate vegetation change in relation to brood locations through time. We also evaluated differences in habitat use between night (roosting) and day (foraging) locations.

To characterize habitat availability, we carried out the same habitat measurements at dependent random points as we did at day locations**.**

5.0 Preliminary Results

5.1 Experimental Translocation Review

To restore populations, we experimentally translocated 60 sage-grouse (n = 40 F, n = 20 M) from the Stewart Creek area northwest of Rawlings, Wyoming to western ND (Figure 1). We outfitted 20 females with necklace style VHF transmitters and 20 males with rump-mounted VHF transmitters. An additional 20 females were fitted with PTT transmitters. All grouse were captured and released from 2 April to 12 April, 2017.

5.2 Post-release Monitoring

In 2017, we recorded 514 telemetry locations from 60 radio-collared sage-grouse and 5,851 GPS locations from 19 PTT-marked sage-grouse (Figures 2 -5).

5.3 Sage-Grouse Survival

In 2017, the average probability of monthly survival for translocated sage-grouse was 0.80 (95% CI, 0.73 – 0.85; Table 1) and their cumulative probability of annual survival was 0.07 (95% CI, 0.02 – 0.14; Figure 6; Table 1). We confirmed and recovered 31 mortalities of translocated individuals at the ND site. Interestingly, we recovered one PTT-marked sage-grouse that was harvested in Montana and seven VHF-marked sage-grouse that died of unknown causes.

5.4 Nest Survival

In 2017, we located seven nests, of which three were successful and four failed. The daily probability of nest survival was 0.96 (95% CI, 0.90 – 0.98; Table 2), and the cumulative average probability of a nest to survive the 37-day egg laying and incubation phase was 0.22 (95% CI, 0.02 – 0.47; Figure 8; Table 2). Of the failed nests in 2017, one was discovered empty,

suggesting eggs may have been removed by a predator, one contained only eggshell fragments suggesting mammalian predation, and two had largely intact eggs with holes in the side, suggesting avian predation.

5.5 Nest Habitat Selection

During 2017, we sampled 26 nest plots (n = 13 used; n = 13 DR). The preliminary results of nest site microhabitat surveys for the first year of study at the North Dakota study area are not reported in this data summary due to insufficient sample sizes. A robust modeling approach will be employed after obtaining appropriate sample sizes.

5.6 Brood Survival

In 2017, we monitored three broods, of which one was successful. The 10-day probability of brood survival was 0.85 (95% CI, 0.52 – 0.96; Table 3), and the cumulative 50-day probability of brood survival was 0.44 (95% CI, 0.04 – 0.82; Figure 9; Table 3).

5.7 Brood-rearing Habitat Selection

During 2017, we sampled 68 brood location plots (n = 34 used day; n = 34 DR). The preliminary results of brood site microhabitat surveys for the first year of study at the North Dakota study area are not reported in this data summary due to insufficient sample sizes. A robust modeling approach will be employed after obtaining appropriate sample sizes.

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7.0 References Cited

Ammann, G.A., 1944, Determining the age of pinnated and sharp-tailed grouse: Journal of Wildlife Management, v. 8, p. 170–171.

Armstrong, D.P., and Seddon, P.J., 2008, Directions in reintroduction biology: Trends in Ecology and Evolution, v. 23, 20-25.

Blanco, J.M., Wildt, D.E., Hofle, U., Voelker, W., and Donoghue, A.M., 2009, Implementing artificial insemination as an effective tool for *ex situ* conservation of endangered avian species: Theriogenology, v. 71, 200 – 213.

Canfield, R.H. 1941, Application of the line intercept method in sampling range vegetation: Journal of Forestry, v. 39, p. 388–394.

CFR, 2015, Endangered and threatened wildlife and plants; 12-Month finding on a petition to list greater sage-grouse (*Centrocercus urophasianus*) as an endangered or threatened species; proposed rule. U.S. Fish and Wildlife Service, Department of Interior. 80 FR 59858.

Coates, P.S., and Delehanty, D.J., 2006, Effect of capture date on nest-attempt rate of translocated sharp-tailed grouse *Tympanuchus phasianellus*: Wildlife Biology, v. 12, 277-283.

Coates, P.S., Stiver, S.J., and Delehanty, D.J., 2006, Using sharp-tailed grouse movement patterns to guide release site selection: Wildlife Society Bulletin, v. 34, 1376 – 1382.

Coates, P.S., and Delehanty, D.J., 2008, Effects of environmental factors on incubation patterns of greater sage-grouse: The Condor, v. 110, p. 627–638.

Coates, P.S., Ricca, M.A., Prochazka, B.G., Brooks, M.L., Doherty, K.E., Kroger, T., Blomberg, E.J., Hagen, C.A., and Casazza, M.L., 2016, Wildfire, climate, and invasive grass interactions negatively impact an indicator species by reshaping sagebrush ecosystems: Proceedings of the National Academy of Sciences, v.113, p. 12745-12750.

Connelly, J.W., Knick, S.T., Schroeder, M.A., and Stiver, S.J., 2004, Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats: Western Association of Fish and Wildlife Agencies, Unpublished Report, Cheyenne, Wyoming.

Daubenmire, R.F., 1959, A canopy-coverage method of vegetation analysis: Northwest Science, v. 33, p. 224–227.

Falkowski, M. J., J. S. Evans, D. E. Naugle, C. A. Hagen, S. A. Carleton, J. D. Maestas, A. H. Khalyani, A. J. Poznanovic, and A. J. Lawrence, 2017, Mapping Tree Canopy Cover in Support of Proactive Prairie Grouse Conservation in Western North America: Rangeland Ecology and Management, v. 70, pp. 15-24.

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

Horne, J.S., and Garton, E.O., 2009, Animal Space Use 1.3 [software, beta test version]: Moscow, Idaho, University of Idaho, College of Natural Resources, Dr. Edward O. Garton Web page, accessed August 6, 2010, at *http://www.cnr.uidaho.edu/population_ecology/animal_space_use.htm.*

Intellicast: The Authority in Expert Weather. 2017. Historic Average Oreana, Idaho. Accessed October 20, 2017. < http://www.intellicast.com/Local/History.aspx?location=USID9847>

Jones, R.E., 1968, A board to measure cover used by prairie grouse: Journal of Wildlife Management, v. 32, p. 28–31.

Kernohan, B. J., Gitzen, R.A., and Millspaugh, J.J., 2001, Analysis of animal space use and movements, *in* Millspaugh, J.J., and Marzluff, J.M., eds., Radio Tracking Animal Populations: Academic Press, San Diego, California.

Laake J., and Rexstad, E., 2008, Rmark – an alternative to building linear models in MARK. *In* Cooch, E., and White, G. eds., Program MARK – "a gentle introduction":http://www.phidot.org/software/mark/docs/book

Manly, F.J., McDonald, L.L., Thomas, D.L., McDonald, T.L., and Erickson, W.P., 2002, Resource selection by animals—Statistical design and analysis for field studies: London, Chapman and Hall, 221 p.

Mathews, S.R., Coates, P.S., and Delehanty, D.J., 2016, Survival of translocated sharp-tailed grouse: temporal threshold and age effects: Wildlife Research, v. 43, 220 – 227.

Musil, D.D., 1989, Movements, survival and habitat use of Sage Grouse translocated into the Sawtooth Valley, Idaho. Unpublished master's thesis, University of Idaho, Moscow. 72 pp.

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

Quinn, J. P., and W. H. Burrows. 1936. Artificial Insemination in Fowls. The Journal of Heredity.

Prochazka, B.G., Coates, P.S., Ricca, M.A., Casazza, M.L., and Hull, J.M., 2017, Encounters with pinyon-juniper influence riskier movements in greater sage-grouse across the Great Basin: Rangeland Ecology and Management, v.70, p. 39-49.

Rowland, M. W., Wisdom, M. J. Suring, L. H. and Meinke, C. W. 2006, Greater sage-grouse as an umbrella species for sagebrush-associated vertebrates: Biological Conservation, v. 129, p. 323–335.

Schroeder, M.A., Young, J.R., and Braun, C.E., 1999, Greater sage-grouse (*Centrocercus urophasianus*), *in* Poole, A., ed., The birds of North America online, no. 425: Ithaca, New York, Cornell Laboratory of Ornithology, accessed April 18, 2011, at http://bna.birds.cornell.edu/bna/species/425.

Severson, J.P., Hagen, C.A., Maestas, J.D., Naugle, D.E., Forbes, J.T., and Reese, K.P., 2017, Effects of conifer expansion on greater sage-grouse nesting habitat selection: Journal of Wildlife Management, v. 81, p. 86 – 95.

Snyder, J. W., Pelren, E. C. and Crawford, J. A., 1999, Translocation histories of prairie grouse in the United States: Wildlife Society Bulletin, v. 27, p. 428–432.

R Development Core Team, 2008, R: A language and environment for statistical computing: R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

Reese, K.P, and Connelly, J.W., 1997, Translocations of sage grouse *Centrocercus urophasianus* in North America: Wildlife Biology, v.3, p. 235 – 241.

Rodgers, R.D., 1992, A technique for establishing sharp-tailed grouse in unoccupied range: Wildlife Society Bulletin, v, 20, p. 101 – 106.

Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A., and Burnham, K.P., 2010, Distance software—Design and analysis of distance sampling surveys for estimating population size: Journal of Applied Ecology, v. 47, p. 5–14.

U. S. Department of Agriculture. Natural Resource Conservation Service. National Water and

Climate Center. Reynold's Creek Historical Precipitation and Temperatures. Accessed November 9, 2017. <https://wcc.sc.egov.usda.gov/nwcc/site?sitenum=2029>

U.S. Department of the Interior Bureau of Land Management. Boise District Office Bruneau-Owyhee Sage-grouse Habitat Project (BOSH) Environmental Impact Statement. DOI-BLM-ID-B000-2014-0002-EIS. November 2016.

U.S. Geological Survey, 2015, Greater Sage-grouse Project, Nevada—General information and protocols for field operations and monitoring (2015 ed.): U.S., Geological Survey, Western Ecological Research Center, Dixon, California, 83 p. http://www.werc.usgs.gov/ProductDetails.aspx?ID=5422

White, G.C. and Burnham, K.P., 1999, MARK: survival estimation from populations of marked animals: Bird Study, v. 46: 120 – 139.

Worton, B. J., 1989, Kernel methods for estimating the utilization distribution in home-range studies: Ecology, v. 70, p. 164–168.

8.0 Maps and Figures

Figure 1. The North Dakota study area for experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) and the Steward Creek source population, WY.

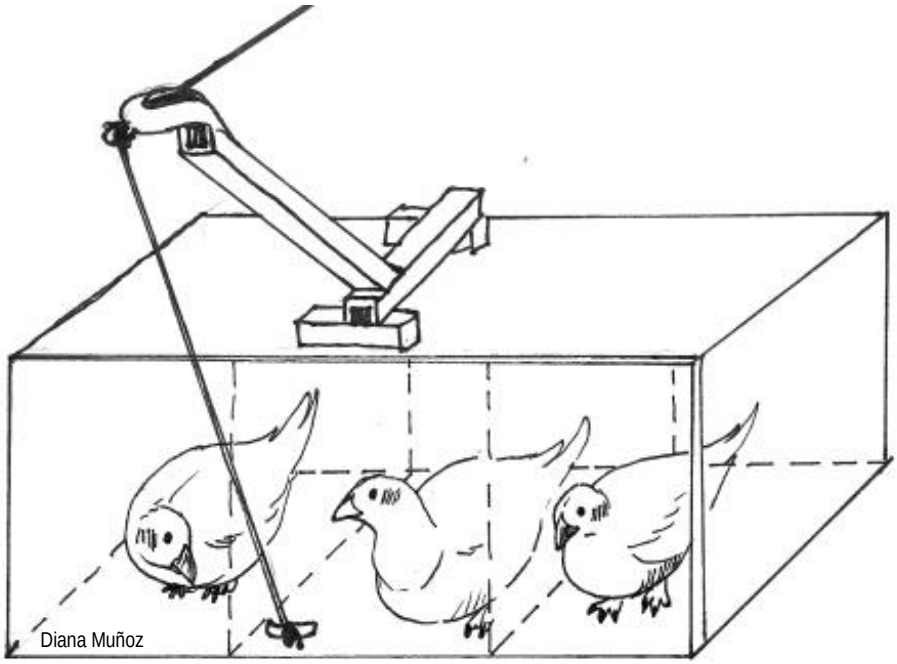


Figure 2. Schematic of a compartmentalized box utilized during greater sage-grouse (*Centrocercus urophasianus*) release.

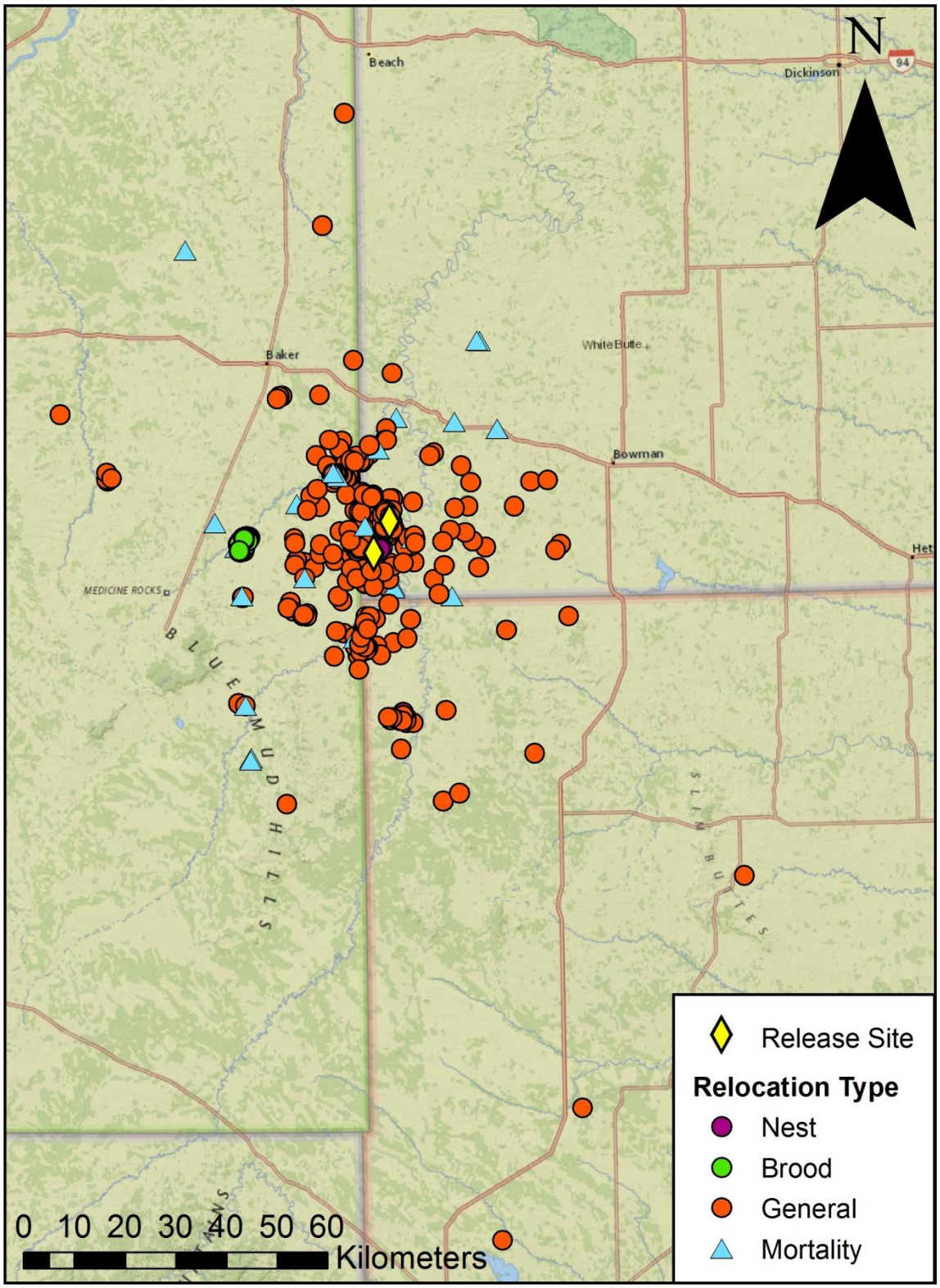


Figure 3. Nest, brood, mortality, and general telemetry locations (n = 573) of experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) in the North Dakota study area, 2017.

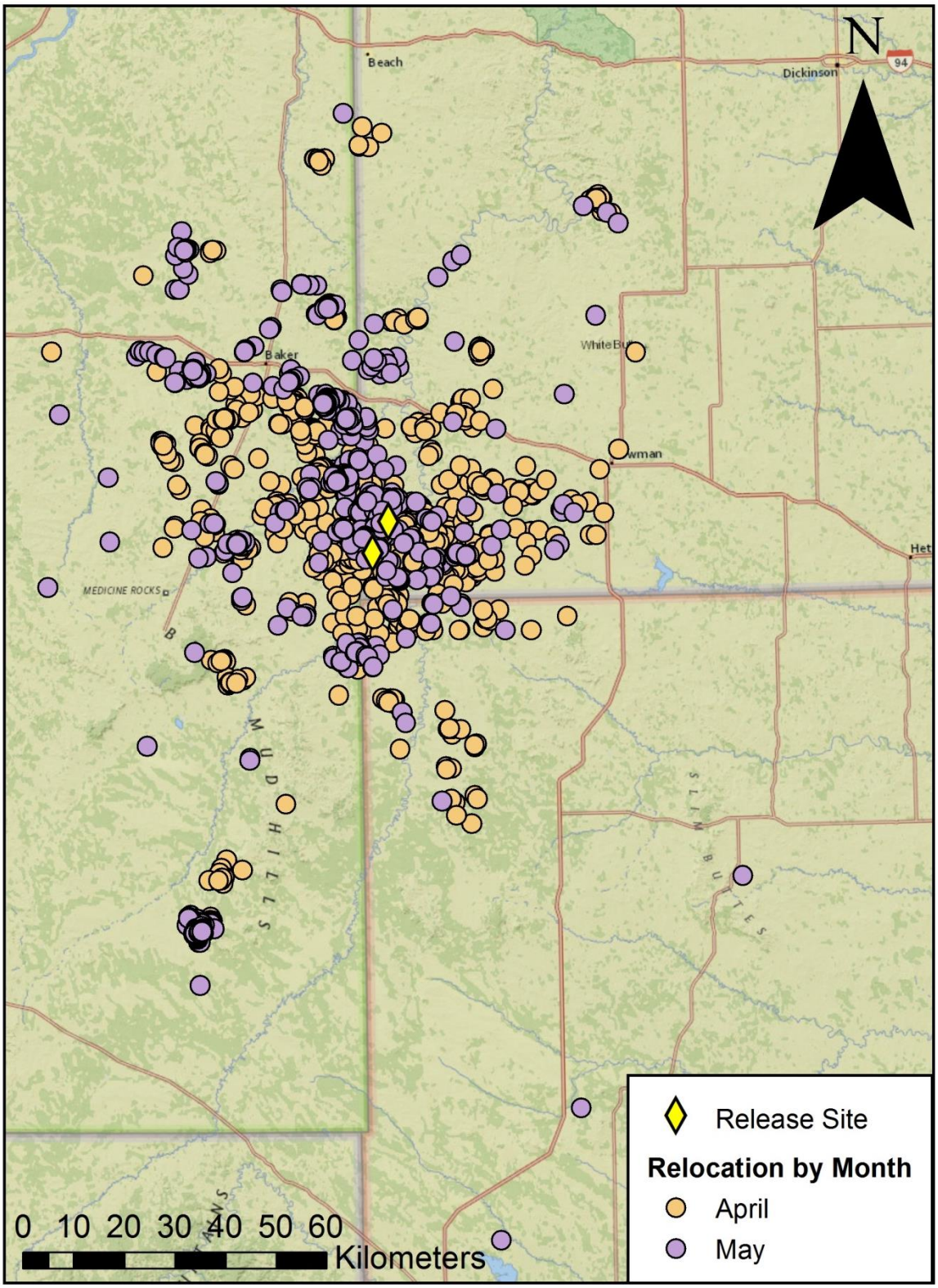


Figure 4. GPS locations of experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) during spring (n = 2,864) by month in the North Dakota study area, 2017.

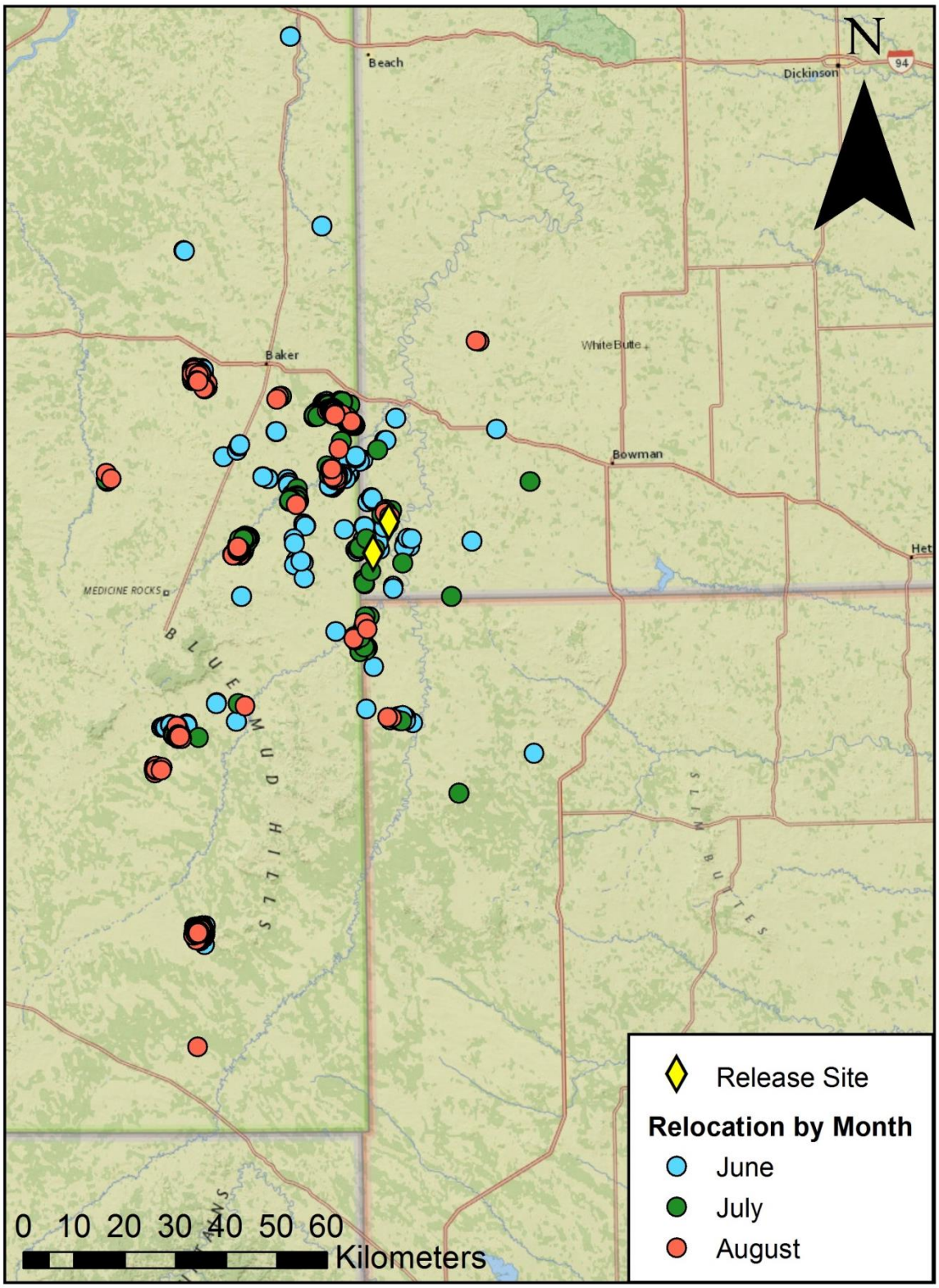


Figure 5. GPS locations of experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) during summer (n = 2,891) by month in the North Dakota study area, 2017.

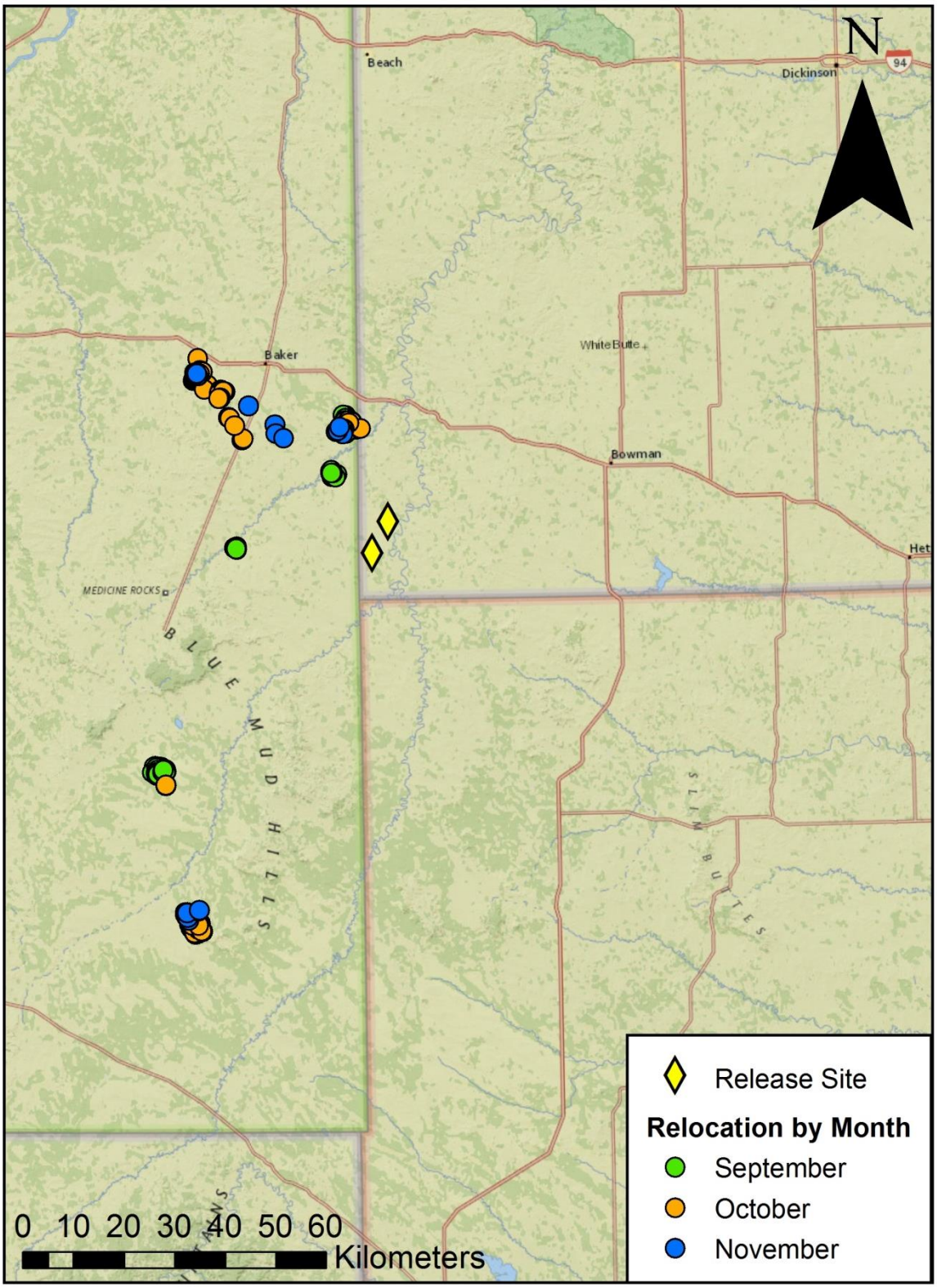


Figure 6. GPS locations of experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) during fall (n = 903) by month in the North Dakota study area, 2017.

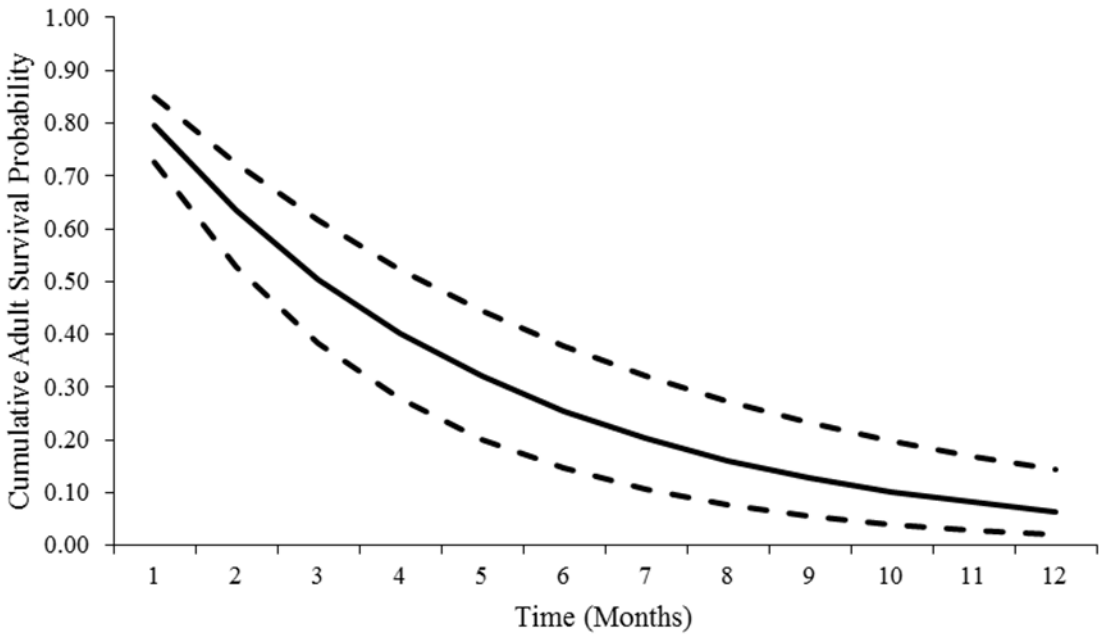


Figure 7. Cumulative probability of annual survival for experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) in the North Dakota study area during 2017. The solid line represents survival estimate while the dashed lines represent the 95% confidence intervals. This information is preliminary and subject to revision.

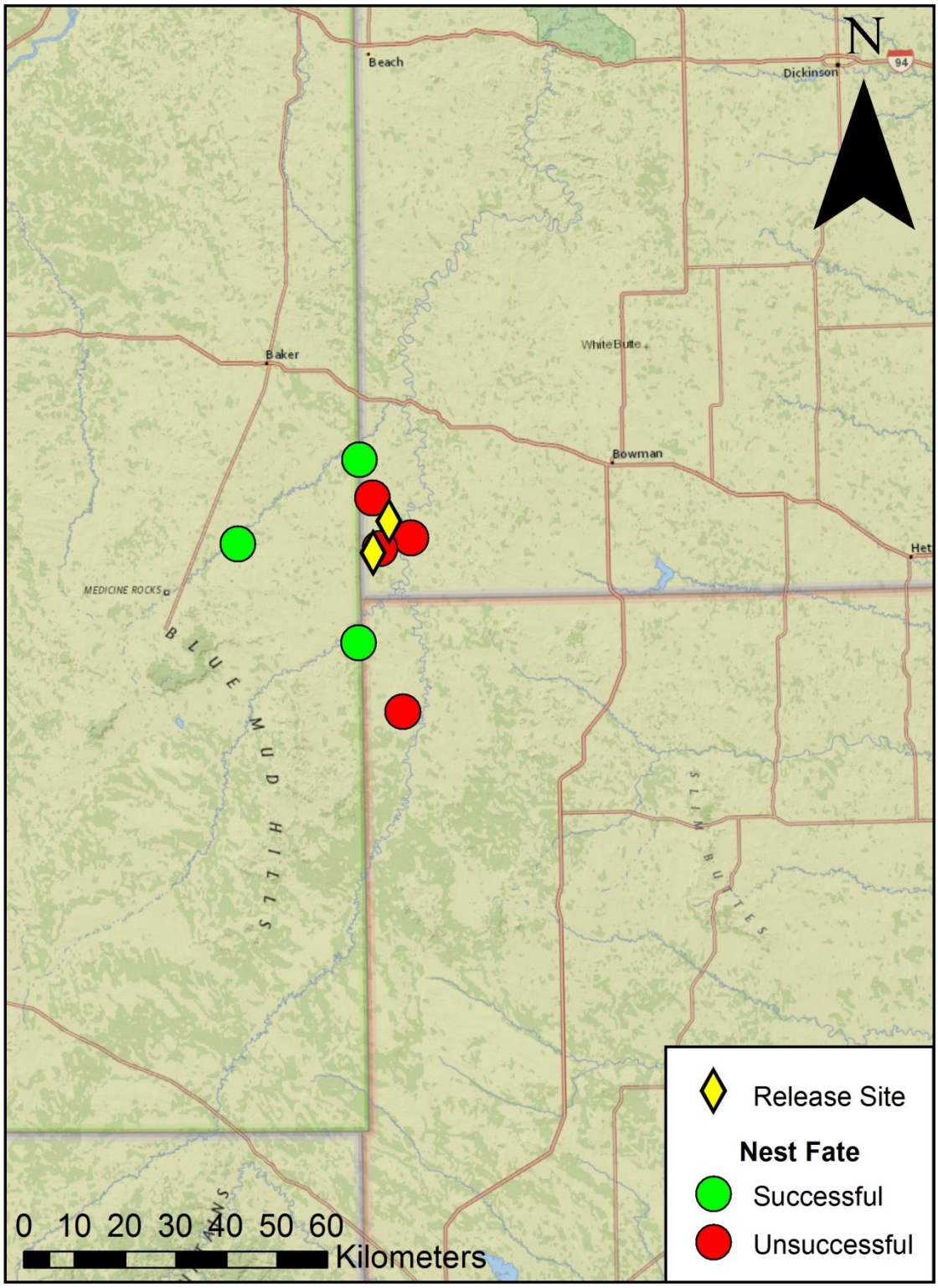


Figure 8. Nest locations (n = 7), and fate (successful n = 3; unsuccessful n =4) of radio-marked experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) in the North Dakota study area, 2017.

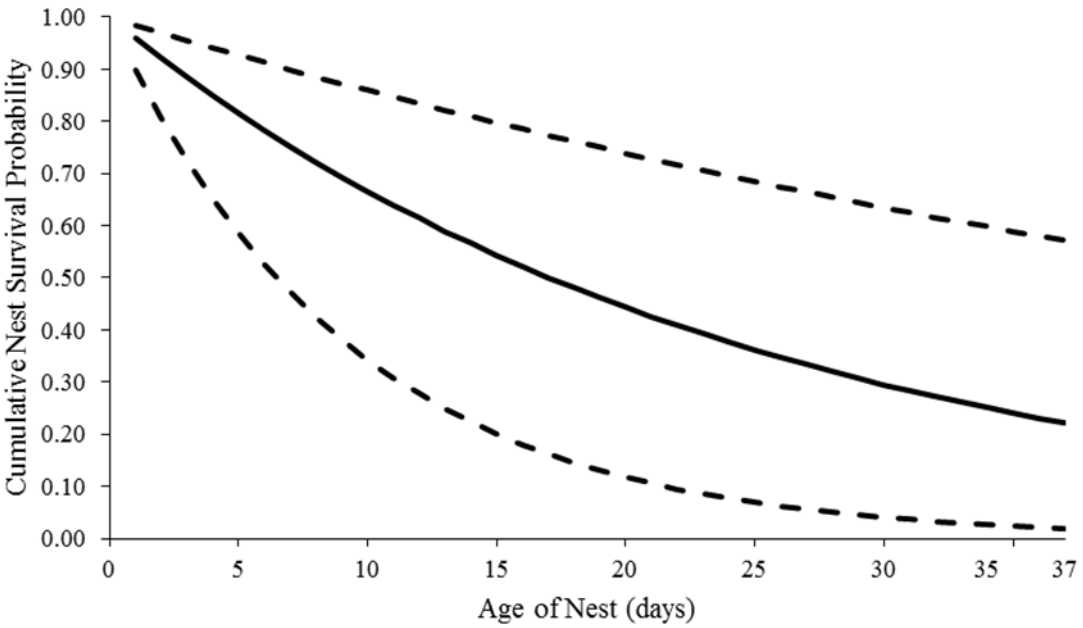


Figure 9. Cumulative probability of annual survival for nests of experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) in the North Dakota study area during 2017. The solid line represents survival estimate while the dashed lines represent the 95% confidence intervals. This information is preliminary and subject to revision.

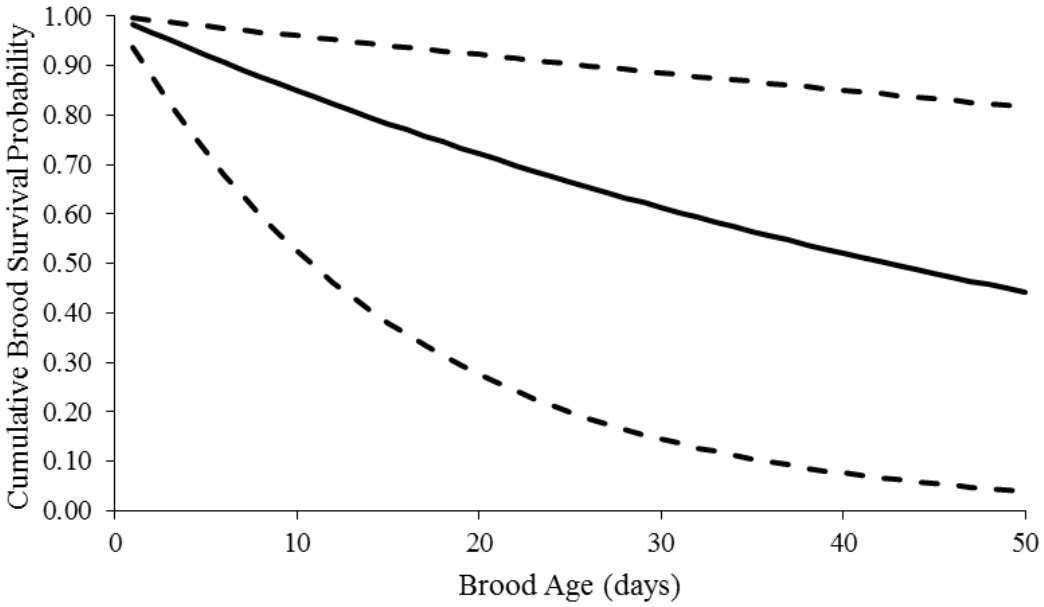


Figure 10. Cumulative probability of annual survival for broods of experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) in the North Dakota study area during 2017. The solid line represents survival estimate while the dashed lines represent the 95% confidence intervals. This information is preliminary and subject to revision.

9.0 Tables

Table 1. Estimated survival probabilities of experimentally translocated greater sage-grouse (*Centrocercus urophasianus*) to North Dakota from April – November 2017. This information is preliminary and subject to revision.

Estimated Monthly and Annual Survival Probabilities

Year	Monthly Survival Probability	95% CI	Annual Survival Probability	95% CI
2017	0.80	0.73 – 0.85	0.07	0.02 – 0.14

Table 2. Estimated probability of nest survival of experimentally translocated greater sage-grouse (*Centrocercus urophasianus)* to North Dakota from May – June 2017. This information is preliminary and subject to revision.

Estimated Probability of Nest Survival

Year	Daily Survival Probability	95% CI	Probability of Nest to Survive 37-day Nesting Period	95% CI	Average Clutch Size
2017	0.96	0.90 – 0.98	0.22	0.02 – 0.47	5.3

Table 3. Estimated probability of brood survival of experimentally translocated greater sage-grouse (*Centrocercus urophasianus)* to North Dakota from May – June 2017. This information is preliminary and subject to revision.

Estimated Probability of Brood Survival

Year	Daily Survival Probability	95% CI	Probability of Brood to Survive 50-day Rearing Phase	95% CI	Estimated Number of Chicks to Survive Brood Rearing
2017	0.98	0.94 – 1.00	0.36	0.05 – 1.00	1

Project: North Dakota Greater Sage-Grouse Translocation Project
Partners: North Dakota Game and Fish Department (NDGF), Utah State University (USU), and U.S. Geological Survey (USGS), Wyoming Game and Fish Department (WYGF)
Update Period: mid-March to May 1, 2018
Authored by: David Dahlgren and Kade Lazenby, USU

Introduction

In January 2017, in a partnership between NDGF, USU, and USGS to translocate and monitor 40 female greater sage-grouse (*Centrocercus urophasianus*; hereafter sage-grouse) each from Wyoming to southwest North Dakota, releasing them within the historical range of sage-grouse in the state. Sage-grouse populations in North Dakota had been slowly declining for nearly a decade. The WYGF approved the capture and translocation of grouse from the Stewart Creek population, ~ 20 miles northwest of Rawlins, WY. In addition to monitoring the translocated females, this project included the monitoring of 20 (VHF necklace-style radios) additional females in the source population that would be captured and released in Wyoming. During the 2017 spring lek counts in North Dakota no consistent lekking areas were identified for resident sage-grouse males, and therefore 20 additional sage-grouse males were radio-marked (VHF rump-style radios) and translocated with the 40 females (n = 20 VHF necklace-style radios; n = 20 GPS PTT rump-style radios). This project is in coordination with two other sage-grouse translocation projects, one in the Bi-State population in California and one in the Sheeprock Mountains in Utah. All three projects are monitoring female sage-grouse that are translocated and in the source population, as well as including an experimental design, with treatment and control equally distributed by radio type, for artificial insemination (AI) of females to test if AI methods will result in less movement and higher reproductive rates the first breeding season post-release.

During the 2018 season all existing parameters are the same with two exceptions; first, we captured and radio-marked 20 female sage-grouse and released them back into the source population with the intention of translocating the entire brood after successful nesting has occurred. We testing to see if brood translocations might have a higher probability of recruitment into the population and site fidelity from the hen and chicks. We decreased the number of spring translocated hens to n = 20. Total number of sage-grouse that were translocated in the spring was 40 (n=10 GPS PTT rump-style radios; n=10 VHF necklace-style radios; n=20 male rump-style radios). All translocated birds will be tested for diseases by the WYGF veterinarian, Mary Wood, DVM.

Trapping and Translocation

We began trapping birds on April 2, 2018. We ended trapping on April 09, 2018 and our last release occurred the morning of April 10. Grouse were trapped during the night and processed in the early morning. They were loaded on a NDGF airplane in the morning, flown to North Dakota, and released the following morning at two different historical lek sites in North Dakota. We attempted a soft release with a release box that opened remotely and observers hidden from view in ground blinds, hundreds of feet from the boxes. We successfully released 20 male and 20 female sage-grouse in North Dakota during the spring of 2018. One VHF female sage-grouse died of capture myopathy in the holding box just hours before release. We had 2 other capture myopathies in Wyoming. One male had complications during processing and was euthanized, and 1 female died during capture.

We also trapped 27 female sage-grouse that were released back into the source population. Of these, 20 are part of our potential brood translocations. The remaining trapped sage-grouse where outfitted with a VHF transmitter and released to raise the sample within the source population back to 20 after last year's mortalities and failed transmitters.

Movements and Survival

As of this report we have monitored and located 57 out of 60 translocated and marked grouse. The GPS radios record up to 6 locations a day and report those locations every 3 days. We have been using both aerial (~ 2 times per week) and ground telemetry (daily) to monitor the VHF marked grouse. Of the 30 GPS females in Wyoming (n = 20) and North Dakota (n = 10), 26 are still alive. Of the 10 VHF females, 8 are still alive and being monitored. Of the 20 VHF males, 16 are still alive and being monitored.

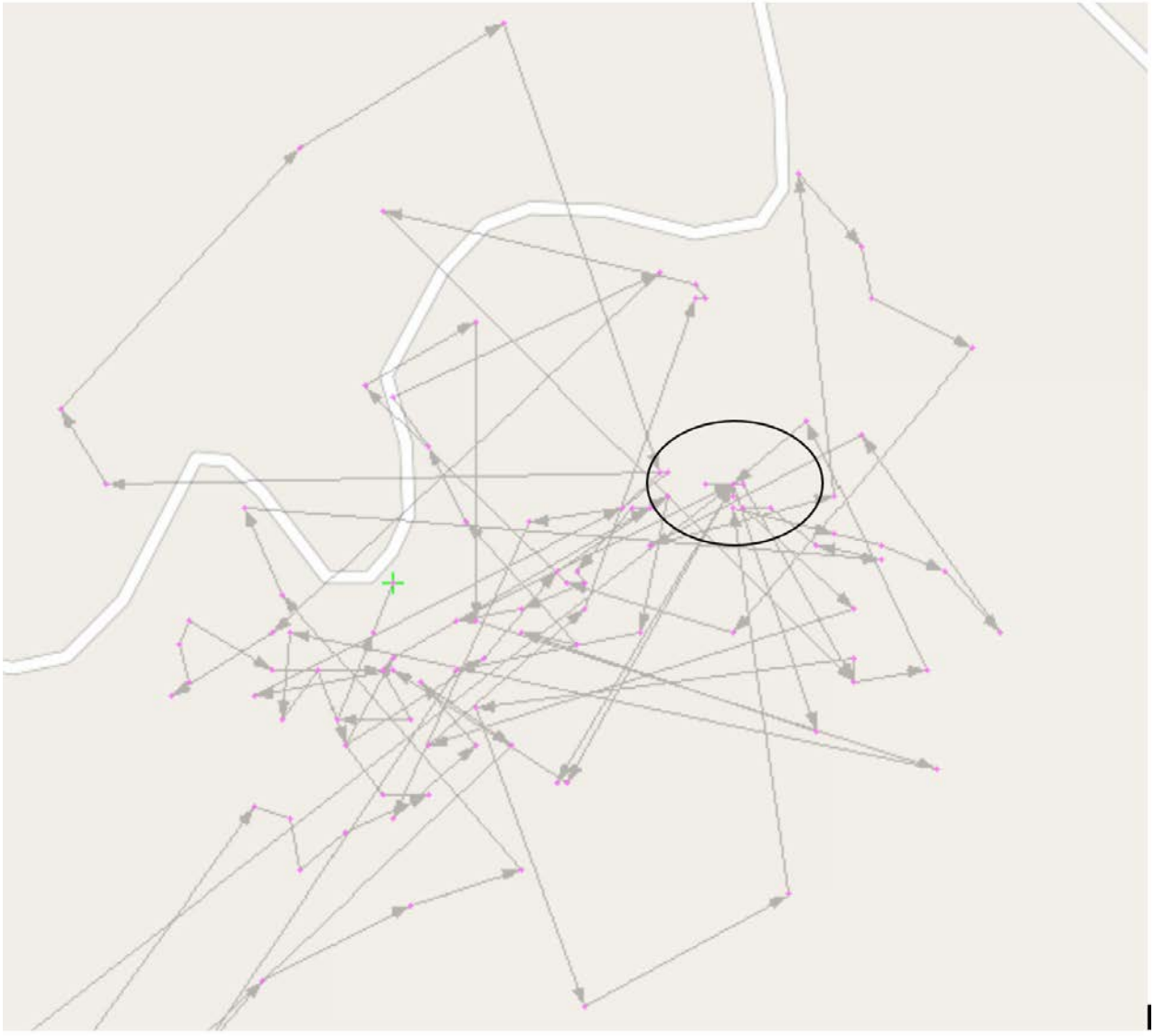


Figure 1. Movement patterns and nest site of GPS female sage-grouse in Wyoming. Lines are movement patterns of female sage-grouse. Circle is around the nest site. This is a good example of more concentrated movements exhibited before nesting.

Nest initiation rates are often lower for translocated birds their first breeding season post-release. VHF location data has inherently less resolution than GPS radios, but we believe 1 of the VHF females in Wyoming have localize and are likely initiating a nest.

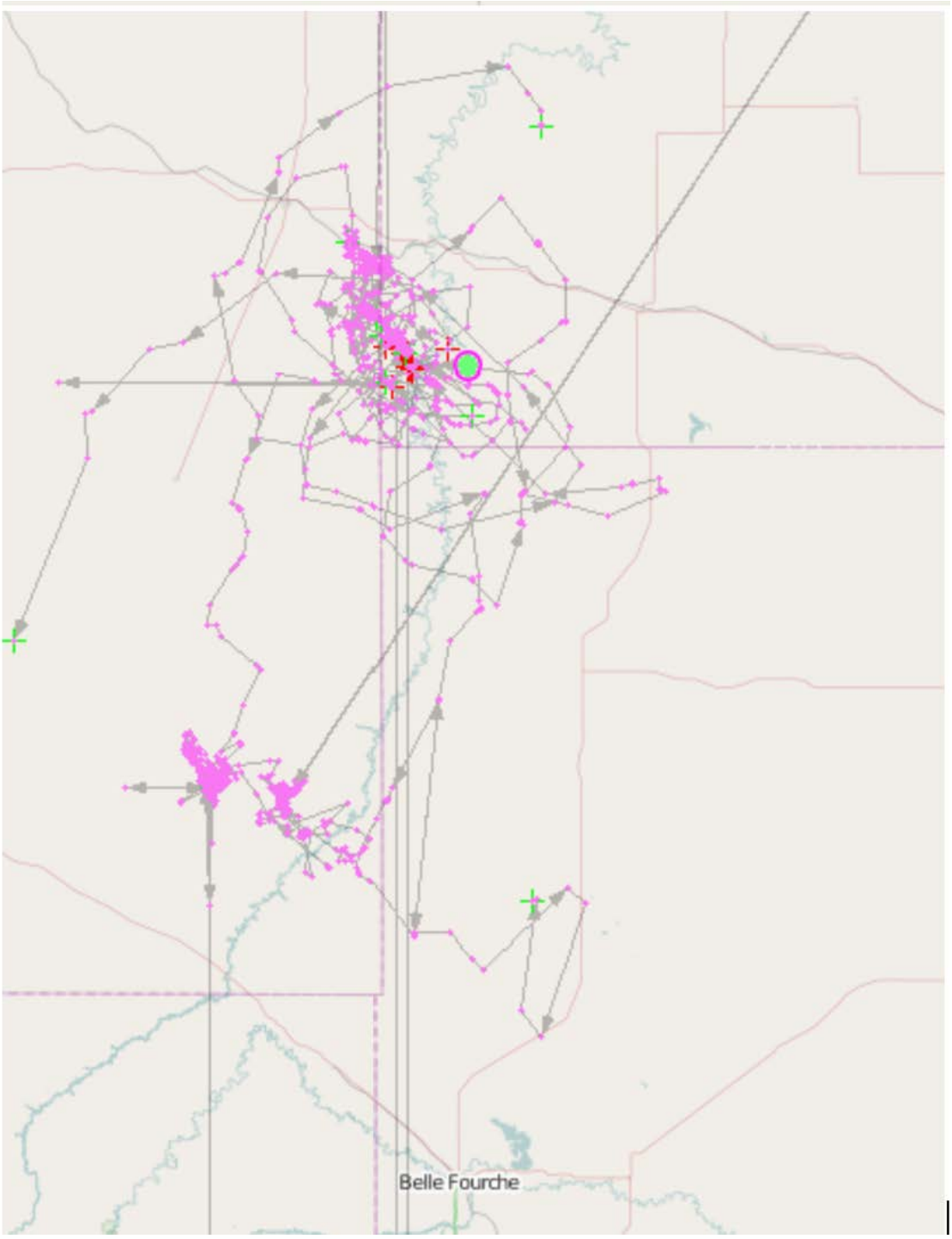


Figure 2. This GPS females translocated to North Dakota, including two remaining female sage-grouse translocated in 2017. Movements are indicated by the blue lines and arrows shows movements in these large areas over time.

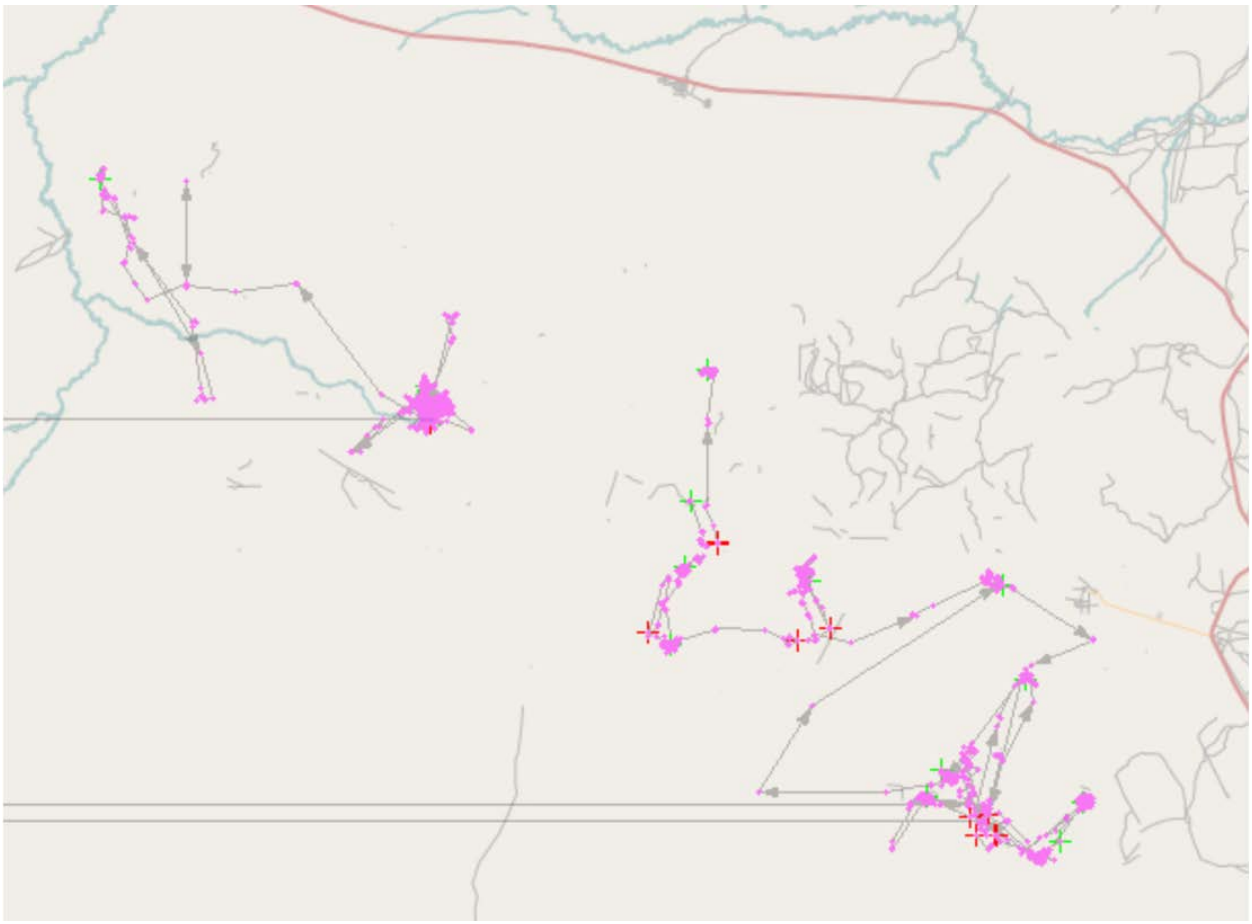


Figure 3. This GPS females designated to be Brood hens that will be translocated after successful nests occur; 6 of the 20 are currently initiating nests. We monitor these movements daily to detect nests as soon as possible. Movements are indicated by the blue lines and arrows shows movements in these areas over time.

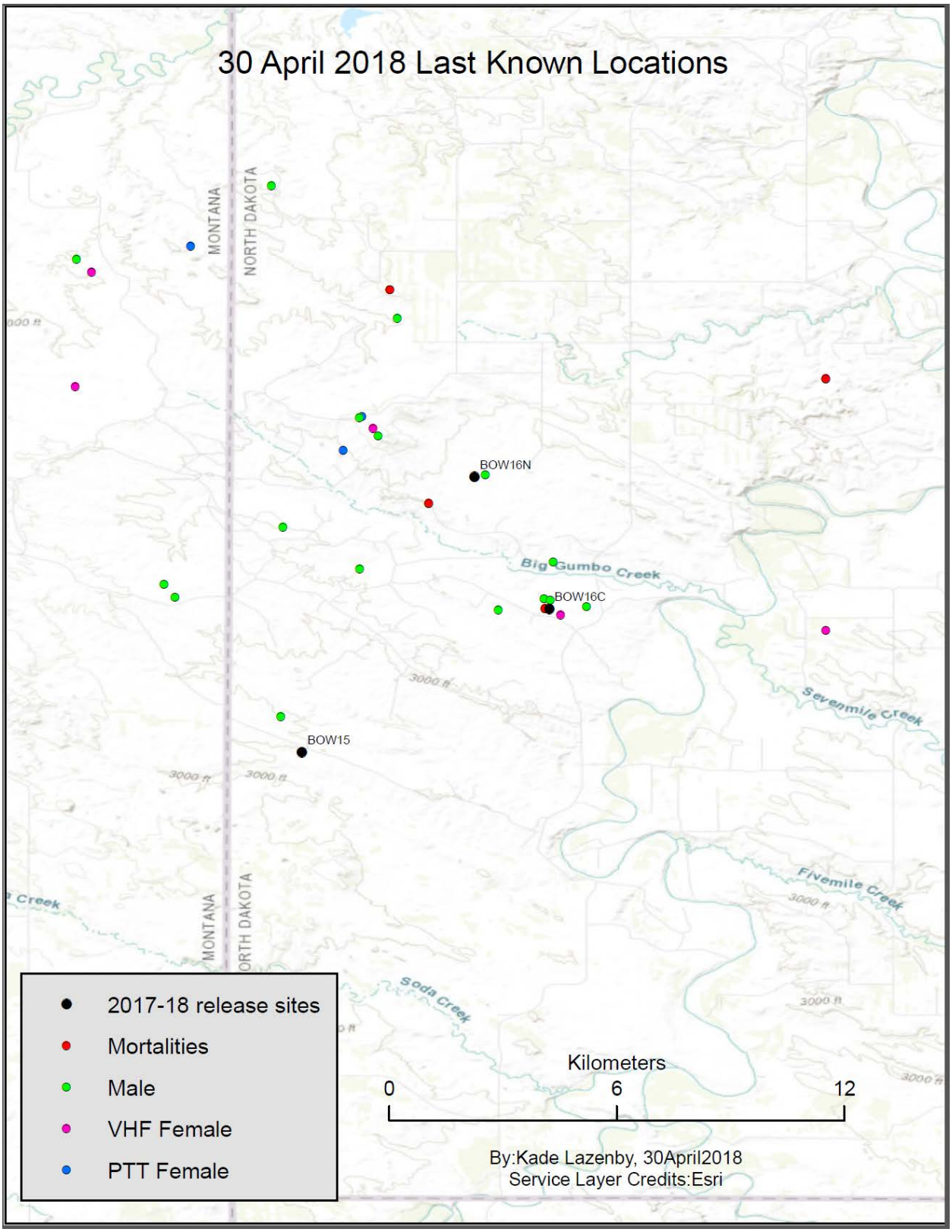
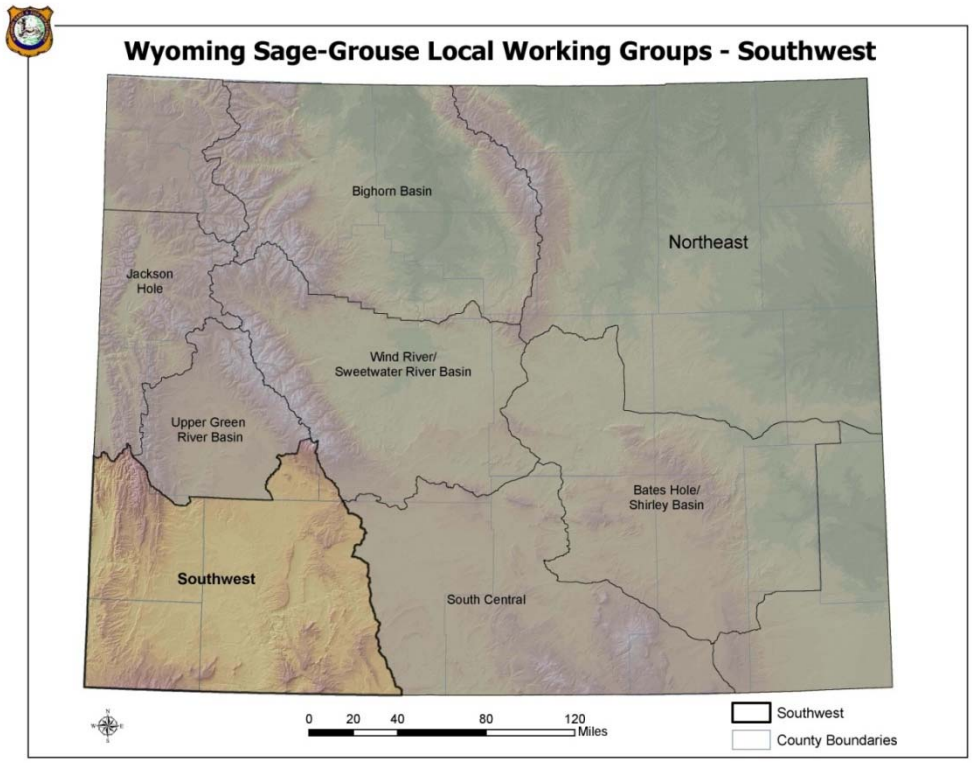


Figure 3. Last known locations of translocated sage-grouse radio-marked with GPS (PTT; Blue Dots), VHF females (Pink dots), VHF males (Green Dots), and mortalities (Red dots).

We have done similar VHF monitoring work at our Stewart Creek study area in Wyoming. In addition to the hens that we marked for potential translocation brood hens; we currently have 20 source population females that we are monitoring in Wyoming. We have 1 VHF hen that is localizing or incubating. We will continue to monitor and find nests in this study area. We have had 1 mortality to date in Wyoming. We look forward to continual monitoring of our radio-marked birds both in North Dakota and in Wyoming. We will begin vegetation sampling of nest sites as the season continues, and hopefully brood sites as nests begin to hatch.

Southwest Conservation Area
Job Completion Report

Species: Greater Sage-grouse
Management Areas: G, Green River Region
Biological Year: June 1, 2017 – May 31, 2018



Sage Grouse Lek Characteristics

Working Group: Southwest

Region	Number	Percent
Green River	398	88.1
Pinedale	54	11.9

Working Group	Number	Percent
Southwest	452	100.0

Classification	Number	Percent
Occupied	336	74.3
Undetermined	8	1.8
Unoccupied	108	23.9

BLM Office	Number	Percent
Kemmerer	198	43.8
Pinedale	14	3.1
Rawlins	4	0.9
Rock Springs	236	52.2

Biologist	Number	Percent
Green River	167	36.9
Mountain View	231	51.1
Pinedale	53	11.7
South Lander	1	0.2

Warden	Number	Percent
Cokeville	56	12.4
Evanston	36	8.0
Green River	74	16.4
Kemmerer	70	15.5
Mountain View	51	11.3
Rock Springs	111	24.6
South Pinedale	54	11.9

County	Number	Percent
Fremont	4	0.9
Lincoln	136	30.1
Sublette	34	7.5
Sweetwater	211	46.7
Uinta	67	14.8

Land Status	Number	Percent
BLM	311	68.8
BOR	15	3.3
National Park	2	0.4
Private	107	23.7
State	16	3.5
USFS	1	0.2

Management Area	Number	Percent
G	452	100.0

Lek Status	Number	Percent
Active	284	62.8
Inactive	62	13.7
Unknown	106	23.5

Sage Grouse Job Completion Report

Year: 2009 - 2018, 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)
2009	282	71	25	2651	40.2
2010	288	77	27	2214	30.8
2011	297	73	25	1855	26.9
2012	303	81	27	1719	23.5
2013	310	116	37	1955	19.4
2014	312	96	31	1613	19.9
2015	318	70	22	2197	34.9
2016	327	94	29	3744	44.0
2017	336	97	29	2950	34.3
2018	340	102	30	2654	30.2

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2009	282	188	67	5485	35.4
2010	288	183	64	3753	26.6
2011	297	165	56	2893	21.3
2012	303	183	60	2871	21.0
2013	310	177	57	2254	16.9
2014	312	191	61	3177	21.2
2015	318	224	70	6256	35.5
2016	327	213	65	6488	40.3
2017	336	204	61	5991	38.7
2018	340	210	62	5333	32.3

Sage Grouse Job Completion Report

Year: 2009 - 2018, Working Group: Southwest

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

c. Leks Checked

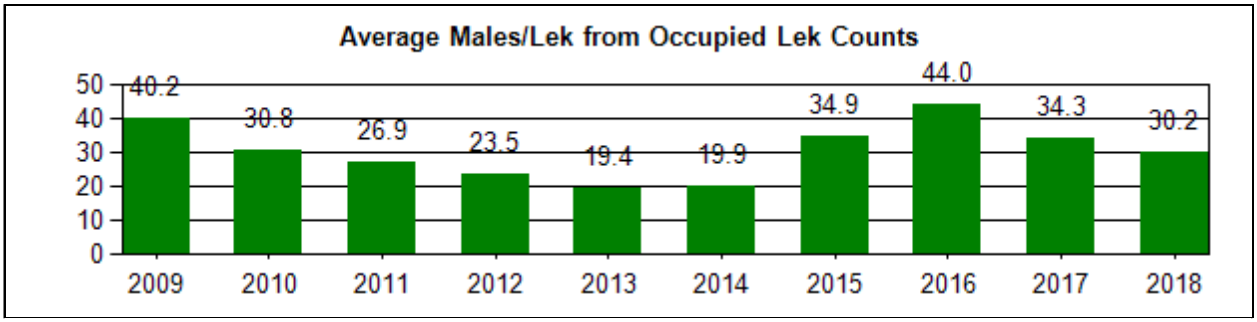
Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2009	282	259	92	8136	36.8
2010	288	260	90	5967	28.0
2011	297	238	80	4748	23.2
2012	303	264	87	4590	21.9
2013	310	293	95	4209	18.0
2014	312	287	92	4790	20.7
2015	318	294	92	8453	35.4
2016	327	307	94	10232	41.6
2017	336	301	90	8941	37.1
2018	340	312	92	7987	31.6

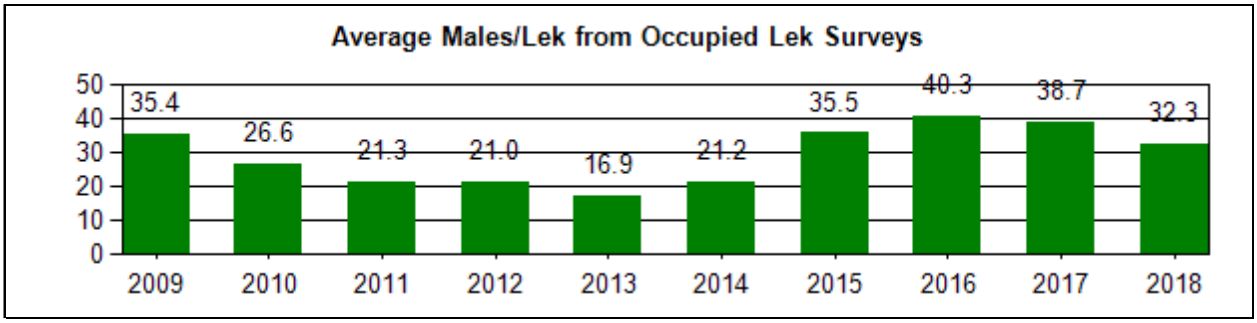
d. Lek Status

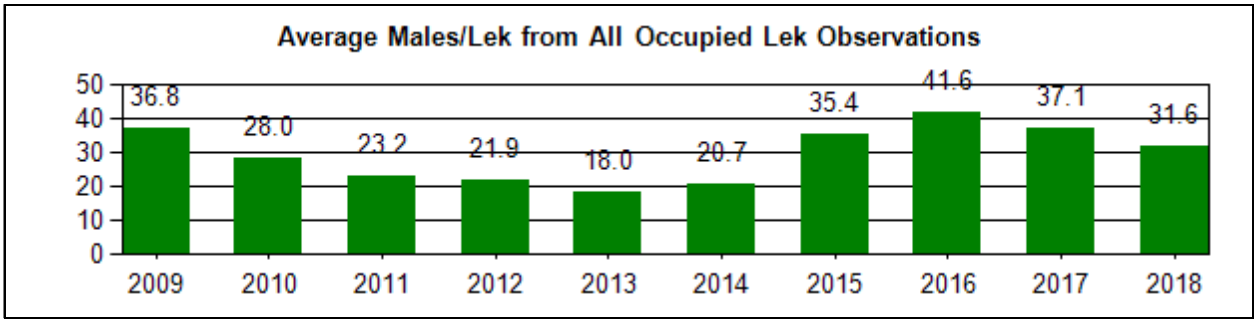
Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2009	230	19	10	249	92.4	7.6
2010	225	13	22	238	94.5	5.5
2011	218	6	14	224	97.3	2.7
2012	226	25	13	251	90.0	10.0
2013	242	29	22	271	89.3	10.7
2014	236	24	24	260	90.8	9.2
2015	252	21	21	273	92.3	7.7
2016	264	27	16	291	90.7	9.3
2017	254	30	17	284	89.4	10.6
2018	260	32	20	292	89.0	11.0

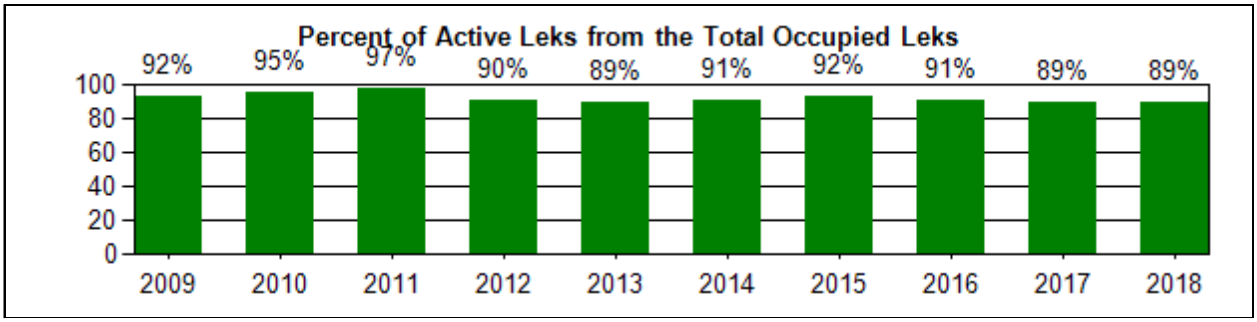
Sage Grouse Occupied Lek Attendance Summary

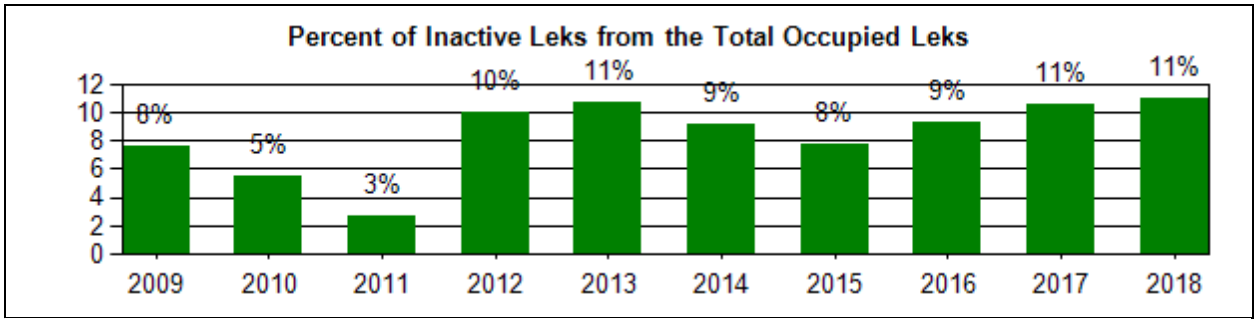
Year: 2009 - 2018, Working Group: Southwest











Sage Grouse Job Completion Report

Year: 2009 - 2018, Working Group: Southwest

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
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
2017	Sep-16	Sep-30	15	2/4

b. Harvest

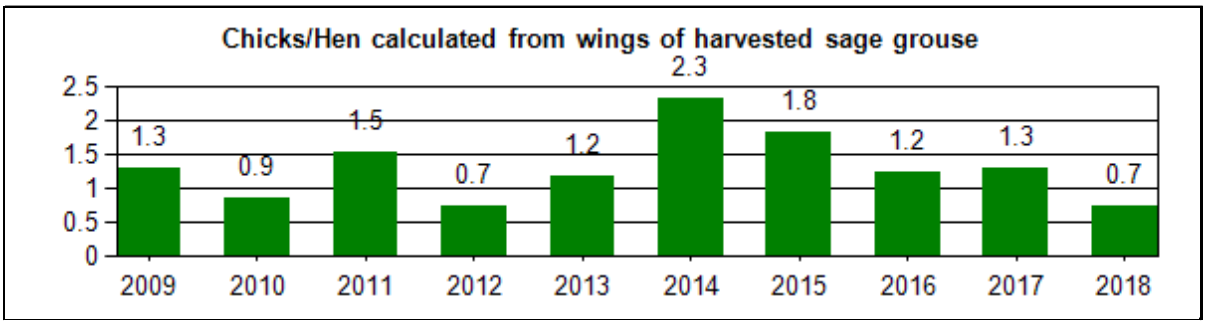
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2009	4236	1645	4014	1.1	2.6	2.4
2010	4225	1788	4048	1.0	2.4	2.3
2011	3901	1709	4276	0.9	2.3	2.5
2012	3737	1775	4503	0.8	2.1	2.5
2013	2513	1307	3139	0.8	1.9	2.4
2014	2645	1165	2835	0.9	2.3	2.4
2015	4479	1586	4057	1.1	2.8	2.6
2016	4163	1672	4036	1.0	2.5	2.4
2017	3590	1421	3675	1.0	2.5	2.6
Avg	3,721	1,563	3,843	1.0	2.4	2.5

Sage Grouse Job Completion Report

Year: 2009 - 2018, Working Group: Southwest

4. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
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
2017	813	9.5	31.0	2.8	7.0	22.6	27.1	1.3
2018	827	12.0	33.4	6.5	13.4	13.1	21.6	0.7



Lek Monitoring

A total of 340 occupied leks were known to exist in the SWSGCA during the 2018 lekking season. Of these 340 occupied leks, 312 of them were checked, with 102 of those checks being lek counts with three or more visits during the breeding season, with the remaining 210 checks consisting of lek surveys where less than three lek visits were made during the breeding season. In 2017, 90% of the known leks were checked at least once during the lekking season; in 2018, however, that percentage increased to 92% of the known leks being checked. The lower visitation rate in 2017 was largely caused 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 312 lek visits to known lek sites in the SWSGCA conducted in 2018, 260 of them were documented as being active, 32 were classified as being inactive and 20 leks were of unknown or undetermined status. All lek monitoring data from 2018, 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 2018 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 2018 lekking season was 31.6 males per active lek. This is a 24% decrease from the 41.5 males per active lek observed in 2016, but still above the 10 year average of 29.2 males per active lek. The average number of males in attendance on the 102 count leks in 2018 was 30.2 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 34.3 males per active lek, and below the 10-year average of 30.4

males per count lek. For the 210 leks that were surveyed in 2018, the average lek had 32.3 males in attendance, which is above the recent average of 28.5, but down from 2016's and 2017's observed values of 40.2 and 38.7.

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 2017 hunting season for sage-grouse in the SWSGCA ran from September 16 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 2017 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, 1,421 hunters harvested 3,590 sage-grouse during the 2017 hunting season (Table 3b). This is down slightly from the 4,036 birds reported harvested in 2017, and is below the 10 year average harvest of 3,843 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 827 grouse wings from the 2017 hunting season (Table 4). This represents just over 23% of the estimated total harvest for 2017, 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 2017 hunting season was 0.7 chicks/hen (Table 4). 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 2018.

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.

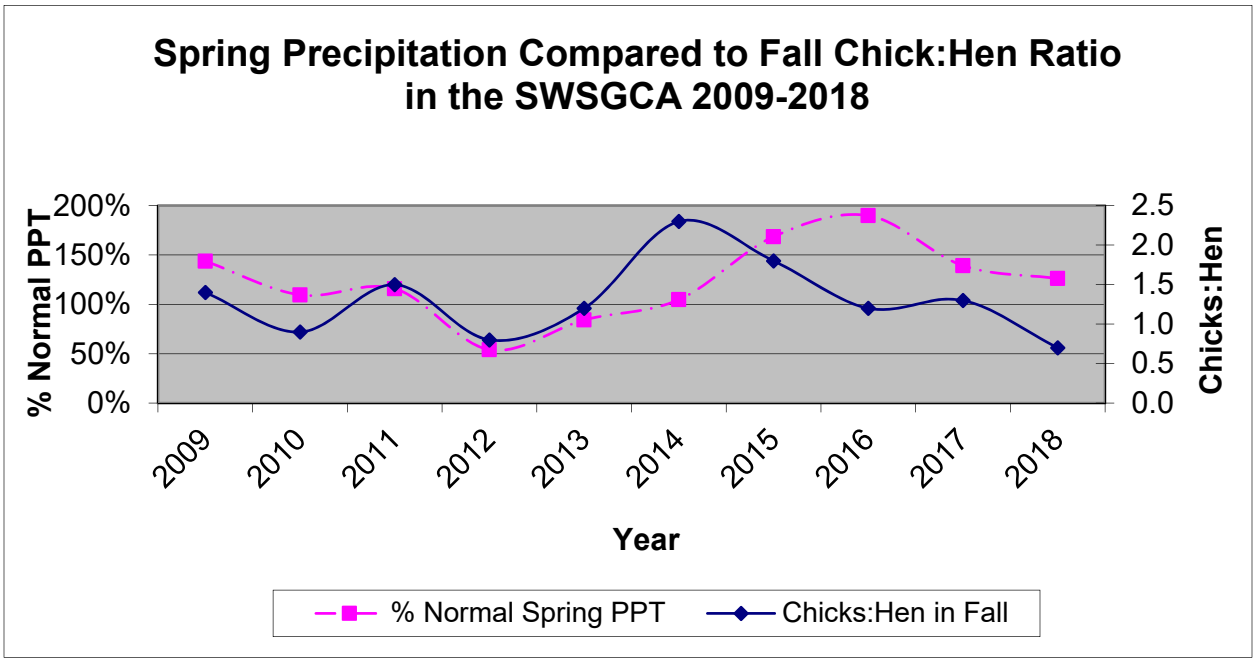
Winter weather has not been shown to be a limiting factor to sage-grouse except in areas with persistent snow cover that is deep enough to limit sagebrush availability. This condition is rarely present in the SWSGCA even during the above average winter of 2010-2011.

The spring (March-June) precipitation and fall chick:hen ratios (as determined by hunter submitted wings) are given in Table 5 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 through 2018 did not, however result in as high of chick to hen ratios as would have been expected. This may have been one of those years when the high precipitation levels resulted in cold, wet conditions that negatively impacted chick survival.

Table 5. 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
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
2017	139%	1.3
2018	126%	0.7



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, 2017.

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
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., 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., 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.

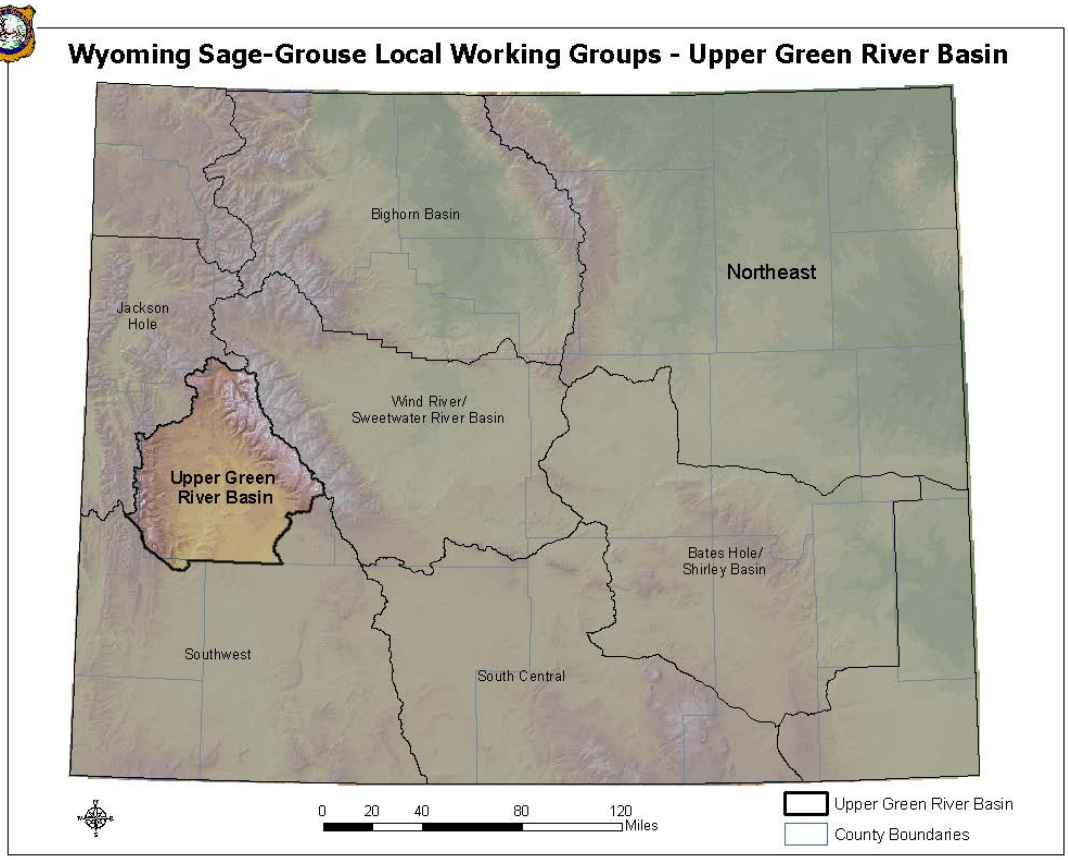
Dinkins, J. B., M. R. Conover, C. P. Kirol, J. L. Beck, and S. N. Frey. 2016b. Effects of common raven and coyote removal and temporal variation in climate on greater sage-grouse nesting success. Biological Conservation 202:50–58.

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 Working Group Area
Job Completion Report

Species: **Greater Sage-grouse**
Conservation Plan Area: **Upper Green River Basin**
Period Covered: **6/1/2017 – 5/31/2018**
Prepared by: **Dean Clause, Pinedale Wildlife Biologist**



Sage Grouse Lek Characteristics

Management Area: D, Working Group: Upper Green River

Region	Number	Percent
Pinedale	160	100.0

Working Group	Number	Percent
Upper Green River	160	100.0

Classification	Number	Percent
Occupied	133	83.1
Unoccupied	27	16.9

BLM Office	Number	Percent
Pinedale	148	92.5
Rock Springs	12	7.5

Biologist	Number	Percent
Pinedale	92	57.5
Thayne	68	42.5

Warden	Number	Percent
Big Piney	80	50.0
North Pinedale	24	15.0
South Pinedale	56	35.0

County	Number	Percent
Lincoln	2	1.3
Sublette	158	98.8

Land Status	Number	Percent
BLM	131	81.9
Private	19	11.9
State	10	6.3

Management Area	Number	Percent
D	160	100.0

Lek Status	Number	Percent
Active	105	65.6
Inactive	52	32.5
Unknown	3	1.9

Sage Grouse Job Completion Report

Year: 2009 - 2018, Management Area: D, Working Group: Upper Green River

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

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2009	115	84	73	3850	55.0
2010	127	92	72	3099	41.9
2011	131	100	76	2692	31.7
2012	132	117	89	3514	36.6
2013	130	116	89	3125	34.3
2014	130	111	85	3207	36.9
2015	134	109	81	4667	53.6
2016	137	117	85	5229	55.0
2017	136	97	71	4206	54.6
2018	135	114	84	4015	42.3

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2009	115	27	23	619	38.7
2010	127	30	24	573	26.0
2011	131	25	19	943	47.2
2012	132	6	5	149	37.3
2013	130	8	6	280	40.0
2014	130	14	11	290	29.0
2015	134	22	16	923	48.6
2016	137	18	13	878	67.5
2017	136	29	21	1086	54.3
2018	135	15	11	457	50.8

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: 2009 - 2018, Management Area: D, Working Group: Upper Green River

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

c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2009	115	111	97	4469	52.0
2010	127	122	96	3672	38.3
2011	131	125	95	3635	34.6
2012	132	123	93	3663	36.6
2013	130	124	95	3405	34.7
2014	130	125	96	3497	36.1
2015	134	131	98	5590	52.7
2016	137	135	99	6107	56.5
2017	136	126	93	5292	54.6
2018	135	129	96	4472	43.0

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2009	86	25	0	111	77.5	22.5
2010	95	27	0	122	77.9	22.1
2011	104	21	0	125	83.2	16.8
2012	101	22	0	123	82.1	17.9
2013	98	26	0	124	79.0	21.0
2014	98	27	0	125	78.4	21.6
2015	106	25	0	131	80.9	19.1
2016	108	24	3	132	81.8	18.2
2017	97	29	0	126	77.0	23.0
2018	104	24	1	128	81.3	18.8

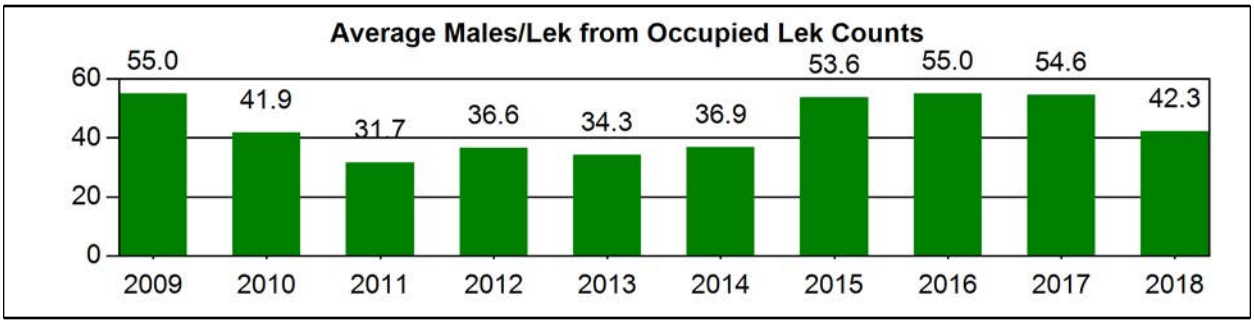
1) Occupied - Active during previous 10 years (see official definitions)

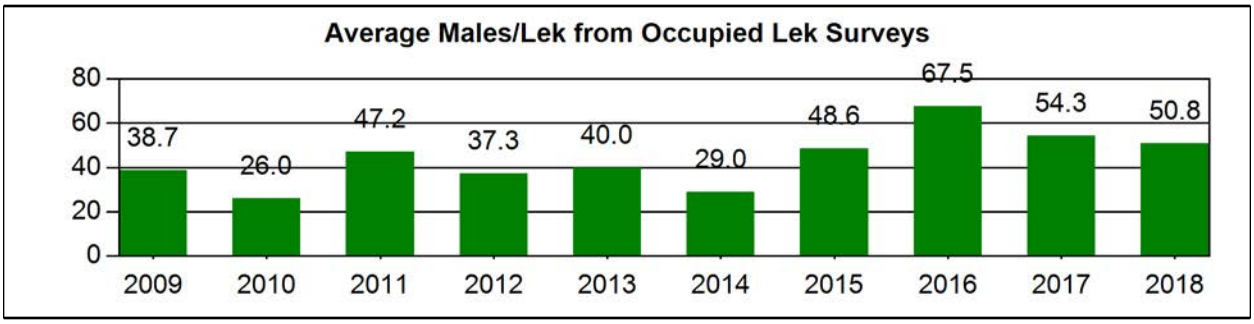
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

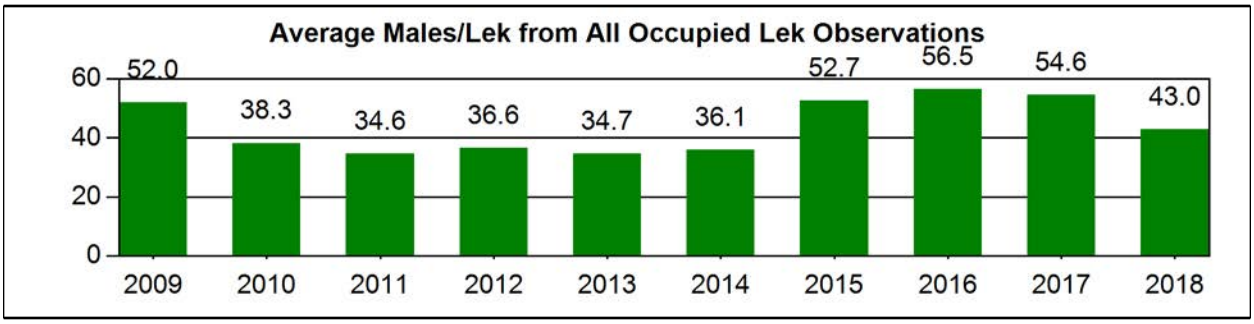
3) Inactive - Confirmed no birds/sign present (see official definitions)

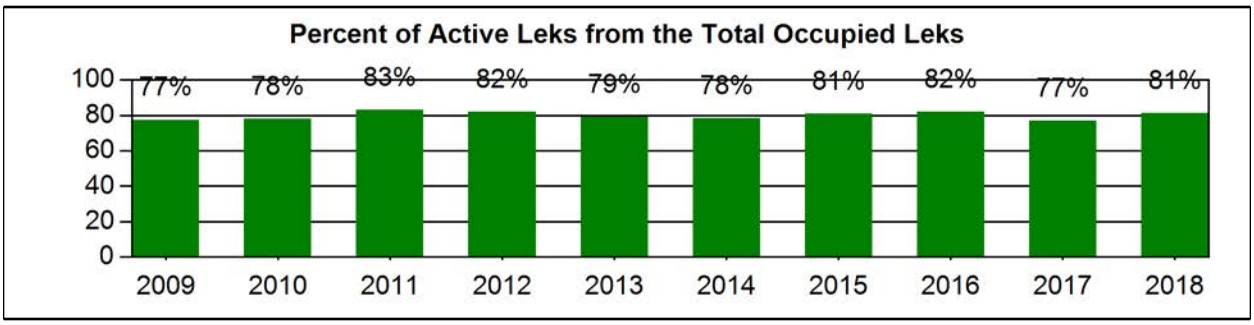
Sage Grouse Occupied Lek Attendance Summary

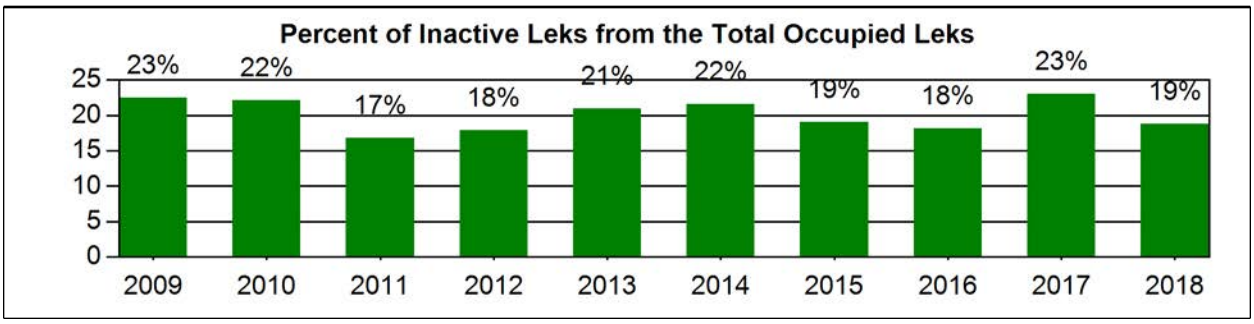
Year: 2009 - 2018, Management Area: D, Working Group: Upper Green River











Sage Grouse Job Completion Report

Year: 2008 - 2017, Management Area: D, Working Group: Upper Green River

3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
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
2017	Sep-16	Sep-30	15	2/4

b. Harvest

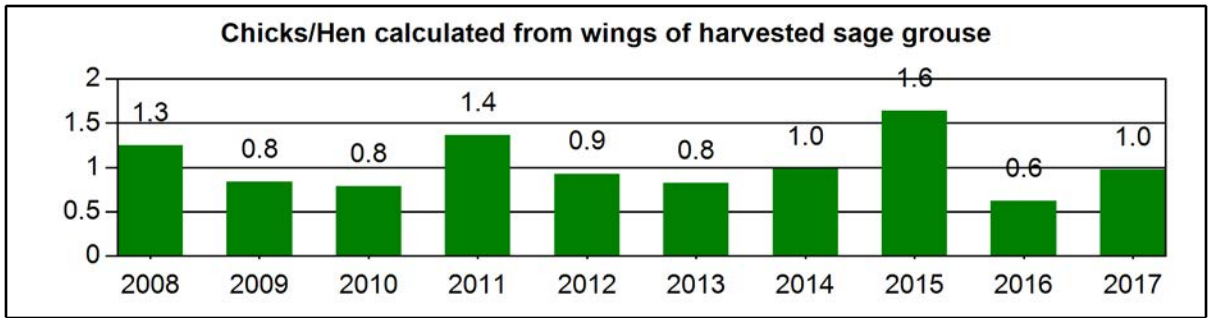
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2008	1109	453	1116	1.0	2.4	2.5
2009	1203	460	1177	1.0	2.6	2.6
2010	1510	526	1497	1.0	2.9	2.8
2011	1720	565	1605	1.1	3.0	2.8
2012	1320	476	1296	1.0	2.8	2.7
2013	628	387	848	0.7	1.6	2.2
2014	1056	406	1266	0.8	2.6	3.1
2015	1205	500	1129	1.1	2.4	2.3
2016	1990	706	2012	1.0	2.8	2.8
2017	988	402	921	1.1	2.5	2.3
Avg	1,273	488	1,287	1.0	2.6	2.6

Sage Grouse Job Completion Report

Year: 2008 - 2017, Management Area: D, Working Group: Upper Green River

4. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
2008	494	12.8	29.4	3.4	7.9	22.3	24.3	1.3
2009	445	14.8	38.7	3.4	5.8	15.7	21.6	0.8
2010	469	13.6	39.2	2.1	7.9	17.3	19.8	0.8
2011	547	8.6	32.5	4.0	4.4	24.1	26.3	1.4
2012	544	12.1	34.2	3.5	9.6	17.1	23.5	0.9
2013	372	12.1	40.9	3.2	5.6	17.2	21.0	0.8
2014	337	13.4	33.8	3.0	8.3	18.1	23.4	1.0
2015	482	12.4	27.0	2.1	5.4	24.7	28.4	1.6
2016	450	17.6	43.1	3.1	5.8	12.4	18.0	0.6
2017	573	15.0	35.1	3.3	6.3	18.8	21.5	1.0



Lek Monitoring

A total of 160 leks are currently documented in the Upper Green River Basin Working Group Area (UGRBWGA). These leks are classified as follows; 133 occupied, 27 unoccupied, and 0 undetermined. During 2018, a total of 129 occupied leks (96%) were checked (survey or count). Lek monitoring efforts in 2018 primarily focused on counts (84%) over surveys (11%). Compared to previous years, the proportion of overall leks monitored in 2018 were higher due to lower snow accumulation this past winter resulting in better access during lek monitoring. Results from the counts and surveys showed that 81% of the leks were active and 19% were inactive. The average number of males/lek for all active leks decreased to 43 in 2018, compared to the past three years of 55 in 2017, 57 in 2016, and 53 in 2015. This results in nearly a 22% decrease compared to 2017 (Figure 1).

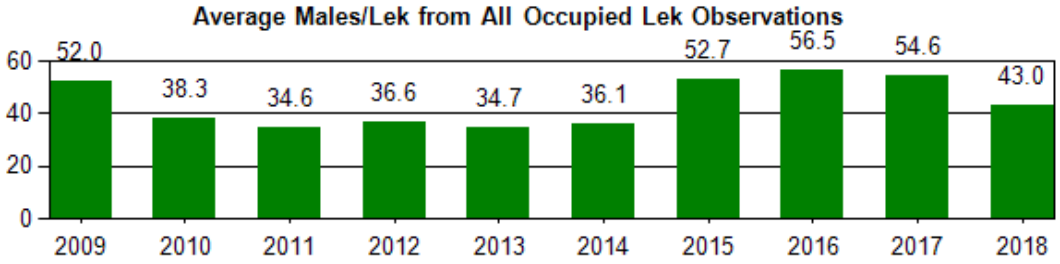


Figure 1. Average Peak Male Sage-grouse Lek Attendance 2009-2018, UGRBWG Area.

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 males has declined through 2010, stabilized from 2011-2014, and increased in 2015, stabilized in 2016-2017, and declined in 2018 (Figure 1). The 2018 male lek attendance is 38% 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 83%. 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 (59 new leks since 2004) mathematically negating the downward trend in the proportion of active leks in the UGRBWGA.

Peak male lek attendance from 1997-2008, using only leks known in 1997, reveals a trend similar to all known leks within the UGRBWGA (Figures 2 & 3). Since 1997, the discovery and monitoring of leks has more than doubled, explaining the variation in the

average number peak males between the two data trends (known leks from 1997 verses all known leks).

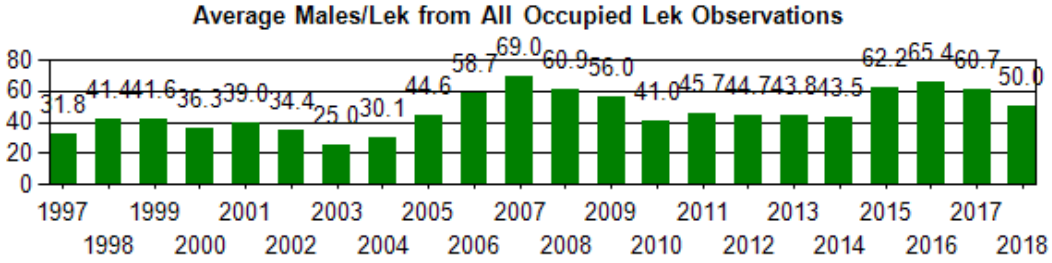


Figure 2. Average Peak Male Sage-grouse Lek Attendance 1997-2018 using only leks known in 1997, UGRBWG Area.

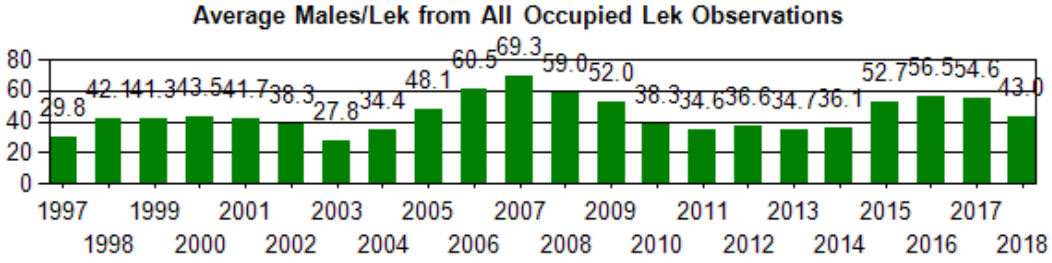


Figure 3. Average Peak Male Sage-grouse Lek Attendance 1997-2018 using all known leks, UGRBWG Area.

An analysis to assess natural gas development impacts to sage grouse leks in the Pinedale area shows lower male attendance, reduced occupancy and reduced activity on those leks within or near gas field development. Using aerial imagery (2018 Sublette County Imagery), leks located within or less than one mile of gas field activity in the Pinedale Anticline (PAPO) and Jonah Gas Fields were grouped for comparison. The group of leks referred to as "Disturbed Leks" (n=19) 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" were the remaining leks in the UGRBWGA. The range of data used in this comparison was from 1997 – 2018 for the same reasons mention earlier (lack of lek monitoring and standardized monitoring protocol). In comparing Disturbed Leks vs. Undisturbed Leks, the average number of peak males/lek for occupied leks reveal somewhat similar trends, although the long-term peak number of males in the Disturbed Leks has declined while the Undisturbed Leks have increased slightly (Figures 4 & 5).

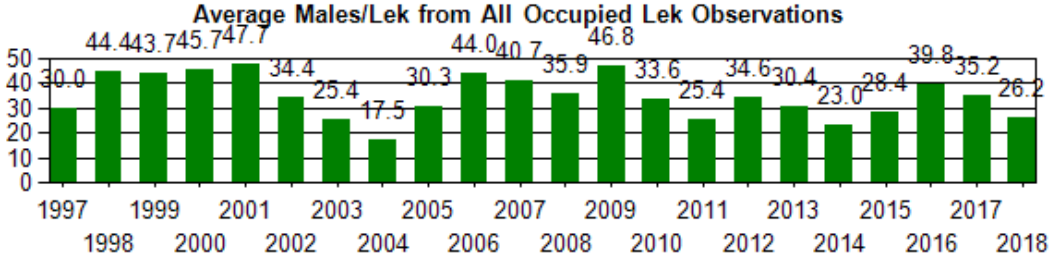


Figure 4. Average Peak Male Sage-grouse Lek Attendance 1997-2018, Disturbed Leks.

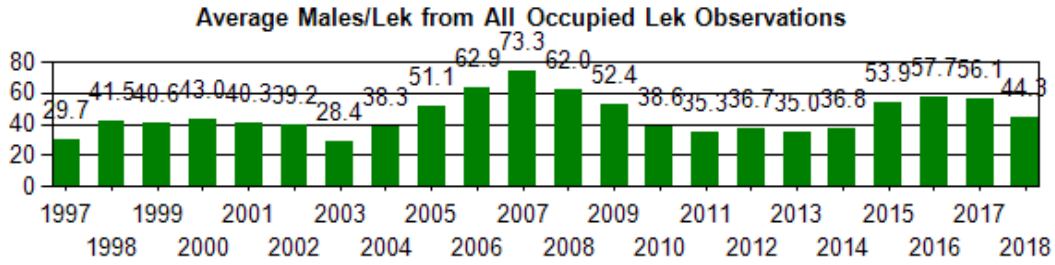


Figure 5. Average Peak Male Sage-grouse Lek Attendance 1997-2018, Undisturbed Leks.

Another 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 50% (2014-2018) for occupied lek only (leks active within the past 10 years). The Undisturbed Leks show activity levels changing very little with an average of 81% (1997-2001) to 82% by 2018, see Figure 6. The increase to 63% for active leks in Disturbed Leks during 2018 is due to the lower number of occupied leks (10 occupied in 2017 to 8 occupied in 2018). Currently only 5 out of 8 occupied leks were active in 2018, compared to 10 active leks out of 15 occupied leks in 2008.

A much higher proportion of leks are currently unoccupied (abandoned or destroyed) within or near the PAPA and Jonah gas fields (Disturbed Leks) at 58% compared to 11% outside the PAPA and Jonah as fields (Undisturbed Leks).

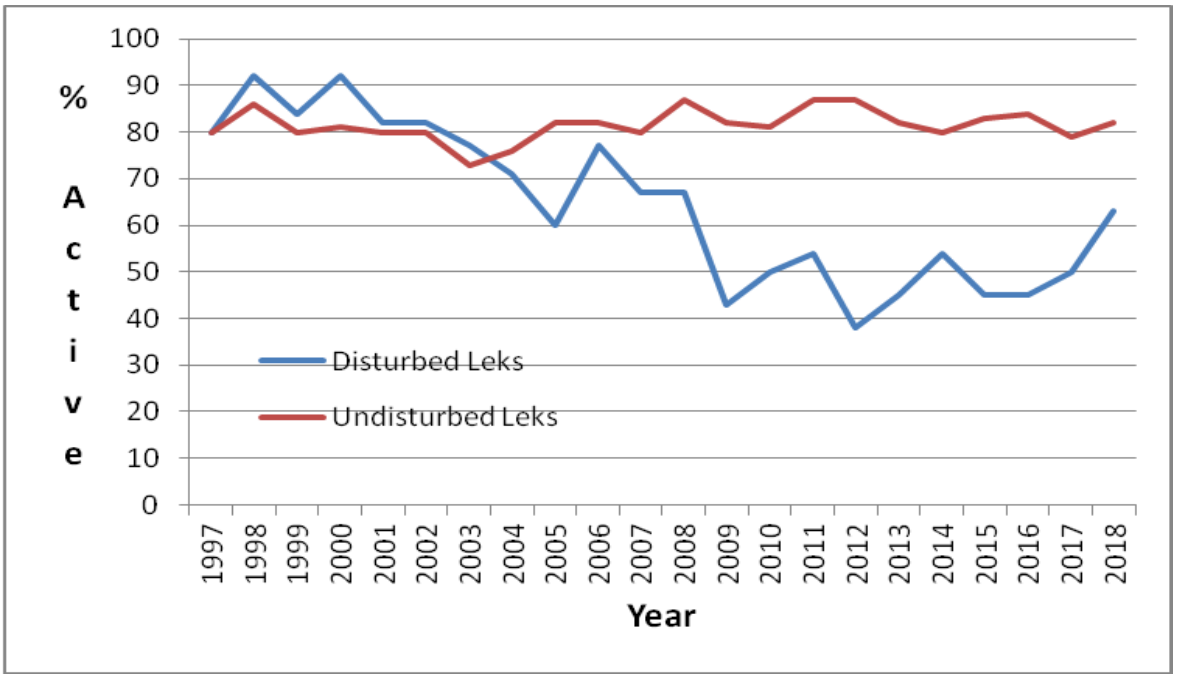


Figure 6. Proportion of active leks 1997-2018, Disturbed Leks verses Undisturbed Leks.

Population Trends and Estimates

No reliable population estimates have been made from data collected during 2018 (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 stabilization in 2016-17, and a decline in 2018. With the exception of the disturbed leks noted previously, the proportion of active leks in the UGRBWGA has remained relatively stable, ranging from 77% to 83% over the last ten years. Thus the average males/lek is a reasonable indicator of population trend over that time.

Harvest

The 2017 sage-grouse season was September 16 through September 30, a 15-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 2017 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 2017 harvest survey estimated that 402 hunters bagged 988 sage grouse and spent 921 days hunting, a decrease from 2016 and lower participation than most years during the last 10-year period. The average number of birds per day was 1.1, the average number of birds per hunter was 2.5, and the number of days spent hunting per hunter was 2.3 during 2017. 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 SGMA 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 7). 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.

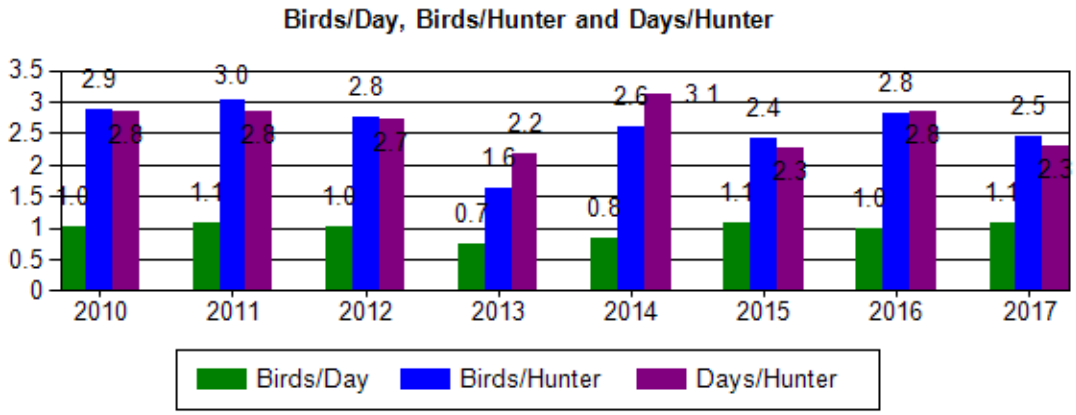


Figure 7. Sage grouse harvest rates 2010-2017 in SGMA D.

Wing Collections

Eighteen sage-grouse wing barrels were distributed throughout Sublette County in 2017 within SGMA 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. The wings are used to determine age and sex based on molting patterns and feather characteristics.

A total of 573 sage-grouse wings were collected from barrels in the UGRBWGA during 2017, higher than the 450 wings in 2016 and 482 wings collected during 2015. The number of wings collected during 2013 and 2014 was the lowest sample during the past 10-year period, ranging from 337 to 573. Of the 573 wings collected in 2017, 40% were juvenile birds and 41% were adult and yearling hens. The overall composition of wings in 2017 indicated a ratio of 1.0 chicks/hen (adult and yearling females), which typically results in lower lek counts the following spring. The 2016 wing collections showed a 0.6 chicks/hen ratio, representing the lowest production during the past 10-year period. Conversely, wing collections during 2015 showed 1.6 chicks/hen, resulting in the highest production during the past 10-year period (Figure 8). The combination of low chick production during the past two years explains the decline (-22%) in the 2018 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.

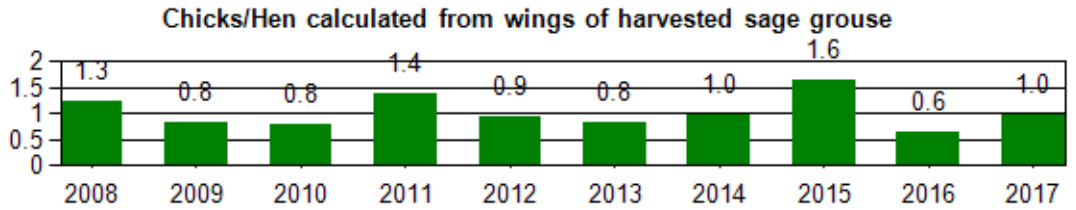


Figure 8. Sage grouse chick/hen ratios derived from wing collections 2008-2017, UGRBWGA.

Winter Distribution Surveys
No winter sage grouse surveys were conducted during the 2017-2018 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. Efforts to re-delineate WCA's throughout the UGRBWGA are planned for 2019.

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 not 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 transmitter locations 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 is currently continuing research and data collection efforts for this geophagy project.

Sage-Grouse Working Group
The UGRBWG 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 UGRBWG 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. The 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 completed an addendum to this 2007 plan (Upper Green River Basin Sage-Grouse Conservation Plan Addendum – 2014) that provides updated information on activities, projects, and management strategies within the UGRBWGA. Appropriation of State monies approved for sage grouse projects during past years have been allocated to the UGRBWG for 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 UGRBWG in recent years.

Management Summary

Data collected and reported in this 2017 Sage-Grouse Job Completion Report (June 2017 thru May 2018) gives insight to population trends. Analysis of lek trend 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, followed by a relatively stable population in 2016 and 2017, and population decline in 2018. Lek trend data suggest 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, 4% decrease in 2017, and 22% decrease in 2018. 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 sage grouse in and near natural gas fields. Existing leks within non-core habitats and within gas development fields 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, increasing in 2015-2016, and decreasing in 2017, 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), and hunter perceptions of sage-grouse populations.

Wing collection from barrels (drop locations) continues to provide good sample sizes to determine overall chick survival trends within the UGRBWGA. During 2008-2017 wing collections ranged from 31% to 58% of the reported harvest. The sample size of 573 wings in 2017 accounted for 58% of the reported harvest, the highest 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 (2013-2017) the chicks/hen ratio has varied from 0.6 to 1.6 and averaging 1.0 chicks/hen.

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 2007-2011 and remained stable from 2012-2014. 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 2017-18 winter was mild with low snow accumulations and above average temperatures followed by a relatively wet spring, and a decline in 2018 lek counts. The predictability of factors that determine nest success and chick survival remains complex and is likely more dynamic than just climate conditions such as precipitation and temperature trends.

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 abandonment of 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

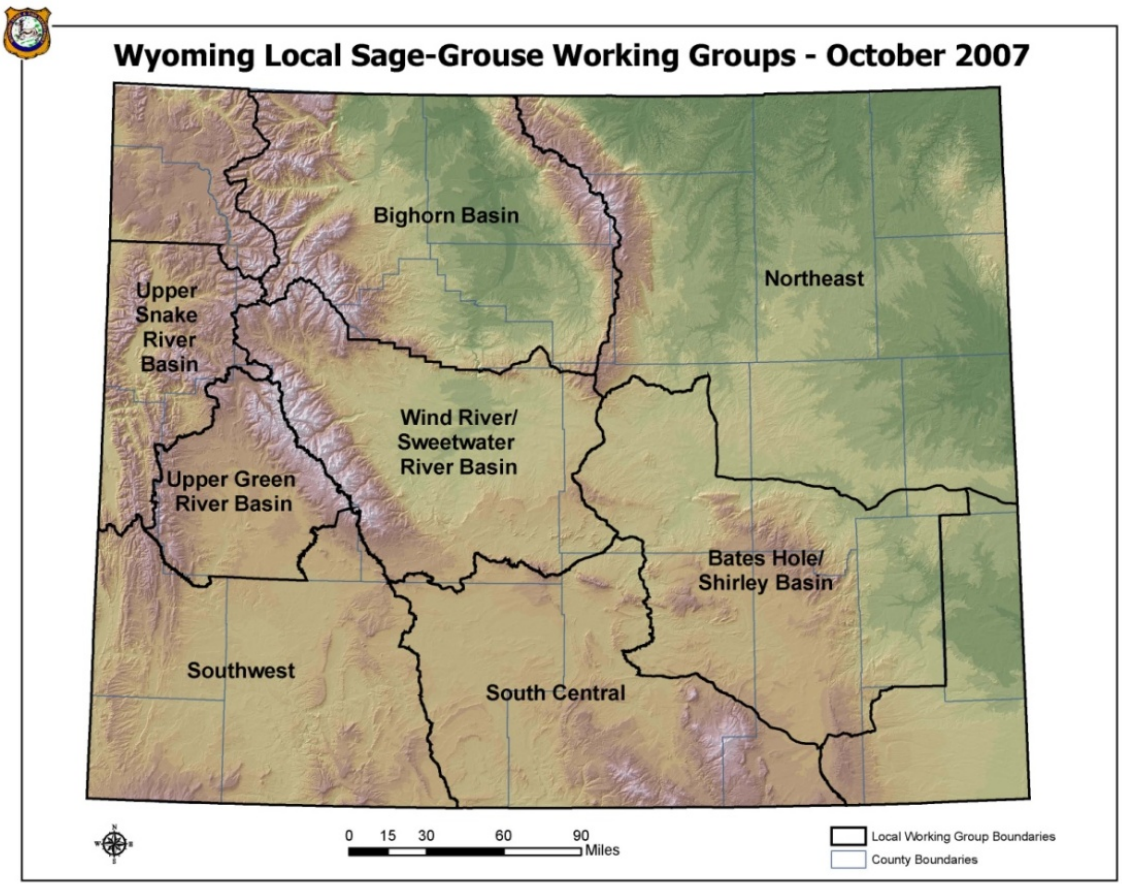
Christiansen, T. 2012. Chapter 12: Sage Grouse (*Centrocercus urophasianus*). Pages 12-1 to 12-55 in S.A. Tessmann and J. R. Bohne (eds). Handbook of Biological Techniques: third edition. Wyoming Game and Fish Department. Cheyenne.

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 Conservation Area
Job Completion Report

Species: Greater Sage-Grouse
Period Covered: June 1, 2017 – May 31, 2018
Management Areas: A; Jackson Region
Prepared by: Alyson Courtemanch, Wildlife Biologist



Sage Grouse Job Completion Report

Year: 2009 - 2018, Working Group: Upper Snake River Basin

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

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek (2)
2009	13	12	92	124	12.4
2010	14	12	86	151	16.8
2011	14	14	100	112	14.0
2012	16	15	94	142	14.2
2013	16	13	81	149	16.6
2014	16	13	81	163	16.3
2015	16	14	88	227	25.2
2016	15	15	100	227	20.6
2017	15	13	87	171	17.1
2018	15	2	13	18	9.0

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2009	13	0	0		#Error
2010	14	2	14	13	13.0
2011	14	0	0		#Error
2012	16	0	0		#Error
2013	16	0	0		#Error
2014	16	0	0		#Error
2015	16	0	0		#Error
2016	15	0	0		#Error
2017	15	2	13	5	5.0
2018	15	13	87	90	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 Job Completion Report

Year: 2009 - 2018, Working Group: Upper Snake River Basin

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

c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2009	13	12	92	124	12.4
2010	14	14	100	164	16.4
2011	14	14	100	112	14.0
2012	16	15	94	142	14.2
2013	16	13	81	149	16.6
2014	16	13	81	163	16.3
2015	16	14	88	227	25.2
2016	15	15	100	227	20.6
2017	15	15	100	176	16.0
2018	15	15	100	108	10.8

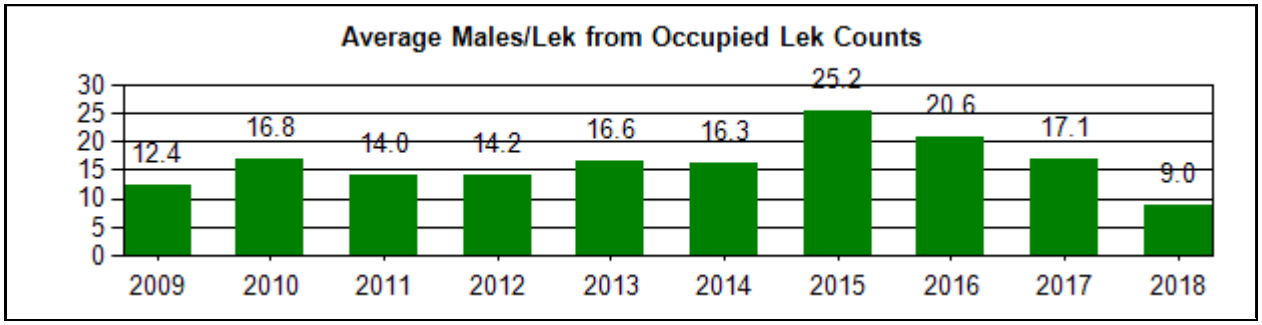
d. Lek Status

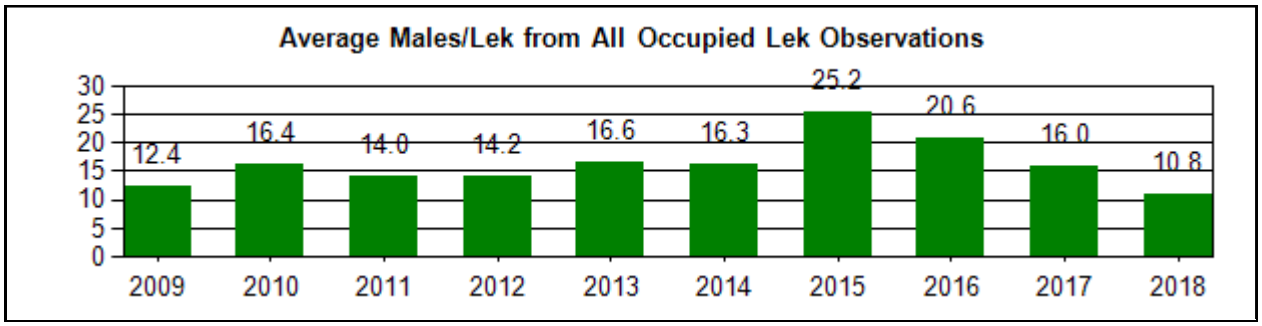
Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2009	10	1	1	11	90.9	9.1
2010	10	3	1	13	76.9	23.1
2011	8	3	3	11	72.7	27.3
2012	11	3	1	14	78.6	21.4
2013	9	4	0	13	69.2	30.8
2014	10	3	0	13	76.9	23.1
2015	9	5	0	14	64.3	35.7
2016	11	4	0	15	73.3	26.7
2017	11	4	0	15	73.3	26.7
2018	11	4	0	15	73.3	26.7

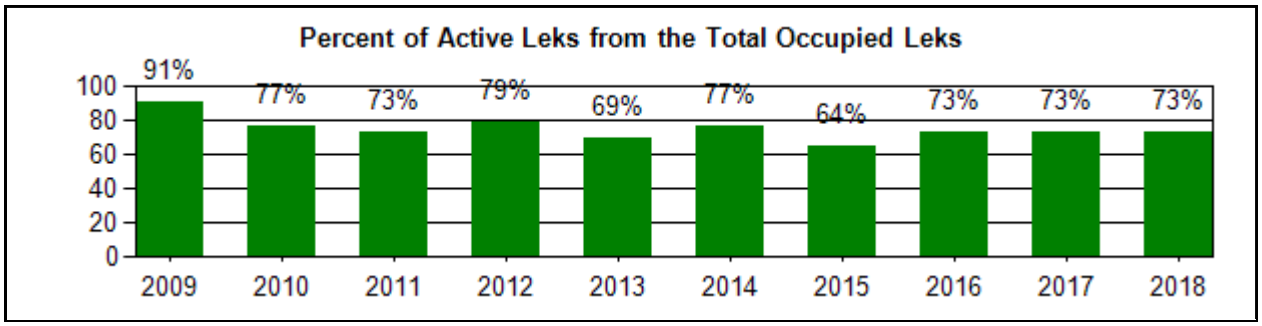
1) Occupied - Active during previous 10 years (see official definitions)

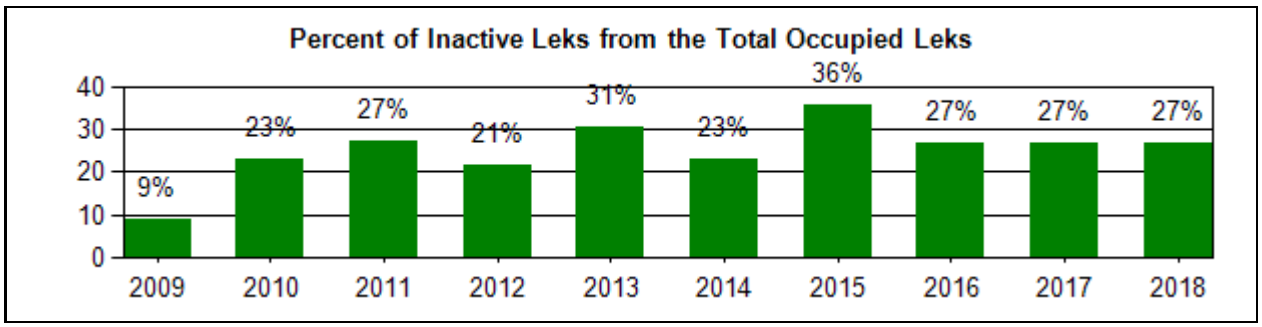
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

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


Average Males/Lek from Occupied Lek Counts
30
25
20
15
10
5
0
12.4
16.8
14.0
14.2
16.6
16.3
25.2
20.6
17.1
9.0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


Average Males/Lek from All Occupied Lek Observations
30
25
20
15
10
5
0
12.4
16.4
14.0
14.2
16.6
16.3
25.2
20.6
16.0
10.8
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


Percent of Active Leks from the Total Occupied Leks
100
80
60
40
20
0
91%
77%
73%
79%
69%
77%
64%
73%
73%
73%
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


Percent of Inactive Leks from the Total Occupied Leks
40
30
20
10
0
9%
23%
27%
21%
31%
23%
36%
27%
27%
27%
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Lek Monitoring

Sage-grouse data collection within the Upper Snake River Basin Conservation Area (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 2018. 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 16 males in 2018.

There are currently 12 occupied and 4 historical leks in the USRBCA that are monitored on an annual or semi-annual basis. In 2018, 12 occupied leks were monitored. Nine of the occupied leks were active with sage grouse observed. Three leks were inactive (no grouse observed) (Airport Pit, Simpson, and Dry Cottonwood). Beacon, 3 Bar H/Circle EW, McBride, and Antelope Flats leks were not checked in 2018. These leks are not checked on an annual basis because they have been unoccupied for many years.

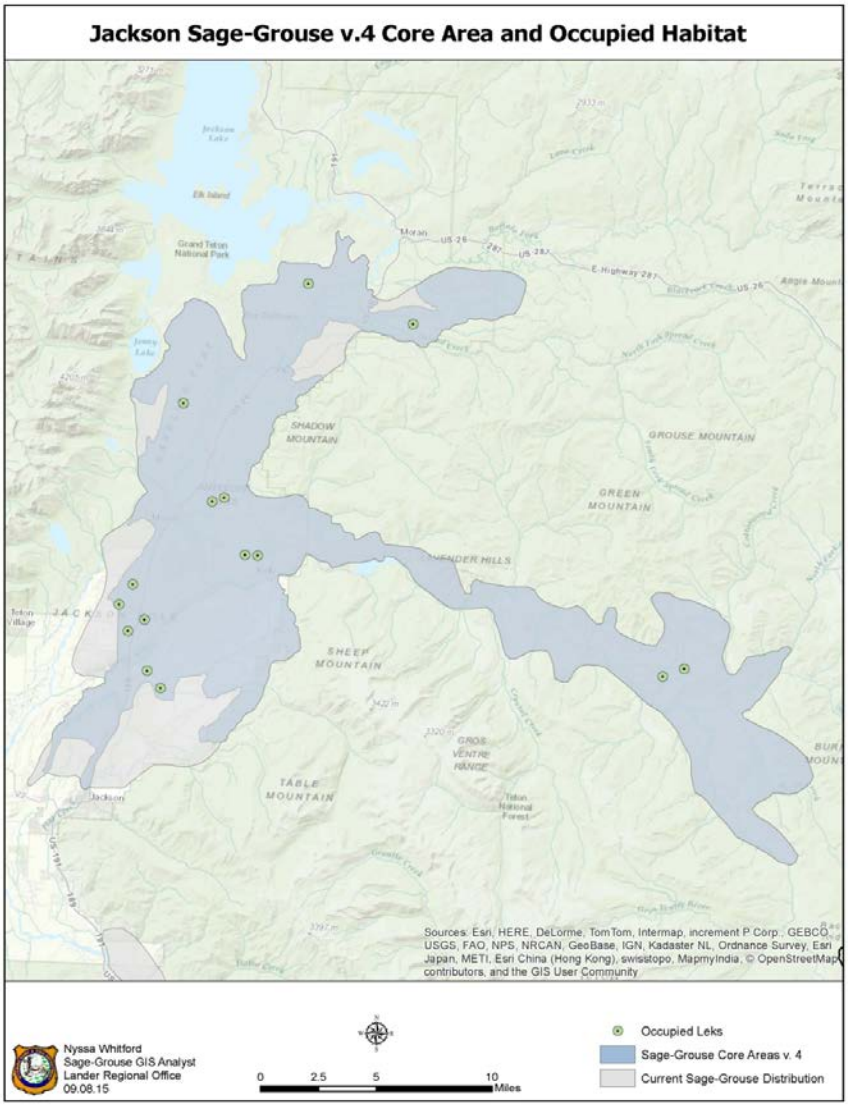


Figure 4. Sage-grouse core area, occupied habitat, and occupied leks in the Upper Snake River Basin Area (does not show Clark's Draw lek).

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
2018	13	NC	0	NC	NC	NC	28	5	7	12	6	0	8	0	16	5	100	8.3

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 2009 - 2016 years showed a generally increasing trend, however there was a steady decrease from 2017 – present (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 and to 8.3 in 2018.

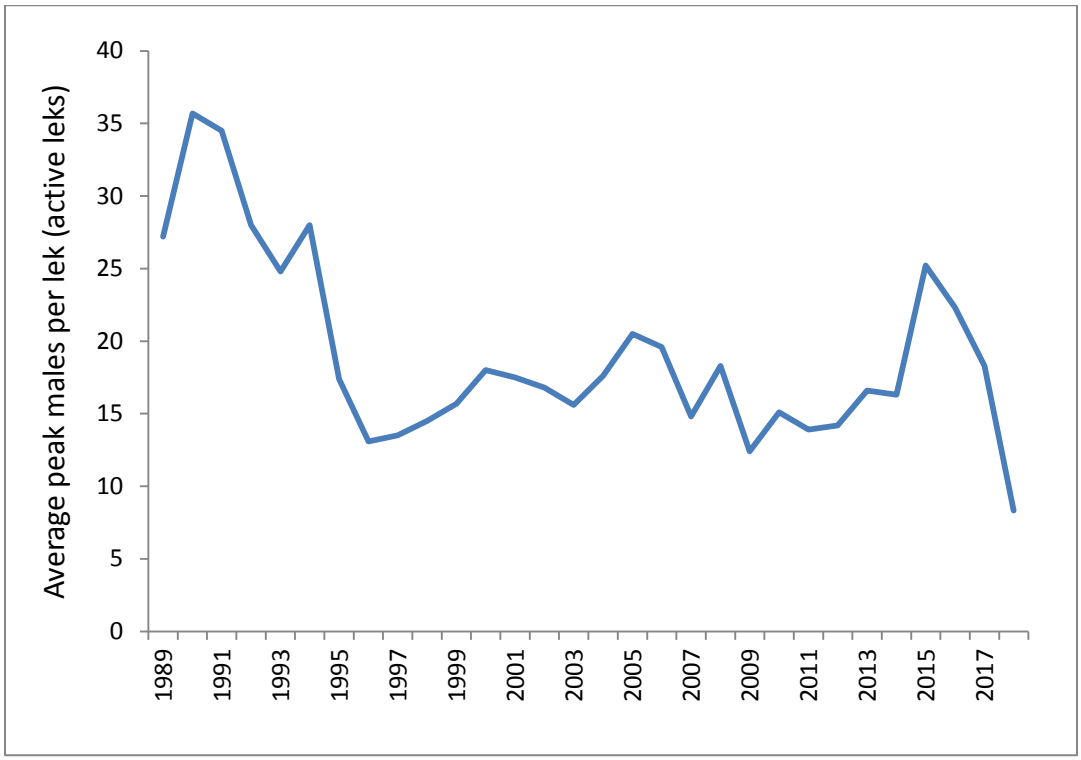


Figure 5. Average peak male counts for active leks in the Upper Snake River Basin Conservation Area, 1989-2018.

Data from the most recent 10 year period suggests that the population experienced a peak in 2015 and then declined from 2017 - 2018. In 2015 and 2016, the peak number of males were 227 and 223, respectively. However, peak males dropped to 165 in 2017 and to 100 in 2018 (Table 1). Despite increases in recent years, the drops in 2017 and 2018 are concerning. The long term persistence of this population continues to be of paramount concern to the local working group and resource managers.

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 has been allowed on lands under the jurisdiction of GTNP or the NER. In 2000, the hunting season was closed in the entire USRBCA and remains so today.

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 Core Area Policy can be found on the WGFD website and attached to the Statewide JCR.

The majority of sage-grouse habitat in the USRBCA is located within GTNP. There is also habitat in the Gros Ventre drainage on Bridger-Teton National Forest and the NER. Little habitat occurs on private lands.

No wildfires or prescribed burns occurred in significant areas of sagebrush habitat in sage-grouse core areas within the USRBCA this year. Grand Teton National Park built a traffic circle at Gros Ventre Junction on Highway 89, which permanently removed a relatively small area of sagebrush near the road. The Kelly Hayfields restoration project continued this year in GTNP, which is a project to remove smooth brome hayfields and reestablish a sagebrush community. There were no other significant human developments or surface disturbances in the core area during this reporting period.

Summer 2017 had average precipitation and moisture conditions. Winter 2017/2018 was very mild in Jackson Hole. Most sage grouse wintering areas had shallow or no snow for much of the winter due to several rain events in February and March 2018.

Conservation Planning

The Upper Snake River Basin Sage-Grouse Conservation Plan was updated in March 2014 and can be found on the WGFD website at:
https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Sage%20Grouse/SG_USR_CONSERVPLAN.pdf
The Upper Snake River Basin Sage-Grouse Working Group met several times during the reporting period to plan lek monitoring schedules, review lek survey data, discuss and fund special projects, and review other issues affecting sage-grouse in the area. The grouped reviewed and provided comments on the Jackson Hole Airport Wildlife Hazard Management Plan Environmental Analysis.

Special Projects

Sage-Grouse Movements, Productivity, and Habitat Use in the Spread Creek Area

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

Jason Wilmot, 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.

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

Mark Daluge, Teton County Weed and Pest District
Jason Wilmot, Bridger-Teton National Forest

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 counts in 2017 and 2018 represent 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.

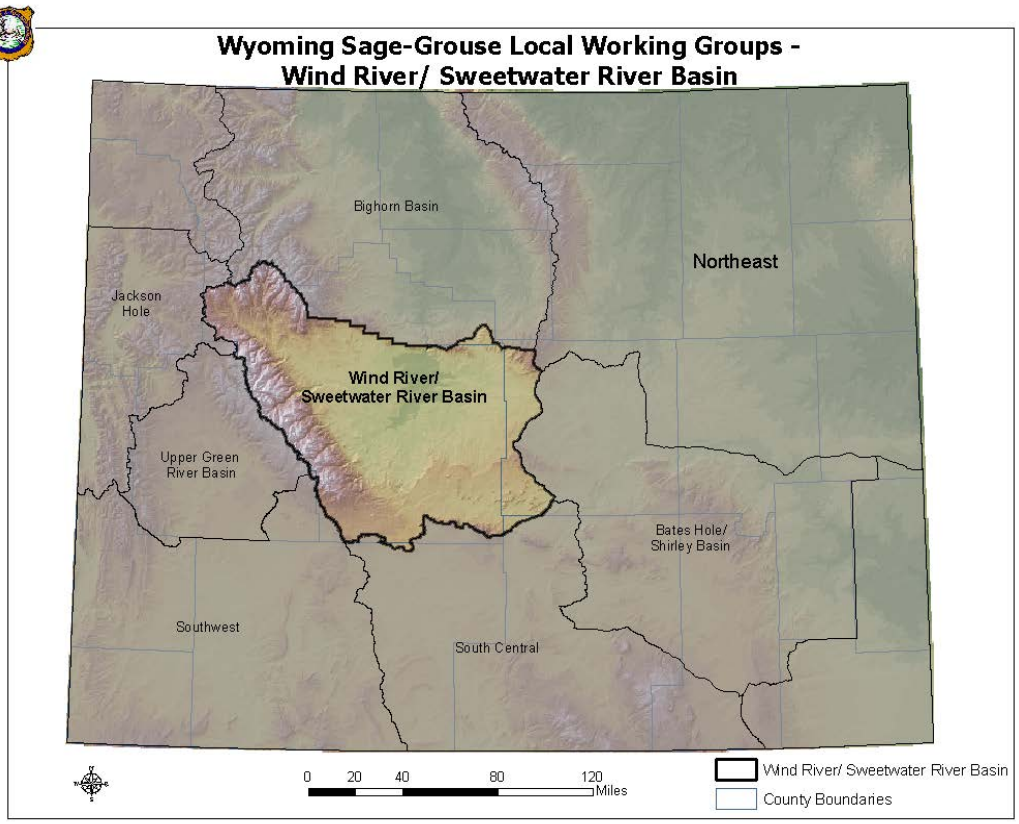
Patterson, R.L. 1952. The sage grouse in Wyoming. Sage Books, Denver, Colorado, USA.

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 Conservation Area
Job Completion Report

Species: **Greater Sage Grouse**
Mgmt. Areas: **E & WR, Lander Region**
Period Covered: **June 1, 2017 – May 31, 2018**
Prepared by: **Stan Harter, South Lander Wildlife Biologist**



Sage Grouse Lek Characteristics (2018)

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	203	79.0
Undetermined	17	6.6
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	147	57.2
BOR	4	1.6
Private	30	11.7
Reservation	60	23.3
State	16	6.2

Management Area	Number	Percent
E	196	76.3
WR	61	23.7

Lek Status	Number	Percent
Active	162	63.0
Inactive	26	10.1
Unknown	69	26.8

Sage Grouse Job Completion Report

Year: 2009 - 2018, 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)
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	116	54	4589	44.1
2016	212	95	45	4694	55.2
2017	207	87	42	3499	44.3
2018	208	109	52	3669	39.0

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
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	85	40	1595	25.3
2016	212	104	49	2744	34.3
2017	207	103	50	2542	33.4
2018	208	87	42	1402	22.3

Sage Grouse Job Completion Report

Year: 2009 - 2018, Working Group: Wind River/Sweetwater River

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

c. Leks Checked

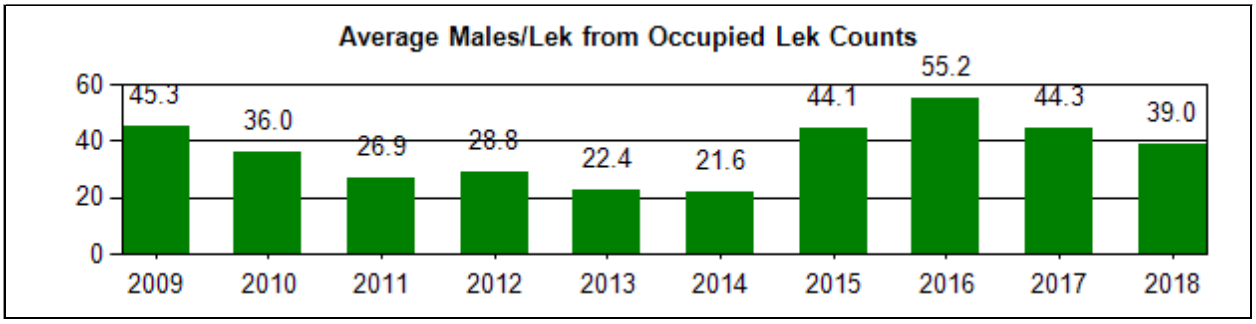
Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek (2)
2009	177	144	81	4473	39.2
2010	179	144	80	3281	28.3
2011	187	156	83	2979	24.8
2012	193	167	87	3257	25.1
2013	196	171	87	2599	18.8
2014	199	188	94	2836	20.1
2015	215	201	93	6184	37.0
2016	212	199	94	7438	45.1
2017	207	190	92	6041	39.0
2018	208	196	94	5071	32.3

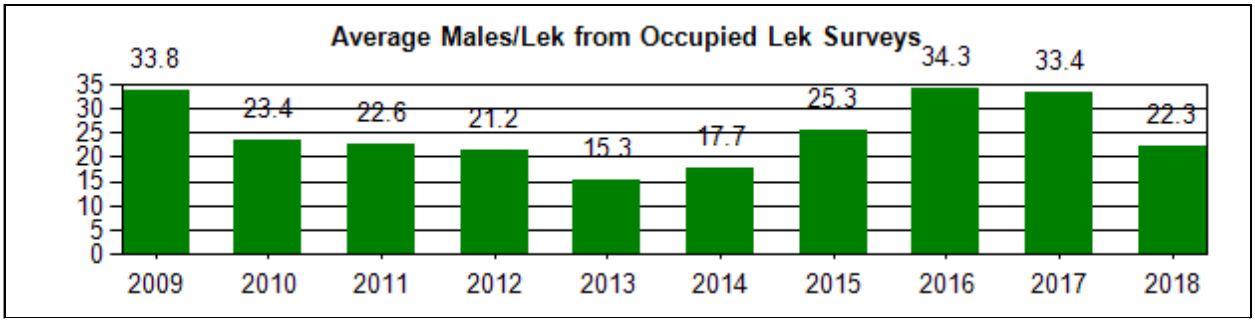
d. Lek Status

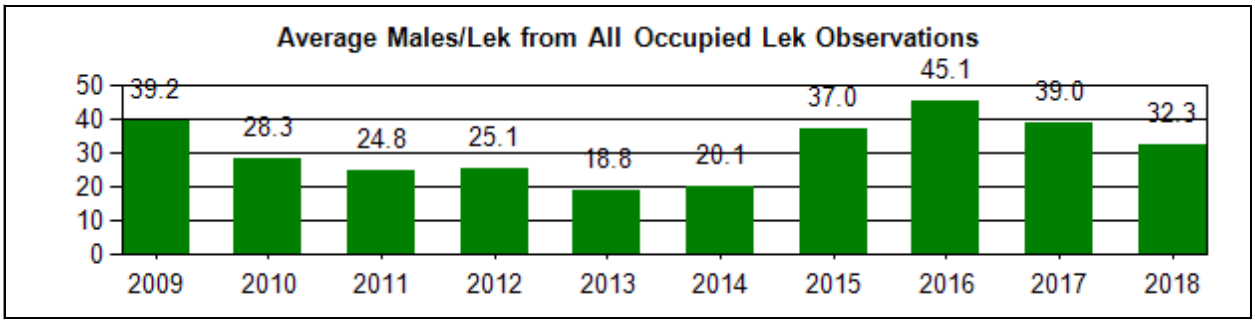
Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2009	114	14	16	128	89.1	10.9
2010	119	9	16	128	93.0	7.0
2011	121	10	25	131	92.4	7.6
2012	131	16	20	147	89.1	10.9
2013	139	14	18	153	90.8	9.2
2014	142	22	24	164	86.6	13.4
2015	167	17	17	184	90.8	9.2
2016	167	11	21	178	93.8	6.2
2017	156	8	26	164	95.1	4.9
2018	157	14	25	171	91.8	8.2

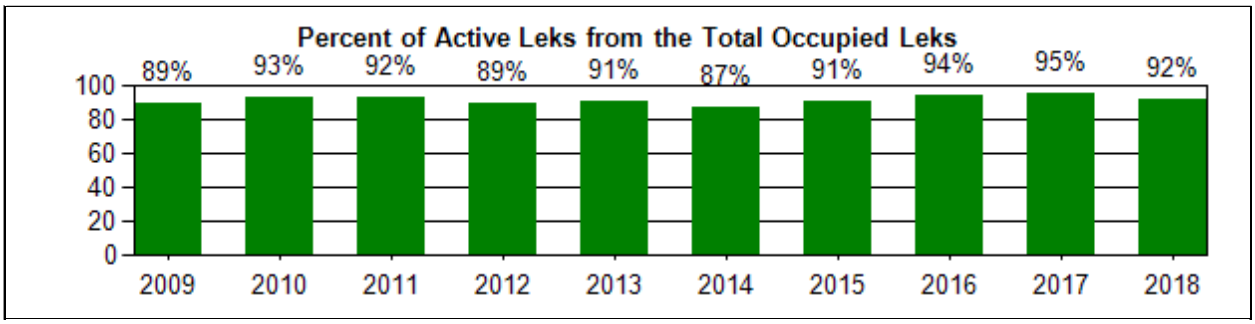
Sage Grouse Occupied Lek Attendance Summary

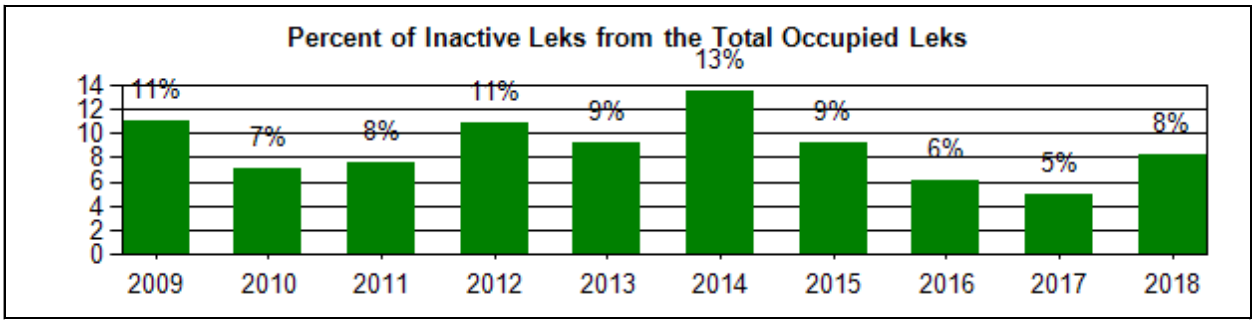
Year: 2009 - 2018, Working Group: Wind River/Sweetwater River











Sage Grouse Job Completion Report

Year: 2008 - 2017, 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
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
2017	Sep-16	Sep-30	15	2/4

b. Harvest

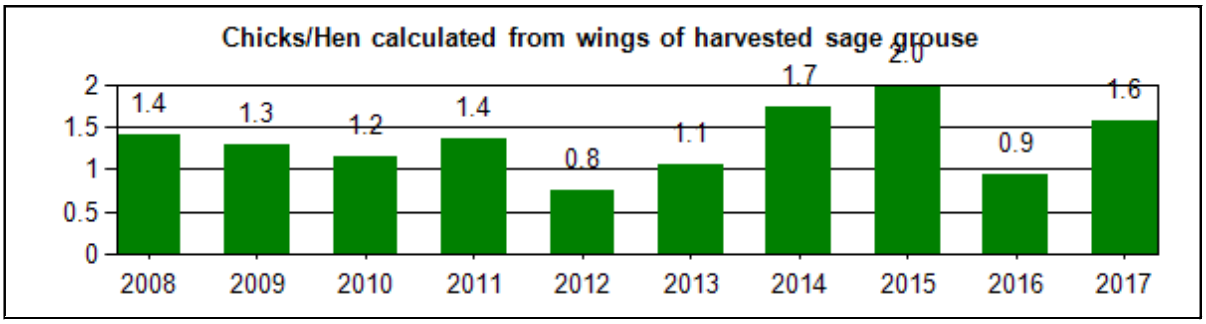
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2008	2144	863	2059	1.0	2.5	2.4
2009	2295	875	2114	1.1	2.6	2.4
2010	2495	1056	2866	0.9	2.4	2.7
2011	1779	771	1801	1.0	2.3	2.3
2012	2068	890	2296	0.9	2.3	2.6
2013	1240	565	1325	0.9	2.2	2.3
2014	1546	772	1853	0.8	2.0	2.4
2015	2158	737	1846	1.2	2.9	2.5
2016	1910	922	2264	0.8	2.1	2.5
2017	1364	630	1427	1.0	2.2	2.3
Avg	1,900	808	1,985	1.0	2.3	2.4

Sage Grouse Job Completion Report

Year: 2008 - 2017, Working Group: Wind River/Sweetwater River

4. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
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
2017	393	18.8	28.5	2.8	2.0	20.9	27.0	1.6



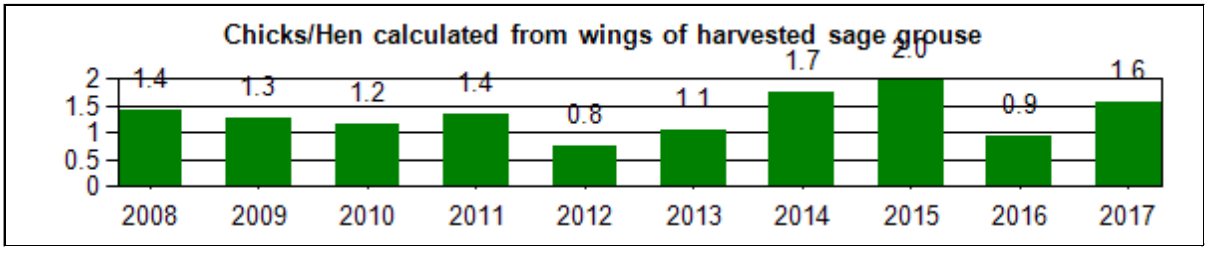
Sage Grouse Wing Analysis Summary

Year: 2017, Working Group: Wind River/Sweetwater River

Adult Males:	74	% of All Wings:	18.8
Adult Females:	112	% of All Wings:	28.5
Adult Unknown:	0	% of All Wings:	0.0
Total Adults:	186		
Yearling Males:	11	% of All Wings:	2.8
Yearling Females:	8	% of All Wings:	2.0
Yearling Unknown:	0	% of All Wings:	0.0
Total Yearlings:	19		
Chick Males:	82	% of All Wings:	20.9
Chick Females:	106	% of All Wings:	27.0
Chick Unknown:	0	% of All Wings:	0.0
Total Chicks:	188		
Unknown Sex/Age:	0		
Total for all Sex/Age Groups:	**393**		

Chick Males:	82	% of All Chicks	43.6
Yearling Males:	11	% of Adult and Yearling Males	12.9
Adult Males:	74	% of Adult and Yearling Males	87.1
Adult and Yearling Males:	85	% of Adults and Yearlings	41.5
Total Males:	167	% of All Sex/Age Groups	42.5
Chick Females:	106	% of All Chicks	56.4
Yearling Females:	8	% of Adult and Yearling Females	6.7
Adult Females:	112	% of Adult and Yearling Females	93.3
Adult and Yearling Females:	120	% of Adults and Yearlings	58.5
Total Females:	226	% of All Sex/Age Groups	57.5

Chicks:	188	% of All Wings:	47.8
Yearlings:	19	% of All Wings:	4.8
Adults:	186	% of All Wings:	47.3
Chicks/Hen	1.6		



Lek Monitoring

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 abundance data currently available for sage-grouse. Known leks indicate sage-grouse distribution within the WRSRCA as represented below in Figure 1.

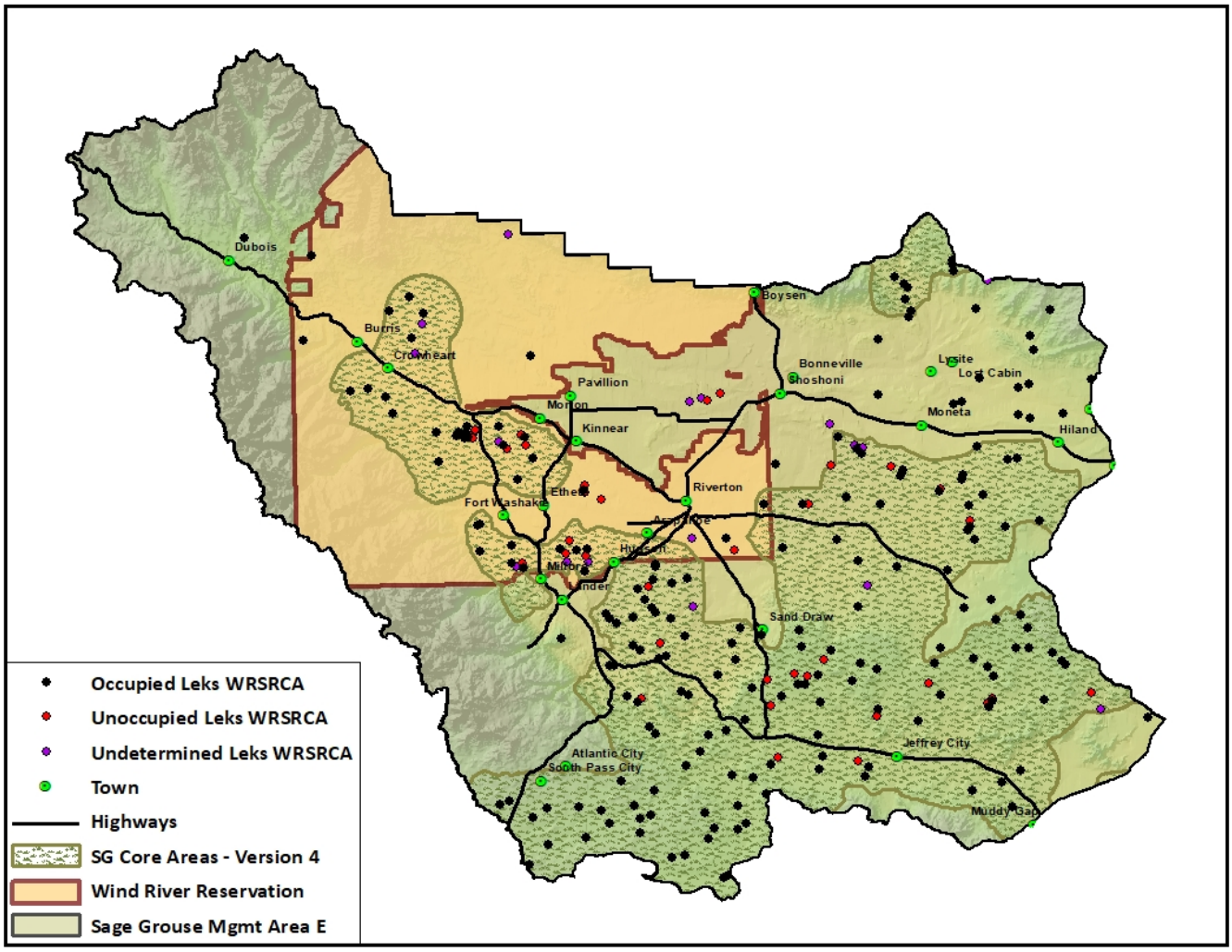


Figure 1. Known sage-grouse lek and core area distribution within the Wind River/Sweetwater River Conservation area.

Lek Attendance - 2018

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 203 known occupied leks within the conservation area in 2018, along with 37 unoccupied and 17 undetermined leks. As seen above in Figure 1, a good majority of leks of all 3 classification levels occur within the 3 core areas that are partially or entirely within the WRSRCA (Crowheart, Greater South Pass, and Washakie). 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 and 2018, mimicking Wyoming's statewide trends, but with generally higher numbers than the Wyoming average (Figures 2 and 3).

Personnel from WGFD, BLM, USFWS, and Shoshone-Arapahoe Tribal Fish and Game (SATFG), assisted by several researchers, consultants, and volunteers checked 196 of the 208 known occupied leks in the WRSRCA in 2018. Of those checked, 109 were counted and 87 were surveyed. Of the 171 leks where status was confirmed, 157 (91.8%) were active and 14 (8.2%) were inactive, with a slightly greater proportion in active status than the average since 2008.

Average male lek attendance for all leks checked dropped from 39.0 in 2017 to 32.3 in 2018. Average maximum male attendance at count leks also dropped from 44.3 in 2017 to 39.0 in 2018, still 7% above the count lek average since 2009 (36.4), but 49% below the peak in 2006 (76.0).

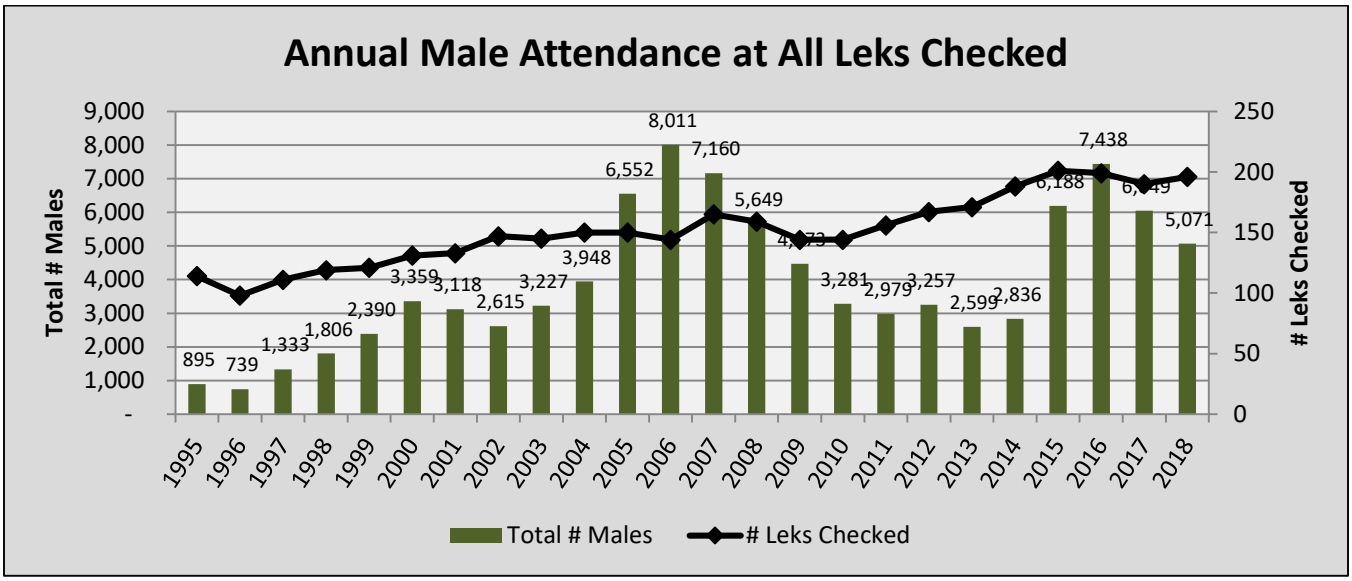


Figure 2. Total male attendance at all leks within the Wind River/Sweetwater River Conservation Area, 1995–2018.

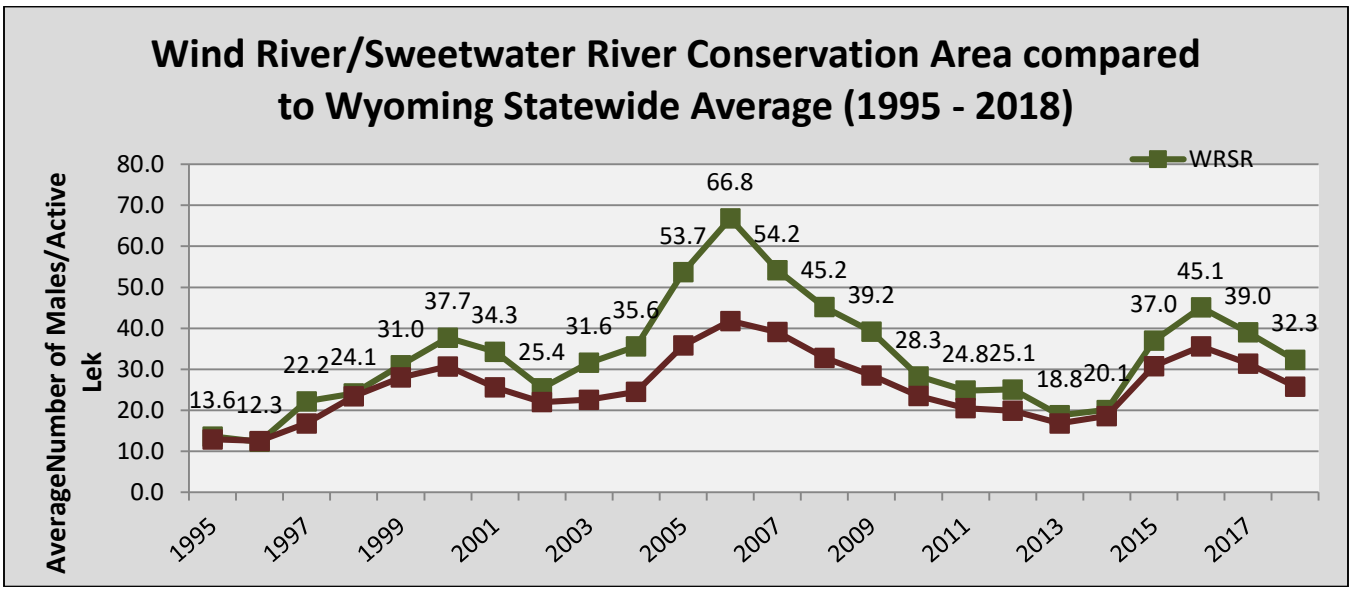


Figure 3. Average male lek attendance (all leks checked) in WRSRCA relative to Wyoming statewide trends, 1995 –2018.

Lek Perimeter Mapping

Nearly all leks in the WRSRCA have perimeters mapped, as of 2018.

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 2008 – 2017, and reported in detail for 2017 (pages 7 and 8). Wings collected from harvested birds during the 2017 hunting season yielded an average brood size of 1.6 chicks per hen, 23% above the average of 1.3 chicks per hen over the last 10 years. This was the third highest average brood size since 2008, and was 45% higher than in 2016. Population growth typically requires 1.7 chicks/hen or more based on historic statewide averages. With chick survival in 2017 being just below that threshold, albeit substantially higher than in 2016, male lek attendance in 2018 still showed a 17% decline.

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 on page 6, bag limits, season lengths, and harvest levels area within acceptable levels for the "population" of sage grouse within the WRSRCA. Wings are collected annually from harvested birds in 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. Sage-grouse hunting on tribal lands within the Wind River Reservation is minimal and data are not included in this report.

Sage-grouse hunting season in Management Area E lies entirely within Wyoming Hunt Area 1, which has been "standardized" since 2009, keeping opening day on the 3rd Saturday in September. The 2017 sage-grouse hunting season was 15 days long (Sept. 16 – 30). Hunter numbers dropped 32% and sage grouse harvest was 28.6% lower in 2017, compared with the 2016 hunting season. Hunter effort (days/bird) and (birds/hunter) statistics remained near the 10-year average (Page 6).

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

Habitat monitoring is discussed in past WRSRCA JCRs, and in the 2007 WRSRCA Local Sage Grouse Conservation Plan and 2014 Addendum. No habitat monitoring transects were measured in 2017, except for vegetation monitoring in association with research in the Jeffrey City area by the University of Wyoming (Leonard, et al., ongoing). However, implementation of Rapid Habitat Assessments (RHAs) has begun as part of the South Wind

River/Sweetwater Mule Deer Initiative, to develop a baseline from which to gauge overall habitat condition. A minimum of 5 RHAs covering 3,614 acres of shrub/rangeland habitats were completed within the WRSRCA in 2017, and offer insight as to the condition of sage-grouse habitats within the South Wind River and Sweetwater Mule Deer herd units that overlap the WRSRCA.

Winter Habitat Use Survey

Limited winter observations were collected in 2017-18, mostly as opportunistic observations during deer, elk, and moose classifications flights or random ground surveys.

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. No new treatments occurred during 2017.

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 2017. 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 2017 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. Citations for ongoing research and published works from the WRSRCA are included at the end of this report.

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 2017.

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

Ongoing Research within the Wind River/Sweetwater River Sage-grouse Conservation Area

Response of Greater Sage-grouse to Treatments in Wyoming Big Sagebrush –
Leonard, Smith, Beck, et al - University of Wyoming

Comparison of Avian and Mammalian Predators in Sage-Grouse Core and Non-Core Areas: Assessing Predator Abundance and Responses to Anthropogenic Features –
Claire L. Revekant[1] and Jonathan B. Dinkins[1] [1]Department of Animal and Rangeland Sciences, Oregon State University, Corvallis, OR 97331

Published Works

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., A.D. Chalfoun, K.T. Smith, and J.L. Beck. 2018. Nontarget effects on songbirds from habitat manipulation for greater sage-grouse: implications for the umbrella species concept. The Condor: Ornithological Applications 120(2):439-455.

Carlisle, J.D., D.R. Stewart, and A.D. Chalfoun. 2017. An invertebrate ecosystem engineer under the umbrella of sage-grouse conservation. Western North American Naturalist 77(4):450–463.

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.

Carlisle, J.D., G. Bedrosian, and T.L. McDonald. 2017. The influence of Greater Sage-Grouse management on risks faced by Golden Eagles in sagebrush ecosystems: a spatially explicit assessment of the umbrella species concept. Prepared for Western Golden Eagle Team, U.S. Fish and Wildlife Service. Final report, Western EcoSystems Technology, Inc., 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. 2017. Quantifying overlap and fitness consequences of migration strategy with seasonal habitat use and a conservation policy. Ecosphere 8(11):e01991. 10.1002/ecs2.1991

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.

Forbey, J.S., G.L. Patricelli, D.M. Delparte, A.H. Krakauer, P.J. Olsoy, M.R. Fremgen, J.D. Nobler, L.P. Spaete, L.A. Shipley, J.L. Rachlow, A.K. Dirksen, A. Perry, B.A. Richardson, and N.F. Glenn. 2017. Emerging technology to measure habitat quality and behavior of grouse: examples from studies of greater sage-grouse. Wildlife Biology 2017(SP1)

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. 2018. Effects of mowing and tebuthiuron treatments on the nutritional quality of Wyoming big sagebrush. Rangeland Ecology & Management

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.