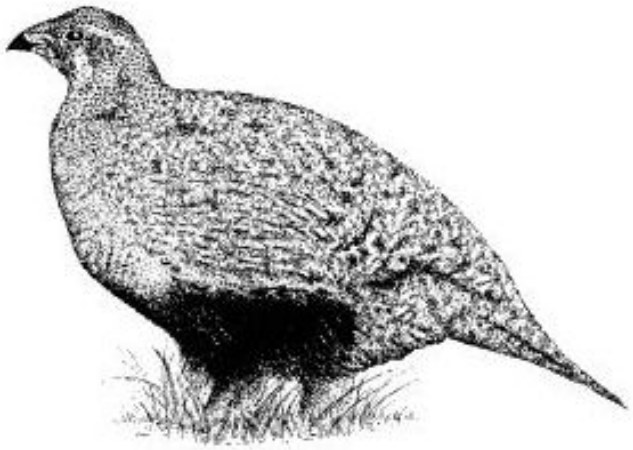
2013
GREATER SAGE-GROUSE
JOB COMPLETION REPORT



June 1, 2013 – May 31, 2014

Wyoming Game and Fish Department
Cheyenne, WY

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June 2013-May 2014

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Wyoming Sage-Grouse Job Completion Report

Conservation Plan Area: **Statewide Summary**
Period Covered: **6/1/2013– 5/31/2014**
Prepared by: **Tom Christiansen – Sage-grouse Program Coordinator**

INTRODUCTION

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 the 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. Since 2006, average lek size has declined though not to levels recorded in the mid-1990s.

In March 2010 the U.S. Fish and Wildlife Service (Service) issued a decision of "warranted but precluded" for listing Greater Sage-grouse as threatened or endangered under the Endangered Species Act. This means the bird has become a "candidate" for listing but is precluded from immediate listing due to higher priorities. This status is reviewed annually by the Service.

Governor Matt Mead issued an Executive Order in 2011 which reiterated and clarified the intent of Wyoming's Core Area Strategy (CAS) originally developed under former Governor Freudenthal's administration with the assistance of the Governor's Sage-Grouse Implementation Team (SGIT) and the local sage-grouse working groups (LWGs). The CAS addresses the threats (habitat loss and fragmentation and insufficient regulatory mechanisms) specifically identified by the Service in their 2010 listing decision. The Core Areas are shown in Figure 1.

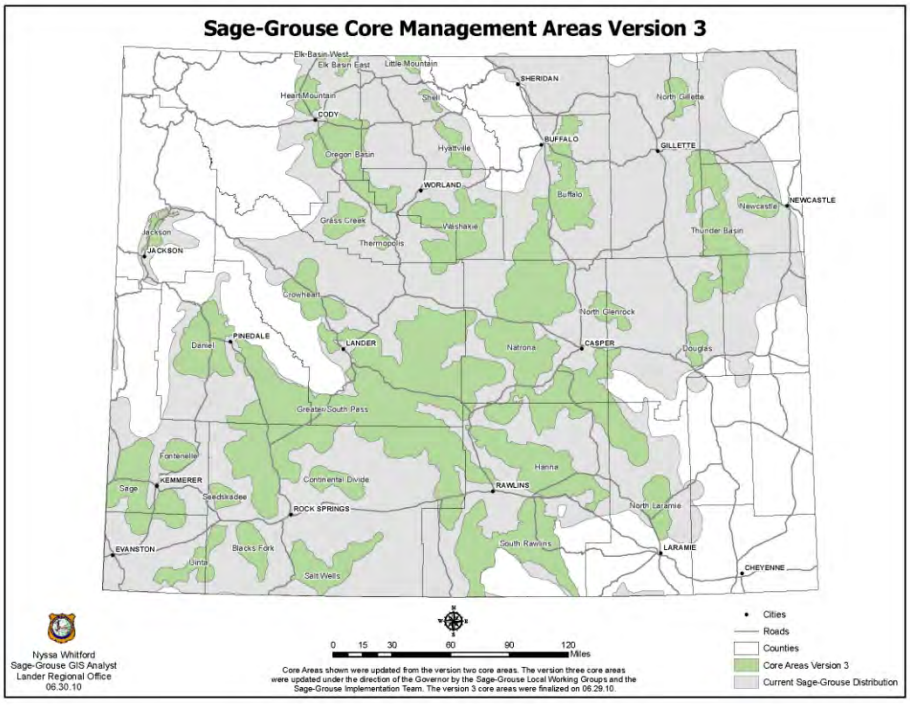


Figure 1. Wyoming Core Areas (version 3).

The 2014 Legislature approved the 2015-2016 biennium General Fund budget which again includes funding for the sage-grouse program. Allocation of over $1 million of these funds to local projects will begin in mid-2014 and will continue through mid-2016.

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. Knick and Connelly (2011), provide state of the art information on the ecology and conservation of Greater Sage-grouse.

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 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.

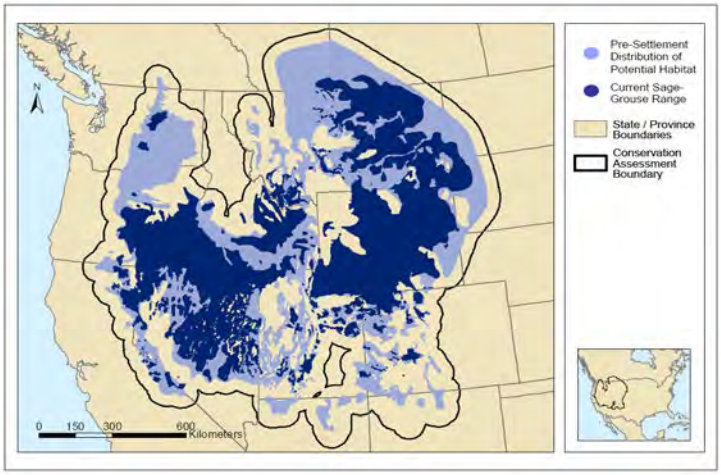


Figure 3. Current distribution of sage-grouse and pre-settlement distribution of potential habitat in North America (Schroeder 2004). For reference, Gunnison sage-grouse in SE Utah and SW Colorado are shown.

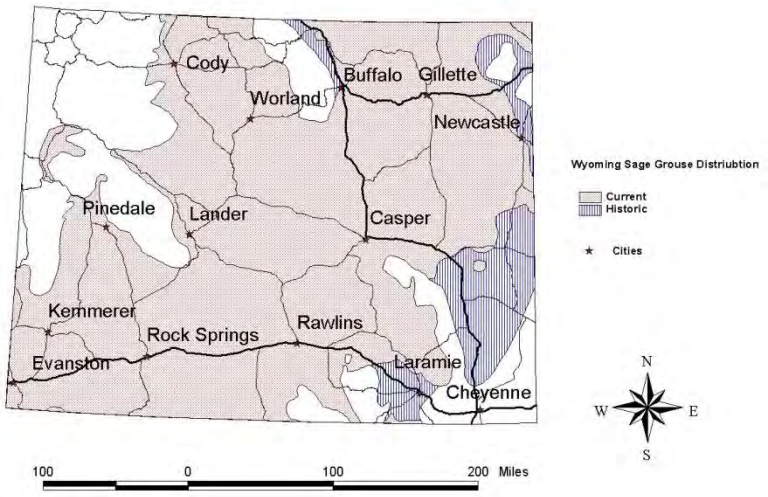


Figure 4. Sage-grouse distribution in Wyoming.

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.

Endangered Species Act Status

In March 2010 the U.S. Fish and Wildlife Service (Service) issued a decision of "warranted but precluded" for listing Greater Sage-grouse as threatened or endangered under the Endangered Species Act. This means the bird has become a "candidate" for listing but is precluded from immediate listing due to higher priorities. This status is reviewed annually by the Service. The Department's reply to the Service's annual data call to assist in their annual review is on file in the WGFD Habitat Protection Program's office in Cheyenne.

In its decision document, the Service specifically cited Wyoming's Core Area Strategy (CAS - described below) as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude a future listing.

The Wyoming Game and Fish Department and Commission maintain management authority over candidate species and management emphasis will continue to focus on implementation of the Core Area Strategy.

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 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 most recent seven-year period during which the average number of cocks observed on leks declined, though not to levels documented in the mid-1990s. Thus, there has been a long-term decline, a mid-term increase and short-term decline in the statewide sage-grouse population. The mid- and 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. Figures 12 and 13 illustrate sage-grouse density changes between 2005-07 and 2012-14 based on peak male lek counts and surveys.

Recent analyses suggest 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.

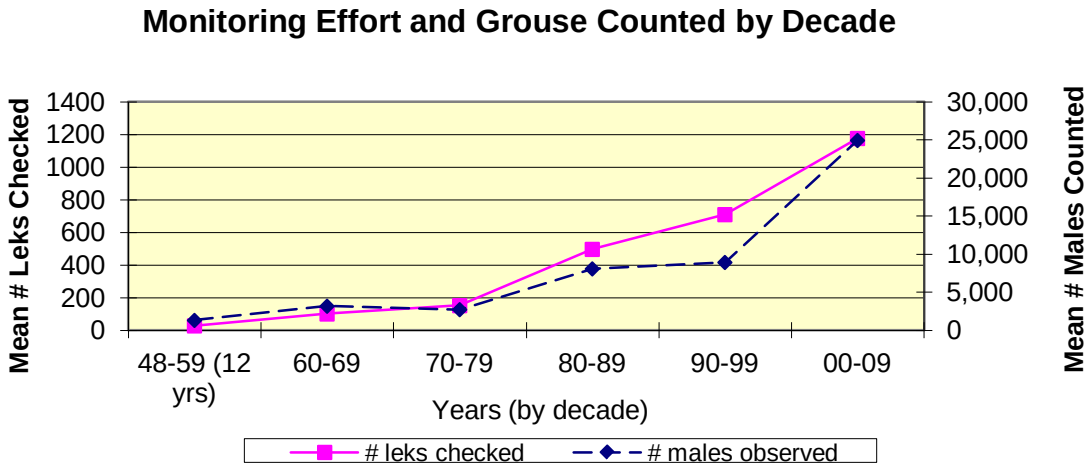


Figure 5. Mean annual numbers of leks checked (monitoring effort) and male grouse counted in Wyoming 1948-2009 by decade.

A new sage-grouse database was developed in 2012 in order to improve efficiency, reduce errors, and better facilitate data analysis. Changes were made to the manner in which lek data are calculated and reported in Table 1. The new version is based solely on "occupied" leks. The past version suggested that was the case in the title of Table 1, but when unoccupied leks were monitored those data were also included in the Table. The result of this change is that the number of "known occupied" leks is now more accurate, but reflects fewer leks than in the previous version. Similarly, the new version calculates average male lek attendance using only monitoring observations where one or more male grouse were observed strutting. The old version included a count of "0" males for leks where activity was confirmed by the presence of sign but no birds were observed. Together, these two changes result in somewhat higher, but more accurate, average male attendance for active leks than previously reported. The changes do not result in any change in population trend based on average male lek attendance. Interpreted population increases and decreases over time remain the same so no revisions to past reports are required.

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 no longer being reported since our data collection techniques is not designed to accurately capture these data and is therefore not a useful figure in assessing population trend.

Lek monitoring data for the 2014 breeding season are summarized in Tables 1a-d and Figures 6-11. Department personnel and others checked 89% (1,606/1,812) of the known occupied leks in 2014 (Table 1-c). Male attendance at all leks visited (counts and surveys) averaged 18.6 males per lek during spring 2014, an 11% increase above the 16.7 males/lek observed in 2013 but still 55% below the 41.8 males/lek observed in 2006. For the 10-year period (2005-2014), average male lek attendance ranged from 16.7 males/lek in 2013, the lowest average males per lek since 1997, to 41.8 males/lek in 2006, which was the highest average males per lek figure recorded since 1978.

The number of active, occupied leks decreased from 80% in 2013 to 76% in 2014. While this suggests a continuing population decline, monitoring efforts have increased in recent years in order to reduce the number of "unknown" annual status leks to better determine active or inactive status. This had the effect of increasing the proportion of known inactive leks because a higher proportion of "unknown" leks were actually inactive but monitoring intensity was not sufficient to meet the criteria for being "inactive." See the Northeast JCR for a local exception to this analysis/conclusion.

In 2014, about 700 more male sage-grouse were observed on 21 more active leks checked. Cumulatively, the lek attendance data suggest there were more grouse in 2013 year than in 2012. Together with the favorable nesting/brood reports so far this spring/summer, the decline in sage-grouse numbers documented in recent years may be ending. It is important to note that the number of leks sampled increased substantially 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 does not yet exist, 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.

Three 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, Garton et al. 2011). The trends reflected by these analyses are generally consistent with each other and with that shown in Figure 6. These or similar methods of analysis should be incorporated into Wyoming's JCRs as they mitigate some of the limitations of using only average males/lek to determine population trend.

Table 1. Lek Attendance Summary (Occupied Leks)[1]

a. Leks Counted

Year	Occupied	Counted	Percent Counted	Peak Males	Avg Males / Active Lek [2]
2005	1474	452	31	16357	41.8
2006	1545	462	30	21875	53.4
2007	1611	510	32	21329	48.3
2008	1671	565	34	19429	39.2
2009	1700	583	34	15553	31.9
2010	1733	653	38	14154	27.2
2011	1769	648	37	11299	22.6
2012	1805	722	40	12671	22.9
2013	1816	649	36	10613	20.7
2014	1812	773	43	11421	20.5

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek[2]
2005	1474	795	54	19130	31.6
2006	1545	887	57	22772	34.6
2007	1611	922	57	22242	33.1
2008	1671	835	50	16163	27.5
2009	1700	868	51	15061	25.5
2010	1733	828	48	11605	20.1
2011	1769	845	48	10147	18.7
2012	1805	833	46	8662	16.7
2013	1816	934	51	7502	13.2
2014	1812	833	46	8392	16.5

c. Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek [2]
2005	1474	1247	85	35487	35.6
2006	1545	1349	87	44647	41.8
2007	1611	1432	89	43571	39.1
2008	1671	1400	84	35592	32.9
2009	1700	1451	85	30614	28.4
2010	1733	1481	85	25759	23.5
2011	1769	1493	84	21446	20.5
2012	1805	1555	86	21333	19.9
2013	1816	1583	87	18115	16.7
2014	1812	1606	89	19813	18.6

d. Lek Status

Year	Active	Inactive[3]	Unknown	Known Status	Percent Active	Percent Inactive
2005	1002	92	153	1094	91.6	8.4
2006	1084	107	158	1191	91.0	9.0
2007	1135	128	169	1263	89.9	10.1
2008	1102	155	143	1257	87.7	12.3
2009	1098	184	169	1282	85.6	14.4
2010	1118	194	169	1312	85.2	14.8
2011	1085	212	196	1297	83.7	16.3
2012	1129	239	187	1368	82.5	17.5
2013	1115	281	187	1396	79.9	20.1
2014	1094	353	151	1447	75.6	24.4

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)

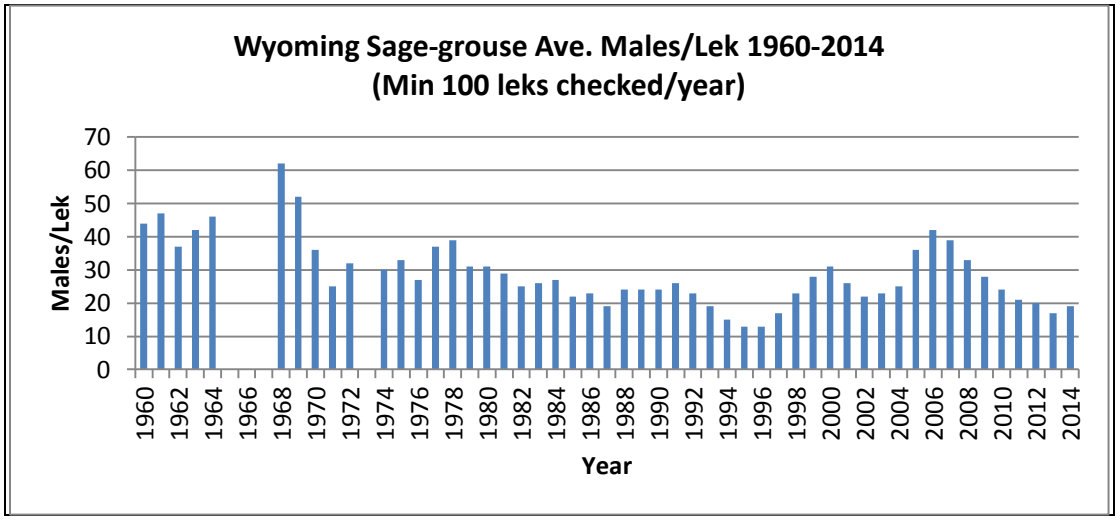


Figure 6. Average number of males per lek counted in Wyoming from 1960-2014 with a minimum of 100 leks checked each year.

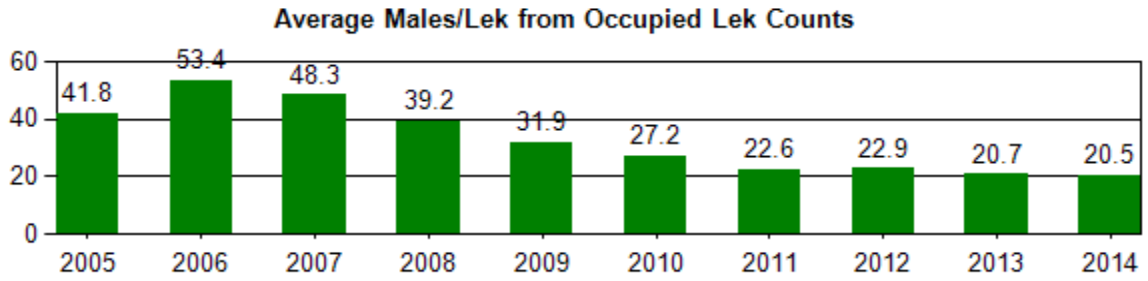


Figure 7. Average males/lek from occupied lek counts.

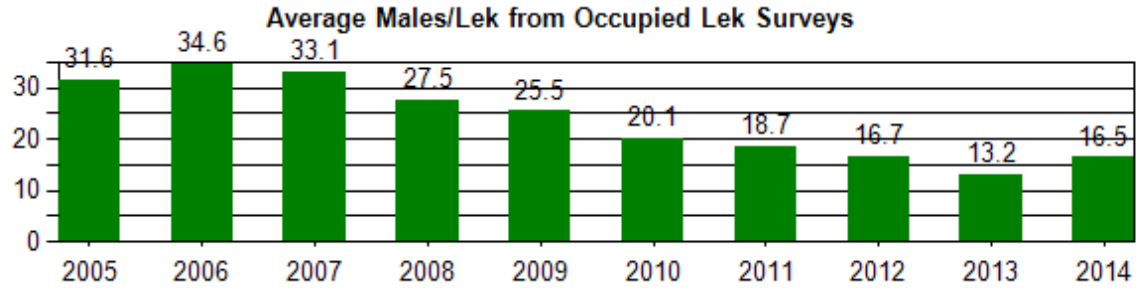


Figure 8. Average males/lek from occupied lek surveys.

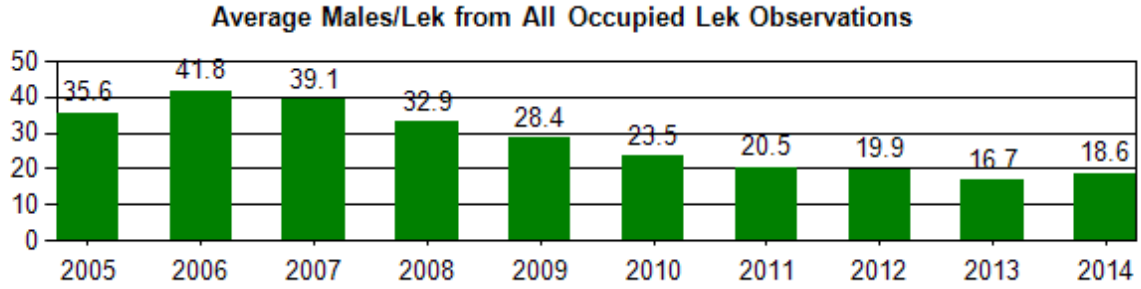


Figure 9. Average males/lek from all occupied leks checked (counts+surveys).

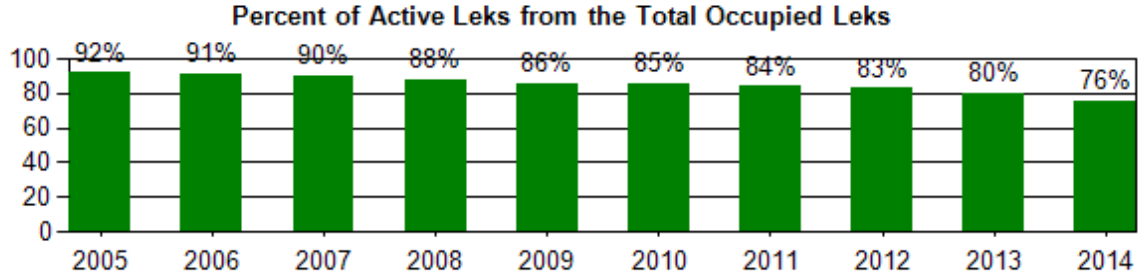


Figure 10. Percent active leks from the occupied leks checked with known status.

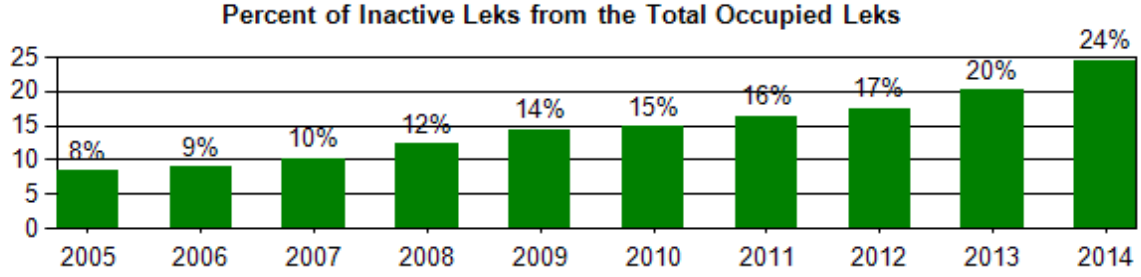
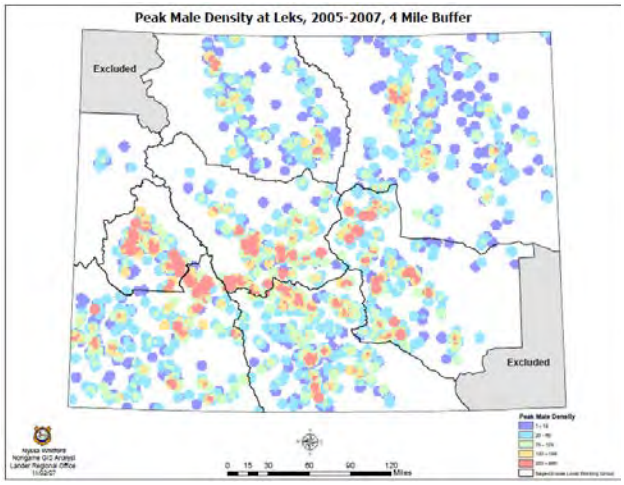
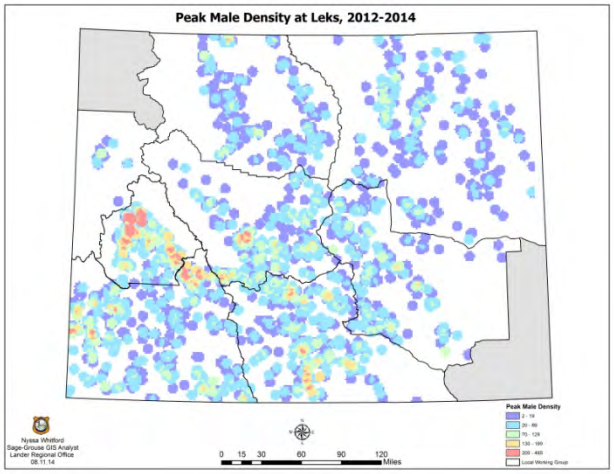


Figure 11. Percent inactive leks from the occupied leks checked with known status.



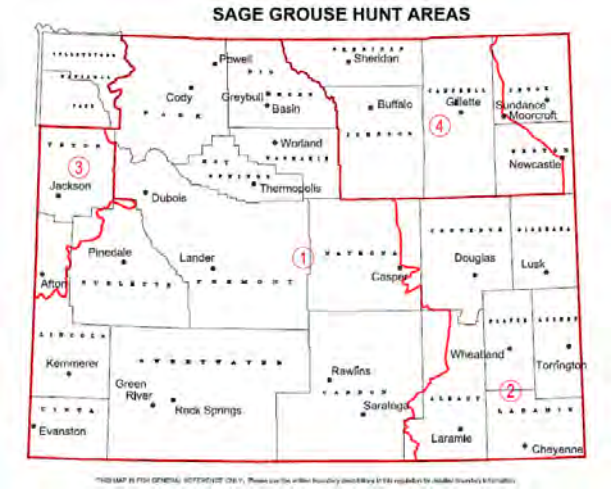


Figures 12 and 13. Relative sage-grouse density comparing 2005-2007 and 2012-2014 based on peak male lek counts and surveys.

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 2013 hunting season (Figure 14, Table 2) was 6 days shorter than 2011 due to the calendar effect of opening the season on the third Saturday of September. In 2012 the third Saturday was September 15 but in 2013 it was September 21.



Area	Season Dates	Daily/Poss. Limits	Falconry
1	Sept. 21-Sept. 30	2/4	Sept. 1-Mar. 1
2, 3	Closed	Closed	Closed
4	Sept. 21-Sept. 23	2/4	Sept. 1-Mar. 1

Figure 14 and Table 2. 2013 sage-grouse hunting season map and regulations.

Hunting seasons in Wyoming are shown in Table 3a. 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 in 2002 and 2003. 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. But since 2004, hunter numbers and harvest have rebounded as a result of generally increased sage-grouse numbers. Hunter numbers increased and harvest declined greatly between 2012 (4,700 hunters/9,869 birds) and 2013 (3,383 hunters/5,726 birds). The 2012 harvest data were well below the 10-year averages. The decline in the number of birds harvested since 2006 is generally correlated with the declining population indicated by lek attendance trends. The six day shorter season, as well as poor weather conditions in some locations, likely reduced hunter participation and harvest as well.

Table 3. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
2004	Sep-23	Oct-3	11	2/4
2005	Sep-23	Oct-3	11	2/4
2006	Sep-23	Oct-3	11	2/4
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009-1	Sep-19	Sep-30	12	2/4
2009-4	Sep-19	Sep-25	7	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

b. Harvest

Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2004	11783	5436	13229	0.9	2.2	2.4
2005	13178	5230	12175	1.1	2.5	2.3
2006	12920	5412	11981	1.1	2.4	2.2
2007	10378	5180	10699	1.0	2.0	2.1
2008	10302	4745	10065	1.0	2.2	2.1
2009	11162	4732	10812	1.0	2.4	2.3
2010	11057	4732	11434	1.0	2.3	2.4
2011	10290	4568	11186	0.9	2.3	2.4

2012	9869	4700	11342	0.9	2.1	2.4
2013	5726	3383	7672	0.7	1.7	2.3
Avg	10,667	4,812	11,060	1.0	2.2	2.3

The number of sage-grouse wings collected from hunters decreased by 37% in 2013, which is similar to the 42% decrease in estimated harvest between 2012 and 2013. In 2013, 1,232 wings were recorded (Table 4), which is about 22% of the estimated harvest. This is near the 10-year average of 20% and the changes between years are minor.

The 2013 chick:hen ratio (based on harvested wing analysis) was 1.0 chicks per hen (Table 4 and Figure 15). This level of productivity is typically associated with a declining population. This is not consistent with the 2014 lek data (all lek checks), which indicated a 11% increase in the average numbers of males on leks (Table 5). When average males per lek were increasing from 1997-2000 and 2005-2006, the proceeding years' chick:hen ratio averaged 2.1. Conversely, when the chick:hen ratio dropped to 1.1:1 in 2000, .8:1 in 2007, 1.1:1 in 2009 and .9:1 in 2010 the average males:lek decreased 20%,16%, 21% and 13% respectively. Relatively small changes in average males/lek observed in 2002 (+3%) and 2003 (+4%) were proceeded by chick:hen ratios of 1.6:1and 1.5:1 respectively, although similar chick:hen ratios resulted in declines of about 15% in both 2002 and 2008. The 57% increase in average males/lek observed in 2005 was preceded by a statewide chick:hen ratio of 2.4:1 in 2004. In general it appears that 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 increased lek counts and ratios below 1.2:1 result in declines. Additional data are required to strengthen the statistical strength 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
2004	2268	9.6	22.0	1.3	4.0	30.6	32.5	2.4
2005	2841	13.0	21.8	3.4	6.4	24.3	31.1	2.0
2006	2101	19.5	27.9	4.0	6.7	17.7	24.2	1.2
2007	2232	19.8	37.1	3.4	5.3	15.6	18.8	0.8
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	1964	13.2	36.6	4.5	9.1	15.5	21.1	0.8
2013	1232	12.2	35.7	2.4	6.1	18.8	24.7	1.0

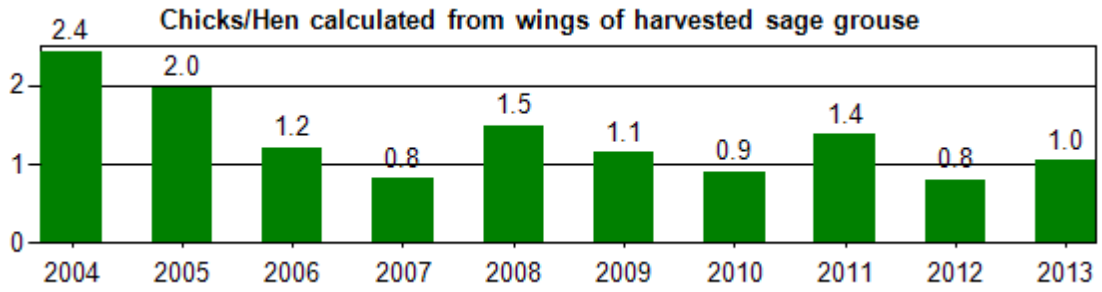


Figure 15. Chicks/Hen 2002-2011 based on wings from harvested grouse.

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%

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

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). 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 both 2009 and 2010 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 ago (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 a mid-May snowstorm, most of Wyoming experienced favorable spring conditions in 2014.

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, BLM, WGF, the Wyoming Geographic Information Science Center (WYGISC) of the University of Wyoming and others.

CONSERVATION STRATEGIES

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

In an unprecedented move to coordinate sage grouse conservation efforts across the State of Wyoming, then Governor Dave Freudenthal utilized the recommendations from his Sage-Grouse Implementation Team (SGIT) and released an Executive Order in August 2008 that directed state agencies to work to maintain and enhance greater sage grouse habitat in Wyoming. These actions constituted Wyoming's Core Area Strategy (CAS). Following the release of the new "warranted but precluded" listing decision by the Service in 2010, the Governor reconvened the SGIT to revise and update the CAS. Following the updates prepared during the spring and summer of 2010 by the Implementation Team, with the assistance of the local sage-grouse working groups, Governor Freudenthal issued a new Executive Order August 2010 to replace that from 2008. Then, newly elected Governor Matt Mead issued an Executive Order on June 2, 2011 which reiterated and further clarified the intent of the CAS (which was attached to the 2011-12 statewide JCR and also available at http://wgfd.wyo.gov/web2011/wildlife-1000817.aspx) . A list of the projects reviewed for consistency with the CAS is maintained by the WGFD Habitat Protection Program in Cheyenne.

The Core Area Strategy addresses the threats (habitat loss and fragmentation and insufficient regulatory mechanisms) specifically identified by the Service in their 2010 listing decision. In a June 2011 letter to Governor Mead, the Service said, "In summary, the Service believes the Greater Sage-grouse Core Area Protection provides an excellent model for meaningful conservation of sage-grouse if fully supported and implemented. We believe that when fully realized, this effort could ameliorate many threats to the Greater sage-grouse in Wyoming."

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.

The Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) are working to adopt Wyoming's Core Area Strategy into their land management decision processes in Wyoming. A WY-BLM sage-grouse instruction memorandum was issued in early 2012 (WY-BLM IM 2012-19). BLM Resource Management Plans (RMPs) and USFS Forest Plans across the state are being amended to incorporate Wyoming's Core Area Strategy and BLM national sage-grouse policy (BLM-IM-2012-043 and 044).

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 2005-2014, Local Working Groups were allocated approximately $5.2 million to support implementation of local sage-grouse conservation projects. One hundred sixty-five (165) projects have been approved over that time. The source of this funding is the State of Wyoming General Fund as requested by Governor Freudenthal and approved by the legislature. Thirty-one (31) projects (Attachment B) were implemented during the 2013-14 biennium. Most of the projects are supported by multiple cost-sharing partners. Projects include habitat treatments/restoration, improved range management infrastructure and grazing management plans, applied research, inventories, monitoring and public outreach.

The 2014 Legislature approved the 2015-2016 biennium General Fund budget which included another $1.2 million for local projects. Allocation of these funds will begin in mid-2014.

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 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. Currently, a CCAA and a CCA are being developed cooperatively by local, state, and federal resource agencies that will provide assurances or reduce the potential for additional regulatory requirements for Wyoming ranch operations in the event that the sage grouse is listed under ESA. Individual ranches will be able to participate in conservation practices appropriate to their ranch. The Service is beginning the process of signing up individual ranches to the CCAA.

OTHER ISSUES

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 2013 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.

In 2013, five confirmed West Nile virus sage-grouse mortalities were documented, two in Carbon County and one each in Natrona, Big Horn and Campbell Counties. These numbers are higher than in recent years, which parallel Wyoming Department of Health reports of increased human cases and positive mosquito pools. Even so, there is little evidence to suggest a major mortality event. The positive birds were found scattered around the state and 2014 lek data don't suggest otherwise unexplained population declines.

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. 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 to focus on this issue and during this reporting period five peer-reviewed manuscripts based on Wyoming research were released (Fedy et al. 2014, Harju et al.2013a, b, Smith et al. 2014 and Taylor et al. 2013.

On-going research examining energy development impacts to sage-grouse and sage-grouse habitat includes research on the effects of wind energy development in eastern Carbon County. A master's thesis (LeBeau 2012) resulted from this research and LeBeau et al. (2014) is a new peer-reviewed article based on this research.

The results of these research efforts inform and guide management actions where energy development occurs in sage-grouse habitat (Wyoming Game and Fish Department 2010 and

Bureau of Land Management 2012). The Wyoming Core Area Strategy is reliant on research efforts.

RESEARCH AND PUBLICATIONS

See Attachment C 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 D 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) Continue to refine and de-bug the new sage-grouse database and Job Completion Report software to an intranet application.

4) 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.

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

6) 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.

7) Update the sage-grouse occupied/historic range map for Wyoming.

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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: Wyoming sage-grouse projects supported with 2013-14 Wyoming General Fund Appropriation.

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
134 - Shell Black Mtn Juniper Control (see also #60, 107, 135, 167, 168, 171)	2013-14	Big Horn Basin	$64,000	$32,000 requested, $30,000 approved	Mechanical juniper removal from sage-grouse habitat	BLM	Grant Complete; Project On-going
135 - Rome Hill Juniper Control (see also #60, 107, 134, 135, 167, 168, 171)	2013-14	Big Horn Basin	$216,000	$35,000 requested, $30,000 approved	Mechanical juniper removal from sage-grouse habitat	BLM	Grant Complete; Project On-going
136 - UW Bentonite impacts research (see also #169)	2013-14	Big Horn Basin	$125,140	$24,244 requested, $11,000 approved	Research of bentonite mining impacts to sage-grouse	American Colloid Co.	Grant Complete; Project On-going
137 - Improving habitat in the Cottonwood Crk drainage (see also #113)	2013-14	Big Horn Basin	$104,590	$50,090 requested, $25,000 approved	LWG $ to pay for mechanical conifer removal from sage-grouse habitat as part of a larger habitat restoration project	BLM, WY DEQ	Grant and Project Complete
138 - SG habitat use in the Big Horn Basin (see also #170)	2013-14	Big Horn Basin	$223,272	$25,000 requested, $22,000 approved	Determining sage-grouse habitat use and movements on the west side of the Big Horn Basin	WY ADMB, WY Private Lands Grazing Team, Breitburn Operating L.P., Legacy Reserves, Shoshone CD, Meeteetse CD, Big Horn Basin Pred Mgt Dists., National Wildlife Research Center, USDA/APHIS/Wildlife Services	Grant Complete; Project On-going
139 - Mich Tech sagebrush reclamation research (see also #109)	2013-14	Big Horn Basin	$82,344	$26,124 requested, $20,000 approved	Research of enhanced sagebrush reclamation techniques on bentonite mined sites	Michigan Technical University, Wyoming Wildlife and Natural Resources Trust	On-going

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
140 - Jackson Hole SG Habitat and Movement Modeling (see also #30, 75 and 105)	2013-14	Upper Snake River Basin	$24,000	$8,800 requested/approved	Finish sage-grouse habitat selection and home-range models using data from prior work.	Craighead Beringia South, Community Foundation Jackson Hole, private donors	On-going
141 - Kelly Hayfields restoration Phase 3 (see also #95, 114, 183)	2013-14	Upper Snake River Basin	$87,534	$30,000 requested; $28,200 approved	Restore native vegetation to abondoned smooth brome hayfields.	Grand Teton National Park, NRCS	On-going
142 - Invasive species control in Teton Co. (see also #112, 133, 181)	2013-14	Upper Snake River Basin	$46,728	$3,000 requested/approved	Invasive weed control in Teton County	Jackson Hole Weed Mgt Assoc.	Grant Complete; Project On-going
143 - Raven/raptor density effects to lek count (see also #111, 179)	2013-14	Southwest, South-Central	not provided by applicant	$100,000 requested; $70,000 approved	Research to determine impacts of raven control to sage-grouse	Utah State University	Grant Complete; Project On-going
144 - Cheatgrass mapping and control in Sublette Co. phase III (see also #100, 126)	2013-14	Upper Green River Basin, Southwest	$137,142	$62,142 requested/approved	Cheatgrass mapping and spot control	Sublette County Weed & Pest, Green River Basin Coordinated Weed Mgt Assoc.; WLCI	Grant Complete; Project On-going
145 - Impacts of noise on sage-grouse (see also # 17, 46, 77 & 118)	2013-14	Wind River-Sweetwater River, Northeast, South-Central, Southwest	$63,388	$41,626 requested/approved	Continuing research examining the effects of noise resulting from energy exploration and development	University of California-Davis, BLM	On-going
146 - Response of SG to sagebrush treatments Phase II (see also #117, 186)	2013-14	Wind River-Sweetwater River, South-Central, Southwest	$956,593 (multi-year)	$99,841 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

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
147 – Impacts of wind energy development on sage-grouse (see also #84, 115, 184)	2013-14	Bates Hole-Shirley Basin, South-Central, Southwest	$1,023,250 (multi-year)	$105,000 requested/approved	Continuing research to determine sage-grouse demographic and habitat use response to wind energy development.	National Wind Coordinating Collab., Iberdrola Renewables, Pacificorp, EnXco, Wyoming Wildlife Foundation, UW, W.E.S.T. Inc., Wyoming Wildlife Consultants, LLC	On-going
148 - Spring development/protection and habitat restoration (see also #47, 99, 110, 128, 129)	2013-14	South-Central Southwest		$59,000 requested/approved/spent	3 embedded projects - Beaver Hills water development - spring development/protection in the Saratoga area ($12K), restoration seed mix purchase for Saratoga area restoration project ($10K), purchase of steel spring protection fencing for future sites statewide ($37K)	Saratoga, Encampment, Riverside Cons. Dist., Wyoming Game & Fish, IK Ranch, other landowners pending approval	On-going
149 - Road attribute inventory in greater sage-grouse core habitat	2013-14	Wind River-Sweetwater River	$36,000	$50,000 requested, $36,000 approved	BLM contractor to inventory roads and associated attributes in the Twin Crk Travel Mgt Area	BLM Lander FO	Grant Complete; Project On-going
150 - Sublette Windmil Conversions	2013-14	Upper Green River Basin	$71,757	$71,757 requested/approved	Convert existing windmills to solar pumping units to reduce raven nesting substrate	Sublette Co. Conservation District, landowners/permittees, BLM	Grant and Project Complete
151 - Sublette Raven Control and nest deterrents (see also #127)	2013-14	Upper Green River Basin	$15,000	$15,000 requested/approved	Raven nest removal and habitat modification	Sublette Co. Conservation District. Gas field operators, BLM, WGFD, USDA Wildlife Services	Grant and Project Complete

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
152 - Sagebrush ID in the Cato Wildfire - Buffalo Core SG habitat	2013-14	Northeast	$23,773	$17,794 requested/approved	Mapping of sagebrush restoration potential and inv. spp. control effectiveness in the Cato Wildfire area	DeSmet Conservation District, BLM, landowners, Johnson Co. Weed & Pest, NRCS	Grant and Project Complete
153 - Converting CBM wells to wildlife water	2013-14	Northeast	$72,716	$19,808.16 requested, $3,025 approved	Converting CBM wells to wildlife/livestock water sources	Campbell Co. Conservation District, landowners, BLM, NRCS	On-going
154 - Douglas Core Area Wildfire Restoration	2013-14	Northeast	$178,200	$40,000 requested, $30,000 approved	Wildfire restoration	Landowners, WGFD, others applied for	On-going
155 - Identifying priorities for land use and habitat restoration (see also #174)	2013-14	Northeast	$207,376 (multi-year)	$48,830 requested, $24,415 approved	Research to prioritize habitats for land use and habitat restoration	University of Wyoming, others pending	On-going
156 - CBM reclamation brochure for landowners	2013-14	Northeast	$9,422	$6,747 requested, $3,800 approved/spent	Develop, print and distribute a brochure for landowners describing CBM reclamation practices	NRCS, Cambell Co. Conservation District, BLM, Landowners	Grant and Project Complete
157 - Fathead minnows for mosquito control research (see also #172)	2013-14	Northeast	$71,060	$71,060 requested, $23,700 approved	Research to determine efficacy of fathead minnows for mosquito control to address West Nile virus	University of Waterloo, Big Horn Environmental Consultants, landowners	On-going
158 - Effects of mowing and herbicide treatments on the nutritional quality of sagebrush in south-central, Wyoming	2013-14	Wind River-Sweetwater River, Southwest	$29,061	$14,531 requested/approved	Research to determine the effects of habitat treatment on the nutritional quality (crude protein and chemical defenses) of sagebrush	Boise State University, University of Wyoming	On-going
159 - PRB Mammalian nest predators	2013-14	Northeast	$25,000	$2,620 requested/approved $2,500 spent	Research to determine the species of mammalian nest predators in the PRB using DNA from hair left at the nest sites	Johnson Co. Predator Board, Bighorn Environmental Consultants	Grant and Project Complete

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
160 - Audubon Community Naturalist (see also #53 and 131)	2013-14	Bates Hole/Shirley Basin	$201,500	$10,000 requested/approved/spent	Sagebrush ecosystem education program for schools	various foundations and grants	Grant Complete; Project On-going
161 - Currant Creek Ridge juniper removal (see also #177, 178)	2013-14	Southwest	$135,000	$25,000 requested/approved/spent	Mechanical juniper removal from sage-grouse habitat	BLM, Muley Fanatics	Grant Complete; Project On-going
162 - Sage Creek cheatgrass treatment (see also #176)	2013-14	Southwest	$250,000	$50,000 requested; $25,000 approved/spent	Chemical control of cheatgrass within a wildfire area	BLM; Sweetwater Co. Weed & Pest	Grant Complete; Project On-going
163 - Natrona Core Area cheatgrass treatment	2013-14	Bates Hole/Shirley Basin	$160,000	$60,000 requested/approved/spent	Chemical control of cheatgrass	BLM; Natrona Co. Weed & Pest	Grant Complete; Project On-going
164 - North Gillette Core Area sagebrush mapping (see also #121)	2013-14	Northeast	$551,000	$25,000 requested/approved/spent	Develop an accurate sagebrush map using 1' aerial photography	Thunder Basin Grasslands Prairie Ecosystem Assoc.	Grant and Project Complete
165 - Sage-grouse geophagy (see also #182)	2013-14	Upper Green River Basin	$259,883	$45,600 requested; $16,022 approved; $14,688 spent	Research the biological significance of newly documented phenomenon of sage-grouse geophagy	BLM, Craighead Beringia South, Wyoming Wildlife Consultants, LLC, WLCI	Grant Complete; Project On-going

GREATER SAGE-GROUSE RESEARCH CONDUCTED IN WYOMING IN 2013

Presented to Wyoming Game and Fish Department

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

November 17, 2013

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

1. A SPATIALLY EXPLICIT INDIVIDUAL-BASED MODELING APPROACH TO EVALUATE THE CUMULATIVE EFFECTS OF WIND ENERGY DEVELOPMENT ON THE GREATER SAGE-GROUSE

Contact: Argonne National Laboratory (Dr. Kirk LaGory); Phone: (630) 252-3169; Email: lagory@anl.gov

Argonne National Laboratory, Environmental Science Division, Drs. Kirk LaGory and Yuki Hamada

We recently completed development of a spatially explicit, proof-of-concept individual-based model to examine how wind energy development affects greater sage-grouse populations in Albany County, Wyoming. The model, based on published life history information, represents six major processes for seven age-sex classes of sage-grouse: seasonal movements, habitat selection, competition, body condition change, reproduction, and survivorship. The model estimates population size and distribution based on individual sage-grouse habitat selection and resultant reproduction and mortality rates that are based on habitat suitability and proximity to infrastructure. Scenario tests showed that the location and configuration of wind energy development are critically important to determining the effect of development on the population, and that indirect effects can be as significant as direct effects. In 2012, we completed a series of validation tests and sensitivity analyses of key parameters, resulting in some adjustments to the model. In 2013, we updated the model based on recent research findings; updated our habitat suitability models and used them to develop a suitability map for the entire state of Wyoming; and refined infrastructure submodels. We used the updated model to evaluate population-level effects of a realistic wind energy development scenario and various mitigation strategies. The model has the potential to provide valuable information for planning, siting, and assessment of the cumulative impacts of extensive regional wind development on sage-grouse.

Funding provided by: U.S. Department of Energy, Energy Efficiency and Renewable Energy, Wind and Water Program.

2. AN ANALYSIS OF ENERGY WILDLIFE CONSERVATION POLICY AND STRATEGIES FOR GREATER SAGE GROUSE AND MULE DEER IN WYOMING

Contact: Dr. Jeff Beck; E-mail: jlbeck@uwyo.edu; Phone: (307) 766-6863 or R. Scott Gamo; E-mail: scott.gamo@wyo.gov; Phone: (307) 777-4509

R. Scott Gamo, Department of Ecosystem Science and Management, University of Wyoming, and Wyoming Game and Fish Department, Cheyenne
Jeffrey L. Beck, Department of Ecosystem Science and Management, University of Wyoming

We are evaluating the Wyoming Governor's Executive Order for Sage-Grouse (SGEO) to: 1) assess its effectiveness in maintaining sage-grouse populations in sage-grouse core population areas, and 2) understand better its indirect impact in providing habitat protections for wintering mule deer. Our approach to assess the effectiveness of the SGEO in maintaining sage-grouse populations is to use a Before-After-Control-Impact (BACI) design to evaluate sage-grouse lek counts statewide in core and non-core areas. Our objectives are two-fold: 1) test the effectiveness of the SGEO, and 2) evaluate the mechanisms affecting the effectiveness of this policy. We will compare the dynamics of male sage-grouse lek attendance inside core areas across time as well as compare these dynamics to sage-grouse occurring in non-core areas. In addition, we will evaluate differences in anthropogenic infrastructure between grouse populations in core and non-core areas. We will also use a BACI design to evaluate the influence of the sage-grouse core area policy on mule deer populations and habitat. Our objectives for this portion of our research include evaluating whether: 1) sage-grouse core population areas provide similar protections for mule deer, and 2) disturbance on mule deer winter range inside core areas differs from that on winter ranges outside of sage-grouse core areas. We anticipate our findings will provide important information for upcoming US Fish and Wildlife Service listing decisions for the greater sage-grouse as well as agency support of natural resource policy.

Funding: Provided by U.S. Fish and Wildlife Service and Wyoming Game and Fish Department

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

Contact: Dr. Jeff Beck; E-mail: jlbeck@uwyo.edu; Phone: (307) 766-6863 or Aaron Pratt: E-mail: apratt3@uwyo.edu

Aaron Pratt, Department of Ecosystem Science and Management, University of Wyoming
Jeffrey Beck, Department of Ecosystem Science and Management, University of Wyoming
Lyndon Bucher, American Colloid Company, Belle Fourche, South Dakota
Matthew Dillon, American Colloid Company, Lovell, Wyoming
Tom Easterly, Wyoming Game and Fish Department, Greybull, Wyoming

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 is to monitor (for up to 4 years; 2011–2014) the demographic rates and habitat selection patterns of greater sage-grouse in an area with bentonite mining (Shell) compared to a reference area without mining (Hyattville). We are monitoring female survival, nest success, and brood survival with radio telemetry. For males, we are attaching bands and collecting feathers from leks to estimate survival using mark-recapture techniques. To help guide reclamation we are sampling vegetation in microhabitat plots at nests, early-brood locations, and at paired random locations. In the future we will evaluate habitat selection at the landscape scale and compare demographic rates of grouse relative to their exposure to mining. Our second study objective is describing the migration ecology of these populations using GPS-marked grouse. Observations indicate a wide variety of migratory behavior including differences in the proportion of each population that is migratory, timing, distance, duration, destination, and differences among seasons. We will compare the survival and reproductive success of grouse expressing different migration behaviors and model migration routes and habitat used. We are also experimenting with using stable isotope signatures to identify migration behavior. Field data collection may extend through 2014.

Greater sage-grouse sample sizes obtained in the eastern Bighorn Basin, Wyoming, 2011–2013.

Sample	Female		Male		Nest	Brood	Microhabitat Plots	
	VHF	GPS	Band	GPS			Nest	Brood
2011-2012								
Shell	26	10	22	6	33	11	33	38
Hyattville	91	21	54	10	94	41	93	60
2013								
Shell	17	3	6	0	20	7	20	13
Hyattville	48	19	29	0	56	26	56	34

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

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

Contact: Dr. Jeff Beck; E-mail: jlbeck@uwyo.edu; Phone: (307) 766-6863 or Kurt Smith; E-mail: ksmith94@uwyo.edu

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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 such as greater sage-grouse (*Centrocercus urophasianus*). Treatments are intended to rejuvenate sagebrush stands by killing older sagebrush plants to promote growth of younger 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 in Fremont and Natrona Counties, Wyoming is designed as a Before-After Impact-Control study with 3 years of pre-treatment and 3-to-5 years of post-treatment data comparing demographic rates and habitat selection patterns within treated and non-treated sites. We initiated our study in spring 2011 by capturing female sage-grouse and affixing VHF necklace-mounted radio transmitters to measure pre-treatment nest and brood-rearing success and microhabitat use. We also began attaching GPS transmitters in spring and summer 2012 to female grouse. In fall 2013 we received funding to implement treatments in fall 2013. In 2011, 2012, and 2013 we monitored survival at 161 nests and 78 broods from n = 258 VHF or GPS 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 vertebrate species associated with the sagebrush biome.

Funding Sources: Wyoming Game and Fish Department–Wyoming Sage-Grouse Conservation Fund; Bates Hole/Shirley Basin, South-Central, Southwest, and Wind River/Sweetwater River Local Sage-grouse Work Groups; University of Wyoming–Wyoming Reclamation and Restoration Center; Wyoming Wildlife and Natural Resource Trust; and Margaret and Sam Kelly Ornithological Research Fund

5. OCCURRENCE AND SURVIVAL INFORMED MODELING OF SAGE-GROUSE HABITAT IN JACKSON HOLE, WY

Contact: Bryan Bedrosian; E-mail: bryan@bswy.org; Phone: (307) 734-4417

Bryan Bedrosian, Craighead Beringia South
Trapper Haynam, Craighead Beringia South
Bob Crabtree, Yellowstone Ecological Research Center

The end goal of this project is to develop spatially explicit metrics of greater sage-grouse habitat response in Jackson Hole, WY. This research will relate sage-grouse survival and location data to a suite of environmental variables. We are developing models for nesting, brood rearing, summer foraging, and winter foraging life history stages. Our response data were collected from 2007-2010. We have >70,000 GPS and VHF telemetry locations, from all life history stages, for ~25 male and ~75 female birds. We will utilize well established habitat selection modeling methodologies, such as resource selection probability functions (logistic models) or generalized linear mixed-effects models. In these use-availability modeling frameworks, statistical models are fit to biologically relevant covariates (e.g., sagebrush canopy cover, herbaceous understory, past fire severity, raven occurrence) that are sampled at points where sage-grouse were relocated, or could have been present. Fitting these models will provide relative measures (parameter estimates) of apparent sage-grouse preference for particular habitat characteristics. The estimated parameters can then be used to generate resource use probability surfaces. Using a similar approach, and semi-parametric survival analysis, parameters will be estimated and then survival or risk surfaces can be generated. If a best supported model is deemed to have biologically significant parameter estimates; risk surfaces and resource selection surfaces will be combined to calculate a habitat suitability surface. The final method for generating a habitat suitability surface is still being developed. The candidate model structures have not yet been finalized, some covariates have yet to be synthesized, and covariate data arrays are still being populated.

Funding provided by: Wyoming Game and Fish Department, Community Foundation of Jackson Hole, Charles Engelhard Foundation.

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

Contact: Dr. Anna Chalfoun; E-mail: achalfou@uwyo.edu: Phone: (307) 766-6966
Jason Carlisle[1], Anna Chalfoun[1], Martin Grenier[2], Andrea Orabona[2], Susan Patla[2], Zack Walker[2], Tom Christiansen[2], Kurt Smith[3], Jeffrey Beck[3]

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We are investigating how effective Greater Sage-Grouse is as an umbrella species for the conservation of non-game wildlife associated with the sagebrush-steppe ecosystem, specifically those designated as species of greatest conservation need (SGCN). Wyoming's Greater Sage-Grouse Core Population Areas and the host of current efforts to conserve sage-grouse provide a natural laboratory for testing the umbrella species concept and our findings will be useful to managers interested in indirectly conserving SGCN under the streamlined approach of the sage-grouse umbrella. In order to rigorously test sage-grouse as an umbrella species, we are implementing a four-part approach, focusing on differing spatial scales: 1) quantify overlap statewide between sage-grouse core areas and focal SGCNs' predicted spatial distribution using GIS data, 2) examine the occurrence and relative abundance of SGCN across gradients of sagebrush habitat structure and sage-grouse breeding density in the field, 3) evaluate the reproductive success of two sagebrush-obligate passerine SGCN (Brewer's Sparrow, Sage Thrasher) across gradients of sagebrush habitat structure, and 4) examine the responses of SGCN to sagebrush-reducing habitat treatments designed to improve sage-grouse brood-rearing habitat. We are currently updating the preliminary analyses for objective 1 using a more rigorous overlap analysis. We successfully completed our second field season this past summer, collecting data near Jeffrey City, WY to address objectives 2-4. Following field seasons (2014-2015) will continue to address objectives 2-4. Habitat treatments (in conjunction with K. Smith and J. Beck) are planned for implementation this fall near the Cedar Rim, Lander Region.

Funding provided by: Wyoming Game and Fish Department, Southwest Local Working Group, and Wind River / Sweetwater River Basin Local Working Group.

7. IMPACTS OF RAVEN ABUNDANCE ON GREATER SAGE-GROUSE NESTING SUCCESS IN SOUTHWEST AND SOUTH-CENTRAL WYOMING

Contact: Dr. Mikc Conover; E-mail: mike.conover@usu.edu; Phone: (435) 797-2436

Michael Conover, Jonathan Dinkins, Scott Mabray, and Luke Peebles, Department of Wildland Resources, Utah State University, Logan, Utah, 84322-5230

We have studied female sage-grouse habitat selection, nest success, and survival in relation to avian predators from 2008–2013. Research was conducted at 12 study sites, 16-km or 24-km diameter, in southern Wyoming. This research has been a collaborative effort among the BLM, University of Wyoming, Utah State University, and Wyoming Game and Fish Department. Between BLM, University of Wyoming, and Utah State University, 69–200 sage-grouse hens were monitored per year. This project has produced three individual projects: 1) Common Raven Density and Greater Sage-grouse Nesting Success in Southwest Wyoming: Potential Conservation and Management Implications (Dinkins dissertation 2013), 2) Anthropogenic Resource Use by Common Ravens in Southwestern Wyoming (Mabray M.S. thesis), and 3) Evaluation of Potential Effects of Raven and Raptor Densities on Sage-grouse Lek Counts: Winter Survival and Spring Habitat Selection of Sage-grouse Juveniles (Peebles M.S. thesis).

Common ravens have a long history of living near human development and thriving in human altered landscapes. During winter, anthropogenic development and land use may provide critical roosting and foraging opportunities for ravens in southwestern Wyoming. We conducted 1679 daily point counts at landfills during 2013 to determine the numbers of ravens foraging at different times throughout a given day and variation in use during different seasons of the year. We also captured 23 ravens during 2013 and monitored their movements using remote data logging stations, ground telemetry, aerial telemetry, and direct visual identification at landfills and roosts in the region.

USDA Wildlife Services began targeted raven removal for the benefit of sage-grouse nesting at landfills throughout southwest Wyoming in January of 2013. This provided an opportunity to assess the efficacy of large-scale raven removal for the benefit of sage-grouse. During the summer of 2013, we conducted 1,104 raptor/corvid point counts. This effort involved visiting 168 random locations multiple times in sage-grouse habitat within the project's 12 designated study sites. Each random location was visited at least twice, and most were visited between 5-8 times. Avian predators were spotted in 45% of the point counts. Detections of ravens during point counts occurred 14% of the time.

Study Funders: Anadarko Petroleum Corporation, Bureau of Land Management, Lincoln County Predator Management Board, Predatory Animal District of Sweetwater County, South-central Sage-grouse Local Working Group, Southwest Sage-grouse Local Working Group, Uinta County Predator Management Board, Wyoming Animal Damage Management Board, Wyoming Game and Fish Department, Wyoming Landscape Conservation Initiative

8. STATE-WIDE SEASONAL GREATER SAGE-GROUSE HABITAT MODELING FOR WYOMING

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

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Animal habitat selection is an important and expansive area of research in ecology. In particular, the study of habitat selection is critical in habitat prioritization efforts for species of conservation concern. Wyoming is predicted to remain a stronghold for greater sage-grouse (*Centrocercus urophasianus*) populations and contains approximately 37% of remaining birds. We compiled species data from 14 unique radiotelemetry studies and habitat data from high-quality, biologically relevant, Geographic Information System (GIS) layers across Wyoming. We

developed habitat selection models for greater sage-grouse across Wyoming for three distinct life stages: 1) nesting, 2) summer/late brood-rearing, and 3) winter. We developed patch and landscape models across four different extents, producing Statewide models and regional models for 3 different regions of Wyoming: 1) Southwest, 2) Central, and 3) Northeast. Habitat selection varied among regions and seasons yet, preferred habitat attributes generally matched the extensive literature on sage-grouse seasonal habitat requirements. We chose Resource Selection Function (RSF) thresholds for each model set that delineated important seasonal habitats for sage-grouse. Each model set showed good validation and discriminatory capabilities within our study site boundaries. We tested model performance in areas not used in the development of the model (i.e., novel areas). The associated manuscript was resubmitted to *Wildlife Monographs* after addressing reviewer comments in June 2013.

9. 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
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Dr. Sara Oyler-McCance, U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO 80526, USA

Colorado Greater sage-grouse population connectivity has been identified as a priority management issue by multiple state and federal management agencies. We are currently working on a large-scale project to assess levels of population connectivity using genetic approaches. This project will assist in the delineation of related populations and describe possible sub-population boundaries that transcend all administrative boundaries. The research will also identify likely barriers to the movement of individuals among populations. The study will assist managers in understanding the relative importance of priority habitats and in accordance with policy, assist in the priority management of those habitats. 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 completed the first stage of the project involving the collection of feather samples and the laboratory processing of the approximately 2000 feather samples from across Wyoming. This stage involved DNA isolation, the use of multiple molecular markers, and the development of the genetic data that will be used to quantify connectivity. The second stage of the project has begun will comprise the analysis of the genetic data compiled from the first stage and produce the management-relevant products previously mentioned.

10. ASSESSING THE EFFICACY OF FATHEAD MINNOWS (*PIMEPHALES PROMELAS*) FOR MOSQUITO CONTROL.

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

West Nile virus (WNv) has emerged as an important threat to greater sage-grouse. WNv is an important source of mortality in low and mid-elevation populations throughout the West and severe impacts have been documented in northeastern Wyoming. Infected mosquitos are the primary source for WNv. Likely the most effective approach to controlling WNv and limiting its impacts on sage-grouse populations will involve mosquito control. One of the primary anthropogenic water sources that serves as breeding habitat for mosquitos in northeastern Wyoming are livestock ponds. Fathead minnows (*Pimephales promelas*) can function as effective biological control agents of certain mosquitos. We are proposing to test the efficacy of fathead minnows for mosquito control in northeastern Wyoming, in the hopes of minimizing the threat of WNv and the impacts it can have on sage-grouse population persistence. Beginning in 2013, we have selected control and treatment ponds in Sheridan and Johnson counties. We introduced minnows into the treatment ponds and monitored mosquito densities across both control and treatment ponds. Field work will continue in summer 2014.

11. A STUDY OF THE IMPACTS OF A WIND ENERGY DEVELOPMENT ON GREATER SAGE-GROUSE IN SOUTHEASTERN WYOMING

Contact: Dr. Matt Holloran; E-mail: matth@wyowildlife.com; Phone: (307) 399-6885
Chad LeBeau, Gregory Johnson, Ryan Nielson and Dr. Trent McDonald, Western EcoSystems Technology, Inc.; Dr. Matt Holloran and John Dahlke, Wyoming Wildlife Consultants, LLC; Dr. Jeffrey Beck, University of Wyoming Department of Ecosystem Science and Management.

In June 2008, the U.S. Department of Energy (DOE) set forth development of wind-generated electricity as a national energy priority. DOE estimated that the U.S. has ample wind resources to reach the goal of 20% of our nation's power supplied by wind energy by 2030, but one of the greatest hindrances to this accomplishment may be uncertainties regarding the potential impacts of wind energy developments to wildlife. The impacts of wind development to sage-grouse are currently unknown; however, potential effects to the species are enough to limit energy development in some sagebrush-dominated regions of the West, especially throughout much of central and western Wyoming. The overall goal of the research updated here is to establish the short-term effects of a wind energy development on female sage-grouse. We are studying sage-grouse inhabiting areas near the PacifiCorp Seven Mile Hill wind project located approximately 15 km west of Medicine Bow, WY. Research was initiated in April 2009; the National Wind Coordinating Collaborative joined the effort in 2011. Female sage-grouse equipped with VHF radio-transmitters are being radio-tracked to document seasonal habitats (e.g., nesting, brood-rearing, summer, winter) selected and population demographics (e.g., survival, nesting success, chick productivity). We radio-tracked 131 female sage-grouse in 2013, including 55 females captured from 3 leks located ≤1.4 km from a wind turbine and 76 females captured in a control area. Between April 1 and Sept 1, 2013 we collected 1430 locations of this radio-equipped sample. We additionally collected vegetation and soils data at 114 use and random plots, and have conducted avian predator (e.g., *Corvidae* and raptors) nest and point count surveys throughout the study area. We will compare sage-grouse using habitats near wind turbines to grouse using habitats away from wind turbines to assess population-level effects of the wind energy development. Vegetation and avian predator data will be used to generate covariates for inclusion in wind energy development impact modeling.

Funding provided by: National Fish and Wildlife Foundation as directed by the National Wind Coordinating Collaborative Sage-grouse Committee (2011-2012-2013); Agricultural Experiment Station at the University of Wyoming (2011); Wyoming Reclamation and Restoration Center at the University of Wyoming (2011); Bates Hole/Shirley Basin Local Sage-grouse Working Group (2011-2012-2013); South Central Local Sage-grouse Working Group (2012-2013); Southwest Local Sage-grouse Working Group (2013); EnXco (2011-2012); Iberdrola Renewables (2011); PacifiCorp (2011-2012-2013); and the American Wind Energy Association (2013).

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

Contact: Jon Kehmeier; E-mail: jkehmeier@swca.com; Phone: 303.487.1183
Jon Kehmeier and Nate Wojcik, SWCA Environmental Consultants; Josh Millspaugh and Chris Hansen, University of Missouri; Scott Gamo, Wyoming Game and Fish Department; Mark Rumble, U.S. Forest Service Rocky Mountain Research Station

Power Company of Wyoming (PCW) has proposed to construct the 1,000 turbine, 3,000 megawatt Chokecherry and Sierra Madre Wind Energy 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. In spring 2010, 40 rump-mounted GPS PTTs were deployed on female sage-grouse; recovered PTTs were redeployed in fall 2010. In 2011, the number of tagged females was increased to 55 (11 in each study unit). The number of tagged females will remain at 50 or more through the duration of the research effort. Based on current projections for construction wind energy facilities, it is anticipated that more than 4 years of pre-construction data will be collected. Monitoring and research efforts will continue during construction and post-construction to evaluate potential impacts of wind energy development activities.

Funded by: Power Company of Wyoming

13. HOW DO SAGE-GROUSE RESPOND TO ON-SITE MITIGATION IN AN ENERGY DEVELOPMENT ENVIRONMENT?

Contact: Tom Maechtle; E-mail: tom@bighornec.com; phone: (307) 673-7571
Tom Maechtle, Big Horn Environmental Consultants, P.O. Box 207 Sheridan, Wyoming 82801

Big Horn Environmental Consultants (BHEC), with the support of Anadarko Petroleum Corporation radio-marked and monitored sage-grouse females from 2008-2011 while maintaining a sample size of 100 radio-marked hens. The focus of this research is to understand the response of sage-grouse to on-site mitigation in a Coal Bed Natural Gas (CBNG) development area. Sage-grouse avoidance of energy development has been extensively researched and documented (Naugle et al. 2011) and sage-grouse productivity has been shown to be depressed in human-altered landscapes (Connelly et al. 2011). Sage-grouse researchers and managers have suggested on-site mitigation measures (e.g., remote well monitoring, burying power lines, etc.) as a tool to reduce these impacts; however, few studies have empirically tested the effectiveness of these mitigation efforts. We are quantifying the response of sage-grouse to these mitigation efforts by assessing critical components of sage-grouse population viability—habitat use and associated fitness outcomes during the female reproductive period. First, we are exploring female habitat use— in terms of avoidance of infrastructure— during the nesting and brood-rearing periods to assess if on-site mitigation reduces avoidance behavior in energy-altered landscapes. Second, we are exploring possible associations between specific CBNG infrastructure components and productivity (e.g., nest success and brood survival) in relation to mitigated and non-mitigated development areas to determine if on-site mitigation measures are targeting the energy features that are most consequential to sage-grouse productivity and if on-site mitigation, as a whole, improves sage-grouse productivity in energy-altered landscapes. We are currently drafting manuscripts to share our research findings.

Funding Provided by: Anadarko Petroleum Corporation and in-kind support from BHEC

14. 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: Dr. Josh Millspaugh; E-mail: millspaughj@missouri.edu

Joshua Millspaugh and Christopher Hansen, University of Missouri; Mark Rumble, U.S. Forest Service Rocky Mountain Research Station; Scott Gamo, Wyoming Game and Fish Department; Jon Kehmeier and Nate Wojcik, SWCA Environmental Consultants; Garry Miller, Power Company of Wyoming

Power Company of Wyoming (PCW) has proposed to construct the 1,000 turbine, 3,000 megawatt Chokecherry and Sierra Madre Wind Energy 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 dynamic trends. Our design calls for maintaining 50 males (adult/yearling) tagged with GPS PTTs and 75 males (adult, yearling, and juvenile) tagged with VHF transmitters, distributed evenly among the 5 control/treatment areas. Since 2011, we have collected >92,000 locations on tagged males. Each spring, we conduct lek counts on 50-56 leks and collect sightability data (variables influencing male sage-grouse detection on leks) on tagged individuals on leks. We collected sightability data on 156 uniquely tagged males on leks since 2011. To evaluate male microsite resource selection during summer/autumn, we collect microsite vegetation characteristics at used and paired-random sites, using locations selected from the GPS data. Since 2011, we have collected vegetation measurements surrounding 147 used male sites and 588 paired-random sites. It is anticipated that 4 years of pre-construction data will be collected prior to the initiation of wind development activities.

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

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

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Beth A. Fitzpatrick and Melanie A. Murphy, Department of Ecosystem Sciences and Management, University of Wyoming, Laramie, Wyoming 82071

To meet the management objective of long-term landscape-level sustainability of sage-grouse populations, both occupancy of habitat and functional connectivity through the landscape are required. Avoiding or reclaiming sage-grouse lek sites may influence population networks and can be used for making decisions regarding sage-grouse management. In order to prioritize landscape-level restoration efforts and plan for future development, we are addressing the following objectives in the Bighorn and Powder River basins:

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

We have collected presence-absence (43 sites), genetic (120 leks), and sound (20 sites) data. Preliminary of occurrence models (including DWGF data) show that amount and configuration of habitat, growing season precipitation, and wetness influence probability of lek occurrence. Preliminary genetic data have high genetic diversity (alleles/locus= 13.6) and genetic structure (Fst = 0 - 0.236; Dps = 0.268 – 0.744, n = 35 leks). The preliminary connectivity models suggest that geographic distance, sage brush, topography and mean annual precipitation influence gene flow.

We will collect additional data in 2014 (goal of ~150 leks and ~3,000 genetic samples total). Occurrence (Objective 1) and functional connectivity (Objective 2) of sage-grouse will be integrated in a network framework to identify spatially explicit sites important for sage-grouse population sustainability in the context of alternative development and restoration scenarios (Objective 3).

Funding by: Wyoming Reclamation and Restoration Center, Northeast Wyoming Sage-grouse Working Group, University of Wyoming, Society for Integrative and Comparative Biology, Margaret and Sam Kelly Ornithology Fund, Sigma Xi GIAR, RM-URISA

16. RESOURCE SELECTION AND LANDSCAPE-LEVEL CONSERVATION PLANNING FOR SAGE-GROUSE IN THE GREAT DIVIDE BASIN IN SOUTH-CENTRAL WYOMING

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Chad V. Olson, Mathew R. Dzialak, Seth M. Harju, Jennifer E. Hess, James P. Mudd, and Jeffrey B. Winstead. Hayden-Wing Associates, LLC, Natural Resource Consultants, Laramie, Wyoming 82070

Prioritizing seasonal habitats for greater sage-grouse in landscapes undergoing energy development is critical for guiding future anthropogenic activities. Providing stakeholders with high-resolution modeling of critical habitats based on locally-collected data will improve front-end landscape conservation planning and help prioritize reclamation efforts thereby reducing overall impacts. In our study, we equipped female greater sage-grouse with solar-powered ARGOS/GPS transmitters in and around the Wamsutter Energy Field in south-central Wyoming. Our objectives are to: (1) quantify resource selection/avoidance, (2) generate high-resolution maps predicting probability of use for critical seasonal habitat at the landscape scale, and (3) investigate use of habitat enhancement sites and evaluate future treatment locations. The main study area extends from I-80 between Wamsutter and Creston Junction north to the Chain Lakes, and the Stewart Creek drainage northwest of Rawlins is being used as a reference area. Although some limited fieldwork will continue, our focus will be shifting from data collection to data analysis and report/manuscript preparation in 2014.

Funding is provided by BP America Production Company.

Recent publications from this or related projects are downloadable from:
http://www.haydenwing.com/publications.html

17. EXAMINING THE EFFECTS OF NOISE FROM ENERGY DEVELOPMENT ON THE BREEDING BIOLOGY OF THE GREATER SAGE-GROUSE (*CENTROCERCUS UROPHASIANUS*)

Principal Investigator: Gail Patricelli, Associate Professor, Dept. Evolution and Ecology, University of California, Davis; E-mail: gpatricelli@ucdavis.edu

Additional Investigator:
Dr. Stacie L. Hooper, Postdoctoral Researcher, Dept. Evolution and Ecology, UC Davis

The goal of this project is to investigate the effects of noise from natural gas development on sage-grouse reproductive behaviors. This project has three major objectives. First, we monitored noise sources in Sublette and Campbell counties that are associated with energy development, including drilling rigs, compressor stations, roads, and generators. Second, to examine the impacts of noise on sage-grouse, we conducted a noise playback experiment on leks in our study site in Fremont County from 2006-2009. We found an immediate and sustained decline in male lek attendance and elevated fecal stress hormone levels on noise leks relative to paired control leks. Third, we adapted landscape-level noise modeling software (NMSimNord) and are now using it, along with our measurements from noise sources, to map the "acoustic footprint" of natural gas development in the Pinedale Anticline from 1998-2011. The model has recently been upgraded and expanded, and while this allows us to model noise propagation under different weather conditions that occur in sagebrush habitat, it also has significant bugs. We are currently working with our partners at the National Park Service and the model programmer to fix these bugs and to implement scripts that will allow us to model a large number of noise sources simultaneously. The spatial data layers generated by the model are being included in habitat-selection models to determine the role that noise has played in sage-grouse declines, determine the noise exposure threshold for this species, and determine what metric or metrics are most appropriate for characterizing noise impacts.

This research has been funded by grants from: the Bureau of Land Management, the Wyoming Sage-grouse Conservation Fund (via the Sage-grouse Local Working Groups), the Tom Thorne Sage-Grouse Conservation Fund (via the Wyoming Community Foundation), the National Fish and Wildlife Foundation, the National Parks Service, the National Science Foundation and the University of California, Davis

18. USE OF GENETIC DATA TO DETECT ISOLATION AND TIMING OF ISOLATION OF GREATER SAGE-GROUSE POPULATION IN NORTHWEST WYOMING

Sarah Schulwitz,[1] Bryan Bedrosian,[2] Jeff Johnson[1] [1]*Department of Biological Sciences, University of North Texas;* [2]*Craighead Beringia South*

Recent range-wide, genetic-based studies on Greater Sage-Grouse (*Centrocercus urophasianus*) have identified multiple isolated populations with reduced genetic diversity. These studies, however, excluded a population within Teton National Park, located north of Jackson, WY, which is surrounded by potential natural dispersal barriers as well as recent anthropogenic habitat fragmentation. Using 16 microsatellite loci, we analyzed 300 Greater Sage-Grouse samples collected near Jackson, to the northeast of Jackson (Gros Ventre), in west-central (Pinedale) and east Wyoming (Powder River Basin), and in southeast Montana (Big Horn Basin) to determine levels of genetic diversity and the degree of connectivity of the Jackson population with surrounding populations. Significant population differentiation existed among Sage-Grouse populations with data suggesting that the Jackson population is isolated relative to the other sampled populations, particularly Pinedale, its closest neighboring large population. Additionally, the Gros Ventre and Jackson populations exhibited significantly reduced levels of genetic diversity relative to other sampled populations. This study is currently in review by the journal *Conservation Genetics*. Current work is aimed at determining the timing of divergence (i.e. historic or recent) of the Jackson population relative to surrounding populations in Wyoming. Sequence data at five nuclear introns and mitochondrial control region-I & II has been generated for a subset of individuals from Jackson, Gros Ventre, Pinedale and Powder River Basin. Single nucleotide polymorphisms (SNPs) will be identified at each locus and be used in coalescent-based analyses to determine approximate timing of Jackson Sage-Grouse isolation. These results will inform decisions for future management of the Jackson Greater Sage-Grouse population.

Funding for the Jackson connectivity project was obtained from Upper Snake River Basin Sage-Grouse Working Group, Wyoming Game & Fish Department, Craighead Beringia South, University of Wyoming, Grand Teton National Park, Jackson Hole Airport, US Forest Service and Bureau of Land Management. Funding for the Sage-grouse SNP project was obtained through University of Wyoming-National Park Service Research Center.

19. USING ASSISTED SUCCESSION TO IMPROVE SAGE-GROUSE HABITAT IN HIGH CONFLICT AREAS OF THE BIG HORN BASIN, WY

Catherine Tarasoff – School of Forest Resources and Environmental Science, Michigan Technological University. 1400 Townsend Drive, Houghton, MI. ctarasof@mtu.edu.

Recent research has documented excellent survival (100%) and growth using container grown Wyoming big sagebrush. Additionally, mine operators have observed good survival rates of the perennial species crested wheatgrass, blue grama, bottlebrush squirreltail and slender wheatgrass when direct seeded into cheatgrass infested areas. The combination of grasses with native shrubs could be used to improve sage-grouse habitat. Assisted succession is a 2-step process that starts with 'claiming the site' from cheatgrass, followed by interplanting with sagebrush. The objectives of our proposal are to improve sage-grouse habitat by preventing invasive species, increasing structural complexity, species diversity and overall site productivity.

Two sites were covered with livecast soil and seeded (2012) with:

- 100% crested wheatgrass
- 1:1:1:1 crested wheatgrass:blue grama:bottlebrush squirreltail:slender wheatgrass
- No seeding (control)

All treatments were replicated 4 times at each site. Sagebrush seedlings are being grown and will be transplanted as small islands (~9m^2) within the seeded areas, April 2014 at 2 plants/m^2. We will measure seedling survival and size, vegetation community (including cheatgrass cover), and soil parameters including soil moisture and organic matter between the three site conditions. Overtime, we will measure island expansion through natural dispersal. We do not anticipate that sage-grouse will utilize the sites given the short time frame. However, we will assess the sites for sage-grouse suitability and evidence of sage-grouse utilization.

20. HABITAT USE AND REPRODUCTIVE SUCCESS OF GREATER SAGE-GROUSE IN BIGHORN BASIN

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The Wyoming Greater Sage-grouse Conservation Plan 2003 and the Sage-grouse Conservation Plan for the Bighorn Basin identify predation as a potential source of sage-grouse population declines; however, little information exists on sage-grouse population dynamics in the Bighorn Basin. Research conducted in 2011 and 2012 suggested 1) numerous potential avian and mammalian predators of sage-grouse were present among study sites yet their relative abundance was low, and occupancy estimates were similar among study sites despite levels of coyote treatment, and 2) reported hen survival was greater on areas receiving coyote control, while nest survival was greatest on areas with no coyote control in 2012. Large variation in estimates suggests better accuracy and precision may come from increased sample sizes. From March-May 2013, 64 female sage-grouse were captured on leks, fitted with a VHF or Argos transmitter, and released at the capture site. Approximately 36 female grouse marked previously in the study continue to be relocated by telemetry for a total of 100 tagged birds. If nest survival is truly least in areas with coyote control, this suggests that avian predators may play a larger role than previously expected in sage-grouse fitness. Therefore, the Bighorn Basin Greater Sage-Grouse Project is seeking to improve knowledge of the role of common ravens (*Corvus corax*) in sage-grouse nest survival, while improving estimates of many of the same population parameters (e.g., sage-grouse survival, cause-specific mortality, and habitat use) on Fifteen Mile, Major Basin, Oregon Basin, and Polecat Bench in 2013-2016. Table 1 summarizes raw observations from breeding season 2013, while analyses of survival and movement data are ongoing.

Table 1. Summary of capture, nesting and survival data for sage-grouse hens at four complexes in Bighorn Basin (March – September 2013).

	Complex				
	Fifteen Mile	Major Basin	Oregon Basin	Polecat Bench	Total
# Argos-marked hens	7	3	6	6	22
# VHF-marked hens	17	20	21	20	78
Total marked hens	24	23	27	26	100
# Hen mortalities - Raptor	4	1	2	0	7
# Hen mortalities - Canid	1	3	3	0	7
# Hen mortalities - Badger	0	0	1	0	1
# Hen mortalities - Unknown	2	2	3	4	11
Total hen mortalities	7	6	9	4	26
# Nests (including renests)	17	14	20	19	70
# Renests	1	3	0	1	5
# Nest cameras deployed	14	10	18	16	58
# Nests depredated by raven	0	0	2	8	10
# Nests depredated by coyote	4	1	3	4	12
# Nests depredated by badger	0	4	0	2	6
# Nests lost to unidentified predator	2	1	0	1	4
Total nest lost to predators	6	7	8	17	32
# Nests lost to unknown cause	0	1	3	2	6
# Successful nests	11	7	12	2	32

Funding provided by Meeteetse Conservation District, Bighorn Basin Predator Management Districts, USDA-Wildlife Services, USDA-WS-National Wildlife Research Center, Wyoming

Animal Damage Management Board, and Wyoming Game and Fish Commission. Support from Jim Pehringer and NW District WS Specialists.

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

Principal Investigator: Dr. Brett Walker, Avian Research Program, Colorado Parks and Wildlife, 711 Independent Ave., Grand Junction, CO 81505. Phone: 970-255-6125 (office), 970-778-0886 (cell). Email: brett.walker@state.co.us

Date: October 22, 2013

Implementing effective monitoring and mitigation is crucial for conserving populations of greater sage-grouse (*Centrocercus urophasianus*). Lek-count data are widely used as an index of sage-grouse abundance, and buffers around lek locations are used to identify and protect important sage-grouse habitat, but the reliability and effectiveness of lek-based monitoring and management strategies has not been rigorously tested. It is unclear how closely lek-count data track actual year-to-year changes in male abundance, and the effectiveness of lek buffers at reducing disturbance to male sage-grouse and their habitat during the breeding season is poorly known. Colorado Parks and Wildlife conducted a multi-year study to quantify variation in male breeding-season survival, lek attendance, inter-lek movements, detectability, and habitat use around leks to quantify the reliability of lek-count data and test the effectiveness of lek buffers in the Hiawatha Regional Energy Development project area in northwestern Colorado and southwestern Wyoming. Field crews captured and deployed GPS transmitters on 95 adult and 67 yearling males from fall 2010 through spring 2013. Feather cover causing transmitter failure led to improvements in transmitter design in fall 2012. Poor color-band retention precluded comparing survival between GPS and non-GPS males. Location data from GPS males facilitated the discovery of 9 new leks from 2011-2013. Field crews completed spring field work in May 2013 and analyses of habitat use, lek attendance, inter-lek movement, and detectability are underway. Existing GPS males will be monitored through spring 2014 to obtain additional data on survival, lek attendance, between-year inter-lek movements, and habitat use.

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

Attachment D.
Wyoming Sage-Grouse Research Reports (through May 31, 2014)

The following list includes final research reports from WGF sage-grouse research or theses and dissertations from university research efforts. It does not include annual agency monitoring reports or popular press articles.

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.

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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.

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.

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Bates Hole/Shirley Basin
Local Working Group Area
Job Completion Report

Period Covered:
June 1, 2013 – May 31, 2014

Prepared by: **Justin Binfet**
Wyoming Game and Fish Department

December 7th, 2014

Sage Grouse Job Completion Report

Year: 2005 - 2014, 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)
2005	185	59	32	3358	60.0
2006	195	63	32	3844	63.0
2007	205	56	27	2433	45.9
2008	211	62	29	2226	37.1
2009	212	60	28	1611	29.3
2010	215	109	51	2485	27.0
2011	218	103	47	1670	19.9
2012	218	78	36	1222	20.0
2013	220	77	35	969	16.4
2014	220	87	40	1261	19.4

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2005	185	100	54	2396	31.5
2006	195	116	59	3421	38.4
2007	205	110	54	2913	36.9
2008	211	103	49	2031	27.4
2009	212	100	47	1693	23.5
2010	215	65	30	861	17.6
2011	218	95	44	895	14.9
2012	218	89	41	779	13.0
2013	220	98	45	777	13.9
2014	220	118	54	892	13.3

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: 2005 - 2014, 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)
2005	185	159	86	5754	43.6
2006	195	179	92	7265	48.4
2007	205	166	81	5346	40.5
2008	211	165	78	4257	31.8
2009	212	160	75	3304	26.0
2010	215	174	81	3346	23.7
2011	218	198	91	2565	17.8
2012	218	167	77	2001	16.5
2013	220	175	80	1746	15.2
2014	220	205	93	2153	16.3

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2005	136	5	18	141	96.5	3.5
2006	152	3	24	155	98.1	1.9
2007	134	6	26	140	95.7	4.3
2008	135	17	13	152	88.8	11.2
2009	130	16	14	146	89.0	11.0
2010	143	12	19	155	92.3	7.7
2011	159	31	8	190	83.7	16.3
2012	132	25	10	157	84.1	15.9
2013	121	41	13	162	74.7	25.3
2014	135	50	20	185	73.0	27.0

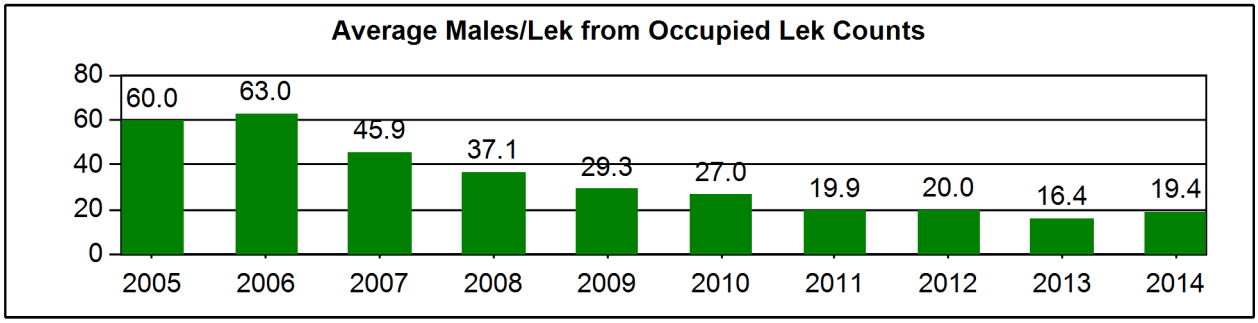
1) Occupied - Active during previous 10 years (see official definitions)

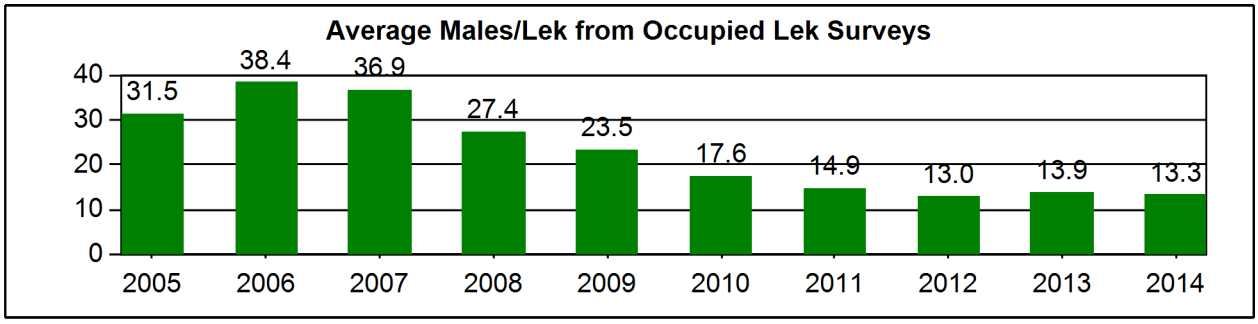
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

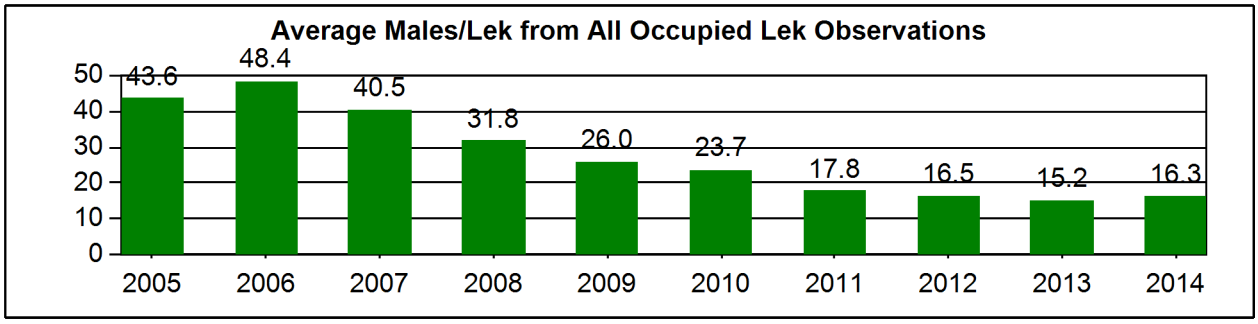
3) Inactive - Confirmed no birds/sign present (see official definitions)

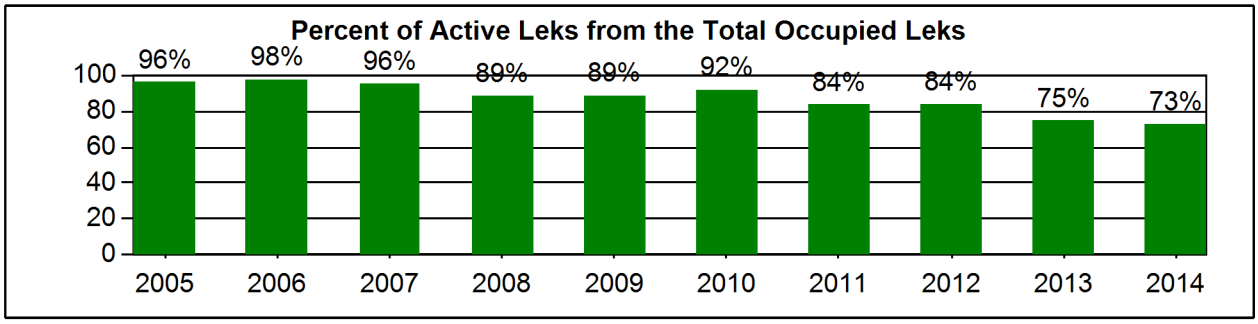
Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Bates Hole



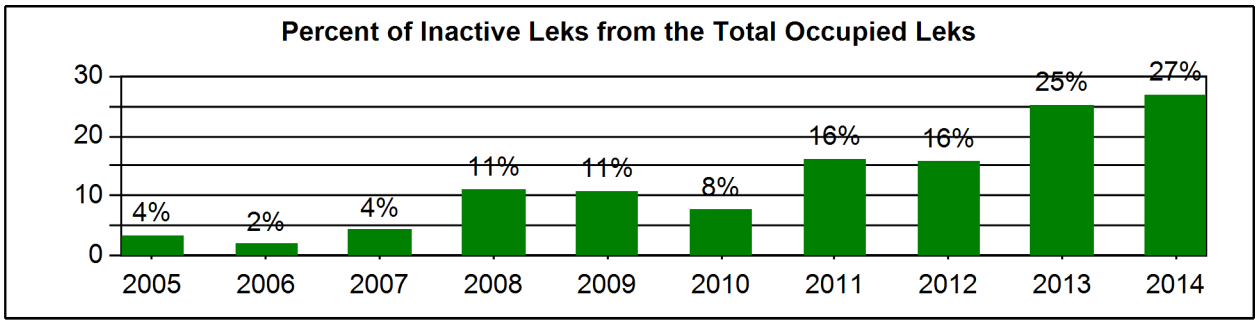






Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Bates Hole



Sage Grouse Job Completion Report

Year: 2004 - 2013, Management Area: F

4. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
2004	Sep-23	Oct-3	11	2/4
2005	Sep-23	Oct-3	11	2/4
2006	Sep-23	Oct-3	11	2/4
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4
2011	Sep-17	Sep-30	14	2/4
2012	Sep-15	Sep-30	16	2/4
2013	Sep-21	Sep-30	10	2/4

b. Harvest

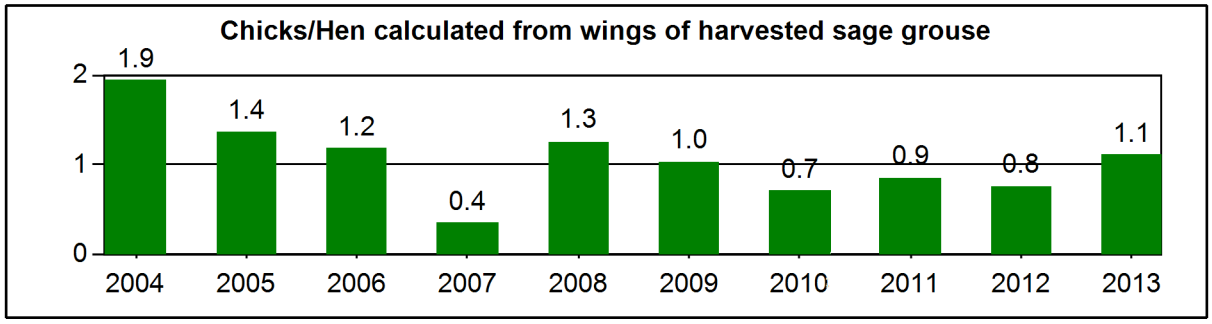
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2004	1237	583	1071	1.2	2.1	1.8
2005	2304	925	1734	1.3	2.5	1.9
2006	1672	717	1169	1.4	2.3	1.6
2007	1365	655	1155	1.2	2.1	1.8
2008	1295	654	1161	1.1	2.0	1.8
2009	1026	532	956	1.1	1.9	1.8
2010	1027	480	1001	1.0	2.1	2.1
2011	1117	514	981	1.1	2.2	1.9
2012	688	415	852	0.8	1.7	2.1
2013	488	399	670	0.7	1.2	1.7
Avg	1,222	587	1,075	1.1	2.0	1.8

Sage Grouse Job Completion Report

Year: 2004 - 2013, Management Area: F

5. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
2004	308	13.6	24.7	1.3	4.2	24.0	32.1	1.9
2005	372	17.5	25.8	3.0	7.8	21.5	24.5	1.4
2006	305	29.8	22.6	4.3	7.5	13.1	22.6	1.2
2007	546	19.4	53.5	4.2	2.9	8.4	11.5	0.4
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	209	18.2	34.4	5.3	6.7	16.3	19.1	0.9
2012	171	18.1	34.5	1.2	11.1	19.3	15.8	0.8
2013	176	10.2	25.6	4.5	14.8	23.3	21.6	1.1



Introduction

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

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

Past and current management of sage-grouse within the BHSBLWG area has focused mainly on the protection and/or enhancement of sagebrush habitats and protection of leks and nesting buffers from surface disturbing activities during the breeding/nesting season. Protection efforts have primarily occurred via controlled surface use or timing stipulations attached to state and federally permitted projects and through ongoing revision of BLM Resource Management Plans. Sage-grouse habitat protection has been increasingly important given the potential listing under the Endangered Species Act. As a result, the State of Wyoming adopted a core area management strategy through Governor's Sage Grouse Executive Order 2011-5. This strategy enhances protections to sage-grouse within delineated core areas, which were further refined in 2010 (version 3). Core areas have been delineated to encapsulate important sage-grouse habitats throughout Wyoming thereby increasing protections for the majority of sage-grouse occurring in the State. Protections applied to sage-grouse habitats outside of core areas are less stringent than those within core areas in an attempt to incentivize natural resource development outside of the best remaining sage-grouse habitats.

Most sage-grouse populations in Wyoming are hunted, though some portions of the state have been closed to sage-grouse hunting to protect small, isolated populations (i.e., in the southeast, northeast, and northwest portions of the state). A technical review of hunting seasons and harvest of sage-grouse in Wyoming was developed by the Wyoming Game and Fish Department (Christiansen 2010). This document details the role of hunting seasons and public use of sage-grouse populations, potential impacts, and management actions taken by the Department to implement more conservative harvest

strategies dating back to the mid-1990's. Within sage-grouse populations having less than 100 males attending leks, hunting seasons should be closed to prevent additive mortality on small, isolated populations (BHSBLWG 2007). Hunting seasons have thus been closed in Niobrara, Platte, Goshen and Laramie Counties, and in the majority of Converse, Weston and Crook Counties. In addition, seasons were closed in the eastern portion of Natrona County including the Hat Six area southeast of Casper. Within these areas, sage-grouse populations occur in small, isolated patches of suitable habitat on the fringe of sage-grouse range. Within these small populations, harvest mortality is far more likely to be additive and potentially detrimental. Within the remaining portion of the BHSBLWG area where robust sage-grouse populations occur, conservative hunting seasons continue to occur each year.

Historically, sage-grouse hunting seasons opened in early September. Research investigating the impacts of hunting on sage-grouse populations indicated a late September opening date had a decreased impact on hen survival, and may increase recruitment compared to an early September season (Braun and Beck 1996, Heath et al. 1997, Connelly et al. 2000). This is due to successful hens with broods being typically more widely distributed across the landscape in later September, which decreases harvest pressure on the most successful segment of the population. In early September, hunters tend to disproportionately focus harvest pressure on successful hens with broods as they are relatively easy to locate, especially near water sources. Sage-grouse seasons within most of the BHSBLWG area currently span two or three weekends, opening the third Saturday in September and closing September 30. From 1982 – 2001, bag and possession limits were 3 per day and 6 in possession. Since 2002, bag and possession limits have been reduced throughout the BHSBLWG area to 2 per day and 4 in possession.

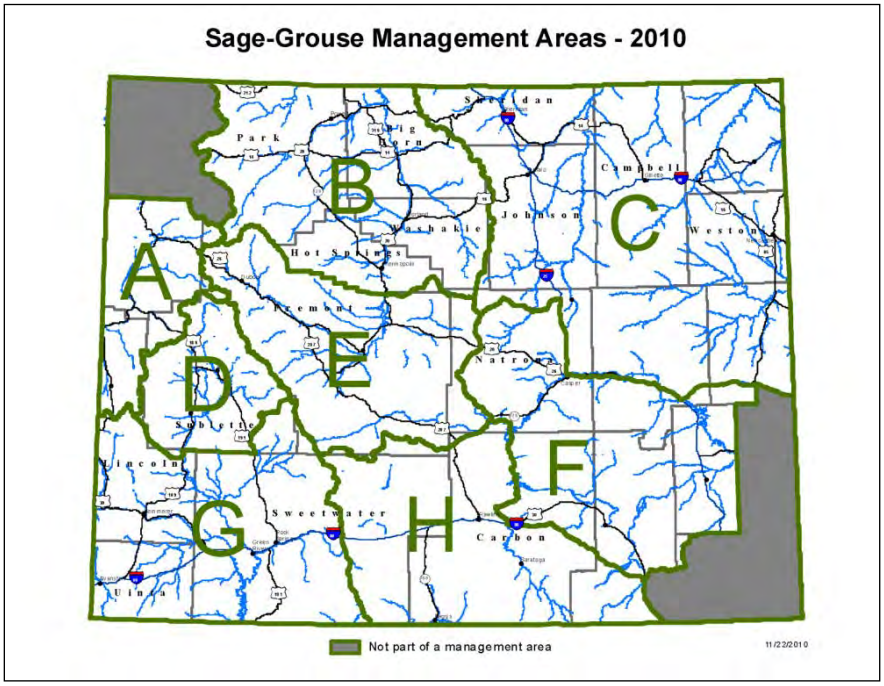
Local Working Group Area

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

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

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

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



Leks and Lek Complexes

A new sage-grouse database was developed in 2012 in order to improve efficiency, reduce errors, and better facilitate data analysis. Changes were made to the manner in which lek data are calculated and reported in Table 1. The new version is based solely on "occupied" leks. The past version suggested that was the case in the title of Table 1, but when unoccupied leks were monitored those data were also included in the Table. The result of this change is that the number of "known occupied" leks is now more accurate, but reflects fewer leks than in the previous version. Similarly, the new version calculates average male lek attendance using only monitoring observations where one or more male grouse were observed strutting. The old version included a count of "0" males for leks where activity was confirmed by the presence of sign but no birds were observed. Together, these two changes result in somewhat higher, but more accurate, average male attendance for active leks than previously reported. The changes do not result in any change in population trend based on average male lek attendance. Interpreted population increases and decreases over time remain the same so no revisions to past reports are required.

Sage-grouse, and therefore occupied leks, are well distributed throughout most of the BHSBLWG area (Figure 3). Much of the historic range in Platte County is no longer occupied due to large scale conversions of sagebrush grasslands to cultivated fields. The Wyoming Game and Fish Department summarizes lek monitoring data each year. As of spring 2014, there are 220 known occupied leks, 63 unoccupied leks, and 23 leks of an undetermined classification within the BHSBLWG area (Figure 4). Lek definitions are presented each year in the statewide Job Completion Report and are included in the monitoring protocol (Christiansen 2012). Undoubtedly, there are leks within the BHSBLWG area that have not yet been identified, while other un-discovered leks have been abandoned or destroyed. The majority of leks classified as "undetermined" lack sufficient data to make a valid status determination. In these cases, historic data indicates these leks were viable at one point, with the leks subsequently being either abandoned or moved. However, location data is either generic or suspect in many of these cases, further confounding the ability to determine the status of these leks.

Figure 3. Sage-grouse lek distribution and core areas within the BHSBLWG area, 2014.

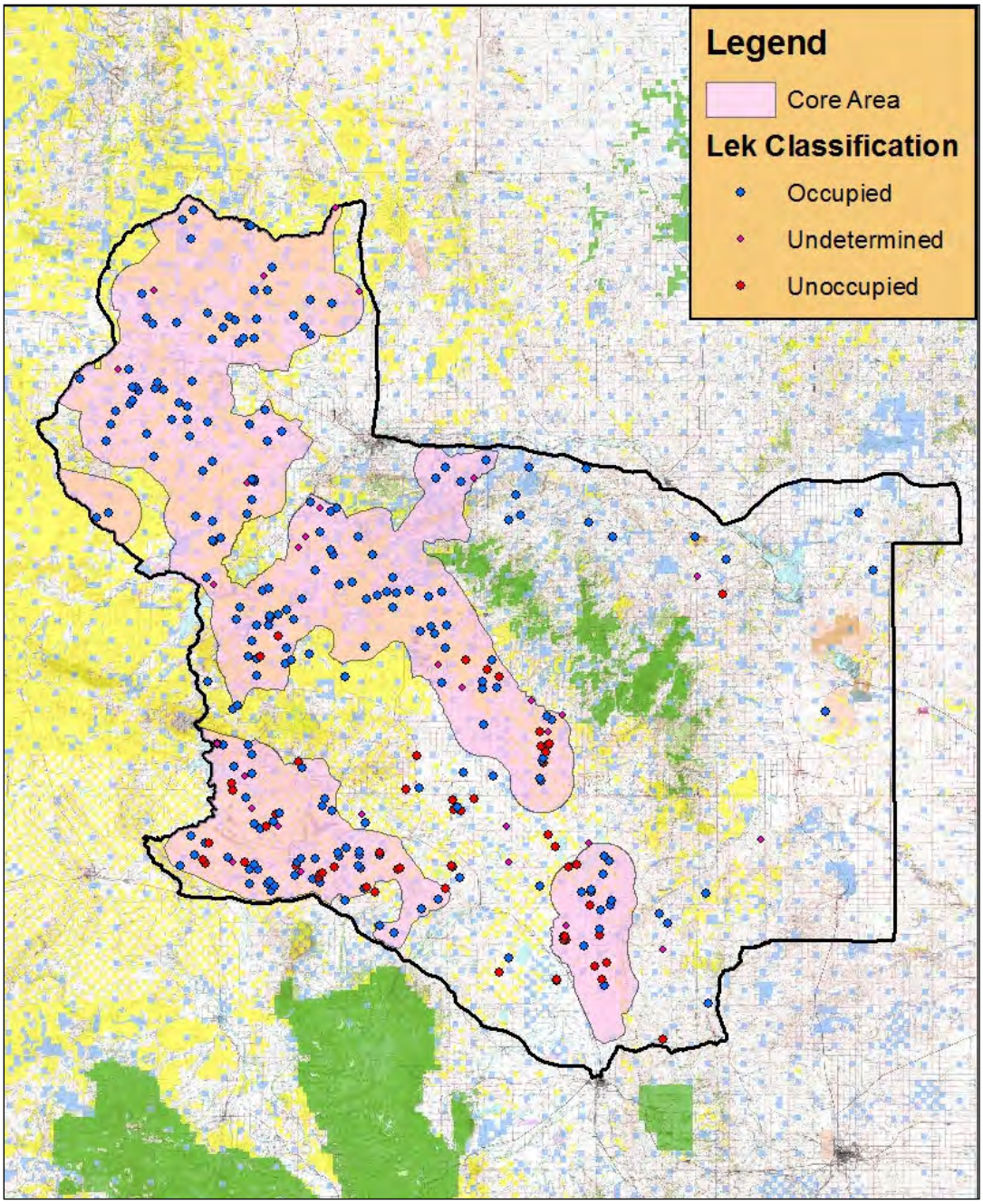


Figure 4. Sage-grouse lek demographics within the BHSBLWG area, 2014.

Sage Grouse Lek Characteristics

Working Group: Bates Hole

Region	Number	Percent
Casper	122	39.9
Lander	2	0.7
Laramie	182	59.5

Working Group	Number	Percent
Bates Hole	306	100.0

Classification	Number	Percent
Occupied	220	71.8
Undetermined	23	7.5
Unoccupied	63	20.6

BLM Office	Number	Percent
Casper	119	38.9
Lander	2	0.7
Newcastle	1	0.3
Rawlins	184	60.1

Biologist	Number	Percent
Casper	113	36.9
Douglas	9	2.9
Laramie	107	35.0
Rawlins	2	0.7
Saratoga	68	22.2
Wheatland	7	2.3

Warden	Number	Percent
Cheyenne	2	0.7
Douglas	3	1.0
East Casper	36	11.8
East Rawlins	2	0.7
Elk Mountain	70	22.9
Glenrock	8	2.6
Lusk	1	0.3
Medicine Bow	66	21.6
North Laramie	40	13.1
West Casper	72	23.5
Wheatland	6	2.0

County	Number	Percent
Albany	74	24.2
Carbon	108	35.3
Converse	11	3.6
Laramie	2	0.7
Natrona	104	34.0
Niobrara	1	0.3
Platte	6	2.0

Land Status	Number	Percent
BLM	97	31.7
BOR	1	0.3
Private	183	59.8
State	25	8.2

Management Area	Number	Percent
F	306	100.0

Lek Status	Number	Percent
Active	135	44.1
Inactive	92	30.1
Unknown	79	25.8

Lek counts and lek surveys have been conducted within the area since the late 1950's, although historically on only a small number of leks. Since 1998, lek monitoring effort has expanded significantly, resulting in increasing numbers of leks being monitored over time and enabling meaningful comparisons of current sage-grouse data to a running 10-year average. In 2014, WGFD personnel, volunteers and consultants checked 205 of the 220 (93%) known occupied leks in the BHSBLWG area. A total of 88 leks were counted while 117 leks were surveyed in 2014. Of the 205

occupied leks that were checked and annual status was confirmed (N=185), 135 (73%) were active and 50 (27%) were inactive.

The percent of occupied leks checked that were active has significantly decreased in the BHSBLWG area over the past 10 years, with the 2014 percentage (73%) being markedly lower than the 10-year average of 88%. This decrease in the percent of active occupied leks is likely due to the substantial population decline realized within the BHSBLWG area since 2006, which may have resulted in many smaller leks becoming inactive (see Population Trend discussion). However, this decline may also be attributed to increased monitoring effort which has shifted emphasis on surveying more leks with less lek counts. This additional effort has resulted in more leks being checked on an annual basis compared to past years, meaning more smaller leks are now being surveyed. As a result, a higher percentage of leks may have become inactive in lieu of population decline. In addition, emphasis on monitoring more leks has also resulted in more occupied leks being checked that have been infrequently monitored in the past. Many of these leks are small, have been inactive or have had unknown activity status in most years, are in marginal habitat, or have been compromised in some fashion. As a result of this expansive effort, a higher percentage of occupied leks are inactive. However, it is important to continue to monitor these marginal leks to ensure they are classified appropriately (i.e. occupied, unoccupied or undetermined). Where sufficient lek monitoring data has shown such marginal leks are no longer occupied, they are reclassified as unoccupied as per established protocol.

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

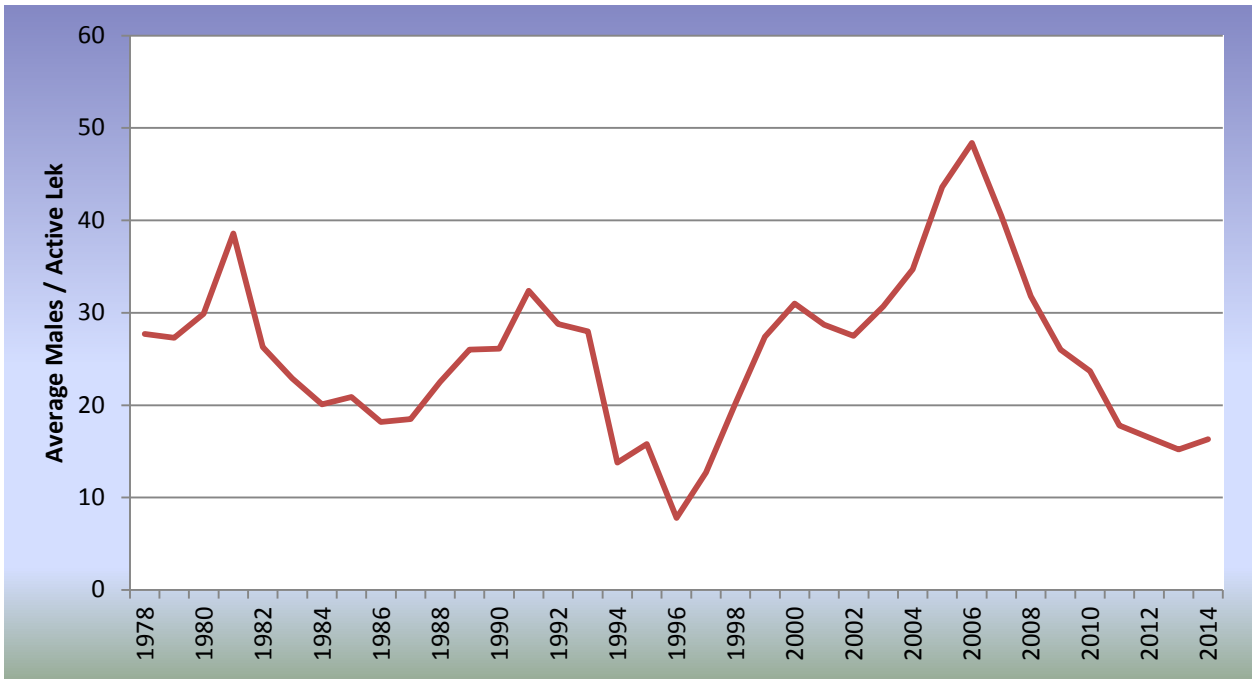
Population Trend

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 or qualified, and 5) lek sites may change over time. Both the number of leks and the number of males attending these leks must be quantified in order to estimate population size. 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.

Following a period of substantial decline since 2006, sage-grouse populations modestly increased over this past year based on the mean maximum number of males observed per counted lek. The average number of males observed per ***count*** lek increased from the early 2000's to a zenith of 63 in 2006 and then subsequently declined each consecutive year to a nadir of 16 in 2013. This dramatic decline in male lek attendance, and therefore sage-grouse populations, was attributed to extremely poor chick production and recruitment over this time frame (see productivity discussion). However, male lek attendance modestly increased in 2014, which marked the first such increase over the past 8 years. In 2014, the average number of males observed per ***count*** lek improved to 19.4, which marked an 18% increase compared to last year. However, this was still 54% below the previous 10-year average of 35.7. The 2013 nadir was the lowest average recorded male lek attendance since intensive lek monitoring began in 1998.

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 the last 36 years within the BHSBLWG area (Figure 6). After a precipitous decline in the mid-1990's, sage-grouse populations increased substantially to a zenith in 2006, declined dramatically through 2013, and then rebounded slightly in 2014. The average number of males observed per *active* lek in 2014 (16.3) was 36% below the long-term average (since 1978) of 25.5.

Figure 6. Mean number of peak males per ***active lek checked*** within the BHSBLWG area, 1978 – 2014.



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

Within the BHSBLWG area, 56 leks have been abandoned since the 1960's. The timing in which these leks were abandoned is usually difficult to determine due to gaps in data collection. Reasons for abandonment are unknown for many historic leks. It is unclear whether these leks have been abandoned due to natural sage-grouse population fluctuations over time or from anthropogenic disturbances such as natural resource development or poor grazing practices. Since 1998, many abandoned leks have been monitored, with no indication these leks have begun to be reoccupied. However, many of these leks have generic location-data, which calls into question the veracity of the original lek locations. In cases where actual leks with historic data have been abandoned, such generic location-data makes (re)locating these leks much more difficult. Regardless, these leks should be maintained within the database until sufficient data has been collected to remove them as per WGFD lek monitoring protocol. Monitoring of abandoned/unoccupied leks has increased in recent years.

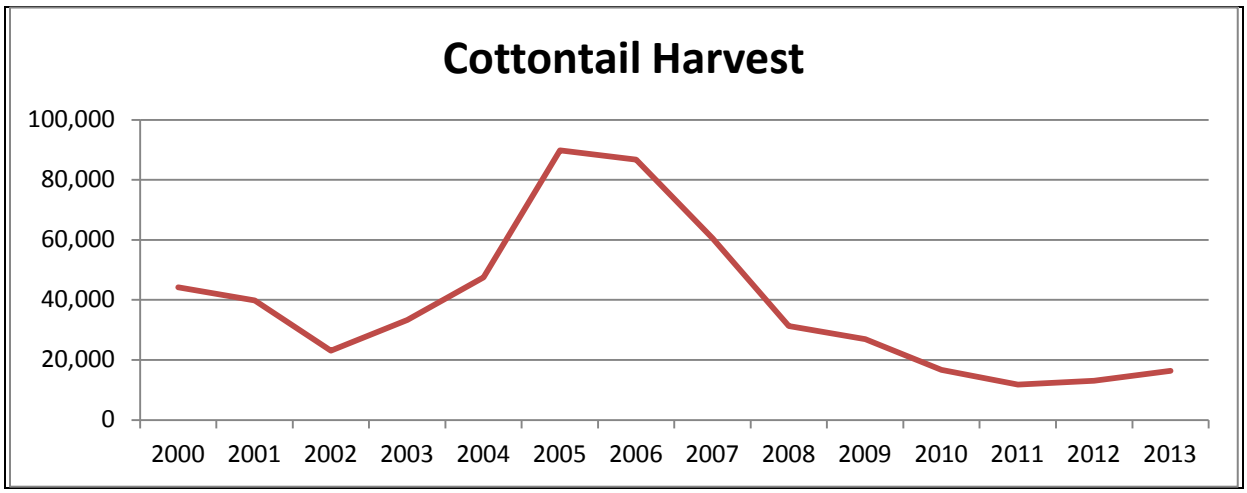
Productivity

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. In addition, many observations of sage-grouse occur along riparian areas during summer brood surveys, which may under-represent the number of barren hens occurring on uplands, thus biasing the actual chick:hen ratio. Brood survey data will therefore not be discussed here.

Based on wing data, chick productivity was estimated to be 1.1 chicks per hen in 2013. Over the last 10 years, wing-barrel estimated productivity has fluctuated between 0.4 and 1.9 chicks per hen. 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). The 2013 ratio marked the ninth consecutive year of moderate to poor chick production/survival (below 1.5 chicks/hen), resulting in overall population decrease. Such population decrease has been detected in the aforementioned lek attendance data. It is unknown whether the declining number of chicks observed in the harvest in recent years is due to poor nest success or chick survival, increased predation, deteriorating habitat conditions, or any combination thereof. The poor chick production/survival observed since 2007 may also be attributed to several consecutive cold and wet springs since 2007, which may have led to increased nest abandonment/failure or poor early brood survival. Cold wet weather can be especially detrimental to sage-grouse hatchlings and juveniles during the first few weeks of life.

In addition, sage-grouse population cycles are highly correlated with cottontail rabbit population cycles over long time series (Fedy and Doherty 2010). Given chick production/survival as measured by wing data, and overall sage-grouse population trend, the influence of cottontail rabbits may be significant within the BHSBLWG area. Both sage-grouse populations and cottontail rabbit densities increased during the early 2000's and peaked in 2006 within the BHSBLWG area. In 2006, widespread epizootics of tularemia were reported in much of Wyoming, and cottontail rabbit densities subsequently crashed that year. The only cottontail rabbit data now collected in Wyoming is the estimated annual statewide harvest (Figure 7). While no population trend data exists for cottontails, annual harvest is highly correlated with cottontail densities. Statewide harvest data also infers cottontail populations peaked in 2006 and subsequently crashed. Anecdotal observations of rabbit densities from WGFD field personnel corroborate this. Regardless, both sage-grouse and cottontail rabbit populations have declined since 2006, although rabbit populations have began to increase over the last two years.

Figure 7. Statewide Wyoming cottontail harvest, 2000 – 2013.



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 (Figure 8). Harvest peaked in 1983 at 14,180 birds and subsequently declined to an historic low of 488 in 2013. Over the last 10 years within the BHSBLWG area, trends observed in harvest data generally mirror those observed in male lek attendance from the spring (Figure 9).

Figure 8. Total sage-grouse harvested per year within the BHSBLWG area, 1983 – 2013.

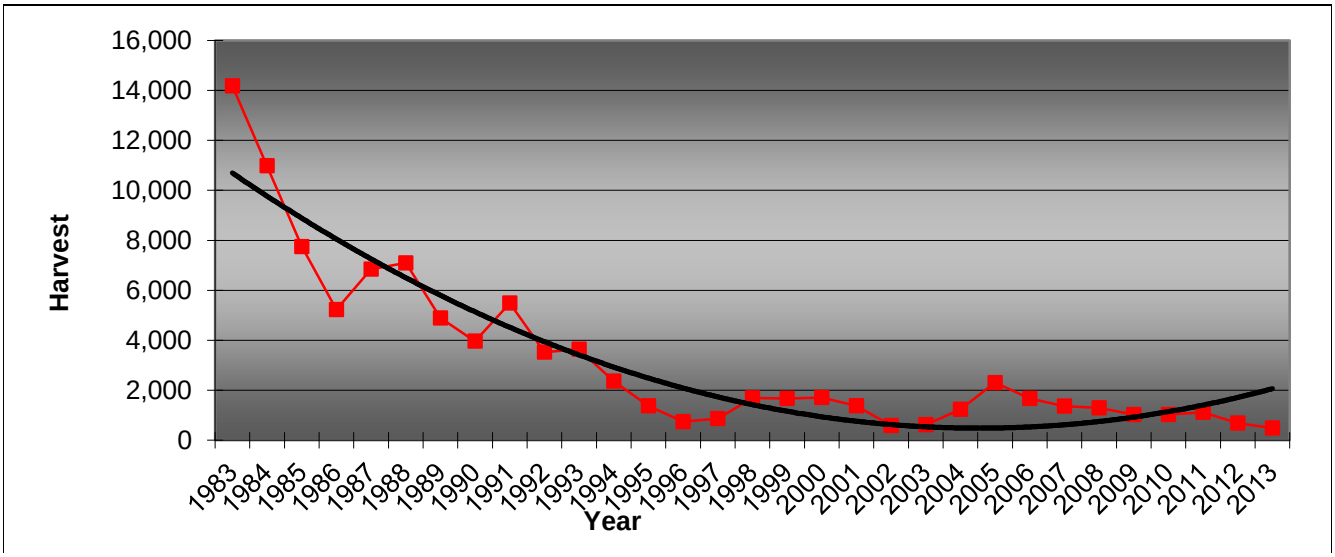
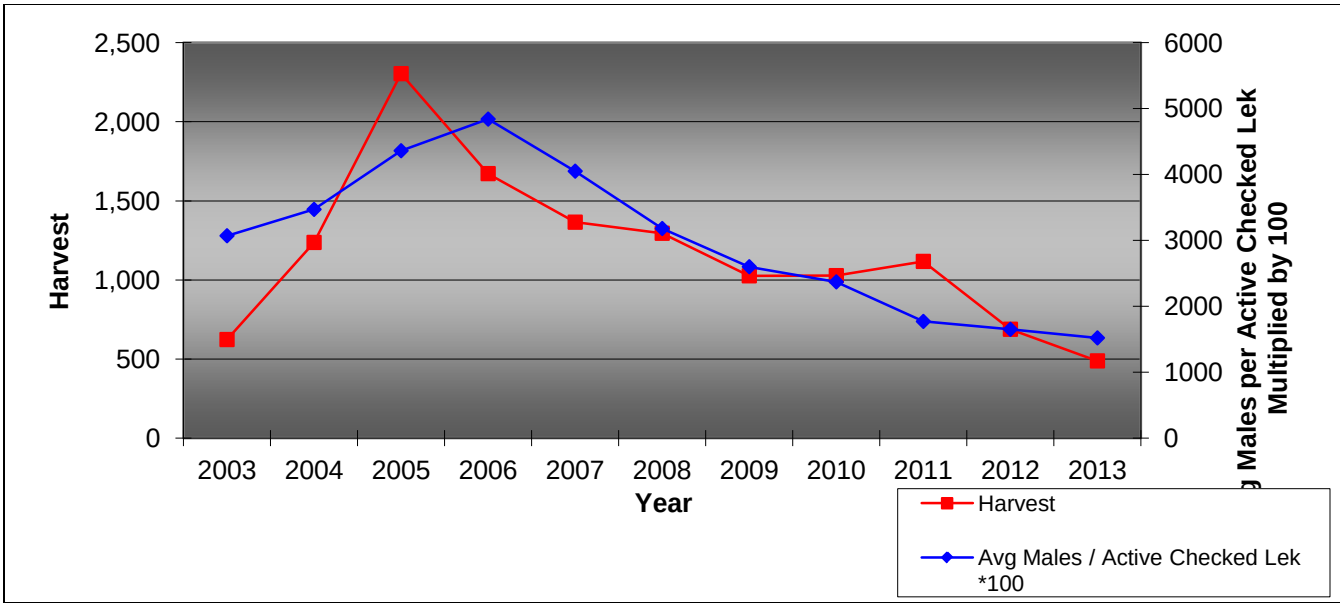


Figure 9. Total sage-grouse harvested per year and the average number of males per active lek checked within the BHSBLWG area, 2004 – 2013.



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

Habitat

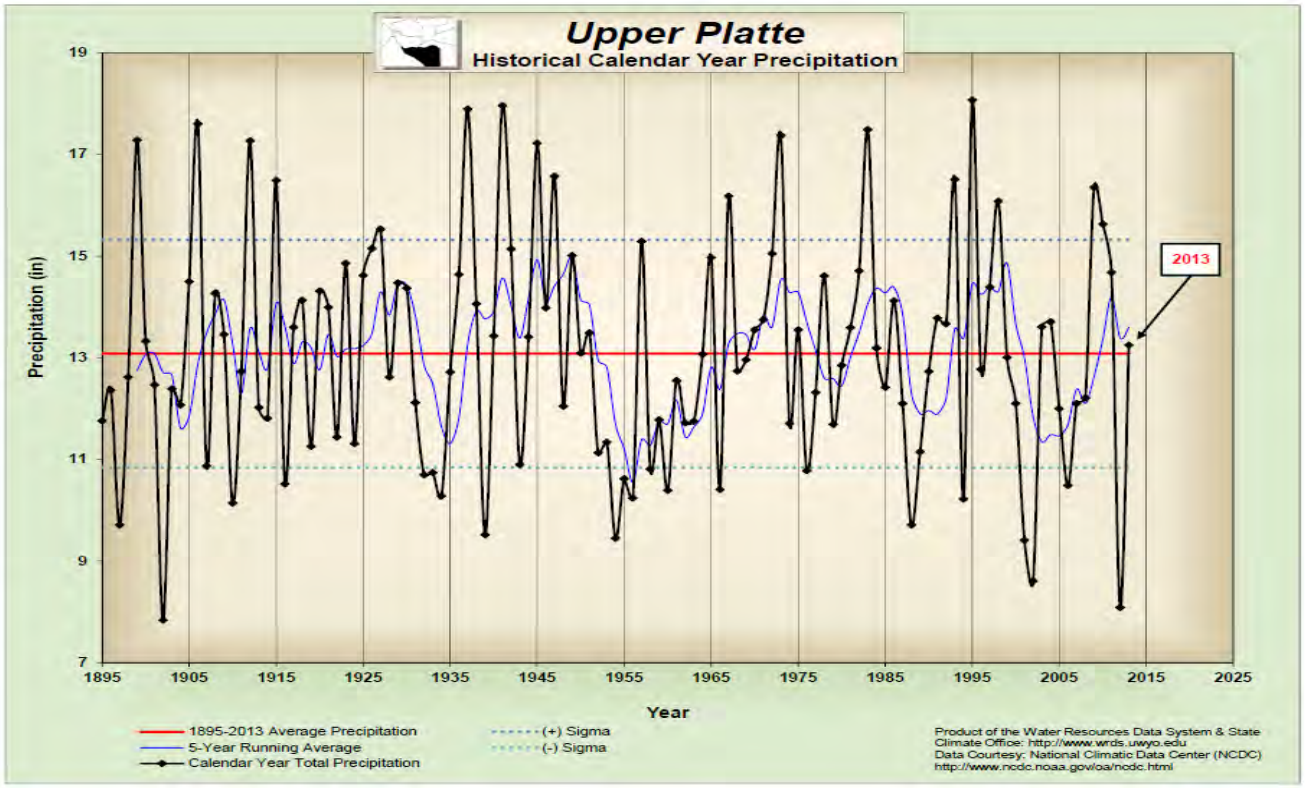
There is little doubt sage-grouse habitat quality has declined over the past several decades throughout the BHSBLWG area. Increased human-caused disturbance (i.e., oil/gas, coal, uranium, and wind energy development), improper grazing by livestock and wildlife, sagebrush eradication programs, and long-term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

for all projects detailed in Appendix I was allocated via the Bates Hole / Shirley Basin Local Working Group.

Weather

Based on the data obtained from the Wyoming State Climate Office, the Upper North Platte climatic division experienced improved precipitation during the growing season compared to 2012, which were the driest conditions on record over the past 100 years (Figure 10). This resulted in much improved sagebrush leader growth and herbaceous vegetation production in 2013. Despite the improved moisture regime in 2013, both sagebrush and herbaceous vegetation production were still somewhat suppressed as plants were extremely stressed and in poor condition entering the 2013 growing season due to the extreme drought from the previous year. Regardless, nesting cover did improve in 2013, and normal weather conditions (periodic precipitation without prolonged cold, wet weather) prevailed during the peak hatching period, which likely improved chick production and survival. However, 2013 chick production was still below what is needed to maintain sage-grouse populations. It is unknown whether the population fluctuations over the last 10 years (increase through 2006 followed by subsequent decline) are a function of prevailing weather conditions, and therefore habitat quality, or due to the cyclical nature of sage-grouse populations. The winter and early spring months of 2014 prior to the breeding season were near normal for temperatures and well above normal for precipitation. Although outside this reporting period, the late spring, summer and fall of 2014 were all far wetter than normal resulting in excellent shrub and herbaceous vegetation production. This should greatly benefit sage-grouse and sagebrush ecosystems entering the 2015 breeding season.

Figure 10. 2012 Water Year for the Upper North Platte drainage, Wyoming Climate Division 5 (http://www.wrds.uwyo.edu/sco/data/divisional_precip/divisional_precip.html)



Special Studies

Western EcoSystems Technology, Inc. has provided progress reports to Horizon Wind Energy for The Greater Sage-Grouse Telemetry Study for the Simpson Ridge Wind Energy Project, Carbon County, Wyoming. This report was not provided within this document, but may be available upon request from the project proponent. 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 will continue through 2015 contingent upon funding. 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.)

Diseases

Three confirmed cases of West Nile virus in sage-grouse were documented in central Wyoming (one each from Natrona, Albany and Carbon counties) in 2013. 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 in recent years is unknown, but potentially significant. However, no data exists to indicate recent declines in the BHSBLWG area sage-grouse population can be specifically attributed to WNV.

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:

http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/SG_BATESSHIRLEYBASIN_ADD0005209.pdf .

Recommendations

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

2. 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.

3. 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.

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

5. Continue to update and refine UTM coordinates (using NAD83) of leks and map lek perimeters where needed.

6. 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.

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Appendix I. Conservation Projects within the BHSBLWG area funded since inception through the Wyoming Governor's Sage-grouse Conservation Fund.

Project Name	Budget Biennium	Conservation Funding	Project Description	Partners
Martin Ranch Range Improvement (Phase I)	2005-06	$19,501 requested/ approved; $19,633 spent	Fence construction to implement 3 pasture rotation grazing system and mosaic prescribed fire in mountain big sagebrush to improve forage including forbs and insects	Martin Ranch, NRCS
7E Ranch Grazing Mgt	2005-06	$44,990 requested/ approved; $44,990 spent	Fence construction and water development to implement a 4-pasture rest-rotation grazing system	NRCS, 7E Ranch, BLM
SG Education and Community Outreach	2007-08	$13,000 requested/ approved	Develop and administer sage-grouse conservation educational programs in the Casper area	Audubon Wyoming
Western Natrona County Sage-Grouse Study	2007-08	$7,210 requested/ approved	Seasonal distribution and habitat use for land use planning along with parasite/disease assay	BLM, WGFD, University of Wyoming, Casper College
M&D Land Company Water Development	2007-08	$7,425 requested/ approved; $4,000 spent	Water development to facilitate grazing plan implementation (dry hole - unsuccessful)	M&D Land Co., NRCS
Shook Ranch Range Improvement	2007-08	$10,000 requested/ approved	Prescribed fire in mountain big sage, developing and protecting water sources, installing a cross fence and implementing rotational grazing system	Shook Ranch, NRCS
Hat-Six Ranch Riparian Buffer	2007-08	$11,600 requested/ approved; $9,936 spent	Fencing riparian buffer to enhance riparian habitat, reduce erosion and improve brood-rearing use by sage-grouse	Hat-Six Ranch, NRCS
Martin Ranch Range Improvement (Phase II)	2007-08	$14,000 requested/ approved; $10,825 spent	Fence construction to implement 3 pasture rotation grazing system and mosaic prescribed fire	Martin Ranch, NRCS

3-Man Ranch Upland Habitat Improvement	2007-08	$13,944 requested/ approved	Water development and fencing to facilitate rest-rotation grazing system	3-Man Ranch, WGF LIP, WWNRT
L3 Cattle Co. fence and spring development	2007-08	$5,297 requested/ approved; $5,194 spent	Water development and fencing to facilitate deferred-rotation grazing system	L3 Cattle Co, NRCS
M&D Land Wildlife Inventory	2007-08	$10,500 requested/ approved; $10,302 spent	Wildlife surveys, range surveys & management consultation	NRCS
Schnoor/Flat Top Big Sagebrush Restoration	2007-08	$18,305 requested/ approved	LWG $ to apply Plateau herbicide to cheatgrass infested areas. Other mechanical, chemical and RX fire to be used to restore big sage communities.	Mule Deer Foundation, WY Gov's Big Game License Coalition, WWNRT, WGFD, NRCS
Water trough escape ramps, spring protection and fence markers*	2007-08	$36,000 requested/ approved	Provide pre-fab wildlife escape ramps, fence collision deterents and spring protection fencing to private landowners throughout the state.	WWNRT, Landowners, WGFD
Impacts of wind energy development in SE WY*	2009-10	$22,750 requested/ approved	Research to determine impacts of wind energy development to sage-grouse	Horizon Wind Energy, Iberdrola Renewables
Grazing Management Assistance	2009-10	$5,000 requested/ approved; $4,600 spent	Small group or 1:1 grazing management assistance from Dr. Roy Roath to landowners	Natrona Conservation District, NRCS, WGFD
Seasonal Habitat Mapping*	2009-10	$155,000 requested/ approved; $141,000 spent	Use predictive habitat models to produce sage-grouse seasonal habitat maps	U.S. Fish & Wildlife Service, BLM, Various energy companies
Fence markers and spring protection fencing*	2009-10	$64,800 requested/ approved; $62,628 spent	Purchase fence markers and Steel Jack spring protection for statewide distribution	Niobrara Conservation District, numerous private landowners, BLM, TNC

Impacts of wind energy development in SE WY*	2011-12	$110,000 requested; $85,000 approved	Research to establish the short-term effects of wind development to sage-grouse	National Wind Coordinating Collaborative, Western Assoc. of Fish & Wildlife Agencies
Henderson Draw cheatgrass treatment	2011-12	$50,000 requested/ approved	Cheatgrass control	BLM - Casper F.O.
Audubon Community Naturalist (see also #53)	2011-12	$10,000 requested/ approved	Sagebrush ecosystem education program for schools	various foundations and grants
North Laramie Range cheatgrass control	2011-12	$26,000 requested/ approved	Cheatgrass control	WWNRT, WGFD, Gov's Big Game Lic. Coalition
Response of sage-grouse to sagebrush treatment in Fremont County*	2011-12	$189,800 requested/ approved	Research to determine sage-grouse demographic and habitat use response to sagebrush treatments	Univ. of Wyoming, WGFD
Estimating noise impacts for habitat selection modeling*	2011-12	$49,335 requested/ approved	Research to develop a noise model and determine noise exposure thresholds	Univ. California-Davis
Audubon Community Naturalist (see also #53)	2013-14	$10,000 requested/ approved	Sagebrush ecosystem education program for schools	various foundations and grants
North Natrona cheatgrass treatment	2013-14	$60,000 requested/ approved	Cheatgrass control northwest of Casper in the Natrona Core Area	BLM - Casper F.O.
Impacts of wind energy development in SE WY*	2013-14	$50,000 requested/ approved	Research to establish the short-term effects of wind development to sage-grouse	National Wind Coordinating Collaborative, Western Assoc. of Fish & Wildlife Agencies
Impacts of wind energy development in SE WY*	2015-16	$18,000 approved	Research to establish the short-term effects of wind development to sage-grouse	National Wind Coordinating Collaborative, Western Assoc. of Fish & Wildlife Agencies
Audubon Community Naturalist (see also #53)	2015-16	$10,000 requested/ approved	Sagebrush ecosystem education program for schools	various foundations and grants
Response of sage-grouse to sagebrush treatment in Fremont County*	2015-16	$15,000 approved	Research to determine sage-grouse demographic and habitat use response to sagebrush treatments	Univ. of Wyoming

Audubon statewide sage-grouse habitat modeling	2015-16	$17,000 approved	Use various remote imaging and GIS mapping techniques to map sage-grouse habitat throughout Wyoming	Unknown
Bates Creek cheatgrass treatment	2015-16	$15,000 approved	Treat cheatgrass in sage-grouse habitat to promote rangeland health and restore perennial grass cover and forb production	WGFD, WWNRT
Mud Springs sagebrush thinning	2015-16	$35,000 approved	Mechanically treat dense high canopy coverage sagebrush in snow accumulation zones to open canopy and promote brood rearing habitat	WGFD, WWNRT
Statewide 0.5 meter resolution NAIP imagery for core areas	2015-16	$10,000 approved	Assist in statewide effort to obtain high resolution aerial imagery for all core areas in Wyoming	Various entities
50-Mile Flat restoration	2015-16	$30,000 approved	Restore vegetation including sagebrush to 50-Mile Flat (which is a monoculture of crested wheatgrass adjacent to sage-grouse habitat)	WGFD, BLM, others

* Other local working groups collaborated on funding these projects with Sage-grouse Conservation Funds

Big Horn Basin
Sage-Grouse
Job Completion Report
2013

June 2013-May 2014

Leslie Schreiber
Wyoming Game & Fish Dept.
Cody Region

Cody Region Annual Report

Species: **Sage-grouse**
Region: **Cody**
Management area: **B**

Period covered: **6/1/2013 – 5/31/2014**
Local Working Group: **Big Horn Basin**
Prepared by: **Leslie Schreiber**

INTRODUCTION

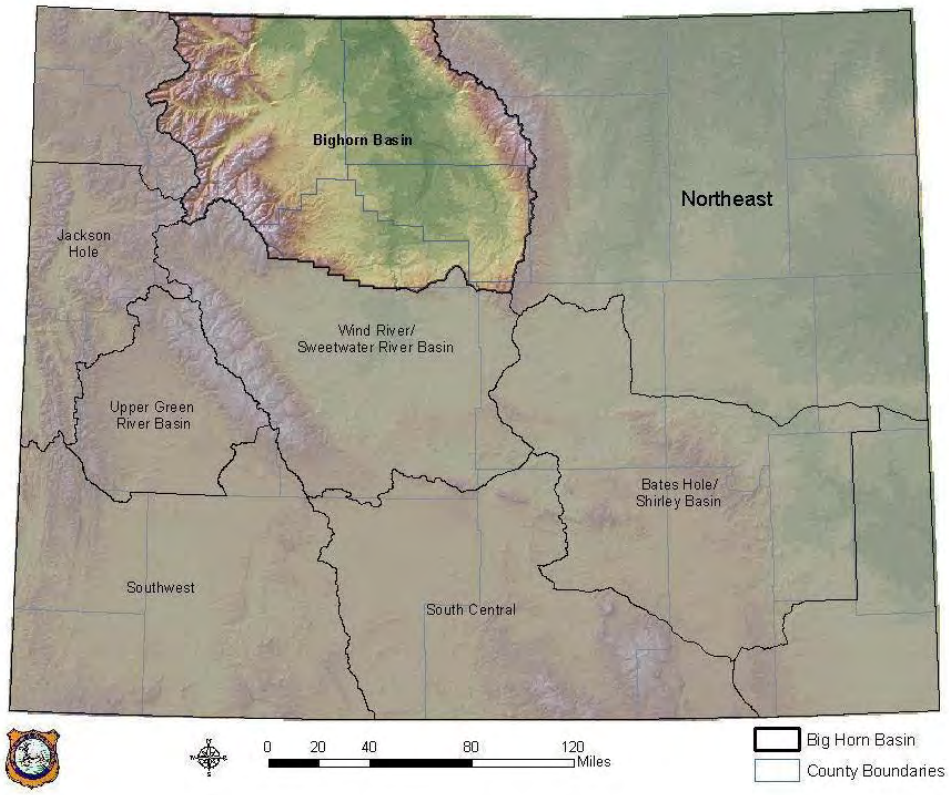
During the late 1990s, concerns increased over degradation and fragmentation of sagebrush ecosystems and declines in greater sage-grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) populations. Wyoming Game & Fish Department (WGFD) increased monitoring efforts for sage-grouse across the state and also formed an internal working group in 1997 to focus on sage-grouse management issues. In addition, a state-wide citizens working group was formed in 2000 consisting of representatives from government agencies (state and federal), agriculture, extractive industries, environmental groups, hunting groups, and Native American tribal interests. This citizens' group produced the *Wyoming Greater Sage-grouse Conservation Plan (The State Plan)*, which was approved and adopted by the WGF Commission in 2003. The State Plan called for creation of local working groups (LWG) to formulate strategies at a local level to address sage-grouse conservation; eight local working groups were formed (Figure 1).

Similar to the state-wide working group, the Big Horn Basin LWG (BHBLWG), in north-central Wyoming (Figure. 1), consisted of representatives from agriculture, mining, oil/gas production, conservation and hunting interests, a citizen at-large, local (county) government, local Conservation Districts, Bureau of Land Management (BLM), Natural Resources Conservation Service (NRCS), and WGFD. BHBLWG produced the *Sage-grouse Conservation Plan for the Big Horn Basin, Wyoming* in 2007. This plan is available under "Final Local Conservation Plans" at: http://wgfd.wyo.gov/web2011/wildlife-1000817.aspx. A five-year (2007-2013) update of that plan is also available at the same web site.

Seven petitions were filed to list the greater sage-grouse for protection under the Endangered Species Act between 1999 and 2003. On March 5, 2010, after judicial and other extended reviews of its decisions, the U.S. Fish and Wildlife Service (USFWS) re-issued its decision of "warranted but precluded" for listing greater sage-grouse as threatened or endangered under the Endangered Species Act. Thus, sage-grouse became a "candidate" for listing but are precluded from immediate listing due to higher priorities. This status is to be reviewed by the USFWS again in 2015.

This report summarizes conservation efforts and data collected on sage-grouse in the Big Horn Basin during the 2013 biological year (1 June 2013–31 May 2014), including the 2014 breeding season (lek surveys).

Figure 1. Wyoming sage-grouse conservation areas, highlighting the Big Horn Basin Conservation Area.



STUDY AREA

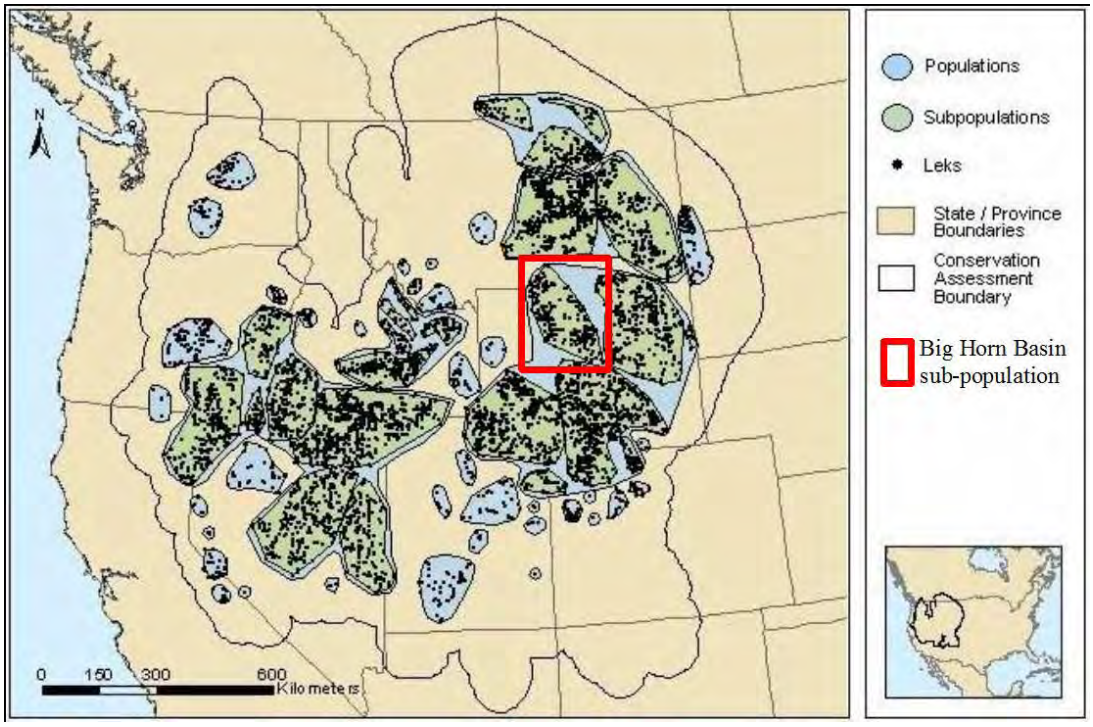
The Big Horn Basin Conservation Area (hereafter, Basin) encompasses over 12,300 square miles and is mostly public land managed by the BLM (40%), Forest Service (25%), State "school lands" (5%), or other government agencies (>1%; Bureau of Reclamation, National Park Service, Department of Defense). Over 3,100 square miles of the Basin are private land (25%). Counties within the Basin include Big Horn, Hot Springs, Park, and Washakie. WGFD divided the state into management areas for data collection and reporting of small and upland game species. In 2010, new management areas were created for sage-grouse management that correspond with conservation areas (as mapped in Figure 1); the Basin is Area B. Primary land uses in the Basin include: livestock grazing, farming, oil and gas development, bentonite mining, urban and suburban developments, recreation and wildlife habitat.

Habitats within the Basin are diverse and vary depending upon soil type, annual precipitation and elevation. Major habitat types within the Basin include: sagebrush/grassland, salt desert shrub, agricultural crops and pasture lands, cottonwood-riparian corridors, mixed mountain shrub, and at higher elevations mixed conifer forests with interspersed aspen stands.

Connelly et al. (2004) recognized sage-grouse in the Basin as a distinct sub-population (Fig 2). Mountain ranges to the east and west restrict most sage-grouse movement due to unsuitable habitat types. Grouse movements in the northwest and southeast portions of the Basin are not

well documented. There are several leks on both sides of the Wyoming-Montana state line, and movement between states is occurring. Suitable habitat on Copper Mountain, the Owl Creek Mountains and the southern Bighorn Mountains serve as travel corridors to adjacent populations (e.g., the South Fork of the Powder River Basin).

Figure 2. Discrete populations and subpopulations of sage-grouse in western North America, highlighting (red rectangle) the Big Horn Basin sub-population. (Adapted from Connelly et. al. 2004).



There are 294 known sage-grouse leks in the conservation area and 130 were known to be active in 2014 (Table 1). Thirty-nine leks are classified as unoccupied (abandoned or destroyed). Leks classified as "Unknown" need additional observations before being reclassified as occupied or unoccupied. A majority of leks (67%) occur on BLM managed land and 25% of known leks occur on private land (Table 1). There are probably other leks in the Basin that have not been discovered.

METHODS

Since 1998, data on numbers of sage-grouse attending leks were collected in two ways: lek surveys or lek counts. Lek surveys determine if the lek is active and require at least one visit to a lek during the breeding season (mid March-mid May). Lek counts document the maximum number of males in attendance and require three or more visits to a lek (separated by about 7-10 days) during the peak of strutting activity (early April-early May). During 2014 WGFD wardens and biologists, BLM personnel, and volunteers counted or surveyed leks within the Basin. Observers returned lek data to the Cody Regional office after completing surveys for data entry into the sage-grouse database.

Table 1. Lek classifications in the Big Horn Basin by activity, ownership and geopolitical boundaries, 2014.

Classification	Number	Percent
Occupied	252	85.7
Undetermined	3	1.0
Unoccupied	39	13.3

Biologist	Number	Percent
Cody	78	26.5
Greybull	50	17.0
Worland	166	56.5

County	Number	Percent
Big Horn	45	15.3
Hot Springs	56	19.0
Park	98	33.3
Washakie	95	32.3

BLM Office	Number	Percent
Cody	106	36.1
Worland	188	63.9

Warden	Number	Percent
Greybull	30	10.2
Lovell	17	5.8
Meeteetse	36	12.2
North Cody	22	7.5
Powell	16	5.4
South Cody	18	6.1
Tensleep	47	16.0
Thermopolis	42	14.3
Worland	66	22.4

Land Status	Number	Percent
BLM	196	66.7
BOR	3	1.0
Private	74	25.2
State	21	7.1

The WGFD changed how lek data were calculated and reported in 2012. Prior to 2012, leks with fresh sign (feathers, droppings), but with 0 males were included in calculating average male lek attendance. Average male lek attendance is now calculated using only leks with ≥1 observation of strutting males, while leks with only sign (feathers, droppings) are excluded.

No consistent methodology has been established for brood surveys. Sage-grouse brood data is opportunistically collected by field personnel while doing other field work during July and August. Data on the number of chicks, adult hens, and adult males along with location (UTM coordinates) and habitat type, are recorded and then entered into the Wildlife Observation System (WOS).

Harvest information is obtained through a mail questionnaire of bird hunters who provide data on number of birds harvested, days hunted, and areas hunted. Hunter survey data was compiled by county prior to 1982; by small and upland game management area from 1982 to 2009; and then in 2010, sage-grouse management areas were consolidated into 8 conservation areas with the Basin designated as Management Area B (Figure 1).

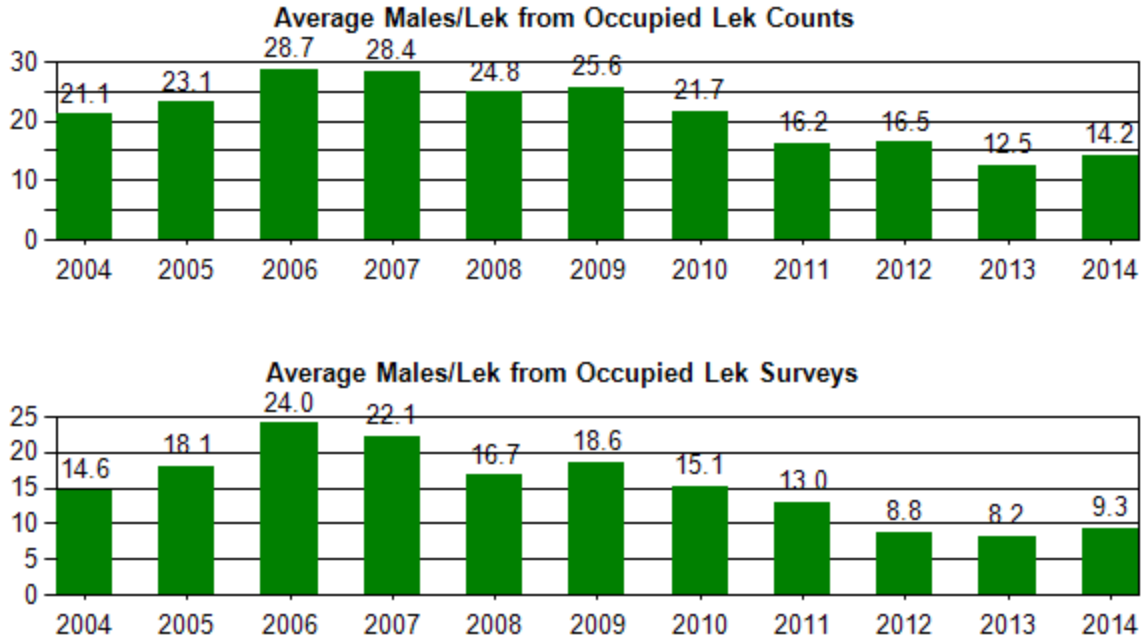
Surveys were conducted during December through early February to delineate winter distribution and identify important habitats. Winter surveys consisted of driving or flying across areas that contain sufficient sagebrush above snow to provide cover and forage. Observers recorded location, grouse numbers, habitat type, aspect, slope, and approximate snow depth.

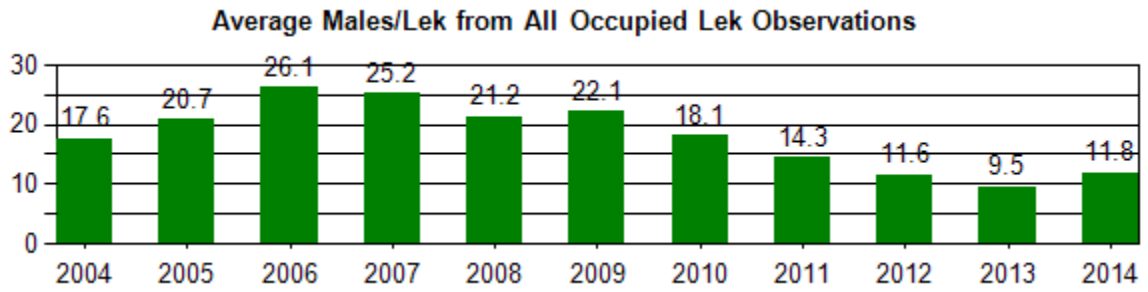
RESULTS AND DISCUSSION

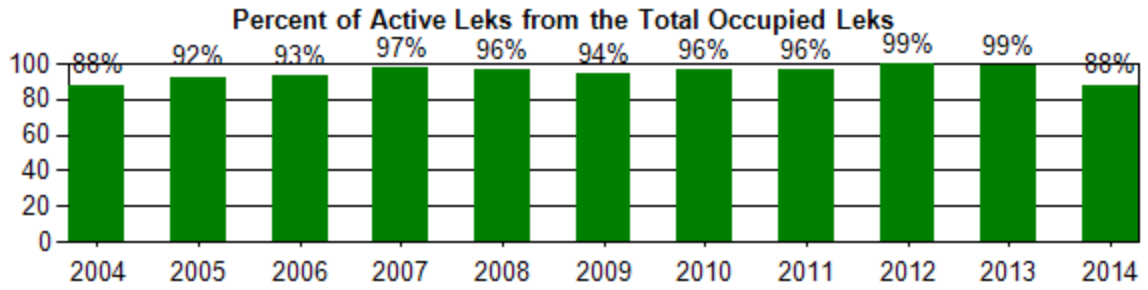
Lek Monitoring. In spring 2014, 70 leks were counted in the Basin, resulting in an average of 14.2 males per lek (Table 2a). Eighty-seven leks were surveyed (2004-13 average=102; Table 2b), and 157 leks were checked (2004-13 average=170; Table 2c). To evaluate long-term trends in the average number of males/lek, we used this metric associated with leks that were *checked*, because leks were *checked,* but not routinely *counted* in the late 1980s-early 1990s. Fortunately, long-term data sets from Wyoming and neighboring states indicate similar trends from both counts and surveys (Fedy and Aldridge 2011; Figure 3).

The average number of male sage-grouse on checked leks increased from 9.5 in 2013 to 11.8 in 2014 (Table 2c), and may be an upswing in the population cycle (Fig 4). Sage-grouse populations cycle on an approximate 7 to 10-year interval (Figure 4). During an upswing in the population, we would expect a decrease in the number of inactive leks. However, the number of inactive leks in the Basin increased from 2 in 2013 to 17 in 2014. Therefore, the slight increase in one metric (# males/active lek) may not adequately describe the trend given the increase in the other metric (# of inactive leks). With only 1 year of data indicating an increase in population numbers, it may be too early to tell if the negative trend of the past 7 years is reversing (Figure 4).

Figure 3. Average number of male sage-grouse observed per lek in the Big Horn Basin by counts, surveys and all observations, 2004-14.







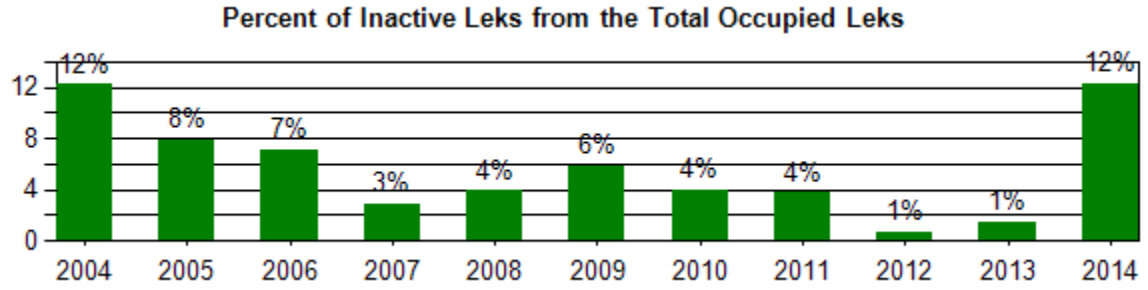


Table 2 (a-d). Lek attendance summary of occupied[1] leks in the Big Horn Basin, 2004-2014.

a. Leks Counted	Year	# Occupied Leks	# Leks Counted	% Leks Counted	Peak Males	Avg # Males / Active Lek[2]
	2004	194	61	31	1140	21.1
	2005	193	85	44	1757	23.1
	2006	203	64	32	1694	28.7
	2007	205	72	35	1901	28.4
	2008	218	96	44	2083	24.8
	2009	219	74	34	1717	25.6
	2010	223	74	33	1495	21.7
	2011	230	64	28	905	16.2
	2012	233	53	23	823	16.5
	2013	237	42	18	501	12.5
	2014	235	70	30	837	14.2

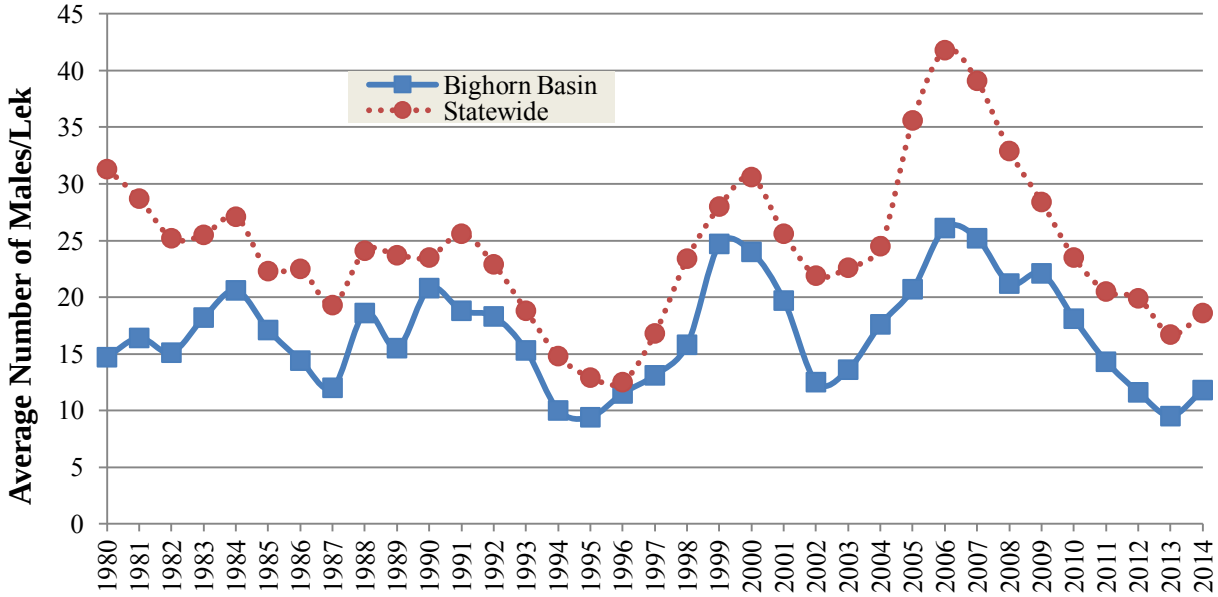
b. Leks Surveyed	Year	# Occupied Leks	# Leks Surveyed	% Leks Surveyed	Peak Males	Avg # Males / Active Lek[2]
	2004	194	83	43	966	14.6
	2005	193	79	41	1230	18.1
	2006	203	97	48	1753	24.0
	2007	205	82	40	1550	22.1
	2008	218	79	36	1121	16.7
	2009	219	95	43	1244	18.6
	2010	223	108	48	1242	15.1
	2011	230	119	52	988	13.0
	2012	233	126	54	771	8.8
	2013	237	147	62	750	8.2
	2014	235	87	37	511	9.3

c. Leks Checked	Year	# Occupied Leks	# Leks Checked	% Leks Checked	Peak Males	Avg # Males / Active Lek[2]
	2004	194	144	74	2106	17.6
	2005	193	164	85	2987	20.7
	2006	203	161	79	3447	26.1
	2007	205	154	75	3451	25.2
	2008	218	175	80	3204	21.2
	2009	219	169	77	2961	22.1
	2010	223	182	82	2737	18.1
	2011	230	183	80	1893	14.3
	2012	233	179	77	1594	11.6
	2013	237	189	80	1251	9.5
	2014	235	157	67	1348	11.8

d. Lek Status	Year	# Active Leks	# Inactive[3] Leks	# Unknown Leks	# Known Status Leks	% Active Leks	% Inactive Leks
	2004	115	21	58	136	84.6	15.4
	2005	140	12	12	152	92.1	7.9
	2006	131	10	20	141	92.9	7.1
	2007	136	4	14	140	97.1	2.9
	2008	148	6	21	154	96.1	3.9
	2009	128	8	33	136	94.1	5.9
	2010	144	6	32	150	96.0	4.0
	2011	129	5	49	134	96.3	3.7
	2012	146	1	32	147	99.3	0.7
	2013	134	2	53	136	98.5	1.5
	2014	121	17	19	138	87.7	12.3

[1] Occupied – Active during previous 10 years.
[2] Avg Males/Active Lek – Includes only those leks where 1 or more strutting males was observed. Does not include "Active" leks where only sign was documented.
[3] Inactive – Confirmed no birds/sign present.

Figure 4. Trends in average male attendance at leks checked in the Bighorn Basin and statewide, 1980-2014.



Production surveys. Only 6 sage-grouse broods were documented in 2014 (Table 3). Sample sizes (number of groups observed) from 2011-2014 were too small to make valid statements on chick production (chicks/brood or chicks/hen). Low sample sizes are likely a product of lack of effort. A direct connection between effort (time spent surveying for broods) and number of broods observed was discussed in previous annual reports. Analysis of wings from harvested grouse are used to estimate chick production in other portions of Wyoming; however an insufficient number of wings have been collected from the Basin in past years, thus this technique was discontinued by the Cody Region.

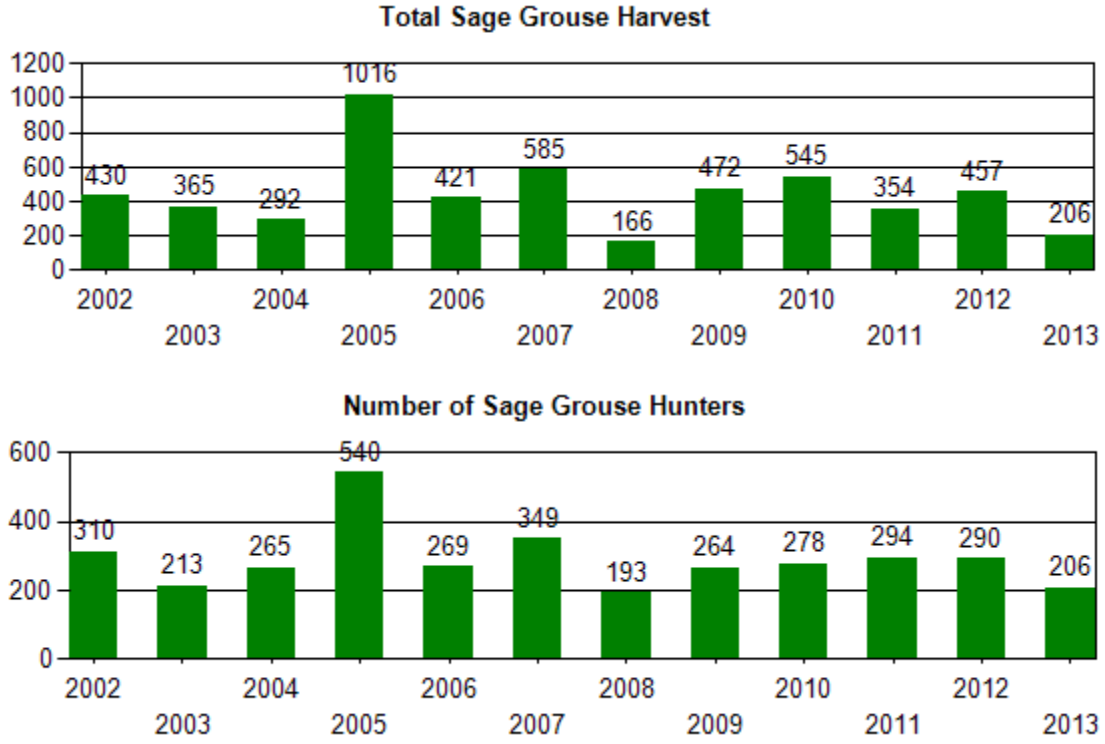
Table 3. Brood survey data collected by Wyoming Game & Fish Department personnel in the Bighorn Basin, 2001-14.

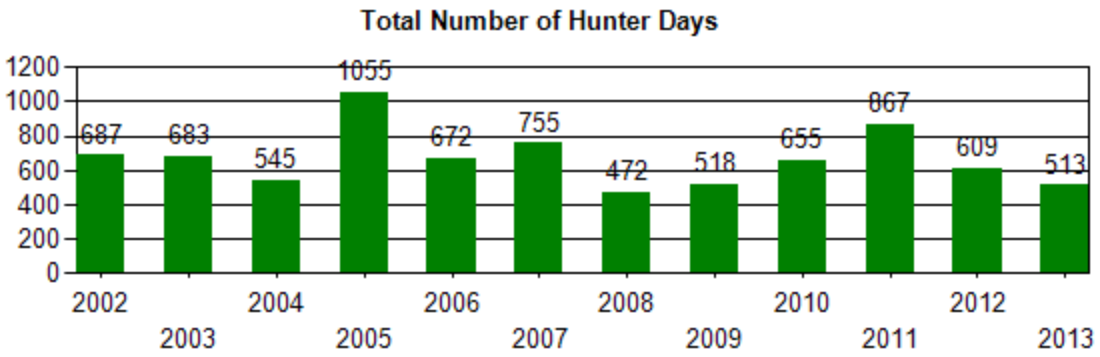
Year Observed	Broods	Chicks	Hens	Chicks/brood	Chicks/hen
2001	14	51	24	3.6	2.1
2002	10	35	16	3.5	2.2
2003	24	103	30	4.3	3.4
2004	17	71	73	4.2	1
2005	23	123	41	5.3	3
2006	24	99	38	4.1	2.6
2007	56	191	99	3.4	1.9
2008	18	88	29	4.6	3
2009	26	104	33	4	3.2
2010	17	64	17	3.8	3.8
2011	0	0	18	0	0
2012	8	26	8	3.3	3.3
2013	8	30	9	3.8	3.3
2014	6	31	27	5.2	1.1
2001-13 average	***19***	***76***	***33***	***3.7***	***2.5***

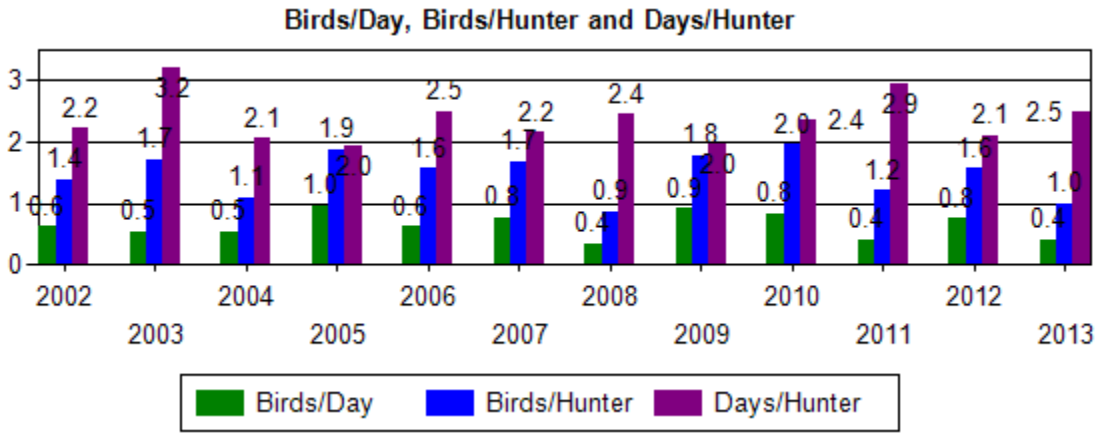
Hunting season and harvest. The opening day of sage-grouse season was moved from 1 September to the third Saturday in September in 1995. Research suggests that hens and broods are more dispersed and less vulnerable to hunting later in the fall. Hunting seasons averaged 25 days long (range 16-31 days) between 1982-94 and about 15 days between 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 since 2002 have averaged 11 days.

Changing the season and decreasing the bag limit reduced sage-grouse harvest and hunters in the Basin (Figure 6). 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 2002-2013 hunters averaged 1.5 birds/hunter and 2.4 days/hunter. In 2013, 206 hunters in the Bighorn Basin harvested 206 sage-grouse (1.0 birds/hunter); spending 513 hunter-days afield (2.5 days/hunter) during the 11-day hunting season. The decrease in sage-grouse harvest observed in 2013 is likely a result of declining sage-grouse populations. Fewer sage-grouse in the population equates to hunters harvesting less sage-grouse, even though hunters expended greater effort in 2013 (2.5 days/hunter) than in 2012 (2.1 days/hunter). In addition, inclement weather during the 2013 hunting season may have hindered the sage-grouse harvest. Opening weekend was hot (≥80°F), then thunderstorms moved in during the week, allowing hunters pleasant weather on the last weekend of the season.

Figure 6. Sage-grouse hunting statistics for the Bighorn Basin, 2002-13.







CONSERVATION PLANNING

The BHBLWG was formed in September 2004 to develop and implement a local conservation plan for sage-grouse and sagebrush habitats. The BHBLWG's mission statement is, "*Through the efforts of local concerned citizens, recommend management actions that are based on the best science to enhance sagebrush habitats and ultimately sage-grouse populations within the Big Horn Basin.*"

The BHBLWG's local plan identifies factors and impacts that may influence sage-grouse populations in the Basin, and outlines goals and objectives to address habitats, populations, research and education. Strategies and commitments in the local plan are designed to improve sage-grouse habitats and populations in the Basin. The local plan was updated in 2013 and highlights completed and ongoing projects in the Basin in addition to summarizing state- and nation-wide policy and programs. The updated plan can be viewed at the WGFD website: http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/SG_BHB_CONSERVPLAN0005524.pdf. Updated conservation plans from all Wyoming local working groups will be submitted to USFWS prior to the sage-grouse status review in 2015.

RESEARCH

Sage-grouse research in the Basin has been limited. Hess (2010) and Hess and Beck (2012a) evaluated the relative influence of prescribed burning and mowing treatments on sage-grouse

nesting and early brood-rearing habitats. Hess and Beck (2012b) evaluated landscape characteristics that explain differences between occupied and unoccupied leks using Basin lek data from 1980 to 2009.

In 2010, two research projects on sage-grouse were begun in the Basin. Pratt and Beck (2012) are evaluating possible effects of bentonite mining on sage-grouse near Hyattville and will be completed by late 2015. Orning and Young (2012, 2012a) started a multiphase sage-grouse predation project, with the completed first phase documenting predation levels on nests, broods, and adult hens at several sites in the Basin (Orning 2013). A second phase of the predation project now focuses on impacts of ravens and is being conducted by Dr. James Taylor USDA-APHIS Wildlife Services Research Branch based at Oregon State University.

CONCLUSIONS & RECOMMENDATIONS

Sage-grouse populations in the Basin experienced a low in the population cycle over recent years, but 2014's data suggests that populations may be on an upswing, in conjunction with improved habitat conditions due to increased spring precipitation. Sage-grouse in the Basin face threats, but are not in danger of foreseeable extirpation, and on-going conservation efforts are intended to mitigate some anthropogenic impacts. Research and monitoring are important to help identify limiting factors and to monitor sage-grouse populations and their habitats.

- Continue to improve the number and intensity of lek surveys.
- Conduct brood surveys whenever possible and work schedules allow, and enlist volunteers where practical.

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Northeast
Sage-Grouse
Job Completion Report
2013

June 2013-May 2014

Dan Thiele
Wyoming Game & Fish Dept.
Sheridan Region

Sage Grouse Job Completion Report

Year: 2005 - 2014, 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)
2005	338	102	30	1489	19.1
2006	373	85	23	1793	28.0
2007	396	108	27	2036	26.1
2008	410	125	30	1900	20.2
2009	413	149	36	1135	10.8
2010	412	180	44	1561	13.7
2011	419	174	42	1125	11.7
2012	421	243	58	1861	12.9
2013	413	109	26	714	10.3
2014	406	195	48	929	9.6

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2005	338	180	53	2099	16.3
2006	373	233	62	3297	19.4
2007	396	257	65	3444	20.3
2008	410	242	59	2209	15.9
2009	413	222	54	1343	11.9
2010	412	175	42	618	7.8
2011	419	192	46	641	8.1
2012	421	149	35	470	9.8
2013	413	248	60	913	8.5
2014	406	154	38	638	10.0

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: 2005 - 2014, 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)
2005	338	282	83	3588	17.3
2006	373	318	85	5090	21.8
2007	396	365	92	5480	22.1
2008	410	367	90	4109	17.6
2009	413	371	90	2478	11.4
2010	412	355	86	2179	11.3
2011	419	366	87	1766	10.1
2012	421	392	93	2331	12.1
2013	413	357	86	1627	9.2
2014	406	349	86	1567	9.7

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2005	211	27	44	238	88.7	11.3
2006	236	32	50	268	88.1	11.9
2007	249	59	57	308	80.8	19.2
2008	234	82	51	316	74.1	25.9
2009	220	83	68	303	72.6	27.4
2010	199	110	46	309	64.4	35.6
2011	182	113	71	295	61.7	38.3
2012	198	116	78	314	63.1	36.9
2013	179	121	57	300	59.7	40.3
2014	163	131	55	294	55.4	44.6

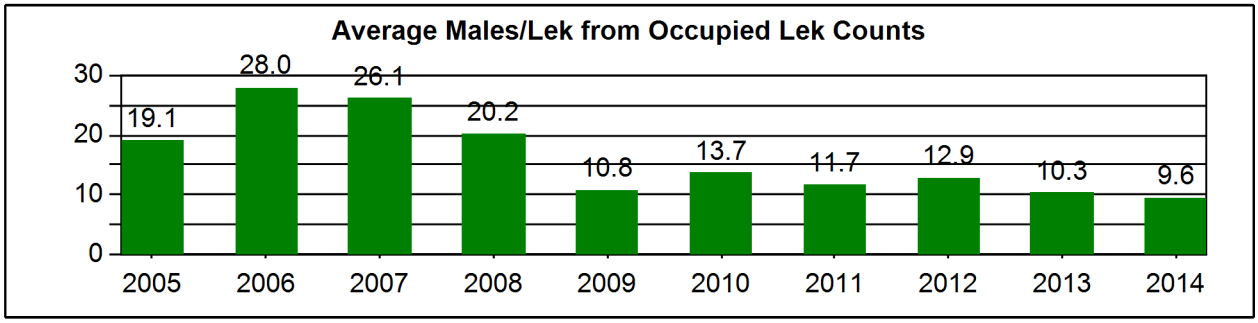
1) Occupied - Active during previous 10 years (see official definitions)

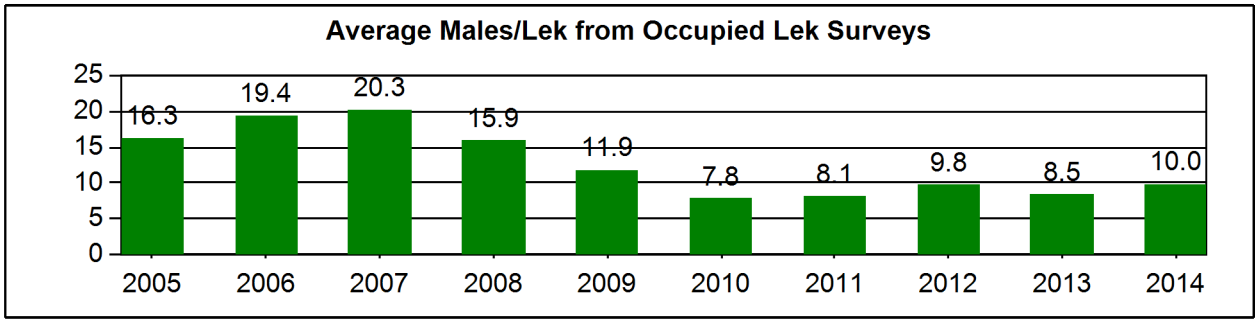
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

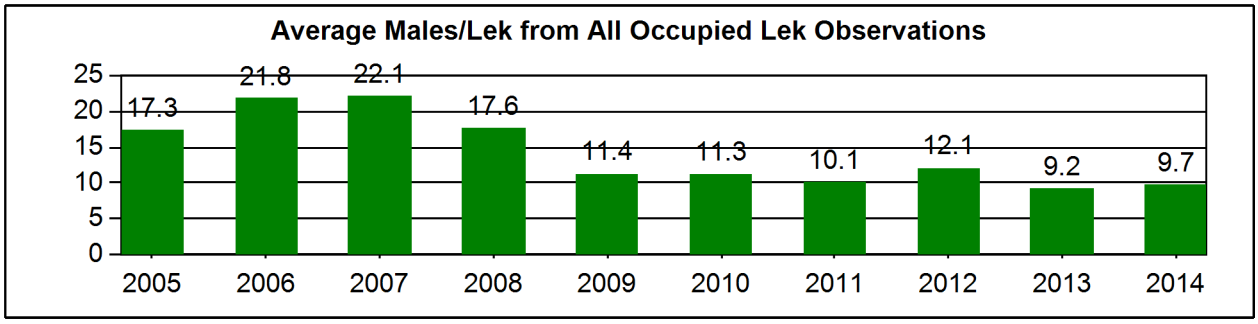
3) Inactive - Confirmed no birds/sign present (see official definitions)

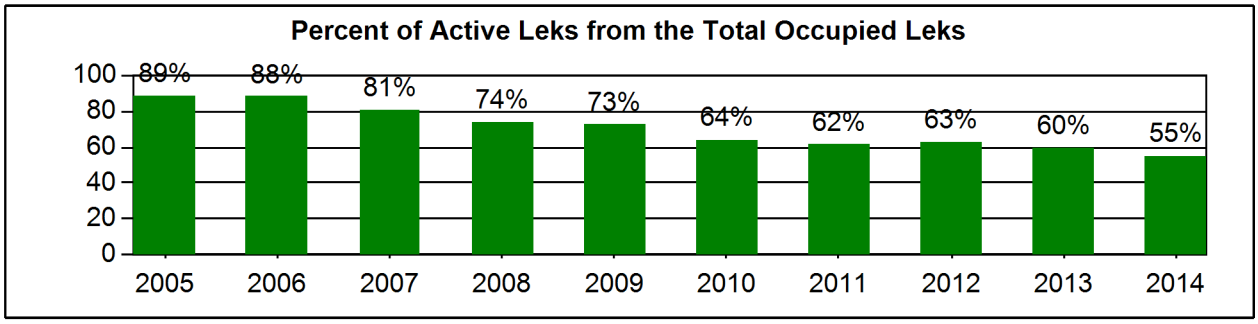
Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Northeast



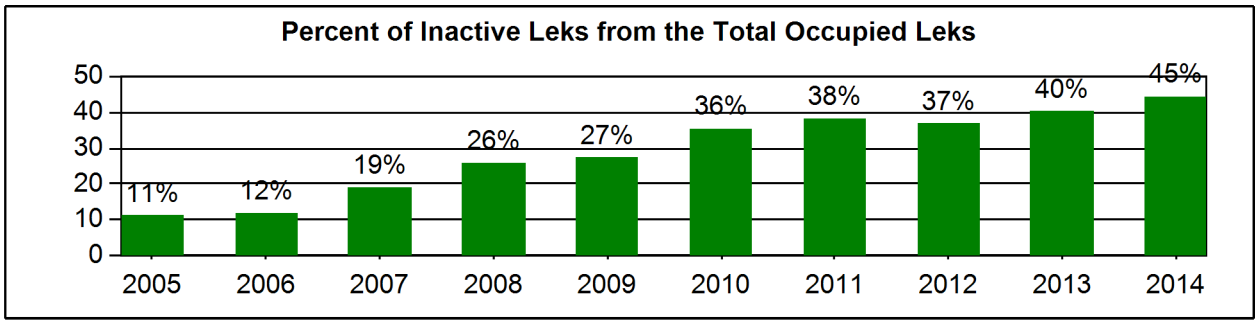






Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Northeast



Sage Grouse Job Completion Report

Year: 2004 - 2013, Management Area: C

4. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possession Limit
2004	Sep-23	Oct-3	11	2/4
2005	Sep-23	Oct-3	11	2/4
2006	Sep-23	Oct-3	11	2/4
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-25	7	2/4
2010	Sep-18	Sep-20	3	2/4
2011	Sep-17	Sep-19	3	2/4
2012	Sep-15	Sep-17	3	2/4
2013	Sep-21	Sep-23	3	2/4

b. Harvest

Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2004	347	271	471	0.7	1.3	1.7
2005	422	342	1649	0.3	1.2	4.8
2006	475	283	509	0.9	1.7	1.8
2007	532	297	632	0.8	1.8	2.1
2008	101	186	295	0.3	0.5	1.6
2009	311	230	559	0.6	1.4	2.4
2010	129	117	202	0.6	1.1	1.7
2011	158	124	173	0.9	1.3	1.4
2012	405	218	404	1.0	1.9	1.9
2013	27	82	249	0.1	0.3	3.0
Avg	291	215	514	0.6	1.2	2.3

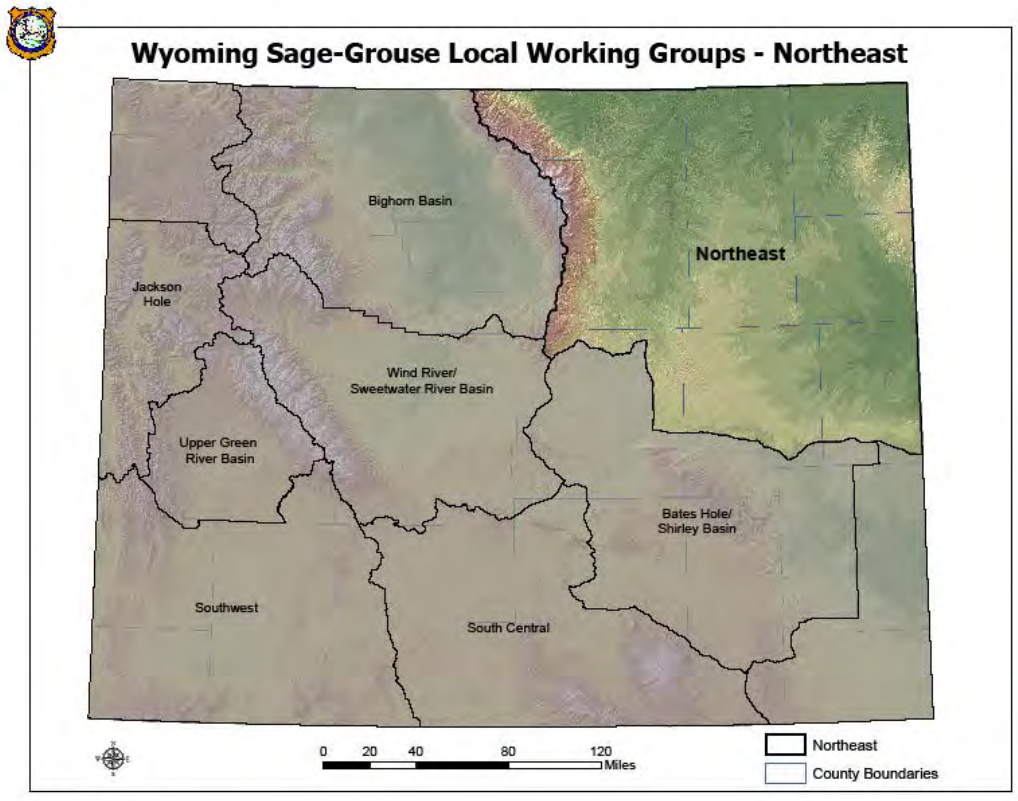
2013 JOB COMPLETION REPORT

Narrative
SPECIES: **Sage-grouse**
DAU NAME: **Northeast Wyoming Working Group**
Period Covered: **6/1/2013 – 5/31/2014**
Prepared by: **Dan Thiele, Wildlife Biologist**

INTRODUCTION

Sage-grouse data are reported for the area encompassed by the Northeast Wyoming Local Working Group Area (NEWLWGA) which was formed in 2004 to develop and facilitate implementation of a local conservation plan for the benefit of sage-grouse, their habitats, and whenever feasible, other wildlife species that use sagebrush habitats. The NEWLWGA covers Wyoming from the Bighorn Mountain divide to South Dakota and from Montana to Interstate Highway 25 and U.S. Highway 20/26 (Figure 1). The Area boundary encompasses the WGFD Sheridan Region and a portion of the Casper Region. In 2010 the Department revised sage-grouse management areas by eliminating the numbered upland and small game management areas and created management areas corresponding to working group area boundaries. The NEWLWGA now corresponds to Management Area C.

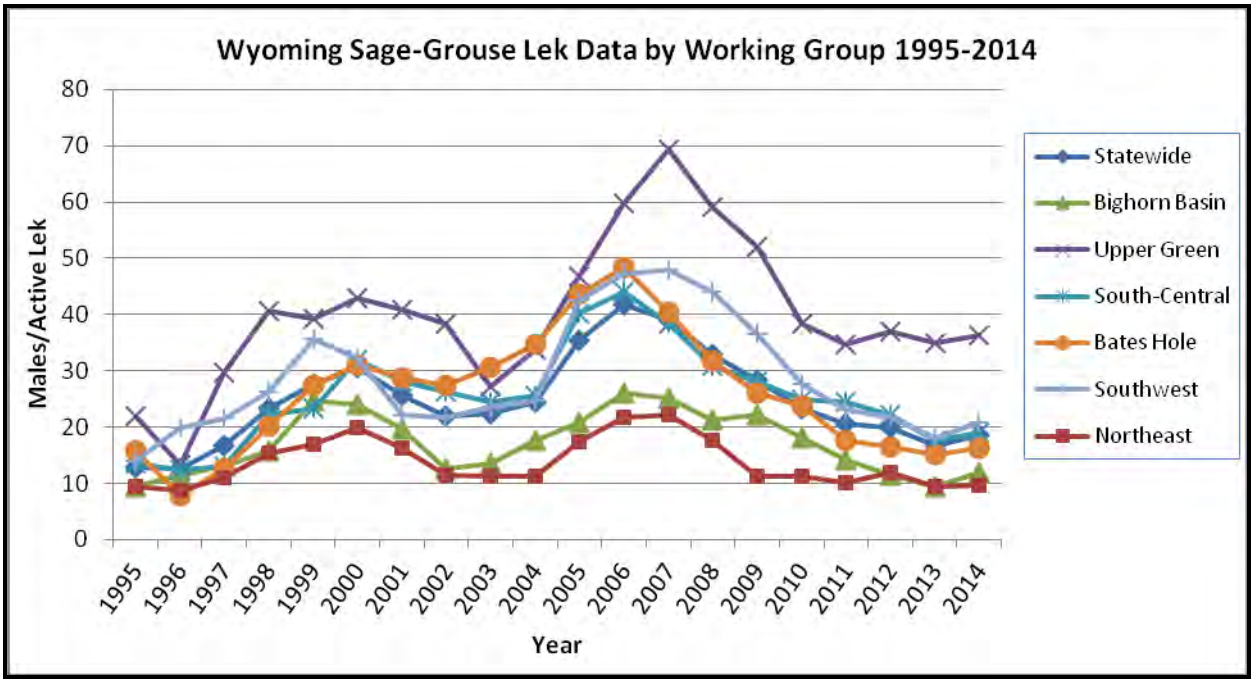
Figure 1. Northeast Wyoming Local Working Group Area.



Sage-grouse are found throughout sagebrush grassland habitats of northeast Wyoming. Occupied habitat is fairly contiguous east of the Bighorn Mountains to the Black Hills and the Wyoming-Nebraska state line with the exception of forested, grassland and highly developed agricultural habitats. Sagebrush habitats are less continuous than western Wyoming, which

contributes to lower sage-grouse densities. Northeast Wyoming has the lowest average male lek attendance in the state, averaging 10 males per active lek in 2014 compared to the statewide average of 19 males per active lek (Figure 2). Male lek attendance for the other working group areas ranged from 12 to 36 males per active lek. It is interesting that over the last six years the Northeast Wyoming Local Working Group has exhibited a more stable trend than the other working group areas. However, the number and proportion of active leks has declined during that period so it is apparent the population has declined. Most leks in northeast Wyoming are small with less than 20 males. In years when grouse are at the peak of their cycle, less than 10% of the leks have greater than 50 males at peak count. No leks exceeded 50 males in 2014 with the Watsabough IV hosting the largest male attendance of 48 males

Figure 2. Wyoming Statewide and Local Working Group Area Lek Attendance Trends.



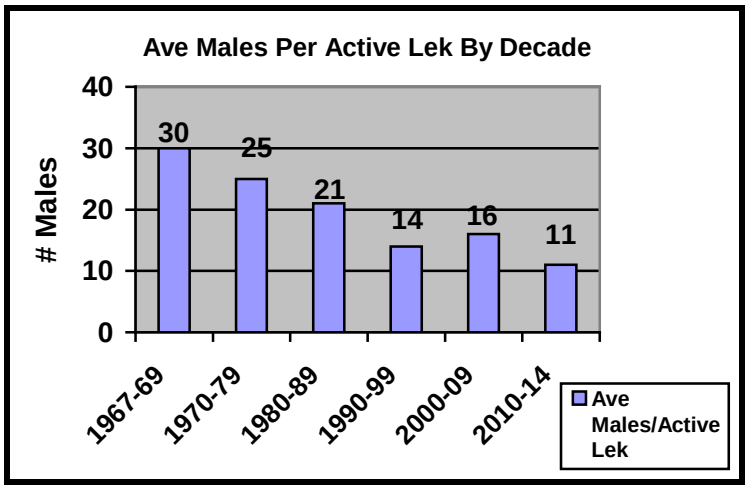
Average male lek attendance in northeast Wyoming has decreased significantly over the years. Figure 3 shows the average number of males per active lek by decade since monitoring efforts began. Average male attendance has decreased by more than one-half over the last thirty years. A slight upswing occurred from 2000-2009, however, the long-term trend remains a concern.

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 coalbed natural gas (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 2013). Much of the development in the energy play involves federal minerals with private surface. Wells, roads, power lines, produced water, activity and dust are components of development which affect sage-grouse habitat at a broad scale. Since 2009, development and production has declined as CBNG leases have been drilled and natural gas prices remain low. In May 2014, the Wyoming Oil and Gas Conservation Commission reported that 8,510 producing wells yielded 21,246,058 Mcf of methane gas (WOGCC 2014). In addition to producing wells there are over 11,657 shut in wells. More than 72,000 permits to drill have been issued, although many have been expired. Federal mineral leases provided for 71% of the production while fee leases accounted for 21% and State leases 8%. This compares to May 2013 when 10,017 producing wells yielded 27,337,563 Mcf of methane gas. Many wells drilled early in the play have completed the production phase of development and are now being plugged and abandoned.

Figure 3. Average Number of Males per Active Lek by Decade for Northeast Wyoming Leks.



Deep well oil and gas development is increasing with new technologies enabling horizontal and directional drilling. While CBNG activity decreases the interest in deep drilling increases. In 2013, counties comprising the NEWLWG had 412 oil wells started (spud) including 272 horizontal wells and 31 directional wells (WOGCC 2014). Drilling for natural gas was limited to six wells, five of which were horizontal wells. Exploration utilizing horizontal drilling has increased markedly from 10 wells in 2007 to 272 wells in 2013. More than 2,300 permits have been issued while nearly 600 horizontal wells have been spudded during the period. Significant 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.

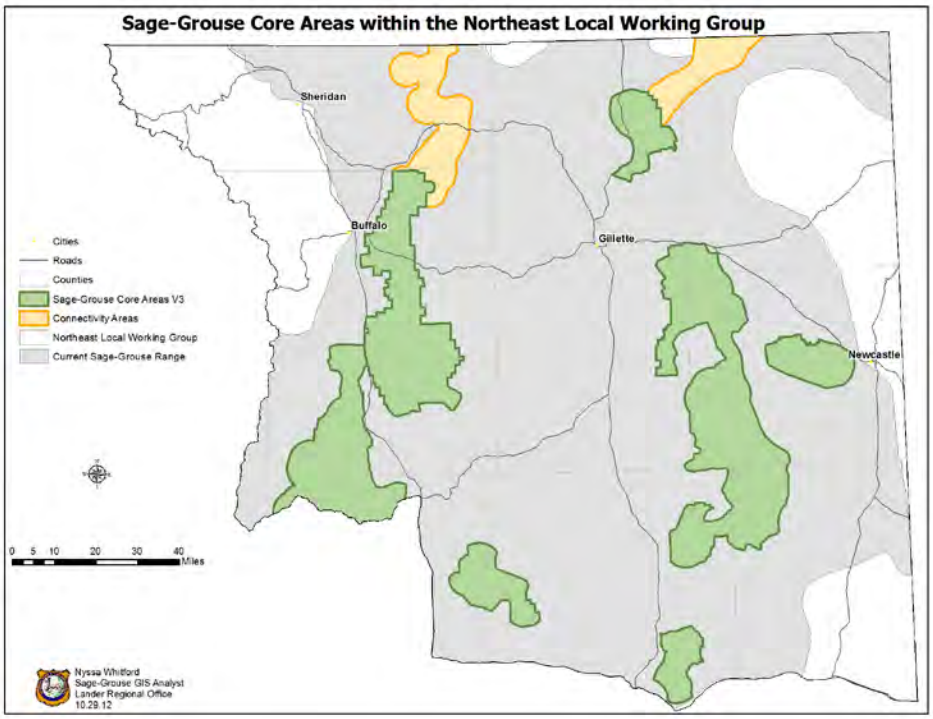
Considerable debate occurred on the effects of energy development on sage-grouse. Peer reviewed research findings show significant impacts (Walker et al. 2007, Doherty et al. 2008, Doherty et al. 2010, Harju et al. 2010 and others). These findings have yet to be accepted by some people and this has contributed 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.

The Wyoming Sage-Grouse Core Area Strategy (CAS) is based on a series of Executive Orders issued by former Governor Dave Fruedenthal and current Governor Matt Mead (WY-EO-2011-5). 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. As a result of the 2008 Governor's Executive Order, core areas were designated with the objective of identifying habitats that supported most of Wyoming's sage-grouse. Statewide, core areas account for approximately 34% of the current sage-grouse range while encompassing leks with 81% of the 2008 peak males. However, within a three county area of the Powder River Basin (Campbell, Johnson and Sheridan Counties), core areas were designated based on CBNG development patterns along with lek density data thereby encompassing leks supporting only 28% of the 2008 peak males.

In June 2010, the Northeast Local Working Group finalized recommendations for delineation of connectivity areas, core area boundary adjustments and sage-grouse development guidelines in and outside connectivity areas. Connectivity areas were identified using larger leks based on recommendations by Knick (2008) and habitat maps. Two connectivity areas were identified linking core habitat in Wyoming with Montana (Figure 4).

Figure 4. Wyoming Sage-grouse Core Area and Connectivity Areas (version 3).



Sage-grouse data collection efforts have focused on lek counts and surveys, which have been conducted each spring within the area since at least 1967. Lek searches may have been conducted earlier; however, no records exist for data verification. Lek counts include those lek observations conducted three to four times each spring, about a week to 10 days apart. Lek counts are conducted to provide population trends based on the average peak male attendance.

Lek surveys include lek attendance observations not following the count protocol, and are intended to determine general lek status (active, inactive or unknown).

Management of sage-grouse within the NEWLWGA has focused mainly on the protection of lek and nesting areas during the breeding season. Protection efforts have primarily occurred through the environmental commenting process and more recently the formation of core areas combined with the issuance of Governor's executive orders guiding development. Although more than 75% of the area's leks are found on private land, the split estate nature of the surface and mineral ownership provides for greater management influence by the BLM for oil and gas resource development.

WEATHER

Weather during the past biological year (June 2013 – May 2014) was wetter with warmer spring and summer temperatures and cooler fall and winter temperatures than the 30-year averages (Figures 5 and 6). Precipitation was 115% of normal compared to the previous year of only 63% of normal. The average temperature was near normal. The biological year started off dry with June precipitation at just 75% of normal. The drought ended with generous September and October rain and snow that was more than double the normal. The fall precipitation proved crucial as April and May precipitation was only 78% of normal.

Figure 5. 2013 Bio-Year: Monthly Precipitation Data (in), Wyoming Climate Division 5.

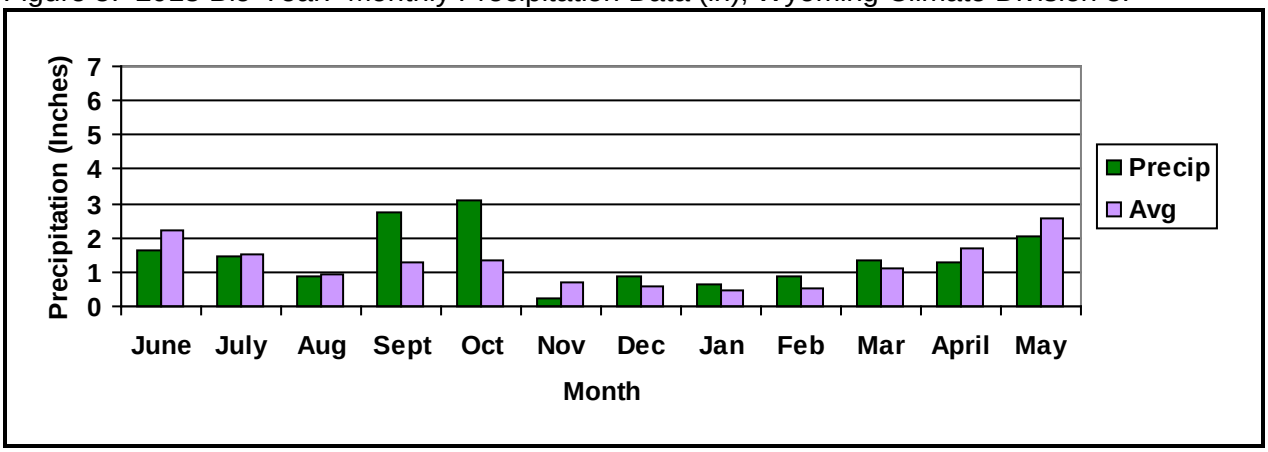
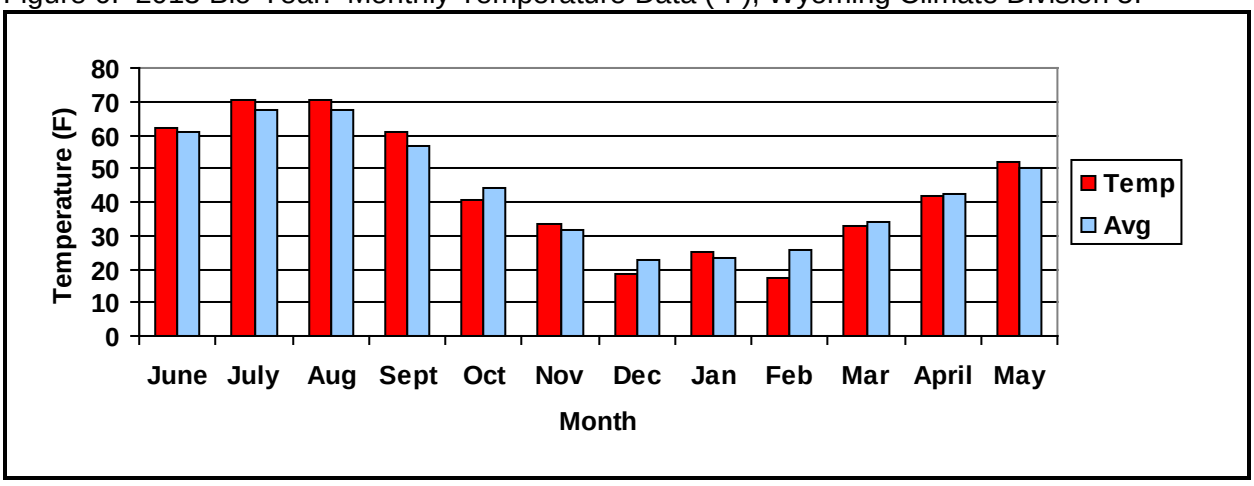


Figure 6. 2013 Bio-Year: Monthly Temperature Data (^{o}F), Wyoming Climate Division 5.



Weather data was obtained from the National Climate Data Center/National Oceanic and Atmospheric Administration (NCDC/NOAA) for Wyoming Climatic Division 5 which includes the Powder River, Little Missouri River and Tongue River drainages. Weather data from this area are provided as a general indication of weather patterns over the entire working group area.

METHODS

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

RESULTS

Variation in this report from previous year's reports is expected because of new data added to the lek database. Old records are added each year as the data become available. Additionally, new leks discovered are added to existing complexes or create new complexes. New lek count routes may also be added. Data adjustments should be taken into consideration when the current report and tables are compared to previous editions.

West Nile Virus

One West Nile virus (WNv) mortality was reported for northeast Wyoming in 2013-14; a bird from Campbell County submitted for testing by a consulting firm. No major mortality events have been documented since 2003, however, there are fewer radio marked sage-grouse being monitored by researchers which decreases the likelihood of finding mortalities. Based on human diagnosed cases of WNv, outbreaks occurred in 2003 and 2007. Sage-grouse in North and South Dakota were reported to have suffered large losses to WNv in 2007 and there may have been undetected impacts in Wyoming.

Taylor et al. (2012) predicted that the low elevation population of northeast Wyoming is susceptible to West Nile virus outbreaks which can decrease a population by more than 50%. Furthermore, even with no additional energy development the authors predict that some local populations may be one outbreak year away from extirpation.

Harvest Results

The Northeast Working Group area is comprised of Hunt Area 4 and portions of Hunt Areas 1 and 2 (Figure 7). 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 in the working group area.

Although sage-grouse numbers have decreased over time and are currently trending down, an adequate population exists to support the conservative hunting season. Over 1,500 males were observed during 2014 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). Even so, some segments of the public continue to voice concern that the WGFD continues to offer hunting seasons while working to reverse declining population trends. In response to this concern 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).

In 2012, the Department proposed to close the Area 4 hunting season due to the decreasing population trend and public concern with continued hunting where energy development and disease (west Nile virus) pose significant threats to the population. Significant public opposition to the proposal was voiced by sportsmen and conservation groups arguing that the proposal to close the hunting season was not science based, hunting was not influencing the population trend and closing the season without merit set a dangerous precedent. A Commission motion to close the Area 4 hunting season failed after which a motion to continue the hunting season passed on a 4 to 2 vote.

Figure 7. Northeast Wyoming Sage-grouse Hunt Areas.

The 2013 harvest survey indicated that 27 sage-grouse were harvested by 82 hunters who spent a total of 249 days hunting during the Hunt Area 4 three day season. The average number of birds harvested per hunter day was 0.1. The average number of sage-grouse harvested per hunter was 1.9 and the average number of days hunted was 0.3.

The 2013 sage-grouse harvest decreased nearly 95% from the 405 birds harvested in 2012 and was the lowest harvest since 101 birds were harvested during the 2008 hunting season. The extremely low harvest was not expected nor is it readily explained. Statistical variation associated with small sample sizes may have influenced these results. 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 (2004-2013) is 291 birds, with harvest ranging from a low of 101 birds in 2008 to a high of 532 birds in 2007. More than 2,000 birds were harvested as recently as 2000. Hunter numbers over the last ten years have ranged from 82 hunters in 2014 to 342 hunters in 2005. Hunter days increased 38% from 2012 but remained well below the 1,649 days logged in 2005.

Even though male lek attendance was higher from 2005 thru 2008, harvest was conservative compared to past levels. Beginning in 2010, the three day season appears to have dampened hunter interest to about one-half of what it was. The more conservative season length and bag limit combined with increased publicity about the sage-grouse's status likely contributes to these trends.

A limited number of sage-grouse wings are collected during the hunting season, primarily in the eastern portion of the Area. Sample sizes are small due to the low harvest and the difficulty to strategically place enough collection barrels along the many roads and highways within the Area. Composition of the harvest as determined by analysis of wings deposited by hunters in wing barrels can provide insight into current year's chick production although in most years the sample is too small to allow for reliable interpretation of the sample. No wings were collected during the 2013 hunting season.

Lek Monitoring Results

A new sage-grouse database was developed in 2012 in order to improve efficiency, reduce errors, and better facilitate data analysis. Changes were made to the manner in which lek data are calculated and reported in Table 1. The new version is based solely on "occupied" leks. The past version suggested that was the case in the title of Table 1, but when unoccupied leks were monitored those data were also included in the table. The result of this change is that the number of "known occupied" leks is now more accurate, but reflects fewer leks than in the previous version. Similarly, the new version calculates average male lek attendance using only monitoring observations where one or more male grouse were observed strutting. The old version included a count of "0" males for leks where activity was confirmed by the presence of sign but no birds were observed. Together, these two changes result in somewhat higher, but more accurate, average male attendance for active leks than previously reported. The changes do not result in any change in population trend based on average male lek attendance. Interpreted population increases and decreases over time remain the same so no revisions to past reports are required.

Since only "occupied" leks are being 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. 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 no longer being 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.

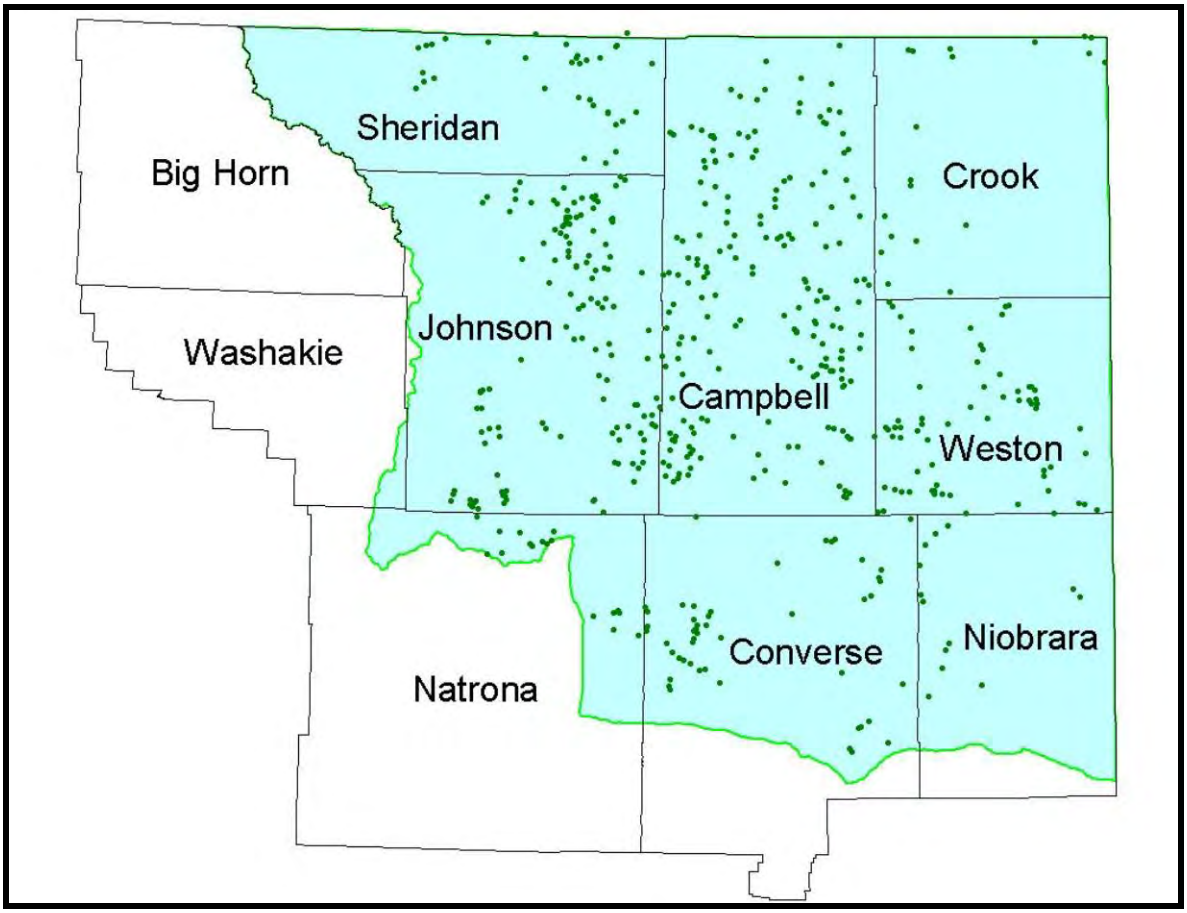
Lek monitoring efforts have increased substantially in recent years due to concerns over range wide declines in sage-grouse populations. Additionally, coalbed natural gas (CBNG) development in the Powder River Basin resulted in extensive survey work to meet federal permitting requirements. The WGFD, BLM, U.S. Forest Service, private consultants and volunteers participated in ground and aerial monitoring of leks.

Sage-grouse lek monitoring efforts are accomplished through lek counts, lek surveys and searches for new leks. The Sheridan Region received additional funds from the Bureau of Land Management for sage-grouse surveys for the fourteenth 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.

Following the 2014 lek monitoring period there are 551 documented leks in the NEWLWGA (Figure 8). Of this total, 410 are classified as occupied leks. During the 2014 breeding season 195 leks were counted, representing 48% of known occupied leks (JCR Table 1a). The 406 occupied leks is less than the 551 total leks because unoccupied leks (abandoned or destroyed) are not considered potentially active. The average number of males per active lek from these lek counts was 9.6. This is down from the 10.3 males/active lek in 2013 and compares to 12.9 males/active lek in 2012. The most recent cycle high of 28.0 males/active lek occurred in 2006.

Figure 8. 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. Designated lek count data, along with the lek counts from the private consultants and volunteers significantly improve the opportunity to better evaluate population trends. Thirty-eight official count routes covering 149 leks have been established.

The number of known occupied leks checked by lek counts and lek surveys combined was 349 leks or 86% of the known occupied leks (JCR Table 1c). The average number of males/active lek was 9.7 compared to 9.2 males/active lek in 2013. The lowest male attendance prior to last year was 8.7 in 1996. For the 10-year period, 2005-2014, the number of males/active lek has ranged from 9.2 in 2013 to 22.1 in 2007. These numbers and trends are comparable to the lek

count data. One-hundred-sixty-three leks were documented as active with peak male attendance ranging from 1 to 48 males. The three leks with the highest number of males were the Watsabaugh IV Lek with 48, the Watsabaugh I Lek with 46 males and the Flying E Creek Lek with 42 males. No lek has exceeded 100 males since 2007. The median peak male attendance was 7 males, unchanged from 2013.

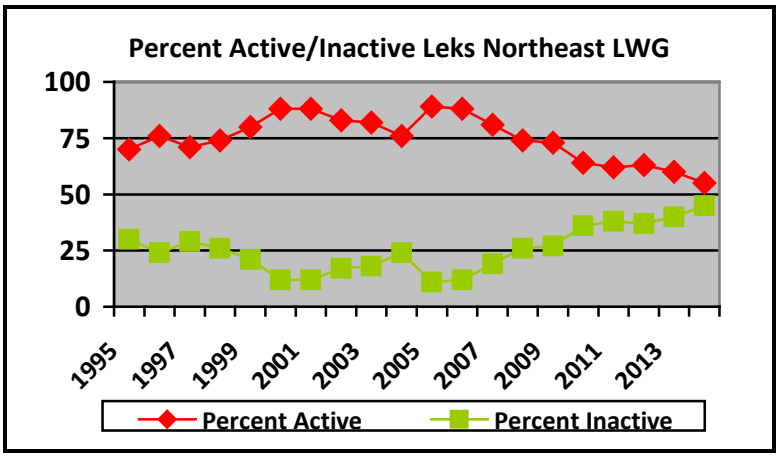
In total, there were 1,383 recorded observations of sage-grouse leks. This was over 800 fewer lek visits than were recorded in 2008 due to reduced survey effort resulting from decreased CBNG development activity and a coordinated effort of agencies and consultants to reduce excessive visits to leks. The Buffalo BLM Field Office sponsored a data sharing website on WYGIS which provided real time data sharing thereby reducing lek visits. This problem was most prevalent in the CBNG fields where monitoring buffers of Plan of Development (POD) boundaries overlap 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.

Lek status as determined from lek counts and lek surveys shows 356 leks with confirmed lek status. Fifty-five percent of the leks (n=163) with confirmed status were determined to be active (JCR Table 1d), meaning strutting males or sign of strutting (feathers/droppings) were observed at the lek site. One-hundred-thirty-one (45%) leks were determined to be inactive based on multiple ground visits and/or checks for sign (feathers/droppings) late in the strutting season. The number of leks monitored annually has remained relatively stable since 2006, which was the last peak in the male lek attendance cycle. Since then, both the average number of males per active lek and the percentage of active leks have decreased significantly, suggesting a notable decrease in the population (Figure 9). This decrease in northeast Wyoming has been greater than that observed for the other working group areas. The decrease in 2014 was five percent. A large number of leks (n=55) 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.

Comparisons of core and non-core area lek monitoring results shows that core areas have a lower number of males per active lek (9.0 vs 10.4) but confirmed lek activity is higher in core areas (64% vs 49%). 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.

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 CBNG development, caution must be used to ensure that strutting activity represents an actual lek and not birds displaced from established leks.

Figure 9. Trends in Active and Inactive Leks, 1995-2014.



Lek Characteristics

There are 551 sage-grouse leks within the NEWLWGA. Table 1 shows the demographics of leks with regard to WGFD region, BLM Office, county, biologist district, game warden district, land status, and lek status.

In 2014, there were 410 occupied leks and 75 leks are classified as unoccupied leks. Unoccupied leks have either been destroyed or abandoned and are not used by sage-grouse, however, abandoned leks should be monitored on occasion. Sixty-six leks have an undetermined status meaning they have not been documented active in the last ten years, but survey information is insufficient to designate the lek as unoccupied. These figures may differ from the data provided in the JCR tables since the lek characteristics data is generated from lek status information entered into the lek database whereas the JCR tables are generated from lek monitoring data. A few discrepancies have yet to be corrected.

Population Trends

No reliable or cost effective method for estimating the sage-grouse population for the NEWLWGA exists at this time. However, the number of males/active lek provides a reasonable index of abundance of sage-grouse populations over time in response to environmental conditions and other influences. However, it must be noted that lek data must be interpreted with caution for several reasons: 1) the survey effort and the number of leks surveyed/counted has varied over time, 2) it is assumed that not all leks in the area have been located, 3) sage-grouse populations can exhibit cyclic patterns over approximately a decade, 4) the effects of unlocated or unmonitored leks that have become inactive cannot be quantified or qualified, and 5) lek sites may change over time. Both the number of leks and the number of males attending these leks must be quantified in order to estimate population size.

Figure 10 shows the average number of males/active lek for lek counts and all lek monitoring (counts and surveys) combined from 1967 to 2014 for the NEWLWGA. If the average number of males/active lek is reflective of the sage-grouse population, the trend suggests about a 10-year cycle of periodic highs and lows. Of concern, however, is that with the exception of the most recent cycle, subsequent peaks in the average male lek attendance are usually lower than the previous peak. Additionally, periodic lows in the average male attendance are generally

lower than the previous low. The long term trend suggests a steadily declining sage-grouse population.

Table 1. Northeast Wyoming Working Group Area Sage-grouse Lek Site Characteristics.

Region	Number	Percent
Casper	145	26.3%
Sheridan	406	73.7%

Working Group	Number	Percent
Northeast	551	100.0%

Classification	Number	Percent
Occupied	410	74.4%
Undetermined	66	12.0%
Unoccupied	75	13.6%

BLM Office	Number	Percent
Buffalo	373	67.7%
Casper	70	12.7%
Newcastle	108	19.6%

Biologist	Number	Percent
Buffalo	68	12.3%
Casper	13	2.4%
Douglas	57	10.3%
Gillette	246	44.6%
Newcastle	75	13.6%
Sheridan	92	16.7%

Game Warden	Number	Percent
Buffalo	76	13.8%
Dayton	18	3.3%
Douglas	22	4.0%
East Casper	6	1.1%
Glenrock	29	5.3%
Kaycee	50	9.1%
Lusk	17	3.1%
Moorcroft	53	9.6%
Newcastle	65	11.8%
North Gillette	68	12.3%
Sheridan	19	3.4%
South Gillette	122	22.1%
Sundance	5	0.9%
West Casper	1	0.2%

County	Number	Percent
Bighorn, MT	1	0.2%
Campbell	198	35.9%
Converse	54	9.8%
Crook	22	4.0%
Johnson	137	24.9%
Natrona	16	2.9%
Niobrara	19	3.4%
Powder River, MT	1	0.2%
Sheridan	36	6.5%
Weston	67	12.2%

Land Status	Number	Percent
BLM	49	8.9%
Private	429	77.9%
State	38	6.9%
US Forest Service	35	6.4%

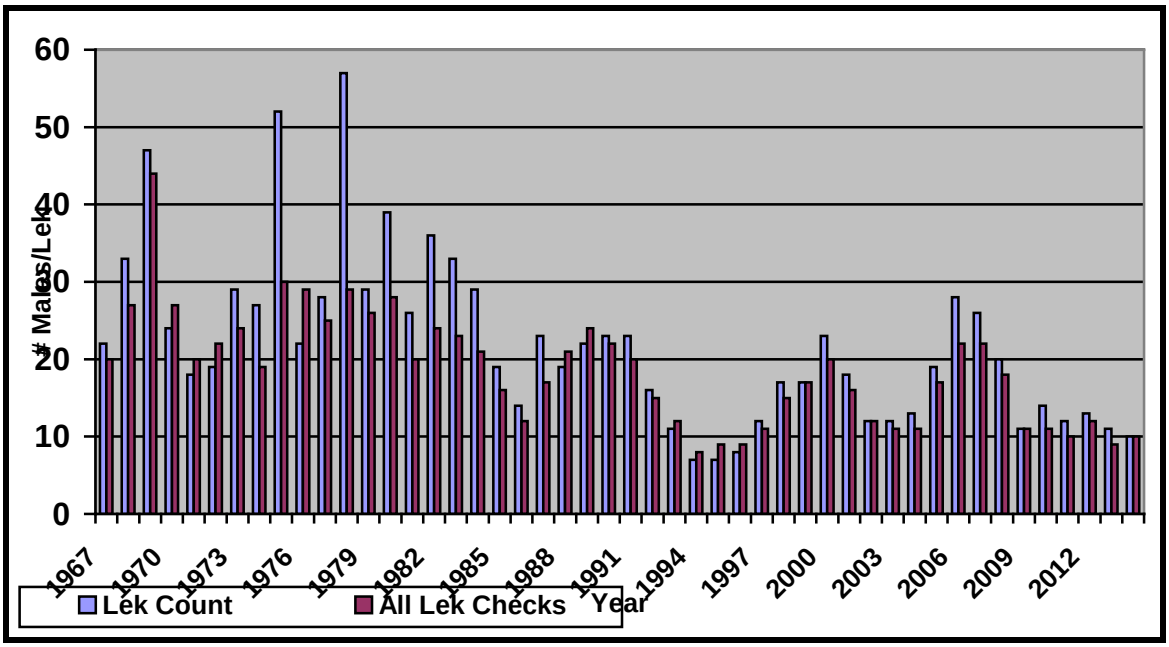
Management Area	Number	Percent
C	551	100.0%

Lek Annual Status	Number	Percent
Active	163	46.7%
Inactive	193	37.5%
Unknown	50	15.8%

It appears that sage-grouse numbers reached a new peak in 2006 and 2007, exceeding the previous peak of 2000. In fact, the trends suggest sage-grouse may have been at their highest numbers since 1991. However, the percentage of active leks was nearly ten percentage points higher in 1991. The 2008 - 2014 data indicate that peak has passed and lek attendance has entered the declining phase of the cycle, rivaling that observed from 1994 through 1997. However, the percentage of inactive leks is currently much higher compared to the mid-1990's.

The number of total leks has increased over the last 15 years primarily due to increased survey effort associated with CBNG activities. However, the number of active leks has decreased in recent years. While the number of leks present historically cannot be known, recent monitoring confirms the number/proportion of active leks is declining.

Figure 10. Northeast Wyoming Working Group Male Sage-grouse Lek Attendance 1967- 2014.



HABITAT

Habitat Conditions

The general condition of native vegetation during the 2013 growing season was poor following an extremely dry 2012. Little residual cover remained following spring 2012 precipitation of just 61% of normal (March to June). Spring precipitation in 2013 was 92% of normal providing for somewhat better growing conditions. The Palmer Drought Index, a measure of long-term meteorological conditions, showed climate divisions in northeast Wyoming experiencing extreme drought in March 2013. By May, conditions improved to severe drought in the climate divisions with the best sage-grouse habitat. In May 2014, the index showed conditions ranging from moderately moist to extremely moist (Belle Fourche River drainage). Shrub surveys showed limited sagebrush leader production reflecting reduced precipitation.

Habitat Impacts

Sage-grouse are influenced by many factors, both individually and cumulatively. Habitat loss and fragmentation, direct mortality and disturbance affect sage-grouse populations. 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 coal bed natural gas (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.

Powder River Basin Restoration Program

In 2011, the BLM created a position to coordinate sagebrush habitat restoration in northeast Wyoming. The biologist will look for opportunities to partner with agencies, industry, landowners and conservation organizations to restore sagebrush habitat. The Powder River Basin Restoration (PRBR) program is a collaborative partnership to restore and enhance sage-grouse habitat on a landscape level in the Powder River Basin. This BLM High Plains District Office program was developed to form partnerships with local cooperators, federal and state agencies, private landowners, and industry to work collaboratively on sage-grouse habitat restoration. PRBR is focusing on areas affected by federal oil and gas development that has occurred over the past decade in the PRB in northeastern Wyoming.

Goals

- Build partnerships to restore habitat for the greater sage-grouse in large landscape or watershed.
- Integrate habitat improvement programs and projects implemented by partners to leverage funding to enhance sage-grouse habitat reclamation.
- Facilitate the sharing of data/data collection methods, monitoring data/methods, and best management practices.

Douglas Core Area

Sage-grouse within the Douglas Core Area (DCA) have declined precipitously since the last population peak in 2007, decreasing from 76 males to 31 males in 2014. This compares to only 11 males attending two leks in 2013. A new lek was discovered in 2014 and two leks in close proximity were combined. There are now five leks in the core area, three of which were active in 2014 including the new lek which had a peak count of eight males.

The DCA has had a substantial increase in energy development over the past three years. Due to the high density of oil and gas development coupled with an extremely large wildfire that eliminated sagebrush cover over a large 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, Department and other partners have worked closely with industry to identify a plan of development and establish a large industry funded restoration effort guided by a multi-faceted restoration team. The Restoration Team will identify future sage-grouse habitat restoration and improvement projects, cheatgrass control projects and will sponsor sage-grouse population monitoring efforts within the DCA.

NRCS Sage-grouse Conservation Initiative

The United States Department of Agriculture – Natural Resource Conservation Service (NRCS) initiated the Sage-grouse Conservation Initiative (SGI) in 2010 to conserve sage-grouse populations by improving sagebrush habitats while improving sustainability and productivity of native rangelands. Because 40% of sage-grouse habitat is found on private lands, the NRCS works with landowners to address limiting factors affecting sage-grouse while maintaining traditional ranching operations. The program focuses on maintaining large, intact grazing landscapes by reducing fragmentation, implementing grazing systems, targeting conifer encroachment and discouraging subdivisions and conversion to cropland. Seventy-five percent of the sage-grouse population occurs on 27% of sagebrush habitats.

SGI implementation in the Northeast Core Area has primarily been contracted using the Wyoming SGI Prescribed Grazing Option 2. This option is comprised of the following requirements:

- A grazing system will be implemented to improve sage-grouse nesting and early brood rearing habitat. At least 20% of total grazingland acres enrolled must improve residual cover for sage grouse nesting and early brood rearing habitat. The goal for nesting and brood rearing habitat is to provide at least 6 inches of residual herbaceous cover by March 15th and leave undisturbed until July 15th. Average perennial cover of 4 inches during the same period is the goal for precipitation zones of 10 inches or less. In order to achieve this, implementation of a rest/rotation grazing system or a deferred grazing system with light utilization will likely be required.

- All fences located within the high collision risk areas, as identified by the 2012 collision class GIS layer will be marked. In addition those fences within .6 miles of leks not identified by the collision class layer will be marked.

- All watering facilities will be equipped with escape ramps

- Monitoring at a minimum includes:
    - Actual Use Record, or equivalent; including percent utilization by weight of key species, AND
    - Photo point (follow procedure in 2008 WY Rangeland Monitoring Guide), AND
    - At least one additional different monitoring technique from the 2008 Wyoming Rangeland Monitoring Guide.

Information on the Sage-grouse Initiative is available at http://www.sagegrouseinitiative.com.

SPECIAL PROJECTS

Conservation Planning

The Local Working Group held two meetings during the reporting period. The group finalized a conservation plan addendum to update the 2006 conservation plan. The group also allocated Wyoming Sage-grouse Conservation Funds and received presentations on ongoing research and habitat projects. The plan and other LWG information is available on the WGFD website at http://gf.state.wy.us/wildlife/wildlifemanagement/ sagegrouse/index.asp.

The LWG reviewed and allocated $135,900 from the 2013-14 Wyoming Sage-grouse Conservation Fund which totaled $990,000 for conservation projects. The LWG prioritized the local projects for funding and supported funding a statewide project. Eight local projects and one statewide project were approved. Projects included wildfire restoration, noise research, habitat restoration research and education, water development, habitat mapping, disease management research and predator identification.

The group also coordinated with the Governor's Sage-grouse Implementation Team by identifying priority areas for reclamation. Areas identified included core area habitat and priority areas outside of core boundaries identified using the lek density map (male sage-grouse densities). Priority reclamation projects included habitat restoration within the energy play and restoration of habitat impacted by wildfires.

Research

The following publications have been authored relative to research conducted in the Powder River Basin of Wyoming and Montana.

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RECOMMENDATIONS

1. Participate in the Northeast Wyoming Sage-grouse 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 identified in the plan.
2. 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. Coordinate with the BLM and industry to minimize the number of visits to leks during lek monitoring efforts.
4. Participate in WNv monitoring.
5. 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 2015 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 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. Document wintering sage-grouse locations. Develop a seasonal range map for sage-grouse for the Working Group Area based on guidelines provided in the Wyoming Sage-grouse Conservation Plan.
12. Document lek perimeters to ensure adequate buffer distance in protecting leks.

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South-Central
Sage-Grouse
Job Completion Report
2013

June 2013-May 2014

Will Schultz
Wyoming Game & Fish Dept.
Laramie Region

South Central Conservation Area

Job Completion Report

Species: **Sage-grouse** Conservation Plan Area: **South Central**

Period Covered: **June 1, 2013 – May 31, 2014** Sage-Grouse Mgmt Area: **H**

Prepared by: **Will Schultz**

Introduction

The South Central Conservation Area (SCCA) generally includes The Platte Valley, Laramie Plains, Great Divide Basin, North Ferris, south Sweetwater and Little Snake River Valley in the counties of Carbon, Sweetwater, Albany, Fremont and Natrona in southern Wyoming (Figure 1).

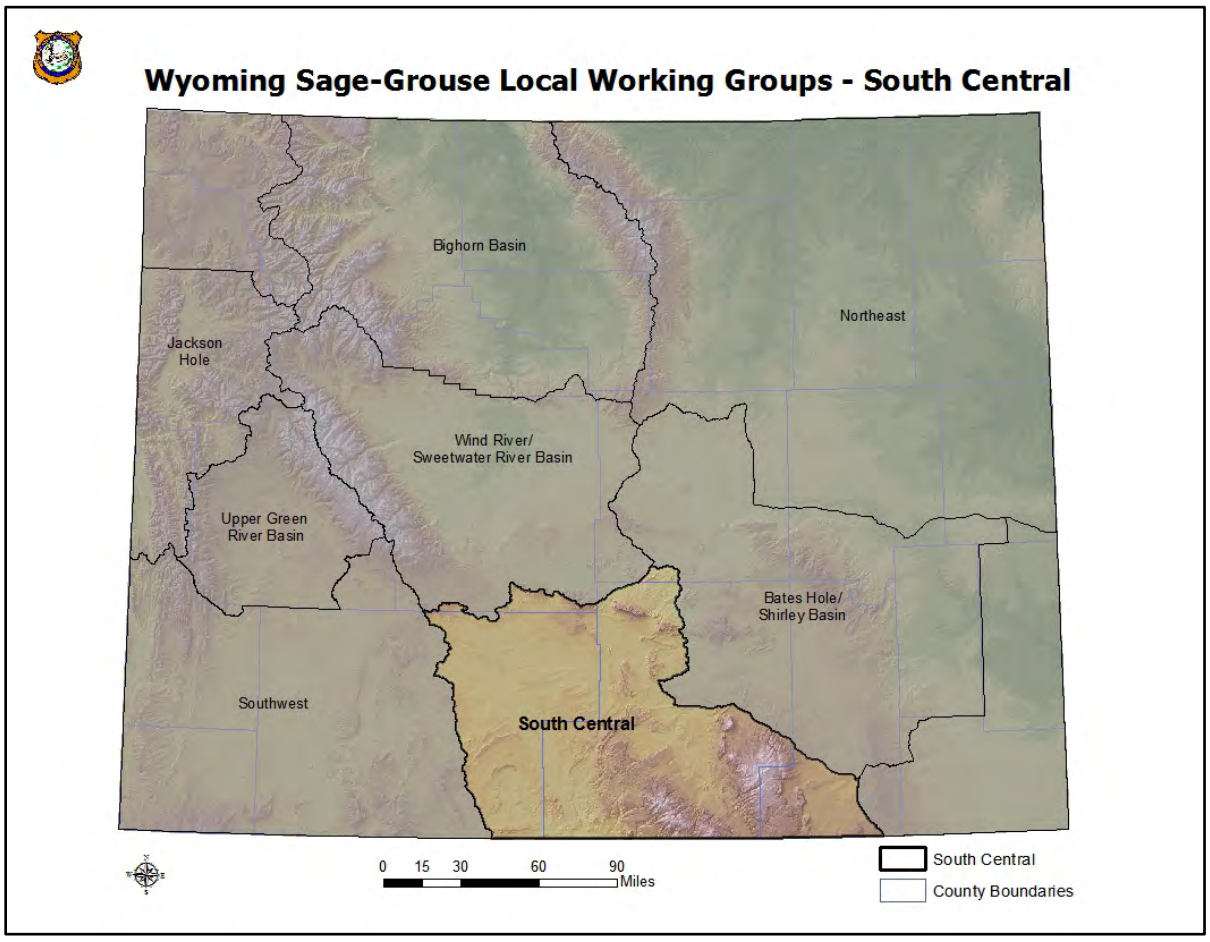

Figure 1. South Central Conservation Area in Wyoming.

Sage-grouse habitat in the SCCA is comprised of public land administered by the Bureau of Land Management (BLM), Wyoming State Land and Investments Board, and private land. A very minor portion of sage-grouse habitat is located on the fringe of the US Forest Service's (USFS) Medicine Bow National Forest (Figure 2). A major portion of the SCCA is "checkerboard" land ownership (alternating public and private lands) within 20 miles of the railroad corridor in the center of the area. Major habitat types include sagebrush/grassland, salt desert shrub, short-grass prairie, mixed mountain shrub, mixed forest types, agricultural, riparian, and urban types. Transportation corridors include Interstate 80 (I-80), Union Pacific Railroad (mostly parallel to I-80), and State Highways 70, 789, 287, 230/130. Major cities and towns found in the area are Rawlins, Laramie, Saratoga, Encampment, Baggs, and Wamsutter.

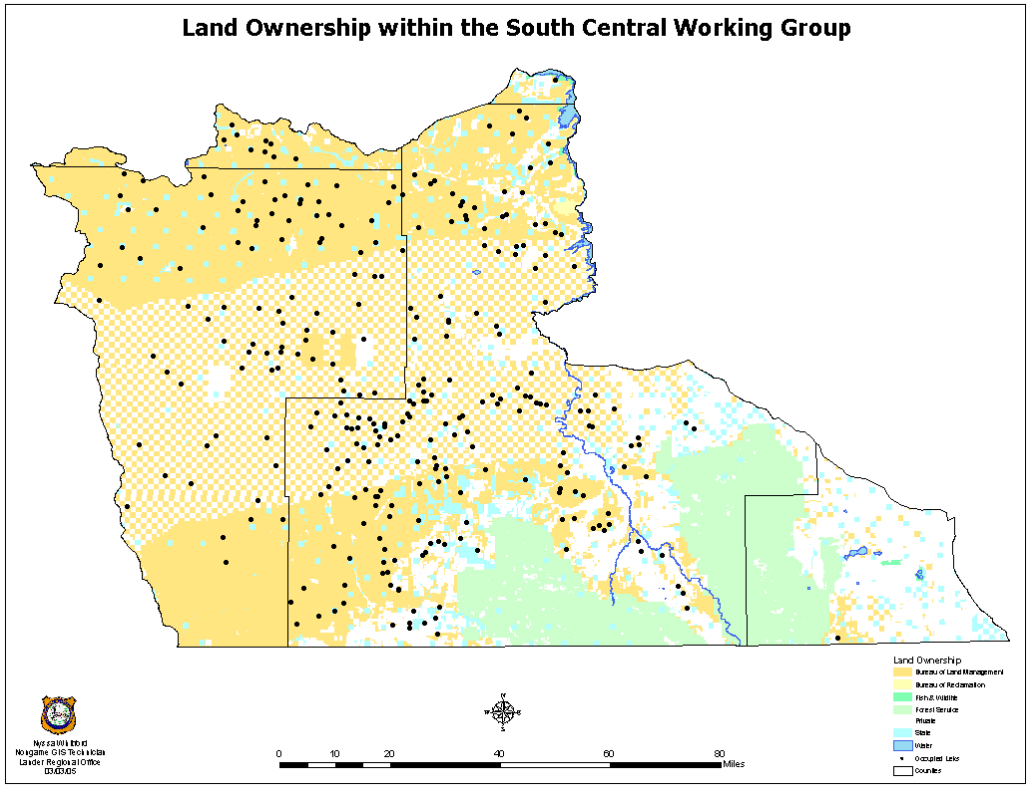

Figure 2. Landownership within the South Central Conservation Area of Wyoming.

The South Central Sage-Grouse Local Working Group (LWG) was initiated in September of 2004 and completed their Sage-grouse Conservation Plan (Plan) in 2007. Much has changed since 2007 with regard to our knowledge about this species and the conservation efforts which have been implemented at both the state and range-wide level. The LWG completed an addendum to their plan in 2014.

http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/SG_SC_CONSERVPLAN0005526.pdf.

The addendum documents research and habitat projects the LWG supported since their Plan was completed, and explains how these projects addressed the goals and action items identified in the Plan. The addendum also provides a brief review of new science and regulatory conservation mechanisms which support sage-grouse conservation efforts in the SCCA.

In bio-year 2013 (June 1, 2013 – May 31, 2014), there were 324 known status leks in the SCCA. A total 281 of these leks were monitored. From these monitoring efforts it was determined 197 leks were active; producing an average peak males/lek ratio of 19.0 males.

The 2013 upland harvest survey indicated 437 hunters spent 928 days to harvest 624 sage-grouse in the SCCA. Analyses of wing data from hunter harvested sage-grouse indicated the proportion of chicks in the harvest was 1.8 chicks/hen in the SCCA.

Weather

The National Climate Data Center/National Oceanic and Atmospheric Administration (NCDC/NOAA) has divided Wyoming into 10 climatic divisions for the purpose of weather data recording (Figure 3). These divisions correspond to major watersheds within the state. Wyoming's climatic division 10, the Upper Platte, covers much of the SCCA. Climatic data for all divisions can be found at the NCDC/NOAA web site: http://www.ncdc.noaa.gov/oa/ncdc.html

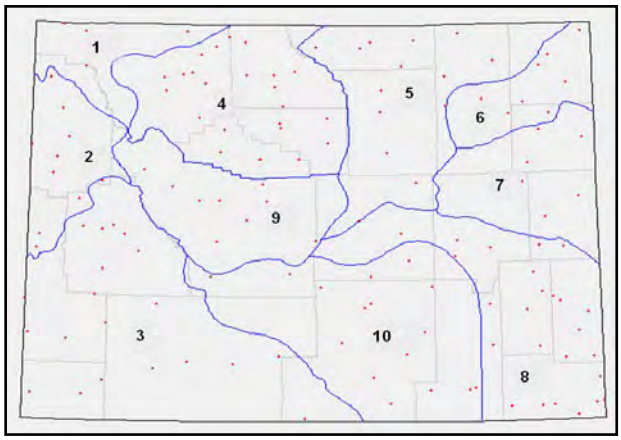

Figure 3. NCDC/NOAA, State of Wyoming Climate Division Map.

The Palmer Drought Severity Index uses temperature and precipitation data to determine dryness. For more information about the PDSI please visit the following website. http://www.ncdc.noaa.gov/oa/climate/research/prelim/drought/palmer.html. Palmer Drought Severity Index (PDSI) data indicated Division 10 has experienced 12 years of drought over the past 20 years (Figure 4) http://www.ncdc.noaa.gov/cag/time-series/us/pdsi/ytd/48/10/6/1895-2004?base_prd=true&begbaseyear=1901&endbaseyear=2000. There was a short period of time

in bio-years 2009 - 2011 when Division 10 experienced a short period of wetter than average weather.

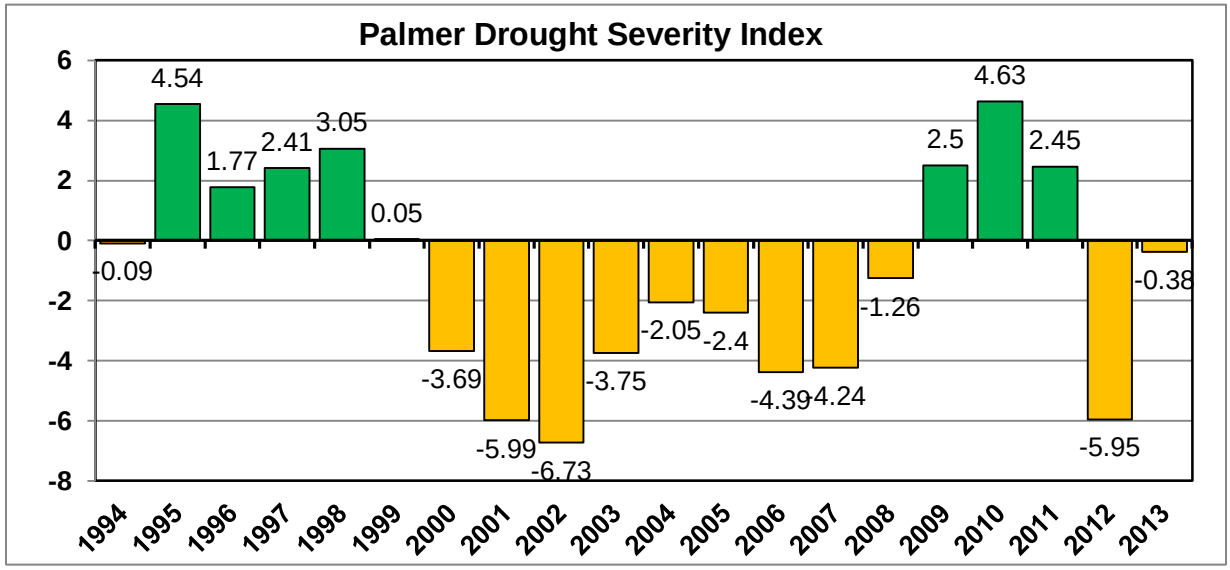

Figure 4. Bio-years 1994-2013 Palmer Drought Severity Index indices for the Upper Platte Climatic Division 10, Wyoming.

The 2013 bio-year PSDI improved to -0.38 for Wyoming's Division 10. The preceding bio-year's PDSI (n = -5.95), was second only to bio-year 2002 in ranking for the most severe drought period recorded since 1913. Residual effects of the 2012 drought were noticeable in the early months of bio-year 2013 with less residual vegetation for nesting cover and overall drier habitat conditions. This likely contributed to reduced nesting success and chick survival in bio-year 2013. Spring habitat conditions are one of the most important factors in determining nesting success and chick survival. Specifically, shrub height, live and residual grass height and cover, and forb cover have a large impact on sage-grouse nesting success. The shrub and grasses provide screening cover from predators and weather while the forbs provide forage and also provide insects that reside in the forbs. 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.

Habitat

Much of the sage-grouse habitat in the SCCA is comprised of an 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 sage-brush obligates.

Energy and mineral extraction development are another predominate use of sage-grouse habitat within the SCCA. Most of the energy extraction activity associated with producing natural gas from both deep gas and coal bed methane sources. Past and present uranium mining has also contributed to reducing sage-grouse habitat in the SCCA.

Lek Monitoring and Population Trend

Tables and graphs describing annual lek monitoring efforts, observations, and lek characteristics are provided in APPENDIX A. Wyoming Game and Fish Department (WGFD) and BLM personnel, as well as environmental consultants and volunteers, monitored 281 leks in the spring of 2014. This represented checking approximately 98% of the occupied status leks in the SCCA. This effort was up from 91% of leks checked in 2013. The 2005-2014 annual average of leks checked was 86%. The proportion of leks checked in the spring of 2012 was above the 10-year average.

Since only occupied leks are being reported on Table 1 in APPENDIX A., it is important to consider trends in the numbers of active versus inactive leks in addition to the average size of active leks. The number of occupied leks which were inactive increased from 20% in 2013 to 28% in 2014. The average peak male/lek for active leks increased from 17.6 in 2013 to 19.0 in 2014. During periods 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. In addition, monitoring efforts have increased in recent years in order to reduce the number of "unknown" annual status leks to better determine active or inactive status. This had the effect of increasing the proportion of known inactive leks because a higher proportion of "unknown" leks were actually inactive but monitoring intensity was not sufficient to meet the criteria for being "inactive."

Average female lek attendance is no longer being reported since our data collection techniques is not designed to accurately capture these data and is therefore not a useful figure in assessing population trend.

Monitoring the total number of males on a lek is used as an index of trend, but these data should be viewed with caution since survey effort has varied over time, leks have moved, birds move

among leks in a complex, and other reasons that are explained on page 12 in the Wyoming Greater Sage-grouse Conservation Plan (2003).

In 2014 (2013 bio-year), the peak male lek attendance was 3,555 and averaged 19.0 males/lek. The 2014 males/lek average was 36% below the average for the previous 10 years of 29.6 males/lek. Although the males/lek average had been declining since 2006, a slight increase from 2013 of 1.3 males/lek was observed in 2014. Count monitored leks averaged 21.0 males/lek compared to 17.7 males/lek for survey monitored leks. Overall, the average males/lek was 19.0 in 2014. The current low male attendance rate is within the parameters observed since 1996 and most likely attributable to normal cyclic variation in populations and to weather conditions in recent years, at least within habitats least impacted by human disturbance. Figure 5 illustrates the trends in average peak males/lek for all sage-grouse conservation areas in Wyoming, as well as the statewide average.

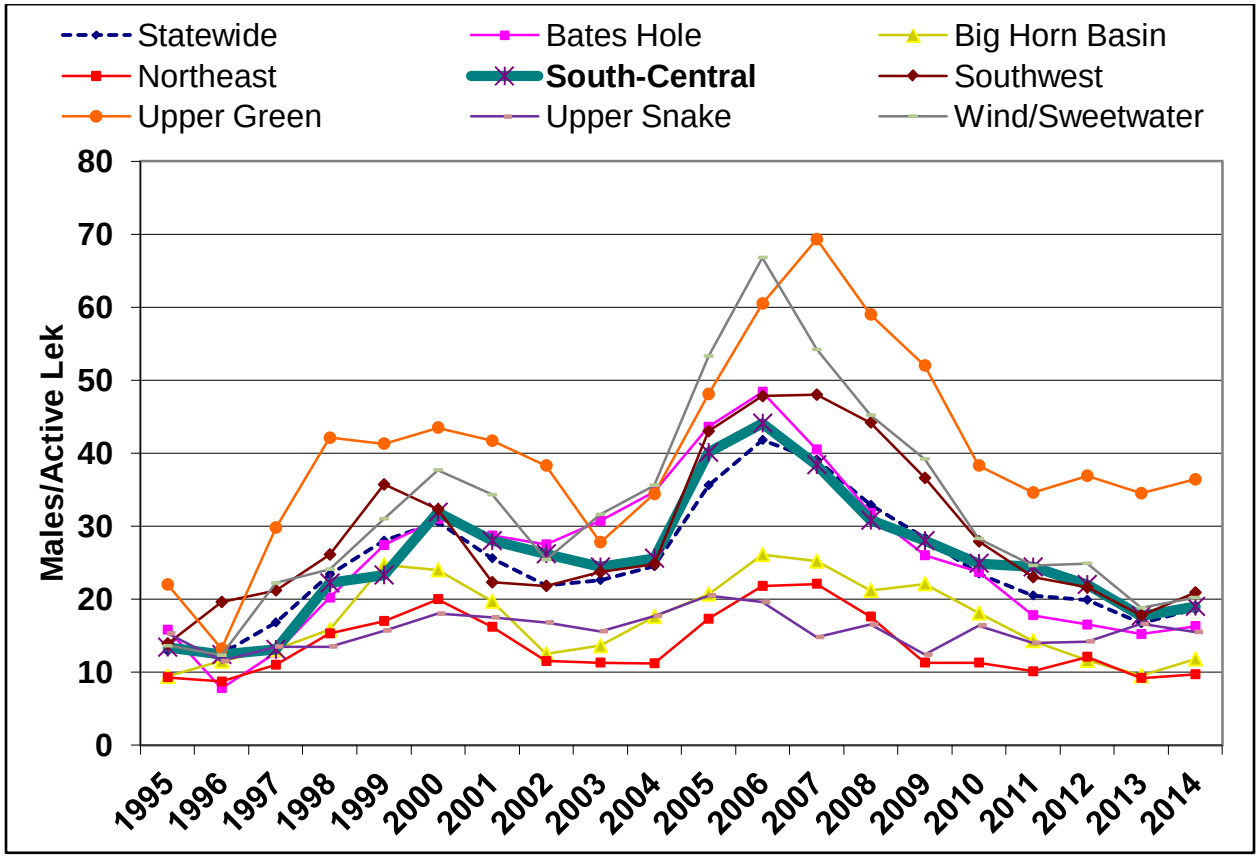

Figure 5. 1995-2014 Average peak male sage-grouse lek attendance, by local working groups and statewide, Wyoming.

Harvest

Tables and graphs describing hunting season structure, annual harvest and subsequent wing survey analyses are provided in APPENDIX A. The 2013 sage-grouse hunting season was from September 21 to September 30, and allowed for the harvest of 2 sage-grouse/day and 4 in possession. The 2013 upland harvest survey indicated 437 hunters spent 928 days to harvest 624 sage-grouse in the SCCA. This equals about 0.7 birds/day, 1.4 birds/hunter, and 2.1 days/hunter. These hunter and harvest statistics were the lowest observed during the past 10-years. Compared to 2012, when hunting regulations were similar with the exception of 7 more days in the 2012 season length, hunter numbers decreased by 31%, the birds/day decreased by 0.2, and the birds/hunter decreased by 0.5 birds. Generally during the past 10 years, harvest indices have been similar, and overall harvest would appear be correlated to hunter numbers rather than grouse abundance. Weather may have negatively influenced the harvest in 2013 as heavy rains limited hunter access and hunting in much of the SCCA.

Hunter-harvested sage-grouse wings have been collected annually and used for estimating productivity. Wings were collected in barrels set 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 2013 hunting season WGFD collected 107 wings from wing barrels within the SCCA. This was a decrease of 51% when compared to the 220 collected in 2012, which correlates with the decreased harvest. Age and sex composition of the wings indicated the proportion of chicks/hen also increased from 0.8 in 2012 to 1.1 in 2013. Statewide analyses of wing data have suggested chick/hen ratios of 1.4-1.7 typically results in relatively stable populations as determined by lek counts the following year. The chicks/hen ratio observed in the 2013 was the second lowest during the past 10 years and appeared to correlate with the lower population size and lower production we have documented in recent lek monitoring efforts in the SCCA.

Disease

One confirmed case of West Nile Virus was documented within the SCCA, during bio-year 2013. This was a telemetered bird associated with the University of Missouri's research into wind development impacts to sage-grouse.

Special Studies

Several long term sage-grouse research projects related to the development of wind energy are currently underway in the immediate vicinity of the SCCA. In conjunction with development of the proposed Chokecherry/Sierra Madre Wind Farm, located south of Rawlins, a multi-faceted sage-grouse research project was initiated in late 2010. The principal investigators include the consulting firm SWCA, University of Missouri, and US Forest Service. A similar wind energy development research effort was also initiated at the 7-Mile/Simpson Ridge area which is located within the Bates Hole/Shirley Basin Conservation Area; immediately adjacent to the SCCA. Principal investigators for the 7-Mile/Simpson Ridge project are WEST Inc., Wyoming Wildlife Consultants, Inc. and the University of Wyoming.

Several academic research projects and publications related to sage-grouse in the SCCA have been completed in recent years (Table 1). The SCCA LWG supported several of these research projects, in part, by awarding grants from the Wyoming Sage-Grouse Conservation Fund.

State and Federal Conservation Strategies

The Wyoming Sage-Grouse Core Area Strategy is based on a series of Executive Orders issued by former Governor Dave Fruedenthal and current Governor Matt Mead (WY-EO-2011-5). This strategy continued in 2013, to maintain and enhance greater sage grouse habitat in Wyoming.

The BLM and the USFS continued to work on adopting Wyoming's Core Area Strategy into their land management decision processes in Wyoming. The WY-BLM sage-grouse instruction memorandum was issued in early 2012 (WY-BLM IM 2012-19). In bio-year 2013 BLM Resource Management Plans (RMPs) and USFS Forest Plans across the state were still in the process of being amended to incorporate Wyoming's Core Area Strategy and new BLM national sage-grouse policies (BLM-IM-2012-043 and 044).

In 2010, U.S. Fish and Wildlife Service (Service) issued a decision for greater sage-grouse of warranted but precluded from immediate listing due to higher priorities. 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 a future listing. The Wyoming Game and Fish Department maintained management authority over sage-grouse and management emphasis continued to focus on implementation of the Core Area Strategy.

In 2011, the Service created a Conservation Objectives Team (COT) of state and Service representatives to develop conservation objectives by defining the degree to which the threats need to be reduced or ameliorated to conserve the sage-grouse so that it is no longer in danger of

extinction or likely to become in danger of extinction. In summary, the report prepared by the COT (U.S. Fish and Wildlife Service 2013) listed energy development, infrastructure, improper livestock and/or improper wildlife grazing and recreation as broad scale threats to sage-grouse in the Wyoming portions of the Wyoming Basin Management area.

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_____, 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.

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

_____, 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.

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.

Table 1. Academic research projects and publications related to sage-grouse in the South Central Conservation Area, Wyoming.

Local Working Group Conservation Plan Implementation

The South Central Sage-Grouse Local Working Group (LWG) was initiated in September of 2004 and completed their Sage-grouse Conservation Plan (Plan) in 2007. In 2014, the LWG adopted an addendum to their Plan. This addendum documented conservation action such as research and habitat projects the LWG had supported since their Plan was completed, as well as how these projects addressed the goals and action items identified in the Plan. In bio-year 2013, the LWG continued to support several new and ongoing conservation actions (Table 2).

Recipient	Project	LWG Support
Utah State University	Impacts of raven abundance on greater sage-grouse nesting success in south-central Wyoming	$13,000
Wyoming Wildlife Consultants, LLC	7-Mile Hill/Simpson Ridge wind energy and sage-grouse research	$10,000
Wyoming Game and Fish Department	Big Creek Ranch native vegetation reseeding habitat project	$10,000

Table 2. Conservation actions supported by the South Central Local Working Group, bio-year 2013, Wyoming.

Recommendations

1) Improve efforts to monitor at least 80% of the occupied leks in the SCCA.

2) Support LWG efforts to work on reclamation issues, especially seed mixes that benefit sage-grouse.

4) Continue to document seasonal habitats, especially winter habitats.

5) Coordinate with BLM and USFS to ensure that prescribed fire and other treatments in and around sage-grouse Core area comply with WY-EO-2011-5.

8) Build partnerships with private landowners to maintain or improve sage-grouse habitats on private lands through mutually beneficial habitat projects.

Literature Cited

U.S. Fish and Wildlife Service. 2013. Greater Sage-grouse (*Centrocercus urophasianus*) Conservation Objectives: Final Report. U.S. Fish and Wildlife Service, Denver, CO. 113pp.

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Sage Grouse Job Completion Report

Year: 2005 - 2014, 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)
2005	253	27	11	1453	58.1
2006	250	39	16	2106	58.5
2007	250	47	19	2090	48.6
2008	258	49	19	1683	37.4
2009	262	68	26	2021	33.7
2010	267	54	20	1528	33.2
2011	264	50	19	1272	31.0
2012	277	56	20	1490	28.1
2013	281	94	33	1638	21.8
2014	286	101	35	1536	21.0

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2005	253	184	73	4882	36.7
2006	250	181	72	5564	40.3
2007	250	176	70	4523	35.1
2008	258	151	59	3085	28.0
2009	262	152	58	2648	24.7
2010	267	170	64	2849	21.9
2011	264	157	59	2460	22.0
2012	277	182	66	2206	19.2
2013	281	161	57	1532	14.7
2014	286	180	63	2019	17.7

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

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

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

Sage Grouse Job Completion Report

Year: 2005 - 2014, 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)
2005	253	211	83	6335	40.1
2006	250	220	88	7670	44.1
2007	250	223	89	6613	38.4
2008	258	200	78	4768	30.8
2009	262	220	84	4669	28.0
2010	267	224	84	4377	24.9
2011	264	207	78	3732	24.4
2012	277	238	86	3696	22.0
2013	281	255	91	3170	17.7
2014	286	281	98	3555	19.0

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2005	158	9	44	167	94.6	5.4
2006	173	10	37	183	94.5	5.5
2007	175	10	38	185	94.6	5.4
2008	163	8	29	171	95.3	4.7
2009	176	20	24	196	89.8	10.2
2010	181	14	29	195	92.8	7.2
2011	160	24	23	184	87.0	13.0
2012	179	31	28	210	85.2	14.8
2013	191	48	16	239	79.9	20.1
2014	197	77	7	274	71.9	28.1

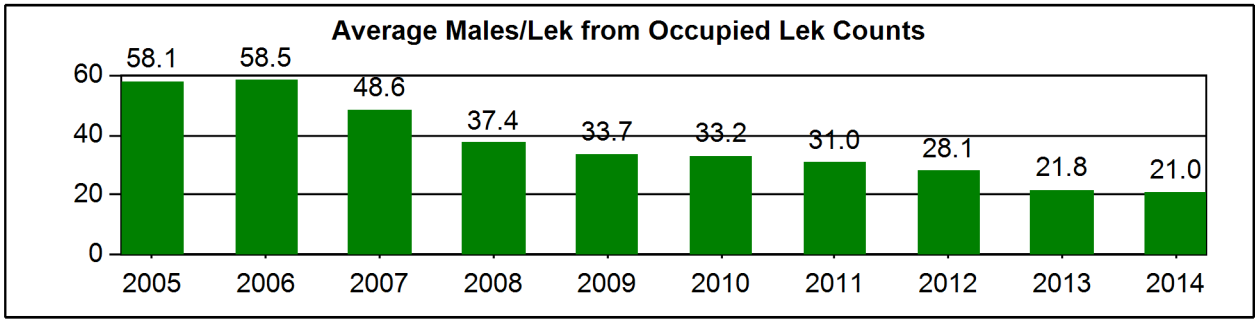
1) Occupied - Active during previous 10 years (see official definitions)

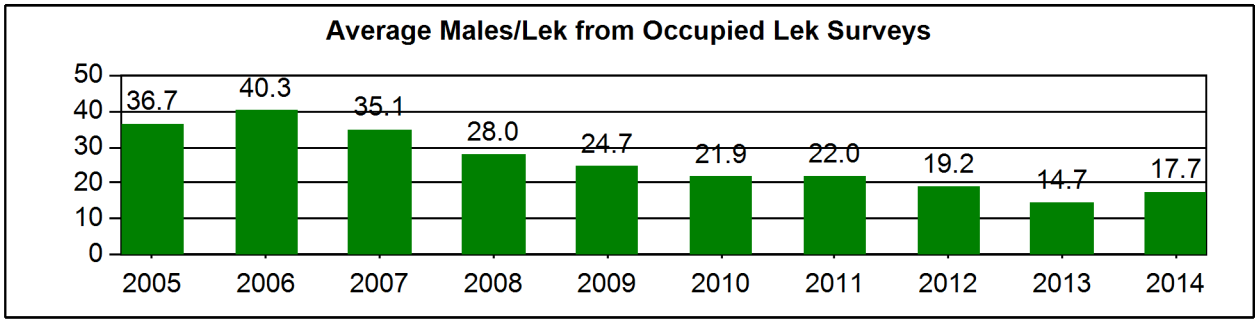
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

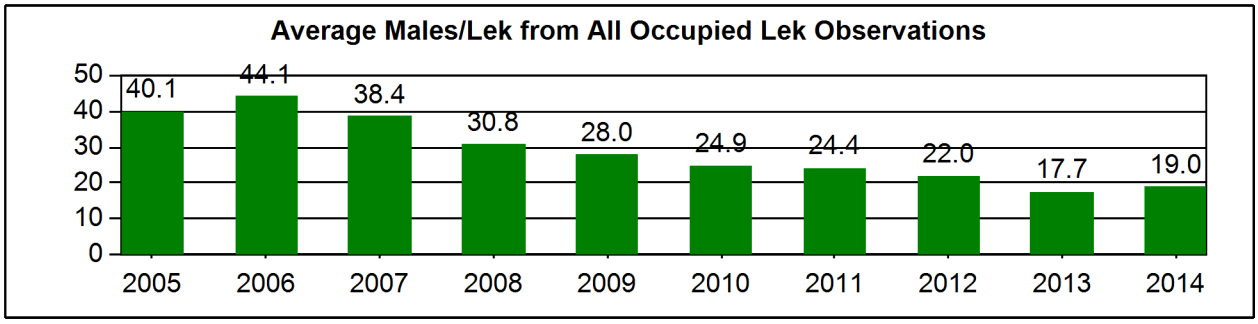
3) Inactive - Confirmed no birds/sign present (see official definitions)

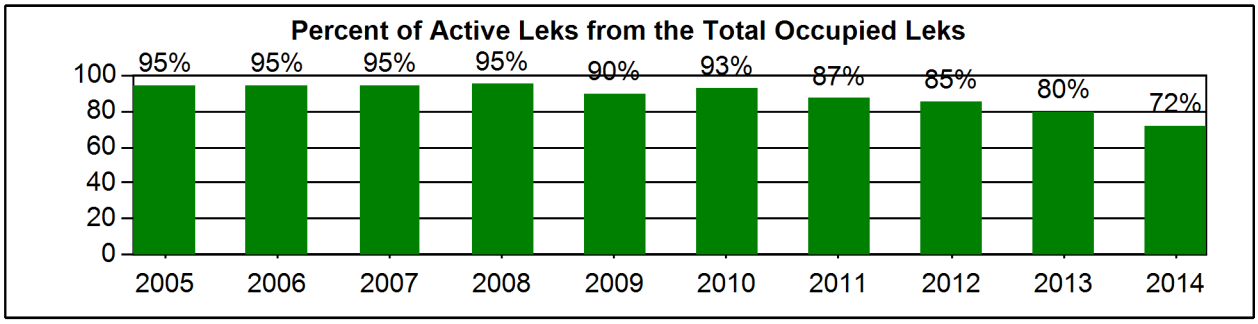
Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: South Central



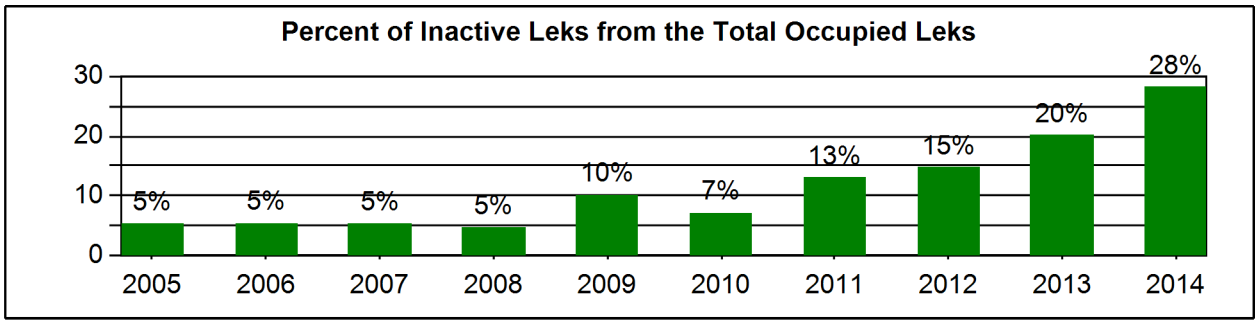






Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: South Central



Sage Grouse Lek Characteristics

Working Group: South Central

Region	Number	Percent
Green River	125	32.4
Lander	207	53.6
Laramie	54	14.0

Working Group	Number	Percent
South Central	386	100.0

Classification	Number	Percent
Occupied	323	83.7
Undetermined	28	7.3
Unoccupied	35	9.1

BLM Office	Number	Percent
Casper	2	0.5
Lander	26	6.7
Rawlins	341	88.3
Rock Springs	17	4.4

Biologist	Number	Percent
Baggs	111	28.8
Green River	14	3.6
Laramie	5	1.3
Rawlins	191	49.5
Saratoga	49	12.7
South Lander	16	4.1

Warden	Number	Percent
Baggs	110	28.5
East Rawlins	57	14.8
Elk Mountain	6	1.6
Rock Springs	15	3.9
Saratoga	43	11.1
South Laramie	5	1.3
West Rawlins	150	38.9

County	Number	Percent
Albany	5	1.3
Carbon	253	65.5
Fremont	13	3.4
Natrona	2	0.5
Sweetwater	113	29.3

Land Status	Number	Percent
BLM	218	56.5
Private	143	37.0
State	24	6.2
USF&WS	1	0.3

Management Area	Number	Percent
H	386	100.0

Sage Grouse Job Completion Report

Year: 2005 - 2014, Management Area: H

4. Sage Grouse Hunting Seasons and Harvest Data

a. Season

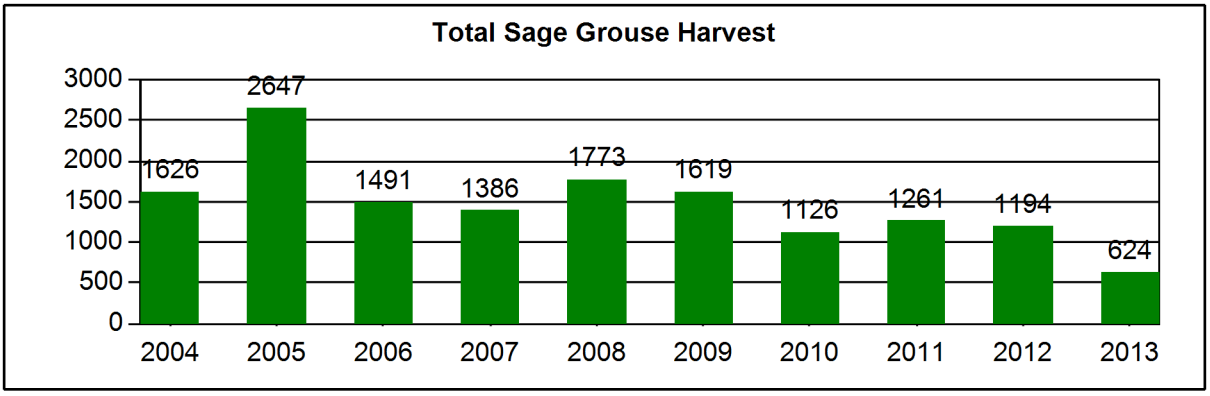
Year	Season Start	Season End	Length	Bag/Possesion Limit
2005	Sep-23	Oct-3	11	2/4
2006	Sep-23	Oct-3	11	2/4
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4
2011	Sep-17	Sep-30	14	2/4
2012	Sep-15	Sep-30	16	2/4
2013	Sep-21	Sep-30	10	2/4

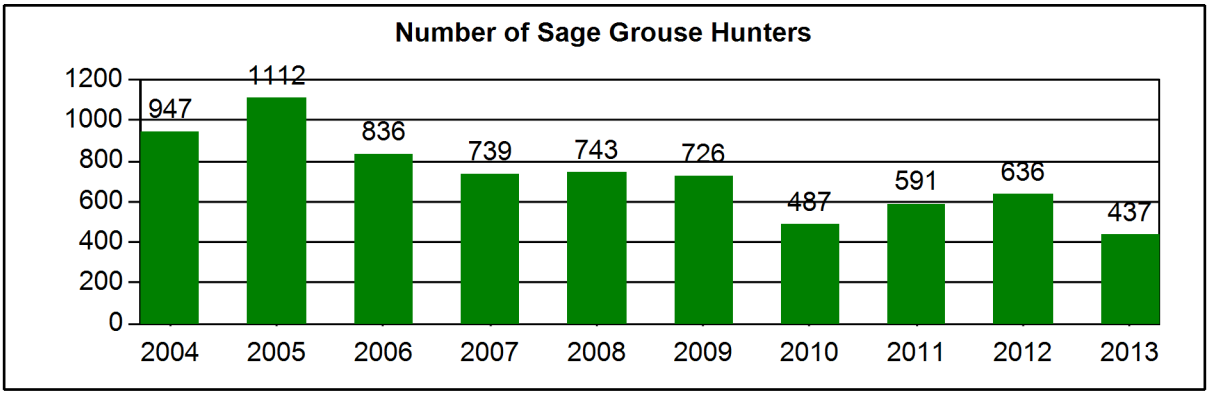
b. Harvest

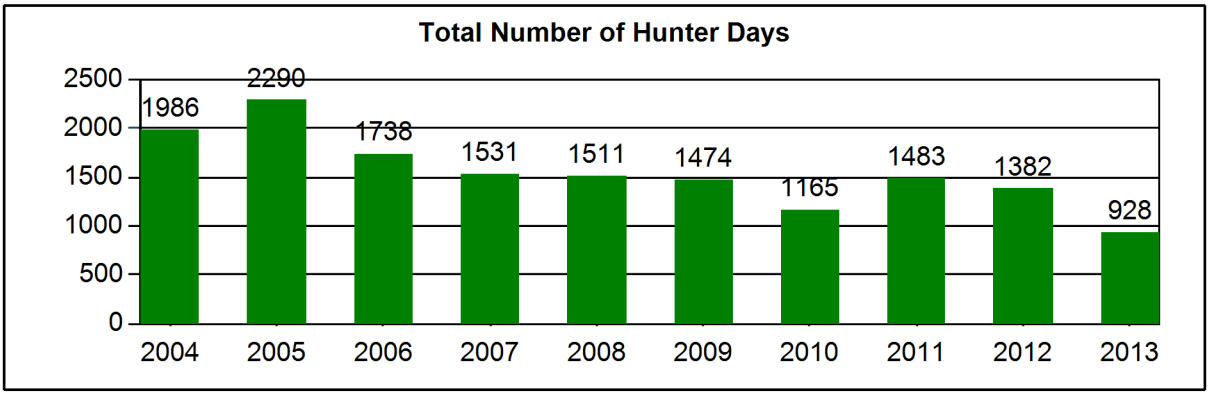
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2005	2647	1112	2290	1.2	2.4	2.1
2006	1491	836	1738	0.9	1.8	2.1
2007	1386	739	1531	0.9	1.9	2.1
2008	1773	743	1511	1.2	2.4	2.0
2009	1619	726	1474	1.1	2.2	2.0
2010	1126	487	1165	1.0	2.3	2.4
2011	1261	591	1483	0.9	2.1	2.5
2012	1194	636	1382	0.9	1.9	2.2
2013	624	437	928	0.7	1.4	2.1
Avg	1,458	701	1,500	0.9	2.0	2.2

Sage Grouse Harvest Summary

Management Area: H

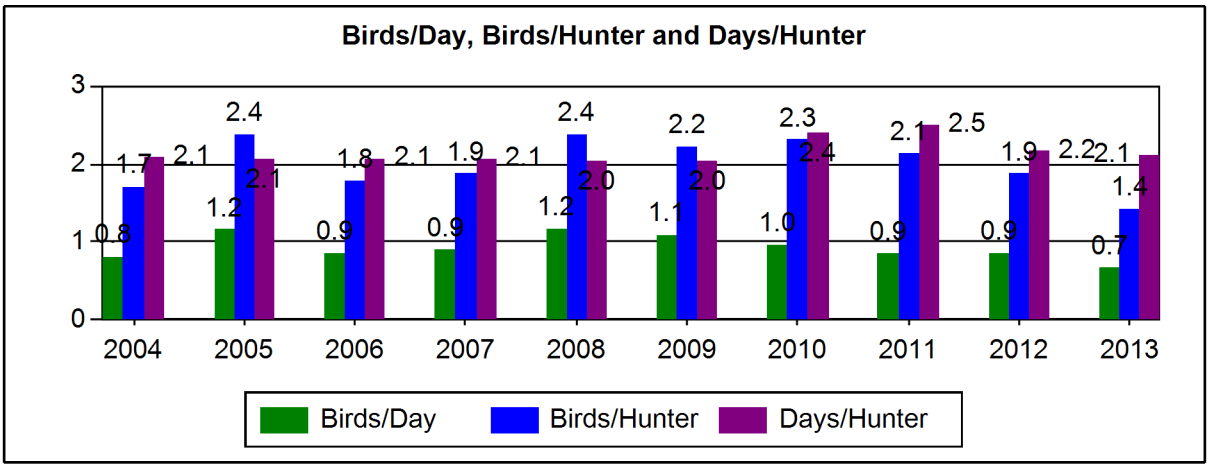






Sage Grouse Harvest Summary

Management Area: H

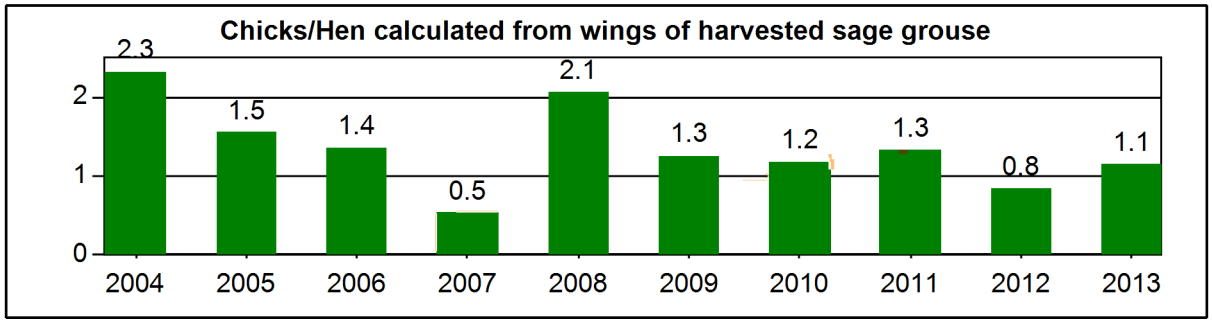


Sage Grouse Job Completion Report

Year: 2004 - 2013, Management Area: H

5. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
2004	284	7.4	22.5	0.4	5.3	30.3	34.2	2.3
2005	345	13.6	27.8	3.8	4.6	20.0	30.1	1.5
2006	315	16.8	28.3	3.8	5.4	21.6	24.1	1.4
2007	199	20.1	35.2	7.0	12.6	10.6	14.6	0.5
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



Southwest
Sage-Grouse
Job Completion Report
2013

June 2013-May 2014

Patrick Burke
Wyoming Game & Fish Dept.
Green River Region

2013 Annual Sage-Grouse Job Completion Report

Conservation Plan Area: **Southwest**
Biological Year: **June 1, 2013 – May 31, 2014**
Prepared by: **Patrick Burke**

INTRODUCTION

The Southwest Wyoming Sage-Grouse Conservation Area (SWSGCA) is one of eight in Wyoming (Figure 1). In 2004, eight local working groups, one for each conservation area were created and charged with developing and implementing plans to promote sage-grouse conservation for their respective areas. The conservation plan put together by the Southwest Local Working Group for the SWSGCA was completed in July 2007 and an updated version was completed during this reporting period. This report focuses on analysis of data for the biological year June 1, 2013- May 31, 2014, with some comparisons made to the last ten years of data.

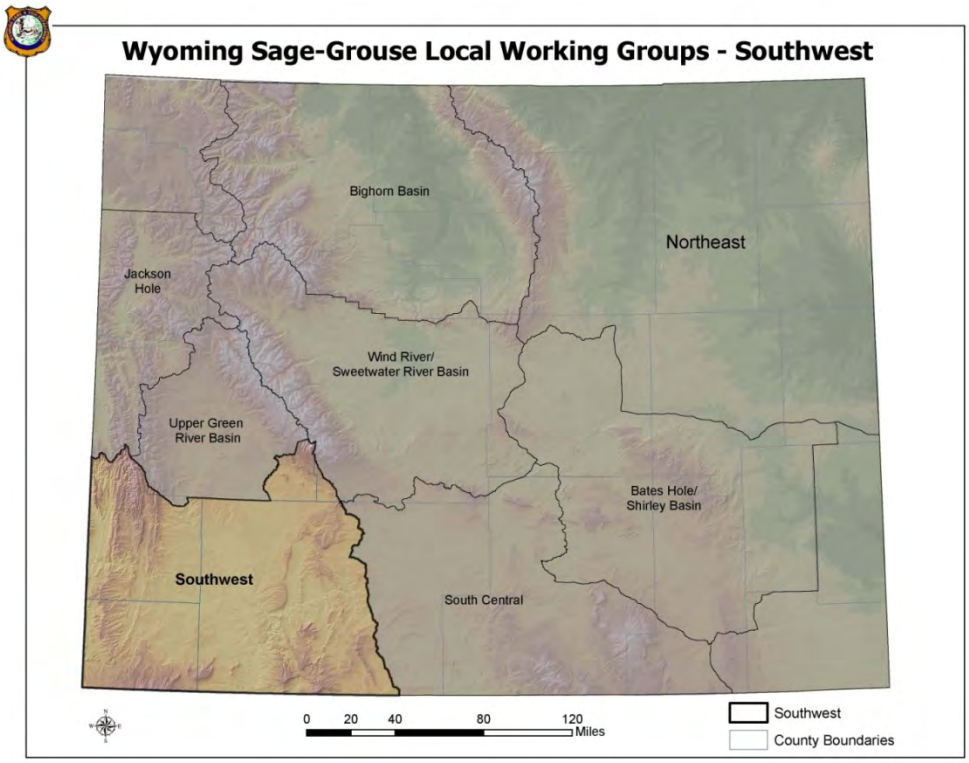


Figure 1. Wyoming Local Sage-Grouse Working Group Boundaries

In response to range-wide sage-grouse population declines and loss of sagebrush, upon which sage-grouse depend, habitats in the past two decades, there has been an increased emphasis on sage-grouse data collection. Those monitoring efforts have suggested that sage-grouse populations in the SWSGCA were at their lowest levels ever recorded in the mid-1990s. Grouse numbers then responded to increased precipitation during the late 1990's with some individual leks seeing three fold increases in the number of males counted between 1997 and 1999. The return of drought conditions in the early 2000's led to decreases in chick production and survival and therefore population declines; although the populations have not fallen back to mid-1990s levels. Well-timed precipitation in 2004-05 increased chick survival and later lek attendance, however drought conditions from 2006-08 appear to have caused the population in the southwest part of the state to

decline. Increased springtime precipitation in 2009-2011 did not resulted in increased sage-grouse numbers. We suspect the moisture arrived with cold temperatures during the peak of hatching which may have reduced hatching success and early chick survival. Drought conditions again returned in 2012 and 2013, which resulted in decreased chick to hen ratios, suggesting a continuation of overall population declines.

In addition to the continuing drought conditions that have been experienced off and on for the last decade and a half, and the impacts that drought might have on sage-grouse, some of the other causes of concern for sage-grouse populations in the SWSGCA include continued pressure from natural gas development, livestock grazing practices and vegetation treatment practices. In addition to the aforementioned threats, the recent interest in wind energy development is a cause for concern and could potentially have measurable impacts on sage-grouse populations throughout Wyoming and the west. While most of the proposed wind energy projects in the SWSGCA have been placed on the back burner, the potential for harm still exists if these projects are reinitiated.

The issues of hunting and predation and the potential impacts of hunting are concerns that are often raised by the public. There is little evidence suggesting that hunting has any population level impacts on sage-grouse in Wyoming (Christiansen 2010). Research in the Upper Green River Basin area suggests raven populations are heavily subsidized by human activities and raven predation may be impacting grouse in that area (Bui 2009). Other raven impacts studies are continuing in the SWSGCA and South-Central SGCA with several resulting publications (Conover et al. 2010, Dinkins et al. 2012, Dinkins 2013, Dinkins et al. 2013, Dinkins et al. 2014).

WYOMING CORE AREA STRATEGY

In a move to coordinate sage-grouse conservation efforts across the State of Wyoming, Gov. Dave Freudenthal utilized the recommendations from his Sage-Grouse Implementation Team (SGIT) and released an Executive Order on Aug. 1, 2008 that directed state agencies to work to maintain and enhance greater sage-grouse habitat in Wyoming. The 2008 Executive Order is appended to the 2008 Statewide Sage-Grouse JCR. These actions constituted Wyoming's Core Area Strategy. The executive order established a "core area" strategy of management.

Following the March 2010 "warranted but precluded" listing decision by the U.S. Fish & Wildlife Service, Governor Freudenthal reconvened the SGIT and tasked them to update the core area map and strategy using the most recent data. The SGIT, with the assistance of the local working groups, prepared these updates during the spring and summer of 2010 and Governor Freudenthal issued a new Executive Order on August 18, 2010 to replace that from 2008.

Governor Freudenthal did not seek reelection and in January 2011 newly elected Governor Matt Mead was inaugurated. Governor Mead issued his own Sage-Grouse Executive Order on June 2, 2011 which reiterated and clarified the intent of Wyoming's Core Area Strategy. The current executive order is appended to the 2010-11 Statewide JCR and also available on the WGFD website. The current core areas are shown in Figure 2.

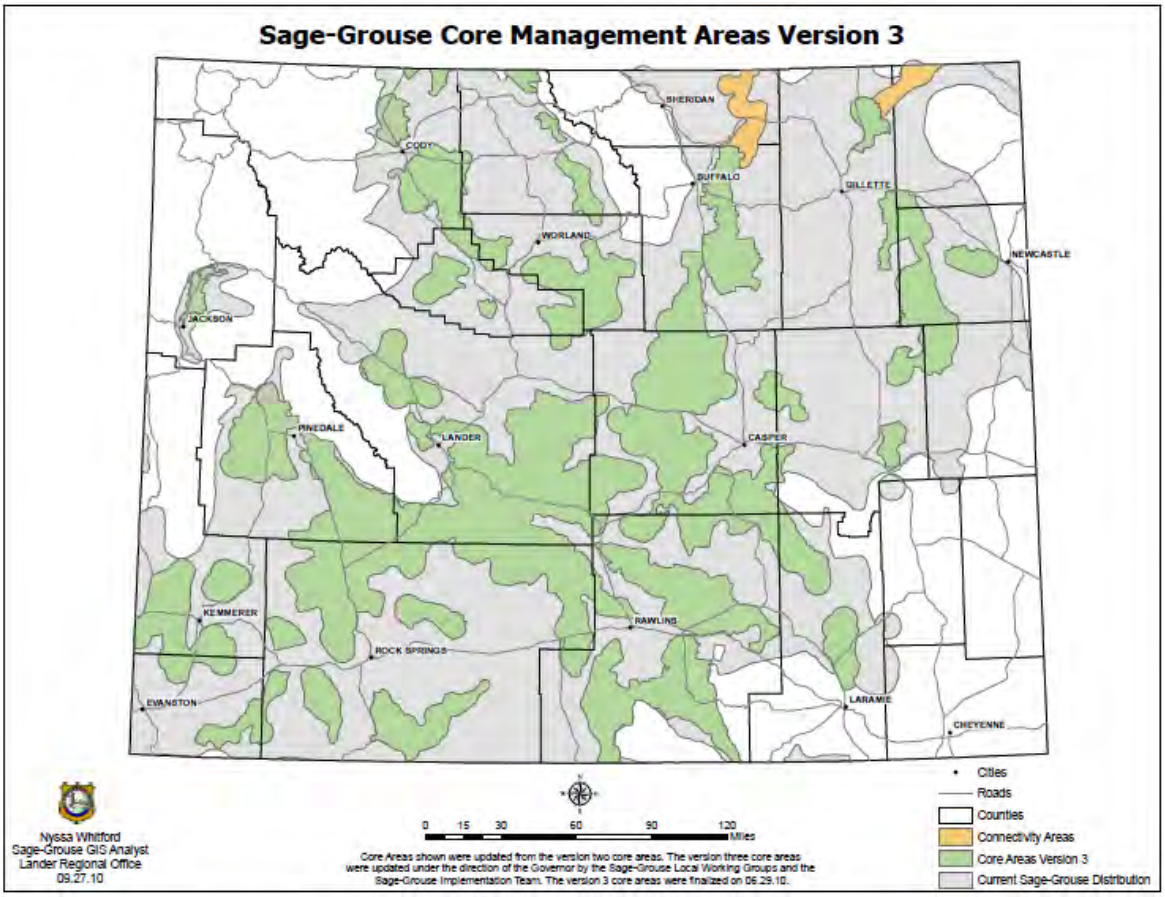


Figure 2. Wyoming sage grouse core areas Version 3.

METHODS

Data on numbers of sage-grouse males attending leks are collected in two ways: lek surveys and lek counts. Lek surveys are defined as at least one visit to a lek during the breeding season to determine if the lek is active or inactive. A lek is considered to be active if one or more males were observed strutting on the lek during one of the lek visits. Lek counts consist of three or more visits (separated by about 7-10 days) to a lek during the peak of strutting activity (late March-mid May) to more precisely estimate the maximum number of males attending that lek. Average male attendance is calculated as the maximum number of males observed on each lek divided by the number of leks checked, using only those leks that were known to be active that year.

Harvest information is obtained through a mail/internet questionnaire of Wyoming game bird license holders. From 1982 to 2009 sage-grouse harvest data were compiled by Upland Game Management Area. Management Areas in the SWSGCA included Areas 4, 5, 6, and a portion of Area 7 (Figure 3). The remainder of Management Area 7 was included in the Upper Green River Basin Conservation Planning Area (UGRBCA). Starting in 2010, sage-grouse harvest data are being reported by Sage-Grouse Management Area. The Sage-Grouse Management Areas were created to correspond to the local working group boundaries, which will allow for harvest data to be more accurately attributed to each conservation planning area. The Sage-Grouse Management Area for the SWSGCA is Management Area G. This change may result in a slight decrease in the harvest reported in the SWSGCA.

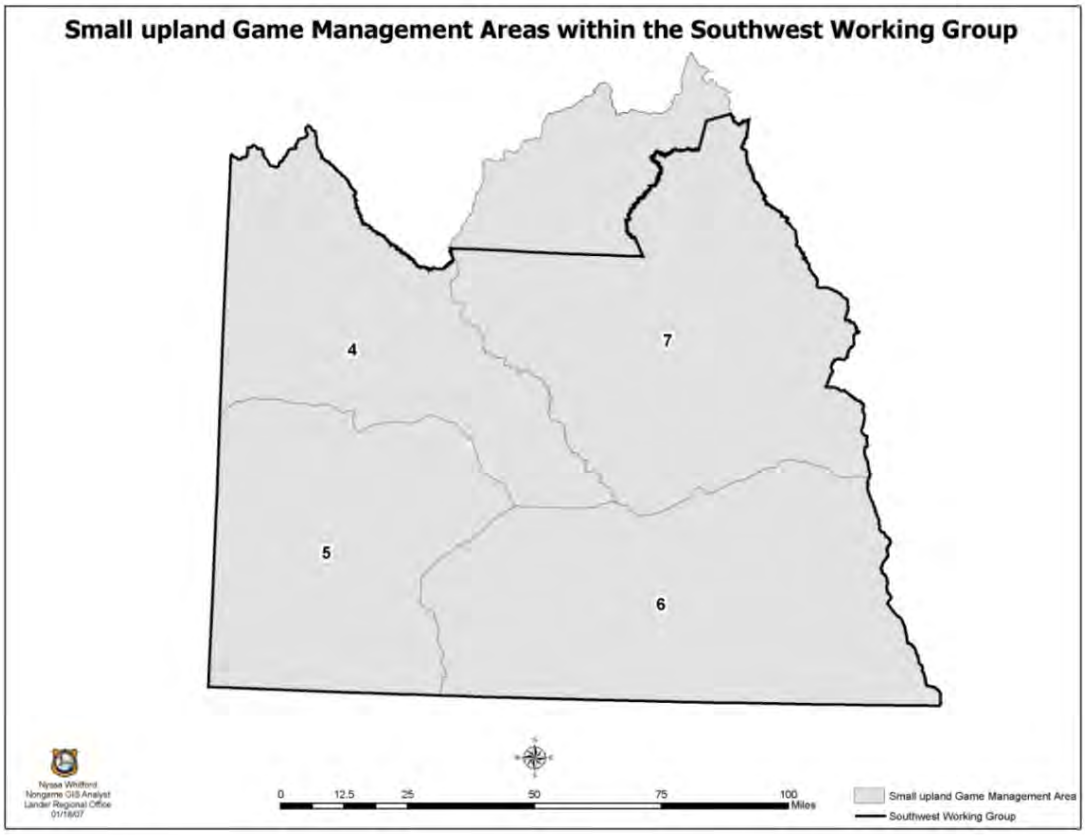


Figure 3. Small Game Management Areas within the Southwest Wyoming Sage-Grouse Conservation Planning Area. Small Game Management Areas were used to report sage-grouse harvest prior to 2010.

In addition to the mailed questionnaire, wings are collected on a voluntary basis from harvested sage-grouse in order to determine the proportions of adults, juveniles, males, and females in the harvest. Wings were submitted by successful hunters at wing collection barrels distributed throughout the SWSGCA. Of primary interest is the chick to hen ratio, a statistic that provides an index of annual chick productivity and survival.

More specific methods for collecting sage-grouse data are described in the sage-grouse chapter of the WGFD Handbook of Biological Techniques (Christiansen 2012), which is largely based on Connelly et al (2003).

RESULTS

Lek Monitoring

A new sage-grouse database was developed in 2012 in order to improve efficiency, reduce errors, and better facilitate data analysis. Changes were made to the manner in which lek data are calculated and reported in Appendix B Tables 1 a-d. The new version is based solely on "occupied" leks. The past version suggested that was the case in the title of Table 1, but when unoccupied leks were monitored those data were also included in the table. The result of this change is that the number of "known occupied" leks is now more accurate, but reflects fewer leks than in the previous version. Similarly, the new version calculates average male lek attendance using only monitoring observations where one or more male grouse were observed strutting. The old version included a count of "0" males for leks where activity was confirmed by the presence of sign but no birds were observed. Together, these two changes result in somewhat higher, but more accurate, average male attendance for active leks than previously reported. The changes do not result in any change in population trend based on average male lek attendance. Interpreted population increases and decreases over time remain the same so no revisions to past reports are required.

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.

Average female lek attendance is no longer being reported since our data collection techniques is not designed to correctly capture these data and is therefore not a useful figure in assessing population trends.

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 is assumed that not all leks in the area have been located, 3) sage-grouse populations can exhibit cyclic patterns over approximately a decade, 4) the effects of unlocated or unmonitored leks that have become inactive cannot be quantified or qualified, and 5) lek sites may change over time. Both the number of leks and the number of males attending these leks must be quantified in order to estimate population size.

All lek monitoring data for the 2014 breeding season 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. There were 317 occupied leks known to exist in the SWSGCA during the 2014 breeding season. Of the known lek sites in the SWSGCA, 287 of them were checked in 2014 resulting in 230 being documented as being active, 26 were classified as being inactive and 23 leks were of unknown or undetermined status. Because of the quantity of leks in the SWSGCA, data collection efforts were 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.

The average number of males per active lek for all leks checked (both counted and surveyed) during the 2014 breeding season was 20.9 males per active lek. This is an increase from the 17.9 males per active lek, but below the 10 year average of 34.4 males per active lek. The average number of males in attendance on the 96 count leks in 2014 was 20.4 males per lek. This number is a slight increase from 2013, but is a still below the observed averages of recent years. For the 191 leks that were surveyed in 2014, the average lek had 21.2 males in attendance, which is an increase from the observed 2013 average of 16.4 males per survey lek.

It is important to note that data collection efforts have increased considerably since the early 2000's. Because of this, the observed increase in the number of grouse observed in the mid 2000's is probably an artifact of an increased sampling effort and does not necessarily represent an actual increase in the sage-grouse population. In 2000, only 63% of known occupied leks were checked, but in 2014, 91% of the occupied leks were checked. 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 sage-grouse population size in a statistically significant way. However, the decreased male per lek averages in recent years along with lower chick per hen ratios indicates the sage-grouse population in southwest Wyoming has been declining but may have begun to increase during this reporting period.

Harvest

The 2013 hunting season for sage-grouse in the SWSGCA ran from September 21 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 2013 season was consistent with how the season has been run since 2002 when the season was shortened and the daily bag limit was reduced to 2 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 2013 season was six days shorter than 2012.

The data for grouse harvested in the SWSGCA are reported under Sage-Grouse Management Area G for the 2010 through 2013 hunting seasons. Note that for 2001-2009 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. 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 this report.

Based on the estimates resulting from harvest surveys returned by hunters, 1,307 hunters harvested 2,513 sage-grouse during the 2013 hunting season (Appendix B Table 2 b and Figures 2 a-d). Hunter numbers declined 26% from 2012 to 2013. The estimated number of grouse harvested in 2013 also declined substantially. The estimated harvest of 2,513 birds in 2013 was one-third of 2012's harvest and half of the estimated harvest in 2006, when hunters harvested over 5,000 grouse.

Part of this can explained by the change in how harvest is reported between 2006 and 2013 and the shorter hunting season in 2013, the rest is probably a result of lower sage-grouse numbers, wet weather during the hunting season and a concern from the public about the condition of the sage-grouse population.
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 over that period.

Successful hunters submitted 390 grouse wings during the 2013 hunting season (Appendix B Table 3). This represents just under 16% of the estimated total harvest for 2013, which is right in line with the ten-year average submission rate of 16%, but down from the 2011 submissions, when almost one quarter of the estimated harvest was submitted.

Wings are collected to allow for the determination of the sex and age of harvested birds. 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. The most important ratio from the wing analysis is the chick to hen ratio; this ratio provides a general indication of chick recruitment. 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 2013 hunting season was 1.2 chicks/hen (Appendix B Table 3 and Figure 3). This ratio suggests an overall weakly declining population. However, lek attendance increased in 2014 so factors other than chick production likely influenced the population growth rate.

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 have a large impact on sage-grouse nesting and brood rearing success. The shrubs and grasses provide screening cover from predators and weather while the forbs provide forage and insects that reside in the forbs, which are an important food source for chicks. Spring precipitation is an important determinant of the quality and quantity of these vegetation characteristics. Residual grass height and cover depends on the previous year's growing conditions and grazing pressure while live grass and forb cover are largely dependent on the current year's precipitation.

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

The spring (March-June) precipitation and fall chick:hen ratios (as determined by hunter submitted wings) are given in Table 1 and Figure 4. Generally speaking, when spring precipitation is at or above 90% of average, chick to hen ratios are above average, but when spring precipitation is below average, chick:hen ratios are also below average.

In 2013, spring precipitation was only 55% of normal. 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.

Table 1. Spring precipitation compared to fall chick:hen ratios in the SWSGCA 2004-2013. 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
2004	92%	2.2
2005	134%	3.2
2006	50%	1.1
2007	57%	1.8
2008	64%	2.1
2009	141%	1.4
2010	139%	0.9
2011	117%	1.5
2012	30%	0.7
2013	55%	1.2

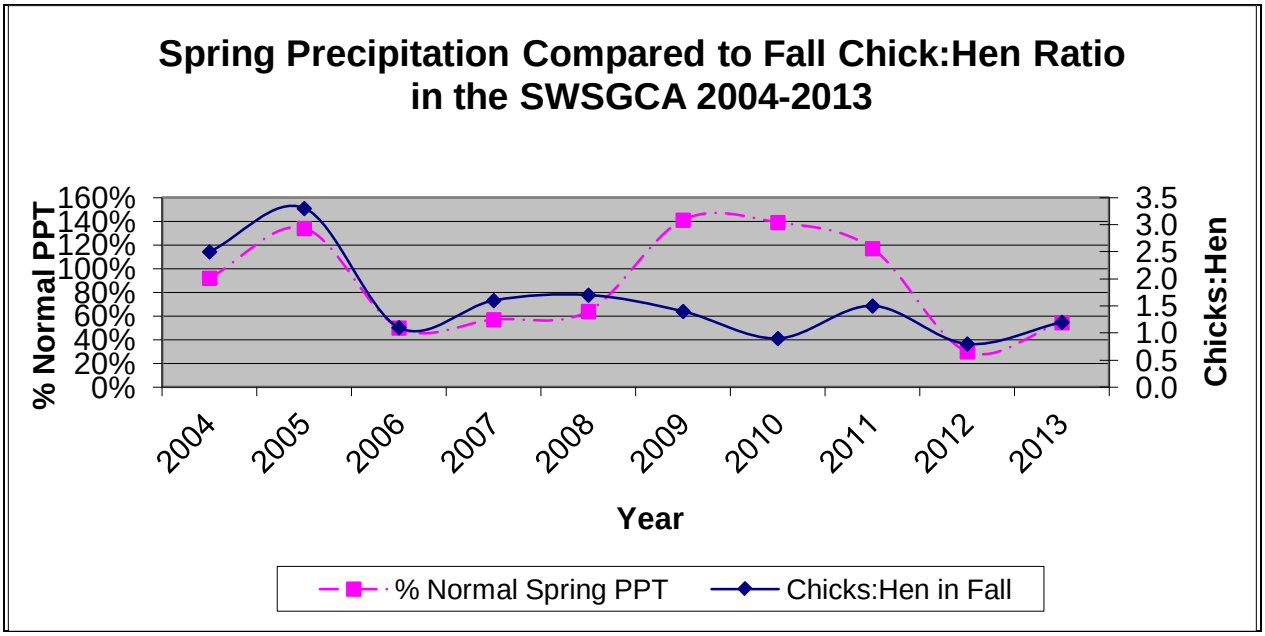


Figure 4. Percent of normal spring precipitation compared to fall chick to hen ratios in the Southwest Wyoming Sage-Grouse Conservation Planning Area

Habitat and Seasonal Range Mapping

While we believe that the majority of the currently occupied leks in the SWSGCA have been documented, other seasonal habitats such as nesting/early brood-rearing and winter concentration areas have not yet been adequately identified. Efforts to map seasonal ranges for sage-grouse will continue by utilizing winter observation flights and the product of the current research effort by the USGS Science Center in Fort Collins, CO to model seasonal sage-grouse habitat in Wyoming.

CONSERVATION PLANNING/IMPLEMENTATION

Since 2005, Local Working Groups have been allocated approximately $4.2 million to support implementation of local sage-grouse conservation projects. The source of this funding is the State of Wyoming General Fund as requested by Governor Freudenthal and approved by the legislature. See Attachment A for a list of the projects implemented in, or on behalf of, the SWSGCA during the 2013-14 biennium. Additional projects from this appropriation will be implemented during the 2013 bio-year.

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. 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.

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.

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CURRENT RESEARCH IN THE SWSGCA

- Impacts of raven abundance on greater sage-grouse nesting success in southwest Wyoming – Utah State University. Peer reviewed publications from this effort published during this analysis period include Dinkins et al. 2013 and 2014 along with a dissertation (Dinkins 2013). Raven research in southern Wyoming is continuing with a new graduate student.

RECOMMENDATIONS

1) Identify important seasonal habitats, especially early brood rearing areas.

2) Continue to implement provisions of the Governor's executive order for sage-grouse core area management.

3) Continue to implement the SWSGCA Conservation Plan.

4) Map and integrate into the WGFD database perimeters for all known sage-grouse leks.

5) Expand lek searches to ensure that all active leks within the SWSGCA have been identified.

6) Ensure that all known lek locations are accurate and recorded using UTM grid coordinates in map datum NAD83.

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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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Attachment A: SWSGCA Sage-Grouse Projects Supported with 2013-14 General Fund Budget

Project Name	Budget Biennium	Local Working Group	Total Cost	SG $	Project Description	Partners	Status
143 - Raven/raptor density effects to lek count	2013-14	Southwest, South-Central	not provided by applicant	$100,000 requested; $70,000 approved	Research to determine impacts of raven control to sage-grouse	Utah State University	On-going
144 - Cheatgrass mapping and control in Sublette Co. phase III	2013-14	Upper Green River Basin, Southwest	$137,142	$62,142 requested/approved	Cheatgrass mapping and spot control	Sublette County Weed & Pest, Green River Basin Coordinated Weed Mgt Assoc.; WLCI	On-going
145 - Impacts of noise on sage-grouse	2013-14	Wind River-Sweetwater River, Northeast, South-Central, Southwest	$63,388	$41,626 requested/approved	Continuing research examining the effects of noise resulting from energy exploration and development	University of California-Davis, BLM	On-going
146 - Response of SG to sagebrush treatments Phase II	2013-14	Wind River-Sweetwater River, South-Central, Southwest	$956,593 (multi-year)	$99,841 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
147 – Impacts of wind energy development on sage-grouse (see also #84, 115, 184)	2013-14	Bates Hole-Shirley Basin, South-Central, Southwest	$1,023,250 (multi-year)	$105,000 requested/approved	Continuing research to determine sage-grouse demographic and habitat use response to wind energy development.	National Wind Coordinating Collab., Iberdrola Renewables, Pacificorp, EnXco, Wyoming Wildlife	On-going

						Foundation, UW, W.E.S.T. Inc., Wyoming Wildlife Consultants, LLC	
148 - Spring development/protection and habitat restoration (see also #47, 99, 110, 128, 129)	2013-14	South-Central Southwest		$59,000 requested/approved	3 embedded projects - Beaver Hills water development - spring development/protection in the Saratoga area ($12K), restoration seed mix purchase for Saratoga area restoration project ($10K), purchase of steel spring protection fencing for future sites statewide ($37K)	Saratoga, Encampment, Riverside Cons. Dist., Wyoming Game & Fish, IK Ranch, other landowners pending approval	On-going
158 - Effects of mowing and herbicide treatments on the nutritional quality of sagebrush in south-central, Wyoming	2013-14	Wind River-Sweetwater River, Southwest	$29,061	$14,531 requested/approved	Research to determine the effects of habitat treatment on the nutritional quality (crude protein and chemical defenses) of sagebrush	Boise State University, University of Wyoming	On-going
161 - Currant Creek Ridge juniper removal (see also #177, 178)	2013-14	Southwest	$135,000	$25,000 requested/approved	Mechanical juniper removal from sage-grouse habitat	BLM, Muley Fanatics	On-going
162 - Sage Creek cheatgrass treatment (see also #176)	2013-14	Southwest	$250,000	$50,000 requested; $25,000 approved	Chemical control of cheatgrass within a wildfire area	BLM; Sweetwater Co. Weed & Pest	On-going

Sage Grouse Job Completion Report

Year: 2005 - 2014, 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)
2005	230	59	26	2955	51.8
2006	240	67	28	4153	62.9
2007	257	69	27	3914	58.4
2008	267	69	26	4284	63.0
2009	285	71	25	2651	40.2
2010	292	78	27	2214	30.8
2011	302	73	24	1855	26.9
2012	310	82	26	1720	23.2
2013	317	117	37	1974	19.5
2014	317	96	30	1629	20.4

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2005	230	118	51	3537	37.6
2006	240	152	63	4074	38.4
2007	257	175	68	5791	42.9
2008	267	149	56	4021	33.5
2009	285	190	67	5485	35.2
2010	292	185	63	3789	26.5
2011	302	168	56	2909	21.1
2012	310	188	61	2889	20.8
2013	317	178	56	2183	16.4
2014	317	191	60	3121	21.2

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: 2005 - 2014, 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)
2005	230	177	77	6492	43.0
2006	240	219	91	8227	47.8
2007	257	244	95	9705	48.0
2008	267	218	82	8305	44.2
2009	285	261	92	8136	36.6
2010	292	263	90	6003	27.9
2011	302	241	80	4764	23.0
2012	310	270	87	4609	21.6
2013	317	295	93	4157	17.8
2014	317	287	91	4750	20.9

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2005	153	12	12	165	92.7	7.3
2006	183	26	10	209	87.6	12.4
2007	215	18	11	233	92.3	7.7
2008	196	13	9	209	93.8	6.2
2009	234	17	10	251	93.2	6.8
2010	227	13	23	240	94.6	5.4
2011	221	5	15	226	97.8	2.2
2012	230	25	15	255	90.2	9.8
2013	242	27	26	269	90.0	10.0
2014	230	26	23	256	89.8	10.2

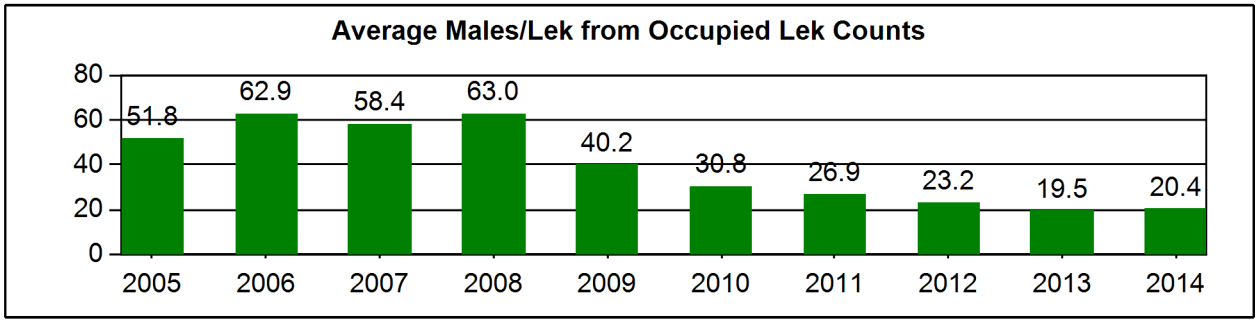
1) Occupied - Active during previous 10 years (see official definitions)

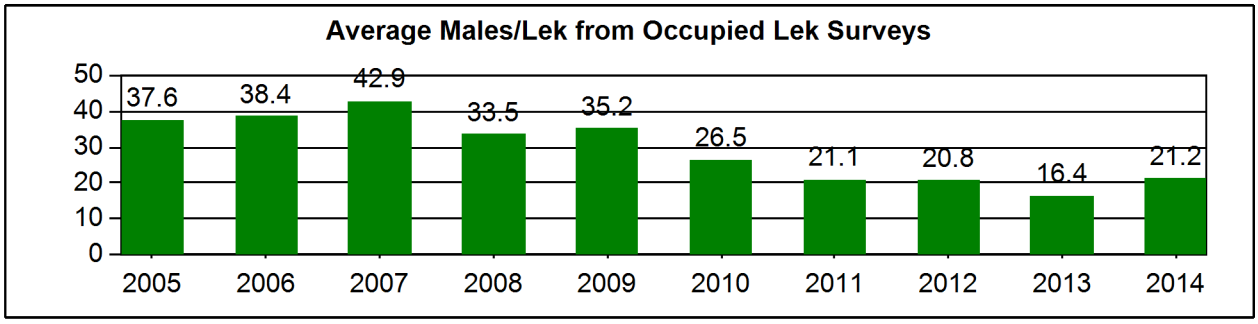
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

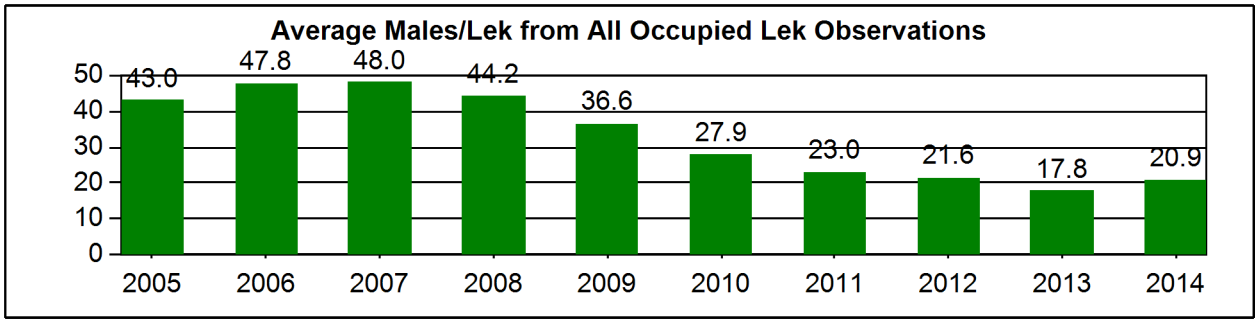
3) Inactive - Confirmed no birds/sign present (see official definitions)

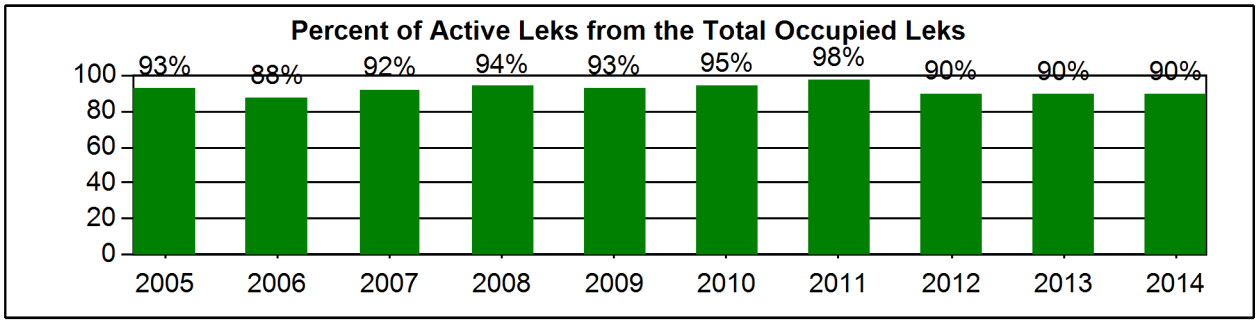
Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Southwest



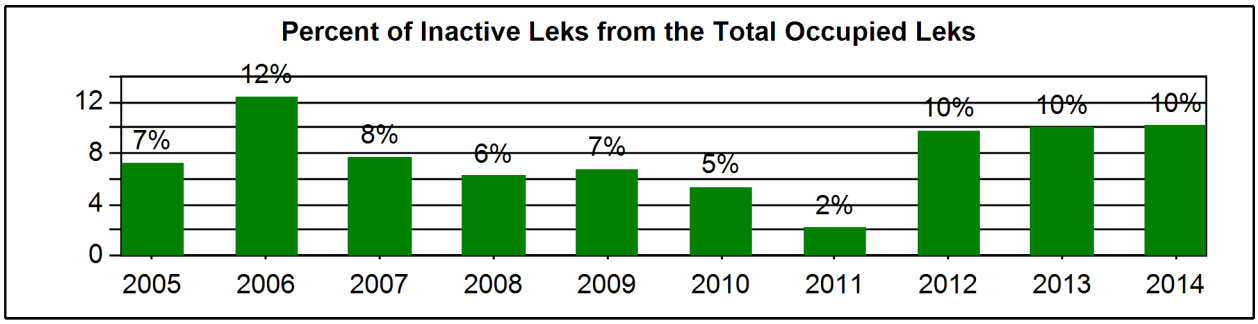






Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Southwest



Sage Grouse Lek Characteristics

Working Group: Southwest

Region	Number	Percent
Green River	384	87.7
Lander	1	0.2
Pinedale	53	12.1

Working Group	Number	Percent
Southwest	438	100.0

Classification	Number	Percent
Occupied	316	72.1
Undetermined	18	4.1
Unoccupied	104	23.7

BLM Office	Number	Percent
Kemmerer	192	43.8
Pinedale	11	2.5
Rawlins	5	1.1
Rock Springs	230	52.5

Biologist	Number	Percent
Green River	163	37.2
Kemmerer	221	50.5
Pinedale	53	12.1
South Lander	1	0.2

Warden	Number	Percent
Cokeville	61	13.9
Evanston	30	6.8
Green River	75	17.1
Kemmerer	69	15.8
Lander	1	0.2
Mountain View	48	11.0
Rock Springs	101	23.1
South Pinedale	53	12.1

County	Number	Percent
Fremont	4	0.9
Lincoln	128	29.2
Sublette	34	7.8
Sweetwater	205	46.8
Uinta	67	15.3

Land Status	Number	Percent
BLM	307	70.1
BOR	14	3.2
National Park	2	0.5
Private	102	23.3
State	12	2.7
USFS	1	0.2

Management Area	Number	Percent
G	438	100.0

Lek Status	Number	Percent
Unknown	438	100.0

Sage Grouse Job Completion Report

Year: 2005 - 2014, Working Group: Southwest

4. Sage Grouse Hunting Seasons and Harvest Data

a. Season

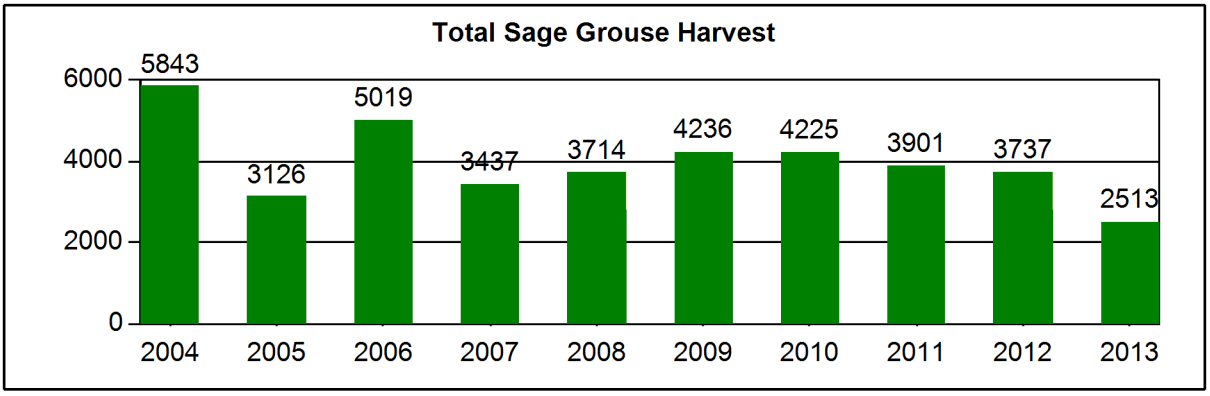
Year	Season Start	Season End	Length	Bag/Possesion Limit
2005	Sep-23	Oct-3	11	2/4
2006	Sep-23	Oct-3	11	2/4
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4

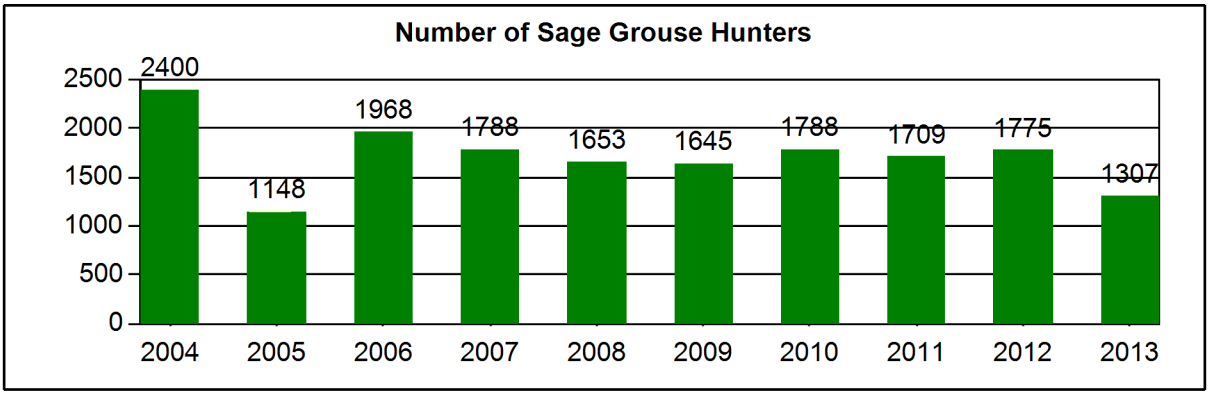
b. Harvest

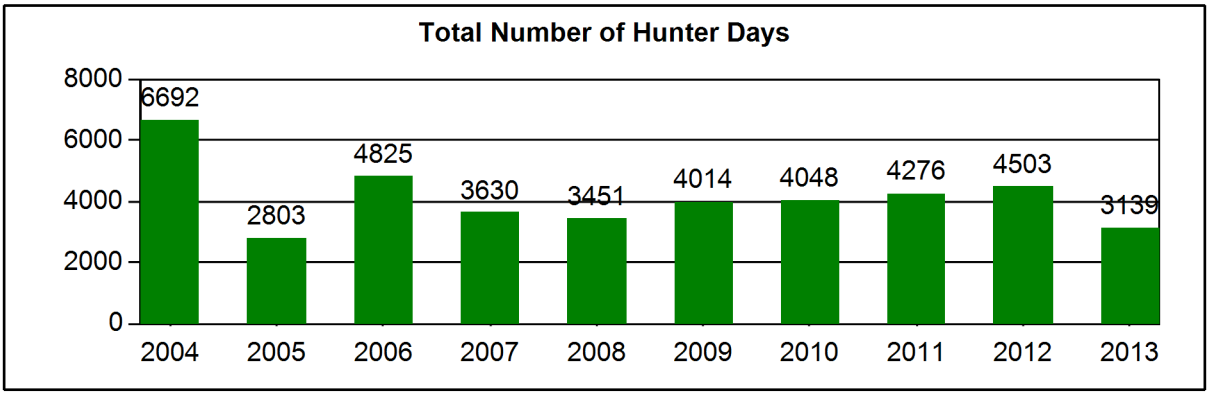
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2005	3126	1148	2803	1.1	2.7	2.4
2006	5019	1968	4825	1.0	2.6	2.5
2007	3437	1788	3630	0.9	1.9	2.0
2008	3714	1653	3451	1.1	2.2	2.1
2009	4236	1645	4014	1.1	2.6	2.4
2010	4225	1788	4048	1.0	2.4	2.3
Avg	3,960	1,665	3,795	1.0	2.4	2.3

Sage Grouse Harvest Summary

Management Area: G

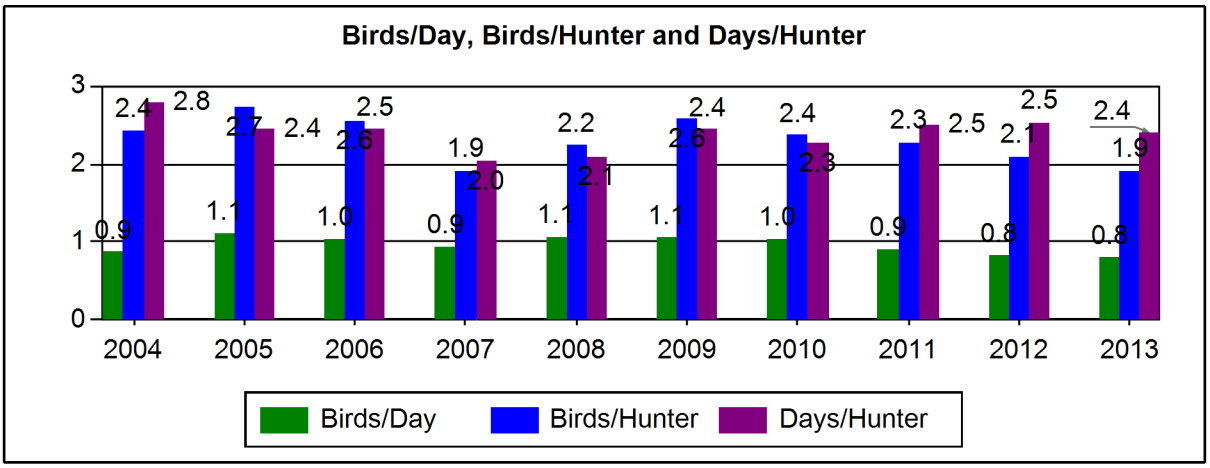






Sage Grouse Harvest Summary

Management Area: G

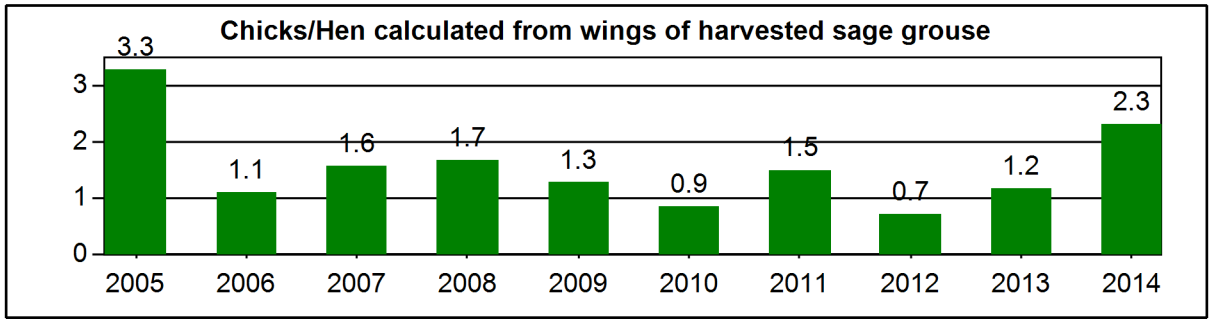


Sage Grouse Job Completion Report

Year: 2005 - 2014, Working Group: Southwest

5. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
2005	845	8.3	16.9	1.9	4.0	32.7	36.2	3.3
2006	638	16.3	32.3	2.8	6.0	17.2	25.4	1.1
2007	509	18.5	26.5	3.3	3.7	22.6	25.3	1.6
2008	666	12.9	24.6	5.0	6.0	20.1	31.4	1.7
2009	887	11.7	30.0	4.4	6.7	20.0	27.3	1.3
2010	696	2.6	51.0	0.6	0.9	2.9	3.6	0.9
2011	998	6.1	31.9	2.9	4.3	23.9	30.9	1.5
2012	581	10.0	38.9	4.6	10.3	16.5	19.6	0.7
2013	390	9.2	38.5	1.5	2.3	20.5	27.9	1.2
2014	517	5.6	20.7	2.3	7.0	33.5	30.9	2.3



Upper Green River Basin
Sage-Grouse
Job Completion Report
2013

June 2013-May 2014

Dean Clause
Wyoming Game & Fish Dept.
Pinedale Region

Narrative
Conservation Plan Area: **Upper Green River Basin**
Period Covered: **6/1/2013 – 5/31/2014**
Prepared by: **Dean Clause**

Introduction

The Upper Green River Basin Working Group Area (UGRBWGA) covers Sage-grouse Management Area (SGMA) D that lies within Sublette County (prior to 2010 designated Upland Game Bird Management Area (UGBMA) 3 and the north portion of UGBMA 7). All lek data and harvest data from SGMA D is included in this 2013 JCR. Prior to 2010, only harvest data from UGBMA 3 was included in the report while that portion of UGBMA 7 that lies with UGRBWGA was reported in the Southwest WG JCR.

Sage-grouse are found in suitable sagebrush uplands throughout the Upper Green River Basin. Sage-grouse habitats within Sublette County are expansive and relatively intact outside of developing natural gas fields. Habitats for sage-grouse within Sublette County occur throughout mixed land ownership jurisdictions. Most sage-grouse leks are found on Bureau of Land Management (BLM) lands (81%), with fewer leks found on private (12%), and state (7%) ownership. Nesting and early brood rearing habitats are also found predominantly on BLM lands, while many birds move to moist meadow habitat located on private or public/private interfaces during late brood rearing and/or summer. Fall movements away from these moist areas to sagebrush-dominated uplands on BLM lands occur in late September/early October. As winter progresses, birds concentrate on sagebrush upland habitats. These winter concentration areas are also located primarily on BLM lands.

Traditionally, sage-grouse data collection within the Pinedale Region has focused on lek surveys, with a secondary emphasis on collecting information from harvested birds. Prior

to 1994, relatively few leks were monitored and prior to 2000, standardized efforts were not used to collect sage-grouse lek information. Since 2000, efforts have been made to standardize lek data collection methods and increase lek monitoring efforts (i.e. collect data on more leks along with increasing the number of site visits per lek). Current lek monitoring has shifted from "lek surveys" to "lek counts" as described below.

Information presented in this report includes data and trend analysis for lek monitoring, population trends, harvest rates, productivity rates, winter distribution surveys, and weather data. Other categories covered in this report include special projects/research, management summaries, and recommendations.

Data Collection Efforts and Methods

Lek monitoring consists of inventory methods called "lek counts" or "lek surveys". A lek count consists of at least 3 site visits during the strutting season, with each visit conducted at least 7 days apart. Lek counts are used to determine annual status (active or inactive) along with determining population trends. A lek count can also be a census technique that documents the actual number of male sage-grouse observed on a lek complex. A lek complex is defined as a group of leks in close proximity between which male sage-grouse may be expected to interchange from one day to the next. In order to be classified as an accurate lek count (or census), a lek observation must include all leks within a complex on the same morning. These simultaneous observations must be performed at least 3 times during the strutting season, with at least 7 days separating each lek observation. Lek complex counts have not routinely been conducted due to manpower and logistical restraints. Lek complex counts are only practical when a few leks comprise a complex.

A lek survey consists of only 1 or 2 site visits during the strutting season. Lek surveys are primarily important to identify annual status (active or inactive) of a particular lek or lek complex and not for estimating population trends. Overall, lek counts are preferred over surveys and recent emphasis has been placed on collecting lek counts.

Based on the findings at each lek, the lek is assigned an annual status of "Active" (attended by more than one male sage-grouse), "Inactive" (it was known that there was no strutting activity during the breeding season), and "Unknown" (either active or inactive status has not been determined). Based on the past and current status, leks are assigned one of the three categories for management purposes. The category "Occupied" is a lek that has been active during at least one strutting season within the last ten years. Management protection will be afforded to occupied leks. An "Unoccupied" lek has not been active during the past 10 years, although there must be sufficient data to justify placing a lek into this category. A lek survey or count must have been conducted 4 out of 10 years during non-consecutive years (i.e. every other year) without activity to be placed in the "Unoccupied" category. Unoccupied leks are also broken down into two sub-categories ("Destroyed" – habitat no longer exists or "Abandoned" – habitat still exists). Management protection is not afforded to unoccupied leks. The third category is "Undetermined" which is a lek that has not documented grouse activity in the past 10

years, but doesn't have sufficient data to be classified as unoccupied (as mentioned above).

Information on the sex/age composition of harvested birds is collected through the use of wing barrels distributed throughout Sublette County each fall. Productivity information is estimated from this data set, as the number of chicks/hen can be derived. Wing collections can also provide valuable harvest trend data. Harvest estimates for each Sage-Grouse Management Area are obtained through a hunter harvest questionnaire that is conducted annually.

With declining long-term sage-grouse populations, both locally and range-wide, increased effort has been placed on collecting sage-grouse data. In addition, the increase in natural gas exploration and development within Sublette County raised concerns regarding the impact of such large-scale landscape developments on sage-grouse populations. In response, several sage-grouse research projects were initiated in this region. Local research indicated that habitat protection measures (stipulations) being implemented during the studies were not sufficient to protect sage-grouse and their habitats. The results of this research have been important in the revision of some stipulations, the development of the Wyoming Core Area Strategy (discussed below) and revisions to BLM and Forest Service planning documents.
Prior to the winter of 2003, sage-grouse winter distribution information had only been collected opportunistically during other winter surveys (deer, elk, and moose composition counts) and ground observations that were documented in the Wildlife Observation System (WOS). Some data had also been collected by private wildlife consultants conducting ground surveys directed by the BLM for clearance associated with gas development. Since 2004, certain areas within the Upper Green River Basin have been surveyed to document important sage-grouse wintering areas. These surveys have been conducted aerially with a helicopter during January/February using stratified transects at approximately 1 minute (1 mile) intervals or less to document sign and live observations of grouse. These aerial surveys, along with other existing data, are very useful baseline information to identify important winter grouse habitats for future management decisions.

Habitat Protection and Core Area Policy

In July 2007 Wyoming Governor Freudenthal convened a summit and created the Wyoming Governor's Sage-grouse Implementation Team (SGIT) to develop a conservation strategy, the Wyoming Core Population Area strategy, to manage sage-grouse to prevent listing under the ESA and retain State authority in management decisions. The strategy identified the most important sage-grouse habitat in Wyoming using a lek density map showing areas of the state which supported the highest densities of breeding activity from 2005 thru 2007.

The Governor issued Executive Order 2008-2 in August 2008 outlining the core area strategy with 21 recommendations that conserve Wyoming's most important sage-grouse

habitats while allowing for development outside core areas. Statewide, core areas accounted for approximately 34% of the current sage-grouse range while encompassing leks with 81% of the 2008 peak males. Intentionally excluded from "core" habitat were existing, planned, and authorized energy development areas in the Upper Green River Basin.

Following the March 2010 listing decision of "warranted, but precluded" by the FWS, Governor Freudenthal asked the SGIT to revisit Wyoming's sage-grouse management strategy. The group's three tasks were to: 1) review core area boundaries; 2) review development guidelines inside and outside core habitats; and 3) identify connectivity areas to ensure movement corridors between populations to preserve genetic integrity. At the direction of the SGIT, the eight local working groups held meetings to review core area boundaries and make adjustments based on finer scale mapping of existing and planned development, suitable and unsuitable habitats, seasonal habitat data and connectivity between core areas.

Following revisions, Governor Freudenthal signed Executive Order 2010-4 which updated Wyoming's core area strategy as the framework to guide sage-grouse management in Wyoming. The revision incorporated connectivity areas and select recommendations for connectivity management. This was a significant milestone as the FWS had already approved the core area strategy as a sound framework for a policy by which to conserve sage-grouse. Currently the UGRBLWG area encompasses approximately 2,630,744 total acres, with 1,726,232 acres of occupied sage-grouse habitat (66% of the UGRBLWG area), and 847,893 acres of Core Area habitat (49% of occupied sage-grouse habitat).

Subsequent to the 2010 gubernatorial election, Governor Mead signed a 2011 version of the Executive Order (2011-5), reiterating and clarifying the Wyoming Core Area Strategy (see: http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/SAGEGROUSE_EO_COREPROTECTION0000651.pdf). In June 2011 the FWS wrote in a letter to Governor Mead, *"In summary, the Service believes the Greater Sage-grouse Core Area Protection provides an excellent model for meaningful conservation of sage-grouse if fully supported and implemented. We believe that when fully realized, this effort could ameliorate many threats to the Greater sage-grouse in Wyoming."*

The BLM and Forest Service are now in the process of revising their land use planning documents in order to be more consistent with the Executive Order and to address the regulatory concerns expressed by the U.S. Fish and Wildlife Service in their 2010 decision that made greater sage-grouse a candidate species for listing under the Endangered Species Act.

The UGRBLWG has acknowledged the Wyoming Core Area Strategy and its adoption by managers and regulators as the primary mechanism by which the identified threats of habitat loss and fragmentation and the inadequacy of regulatory mechanisms are addressed.

Local, state and federal resource agencies are also working to develop conservation strategies including Candidate Conservation Agreements with Assurances (CCAA) for private lands and Candidate Conservation Agreements (CCA) for public lands (see: http://www.fws.gov/wyominges/PDFs/Species_Listed/Umbrella_CCAA/Sage-grouse%20CCAA%20Draft%2012-19-2012.pdf). These agreements provide a mechanism for conserving sage-grouse through proactive conservation measures that reduce the potential for additional regulatory requirements that could result if the species is listed as threatened or endangered.

Climate

Weather data (particularly precipitation data) may be helpful in understanding the effects of environmental conditions on sage-grouse population dynamics. Lower than normal precipitation can affect sage-grouse by reducing the amount of herbaceous vegetation necessary for successful nesting, reduce insect and forb production for early brood success, and reduce the quantity and quality of sagebrush. Not only the amount of annual precipitation, but the timing of precipitation events can be a very significant influence on sage-grouse populations. Temperatures during nesting and early brood rearing periods (April – June) can also influence nest success and chick survival. Individual weather stations within the Upper Green River Basin include Big Piney, Cora, Daniel Fish Hatchery, and Pinedale. Some of these weather stations have incomplete and missing data, which makes monthly and annual comparisons difficult. In addition, these local weather stations do not adequately represent large portions of the Upper Green River Basin. For these reasons, a National Climatic Data Center (NOAA Satellite and Information Service) weather site has been utilized to gather moisture and temperature data. Wyoming is split into 10 different weather reporting Divisions. Division 3 covers the entire southwestern portion of Wyoming and is used in this UGRB Sage-grouse JCR to report precipitation and temperature trends. Climatic data for Division 3 can be found at the NCDC/NOAA web site: http://www.ncdc.noaa.gov/cag/time-series/us .

More specific methods for collecting sage-grouse data are described in the sage-grouse chapter of the WGFD Handbook of Biological Techniques (Christiansen 2012).

Results

Lek Monitoring

A new sage-grouse database was developed in 2012 in order to improve efficiency, reduce errors, and better facilitate data analysis. Changes were made to the manner in which lek data are calculated and reported in Table 1. The new version calculates average male lek attendance using only monitoring observations where one or more male grouse were observed strutting. The old version included a count of "0" males for leks where activity was confirmed by the presence of sign but no birds were observed. Together, these two changes result in somewhat higher, but more accurate, average male

attendance for active leks than previously reported. The changes do not result in any change in population trend based on average male lek attendance. Interpreted population increases and decreases over time remain the same so no revisions to past reports are required.

A total of 149 leks are currently documented in the UGRBWGA. These leks are classified as follows; 129 occupied, 20 unoccupied, and 0 undetermined. During 2014, a total of 123 occupied leks (95%) were checked (survey or count). Lek monitoring efforts in 2014 primarily focused on counts (89%) over surveys (11%). Results from the counts and surveys showed that 79% of the leks were active and 21% were inactive. The average number of males/lek for all active leks remained similar at 36 in 2014, compared to the past three years of 35 in 2013, 37 in 2012, and 35 in 2011. Declining trends since 2007 is opposite to increasing trends from 2003-2007 (Figure 1).

Generally, the proportion of leks checked that are confirmed "active" has stayed relatively stable during the past 10 years, ranging from 78% to 85%. 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 (48 new leks since 2004) negating the downward trend in the proportion of active leks in the UGRBWGA .

Since 2007, observed average peak male sage-grouse lek attendance has declined by 47% (2007-2014) for all occupied lek within the WGRBWGA. This trend is likely a combination of the cyclic nature of sage-grouse populations (Fedy and Doherty 2010) combined with documented influences from habitat fragmentation in the Upper Green River Basin. The last peak in attendance occurred in 2007 and was the highest level ever recorded for the area. Caution is warranted when analyzing long-range data sets within the UGRBWG area as the number of known (documented) leks have more than doubled during the past 15 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.

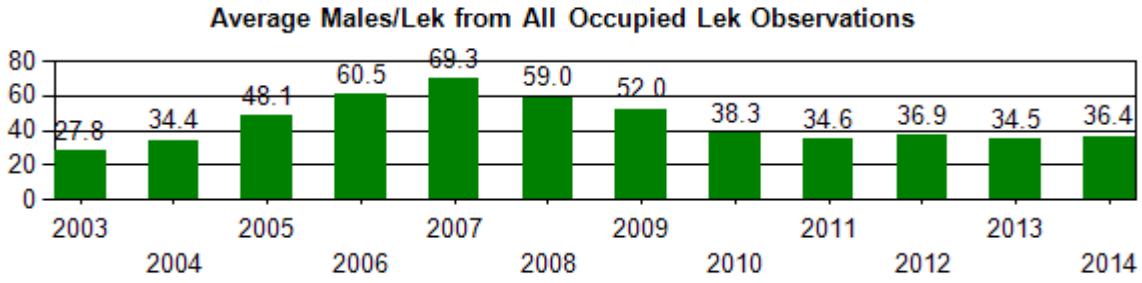


Figure 1. Average Peak Male Sage-grouse Lek Attendance 2003-2014, UGRBWG Area.

An analysis was performed to possibly represent a more accurate assessment of longer range population trends in the UGRBWG area using only the reliable data from known leks that had some level of activity during 1997, with no new leks added after this year. The start year of 1997 was used since lek monitoring became more structured about this

time and this was the first year that actual "count" data started to be collected in the UGRBWG Area. Fifty-one of the 66 known leks were used in this trend analysis (1997-2014). These leks were tracked from 1997 through 2014 to represent population trends (Figure 2). This trend in average peak males/active lek represents a stable grouse population from 1997-2001, declining through 2003, increasing through 2007, declining through 2010, slightly increasing in 2011, and stabilizing in 2012 -2014. Although this trend analysis is only a sub-set of all the known leks in the UGRBWG Area, overall trends are similar compared to all lek data within the UGRBWG Area.

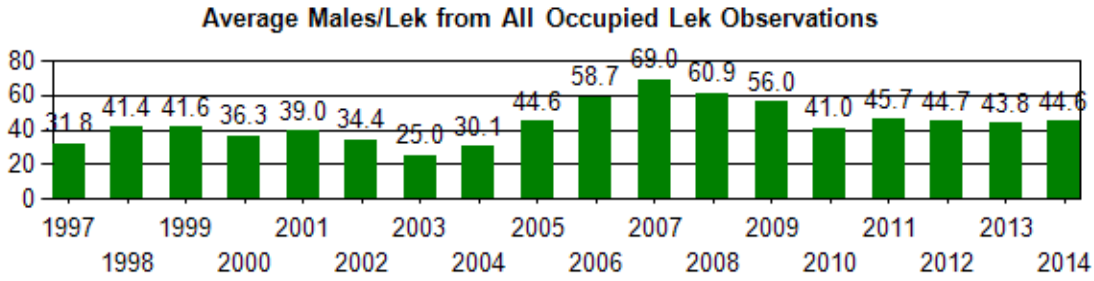


Figure 2. Average Peak Male Sage-grouse Lek Attendance 1997-2014, UGRBWG Area.

A lek analysis to assess natural gas development impacts in the Pinedale area has shown higher rates of decline (males) on leks near or within gas field development compared to leks away from gas development. Two data sets were derived in 2013 from all the known leks within the UGRBWGA using the most current aerial imagery. The group of leks referred to as "Disturbed Leks" were those leks within or near (roughly within one mile) active gas field development within the Pinedale Anticline Project Area (PAPA) and the Jonah. The other group of leks referred to as "Undisturbed Leks" used all the remaining leks not included in the Disturbed Leks data set. Note that some leks in the Undisturbed Leks data set may have or had impacts associated with older gas development activities, such as the LaBarge and Deer Hills gas fields. Since the analysis with these two data sets only covers the periods 1997-2014 (same reasons described in the paragraph above), all leks outside the PAPA and Jonah were added to the Undisturbed Leks data set.

The Disturbed Leks data set includes 19 total leks in which 11 (58%) were classified as occupied and 8 (42%) were classified unoccupied in 2014. Of the 11 occupied leks, 11 were checked in 2014 resulting in 5 (45%) of those leks being active. The average peak number of males/lek for occupied leks showed 23% decline from 1997-2014 and a decline of 43% during the period of 2007-2014 (Figure 3).

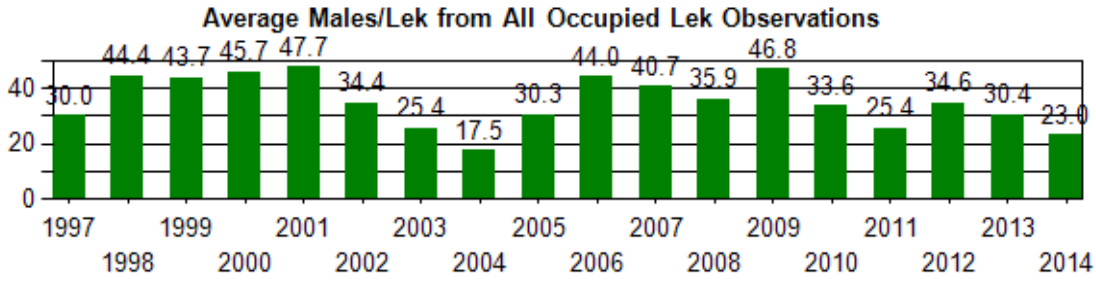


Figure 3. Average Peak Male Sage-grouse Lek Attendance 1997-2014, Disturbed Leks.

The Undisturbed Leks data set includes 130 total leks in which 118 (91%) were classified as occupied and 12 (9%) were classified as unoccupied in 2014. Of the 118 occupied leks, 111 were checked in 2014 resulting in 89 (80%) of those leks being active. The average peak number of males/lek for occupied leks showed 27% increase from 1997-2013 and a decline of 49% during the period of 2007-2013 (Figure 4).

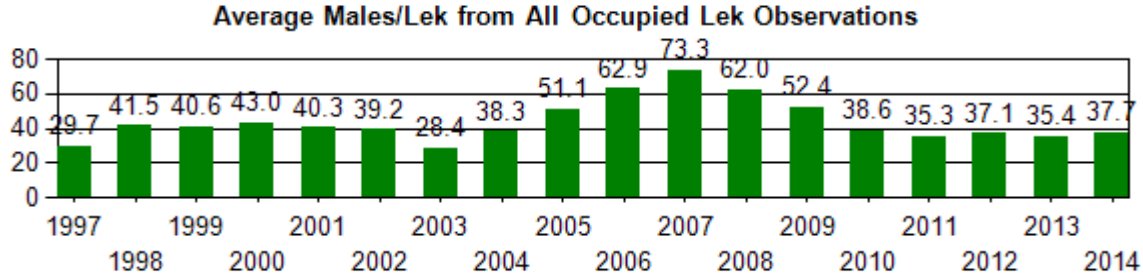


Figure 4. Average Peak Male Sage-grouse Lek Attendance 1997-2014, Undisturbed Leks.

In comparing the two data sets (Disturbed Leks vs. Undisturbed Leks), the average number of peak males/lek for occupied leks reveal similar trends as males declined in early 2000's, increased into the late 2000's, declined in 2010 and 2011, and stabilized somewhat during 2012-2014. The overall changes (both up and down) in male lek numbers are more pronounced with the Undisturbed Leks data set, which is also much more robust (many more leks). The significant 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 83% (1997-2001) to 43% by 2014, a decline of 40 percentage points in active leks. The Undisturbed Leks show activity levels changing very little with an average of 80% (1997-2001) to 78% by 2014 (an decrease of 2 percentage points in active leks), see Figure 5. In addition, a much higher proportion of leks are currently unoccupied (abandoned or destroyed) within or near the PAPA and Jonah gas fields (Disturbed Leks) at 43% compared to 9% outside the PAPA and Jonah as fields (Undisturbed Leks).

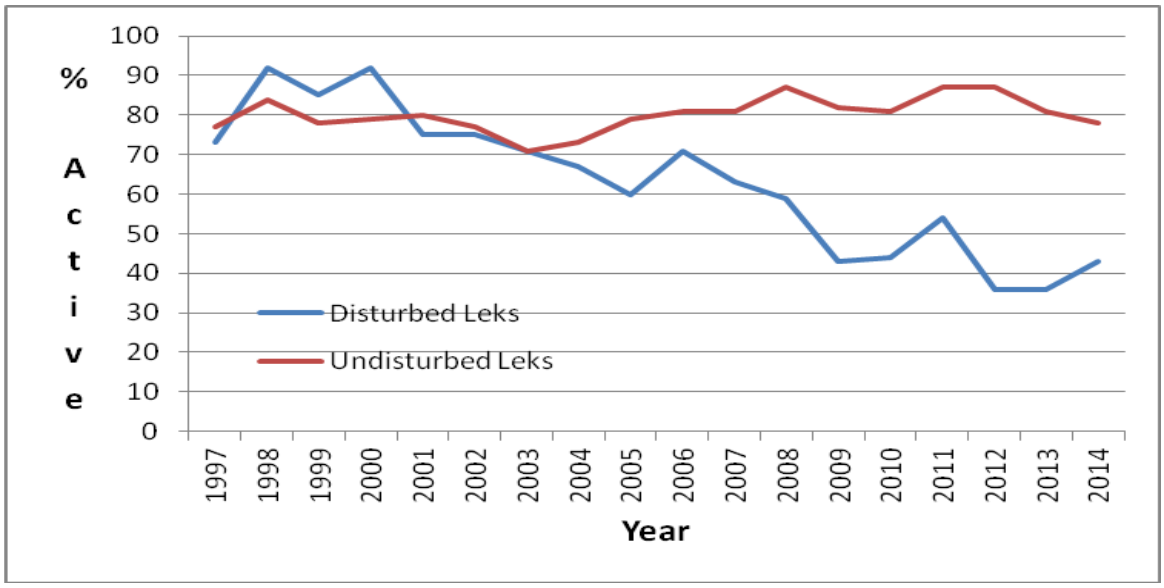


Figure 5. Proportion of active leks 1997-2014, Disturbed Leks verses Undisturbed Leks.

Population Trends and Estimates

No reliable population estimate have be made from data collected during 2014 (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. With the exception of the disturbed leks noted above, the proportion of active leks in the UGRBWGA has remained relatively stable at 75-83% over the last ten years. Thus the average males per lek is a reasonable indicator of population trend over that time.

Harvest

The 2013 sage-grouse season was September 21 through September 30, which allowed a 10-day hunting season. The 2013 season was similar to the 2004 – 2012 seasons. A nine-day hunting season was initiated during both 2002 and 2003. Essentially, hunting seasons since 2002 allowed for 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 2013 were 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) were developed in 2010, in which SGMA D covers all of the UGRBWGA and will be reported that way in future years.

The 2013 harvest survey estimated that 387 hunters bagged 628 sage grouse and spent 848 days hunting. The average number of birds per day was 0.7, the average number of birds per hunter was 1.6, and the number of days spent hunting per hunter was 2.2 during 2013. The harvest trend data indicates there had been similar hunter participation and overall harvest since 2007, although during 2013 hunter participation, harvest, and harvest rates all declined significantly. This decline may be attributed to the shorter season length, inclement weather during the hunting season, and birds less concentrated due to wet summer/fall conditions. Prior to 2010, only a portion (UGBMA 3) of the UGRBWGA was included in the harvest statistics, and that portion of UGBMA 7 was left out of the reported harvest. Starting in 2010, all harvest within the UGRBWGA is now reported in Sage-grouse Management Area D. Harvest rates (# birds/day, # birds/hunter, and # days/hunter) have remained similar the past ten years (2003-2012), while declining in 2013. From 1995 to 2002, overall harvest and harvest rates significantly declined following altered seasons (shortened and moved to a later date). Since 2003, hunter participation has varied from 233-781 averaging 484.

Wing Collections

A total of 18 sage-grouse wing barrels were distributed throughout Sublette County in 2013 within Sage-grouse Management Area D. Barrels were placed prior to the sage-grouse hunting season opener and were taken down following the closing date. Wing collections were typically made following each weekend of the hunting season (collected twice). The primary feathers from these wings are used to determine age and sex based on molting patterns and feather characteristics.

A total of 372 sage-grouse wings were collected from barrels in the UGRBWGA during 2013, which is lower than the 544 wings collected during 2012. The lower 2013 wing sample correlates well with the lower harvest reported in 2013. During the 5-year period prior to 2013, wing collections have ranged from 445 to 547 wings per year. Of the 372 wings collected in 2013, 38% were juvenile birds, indicating a lower proportion of harvest on juveniles compared to 2011 and 2012. The overall composition of wings in 2013 indicated a ratio of 0.8 chicks/hen (adult and yearling females), which is lower than 0.9 chicks/hen in 2012 and 1.4 chicks/hen in 2011. During 2009 and 2010, a low chick/hen ratio of 0.8 was also documented. Four of the past five years (2009-2013) chick survival has been poor, resulting in a slight decline to stable grouse number. The good chick production during 2011 can be attributed to keeping grouse number stable in recent years. This chick/hen ratio from wing collections has provided a good indicator for future grouse population trends, as male lek attendance trends have correlated relatively well with previous year's production (# chicks/hen) data.

Winter Distribution Surveys

Winter sage-grouse surveys were conducted by WGFD personnel in portions of the UGRBWGA during January of 2014, with funds secured through the BLM and natural gas companies. Winter surveys have been conducted annually since 2004 in 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 existing winter concentration areas. Efforts will continue to update sage grouse winter concentration maps as new data becomes available.

Weather Data

Wyoming Climatic Division 3 (Green and Bear Drainage Basin) monthly temperature and precipitation data were obtained from: http://www.ncdc.noaa.gov/cag/time-series/us. A graph was generated comparing 6-month (January-June) average precipitation (Figure 6) which should correlate to forage production during that year. A graph comparing 3-month (April-June) average temperatures (Figure 7) for years 2011-2014 might provide some insight on nest and early brood-rearing success. A 30-year average was also plotted on these graphs to indicate a long range average.

Precipitation during January thru June was above average during 2011, well below average during 2012, below average in 2013, and near average during 2014 (Figure 6). Although the reported 2014 precipitation within this Climatic Division 3 was near the 30-year average (7 inches) during this 6-month period, the UGRBWGA was above average. Temperatures had an inverse relationship to precipitation during these same years (2011-2014) as 2011 and 2014 had below average temperatures (30-year average = 47.4 degrees Fahrenheit), while 2012 and 2013 had above average temperatures for the months of April-June. (Figure 7). Overall, the reported climate data from Division 3 precipitation and temperature trends reflect conditions documented within the UGRBWGA.

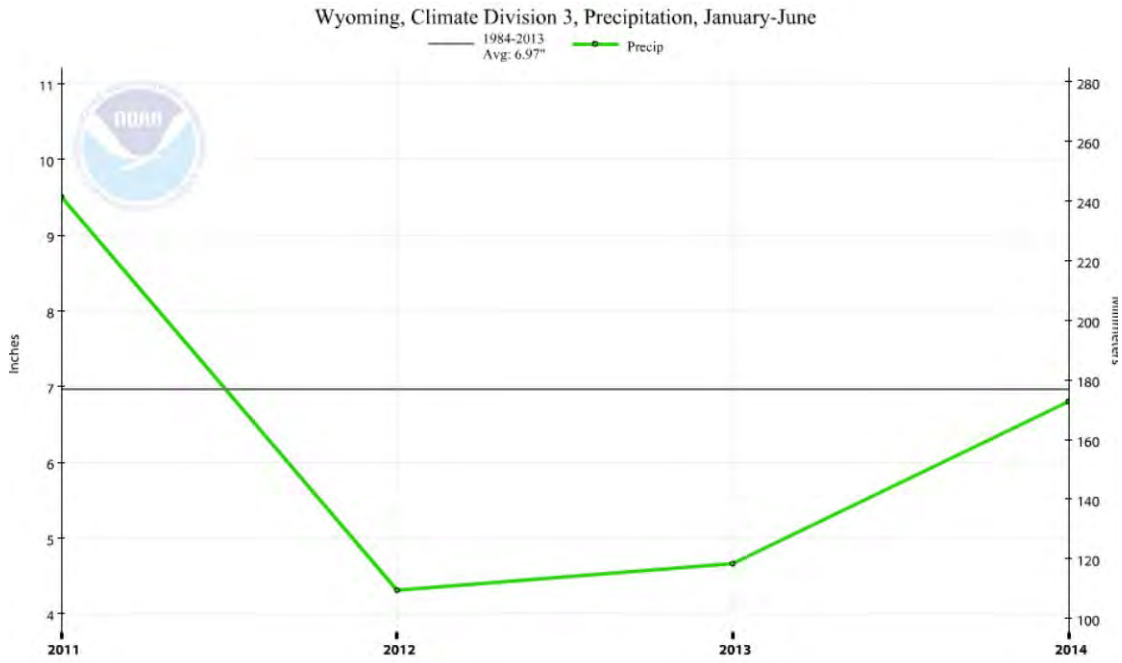


Figure 6. 6-month average (January-June) precipitation for 2011-2014.

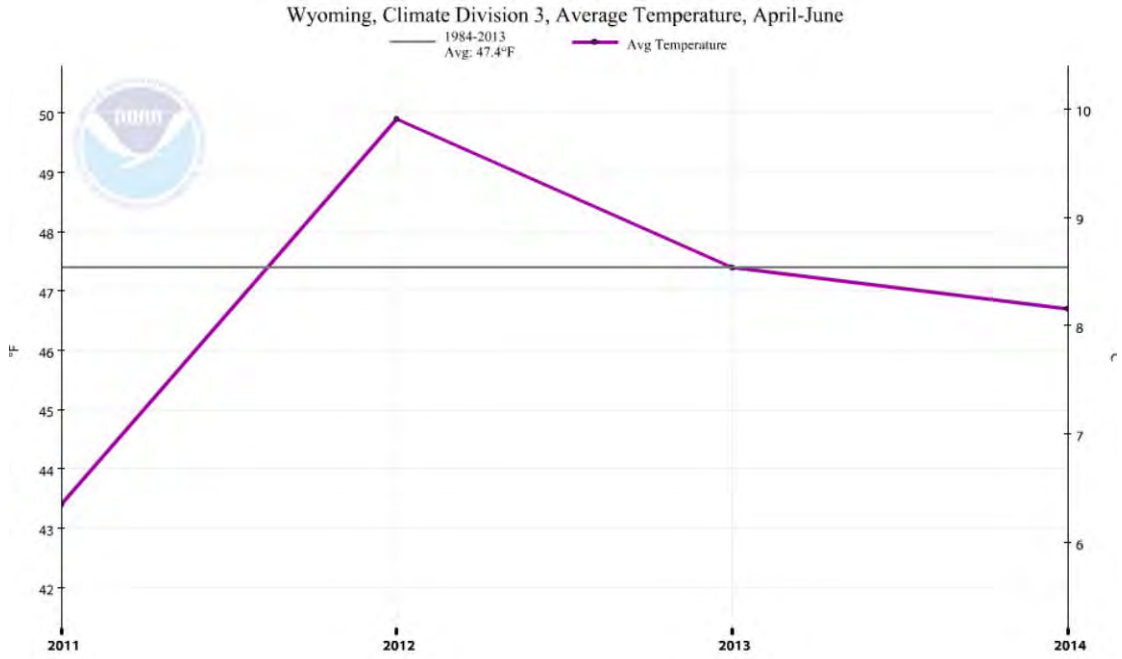


Figure 7. 3-month average (April-June) temperature for 2011-2014.

Special Projects

Sage-grouse Research Projects

From 1998-2009 there have been 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 currently one on-going study (initiated in 2013) looking into the significance of geophagy (consumption of soil) by sage grouse within the UGRBWGA. Nine verified locations have been documented where grouse are seeking out areas to ingest soil. Efforts to locate additional geophagy sites are underway using mapping efforts, winter grouse location data, and gps transmittered sage grouse. Soil samples from these geophagy sites have and will continue to be collected and analyzed. The Objectives of this study are:

Objective 1: Determine if soil characteristics at areas where geophagy has been documented differ from those of other available soils and food items.
Objective 2: Document and verify additional geophagic locations in southwestern Wyoming frequented by sage-grouse.
Objective 3: Map in a GIS the distribution of potential geophagy sites throughout the UGRB and potentially southwest Wyoming.
Objective 4: Assess how important the availability and distribution of geophagy sites are to sage-grouse selection of winter habitats.

Sage-Grouse Working Group

The Upper Green River Basin Sage-grouse Working Group was formed in March of 2004. The group is comprised of representatives from agriculture, industry, sportsmen, public at large, conservation groups, and government agencies (federal and state). The purpose of the UGRB Working Group is to work towards maintaining or improving sage-grouse populations in the Upper Green River basin. The group is directed to formulate plans, recommend management actions, identify projects, and allocate available funding to support projects that will benefit sage-grouse. A local sage-grouse plan (Upper Green River Basin Sage-Grouse Conservation Plan) was finalized in May of 2007 and can be found on the WGFD website (http://wgfd.wyo.gov/). This Plan identifies past, proposed, and ongoing projects; recommended management activities; funding sources; and other relevant sage-grouse information within the Working Group Area intended to maintain and/or increase sage-grouse populations. The Working Group recently completed an addendum to this 2007 Conservation Plan (Upper Green River Basin Sage-Grouse Conservation Plan Addendum – 2014) that provides updated information on activities, projects, and management strategies within the UGRBWGA, which can also be found at http://wgfd.wyo.gov/. A new appropriation of State monies was approved for sage grouse projects during 2015 and 2016 to be allocated by UGRB Working Group on local conservation measures that benefit sage grouse. Raven control and cheatgrass inventory

projects continue to accounted for the majority of allocated funds granted to the UGRB Working Group in recent years.

Management Summary

Data collected and reported in this 2013 Sage-Grouse Job Completion Report (June 2013 thru May 2014) gives insight to population trends. Analysis of the past years of data indicates that the sage-grouse populations steadily increased from 2003 to 2007, dropped slightly in 2008, continued to decline through 2011, and stabilized through May of 2014. Lek trend data indicate grouse populations were at the lowest level in 2003.

Lek monitoring in the UGRBWGA showed a 149% increase in the peak number of males per lek from 2003 to 2007 as males increased from 27.8 males/lek to 69.3 males/lek. This trend has reversed since 2007, as the number of males/lek has declined by 47% dropping to 36.4 males/lek by spring of 2014. Sage-grouse leks within developing gas fields continue to show declines and lek abandonment regardless of lek trends outside of gas development, indicating negative impacts to leks and populations in and near natural gas fields.

Sage-grouse hunting season dates, season length, and bag limits have remained similar since 2002, running from late September to early October for 9-14 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. With grouse numbers steadily increasing from 2003-2007 and declining since 2007, the progression of hunter participation was expected to show similar trends. . Variation in hunter participation can be affected by hunting season structure, weather conditions, especially during the current short seasons, as well as hunter perceptions of sage-grouse population status.

Wing collection from wing barrels (drop locations) continue to provide good sample sizes to determine overall chick survival trends within the UGRBWGA. During 2008-2012 wing collections ranged from 31% to 45% of the reported harvest. Although the sample size declined by 172 wings in 2013, wing collections accounted for 59% of the reported harvest due to the low reported harvest (628 grouse) in 2013. These annual wing samples can vary significantly based on weather conditions affecting hunter participation, especially during the weekend days of hunting season. Overall, wing trends have not shown a good correlation between trends in sample sizes and harvest, but do provide 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 direct 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 1.4 chicks/ hen has shown stable attendance, and a chick/hen

ratio greater than 1.4 has shown increases in lek attendance in the UGRBWGA. During the past 7 years (2007-2013 average ratio of chicks/hen average was 0.94 correlating with a 47% decline in the peak number of males on leks since 2007.

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 since 2007 with some stabilization in recent years. Good to above average spring precipitation during 2008-2011 has led to good herbaceous production, which should have helped turn around the recent declining trends in the UGRBWGA. Although, 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 some of the better habitat production documented in quite some time, 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.

The sage-grouse population in the UGRBWGA appears to be showing some fluctuation attributed to natural influences, such as spring precipitation and temperature. On a more localized level, the current amount and rate of natural gas development in the Upper Green River Basin has and will continue to impact sage-grouse habitat and local populations. Lek monitoring data has shown lower male attendance and in several cases total bird abandonment on leks within and adjacent to developing gas fields. Sage-grouse studies and research in the UGRBWGA has also documented impacts to grouse from gas development. Direct, indirect, and cumulative impacts to sage-grouse from gas and residential development will continue to challenge managers to maintain current grouse numbers.

Recommendations

1. Continue to monitor sage-grouse leks and look for new 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 seasonal range maps (breeding, summer/fall, and winter) to aid land managers in protecting and maintaining important sage-grouse habitats.
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.

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.

Sage Grouse Job Completion Report

Year: 2005 - 2014, 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)
2005	101	75	74	2999	50.0
2006	106	75	71	3953	63.8
2007	111	78	70	4329	69.8
2008	111	79	71	3721	53.9
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	131	116	89	3125	34.3
2014	129	110	85	3206	37.3

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2005	101	19	19	655	40.9
2006	106	22	21	827	48.6
2007	111	27	24	1354	67.7
2008	111	24	22	1414	78.6
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	179	44.8
2013	131	9	7	291	36.4
2014	129	13	10	248	27.6

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: 2005 - 2014, 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)
2005	101	94	93	3654	48.1
2006	106	97	92	4780	60.5
2007	111	105	95	5683	69.3
2008	111	103	93	5135	59.0
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	3693	36.9
2013	131	125	95	3416	34.5
2014	129	123	95	3454	36.4

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2005	74	20	0	94	78.7	21.3
2006	79	18	0	97	81.4	18.6
2007	82	22	1	104	78.8	21.2
2008	87	16	0	103	84.5	15.5
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	99	26	0	125	79.2	20.8
2014	97	26	0	123	78.9	21.1

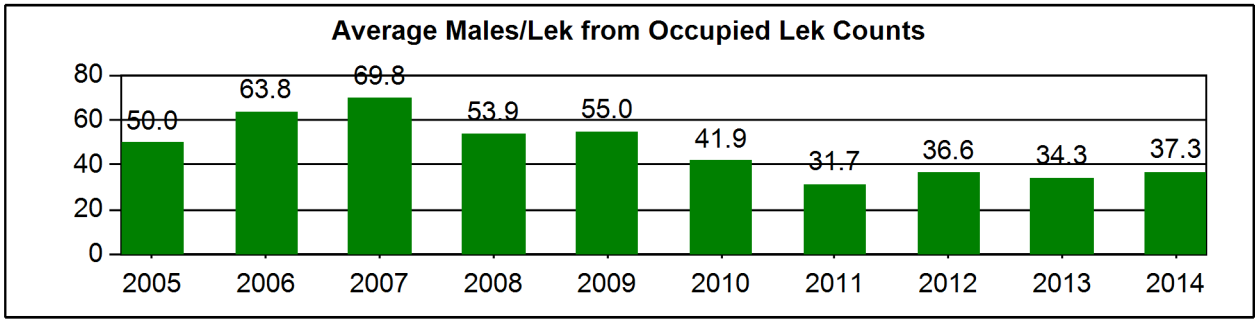
1) Occupied - Active during previous 10 years (see official definitions)

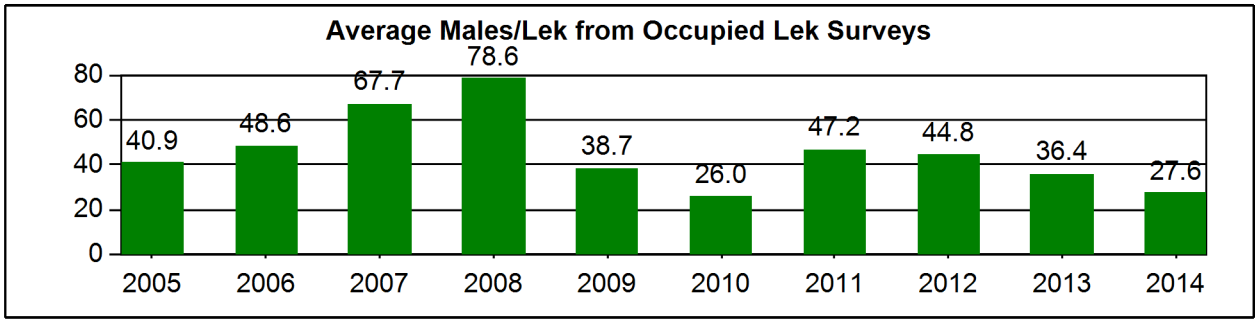
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

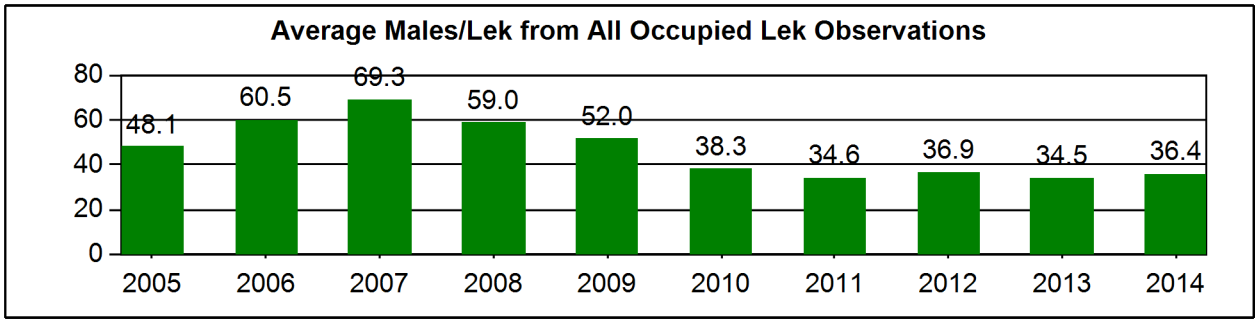
3) Inactive - Confirmed no birds/sign present (see official definitions)

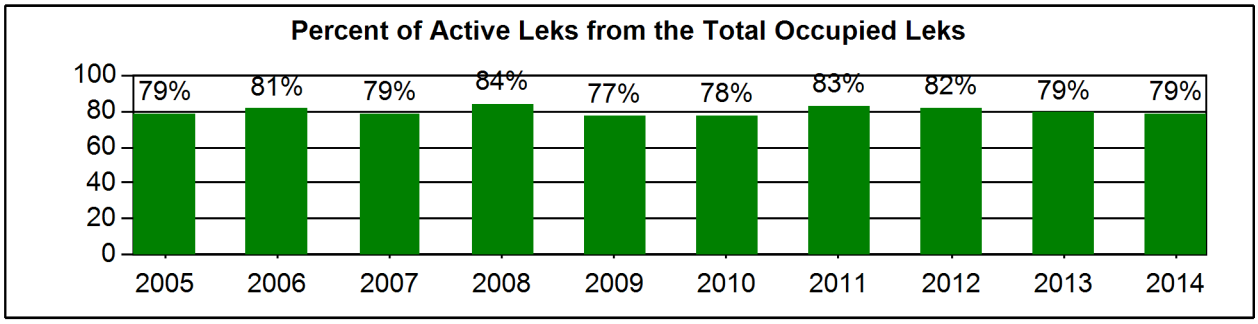
Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Upper Green River



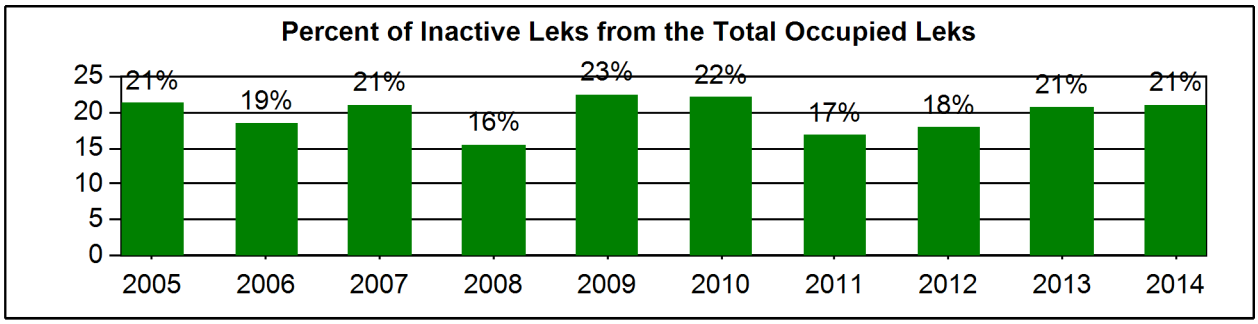






Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Upper Green River



Sage Grouse Lek Characteristics

Working Group: Upper Green River

Region	Number	Percent
Pinedale	149	100.0

Working Group	Number	Percent
Upper Green River	149	100.0

Classification	Number	Percent
Occupied	129	86.6
Unoccupied	20	13.4

BLM Office	Number	Percent
Pinedale	138	92.6
Rock Springs	11	7.4

Biologist	Number	Percent
Pinedale	78	52.3
South Jackson	71	47.7

Warden	Number	Percent
Big Piney	76	51.0
North Pinedale	14	9.4
South Pinedale	59	39.6

County	Number	Percent
Lincoln	2	1.3
Sublette	147	98.7

Land Status	Number	Percent
BLM	121	81.2
Private	18	12.1
State	10	6.7

Management Area	Number	Percent
D	149	100.0

Sage Grouse Job Completion Report

Year: 2004 - 2014, Management Area: D

4. Sage Grouse Hunting Seasons and Harvest Data

a. Season

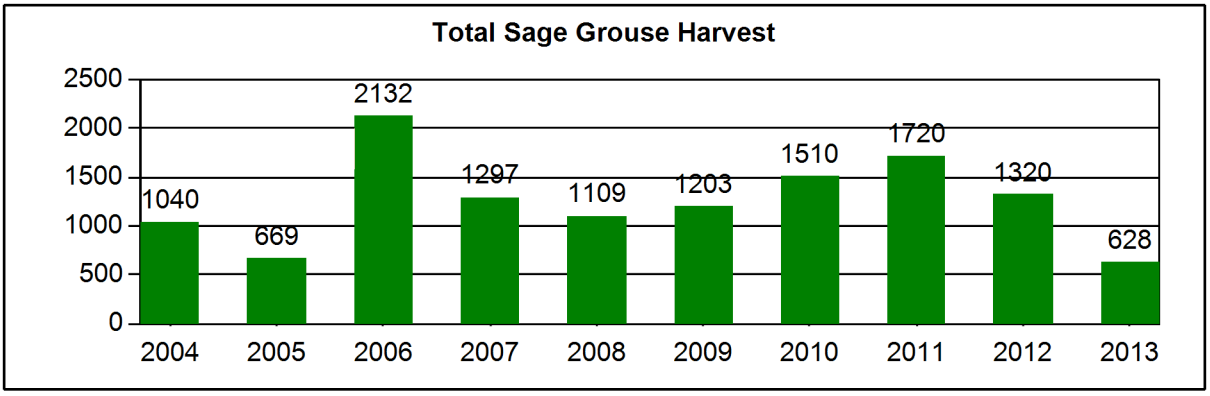
Year	Season Start	Season End	Length	Bag/Possesion Limit
2004	Sep-23	Oct-3	11	2/4
2005	Sep-23	Oct-3	11	2/4
2006	Sep-23	Oct-3	11	2/4
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4
2011	Sep-17	Sep-30	14	2/4
2012	Sep-15	Sep-30	16	2/4
2013	Sep-21	Sep-30	10	2/4

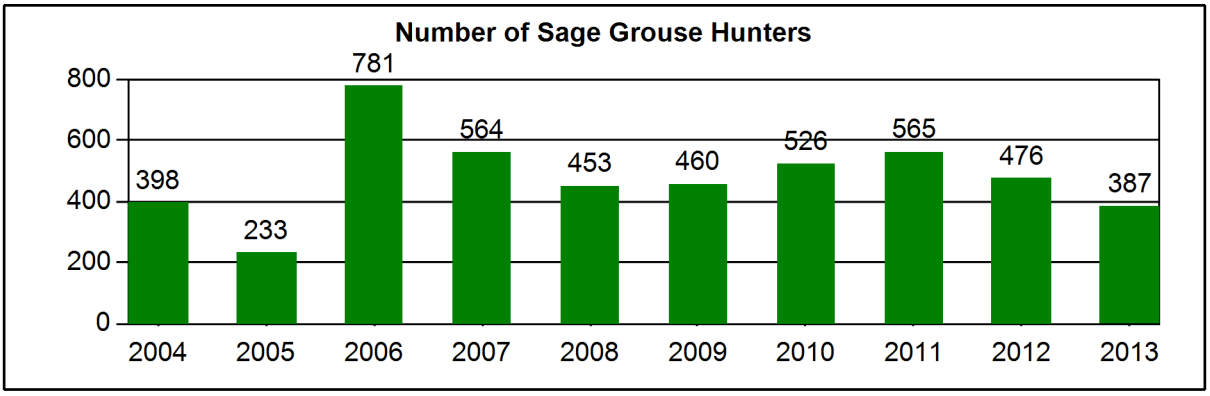
b. Harvest

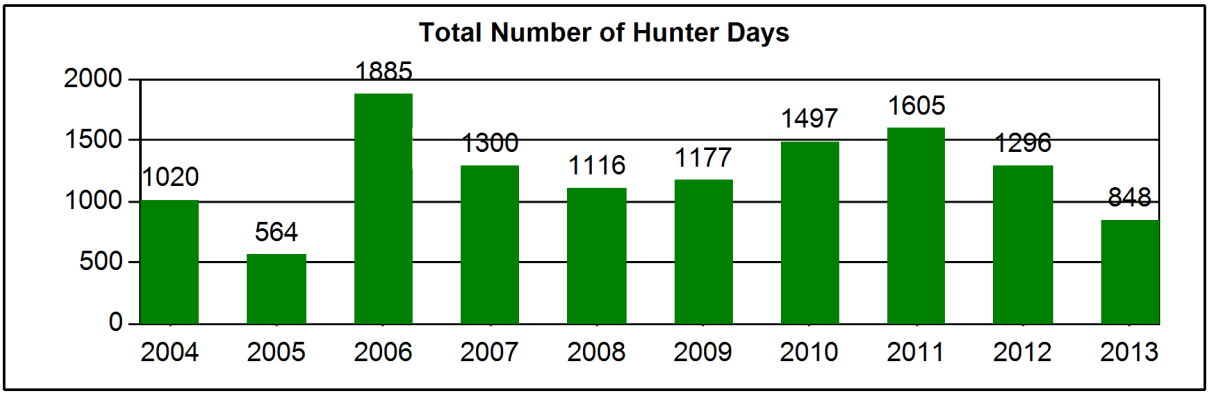
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2004	1040	398	1020	1.0	2.6	2.6
2005	669	233	564	1.2	2.9	2.4
2006	2132	781	1885	1.1	2.7	2.4
2007	1297	564	1300	1.0	2.3	2.3
2008	1109	453	1116	1.0	2.4	2.5
2009	1203	460	1177	1.0	2.6	2.6
2010	1510	526	1497	1.0	2.9	2.8
2011	1720	565	1605	1.1	3.0	2.8
2012	1320	476	1296	1.0	2.8	2.7
2013	628	387	848	0.7	1.6	2.2
Avg	1,263	484	1,231	1.0	2.6	2.5

Sage Grouse Harvest Summary

Management Area: D

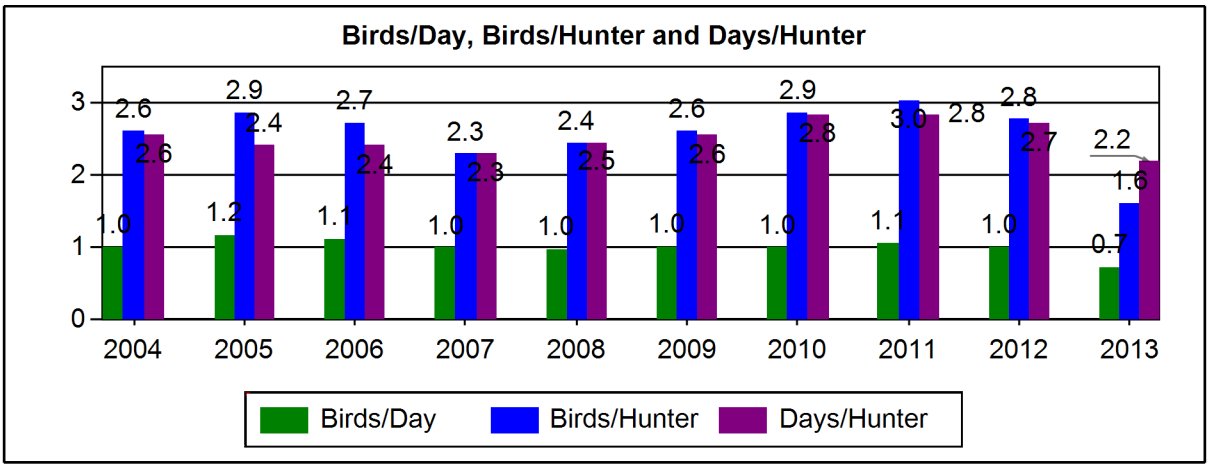






Sage Grouse Harvest Summary

Management Area: D

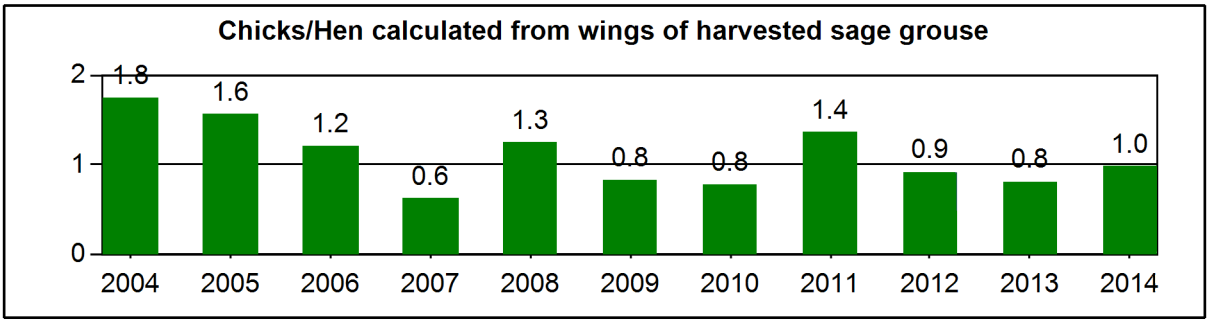


Sage Grouse Job Completion Report

Year: 2004 - 2014, Management Area: D

5. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
2004	402	11.7	28.6	0.5	3.2	28.6	27.4	1.8
2005	537	17.7	23.3	3.4	7.4	19.0	29.2	1.6
2006	421	15.4	28.7	3.6	7.8	20.9	23.5	1.2
2007	485	20.0	39.2	2.3	8.5	13.6	16.5	0.6
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



Upper Snake River Basin
Sage-Grouse
Job Completion Report
2013

June 2013-May 2014

Alyson Courtemanch
Wyoming Game & Fish Dept.
Jackson Region

Species: Sage Grouse
Period Covered: June 1, 2013 – May 31, 2014
Management Areas: A
Working Group Area: Upper Snake River Basin
Prepared by: Alyson Courtemanch

Introduction

With establishment of eight Sage Grouse Working Groups throughout the state in 2004, Sage Grouse Job Completion Reports (JCR) were revised to Working Group Areas and not Wyoming Game and Fish Department Regions. Until 2010, the Upper Snake River Basin Working Group (USRBWG) included Game Bird Management Areas (GBMA) 1 (Gros Ventre and Jackson Hole) and 2 (Hoback Basin and Star Valley). However upland game management areas were revised in 2010 and the Upper Snake River Basin Conservation Area (USRBCA) was designated as Area A, which is covered in this report

The initial role of the USRBWG was to develop and facilitate implementation of a local working group plan for the benefit of sage-grouse and, whenever feasible, other species that use sagebrush habitats. The 2008 Conservation Plan identified management practices for the purposes of improving sage-grouse numbers and maintaining a viable population in entire Snake River Basin in Teton, Lincoln, and Sublette counties in Wyoming. Specifically the plan addressed management of four small, isolated populations in Jackson Hole, the Gros Ventre Drainage, Hoback Basin, and an interstate population shared by Wyoming and Idaho in the Salt River drainage. The 2008 Plan was revised in 2014 to reflect current policy for sage-grouse conservation under Wyoming Executive Order 2011-5 and other relevant information. The 2014 Plan was approved by the Wyoming Game and Fish Commission in February 2014. The plan is available at:
http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/SG_USR_CONSERVPLAN0005529.pdf

Only lek monitoring data is presented in this report. Due to the size of the population in the Upper Snake River Basin, no productivity data or sex/age composition data were collected during 2013. The entire area has been closed to hunting since 2000.

Plan Area

The USRBCA includes the entire Snake River drainage basin in Wyoming including the major tributaries of the Gros Ventre, Hoback and Salt River drainages. The area boundary encompasses almost all of Teton County and small portions of Sublette and Lincoln Counties (Figure 1).

The occupied sage-grouse habitat in the plan area is primarily sagebrush grassland habitat in the valley floor and foothills of Jackson Hole, Hoback Basin, Gros Ventre River Drainage, and in the western foothills of Star Valley. Much of the remainder of the working group area is forested habitat that is not occupied by sage-grouse. The core population in Jackson Hole is found primarily in Grand Teton National Park (GTNP) and on the National Elk Refuge (NER). Sage-grouse also use some of the foothill areas on the Bridger-Teton National Forest and private land on East and West Gros Ventre Buttes. The Jackson population was designated as a core area by the Governor's Sage-grouse Implementation Team (SGIT) in August 2008. The boundaries of

the core areas were revised in 2010 by the SGIT, with input from the local working groups (Figure 2).

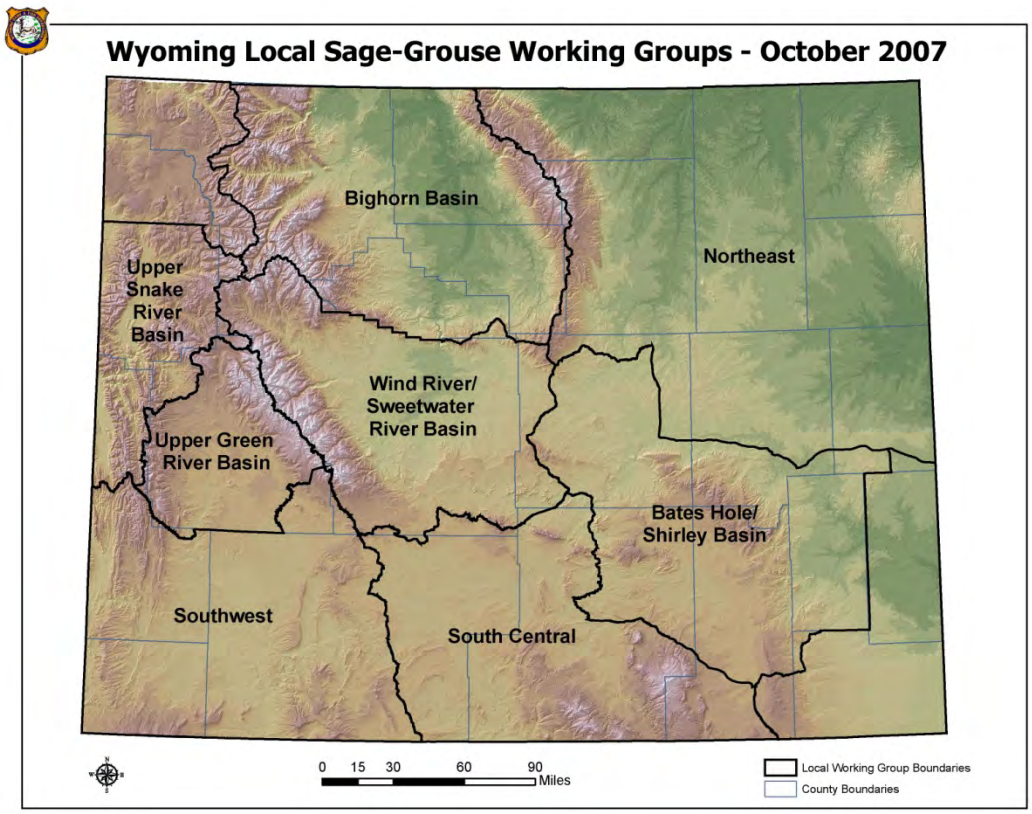


Figure 1. Wyoming local sage-grouse working group boundaries.

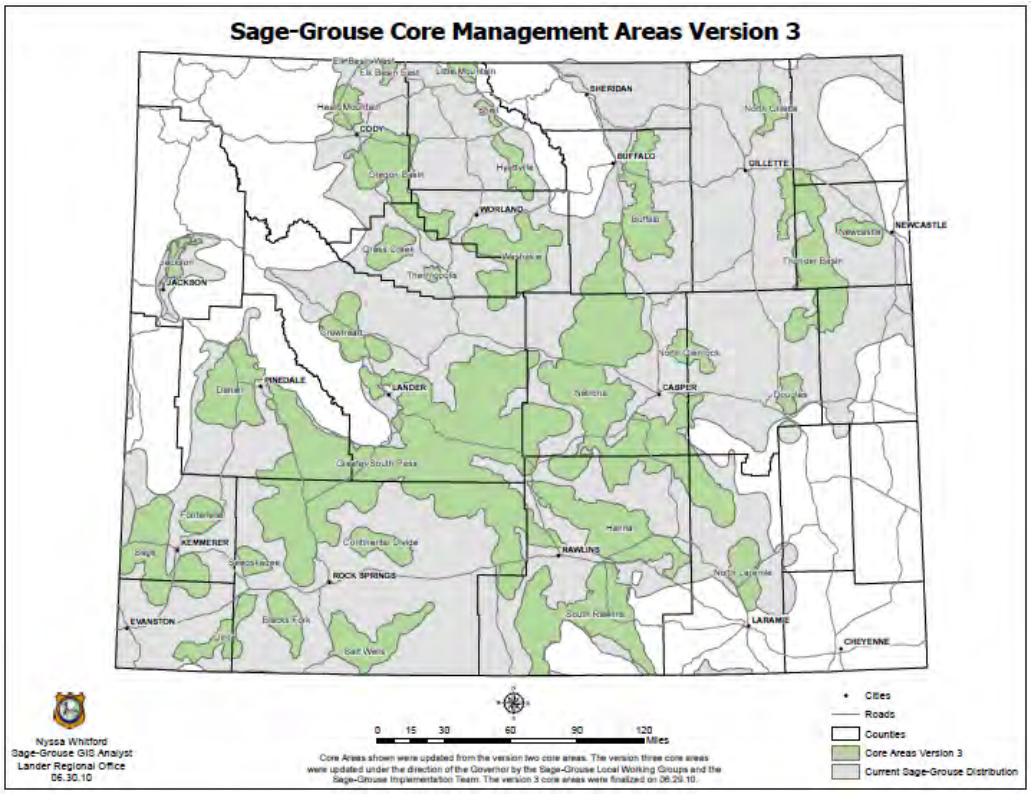


Figure 2. Wyoming Sage-Grouse Core Areas.

Sage-grouse in Jackson Hole are non-migratory and genetically isolated from surrounding populations (Schulwitz et al. 2014). There is evidence of one-way genetic interchange from the Jackson Hole segment to the Gros Ventre Drainage segment, but no interchange with Pinedale populations (Schulwitz et al. 2014). In the Hoback Basin, a lek was discovered in the Clark Draw area in April 2010. A small population of sage-grouse use habitat associated with the Gannet Hills in Wyoming and Idaho along the western edge of Star Valley. There are three leks located in Idaho in the Crow Creek and Stump Creek drainages near the Wyoming-Idaho state line.

Lek Monitoring

Traditionally, sage-grouse data collection within the USRBCA has focused on lek surveys and the age and sex composition of harvested birds. 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 lek complex and the leks in the Gros Ventre drainage constitute a second lek complex. No marked birds from the Gros Ventre leks have appeared on the Jackson Hole leks (Holloran and Anderson 2004, Bryan Bedrosian pers. com.) 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 1989 through 2014. 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. The distribution of leks in the USRBCA is displayed in Figure 3.

Table 1 summarizes the high count of males on each lek over the survey period and the average high count of males across active leks. 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. However data collected in the early years have only been reported as the high count on each lek and the summary in Table 1 is presented in this manner for comparative purposes. We presume the trends in the population based on these counts still mimic actual trends in the population. Similar trends are observed in the report using the conventional analysis provided by the WGFD sage-grouse database report.

There are 16 occupied and historic sage-grouse leks reported in Table 1. Thirteen leks are considered to be occupied and three appear to be unoccupied historic leks within the plan area (3 Bar H/Circle EW, Antelope Flats, and Beacon). 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. The McBride lek is classified as occupied but has only been active on a sporadic basis in recent years (one male in 2007) and warrants additional scrutiny. 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 Cottonwood lek in the Gros Ventre drainage (reported in the 2006-2007 annual report) was dropped as a lek since birds were only observed there once. However, researchers suspect there may be an additional unconfirmed lek near the Fish Creek Elk Feedground and additional searches in the Gros Ventre drainage are warranted (Bryan Bedrosian pers. com).

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 in 2008 - 2014.

During research activities in 2008, a lek was located in the Pot Holes 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 8 males in 2014.

The Clark Draw lek was discovered in the Hoback Basin in April 2010. The lek has been active for the past 5 years. In 2014, 7 males were counted (Table 1).

Of the 16 leks in the USRBCA, 13 were checked in 2014. Ten leks had grouse present and three leks did not have birds (Antelope Flats, Simpson, and Dry Cottonwood). Three leks were not checked during the 2014 season (3 Bar H/Circle EW, Beacon, and McBride).

It must be noted that lek data in Table 1 must be interpreted with caution (as with all sage-grouse lek data) 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 found; 3) sage-grouse populations can exhibit cyclic patterns over approximately a decade; 4) the effects of unknown or unmonitored leks that have become active or inactive cannot be quantified; 5) lek sites may change over time; 6) not all males attend leks on any day or within a lekking season: 7) lek data collected in GTNP from 1952 through 1985 is missing from the agency files and no record has been found from other sources; and 8) in some years it appears that lek and satellite lek data were combined (i.e. Beacon and Airport leks, Moulton East and Moulton West leks, Bark Corral East and West leks, and North Gap and Simpson leks) and it is uncertain in some years if both of these paired leks were surveyed since only a total count is presented for one of the paired leks. However, in some years prior to 2000 it appears totals may have been lumped.

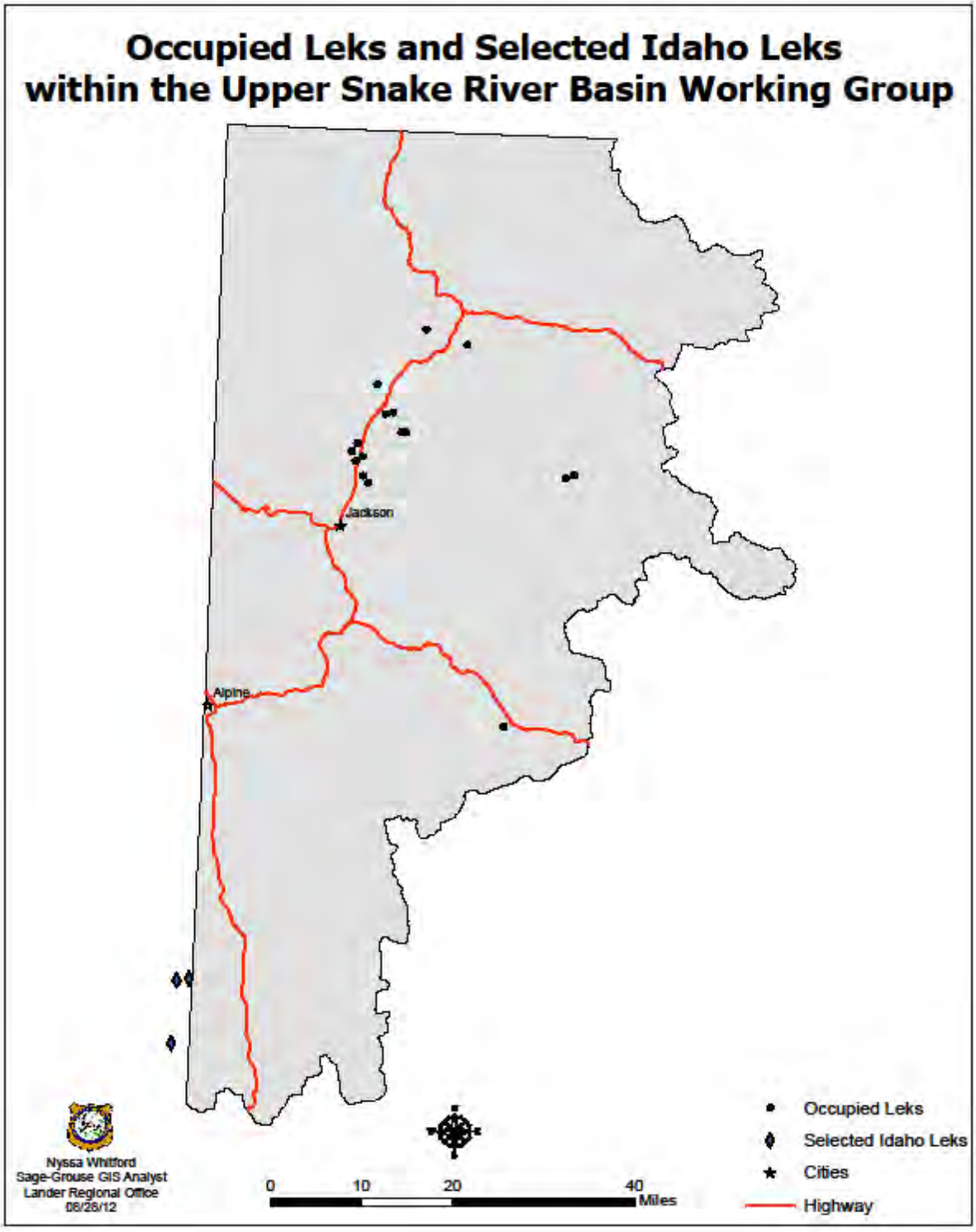


Figure 3. Occupied leks in the Upper Snake River Basin Working Group Area and adjacent selected leks in Idaho.

Table 1. Maximum male counts at sage-grouse leks in the Upper Snake River Basin Conservation Area, 1989-2014 (unpublished data from Grand Teton National Park and Wyoming Game and Fish Department).

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
1989	30			NC	21	7	91		6		8	NC					163	27.2
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

**new lek in 2008 with multiple obs.

***Bark Corral lek has 2 activity centers which may be separate leks. In the past, birds have been observed at both sites but observations have been combined in this report.

Population Trends and Estimates

No reliable method for estimating the sage-grouse population for the USRBCA exists at this time. Both the number of leks and the number of males attending those leks must be accurately quantified in order to estimate the number of males in the population, population size and population trend. 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 and has since varied between 14 and 20 (Figure 4). During the past 10 years, there has been a declining trend, although 2013 and 2014 counts showed improvement (Figure 4). However, this trend appears to be skewed by the addition of newly discovered leks (5 new leks discovered in the past decade). These leks have likely existed all along, but were unknown until recent years when survey and research efforts have increased. Trends in peak males are different when considering only the three main leks (Moulton, Airport, and North Gap) that have been consistently surveyed since 1989 (Figure 5). These data indicate a decline in the early 1990's, a modest rebound by 2006, followed by a decline through 2009, and then an increasing trend during the past five years (Figure 5).

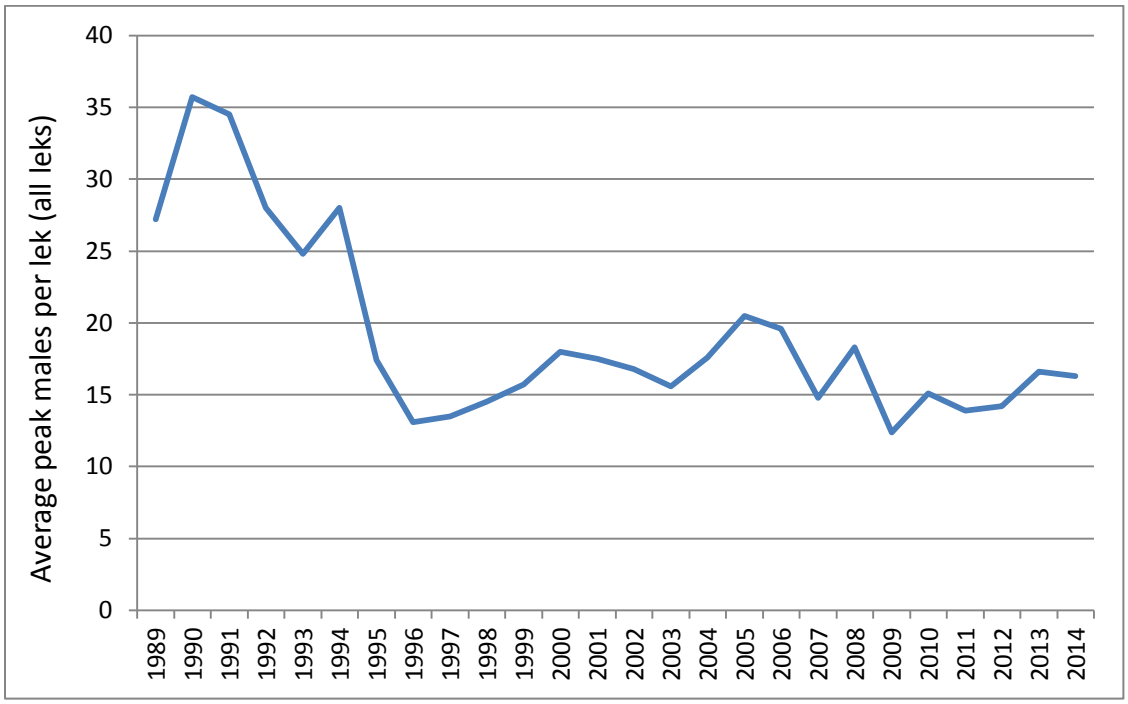


Figure 4. Average peak male counts for all leks in the Upper Snake River Basin Conservation Area, 1989-2014.

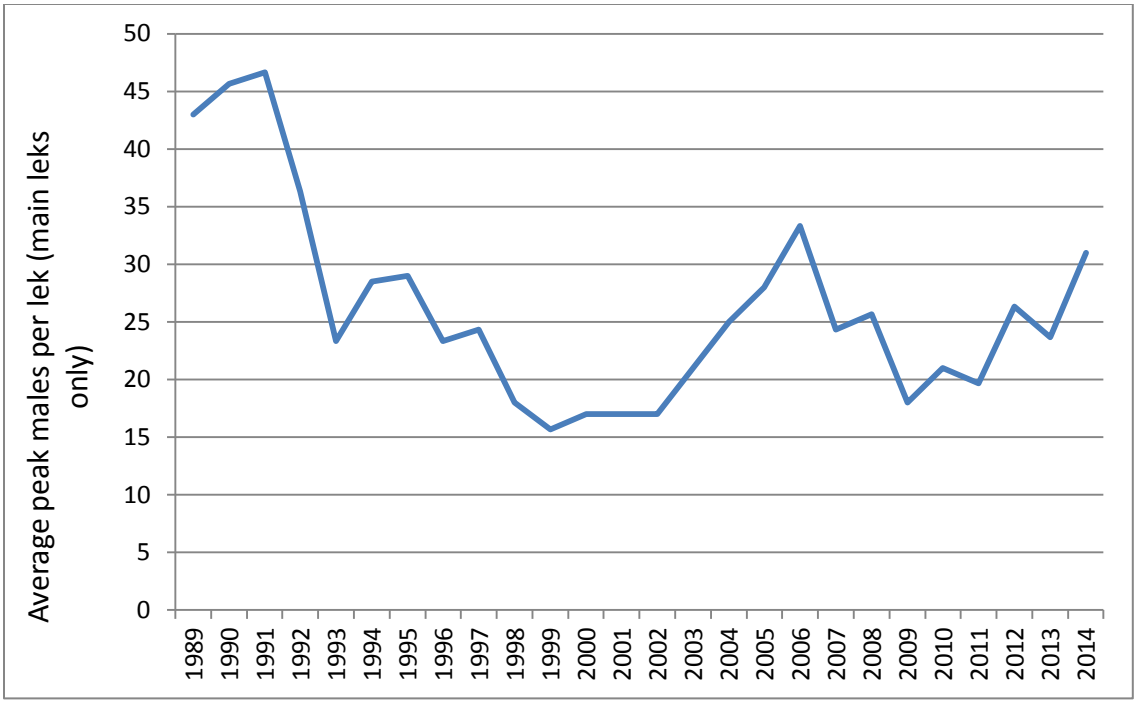


Figure 5. Average peak male counts for three main leks only (Moulton, Airport, and North Gap), 1989-2014.

A new statewide sage-grouse database was developed in 2012 in order to improve efficiency, reduce errors, and better facilitate data analysis. Changes were made to the manner in which lek data are calculated and reported (Table 2). The new version is based solely on "occupied" leks. The past version included unoccupied leks that were monitored. The result of this change is that the number of "known occupied" leks is now more accurate, but may reflect fewer leks than in the previous version. Similarly, the new version calculates average male lek attendance using only monitoring observations where one or more male grouse were observed strutting. The old version included a count of "0" males for leks where activity was confirmed by the presence of sign but no birds were observed. Together, these two changes result in somewhat higher, but more accurate, average male attendance for active leks than previously reported. The changes do not result in any change in population trend based on average male lek attendance. Interpreted population increases and decreases over time remain the same so no revisions to past reports are required.

Table 2. Lek attendance and lek status for leks in the USRBCA 2005 - 2014.

Year: 2005 - 2014, Working Group: Upper Snake River Basin

Lek Attendance Summary (Occupied Leks)

Leks Checked

Year	Occupied	Checked	Percent Checked	Peak Males	Avg Males / Active Lek
2005	11	9	82	123	20.5
2006	11	11	100	157	19.6
2007	11	10	91	133	14.8
2008	13	13	100	165	16.5
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

Lek Status

Year	Active	Inactive	Unknown	Known Status	Percent Active	Percent Inactive
2005	6	1	4	7	85.7	14.3
2006	8	2	1	10	80.0	20.0
2007	10	2	1	12	83.3	16.7
2008	11	1	1	12	91.7	8.3
2009	10	2	1	12	83.3	16.7
2010	10	4	0	14	71.4	28.6
2011	8	5	1	13	61.5	38.5
2012	11	4	1	15	73.3	26.7
2013	10	4	2	14	71.4	28.6
2014	10	3	3	13	76.9	23.1

Since only "occupied" leks are being reported in Table 2, 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 no longer being reported since our data collection techniques are not designed to accurately capture these data and is therefore not useful in assessing population trend.

Data from the most recent 10 year period suggests that the sage-grouse population declined from 2005-2009 in the USRBCA, but has slowly increased during the past 5 years. In 2014, the peak number of males was 163 cocks which is higher than the number of males observed in 2013 (149) and higher than the 2004 – 2013 average (135 males). Despite small increased in recent years, the long term persistence of this population is of paramount concern to the local working group and resource managers.

Productivity

During 2014, no productivity data were collected on this population.

Harvest

Most of the USRBCA has been closed to hunting since the establishment of GTNP 1929. No hunting for sage-grouse has been allowed on lands under the jurisdiction of GTNP or the NER. In 2000, the hunting season was closed in the entire WSRBWGA and remains so today.

Habitat Protection

In 2008, Governor Freudenthal issued Executive Order 2008-2 establishing core areas and stipulations to protect sage-grouse habitat and populations in those core areas. Following the release of the "warranted but precluded" listing decision by the U.S. Fish and Wildlife Service in 2010, the governor issued a new executive order to replace that from 2008. Then, newly elected Governor Matt Mead issued his own executive order in 2011 which reiterated and further clarified the intent of the Core Area Policy. The current Executive Order and Core Area Policy can be found on the WGFD website. Most of the Jackson Hole population's habitat was designated a core area while the remainder of the small sage-grouse populations in the USRBCA fell into the non-core area designation.

No wildfires or prescribed burns occurred in sagebrush habitat in sage-grouse core areas within the USRBCA this year. There were no significant human developments or surface disturbances in core areas this year.

Special Projects

Jackson Hole Airport Wildlife Hazard Management Plan

SUMMARY
Concern has been expressed by the Federal Aviation Administration (FAA) and the Jackson Hole Airport Board over the presence of sage-grouse around the airport and the potential for collisions between aircraft and sage-grouse, which has implications for human safety and economic losses resulting from damaged aircraft. Thirty-two plane strikes with sage-grouse are reported in the FAA's national database at Jackson Hole Airport between 1994 and 2012. Five of these reported strikes occurred in March, 24 occurred from June through September during the brood rearing period, and three occurred from October through December.

Safety issues related to the potential for sage-grouse strikes with airplanes arriving or leaving the airport has prompted the FAA to require the Jackson Hole Airport to create a Wildlife Hazard Management Plan. This plan creates an action plan and mitigation measures for the Jackson Hole Airport to reduce airplane strike risk with all wildlife, but emphasis is placed on sage-grouse given the lek proximity and historical strikes. The FAA is tasked with managing all wildlife risks within 10

miles of the airport perimeter, but GTNP also has jurisdiction over wildlife within that region. This led to a highly collaborative project between many stakeholders, including the local working group, to create a management plan for the Jackson Hole Airport.

Sage steppe plant community restoration in abandoned smooth brome dominated hayfields in Grand Teton National Park

Ken Stella, 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. The park has initiated restoration treatments on 875 acres of abandoned hayfields. These include the Elbo East and Elbo West Units near the Teton Science Schools, the Hunter and Aspen Units, and the Henrie unit. Smooth brome removal and restoration of native sagebrush steppe plant communities is a multi-year and multi-stage process. Generally, removal of smooth brome and other exotic plants is the first stage. Removal can include two or three stages: 1) use of prescribed fire to remove dense thatch accumulations, 2) herbicide applications following fire, and 3) secondary herbicide applications, if necessary. Following smooth brome removal the land is seeded with native seed. National Park Service policy dictates that all seed applied in park lands is native and originates from locally occurring genetics. Thus, seed used in this type of restoration originates from hand collections in the park. Following seeding of native seed in the restoration areas the fields are monitored via transect and quadrat monitoring to track seeded species survivorship and success. Also following seeding, non-native grass and forb species are controlled with manual and chemical treatments while native plants are developing.

Low neutral genetic diversity in an isolated greater sage-grouse (*Centrocercus urophasianus*) population in northwest Wyoming

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ABSTRACT
Habitat loss is well recognized as an immediate threat to biodiversity. Depending on the dispersal capabilities of the species, increased habitat fragmentation often results in reduced functional connectivity and gene flow followed by population decline and a higher likelihood of eventual extinction. Knowledge of the degree of connectivity between populations is therefore crucial for better management of small populations in a changing landscape. A small population of greater sage-grouse (*Centrocercus urophasianus*) exists in northwest Wyoming within the Jackson Hole valley, including GTNP and the NER. To what degree the Jackson population is isolated is not known as natural dispersal barriers in the form of mountains and anthropogenic habitat fragmentation may limit the population's connectivity to adjacent populations. Using 16 microsatellite loci and 300 greater sage-grouse samples collected throughout Wyoming and southeast Montana, significant population differentiation was found to exist among populations. Results indicated that the Jackson population was isolated relative to the other sampled populations, including Pinedale, its closest neighboring large population to the south. The one exception was a small population immediately to the east of Jackson, in which asymmetric dispersal from Jackson into Gros Ventre was detected. Both Jackson and Gros Ventre populations exhibited significantly reduced levels of neutral genetic diversity relative to other sampled populations. More work is warranted to determine the timing at which Jackson and Gros Ventre populations had become isolated and whether it was primarily due to recent habitat fragmentation or more historic processes. Due to its small population size, continual monitoring of the population is recommended with the goal of at least maintaining current population size and, if possible, increasing suitable habitat and population size to levels recorded in the past.

Geophagy and movements of sage-grouse in the Hoback and Upper Green River drainages

Bryan Bedrosian, Craighead Beringia South
Gary Hanvey, Bridger-Teton National Forest
Dale Woolwine, Bureau of Land Management – Pinedale Office

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.

Beginning this year, we began investigating the potential of a resource – geophagy sites – selected by sage-grouse during the winter and/or early spring that to our knowledge has not been investigated or considered in the past. We will further investigate how to map that resource in a GIS for use in spatial modeling. Research objectives are to: 1) determine if soil characteristics at areas where geophagy has been documented differ from those of other available soils and food items, 2) document and verify

additional geophagic locations frequented by sage-grouse, 3) map in a GIS the distribution of potential geophagy sites throughout the Hoback and Upper Green River Basin and potentially southwest Wyoming, 4) assess how important the availability and distribution of geophagy sites are to sage-grouse selection of winter/early spring habitats, and 5) further investigate movements, genetics, and habitat selection of marked sage-grouse to improve management.

Invasive species control in occupied sage-grouse habitat

Amy Collett, Teton County Weed and Pest District
Kerry Murphy, Bridger-Teton National Forest
Travis Ziehl, Teton County Weed and Pest District

SUMMARY
This project is designed to address the issue of noxious weeds out-competing the natural habitat in such a way that sage grouse suffer from lack of cover and inadequate forage. By employing Early Detection/Rapid Response tactics we will be more efficiently managing our resources. Over time this method can greatly conserve cost because it targets small problems while they are still manageable before they become too expensive and extensive to treat. Our project would benefit the grouse in preserving their natural habitat and keeping their habitat free of large noxious weed infestations. Well established noxious weed infestations will be controlled so they do not continue their spread.

Sage grouse in the Upper Gros Ventre watershed number only 80–100 individuals, yet this unique population and key portions of its spatially limited winter range 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. Because the Upper Gros Ventre population is considered to be part of a meta-population complex with ties to populations in Jackson Hole and the Green River Basin, maintaining Gros Ventre birds may be critical to the persistence of sage grouse in the region. Treatment in these areas will cover approximately 3,500 acres of spot spraying weed infestations. This is an ongoing project that has received financial support numerous times by the Upper Snake River Basin Sage Grouse Working Group.

Occurrence and survival informed modeling of sage-grouse habitat in Jackson Hole, WY

Trapper Haynam, Craighead Beringia South
Bryan Bedrosian, Craighead Beringia South
Bob Crabtree, Yellowstone Ecological Research Center

SUMMARY
The end goal of this project is to develop spatially explicit metrics of greater sage-grouse habitat response in Jackson Hole, WY. This research will relate sage-grouse survival and location data to a suite of environmental variables. We are developing models for nesting, brood rearing, summer foraging, and winter foraging life history stages. Our response data were collected from 2007-2010. We have >70,000 GPS and VHF telemetry locations, from all life history stages, for ~25 male and ~75 female birds. We will utilize well established habitat selection modeling methodologies, such as resource selection probability functions (logistic models) or generalized linear mixed-effects models.

In these use-availability modeling frameworks, statistical models are fit to biologically relevant covariates (e.g., sagebrush canopy cover, herbaceous understory, past fire severity, raven occurrence) that are sampled at points where sage-grouse were relocated, or could have been present. Fitting these models will provide relative measures (parameter estimates) of apparent sage-grouse preference for particular habitat characteristics. The estimated parameters can then be used to generate resource use probability surfaces. Using a similar approach, and semi-parametric survival analysis, parameters will be estimated and then survival or risk surfaces can be generated. If a best supported model is deemed to have biologically significant parameter estimates; risk surfaces and resource selection surfaces will be combined to calculate a habitat suitability surface. The final method for generating a habitat suitability surface is still being developed. The candidate model structures have not yet been finalized, some covariates have yet to be synthesized, and covariate data arrays are still being populated.

Past Research Projects

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Management Summary

If the average peak number of males per lek is reflective of the sage-grouse population, the trend suggests relatively high populations in the early 1990s with a sharp decline through 1999 and several small rebounds and declines since. The increased number of males observed on leks in early 2014 may be the result of increased over winter survival during the 2012-13 and 2013-14 winters.

Lek data summarized in Tables 1 and 2 suggest the population has declined over the long term (1989-present). 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 and mapping sagebrush habitats used by sage-grouse are a priority. Additional documentation of sage-grouse distribution is needed to confirm habitat selection and seasonal distribution. 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 farmed in GTNP appears to have the greatest potential to expand and enhance habitat used by sage-grouse in the USRBCA.

The impact of the Jackson Hole Airport on the sage-grouse population is an ongoing issue. Management options that do not adversely affect the Jackson Hole 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.

Sage-grouse research by Craighead Beringia South provides essential information to manage the sage-grouse population and its habitat in Jackson Hole. Recent genetics work by Schulwitz et al. (2014) has provided new insights into the genetic isolation of the Jackson Hole and Gros Ventre populations, but from each other and in a regional context.

Recommendations

1. Continue to help coordinate lek surveys across jurisdictional boundaries using the lek survey protocols adopted by the WGFD.

2. Search for new leks annually and check historic, unoccupied or inactive leks.

3. Continue to document sage-grouse observations to improve occupied habitat mapping.

4. Cooperate with Wildlife Services, the National Park Service, and the Jackson Hole Airport Board to complete the wildlife assessment and design projects to minimize risks of sage-grouse strikes on 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 in Jackson Hole

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.

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Wind River - Sweetwater River Basin

Sage-Grouse

Job Completion Report

2013

June 2013-May 2014

Stan Harter

Wyoming Game & Fish Dept.

Lander Region

Wind River/Sweetwater River Conservation Area
Job Completion Report

Species: **Greater Sage-grouse**
Mgmt. Areas: **E & WR**
Period Covered: **June 1, 2013 – May 31, 2014**
Prepared by: **Stan Harter, South Lander Wildlife Biologist**

Introduction

The Wind River/Sweetwater River Conservation Area (WRSRCA) encompasses just over 10,000 mi^2, including a diverse array of vegetation communities in central Wyoming (Figure 1). Greater sage-grouse (*Centrocercus urophasianus*) are found throughout the sagebrush/grassland habitats of Wind River and Sweetwater River drainages. Occupied habitat is fairly contiguous throughout much of the conservation area, with principal differences in sagebrush species and associated plant communities related to elevation, precipitation, and soil type diversity. Habitats within the Gas Hills and Badwater Creek areas appear to be the most fragmented by changes in habitat type and energy development. Migrant populations of sage-grouse occur within portions of the conservation area, with some overlap among more stationary resident populations. Large, contiguous blocks of sagebrush/grassland communities have been eliminated in most of the Bureau of Reclamation's (BOR) Withdrawal Area near Riverton and converted into agricultural croplands, as well as near most developed urban areas.

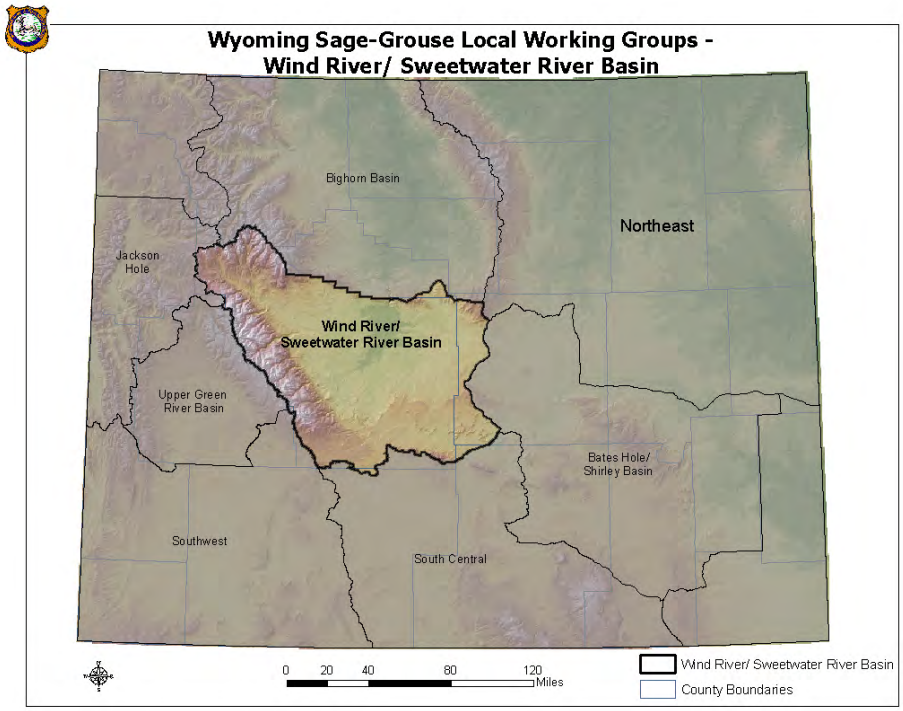

Figure 1. The Wind River/Sweetwater River Conservation Area within Wyoming.

Known sage-grouse leks within the WRSRCA are predominantly located on federal lands (Bureau of Land Management (BLM) - 57% and Bureau of Reclamation (BOR) - 2%), or tribal lands on the Wind River Reservation (WRR) – 25%. Approximately 10% of known leks are found on private land with the remaining 6% found on Wyoming State Trust lands (Appendix 1).

Conservation Area

The Wind River/Sweetwater River Conservation Area features the Wind River and Sweetwater River drainages. The area extends from Dubois in the west to Muddy Gap and Waltman in the east and from South Pass and Cyclone Rim in the south to the Owl Creek Mountains and South Bighorns in the north. The WRR is also included in the local planning area. Political jurisdictions include Fremont, Hot Springs, Natrona, and very small portions of Carbon, Sublette, and Sweetwater counties. Figure 2 shows land ownership within the WRSRCA, including areas managed by the U.S. BLM (Lander, Rock Springs, Casper, and Worland Resource Areas), the U.S. BOR, the U.S. Forest Service (Shoshone and Bridger National Forests), the State of Wyoming, and private landowners. The Eastern Shoshone and Northern Arapaho Tribal Business Councils manage lands within WRR, in association with the U.S. Bureau of Indian Affairs and U.S. Fish and Wildlife Service (USFWS). Major habitat types within the plan area include: sagebrush/grassland, salt desert shrub, mixed mountain shrub, grasslands, mixed forests (conifers and aspen), agricultural crops, riparian corridors, and urban areas. Primary land uses within the WRSRCA include: livestock grazing, oil/gas development, mining, dryland and irrigated crop production, recreation, and urban expansion.

The Wind River/Sweetwater River Local Working Group was organized in fall 2004 to develop and implement a local conservation plan to benefit sage-grouse and other species that use sagebrush habitats. This conservation plan identifies management practices to improve sage-grouse habitat and populations. The mission statement of the Wind River/Sweetwater River Local Sage-grouse Working Group is "to identify issues and implement strategies to enhance sage-grouse and their habitats". The Wind River/Sweetwater River Local Sage-Grouse Conservation Plan was completed in 2007, with an Addendum to the Plan completed in March 2014. The plan, addendum, and other Wyoming sage-grouse information are located on the WGFD website at http://wgfd.wyo.gov/web2011/wildlife-1000817.aspx

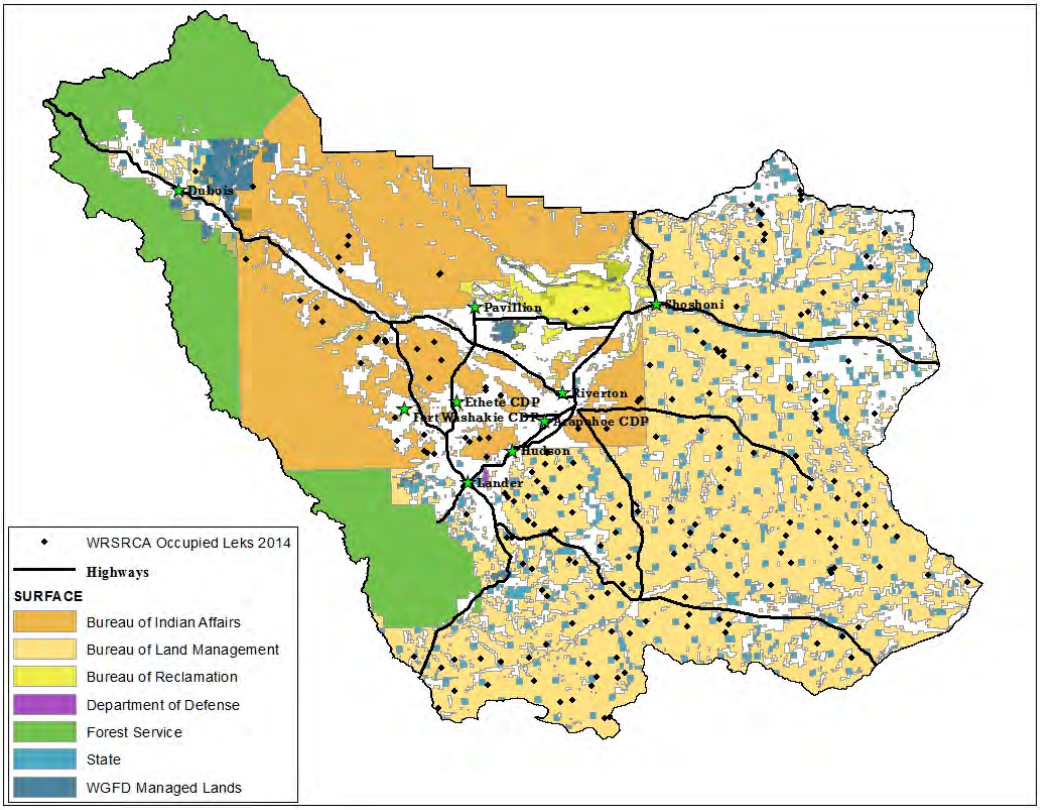

Figure 2. Land ownership within the WRSRCA (dots = 2014 occupied leks). Source: WGFD, BLM.

The WRSRCA encompasses all of the WGFD's Small/Upland Game Management Areas E and WR (Figure 3). Management recommendations and conservation efforts apply to all tribal lands within the WRR in both Fremont and Hot Springs Counties. These management areas do not directly correspond to sage-grouse population boundaries, but are used for general data collection and reporting.

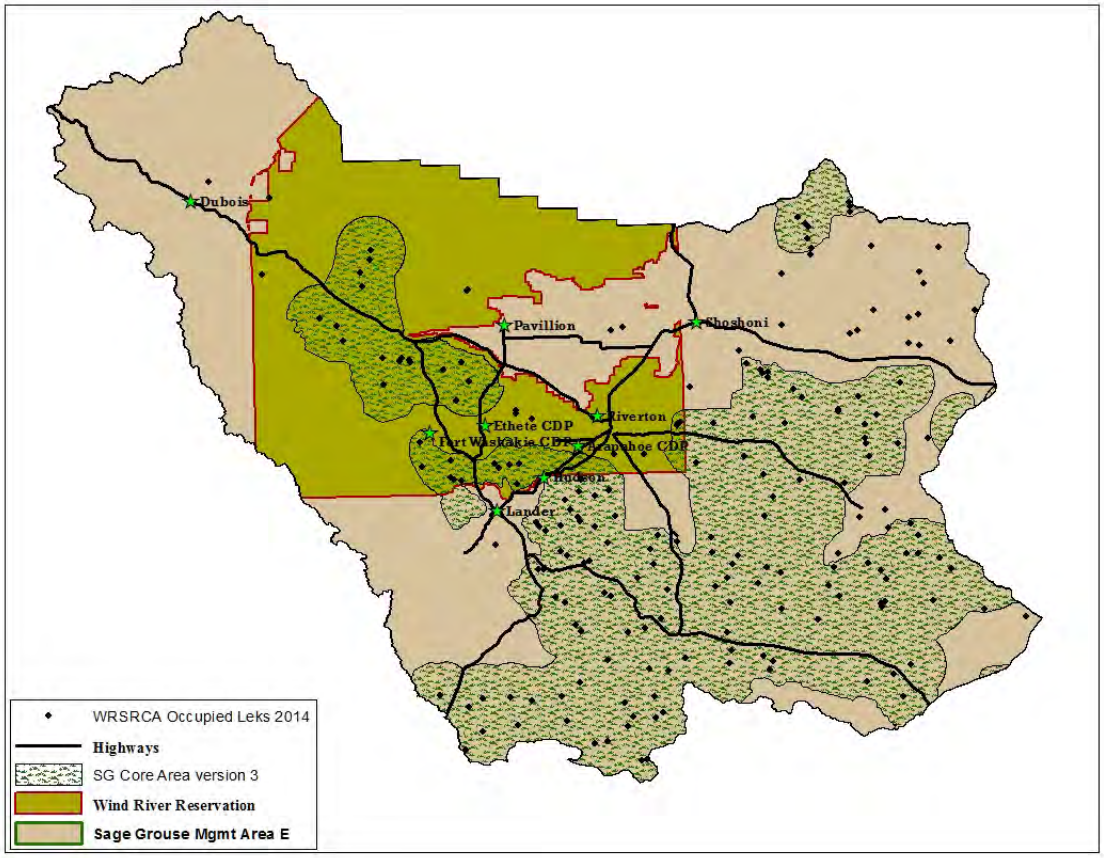

Figure 3. WGFD upland game bird management areas, core areas, and known leks within WRSRCA (dots=leks). Source WGFD.

Wyoming Governors' Executive Orders and Greater Sage-Grouse Core Areas

In 2007, then Wyoming Governor Dave Freudenthal hosted a 2-day Sage-Grouse Summit in Casper and called for development of statewide measures to positively impact sage-grouse numbers and habitats. The summit was clearly motivated by a concern that the US Fish and Wildlife Service (USFWS) might list the greater sage-grouse under the Endangered Species Act. The intent of this summit was not to avert the work of LWGs, but to supplement those endeavors and provide a more directed statewide approach to sage-grouse conservation. Following that meeting, Governor Freudenthal appointed a statewide Sage Grouse Implementation Team (SGIT) that included state and federal agencies, conservation groups, industry and landowners. The team supported the Wyoming Game and Fish Department statewide sage-grouse plan that called for utilizing existing Local Working Groups (LWGs) to implement on the ground actions to benefit sage-grouse.

In an unprecedented move to coordinate sage grouse conservation efforts across the State of Wyoming, Governor Freudenthal utilized the recommendations from the SGIT and released Executive Order 2008-2 on Aug. 1, 2008 establishing "Core Areas" for greater sage-grouse in Wyoming. These core areas

contain the highest densities of sage-grouse in Wyoming based on peak male attendance at leks. Stipulations developed by the SGIT provide additional conservation measures for about 83% of the state's sage-grouse on about 25% of the land area. Following the updates prepared during the spring and summer of 2010 by the SGIT, Governor Freudenthal issued a new Executive Order on August 18, 2010 to replace the 2008 order.

Governor Matt Mead issued an Executive Order on June 2, 2011 which reiterated and clarified the intent of Wyoming's Core Area Strategy originally developed under former Governor Freudenthal's administration with the assistance of the Governor's Sage-Grouse Implementation Team and the local sage-grouse working groups. About 81% of the active leks in the WRSRCA are in core areas (Figure 3).

As a part of the updates made by the Governor's Sage Grouse Implementation Team in 2010, the WRSR LWG reviewed and revised core area boundaries to more accurately reflect actual core habitat values and sage grouse use of these habitats. Most of the changes occurred along the Lander Foothills and agricultural or residential lands near Lander, and in the Gas Hills and Green/Crooks Mountain area where past uranium mining has left the area either non-vegetated or with vegetation cover unsuitable for sage-grouse.

The Wyoming Game and Fish Department and Commission maintain management authority over candidate species and management emphasis will continue to focus on implementation of Wyoming's Core Area Strategy.

Federal Agency Actions regarding Greater Sage Grouse

U.S. Fish and Wildlife Service (USFWS)

On March 5, 2010 the U.S. Fish and Wildlife Service (USFWS) issued a decision of "warranted but precluded" for listing Greater Sage-grouse as threatened or endangered under the Endangered Species Act. This means Greater Sage-grouse have become a "candidate" for listing, but are precluded from immediate listing due to higher priority species. As such the USFWS will evaluate the species status annually with the expectation of future listing if the status does not improve. The USFWS has also entered into a settlement agreement to remove sage-grouse from the candidate list and declare the bird either "warranted" or "not warranted" in 2015.

In its decision document, the USFWS specifically cited Wyoming's Core Area Strategy (described above) as a mechanism that, if implemented as envisioned, should ensure conservation of sage-grouse in Wyoming and therefore help preclude a future listing.

USFWS, in conjunction with the Wyoming Governor's Office, NRCS, WGFD, Wyoming Department of Agriculture, Wyoming Association of Conservation Districts, Wyoming BLM, and the U.S. Forest Service, have released a draft Greater Sage-grouse Umbrella Candidate Conservation Agreement with Assurances (CCAA) for Wyoming Ranch Management. The purpose of this agreement is to encourage landowners to voluntarily implement conservation measures to conserve, restore, or enhance habitat for the greater sage-grouse on non-Federal lands in Wyoming. In return, participating landowners and land managers would receive regulatory assurances concerning land use restrictions that might otherwise apply to them should the greater sage-grouse become protected under the ESA. The Umbrella CCAA will be in effect for 40 years following its approval.

Under the Umbrella CCAA, each participating landowner, with assistance from participating State and Federal agencies, would develop an individual CCAA, selecting conservation measures appropriate to their properties that are described in the Umbrella CCAA. Individual CCAAs would be linked to the Umbrella CCAA. USFWS will issue an enhancement-of-survival permit to each enrolled landowner following approval of the individual CCAA. In the event the greater sage-grouse is listed under the ESA, the permit authorizes incidental take of the species that may result from general farming and ranching operations and recreation. The Service also will not impose commitments or restrictions of land, water, resources, or finances on the enrolled landowner beyond those agreed to in the individual CCAA. Individual CCAAs and enhancement-of-survival permits will have duration of 20 years.

Bureau of Land Management (BLM)

With over 80% of core areas occurring on lands administered by the BLM, that agency initiated a series of state and national Instructional Memoranda (IMs) designed to provide guidance to their field offices on sage-grouse habitat management for proposed activities and resource management planning. These memoranda incorporated the core area concept and executive orders initiated by the Governors. The state IM currently in effect was distributed in March of 2012 (WY-IM 2012-019). The national IMs are WO-IM 2012-43 and 44.

The WRSR LWG area lies predominantly within the BLM's Lander Field Office but also overlaps into the Casper and Worland Field Offices. The Lander and Worland Field Offices are revising their resource management plans (RMP) which will incorporate measures to enhance sage-grouse and sagebrush management, patterned after and including the state and national IMs. The Casper Field Office is in the process of completing an amendment to their existing RMP to incorporate the same types of measures to protect and enhance sage-grouse habitat. The record of decision (ROD) for Lander RMP revision is expected to be released soon and the Worland RMP revision and Casper RMP amendment are expected to be completed later in 2014.

Natural Resources Conservation Service (NRCS)

In 2010, the Natural Resources Conservation Service (NRCS) launched the Sage-Grouse Initiative (SGI). Existing conservation programs (Environmental Quality Incentives Program [EQIP] and Wildlife Habitat Incentive Program [WHIP]) were adapted to improve habitat for grouse and improve sustainability of native rangelands. Practices such as sustainable grazing plans, conifer removal, fence removal or marking will be implemented on a landscape scale across a sage-grouse core area. A range/wildlife specialist was hired, under the auspices of SGI, to specifically recommend and implement grouse-related management practices on private land in the WRSRCA.

Several large-scale threats facing sage-grouse are identical to factors impacting the sustainability and productivity of grazing lands throughout the West. SGI aims to remove or reduce those threats common to sustainable ranching and sage-grouse conservation. Fragmentation of sagebrush habitats from a variety of sources is one of the primary causes of the decline in both sage-grouse populations and rangeland productivity. Exotic species invasions, unsustainable grazing systems, sod-busting, subdivision development, and conifer encroachment are other examples of mutual threats. Identifying the species' limiting factors at the level of the individual property owner is essential to ensure that the goals of the Conservation Practice Standard are met through SGI. SGI fosters coordination and implementation on a range-wide scale while ensuring local input and control. NRCS and USFWS came to an agreement in 2012 that is intended to provide "take protections" for producers/landowners that implement specific, approved conservation practices as part of SGI contracts. Some of the conservation practices

implemented by NRCS, including SGI contracts are reported in the Project Commitments table in Appendix B of the Addendum for the Wind River/Sweetwater River Local Sage Grouse Conservation Plan (2014).

Summary – Management direction and projects implemented or funded by the WRSR LWG have been, and will be, influenced by the guidance provided in the Wyoming Greater Sage-Grouse Conservation Plan (2003), Governor's executive orders, BLM's instructional memorandum and other programs discussed above. As these directives are updated, the WRSR LWG will continue to consult their guidance.

Data Collection Methods

Data collection methods and definitions can be found in the Wyoming Game and Fish Department Handbook of Biological Techniques sage-grouse chapter (Christiansen 2012).

Lek Monitoring

A new sage-grouse database was developed by Wyoming Game and Fish Department in 2012 to improve efficiency, reduce errors, and better facilitate data analysis. Changes were made to the manner in which lek data are calculated and reported. The new version is based solely on "occupied" leks. The past version suggested that was the case in the title of Table 1 of the Sage Grouse Job Completion Report (JCR) outputs, but when unoccupied leks were monitored those data were also included in the table. The result of this change is that the number of "known occupied" leks is now more accurate, but reflects fewer leks than in the previous version. Similarly, the new version calculates average male lek attendance using only monitoring observations where one or more male grouse were observed strutting. The old version included a count of "0" males for leks where activity was confirmed by the presence of sign but no birds were observed. Together, these two changes result in somewhat higher, but more accurate, average male attendance for active leks than previously reported. The changes do not result in any change in population trend based on average male lek attendance. Interpreted population trends (increases and decreases) over time remain the same, so no revisions to past reports are required.

Since only "occupied" leks are being reported on 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 the average lek size alone.

Average female lek attendance is no longer being reported, since data collection techniques are not designed to accurately capture these data, and is therefore not useful in assessing population trend.

WGFD, federal agencies, and volunteers have conducted lek counts and surveys each spring within the WRSRCA for over 40 years, providing some of the best long-term management data currently available for sage-grouse. Lek counts include those lek observations conducted 3–4 times each spring, about 7–10 days apart. Lek counts are a census technique that document the actual number of male sage-grouse observed attending a particular lek or lek complex. Lek surveys typically consist of only one spring visit and are intended to determine general lek status although trends reflected by lek surveys are adequately similar to lek counts when sample sizes exceed 50 leks (Fedy and Aldridge 2011). Known leks indicate sage-grouse distribution within the WRSRCA as represented previously in Figures 2 and 3.

An infrared (IR) thermal imaging survey was conducted in April 2013 in the Antelope Hills vicinity south of the Sweetwater River to attempt location of undiscovered leks. Several potential new leks were identified, but accuracy and timing issues prevented verification of these sites by ground visits. Follow up ground searches were conducted in 2014 in hopes of verifying these new leks, without success.

Lek Attendance - 2014

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 2014, along with 27 unoccupied and 7 undetermined leks. Anecdotal information indicates the possible existence of another 6 leks on WRR; however no data are available for lek attendance. In addition, there are almost certainly leks within the WRSRCA that have not yet been documented, as evidenced by at least 106 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 increased between 1995 and 2006, but has since declined (Figures 4, 5).

Of the 203 known occupied leks in the WRSRCA, 191 were checked in 2014 by WGFD, BLM, USFWS, and Shoshone-Arapahoe Tribal Fish and Game (SATFG), assisted by several researchers, consultants, and volunteers. Of those checked, 101 were counted and 90 were surveyed. Of the 164 leks where status was confirmed, 141 (86%) were active and 23 (14%) were inactive. The proportion of active/inactive leks averaged 92 and 8% respectively between 2005 and 2013. The increased proportion of inactive leks is largely due to increased survey efforts seeking to confirm leks activity status and reduce the number of "unknown" status leks. Light snow cover allowed better access to leks coupled with increased effort, which led to more leks being visited enough times to qualify as counts, as well as verifying leks as inactive versus unknown. Average male lek attendance for all leks checked increased from 18.8 in 2013 to 20.2 in 2014. Average annual maximum male attendance at count leks declined from 22.4 in 2013 to 21.6 in 2014, which is 51% below the average since 2005 (44.4), and 72% below the peak in 2006 (76.0). Overall it appears the spring 2014 population was relatively stable compared to 2013.

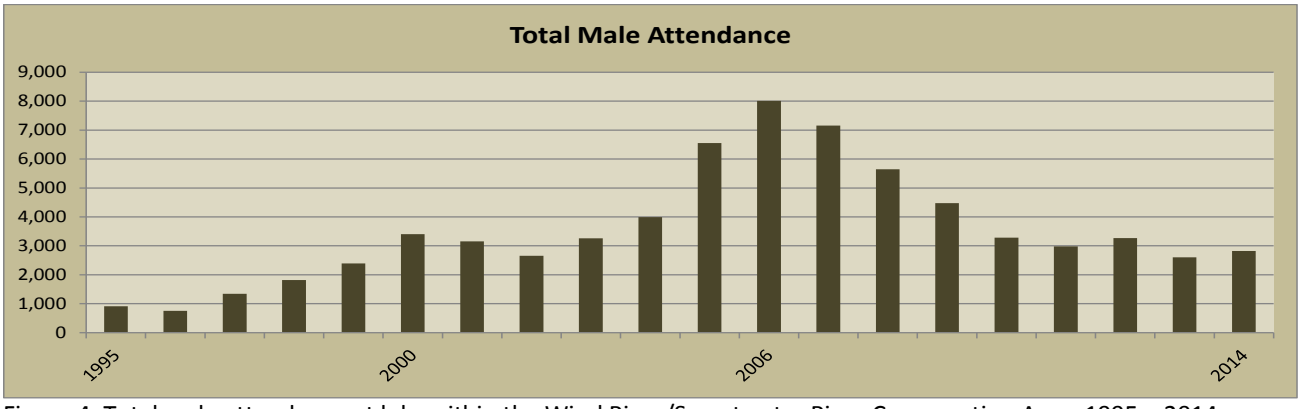

Figure 4. Total male attendance at leks within the Wind River/Sweetwater River Conservation Area, 1995 – 2014.

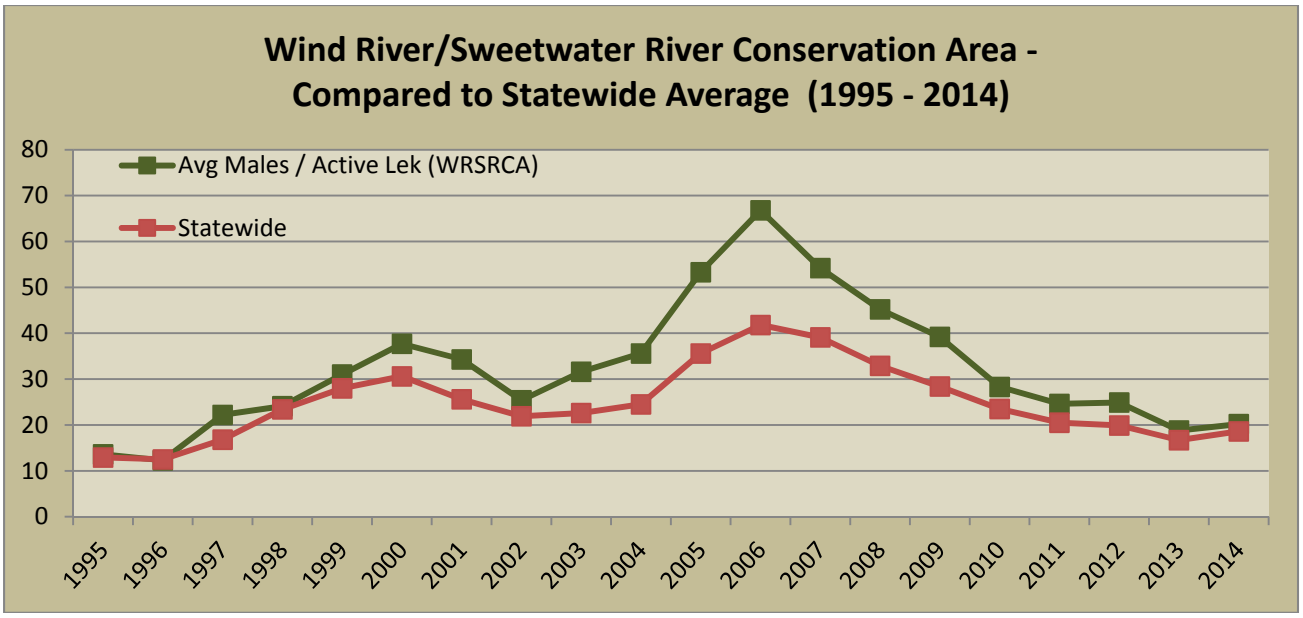

Figure 5. Average male lek attendance in WRSRCA compared with Wyoming statewide trends, 1995 – 2014.

Lek Perimeter Mapping

With increased interest in developing Wyoming's energy resources, emphasis has arisen to map all known sage grouse leks, complete with perimeters outlining the extent of strutting activity on each lek. As of 2014, nearly all lek perimeters were mapped in the WRSRCA. Distance and timing stipulations for developments are applied to the perimeter of each mapped lek, rather than a centralized point. This is a significant difference for many large leks with some total lek perimeter areas reaching 100 acres or larger.

Productivity

Limited annual sage-grouse brood data have been collected and documented during July and early August. Brood data provide some indication of population trend based on production. In most years, brood data are limited because of low sample sizes, due to low populations or conflicting work schedule demands. No brood count protocol is established within the WRSRCA. Annual pronghorn classifications are conducted via ground observations and often allow personnel to observe numerous broods in August.

Where available, harvest wing data provide a more reliable indicator of recruitment than do brood survey data. Several wing barrels placed annually along major hunting area exit roads in Upland Game Bird Management Area E have typically provided significant wing data, due to a relatively high number of sage-grouse hunters. Wing data are summarized for the WRSRCA from 2004 – 2013 and analyzed in detail for 2013 (Appendix 1). Wings collected from hunter harvested birds during the 2013 hunting season yielded an average brood size of 1.1 chicks per hen, signifying summer chick survival was poor albeit higher than the 0.8 chicks/hen observed in 2012. Population growth typically requires 1.7+ chicks/hen based on historic statewide averages.

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, 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 tables in Appendix 1, bag limits, season lengths, and harvest levels do not appear to be excessive for the population of sage grouse within the WRSRCA. Wings are collected from harvested birds annually at barrels placed at major exits from hunting spots within the WRSRCA. Data gathered from these wings are used to calculate age and sex ratios, and chick survival. Hunting seasons and harvest from the WRR are not included in these data.

The 2013 sage grouse hunting season was 10 days long, keeping opening day on the 3rd Saturday in September (Sept. 21 – 30). Hunter numbers and sage grouse harvest decreased with the shorter season (37% and 40% respectively), along with other indications (low lek attendance and productivity) of declining sage grouse populations. Hunter effort (days/bird) and birds/hunter statistics have generally followed numbers of grouse since 2004 (Appendix 1, Table 4b).

Weather

Drought conditions were extreme to exceptional for most of the past two years, beginning with minimal snowfall in winter 2011-12 and continuing with almost no precipitation during spring and summer 2012. In April 2013, a series of several late winter/early spring snow storms produced heavy snow through early May throughout the WRSRCA. These storms were extremely helpful in lessening the effects of drought, yet they only helped change the drought status from Extreme to Severe. Drought returned in summer 2013, with only 0.34 and 0.2 inches of precipitation recorded in Lander and Jeffrey City respectively from June 1 to September 1. This reduced production in herbaceous and shrub species across the WRSRCA, although some improvement over 2012 conditions was noted. Chick/hen ratios also showed slight improvement in 2013 over the low point in 2012, as is shown in the wing analysis table and charts in Appendix 1. Rain and snow returned to the area in September and October 2013, with nearly 300% of "normal" precipitation recorded in Lander and Jeffrey City with warm temperatures between early storms. Although winter 2013-14 had lower than average snowfall, the increase in soil moisture from the fall precipitation carried over into spring 2014 and led to improvement in vegetation condition, primarily grasses. Consequently, this should lead to improved nesting cover and improved nest success and brood survival in 2014.

Habitat (Current and Historic)

Sage-grouse habitat quality has 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 Lander area 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

No habitat monitoring transects were measured in 2013. Habitat monitoring is discussed in past WRSRCA JCRs, and in the 2007 WRSRCA Local Sage Grouse Conservation Plan and 2014 Addendum.

Habitat Inventory

No new habitat inventories were conducted in 2013-14. Habitat assessments have been conducted in past years as reported in previous JCRs, with a detailed summary also included in the 2007 WRSRCA Local Sage Grouse Conservation Plan and 2014 Addendum.

Winter Habitat Survey

Limited winter observations were collected in 2013-14, 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. Reports for current year activities follow.

University of Wyoming - "Response of Greater Sage-grouse to Treatments in Wyoming Big Sagebrush"

This research is a multi-year study intended to measure demographic response of sage grouse to sagebrush treatments in the Beaver Rim area north of Sweetwater Station and Jeffrey City. Mowing treatments were completed in the Dishpan Butte and Cedar Rim project areas in February 2014, with tebuthiuron (Spike 20P®) applications in the West Long Creek and Black Mountain project areas completed in May 2014. In all, just over 2,700 acres were treated as part of this research (1,208 acres mowed and 1,508 acres treated with Spike 20P®).

Lander Front Mule Deer Habitat Improvement

Approximately 400 acres were treated with Spike 20P® to thin sagebrush and encourage bitterbrush in mule deer winter ranges near Red Canyon in fall 2013. Additional mule deer habitat projects have been reported in past year's JCRs and in the 2007 WRSRCA Local Sage Grouse Conservation Plan and 2014 Addendum.

Fairfield Wildfire

A lightning caused wildfire burned portions of Sinks Canyon and Fairfield Hill in July 2013, including some sagebrush habitats occasionally used by sage grouse. Rehabilitation efforts have included application of the herbicide Plateau® in hopes of inhibiting cheatgrass *(Bromus tectorum*), aerial seeding of shrub, grass, and forb seed, planting shrub seedlings, erosion control, and other soil stabilization measures.

Reclamation in Energy Development Fields

Energy Development Reclamation Study

Extremely dry conditions have led to unsuccessful reclamation on newly constructed oil and gas pads in the Lysite and Beaver Creek areas. WGFD assisted the BLM, NRCS, ConocoPhillips, and Devon Energy in the development of a reclamation study being conducted at Conoco-Phillips' Lysite field and at Devon's Beaver Creek field. In an effort to increase reclamation success both companies agreed to complete various planting techniques on three different soil types at each oil field. Tests were set up on a clayey, sandy and saline site on both units. Each pad was divided into a split plot design to test 3 variables: cover crop vs. no cover crop, drilling vs. broadcasting, and irrigated vs. non-irrigated. In 2009, the sections selected to receive a cover crop were planted with barley in May and mowed in July-August. Native seeds were drilled or broadcast in November 2009. Barley germinated at all but one saline site. Initially the reclamation study team decided not to erect temporary electric fencing because of cost, but

grazing on the cover crop was significant. Fences were erected over winter to prevent cattle from grazing seedlings.

Both fields received significant moisture in April, May and early June 2010 and the study team decided not to irrigate. Russian thistle and halogeton were the dominant species present when monitoring was completed in mid-June. A few native species were found in very low numbers, some from the seeding and some recruited from neighboring areas. The saline site in the Conoco-Phillips field had the worst results with very poor germination. Monitoring has been intermittent, with plans to continue in 2014. Long-term results are not yet available.

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 2013. However, at least 3 properties are under contract or being considered for easements with completion anticipated by the end of 2014. Presently, nearly 30,000 acres of private lands are permanently protected by conservation easements within the WRSRCA. These conservation easements provide protection of crucial wildlife habitat, water quality and maintain migration routes, and traditional agricultural uses of the land.

Research

A number of research projects have been conducted in the WRSRCA since 2000. Abstracts and progress reports for studies conducted or published in 2013-14 follow, with earlier studies 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 to date. In addition, abstracts are reported below for 3 studies completed in the Lysite area in 2011 and 2012, which were inadvertently omitted from previous JCRs and the 2013 Plan Addendum.

Identifying and Prioritizing Greater Sage-Grouse Nesting and Brood-Rearing Habitat for Conservation in Human-Modified Landscapes *– Dzialak, et al. (2011)*

ABSTRACT: Background: Balancing animal conservation and human use of the landscape is an ongoing scientific and practical challenge throughout the world. We investigated reproductive success in female greater sage-grouse (Centrocercus urophasianus) relative to seasonal patterns of resource selection, with the larger goal of developing a spatially-explicit framework for managing human activity and sage-grouse conservation at the landscape level.

Methodology/Principal Findings: We integrated field-observation, Global Positioning Systems telemetry, and statistical modeling to quantify the spatial pattern of occurrence and risk during nesting and brood-rearing. We linked occurrence and risk models to provide spatially-explicit indices of habitat-performance relationships. As part of the analysis, we offer novel biological information on resource selection during egg-laying, incubation, and night. The spatial pattern of occurrence during all reproductive phases was driven largely by selection or avoidance of terrain features and vegetation, with little variation explained by anthropogenic features. Specifically, sage-grouse consistently avoided rough terrain, selected for moderate shrub cover at the patch level (within 90 m2), and selected for mesic habitat in mid and late brood-rearing phases. In contrast, risk of nest and brood failure was structured by proximity to anthropogenic features including natural gas wells and human-created mesic areas, as well as vegetation features such as shrub cover.

Conclusions/Significance: Risk in this and perhaps other human-modified landscapes is a top-down (i.e., human-mediated) process that would most effectively be minimized by developing a better understanding of specific mechanisms (e.g., predator subsidization) driving observed patterns, and using habitat-performance indices such as those developed herein for spatially-explicit guidance of conservation intervention. Working under the hypothesis that industrial activity structures risk by enhancing predator abundance or effectiveness, we offer specific recommendations for maintaining high- performance habitat and reducing low-performance habitat, particularly relative to the nesting phase, by managing key high-risk anthropogenic features such as industrial infrastructure and water developments.

Temporal and hierarchical spatial componentsof animal occurrence: conserving seasonal habitat for greater sage-grouse – *Dzialak, et al. (2012)*

ABSTRACT: Developing strategies for sustainable management of landscapes requires research that bridges regionally important ecological and socioeconomic issues, and that aims to provide solutions to sustainability problems. We integrated Global Positioning Systems (GPS) telemetry and statistical modeling to quantify hierarchical spatial and temporal components of occurrence among greater sage-grouse (Centrocercus urophasianus; n ¼ 87), a species of conservation concern, with the larger goal of developing spatially-explicit guidance for conservation of important winter habitat in a Wyoming, USA landscape undergoing development for energy resources. The pattern of occurrence at the landscape level (second-order) and within seasonal use areas (third-order) included selection for shrub vegetation with a prominent sagebrush (Artemisia spp.) component, and avoidance of rough terrain, mesic areas, and human activity. A change in resource selection behavior across the diel cycle was not an apparent component of the higher order selection process; however, at the finer scale of investigation sage-grouse shifted behavior across the diel cycle in ways likely related to risk aversion or maintaining a favorable thermal environment (i.e., daytime-only avoidance of natural gas wells and night-time-only selection for taller shrubs). At both spatial scales there was considerably more variation among individuals in the sign of their association with anthropogenic features than with vegetation and terrain. The final spatially-explicit model, which depicted lower-order selection (local, patch-level, and seasonal use area) across the diel cycle constrained by selection processes at a higher order (second-order), validated well, offering specific guidance for managing human activity and sage-grouse conservation in the study area, and general guidance in developing sustainable landscape management strategies when animal occurrence reflects multiple spatial and temporal processes.

Landscape features and weather influence nest survival of a ground-nesting bird of conservation concern, the greater sage-grouse, in human altered environments – *Webb, et al. (2012)*

ABSTRACT: Introduction: Ground-nesting birds experience high levels of nest predation. However, birds can make selection decisions related to nest site location and characteristics that may result in physical, visual, and olfactory impediments to predators.

Methods: We studied daily survival rate [DSR] of greater sage-grouse (*Centrocercus urophasianus*) from 2008 to 2010 in an area in Wyoming experiencing large-scale alterations to the landscape. We used generalized linear mixed models to model fixed and random effects, and a correlation within nesting attempts, individual birds, and years.

Results: Predation of the nest was the most common source of nest failure (84.7%) followed by direct predation of the female (13.6%). Generally, landscape variables at the nest site (≤ 30 m) were more influential on DSR of nests than features at larger spatial scales. Percentage of shrub canopy cover at the nest site (15-m scale) and distances to natural gas wells and mesic areas had a positive relationship with

DSR of nests, whereas distance to roads had a negative relationship with DSR of nests. When added to the vegetation model, maximum wind speed on the day of nest failure and a 1-day lag in precipitation (i.e., precipitation the day before failure) improved model fit whereby both variables negatively influenced DSR of nests.

Conclusions: Nest site characteristics that reduce visibility (i.e., shrub canopy cover) have the potential to reduce depredation, whereas anthropogenic (i.e., distance to wells) and mesic landscape features appear to facilitate depredation. Last, predators may be more efficient at locating nests under certain weather conditions (i.e., high winds and moisture).

A Flexible Approach for Assessing Functional Landscape Connectivity, With Application to Greater Sage-Grouse (Centrocercus Urophasianus) *– Harju, et al. (2013)*

ABSTRACT: Connectivity of animal populations is an increasingly prominent concern in fragmented landscapes, yet existing methodological and conceptual approaches implicitly assume the presence of, or need for, discrete corridors. We tested this assumption by developing a flexible conceptual approach that does not assume, but allows for, the presence of discrete movement corridors. We quantified functional connectivity habitat for greater sage-grouse (Centrocercus urophasianus) across a large landscape in central western North America. We assigned sample locations to a movement state (encamped, traveling and relocating), and used Global Positioning System (GPS) location data and conditional logistic regression to estimate state-specific resource selection functions. Patterns of resource selection during different movement states reflected selection for sagebrush and general avoidance of rough topography and anthropogenic features. Distinct connectivity corridors were not common in the 5,625 km^2 study area. Rather, broad areas functioned as generally high or low quality connectivity habitat. A comprehensive map predicting the quality of connectivity habitat across the study area validated well based on a set of GPS locations from independent greater sage-grouse. The functional relationship between greater sage-grouse and the landscape did not always conform to the idea of a discrete corridor. A more flexible consideration of landscape connectivity may improve the efficacy of management actions by aligning those actions with the spatial patterns by which animals interact with the landscape.

Response of Greater Sage-grouse to Treatments in Wyoming Big Sagebrush *– Smith and Beck, University of Wyoming (2013 Annual Report is attached as Appendix 2)*

ABSTRACT: Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) has been treated through chemical application, mechanical treatments, and prescribed burning to increase herbaceous forage species released from competition with sagebrush overstory. Originally intended to provide more forage for livestock, these techniques have been applied to improve habitat for sagebrush wildlife species such as greater sage-grouse (*Centrocercus urophasianus*). Treatments are intended to rejuvenate sagebrush stands by killing older sagebrush plants to promote growth of younger 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 in Fremont and Natrona Counties, Wyoming is designed as a Before-After Impact-Control study with 3 years of pre-treatment and 3-to-5 years of post-treatment data comparing demographic rates and habitat selection patterns within treated and non-treated sites. We initiated our study in spring 2011 by capturing female sage-grouse and affixing VHF necklace-mounted radio transmitters to measure pre-treatment nest and brood-rearing success and microhabitat use. We also began attaching GPS transmitters in spring and summer 2012 to female grouse. In fall 2013 we received funding to implement treatments in fall 2013 (treatments were completed in winter/spring 2014). In 2011, 2012, and 2013 we monitored survival at

161 nests and 78 broods from *n* = 258 VHF or GPS 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 vertebrate species associated with the sagebrush biome.

Effects of Mowing and Herbicide Treatments on the Nutritional Quality of Sagebrush in south-central, Wyoming *– Forbey, Boise State University, and Beck, et al – University of Wyoming*

To meet some of the population and habitat objectives outlined in the Wyoming Greater Sage Grouse Conservation Plan and to better understand sage-grouse distribution and population trends, there is a need to identify how various habitat treatments such as mowing and herbicides influence the quality of winter and breeding habitats for sage-grouse. Specifically, we aim to identify how management treatments influence the quality of sagebrush, specifically Wyoming big sagebrush, as food in treated Wyoming big sagebrush communities.

Why is the dietary quality of sagebrush important?

Greater sage-grouse are a sagebrush obligate species because they rely on a variety of sagebrush-dominated habitats for food, cover, and reproductive activities (Connelly et al., 2004; Crawford et al., 2004). Specifically, sagebrush is virtually the only source of food for sage-grouse during mid-to-late fall, winter, and spring before forbs begin growing (Connelly et al., 2000), comprising 100% of the sage-grouse diet during winter. The majority of research has focused on defining sagebrush quality for sage-grouse in terms of height and canopy cover. However, because a substantial proportion of the sage-grouse diet is comprised of sagebrush from October-March, quality should not be defined solely in terms of structural characteristics. There is strong evidence that the nutritional and chemical quality of the diet is important to herbivores (Beckerton and Middleton, 1982; Beckerton and Middleton, 1983; Jakubas et al., 1993a; Jakubas et al., 1993b), including sage-grouse (Frye et al., 2013; Remington and Braun, 1985; Welch et al., 1988). Dr. Forbey and one of her graduate students recently determined that sage-grouse selected black sagebrush with lower plant secondary metabolite (PSM) concentrations over Wyoming big sagebrush in winter in southern Idaho (Frye et al. 2013). Moreover, sage-grouse selected patches and individual plants within black sagebrush patches that were higher in nutrient concentrations and lower in PSM concentrations than those not used (Frye et al. 2013, Fig 1). Thus, we propose that the dietary quality of sagebrush may have a significant impact on body condition as grouse enter the reproductive period. In support, ruffed grouse consuming diets with higher crude protein had higher reproductive success (Beckerton and Middleton, 1982). In addition, ruffed grouse consuming winter diets higher in crude protein and lower chemical defenses had higher population densities (Beckerton and Middleton, 1982; Beckerton and Middleton, 1983; Jakubas et al., 1993b).

The Effectiveness of Sage-Grouse Core Areas as an Umbrella for Conserving Non-Game Wildlife Species *– Carlisle, Chalfoun. University of Wyoming*

We are investigating how effective Greater Sage-Grouse is as an umbrella species for the conservation of non-game wildlife associated with the sagebrush-steppe ecosystem, specifically those designated as species of greatest conservation need (SGCN). Wyoming's Greater Sage-Grouse Core Population Areas and the host of current efforts to conserve sage-grouse provide a natural laboratory for testing the umbrella species concept and our findings will be useful to managers interested in indirectly conserving SGCN under the streamlined approach of the sage-grouse umbrella. In order to rigorously test sage-grouse as an umbrella species, we are implementing a four-part approach, focusing on differing spatial scales: 1) quantify overlap statewide between sage-grouse core areas and focal SGCNs' predicted spatial distribution using GIS data, 2) examine the occurrence and relative abundance of SGCN across gradients of sagebrush habitat structure and sage-grouse breeding density in the field, 3) evaluate the reproductive success of two sagebrush-obligate passerine SGCN (Brewer's Sparrow, Sage Thrasher)

across gradients of sagebrush habitat structure, and 4) examine the responses of SGCN to sagebrush-reducing habitat treatments designed to improve sage-grouse brood-rearing habitat. We are currently updating the preliminary analyses for objective 1 using a more rigorous overlap analysis. We successfully completed our second field season this past summer, collecting data near Jeffrey City, WY to address objectives 2-4. Following field seasons (2014-2015) will continue to address objectives 2-4. Habitat treatments (in conjunction with K. Smith and J. Beck) are planned for implementation this fall near the Cedar Rim, Lander Region.

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 2013-14.

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 with land management agencies 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.

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Appendix 1. Wind River/Sweetwater River Local Working Group JCR Tables and Graphs

Sage Grouse Lek Characteristics (2014)

Working Group: Wind River/Sweetwater River

Region	Number	Percent
Lander	180	75.0
WRIR	60	25.0

Working Group	Number	Percent
Wind River/Sweetwater River	240	100.0

Classification	Number	Percent
Occupied	206	85.8
Undetermined	7	2.9
Unoccupied	27	11.3

BLM Office	Number	Percent
Lander - WRR	60	25.0
Casper	11	4.6
Lander	161	67.1
Rock Springs	6	2.5
Worland	2	0.8

Biologist	Number	Percent
WRR - USFWS	60	25.0
North Lander	66	27.5
South Lander	114	47.5

Warden	Number	Percent
Shoshone-Arapahoe Tribal	60	25.0
Dubois	1	0.4
Lander	65	27.1
North Riverton	30	12.5
South Riverton	52	21.7
West Rawlins	32	13.3

County	Number	Percent
Carbon	1	0.4
Fremont	211	87.9
Hot Springs	5	2.1
Natrona	22	9.2
Sweetwater	1	0.4

Land Status	Number	Percent
BLM	137	57.1
BOR	4	1.7
Private	25	10.4
Reservation	60	25.0
State	14	5.8

Management Area	Number	Percent
E	180	75.0
WR	60	25.0

Sage Grouse Job Completion Report

Year: 2005 - 2014, 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)
2005	163	39	24	2229	65.6
2006	167	60	36	4179	76.0
2007	176	71	40	4494	70.2
2008	183	72	39	3367	51.0
2009	181	65	36	2444	45.3
2010	183	54	30	1621	36.0
2011	191	70	37	1668	26.9
2012	198	78	39	1899	28.8
2013	201	81	40	1543	22.4
2014	203	101	50	1860	21.6

b. Leks Surveyed

Year	Occupied	Surveyed	Percent Surveyed	Peak Males	Avg Males / Active Lek (2)
2005	163	112	69	4325	48.6
2006	167	84	50	3832	59.0
2007	176	94	53	2666	39.2
2008	183	87	48	2282	38.7
2009	181	82	45	2029	33.8
2010	183	93	51	1660	23.4
2011	191	89	47	1311	22.2
2012	198	93	47	1368	21.0
2013	201	93	46	1056	15.3
2014	203	90	44	963	17.8

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: 2005 - 2014, 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)
2005	163	151	93	6554	53.3
2006	167	144	86	8011	66.8
2007	176	165	94	7160	54.2
2008	183	159	87	5649	45.2
2009	181	147	81	4473	39.2
2010	183	147	80	3281	28.3
2011	191	159	83	2979	24.6
2012	198	171	86	3267	24.9
2013	201	174	87	2599	18.8
2014	203	191	94	2823	20.2

d. Lek Status

Year	Active	Inactive (3)	Unknown	Known Status	Percent Active	Percent Inactive
2005	124	6	21	130	95.4	4.6
2006	122	7	15	129	94.6	5.4
2007	134	9	22	143	93.7	6.3
2008	128	12	19	140	91.4	8.6
2009	114	14	19	128	89.1	10.9
2010	119	9	19	128	93.0	7.0
2011	122	10	27	132	92.4	7.6
2012	132	16	23	148	89.2	10.8
2013	139	13	22	152	91.4	8.6
2014	141	23	27	164	86.0	14.0

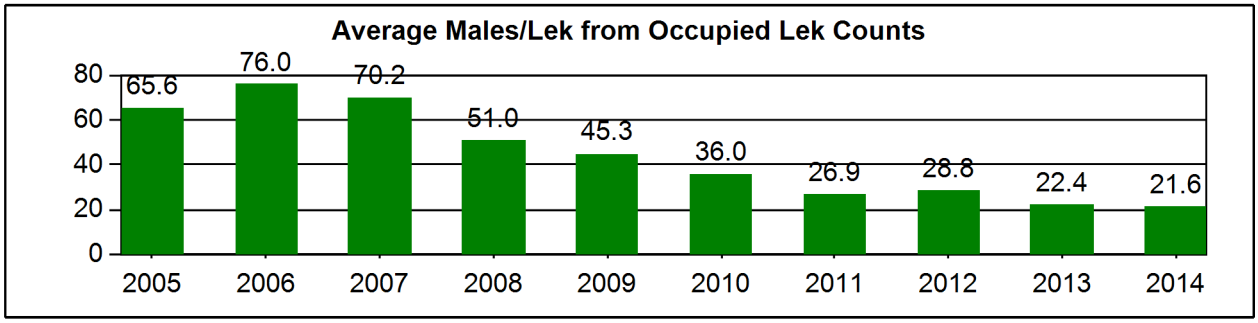
1) Occupied - Active during previous 10 years (see official definitions)

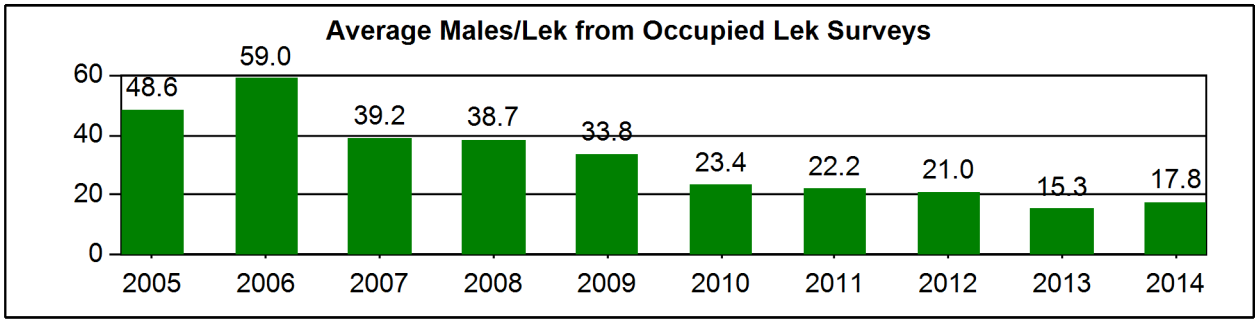
2) Avg Males/Active Lek - Includes only those leks where one or more strutting males were observed. Does not include "Active" leks where only sign was documented.

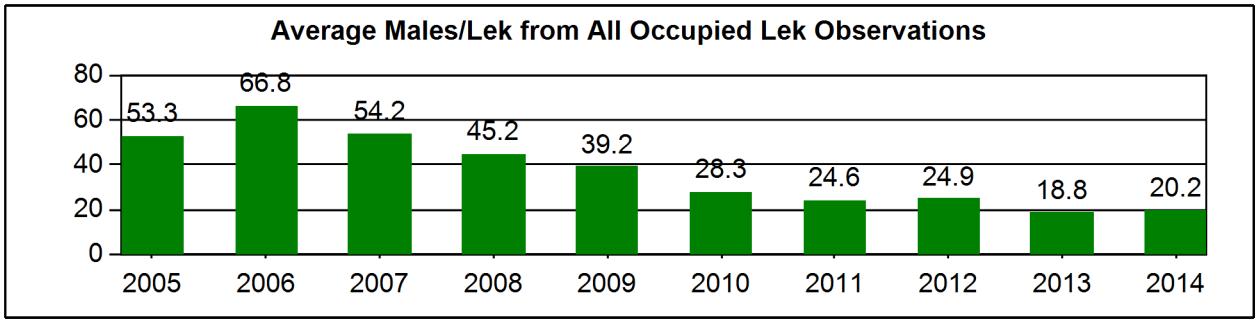
3) Inactive - Confirmed no birds/sign present (see official definitions)

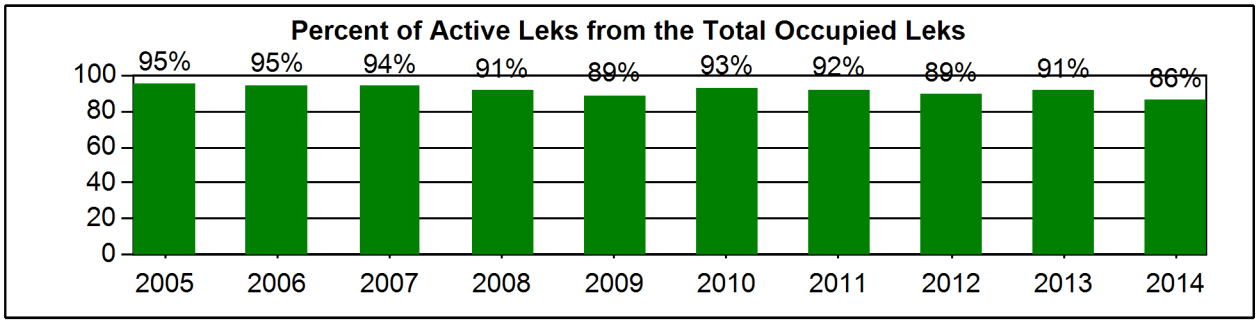
Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Wind River/Sweetwater River



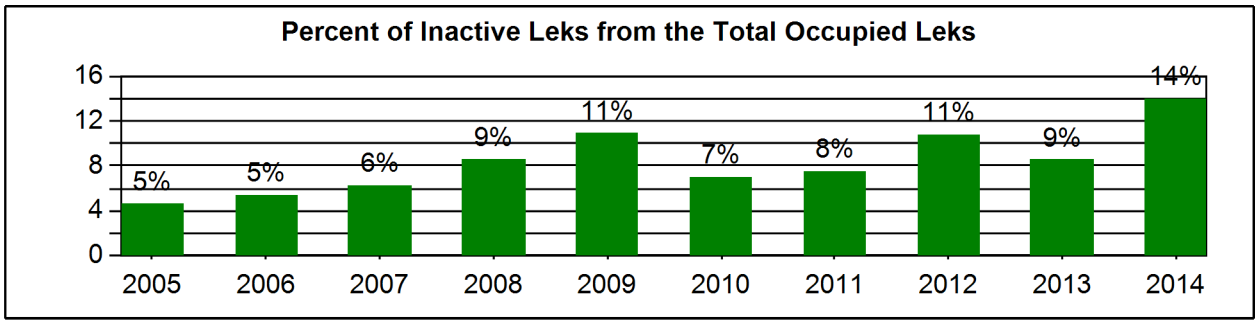






Sage Grouse Occupied Lek Attendance Summary

Year: 2005 - 2014, Working Group: Wind River/Sweetwater River



Sage Grouse Job Completion Report

Year: 2004 - 2013, Management Area: E

4. Sage Grouse Hunting Seasons and Harvest Data

a. Season

Year	Season Start	Season End	Length	Bag/Possesion Limit
2004	Sep-23	Oct-3	11	2/4
2005	Sep-23	Oct-3	11	2/4
2006	Sep-23	Oct-3	11	2/4
2007	Sep-22	Oct-2	11	2/4
2008	Sep-22	Oct-2	11	2/4
2009	Sep-19	Sep-30	12	2/4
2010	Sep-18	Sep-30	13	2/4
2011	Sep-17	Sep-30	14	2/4
2012	Sep-15	Sep-30	16	2/4
2013	Sep-21	Sep-30	10	2/4

b. Harvest

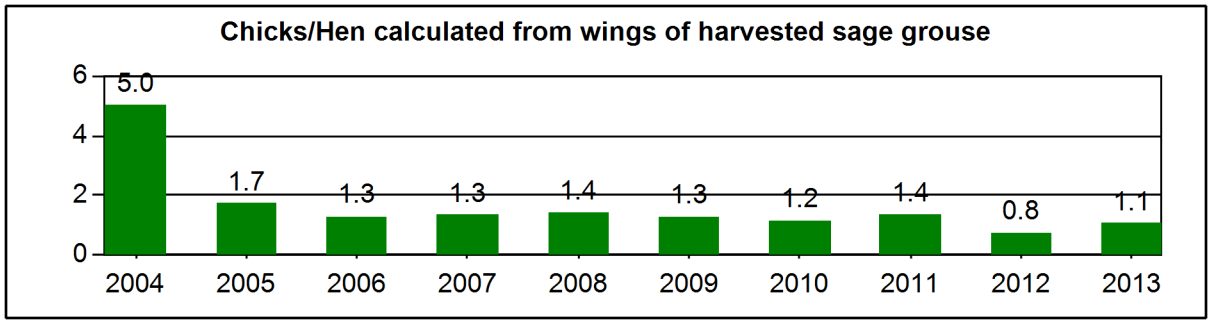
Year	Harvest	Hunters	Days	Birds/ Day	Birds/ Hunter	Days/ Hunter
2004	1398	572	1444	1.0	2.4	2.5
2005	2994	930	2080	1.4	3.2	2.2
2006	1710	558	1183	1.4	3.1	2.1
2007	1776	788	1696	1.0	2.3	2.2
2008	2144	863	2059	1.0	2.5	2.4
2009	2295	875	2114	1.1	2.6	2.4
2010	2495	1056	2866	0.9	2.4	2.7
2011	1779	771	1801	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
Avg	1,990	787	1,886	1.1	2.5	2.4

Sage Grouse Job Completion Report

Year: 2004 - 2013, Management Area: E, Working Group: Wind River/Sweetwater River

5. Composition of Harvest by Wing Analysis

Year	Sample Size	Percent Adult		Percent Yearling		Percent Young		Chicks/ Hens
		Male	Female	Male	Female	Male	Female	
2004	369	11.9	12.5	0.0	2.2	35.8	37.7	5.0
2005	633	13.6	22.7	5.1	7.1	21.0	30.5	1.7
2006	366	26.0	25.4	4.6	4.6	13.4	26.0	1.3
2007	397	23.9	29.2	1.0	3.0	17.1	25.7	1.3
2008	538	21.6	24.5	5.6	5.6	17.8	24.7	1.4
2009	598	16.7	24.6	6.9	8.9	14.7	28.3	1.3
2010	476	16.0	30.3	4.4	6.7	15.1	27.5	1.2
2011	376	9.0	27.1	6.9	8.5	14.4	34.0	1.4
2012	443	18.5	36.1	6.3	6.8	11.1	21.2	0.8
2013	202	18.8	29.7	0.5	9.4	14.9	26.7	1.1



2013 ANNUAL PROGRESS REPORT

Response of Greater Sage-Grouse to Habitat Treatments in Wyoming Big Sagebrush

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INTRODUCTION

Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) is the most widely distributed subspecies of big sagebrush in the sagebrush biome (Beetle 1960, Knick et al. 2003), where it is used as habitat by sagebrush-occurring wildlife (Knick et al. 2003, Larrucea and Brussard 2008). Historically, Wyoming big sagebrush has been treated through chemical application, mechanical treatments, and prescribed burning to increase herbaceous forage species released from competition with sagebrush overstory (Beck et al. 2012). The same techniques that have been used in the past to provide more grassy forage for livestock have been increasingly applied with the underlying idea that they will improve habitat conditions for species such as greater sage-grouse (*Centrocercus urophasianus*). Objectives of many recent treatments are intended to rejuvenate sagebrush stands by killing older sagebrush plants to promote growth of younger sagebrush plants and increase herbaceous production to provide additional food sources and herbaceous structural cover (Perryman et al. 2002, Dahlgren et al. 2006, Davies et al. 2009). However, vegetation response to different treatments is variable. Wyoming big sagebrush experiences slow regeneration (25–100 + years to return to pre-treatment conditions; Baker 2006) following treatments and grass and forb cover and production typically return to pre-treatment conditions within a short time (i.e., 1-to-5 years) post treatment (Peek et al. 1979, Fischer et al. 1996, Hess and Beck 2012).

Studies that have evaluated sage-grouse response to treatments in Wyoming big sagebrush have reported mixed results; with few if any studies documenting positive demographic responses to sage-grouse populations (see Beck et al. 2012 for a review of existing studies). For instance, Connelly et al. (2000) found a reduction in male lek attendance 1-to-5 years after prescribed burning Wyoming big sagebrush habitat in the Big Desert of southeastern Idaho. Fischer et al. (1996) found similar sage-grouse abundance on burned and unburned areas in Wyoming big sagebrush in the same study area 1-to- 3 years after treatment. Sage-grouse pellet densities did not differ between non-aerated reference sites and aerated sites in Wyoming big sagebrush 4-to-6 years following treatment in Rich County, Utah (Stringham 2010), but were higher in tebuthiuron treated sites relative to mechanical (Dixie harrow, Lawson aerator) treatments in mountain big sagebrush (*A. t. vaseyana*) in Parker Mountain in south-central, Utah (Dahlgren et al. 2006). With the use of Global Positioning System (GPS) radio telemetry, Stringham (2010) found that female sage-grouse used treated areas about 40% of the time during the lekking period and use declined during the early brood-rearing period. Unfortunately, this study was based on 2 small study areas (265 and 270 ha) treated with aeration and also lacked pre-treatment sage-grouse use information. Many other studies reporting sage-grouse response to habitat treatments also lack rigorous study designs. As such, information regarding sage-grouse use of treated areas is limited. Identification of specific habitat treatments that promote positive, negative, or neutral sage-grouse reproductive demographic response is necessary to evaluate the efficacy of sagebrush habitat treatments for sage-grouse and other wildlife species (Beck et al. 2012). Our first objective is to evaluate specific habitat treatments or levels of treatment that influence sage-

grouse reproductive demographic response. To obtain data to answer our first objective, we are monitoring adult female survival, nest success, and brood survival, before and after treatment in treated and untreated reference areas. As our study has progressed it has become obvious that it will be necessary to obtain information on grouse demographics in multiple ways. In addition to adult female survival, nest success, and brood survival we will correlate chick diet composition obtained through stable isotopes in wing feathers with body mass and wing chord length (i.e., distance in mm from axial wing attachment with the body to the tip of the wing). The purpose of this analysis is to evaluate the relative ability of locations used by early brood-rearing sage-grouse (first 2 weeks of life; Thompson et al. 2006), random locations paired with those grouse locations, and locations proposed for treatment near Jeffrey City, Wyoming to produce insects and forbs. Our ability to understand the relative capacity of treated sites to provide insects equivalent to the ratio of insects in the diets of sage-grouse chicks will provide information to further elucidate the value of sagebrush treatments to sage-grouse.

The second objective of our study is to identify the spatial and temporal scales where habitat treatments identified in objective 1 are used proportionally equal to their availability (i.e., a neutral response) or more or less often than their availability in specified landscapes by sage-grouse during the nesting and brood-rearing periods. Fine-scale habitat information coupled with demographic response rates will be imperative to answer these research questions. We will continue to monitor radio- and GPS-marked females at treatment and untreated reference sites to evaluate the extent that individually marked grouse use treatment locations. The demographic response of marked grouse will be correlated with their pattern of use of treatments to evaluate the relative value of habitat treatments to grouse. The relative use of treatment sites will provide information surrounding questions of scale and treatment type. The temporal scale necessary to identify responses to sage-grouse populations is beyond the scope of a single PhD dissertation (i.e., 3 years pre-treatment and 3 to 5 years post-treatment). Therefore, additional collaboration will be required during the post-treatment portion of this study. This progress report summarizes the 2011, 2012, and 2013 field seasons of phase 1 (pre-treatment phase) of our study. In addition, we detail our approach to identify suitable locations for treatments and provide an update on the current status of phase 2 (treatment phase).

STUDY AREA

Our study area lies in portions of Fremont and Natrona counties, Wyoming and encompasses ~2,978 km^2 (735,879 ac; Figure 1). The area includes approximately 81% Federal, 6.9% State, and 12.1% privately administered lands. Annual precipitation ranges from approximately 22.9 to 40.6 cm (9 to 16 in). Elevation ranges from 1642 to 2499 m. Important vegetation communities in the study area include Wyoming big sagebrush, mountain big sagebrush, basin big sagebrush (*A. t. tridentanta*), silver sagebrush (*A. cana*), black sagebrush (*A. nova*), and greasewood (*Sarcobatus vermiculatus*). Major land uses during our study included livestock grazing and big game hunting. There is interest to resume uranium mining, once a major land use in the area.

METHODS

Capturing and Monitoring

We captured and radio-marked female sage-grouse from leks in spring 2011, 2012, and 2013 by spot-lighting and hoop-netting (Giesen et al. 1982, Wakkinen et al. 1992). We used roosting locations of radio-marked adult females captured in spring to capture and radio-mark additional females in August 2011, 2012, and 2013. We aged females as juveniles or adults based on the shape and condition of the outermost wing primaries, and the outline of the primary tail feathers and coloration of undertail coverts (Eng 1955, Dalke et al. 1963). We attached radio transmitters (22 g, Model A4060; Advanced Telemetry Systems Incorporated, Isanti, MN, USA) to females with a PVC-covered wire necklace. We attached GPS transmitters (22-g PTT-100 Solar Argos/GPS PTT, Microwave Telemetry, Columbia, MD, USA) via rump mount during August 2012, April 2013, and August 2013. We collected blood samples by clipping a vestigial toenail from a metatarsus and wiping blood drops on Whatman (2008) FTA micro cards; blood samples are being collected for future genetic analyses. Prior to release we weighed captured sage-grouse to the nearest 1 g and measured the wing chord length of the right wing. We began locating female sage-grouse weekly during late April each year with R-1000 hand-held receivers and 3-element Yagi antennas (Communication Specialists, Orange, CA, USA). Because we were initially unable to locate all females on the ground, we used fixed-wing aircraft flights to locate missing grouse. We recorded Universal Transverse Mercator (UTM) coordinates for ground and aerial grouse locations using a hand-held, 12-channel Global Positioning System (GPS) unit (Garmin; Garmin International, Olathe, KS, USA).

Adult Female Survival, Nesting, and Brood Parameters

We used the Kaplan-Meier product-limit survival estimator (Kaplan and Meier 1958) modified for staggered entry (Pollock et al. 1989) to estimate survival rates for marked female grouse from May through August, during each year. The variance estimator for these estimates followed that described by Greenwood (1926). We located nests by circling the radio-marked females signal until the surveyor visually located the bird on a nest or isolated the nest location on the ground. To minimize human-induced nest depredation or nest abandonment, we subsequently monitored nests with triangulation from a distance of at least 50 m. Brood productivity and survival were measured at 35 and 36 days post-hatch, by back-to-back night-time spotlight counts.

Chick Dietary Selection

In 2013 we sampled 4 locations (1 location per week) for each female sage-grouse with a brood during the morning hours of the first 4-weeks of the brood-rearing period to identify potential foraging locations for grouse broods. We established a sampling plot demarcated by 2, 30-m transects, intersecting the center of the brood-rearing location and extending in the cardinal directions (Figure 2). We collected vegetation structural and ground cover data according to methods described in Kirol et al. (2012). In addition, we clipped perennial food forbs (see Kirol

et al. 2012 for a list) within 4, 1 m^2 quadrats placed along each transect. Directly adjacent to each perennial food-forb quadrat, we placed an additional 1 m^2 quadrat for insect sampling. Quadrats used to sample insects were fitted with mesh window screen to prevent insect escapement. We used an insect vacuum (duration, 2 minutes per quadrat; Model 1612, The John W. Hock Company, Gainesville, Florida, USA) to sample relative insect abundance in each quadrat. In addition to each brood-rearing location, we sampled 1 paired random location within 100-500 m of each grouse brood location. In some instances, due to time constraints, we were unable to sample a paired random location. We used night-time spotlighting to count numbers of chicks with each hen on days 35 and 36 post-hatch. During the second night (day 36 post-hatch) of night-time spotlight counts we captured 2 chicks (if available) per brood and plucked the fifth secondary feather from each chick. We selected the fifth secondary wing feather because its growth begins slightly later than more distal secondary feathers and minimizes the influence of egg yolk nutrients influencing nutritional analysis (Romanoff 1944, Johnsgard 1983, Blomberg et al 2013). At the time of capture we also weighed each chick to the nearest 1 g and measured its wing chord length to the nearest mm.

Forb samples were dried in a forced-air drying oven at 60 C for 48 hours to obtain dry mass (Beck and Peek 2005). We are currently in the process of sorting insect samples. Once complete, we will compute the ratio (by weight) of forbs and insects at each site to estimate the proportional availability of each diet item by site. Following methods of Blomberg et al. (2013) we will use feather growth bars (Grubb 1989) to determine the age of each feather isotope sample to match them with their corresponding sample location. For each feather sample we will measure $\delta^{15}N$, and $\delta^{13}C$. Analyses will be performed at the University of Wyoming Stable Isotope Facility. Once analyzed, we will use a two-source mixing model to evaluate the proportional contribution of plants and invertebrates in each sage-grouse chick's diet (Parnell et al. 2010).

Microhabitat Sampling

We evaluated vegetation parameters, ground cover, and micro-topographic microhabitat conditions at nest, brood-rearing locations (early and late brood rearing periods), summer barren hen locations, and 1 dependent-random location for each use location along 2, perpendicular 30-m transects centered at each grouse and random location following methods by Kirol et al. (2012). We sampled herbaceous and ground cover attributes using the Daubenmire (1959) technique in 20 x 50 cm quadrats (n = 17 quadrats per location). We recorded shrub canopy cover with the line intercept method and computed percentage cover for each shrub species as total intercept (m) divided by 60 m, then times 100 (Canfield 1941, Wambolt et al. 2006). We recorded shrub density by counting shrubs rooted within 1-m belt transects positioned along the right side of each 30-m transect and assessed visual obstruction (cm) using a Robel pole (Robel et al. 1970) placed in the center of each location (nest bowl or center of brood rearing, barren hen, or random location), recorded measurements at a distance of 5, 10, and 15 m at 1 m height from each cardinal direction, and averaged these 4 values to provide a single measure of visual

obstruction for each distance recorded at each location. We measured the droop height of current and residual grasses in each 20 x 50 cm quadrat and height of the tallest leader (excluding inflorescences) for each shrub encountered along each 30-m line transect.

We examined microhabitat at random locations at a random distance and direction 100–500 m from each paired grouse location (Aldridge and Boyce 2008). We began sampling nest microhabitat plots after the first successful hatch and sampled all nest and paired random locations within 1 week of known nest fate. We sampled brood-rearing and barren hen microhabitat plots as soon as possible, but no later than 1 week after identifying the location. We used two sample *t*-tests to compare habitat characteristics at use and available locations for each microhabitat plot type.

Identify Treatment Locations for Sage-Grouse Habitat

To detect a demographic change in sage-grouse populations in response to habitat treatments, we are treating habitat that was used by or has a relatively high predicted probability of use by sage-grouse. This approach ensures that we evaluate the effects of treatments in locations that sage-grouse inhabited and where sage-grouse demographic information was collected during phase 1. To capture the effect of treatment on early brood-rearing habitat we employed a use-availability design to evaluate early brood-rearing sage-grouse habitat selection (Boyce et al. 2002, Manly et al. 2002, Johnson et al. 2006). We identified resource use as locations obtained from relocations of radio-collared sage-grouse during 2011 and 2012 and pooled locations across individuals to represent a population level habitat selection response (a Type 1 Design; Manly et al. 2002, Thomas and Taylor 2006). We generated 5-times the number of use locations in each study area to represent available habitat. Available locations were randomly located across a 100% minimum convex polygon generated from sage-grouse use locations during the early brood-rearing period. We used Northwest Gap Analysis (2009) to constrain random locations to sagebrush habitats by excluding areas that were inappropriate to be considered as available habitat such as exposed rock, open water, and conifer stands. We down weighted available units to account for over representation bias (Aldridge and Boyce 2007, Carpenter et al. 2010).

We considered a suite of predictor variables on the basis of *a priori* information from previous landscape-scale research (Homer et al. 1993, Aldridge and Boyce 2007, Doherty et al. 2008, Carpenter et al. 2010, Doherty et al. 2010, Kirol 2012; Table 1). These variables encompassed environmental categories that were evaluated at 3 spatial scales around used and available points: 0.283-km radii (0.25-km²), 0.564-km radii (1.00-km²), and 1.260-km radii (4.99-km²). Our spatial scales were based on previous research documenting relationships between landscape features and sage-grouse selection at those scales (Aldridge and Boyce 2007, Berry and Eng 1985, Doherty et al. 2010, Holloran and Anderson 2005).

We used remotely sensed sagebrush products (Homer et al. 2012; Table 1), to estimate percentage canopy cover of sagebrush (all *Artemisia* species combined), big sagebrush (*A.*

tridentata species), Wyoming big sagebrush, shrubs (all species), herbaceous cover, bare ground, and litter. We calculated the mean estimated percent cover and the standard deviation for each variable across the 3 spatial scales. Standard deviation was used as a proxy for habitat diversity or heterogeneity (Kastdalen et al. 2003, Carpenter et al. 2010). We assessed quadratic relationships to evaluate potential nonlinearities in mean percent cover estimates of all sagebrush and shrub categories (i.e., selection for intermediate landscape features; Dzialak et al. 2013). In addition, we calculated estimated mean and standard deviation of shrub height (all species; Homer et al. 2012).

We used a 10-m digital elevation map (DEM; USGS 2011) to calculate slope, aspect and elevation. We used these estimates to determine a Vector Ruggedness Measure (VRM). VRM uses the variation in slope and aspect to create a single measure of terrain ruggedness (Sappington et al. 2007). VRM values were calculated using a 3 x 3 cell format (Sappington et al. 2007). We rescaled VRM values by multiplying the original values by 1000 for ease of interpretation. In addition, we generated a Normalized Difference Vegetation Index (NDVI; measure of surface greenness) from National Agriculture Imagery Program (NAIP) color aerial imagery (U.S. Department of Agriculture [USDA] 2010).

Statistical Methods

We computed a Pearson's correlation matrix to test for multicollinearity among predictor variables and omitted one of each correlated variable when correlation coefficients (r) were $\geq |0.7|$. We inspected tolerance (t) values and removed one of the correlated variables when (t) $\leq |0.40|$ (Allison 2009, SAS Institute 2009). We checked for stability and consistency of regression coefficient estimates when variables were moderately correlated ($|0.3| \leq r \leq |0.7|$). Undetected correlations between variables can cause instability in the signs of coefficients and also result in inflated standard errors (Doherty 2008). If variables were correlated, the variable with the lowest AIC score was retained. We did not permit correlated variables to compete in the same model at any level of model selection.

We used a 2nd-order Akaike's Information Criterion (AICc) to assess model support. For all scale-dependent variables, we examined the 3 spatial scales described above to determine the scale that was most correlated to sage-grouse early brood occurrence by testing each variable scale individually and comparing AICc scores (Arnold 2010, Carpenter et al. 2010, Doherty et al. 2010). For each variable we retained the scale with the lowest AICc score corresponding to the greatest predictive potential (Burnham and Anderson 2002). After the selection of the appropriate scale, we removed unsupported variables based on whether 85% confidence intervals (CIs) around odds ratios included 1 (Hosmer and Lemeshow 2000, Arnold 2010). An odds ratio of 1 indicates no significant difference between used and available habitat units (Hosmer and Lemeshow 2000). We used variable screening to remove unsupported predictor variables, thereby reducing the likelihood of over fitting models in our model selection process (Burnham and Anderson 2002, Arnold 2010).

We used a sequential model selection approach (Arnold 2010) by evaluating the relative importance of predictor variables for occurrence. We explored all variable combinations (Burnham and Anderson 2002). We considered models with AICc scores in the range of 0–7 units (Burnham and Anderson 2002) to be competitive with the top model. We assessed variable importance by summing Akaike model weights across models that included the variable of interest (Arnold 2010). When a single top model was not apparent based on AICc scores (≤7 units considered competitive) we used multi-model inference to calculate final parameter coefficients, 95% confidence intervals, and odds ratios. We determined confidence sets for those models where Akaike weights (w_i) were within 10% of the top model (Burnham and Anderson 2002). At the final level of model selection we further filtered variables with poor support for a true statistical difference between groups that had odds ratios with 95% CIs that overlapped 1 (Hosmer and Lemeshow 2000). We performed a 5-fold cross validation to evaluate the predictive performance of our top model (Boyce et al. 2002). We conducted all statistical analyses with Statistical Analysis Software (SAS), version 9.2 (SAS Institute 2009).

We mapped our final occurrence model with 30-m pixel resolution across the study area. For interpretation, the final occurrence resource selection function (RSF) models were mapped with values rescaled between 0 and 1 (linear stretch; DeCesare et al. 2012) where 1 represents the highest and 0 represents the lowest predicted probability of occurrence. We distributed our predicted occurrence probabilities into 4 quartiles on the basis of percentile breaks in predicted probabilities (Sawyer et al. 2006). Areas of high occurrence (highest 25% of predicted probabilities for summer occurrence) were assigned a value of 4, moderate-high (51 to 75% predicted probabilities for summer occurrence) a value of 3, moderate-low (26 to 50% predicted probabilities for summer occurrence) a value of 2, and low (lowest 25% of predicted probabilities for summer occurrence) a value of 1.

Upon visual inspection, we documented clusters of early brood-rearing locations spatially separated across the study area. This was attributed to the spatial arrangement of leks that were chosen for capture because females occupied habitats in the relative vicinity of the lek in which they were bred, but also the habitat conditions present in those locations that were harboring use. Because of the relatively high site fidelity of sage-grouse across years (Berry and Eng 1985, Dunn and Braun 1985, Fischer et al. 1993, Holloran and Anderson 2005, this study) clusters of sage-grouse use locations during the early brood-rearing period were deemed appropriate for outlining treatment areas. This ensured that 1) locations were in suitable sage-grouse habitat in a location that we could test for a response to sagebrush treatments, and 2) grouse have occurred in and likely will occur in these locations in the future. Each location was buffered by the mean distance between nest and the week 2 early brood rearing locations (1048 m). Then we generated a 100% minimum convex polygon around buffered locations that were within similar clusters of use locations.

We restricted potential treatment areas to locations falling in the two highest predicted probability bins. We removed from consideration locations of cultural significance, such as

historical trails, and locations where long-term rangeland monitoring takes place (BLM Lander Field Office). Following the Wyoming Game and Fish Department (WGFD) protocols for treating sagebrush for the benefit of sage-grouse in core areas (WGFD 2011) we buffered known leks within the study area by 0.97- km (2.96-km^2) and removed locations closer than 0.97 km to leks from treatment consideration.

We followed the State of Wyoming Executive Order 2011-5 guidelines detailing sage-grouse core area protection within core areas to calculate the maximum allowable disturbance by means of a Density/Disturbance Calculation Tool (DDCT) for our proposed project areas (State of Wyoming 2011). Stipulations for the DDCT are found in the Wyoming Game and Fish Department protocols for treating sagebrush (WGFD 2011). We digitized existing disturbance using NAIP imagery (NAIP 2009). Disturbance included any human alterations such as roads, energy infrastructure, and human dwellings. We used geographic information predictor variables from our best approximating models to further refine suitable treatment locations within overall project locations. We removed locations when shrub cover was less than 2 standard deviations of the mean grouse use location (7.9% as computed from Homer et al. 2012 data layer) so we would not treat locations with already sparse shrub cover. We considered treatment locations as suitable if they were in areas greater than 100 m from water, less than 15% slope, and had VRM values no greater than two standard deviations above the mean grouse use location. Removing steep slopes and high ruggedness (VRM) was a precautionary measure to ensure accessibility and equipment operator safety during treatment.

Sagebrush Nutritional Quality

Jennifer Forbey, an Assistant Professor at Boise State University, and Jeff Beck received funding in 2013 from the Bates Hole, South-Central, and Southwest Local Sage-Grouse Working Groups to examine the effects of mowing and herbicide treatments on the nutritional quality of sagebrush within the study area. Within each of the 4 treatment areas (identified below), we will construct 6, 60 m x 30 m grazing exclosures to evaluate the response of vegetation and ground cover following treatment in the absence of livestock grazing. The general design of these exclosures will exclude a 30 x 30 m (0.22 acre) area of untreated sagebrush with an adjoining 30 x 30 m area excluding livestock grazing in treated sagebrush. The size of these exclosures will permit us to evaluate vegetation and ground cover characteristics within an area equivalent to the size of plots we use to assess sage-grouse microhabitat selection at nests and brood-rearing locations. We will contract to have 6 exclosures installed at random locations in each of the 4 treatment study areas for a total of 24 exclosures.

Prior to treatments, we randomly selected 18 plants (with at least 6 plants less than 25.4 cm [10 in]) within the treated portion of each exclosure to maximize the likelihood of at least 6 of these plants surviving (assuming less than a 50% kill outcome in treatments) and 12 plants (with at least 6 plants less than 25.4 cm) within the untreated portions of each of the 24 exclosures. We collected 5–8 sprigs from each selected sagebrush plant within each collection site by clipping the stems with pruning shears and minimizing damage to remaining leaves and stems. Each plant

was marked with a metal plant tag to allow for long term monitoring of treatment effects on dietary quality of plants. Sagebrush samples were stored in a –20º freezer.

We will collect vegetation from 6 of the same plants that survived treatment during each winter following treatments (winters 2013 –2014 and 2014–2015), plus an additional 6 plants per treatment that were not sampled in the previous sampling period. Collection and analysis of new plants will allow us to account for effects of our clipping on diet quality. Post-treatment samples will be collected between November and March, which is after ephemeral leaves fall and before new ephemeral leaves grow. We will focus on collecting stems from plants containing new growth in the second winter season.

Of the original 18 plants sampled within the treated portions of exclosures, we will only analyze those plants that survived through the post-treatment sampling periods. We will combine the plants within each treatment (untreated or treated pair, repeated sample or new sample) within a treatment type to make a single composite sample for analysis. We will have 24 composite samples of the same plant for the pretreatment, post-treatment 1st winter, post-treatment 2nd winter as well as 24 composite samples of new plants for the post-treatment 1st winter and 2nd winter. We will then grind leaves from each composite sample in liquid nitrogen using a mortar and pestle, and then divide each sample into three subsamples. The first subsample will be used to quantify individual monoterpenes via headspace gas chromatography. The second subsample will be used in a colorimetric assay to quantify total phenolic concentrations. Individual phenolics will be quantified from the same sample using high pressure liquid chromatography. The third subsample will be dried and analyzed for nitrogen using an elemental analyzer to quantify crude protein content.

We will use crude protein as a nutrient variable because it can affect herbivore foraging behavior and reproductive success (Matson 1980). Nutrient concentrations will be quantified as percentage of dry mass. We chose monoterpenes and phenolics as plant secondary metabolite variables because both classes of compounds exert deleterious effects (e.g., toxicity, increased energy expenditure, nutrient binding) on herbivores (Dearing et al. 2005) and occur in relatively high concentrations in sagebrush (Kelsey et al. 1982). To test the response of sagebrush dietary quality (e.g., crude protein or chemical defenses) to treatments, we will use a repeated measures 2-way ANOVA with treatment type (mowing or herbicide as the different conditions) and treatment within an exclosure (untreated or treatment) as the between-subjects effects and time (before and after treatment) as the within-subjects effect. We will also compare diet quality between plants that were sampled repeatedly and new plants within treatments using an ANOVA with plant type (repeat or new plant) as the between-subjects effect.

RESULTS

Capturing and Monitoring

We captured and radio-marked 32 female sage-grouse from 6 leks in spring 2011 and 34 females in August 2011. In 2012, we captured and radio-marked 51 females from 9 leks in spring and 50 females (28 VHF and 22 GPS) in August. In 2013, we captured and radio-marked 96 additional females (70 VHF and 26 GPS). We monitored 32, 84, and 101 females during 2011, 2012, and 2013 field seasons respectively. During the 2011, 2012, and 2013 field seasons we recorded approximately 450, 960, and 786 ground points including nest, brood-rearing, and barren female locations, from radio marked females respectively. From 1 August 2012 through 4 January 2014 we obtained 34,608 locations from 48 females equipped with rump-mounted GPS transmitters.

Adult Female Survival, Nesting, and Brood Parameters

In 2011, 25 of 32 (78 ± 7.6% [SE]) radio-marked female sage-grouse survived from May through 1 August. In 2012, 69 of 84 (83 ± 3.7%) radio-marked females survived from May through 1 August. In 2013, 78 of 101 (79 ± 3.7%) radio-marked females survived from May through 1-August. In 2011, we located 23 nests, which included 21 first nests and 2 re-nests. Both of the re-nests were depredated. Six (28.6%) first nests were successful, 13 (61.9%) were depredated (including 1 hen mortality), and 2 (9.5%) were abandoned (Table 2). Hatch dates for successful nests ranged from 2–24 June 2011. Of the 6 females with successful nests, 4 were alive and with broods 35 days post-hatch (66.6% brood success). On average, there were 0.46 chicks per radio-marked female by day 36 post-hatch in 2011. In 2012, we located 58 nests, which included 55 first nests and 3 re-nests. Twenty-five (45.5%) first nests were successful, 25 (45.5%) were depredated, and 5 (9.0 %) were abandoned. One second nest was successful, one was depredated, and one was abandoned. Hatch dates for successful nests in 2012 ranged from 10 May to 9 June. The percentage of females that were alive and with broods 36 days post-hatch in 2012 was 70.8%. On average, there were 0.68 chicks per radio-marked female by day 36 post hatch in 2012. In 2013, we located 85 nests, which were all first nests. Heavy winter storms during April 2013 may have resulted in some undetected nest abandonment events. Forty-seven (55.3%) nests were successful, 36 (42.4%) were depredated (including 4 hen mortalities), and 2 (2.3 %) were abandoned. Hatch dates for successful nests in 2013 ranged from 27 May to 26 June. The percentage of females that were alive and with broods 36 days post-hatch in 2013 was 52.2%. On average, there were 1.1 chicks per marked female by day 36 post hatch in 2013.

Chick Diet Selection

In 2013, we collected vegetation and insect samples at 128 brood and 73 random brood locations and collected feathers from 44 chicks in 23 broods. To date, we have estimated dry mass for each forb sample and separated insect samples from litter for roughly one third of our samples. Once insect samples are sorted we will estimate dry mass for each insect collection. We will begin

processing feather samples for isotope samples in early January 2014. It is anticipated that we will have results for insect dry mass and feather samples by 1 April 2014.

Microhabitat Sampling

From 2011–2013, we sampled 166 nest locations, 117 brood locations, and 116 barren hen roost locations. We sampled an equal number of paired random locations, which totaled 798 microhabitat locations during 2011, 2012, and 2013. We detected significant differences between habitat characteristics at grouse-used and available locations at the alpha = 0.05 level (Tables 4-7). We found significantly higher percentages of big sagebrush and total shrub cover, greater height (cm) of big sagebrush and total shrubs, greater visual obstruction, lower percentage gravel and rock cover, and higher litter at nest locations relative to random locations (Table 4). Early brood-rearing locations were characterized as having greater big sagebrush cover and big sagebrush height, greater total shrub height, greater visual obstruction, and higher litter relative to available locations (Table 5). During the late brood-rearing period, grouse selected areas with higher percentage big sagebrush and total shrub cover, greater height of big sagebrush and total shrubs, greater visual obstruction, greater cover of food-forbs, more bare ground, and higher litter cover than randomly available (Table 6). Non-brood-rearing females selected locations with greater percentage big sagebrush and total shrub cover, greater height of big sagebrush and total shrubs, greater visual obstruction, higher perennial grass height (cm), lower percentage residual grass cover, greater food-forb cover, less bare ground, lower gravel and rock, and greater litter than what was available at random (Table 7).

Identify Treatment Locations for Sage-Grouse Habitat.

Seventeen models, which included 6 predictor variables at 2 spatial scales, made up our candidate set for early brood-rearing habitat selection. At the 0.25-km^2 (0.283 km radius) scale shrub height was negatively correlated with occurrence and shrub cover was positively correlated with occurrence. NDVI and variability in shrub cover were positive predictors of occurrence when averaged across 4.99-km^2 (1.260-km radii). In contrast, variability (as measured by standard deviation) in Wyoming big sagebrush was a strong negative predictor of occurrence at the 4.99 km^2 scale. Because our candidate set contained more than one model, we performed model averaging to estimate parameter coefficients, 95% confidence intervals, and odds ratios for all variables contained within the candidate set.

Model averaging indicated that the 95% confidence interval for the odds ratios of distance to water, shrub height, and variability of shrub height overlapped 1 and were therefore considered uninformative parameters of habitat selection. Our best approximating model of sage-grouse early brood rearing habitat consisted of shrub cover (0.283 km radius), NDVI (1.260 km radius), and variability in Wyoming big sagebrush cover (1.260 km radius; Table 3). Cross-validation indicated our best model was a strong positive predictor of sage-grouse early brood rearing habitat use (r_s = 0.96, P = 0.001, n = 10). Through the process of developing a RSF (Figure 3)

and retaining the 2 highest predicted relative probability bins we overlayed clusters of early-brood rearing locations that were spatially separated across our study area and located 6 spatially separated project treatment locations (2 mowing, 2 spike, and 2 reference sites). Within the 4 treatment areas, we generated n = 4–5, ~2.59-km^2 polygons that were used to demarcate locations for treatment in each of the 4 treatment sites (Figure 4).

Sagebrush Nutritional Quality

To date, we have collected all sagebrush samples within treated and untreated portions of the 12 mowing exclosure sites. We will complete sampling in the 12 spike exclosure sites during January 2014.

CURRENT STATUS OF TREATMENT IMPLEMENTATION

On 14 October 2013 we were approved for funding by the Wyoming Wildlife and Natural Resource Trust (WWNRT) and have since been actively working with the University of Wyoming, Wyoming Game and Fish Department, Bureau of Land Management, and vendors to process administrative tasks associated with funding, planning, and cultural and ecological clearances necessary to proceed with conducting habitat treatments. We have clearance from the BLM (Ecological Assessment and archaeological clearance) to move ahead with implementation of treatments and have the Density Disturbance Calculation approval from the WGFD (approved on 22 Nov 2013) to treat sagebrush in sage-grouse core areas. We have also established an account at the University of Wyoming to encumber the funding we received from the WWNRT. We have signed agreements with Big Horn Cooperative Marketing Association (i.e., Big Horn Coop) in Greybull, Wyoming to supply diesel fuel for tractors used to mow sagebrush and with Stotz Equipment in Riverton, Wyoming to rent a second tractor and mower and to purchase replacement blades, service the tractor, buy parts and fluids necessary for tractor maintenance. We also signed an agreement with Ag Flyers, Inc. from Torrington, Wyoming to purchase and apply Spike 20P at a specified application rate. We will work on identifying and creating a funding agreement with a fencing contractor to build the exclosures this spring. Currently, we plan to begin mowing in January, 2014 and to apply Spike 20P in spring 2014

FUTURE DIRECTION

During 2014 we intend to maintain our sample of females equipped with VHF and GPS transmitters to achieve our initial goal of 135 VHF-marked and 27 GPS-marked grouse. We will continue to monitor radio-marked female sage-grouse similar to previous years to determine reproductive demographic rates in treatment areas and off-site reference areas. We will sample microhabitat plots at sage-grouse use locations and paired-random locations, and at exclosure sites that will be built in spring 2014. We plan to continue examining the ability of stable isotope analysis of sage-grouse chick feathers to infer diet selection and subsequent body condition. If results from the 2013 field season indicate a strong relationship between chick feather stable isotope samples and diet selection, we may be better capable of understanding the role of diet

selection on chick survivability. Through measuring forb and insect availability at grouse brood-rearing sites we can potentially evaluate the mix of foods that elicit positive responses in chick sage-grouse body condition. The relative availability of food items can in turn be used to assess the ability of treatment sites to promote growth in sage-grouse chicks.

We also plan to begin evaluating the effects of previous treatments on male lek attendance across Wyoming. A retrospective study could be used to replace space with time by returning to locations that were treated at different times to evaluate grouse response to treatments that have recovered at different temporal scales (Morrison 2009). Because sagebrush communities recover over long time periods it may be difficult to estimate demographic responses in sage-grouse populations without evaluating long-term linkages between population and habitat responses. In 2012, sagebrush treatments and disturbances within Wyoming sage-grouse core areas were compiled into an ArcGIS File Geodataset (Conservation Research Center of Teton Science Schools 2012). The Wyoming Game and Fish Department lek database contains annual count data since 1948 for ~ 2,200 leks across Wyoming. With this information, we will model trends in male sage-grouse lek attendance as a function of sagebrush disturbance parameters at multiple spatial scales around leks.

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Table 1. Variables used in the model selection analysis evaluating greater sage-grouse early brood rearing habitat selection in Fremont and Natrona counties, Wyoming, USA, 2011 and 2012.

Variable names	Description
Bsage†	Mean big sagebrush (*Artemisia tridentata*) cover (%; Homer et al. 2012)
Bsagesd	Standard deviation of big sagebrush cover (%; Homer et al. 2012)
DEM	Digital elevation model to calculate aspect, slope, and elevation(USGS 2011)
NDVI	Normalized Difference Vegetation Index (NAIP imagery; USDA 2010)
Sage†	Mean sagebrush (all *Artemisia* spp.) cover (%; Homer et al. 2012)
Sagesd	Standard deviation of sagebrush cover (%; Homer et al. 2012)
Shrub†	Mean shrub cover (%; Homer et al. 2012)
Shrubsd	Standard deviation of shrub cover (%; Homer et al. 2012)
Shrubhgt	Mean shrub height (cm; Homer et al. 2012)
Shrubhgtsd	Standard deviation of shrub height (cm; Homer et al. 2012)
VRM	Mean topographic roughness (vector roughness measure [VRM; Sappington et al. 2007])
Wysage†	Mean Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) cover (%; Homer et al. 2012)
Wysagesd	Standard deviation of Wyoming big sagebrush cover (%; Homer et al. 2012)

†Quadratic transformation assessed

Table 2. Measured demographic rates of sage-grouse during summers 2011–2013 in Fremont and Natrona counties, Wyoming, USA.

Parameter	2011	2012	2013
Females monitored (*n*)	32	84	101
Female survival (% ± SE)	78 ± 7.6	83 ± 3.7	79 ± 3.7
Nests (*n*)	23	58	85
Nest initiation (%)	71	67	84
Nest success (%)	28.6	45.5	55.3
Broods monitored (n)	6	27	47
Brood success (%)	66.6	70.8	52.2
Chicks per marked female	0.46	0.68	1.10

Table 3. Parameter estimates, variable importance values, and odds ratios for variables that were included in top models(s) depicting sage-grouse early brood-rearing habitat selection in south-central Wyoming, USA, 2011 and 2012.

Parameter	Estimate	95% CI		Variable importance	Odds ratio	95% CI	
		Lower	Upper			Lower	Upper
Intercept	-4.260	-6.991	-1.527				
NDVI1260	0.016	0.006	0.025	0.923	1.016	1.006	1.026
Shrub283	0.096	0.013	0.178	0.702	1.100	1.013	1.195
WY1260SD	-0.4921	-0.855	-0.129	0.824	0.611	0.425	0.879

Table 4. Mean habitat characteristics (± SE) surrounding n = 166 sage-grouse nest and n = 166 available locations in Fremont County, Wyoming, summers 2011–2013.

	Nest Locations		Available Locations			
Parameter	**Mean**	**SE**	**Mean**	**SE**	t_{165}	P
Shrub Characteristics						
Big sagebrush canopy cover (%)	23.9	0.7	20.2	0.6	-3.87	<0.001
Big sagebrush height (cm)	30.8	0.9	25.6	0.6	-4.72	<0.001
Big sagebrush density[1]	1.53	0.04	1.48	0.05	-0.83	0.406
Shrub canopy cover (%)	26.9	0.8	22.6	0.6	-4.35	<0.001
Shrub height (cm)	29.8	0.8	25.1	0.6	-4.56	<0.001
Shrub density[1]	1.83	0.04	1.75	0.05	-1.26	0.208
Visual obstruction (cm)[2]	42.6	1.1	34.3	0.8	-6.09	<0.001
Grass Height (cm)[3]						
Perennial grass height	16.5	0.3	15.8	0.3	-1.85	0.066
Residual grass height	13.4	0.4	13.2	0.3	-0.50	0.617
Herbaceous Canopy Cover (%)[3]						
Annual grass	0.14	0.09	0.00	0.00	-1.49	0.136
Perennial grass	11.9	0.5	11.2	0.5	-1.03	0.303
Residual grass	8.2	0.5	8.2	0.5	-0.05	0.957
Food-forb	2.8	0.4	2.4	0.3	-0.81	0.420
Non-food forb	0.9	0.1	1.0	0.1	0.15	0.884
Ground Cover (%)[3]						
Bare ground	20.5	1.1	22.0	1.1	0.94	0.348
Cactus cover	0.14	0.04	0.19	0.05	0.74	0.458
Cryptobiotic crust	0.10	0.03	0.08	0.03	-0.34	0.735
Gravel and rock	7.8	0.8	11.1	1.1	2.54	0.012
Litter	40.9	1.1	34.8	1.1	-3.84	<0.001

[1]Big sagebrush and total shrub density estimates (per 1 m^2) from 1-m belt transects

[2]Visual obstruction estimates averaged across Robel pole readings along each cardinal direction at 5, 10, and 15 m from the intersection of two 30-m transects at use or available locations.

[3]Percent cover attributes from 17 Daubenmire quadrats at each location

Table 5. Mean habitat characteristics (± SE) surrounding *n* = 68 sage-grouse early brood-rearing locations and *n* = 68 available locations in Fremont County, Wyoming, summers 2011–2013.

	Brood Locations		Available Locations			
Parameter	**Mean**	**SE**	**Mean**	**SE**	t_{67}	***P***
Shrub Characteristics						
Big sagebrush canopy cover (%)	19.7	1.0	17.0	0.9	-2.00	0.047
Big sagebrush height (cm)	31.5	1.7	25.5	1.0	-3.05	0.003
Big sagebrush density[1]	1.53	0.09	1.33	0.08	-1.66	0.099
Shrub canopy cover (%)	22.6	1.0	20.0	1.0	-1.86	0.065
Shrub height (cm)	30.3	1.5	24.7	1.0	-3.05	0.003
Shrub density[1]	1.91	0.09	1.80	0.10	-0.86	0.391
Visual obstruction (cm)[2]	27.3	1.3	20.9	1.4	-3.34	0.001
Grass Height (cm)[3]						
Perennial grass height	16.4	0.5	15.4	0.4	-1.53	0.128
Residual grass height	13.1	0.5	13.3	0.5	0.23	0.822
Herbaceous Canopy Cover (%)[3]						
Annual grass	0.05	0.04	0.10	0.09	0.46	0.650
Perennial grass	11.6	1.1	9.2	0.8	-1.81	0.073
Residual grass	10.3	0.8	9.5	0.7	-0.82	0.415
Food-forb	4.5	0.8	2.7	0.7	-1.72	0.087
Non-food forb	1.3	0.3	1.7	0.3	1.04	0.302
Ground Cover (%)[3]						
Bare ground	20.7	1.6	24.0	1.8	1.36	0.177
Cactus cover	0.10	0.06	0.05	0.03	-0.66	0.510
Cryptobiotic crust	0.06	0.02	0.10	0.06	0.71	0.478
Gravel and rock	6.2	1.3	9.0	1.5	1.44	0.152
Litter	42.0	2.3	34.0	2.1	-2.56	0.012

[1]Big sagebrush and total shrub density estimates (per 1 m^2) from 1-m belt transects

[2]Visual obstruction estimates averaged across Robel pole readings along each cardinal direction at 5, 10, and 15 m from the intersection of two 30-m transects at use or available locations.

[3]Percent cover attributes from 17 Daubenmire quadrats at each location

Table 6. Mean habitat characteristics (± SE) surrounding *n* = 49 sage-grouse late brood-rearing locations and *n* = 49 available locations in Fremont County, Wyoming, summers 2011–2013.

	Brood Locations		Available Locations			
Parameter	**Mean**	**SE**	**Mean**	**SE**	t_{48}	***P***
Shrub Characteristics						
Big sagebrush canopy cover (%)	18.4	1.6	13.9	1.6	-2.01	0.047
Big sagebrush height (cm)	40.3	3.7	25.8	3.2	-2.96	0.004
Big sagebrush density[1]	1.07	0.09	3.37	2.31	1.00	0.321
Shrub canopy cover (%)	24.9	1.8	19.4	1.9	-2.14	0.035
Shrub height (cm)	39.2	3.6	25.3	3.0	-2.96	0.004
Shrub density[1]	1.60	0.11	4.08	2.34	1.06	0.293
Visual obstruction (cm)[2]	22.7	3.2	35.8	2.2	-3.36	<0.001
Grass Height (cm)[3]						
Perennial grass height	16.5	0.8	15.1	0.7	-1.35	0.179
Residual grass height	14.1	0.9	14.3	0.7	0.14	0.888
Herbaceous Canopy Cover (%)[3]						
Annual grass	0.10	0.09	0.00	0.00	-1.06	0.293
Perennial grass	11.6	1.6	10.3	2.2	-0.51	0.61
Residual grass	9.8	0.8	11.5	0.8	1.54	0.128
Food-forb	6.9	1.0	4.1	0.9	-2.15	0.034
Non-food forb	1.8	0.4	2.2	0.6	0.50	0.622
Ground Cover (%)[3]						
Bare ground	18.7	2.4	26.5	2.5	2.27	0.026
Cactus cover	0.01	0.01	0.14	0.07	1.82	0.071
Cryptobiotic crust	0.05	0.04	3.14	2.36	1.31	0.193
Gravel and rock	4.0	1.2	7.6	2.5	1.31	0.194
Litter	38.9	2.8	30.9	2.3	-2.18	0.0318

[1]Big sagebrush and total shrub density estimates (per 1 m^2) from 1-m belt transects

[2]Visual obstruction estimates averaged across Robel pole readings along each cardinal direction at 5, 10, and 15 meters from the intersection of two 30-meter transects at use or available locations.

[3]Percent cover attributes from 17 Daubenmire quadrats at each location

Table 7. Mean habitat characteristics (± SE) surrounding *n* = 116 sage-grouse late brood-rearing locations and *n* = 116 randomly available locations in Fremont County, Wyoming, summers 2011–2013.

	Roost Locations		Available Locations			
Parameter	**Mean**	**SE**	**Mean**	**SE**	t_{115}	***P***
Shrub Characteristics						
Big sagebrush canopy cover (%)	21.6	1.1	16.0	0.9	-3.98	<0.001
Big sagebrush height (cm)	36.7	2.0	22.6	0.9	-6.31	<0.001
Big sagebrush density[1]	1.31	0.08	1.43	2.31	1.00	0.318
Shrub canopy cover (%)	27.8	1.2	20.1	0.8	-5.54	<0.001
Shrub height (cm)	36.1	1.8	22.8	0.9	-6.58	<0.001
Shrub density[1]	1.93	0.11	2.00	2.34	0.54	0.592
Visual obstruction (cm)[2]	36.8	1.7	22.1	1.0	7.42	<0.001
Grass Height (cm)[3]						
Perennial grass height	17.6	0.6	15.1	0.5	-3.31	0.001
Residual grass height	15.4	0.6	15.7	0.5	0.36	0.717
Herbaceous Canopy Cover (%)[3]						
Annual grass	0.16	0.13	0.08	0.07	-0.47	0.636
Perennial grass	11.1	0.9	9.8	0.8	-1.06	0.289
Residual grass	9.9	0.6	11.7	0.5	2.43	0.016
Food-forb	3.0	0.5	1.5	0.3	-2.60	0.009
Non-food forb	3.5	0.4	3.6	0.4	0.15	0.882
Ground Cover (%)[3]						
Bare ground	17.2	1.3	20.6	1.4	1.81	0.070
Cactus cover	0.08	0.04	0.08	0.03	0.15	0.878
Cryptobiotic crust	0.13	0.04	0.23	0.07	1.18	0.238
Gravel and rock	4.3	0.7	12.2	1.4	4.99	<0.001
Litter	49.1	1.6	40.3	1.7	-3.78	<0.001

[1]Big sagebrush and total shrub density estimates (per 1 m^2) from 1-m belt transects

[2]Visual obstruction estimates averaged across Robel pole readings along each cardinal direction at 5, 10, and 15 m from the intersection of two 30-m transects at use or available locations.

[3]Percent cover attributes from 17 Daubenmire quadrats at each location

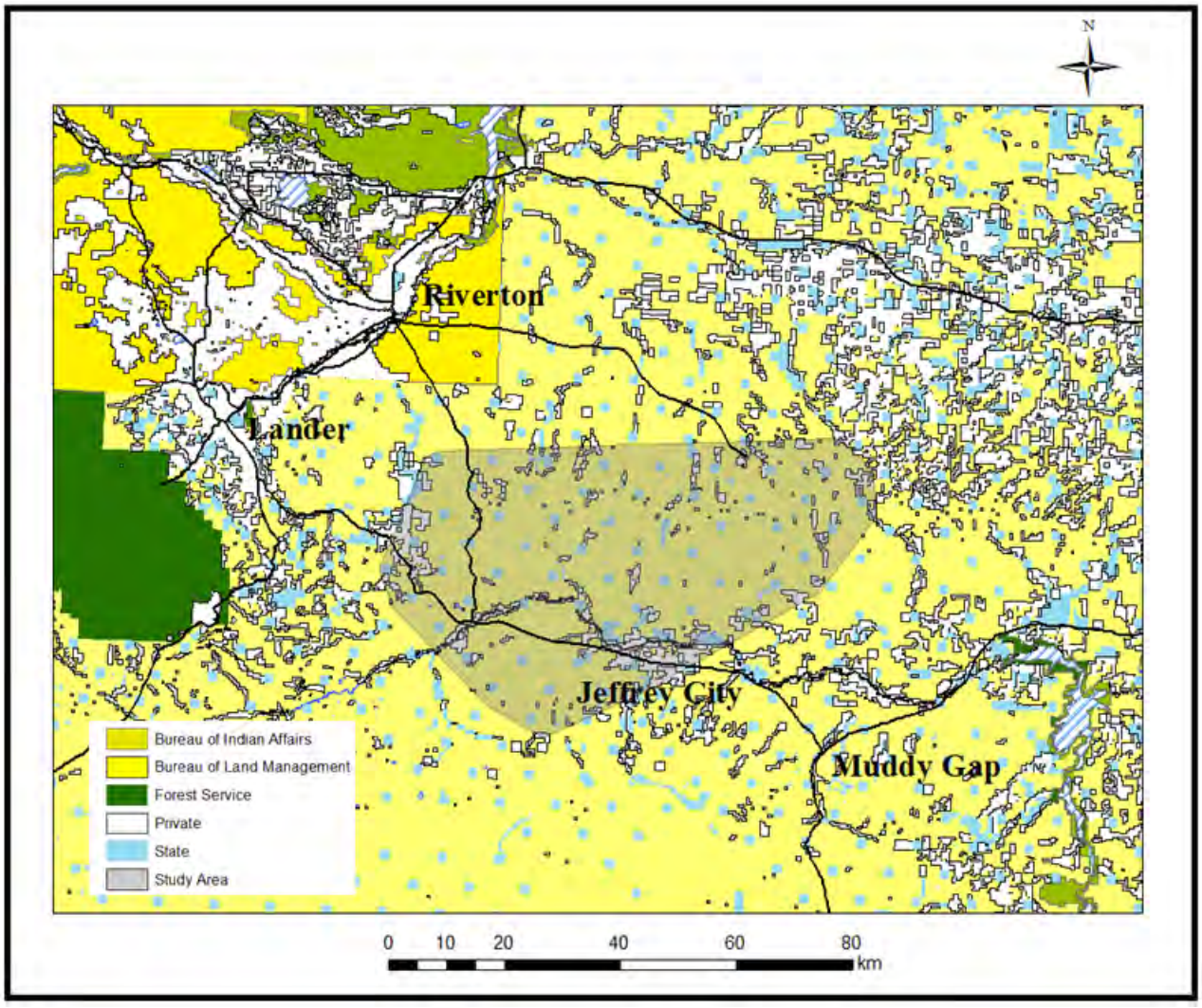

Figure 1. Study area location map (grey-shaded polygon), Fremont and Natrona counties, Wyoming, USA. The study area (2,978 km^2) was defined as a 100% minimum convex polygon surrounding 1085 sage-grouse radio-telemetry locations during May-August 2011 and 2012.

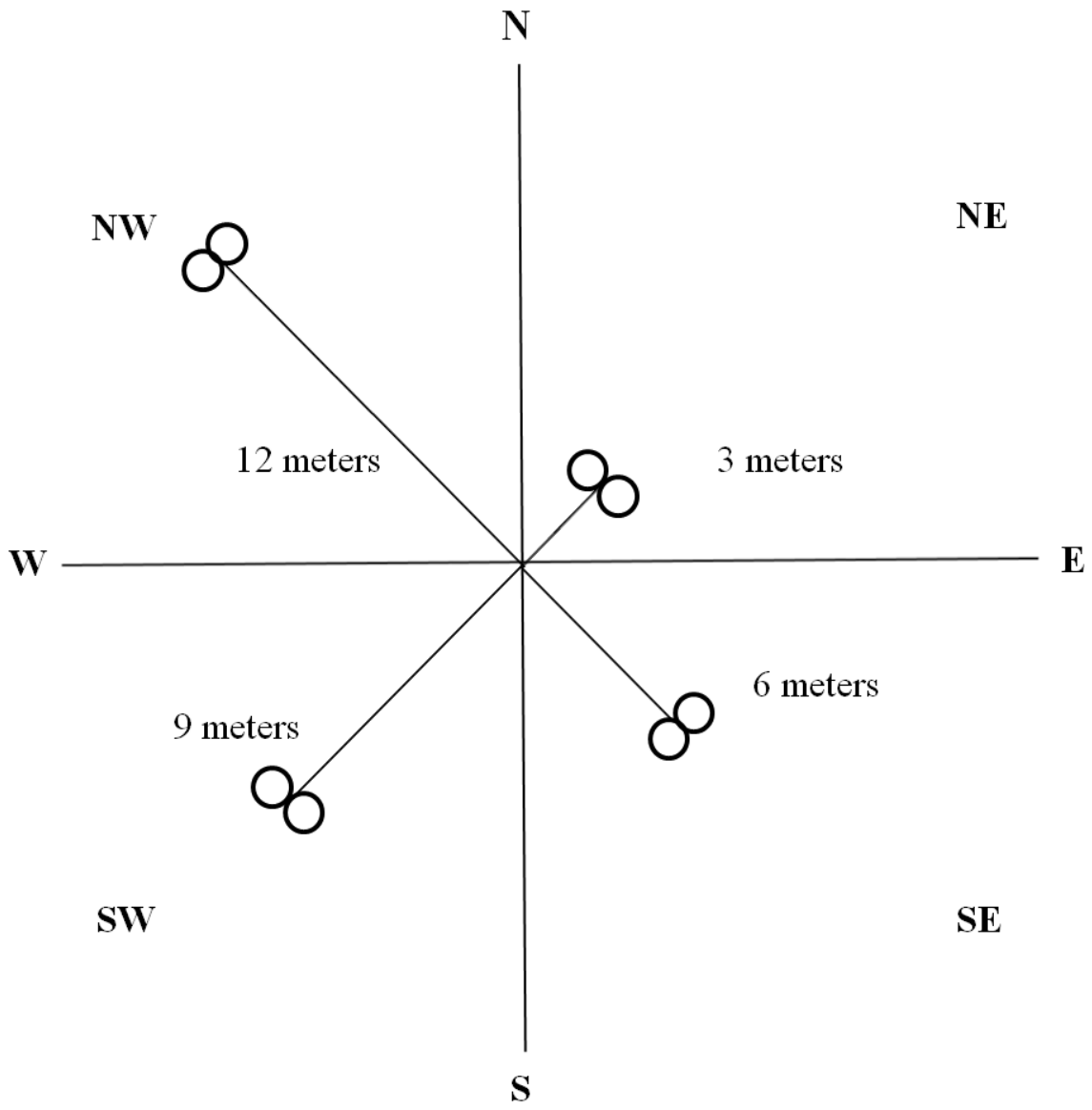

Figure 2. Stratified forb and insect sampling scheme centered on two 30-m transects that created 4 plots (NW, NE, SE, SW). We randomly selected the first sampling quadrat and then sampled each quadrat at 3, 6, 9, and 12 m, respectively from the intersection of two 30-m transects. Circles depict 1 m^2 food-forb and adjacent insect sampling quadrats.

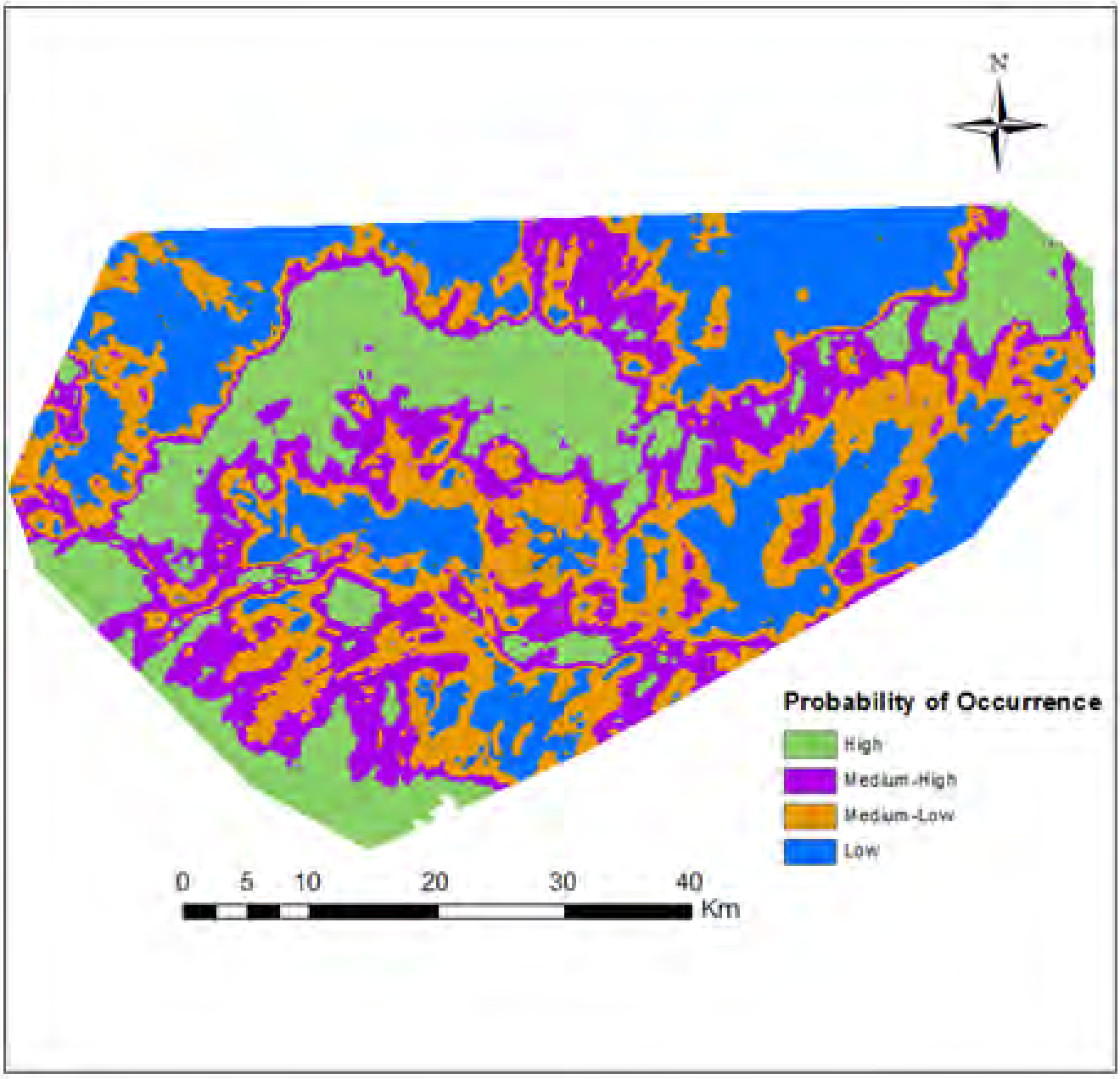

Figure 3. Predicted relative probability of sage-grouse early brood-rearing occurrence in Fremont and Natrona counties, Wyoming, summers 2011 and 2012.

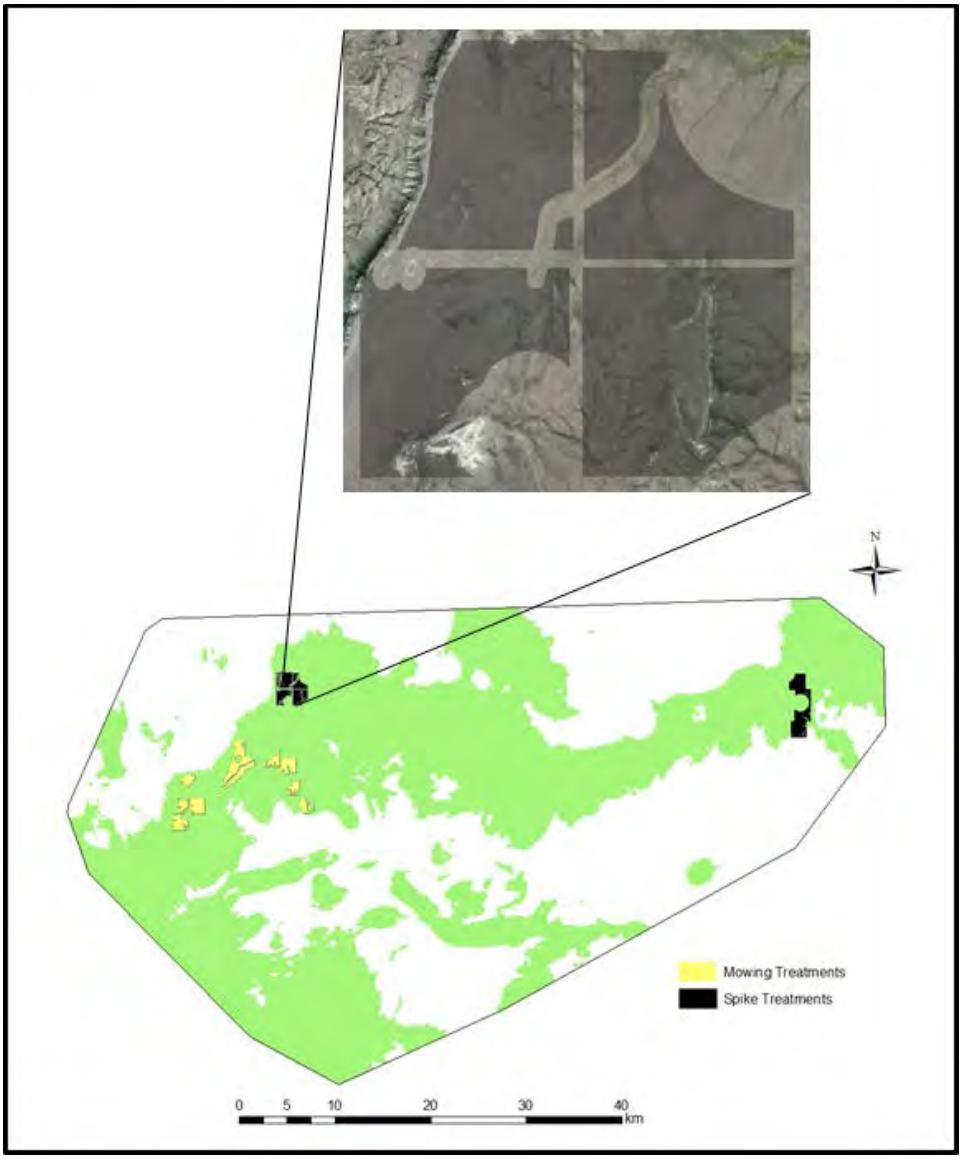

Figure 4. Polygons used to demarcate locations for treatment in each of the 4 treatment sites. The excerpt is from one Spike 20P treatment in the northwestern portion of the study area.