



## Alton Coal Development, LLC

463 North 100 West, Suite 1

Cedar City, Utah 84720

Phone (435) 867-5331 • Fax (435) 867-1192

C/025/0005  
Received 6/12/15  
Task ID #4934

June 12, 2015

Daron R. Haddock  
Coal Program Manager  
Oil, Gas & Mining  
1594 West North Temple, Suite 1210  
Salt Lake City, UT 84114-5801

Subject: **ACD 2014 Annual Progress Report, Alton Coal Development, LLC, Coal Hollow Mine, Kane County, Utah, C/025/0005,**

Dear Mr. Haddock,

Alton Coal Development, LLC is submitting a PDF copy of the Annual 2014 Progress Report for review. The requested changes made to the document have been highlighted in redline strikeout for easier review.

Changes to the MRP associated with this amendment have been uploaded to the DOGM's server for review. Upon approval, 2 (two) clean hard copies of the text for insertion into the MRP will be submitted. Please do not hesitate to contact me if you have any questions 435-691-1551.

Sincerely

B. Kirk Nicholes

Environmental Specialist

## APPLICATION FOR COAL PERMIT PROCESSING

Permit Change  New Permit  Renewal  Exploration  Bond Release  Transfer

**Permittee:** Alton Coal Development, LLC

**Mine:** Coal Hollow Mine

**Permit Number:**

C/025/0005

**Title:** 2014 Annual Sage-grouse Progress Report

**Description,** Include reason for application and timing required to implement:

**Instructions:** If you answer yes to any of the first eight questions, this application may require Public Notice publication.

- |                              |  |   |
|------------------------------|--|---|
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 1. Change in the size of the Permit Area? Acres: _____ Disturbed Area: _____ <input type="checkbox"/> increase <input type="checkbox"/> decrease. |
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 2. Is the application submitted as a result of a Division Order? DO# _____  |
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?                                     |
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 4. Does the application include operations in hydrologic basins other than as currently approved?   |
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?   |
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 6. Does the application require or include public notice publication?   |
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 7. Does the application require or include ownership, control, right-of-entry, or compliance information?   |
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?   |
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 9. Is the application submitted as a result of a Violation? NOV # _____   |
| <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | 10. Is the application submitted as a result of other laws or regulations or policies?  |

*Explain:* \_\_\_\_\_

- |   |  |  |
|---|--|--|
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 11. Does the application affect the surface landowner or change the post mining land use?                          |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2) |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 13. Does the application require or include collection and reporting of any baseline information?                  |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?            |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 15. Does the application require or include soil removal, storage or placement?                                    |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 16. Does the application require or include vegetation monitoring, removal or revegetation activities?             |
| <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No            | 17. Does the application require or include construction, modification, or removal of surface facilities?          |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 18. Does the application require or include water monitoring, sediment or drainage control measures?               |
| <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No            | 19. Does the application require or include certified designs, maps or calculation?                                |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 20. Does the application require or include subsidence control or monitoring?                                      |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 21. Have reclamation costs for bonding been provided?  |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?               |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 23. Does the application affect permits issued by other agencies or permits issued to other entities?              |
| <input type="checkbox"/> Yes            | <input checked="" type="checkbox"/> No | 24. Does the application include confidential information and is it clearly marked and separated in the plan?      |

**Please attach three (3) review copies of the application. If the mine is on or adjacent to Forest Service land please submit four (4) copies, thank you.** (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

B. Kirk Nicholes

Environmental Specialist

06/07/2015

*B. Kirk Nicholes*

Print Name

Position

Date

Signature (Right-click above choose certify then have notary sign below)

Subscribed and sworn to before me this 12 day of June, 2015

Notary Public: Marty Nicholes, state of Utah.

My commission Expires: 9-11-2017

Commission Number: 670359

Address: 1670 E Millstone Cir

City: Erdrich State: UT Zip: 84721

} ss:



Notary Public  
**MARTY NICHOLLES**  
 Commission #670359  
 My Commission Expires  
 Sept 11, 2017  
 State of Utah

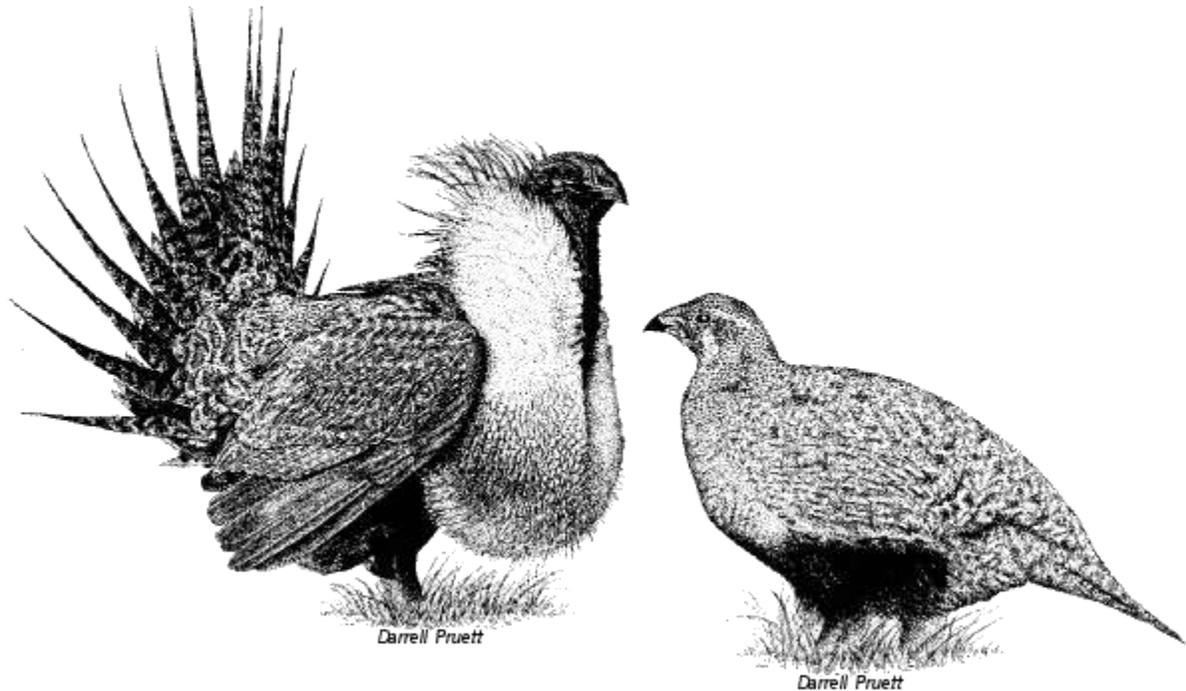
**For Office Use Only:**

Assigned Tracking  
Number:

Received by Oil, Gas & Mining



# Greater Sage-grouse Population Monitoring and Habitat Improvement in the Alton, Utah Area



Drawing provided by USGS ([www.npwrc.usgs.gov](http://www.npwrc.usgs.gov))

## Progress Report For Alton Coal Development, LLC

December 6, 2014  
Last Revised May 20, 2015

Prepared by  
Steven L. Petersen, Ph.D.  
Sage-grouse Population and Habitat Consultant

# Greater Sage-grouse Population Monitoring and Habitat Improvement in the Alton, Utah Region

## Progress Report

Steven L. Petersen, Ph.D., Consultant

FOR YEAR 2013-14

The Alton-Sink Valley region of southern Utah can be described as a multi-use landscape supporting local farmers, ranchers, residents of Alton, and a diversity of wildlife that utilize an arrangement of habitat types for food and shelter. This area is also rich in coal deposits which are currently being extracted to sustain energy demands, primarily for the State of Utah. In 2014, approximately 650,000 tons of coal were extracted by Alton Coal Development Inc. (ACD) from the Sink Valley coal deposit and delivered to a Utah-based power plant near Delta, Utah. This operation has created work opportunities for local residents, provides power for Los Angeles, California, and benefits local and regional economies.

Within the Alton-Sink Valley area, a resident population of greater sage-grouse (*Centrocercus urophasianus*) utilize sagebrush and wet meadow habitats for nesting, brood rearing, wintering. According to Frey et al. (2014), sage-grouse are found in sagebrush-steppe and agricultural lands that comprise 42% and 28% of the available habitat, respectively. This includes areas that had been treated (bullhogged) to remove or thin invasive pinyon-juniper woodlands.

Greater sage-grouse has been a species of concern throughout western North America following declining population densities and habitat availability. The most significant impacts have resulted from habitat loss, habitat fragmentation, degraded habitat condition, fire, invasive plant species, predation, and to a lesser extent disease (i.e. west Nile virus). In Utah, for example, the range of sage-grouse in Utah has been reduced to 50% of historic levels (Utah Division of Wildlife Resources 2009). Subsequently, this sagebrush obligate species is being reconsidered for federal listing as a threatened and/or endangered species. This decision to list sage-grouse or not will be determined in 2015.

Recognizing sage-grouse as an important but also sensitive species to the Alton area, ACD has created and sustained an ongoing monitoring and management program that focuses on sage-grouse population sustainability, bird protection and safety, and habitat restoration and conservation. This program has included the development of detailed plans for restoring critical habitat and monitoring sites for bird use activities. Initiated in 2006, all mitigation and management plans are implemented and assessed annually.

ACD has maintained a close working relationship with partners in sage-grouse conservation, in particular the Utah Division of Oil, Gas, and Mining (UDOGM), the Utah Division of Wildlife Resources (UDWR), the Color Country Adaptive Resource Management group (CCARM), and the Bureau of Land Management (BLM). These partnerships have resulted in more well-developed strategies for improving rangeland resources and providing the conditions that have resulted in a stable sage-grouse population.

Alton Coal Inc. continues to complete tasks and responsibilities established through formal agreements with the Department of Oil Gas and Mining and Utah Department of Wildlife Resources. These efforts met or exceeded the expectations identified by the Bureau of Land Management in Memorandum No. 2012-043 including short-term treatment implementation and monitoring activities and long-term habitat improvement goals.

The purpose of this report is to present the primary 2013-2014 sage-grouse related accomplishments including population monitoring and habitat improvement work.

## TABLE OF CONTENTS

TABLE OF CONTENTS.....	4
FALL 2013 – WINTER 2014 ACCOMPLISHMENTS.....	6
Sage-grouse Population Monitoring.....	6
<i>Employee Observations and Sage-grouse Population Monitoring</i> .....	6
<i>Bird Surveys</i> .....	6
<i>GPS Collaring and Monitoring</i> .....	12
<i>Historic and Current Lek use in Alton/Sink Valley</i> .....	12
<i>Noise Detection and Sound Assessment</i> .....	15
Habitat Mitigation.....	16
Predator Control Activities.....	18
Participation and Involvement with Local Working Groups .....	20
FALL 2014 – WINTER 2015 GOALS, PLANS AND PROPOSALS .....	20
Sage-grouse population monitoring .....	20
Vegetation Improvements and Monitoring.....	21
Predator Control .....	22
Partnership and Collaboration.....	22
REFERENCES.....	24
ACKNOWLEDGEMENTS.....	24
APPENDIX A.....	25
Examples of Greater Sage-grouse Habitat Use in Response to Improved Land Management Practices and Application to the Coal Hollow Mine.....	25
Introduction .....	25
Examples of Improved Habitat and Increased Bird Use .....	25
<i>Utah Range Trend</i> .....	25
<i>Habitat Improvement on Parker Mountains</i> .....	26
<i>Deseret Land and Livestock</i> .....	26
<i>Sagebrush Restoration in the Strawberry Valley</i> .....	27
<i>Habitat Improvement in the Western United States</i> .....	28
<i>Juniper Removal and Lek Success</i> .....	28
Management Implications and Application to Coal Hollow Mine.....	28
<i>Application to the Coal Hollow Mine Site</i> .....	28

<i>History of Lek use in Sink Valley</i> .....	29
<i>Reclamation</i> .....	30
<i>Habitat Improvement Accomplishments and Management Plans</i> .....	30
REFERENCES .....	31

## FALL 2013 – WINTER 2014 ACCOMPLISHMENTS

### Sage-grouse Population Monitoring

#### Employee Observations and Sage-grouse Population Monitoring

ACD employees are trained to identify sage-grouse and report any sighting and the location of that sighting whenever observed. These observations are reported directly to Kirk Nicholes (ACD Environmental Manager) who logs each sighting and manages this information for use in population monitoring and trend analysis (Table 1). Kirk then maps the coordinate location of each sighting, providing a record of sage-grouse population activity and habitat use within the Alton and Sink Valley areas (Figure 1).

#### Bird Surveys

In addition to employee sightings, each month during the non-breeding time period, sage-grouse are monitored within the Alton/Sink Valley region using surveys and field counts within the primary habitat areas. These surveys consist of walking along transects with constant visual (sweeping) observation patterns to detect any bird movement, in particular flushing birds. Dogs are not used to aid in locating birds. Each time a bird or group of birds are observed, a coordinate location is collected at the site where they were last observed. Additionally, a measure of sound (noise levels) is recorded using a PCE Sound Level meter (SL 322). This type of data is new to our survey protocol, used to assess the potential influence of noise on sage-grouse behavior (Table 2).

During each survey performed, the areas visited to locate birds are as follows (Figure 2):

- Sagebrush flat, 0.5km south of the open coal pits (SF)
- Mine sagebrush patch located south (SMSP) and north (NMSP) of the mine spoils piles.
- Original lek (OL)
- Wet meadow (WM) located in grass/rush/sedge community surrounding the well.
- Conservation area (CA)

Other sites that are visited periodically (3-4 times / year) include:

- West sagebrush fields (WSF)
- Fords pasture (FP)
- Rabbitbrush field (RF) where treatments have been applied to reduce rabbitbrush dominance.

Of all potential sage-grouse habitats in the region, the most frequent sightings occur in the sagebrush field area. This area is dominated by black sagebrush (*Artemisia nova*) and a mix of forbs and grasses. This field also serves as a primary site for nesting and early brood-rearing.

Table 1. Observations of sage-grouse reported by ACD employees between October 2013 and December 2014 within the Alton/Sink Valley region.

Date	Time of observation	Number of birds	Location	UTM Coordinates
Oct. 15, 2013	7:00 am	6	Observed birds while pushing overburden near reclamation area	354804 E 1767153 N
Oct. 21, 2013	7:00 am	24	Observed on reclamation area	354730 E 1767158 N
Oct. 29, 2013	7:40 am	10	Observed birds while pushing overburden near reclamation area	354780 E 1767233 N
Nov. 1, 2013	7:12 am	3	Observed by topsoil pile #4	354315 E 1768896 N
Nov. 11, 2013	7:00 am	1	Observed near pit #9	354017 E 1788313 N
Nov. 20, 2013	2:00 pm	16	Flushed in the sagebrush flat with Kathleen Clark and Denise Dragoo,	350217 E 1765331 N
Dec. 13, 2013	7:41 am	30	Flushed east of pit #9	353487 E 1768941 N
Jan. 7, 2014	10:00 am	8	Flyover haul road near pit #26/27	349490 E 1768662 N
Jan. 24, 2014	8:45 am	14	Flyover reclamation area	354575 E 1768721 N
Feb. 1, 2014	7:10 am	6	Observed in sagebrush flat area	350710 E 1766532 N
Feb. 1, 2014	8:00 am	3	Flushed in Fords Pasture	309179 E 1785112 N
Feb. 1, 2014	---	23	Observed in PJ within the sagebrush flat area	351965 E 1767199 N
Feb. 3, 2014	9:55 am	5	Observed south of pit #9	352370 E 1768287 N
Feb. 4, 2014	9:40 am	2	Observed at the south end of pit #9	352271 E 1768304 N
Feb. 5, 2014	7:39 am	5	Observed near spoils pile	352663 E 1768020 N
Feb. 17, 2014	7:00 am	45	Flyover from spoils pile, over reclamation area, landing on BLM land	353834 E 1766939 N
Feb. 24, 2014	midnight	11	Trapping birds west of the mine (SF)	350691 E 1765825 N
Mar. 5, 2014	8:30 am	7	Males strutting on new lek	351095 E 1764836 N
Mar. 6, 2014	8:30 am	10	7 males and 3 hens on new lek	350957 E 1764811 N
Mar. 10, 2014	8:30 am	15	12 males and 3 females on new lek	351007 E 1764911 N
Mar. 11, 2014	6:30 am	1	Observed on road to well	354469 E 1770141 N
Mar. 12, 2014	---	1	Observed on haul road at topsoil stockpile #4	354413 E 1768837 N
Mar. 14, 2014	7:30 am	4	Observed on haul road east of Mechanics conex	355429 E 1769911 N
Mar. 18, 2014	1:45 pm	2	Observed flying near pond 3	353823 E 1765216 N

Table 1 (continued).

Date	Time of observation	Number of birds	Location	UTM Coordinates
Mar. 18, 2014	8:30 am	1	Observed on south side of spoils pile	852885 E 1766111 N
Mar. 21, 2014	3:00 pm	6	Flyover from orchard to spoils pile	853636 E 1770402 N
Mar. 22, 2014	7:30 am	8	Observing and filming grouse on the lek	853788 E 1770522 N
April 4, 2014	7:30 am	1	Hen observed near deer fence west of country road	863390 E 1762634 N
April 7, 2014	8:40 am	12	Observed on new lek	852424 E 1763947 N
June 12, 2014	3:15 pm	2	Observed at HWT-1	852100 E 1768464 N
June 15, 2014	12:00 pm	1	Observed at SP-22	852541 E 1769711 N
June 16, 2014	4:10 pm	1	Observed at SP-22	852447 E 1769914 N
June 23, 2014	11:20 am	12	Flushed from "Pugh's Palace"	853363 E 1770338 N
June 30, 2014	10:00 am	16	Observed 13 chicks and 3 hens at "Pugh's Palace"	853657 E 1770504 N
June 30, 2014	10:52 am	4	Observed at SP-22	852562 E 1769945 N
June 30, 2014	11:40 am	5	5 chicks observed in ditch 1 above the C3 monitoring well	851928 E 1769346 N
July 1, 2014	9:15 am	3	1 hen and 2 chicks cross county road near office	857022 E 1767593 N
July 1, 2014	10:30 am	11	1 hen and 10 checks near old coral	852694 E 1769210 N
July 3, 2014	9:26 am	12	8 adults and 4 chicks observed near new lek	851367 E 1765395 N
July 21, 2014	8:15 am	3	1 hen and 2 chicks observed at cattle guard on bypass road near the sagebrush flat	852298 E 1763743 N
July 23, 2014	9:40 am	3	2 hens and 1 chick observed in ditch 1 by orchard	853262 E 1770222 N
July 23, 2014	10:30 am	8	Flushed at SP-22	852350 E 1769837 N



Table 2. Observations from monthly surveys conducted by S.L. Petersen.

Date	Time of observation	Number of birds	Location
May 15	8:00 am	8	Cursory survey from the road to avoid flushing nesting birds from the SF. Flushed 5 birds from MSP. Frey technician flushed 3 birds from SF by driving 4-wheeler through the field.
June 21	7:35-9:18 am	40	Surveyed SF, MSP, HL, WSF, Well, and CA. 14 birds flushed from the SF area. 11 birds were flushed on the backside of the new lek. 6 adults and 9 chicks flushed from the well.
August 21	7:54-8:08 am	33-45	Surveyed SF, MSP, HL, WSF, Well, and CA. Flushed 4 juveniles from the new lek and 8 from the backside of the new lek.
September 25	7:45 am	21-29	Surveyed SF, MSP, HL, and Well. Flushed 15-20 birds from a phase 3 PJ woodland near the SF where they were roosting.
October	10pm-2am	15	Trapping birds with Nicki and her crew. Flushed a minimum of 15 birds. Most trapping occurred in the SF and MSP.
November	10pm-2am	20	Trapping birds with Nicki and her crew. Flushed birds but did not conduct an accurate count due to trapping efforts. Most trapping occurred in the SF region and MSP.
December 22	3am, 8-11am	43	Surveyed SF, MSP, HL, Well, CA, FP. Flushed 25 birds in the sagebrush flat. Flushed 18 birds adjacent to the open mine. 2 birds found at Fords Pasture using spotlight.
January 24, 2015	8am-1pm	23	Surveyed SF, MSP, HL, Well, CA, WSF, FP. Flushed 10 birds at the sagebrush flat on the first pass, 9 different birds in the same area further east. 5 birds in Fords Pasture, spotlighting.

**SF** = sagebrush field located along the bypass haul road south of the mine, **MSP** = mine sagebrush patch located adjacent to (south) of the reclaimed area of pit #1, **HL** = historic lek located in Sink Valley, **FP** = Fords pasture located 10 miles south of the mine site, **AF** = Alfalfa field, located immediately south of the town of Alton, **WSF** = West sagebrush fields located .5 to 1 mile west of SF, **C** = corridor between Alton and Hoyts Ranch, **Well** = grassy area located adjacent to the well (pump) south of the conservation area, **CA** = conservation area.

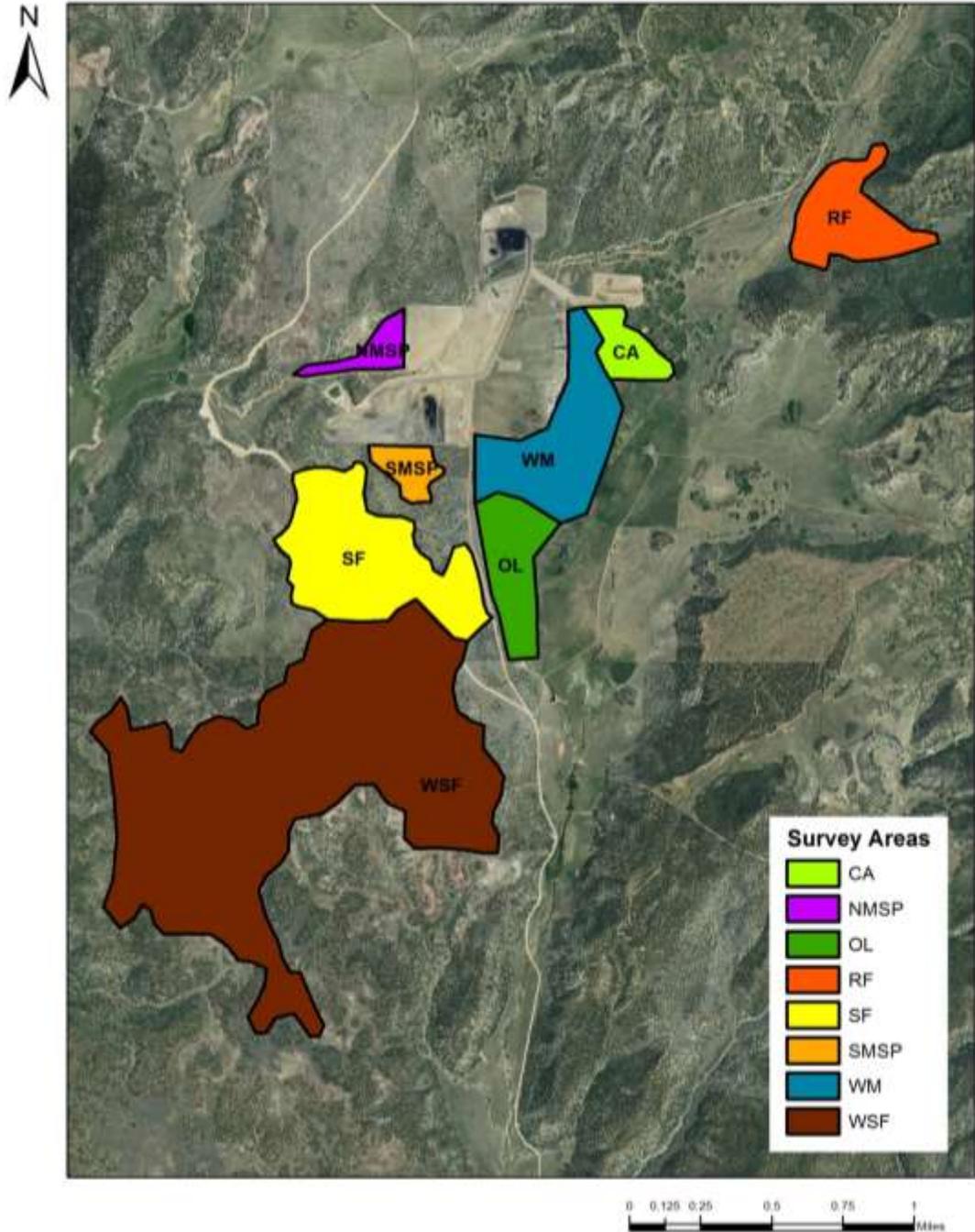


Figure 2. Location of survey areas for greater sage-grouse during the 2012-2014 monitoring seasons. CA = Conservation area, NMSP = North mine sagebrush patch, OL = Original lek, Rabbitbrush field, Sagebrush flat, SMSP = South mine sagebrush patch, WM = Wet meadow, and WSF = West sagebrush fields. Additional sites not shown above include the corridor (C) and the alfalfa fields (AF) south of Alton.

### GPS Collaring and Monitoring

During fall 2014, Dr. Nicki Frey was provided with GPS collars purchased by the BLM and ACD (2 collars) that could be used to monitor sage-grouse movement patterns throughout the valley. On three different nights, 3 birds were trapped and harnessed with a GPS backpack style collars within the sagebrush flat area. Since the time they were collared, these birds have provided daily coordinate location information that can be used to determine bird movement patterns and habitat use throughout the year.

### Historic and Current Lek use in Alton/Sink Valley

Greater sage-grouse have been found in the Sink Valley and Alton areas of Kane County, Utah for many generations. This has consisted of breeding activity (at the Sink Valley lek), nesting and brood rearing (likely near Sink Valley but this has been poorly documented), and winter habitat use primarily in Sink Valley and the Alton area. The density of birds reported using the Sink Valley area has fluctuated widely during the time they have been observed. The most accurate estimates of bird densities in this region are from lek counts that were conducted annually by wildlife biologists with the Utah Division of Wildlife Resources (UDWR). Since 1991, lek counts have experienced significant declines in strutting males. Data suggest that there has been an oscillation in male lek attendance over the past 20 years which likely reflects variable sage-grouse occurrence and habitat use within this area (Figure 3).

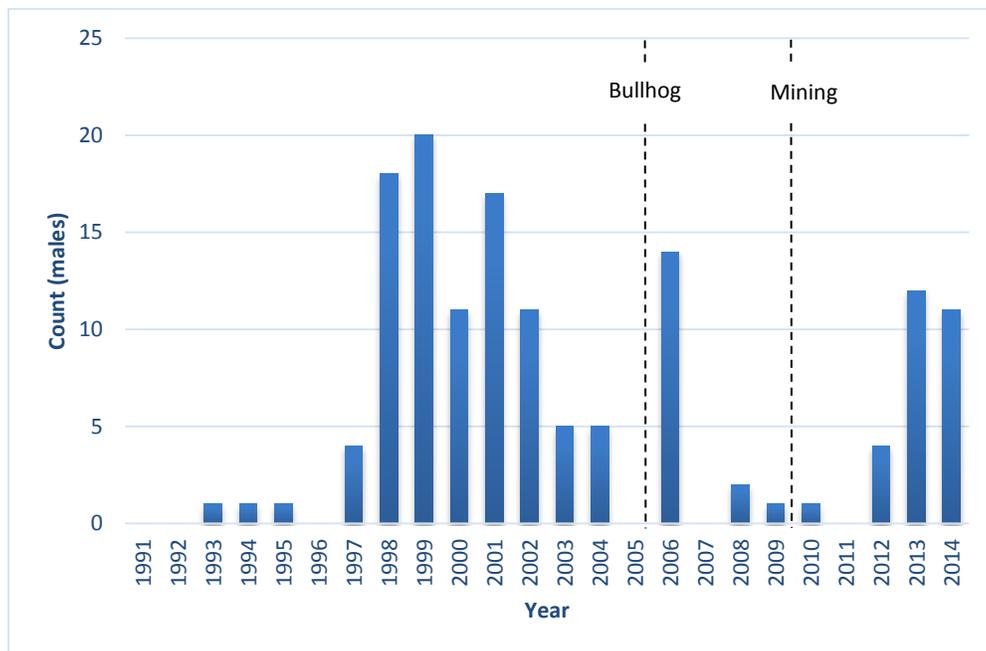


Figure 3. Male bird attendance at the Sink Valley lek, located south of Alton, Utah. Observations were made by Utah DWR employees observing during the spring breeding months (February – April). The 2005 and 2007 data are missing for this graph. Birds recorded from 2012-14 were located on the new lek. Previous observations were from the historic lek.

In 2006, 14 male birds were observed strutting on the Sink Valley lek. However, since that time, the numbers have declined steadily with only 2 birds observed in 2009, 1 bird in 2010, and no sighting of strutting males in 2011. There was concern that the breeding population would not return following several years of low lek attendance and with the beginning of mining activity in the general proximity of the lek. Since mining commenced, sage-grouse have been observed breeding at a location on a hillside located adjacent to the sagebrush flat approximately 0.55 miles away from the original lek. This “new” lek is 0.35 miles from the closest mining activity and has supported 12-15 males observed annual over the past 3 breeding seasons (Figure 4). Additionally, 20-60 birds are seen in the valley annually including a number of chicks and young birds that were raised in the area (ACD annual reports 2012-14).

This pattern of behavior indicates that the birds at the Coal Hollow area have shifted lekking locations and that they have the capacity to shift and adapt to local conditions and human-related activities. It is likely that the number of birds attending leks in the region were consistent, but that birds went undetected in the area until they were discovered displaying on the new lek in 2012.



Figure 4. Five male strutting sage-grouse displaying at the new lek, located south of the sagebrush flat southwest of active coal mining. This photograph was taken on March 22, 2014.

In comparison to the lek data collected from Alton/Sink Valley, lek counts at Hoyts Ranch have experienced similar lek attendance by males ranging from 4 in 2011 to a high of 13 in 2012 (Figure 5).

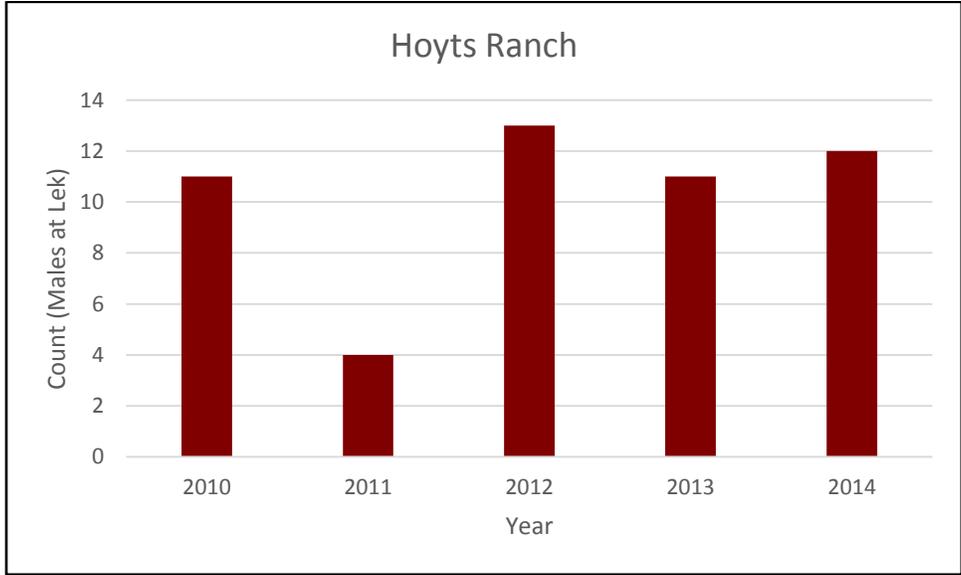


Figure 5. Male bird attendance at the Hoyts Ranch lek, north of Alton. Observations recorded expanded from 2010 to 2014.

Noise Detection and Sound Assessment

The influence of sound (noise pollution) on sage-grouse was assessed by measuring sound (decibel) at specific stations and at each location where birds were flushed. Decibels were recorded at each flush site using an Extech 407735 Sound Level Meter. Patterns of noise detection and bird locations in June and August is presented in figure 6.

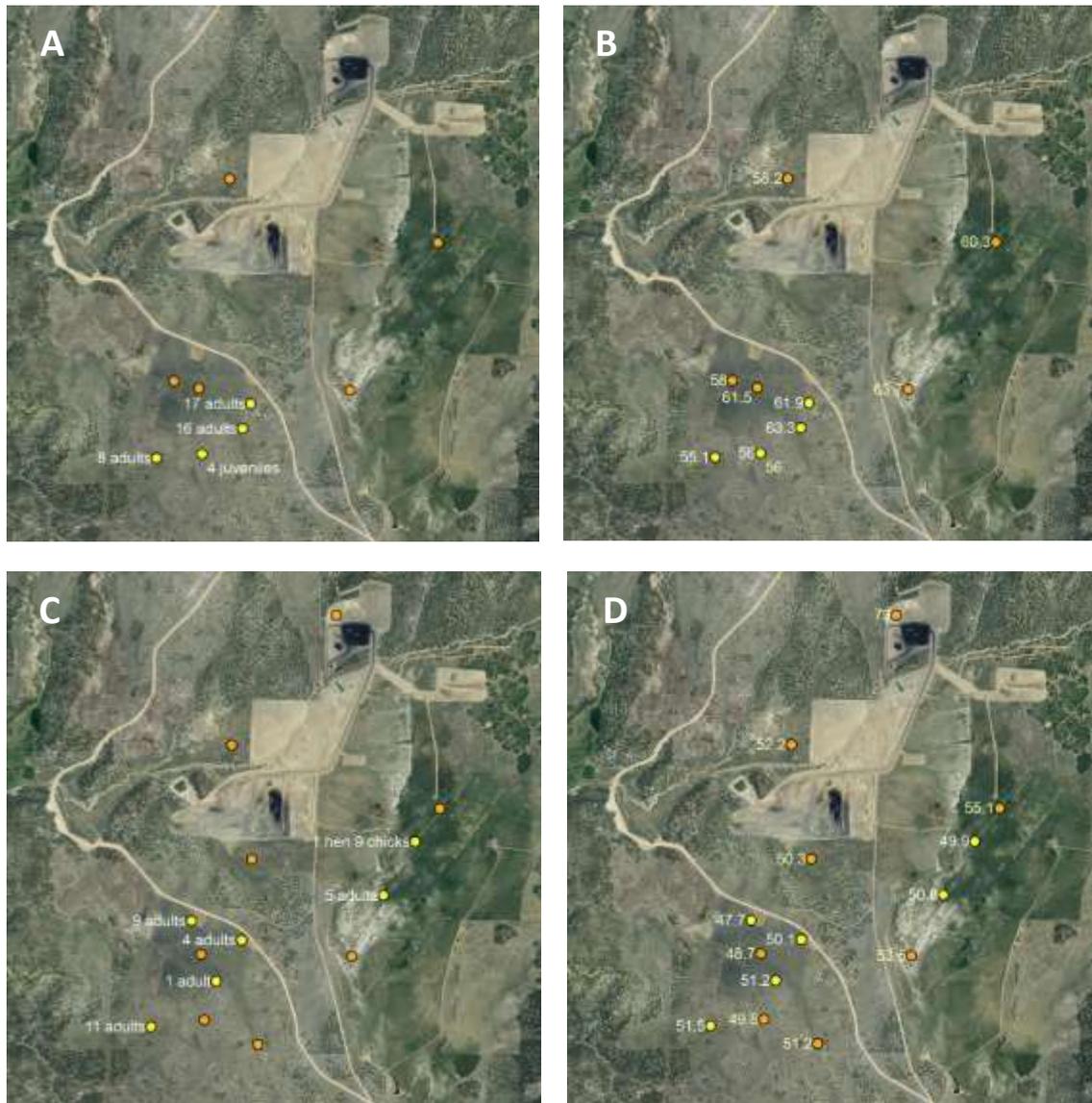


Figure 6. Measure of decibels at set stations (orange) or where birds were flushed (yellow). Figure A and B are bird flush number and decibel reading on June 21, respectively. Figures C and D are flush number and decibel reading on August 21, respectively.

## Habitat Mitigation

In 2014, ACD added an additional 85.88 acres to the Mining and Reclamation Plan (MRP). Although disturbance would be only temporary within this additional area, a 4:1 habitat mitigation was completed along with the 240 acres that were previously scheduled for 2014. ACD chose to combine efforts with UDWR within two Watershed Restoration Initiative projects that are in close proximity to the mine. The ACD portion of the Thompson Creek chaining was 300 acres, with an additional 300 acres of a rabbitbrush treatment for a total of 600 acres of mitigation in 2014. See Figure 6 for location and summary of total mitigation completed to date.

Reclamation of disturbed mined lands can provide habitat for sage-grouse. In December 2014, reclamation will be implemented on 65 acres of spoils pile and backfilled pit area. These reclaimed lands will be seeded with a plant mix that consists of native shrubs and herbaceous species important for sage-grouse habitat (nesting, foraging). [An overview of sage-grouse habitat mitigation is provided in figure 7.](#)

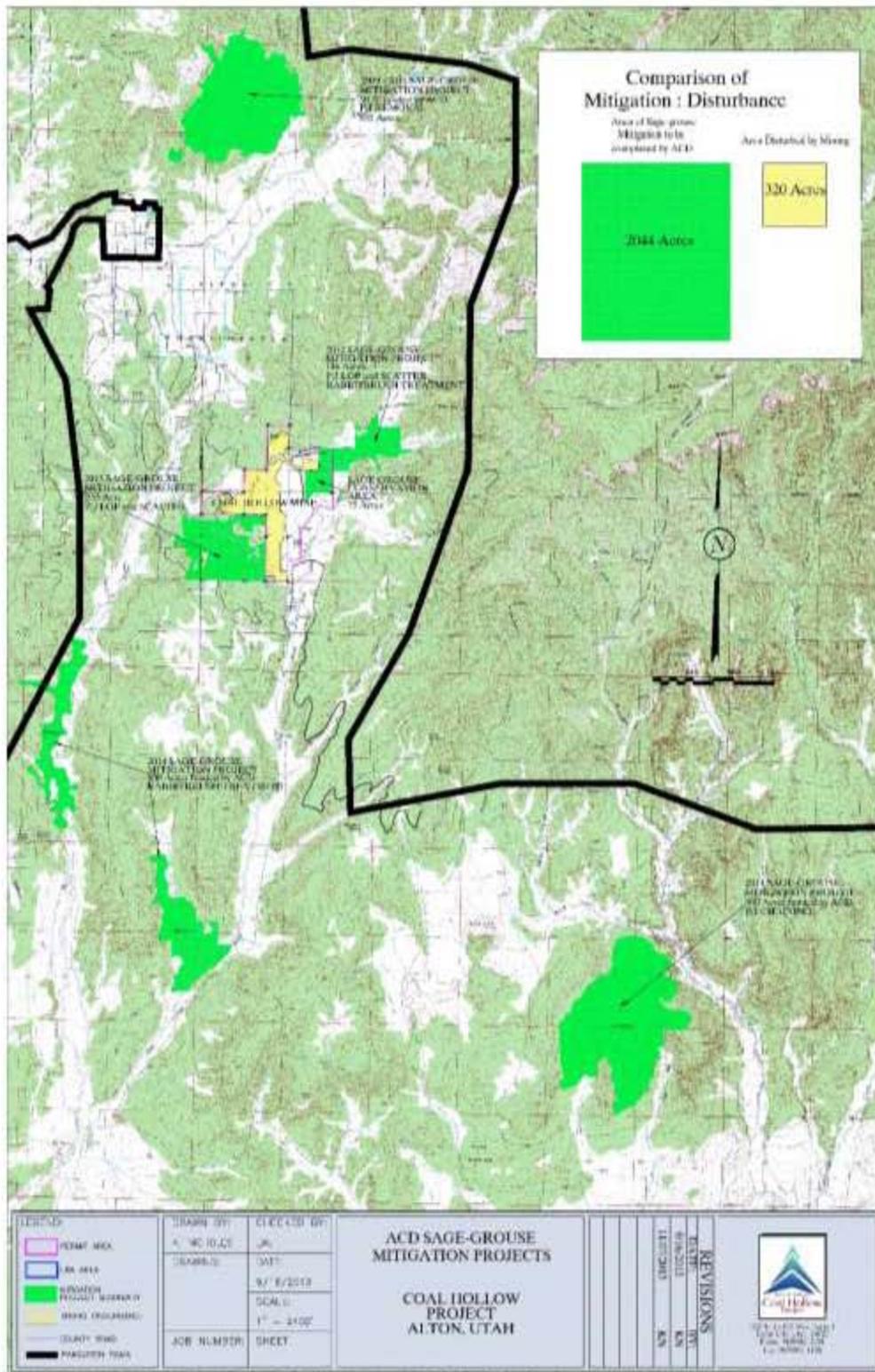


Figure 7. Sage-grouse habitat mitigation within the Alton/Sink Valley region.

## Predator Control Activities

During the 2013-2014 periods, sage-grouse predators were removed to increase potential nesting and brood rearing success. The types of predators that were removed included common ravens (*Corvus corax*), American crows (*Corvus brachyrhynchos*), coyotes (*Canis latrans*), and red fox (*Vulpes vulpes*). All predator control activities were conducted by USDA Wildlife Services.

Ravens are considered one of the greatest ~~threa~~threats to sage-grouse eggs, chicks and adults in the Alton/Sink Valley area. Ravens have been found to increase with a higher availability of resources found near towns (i.e. Alton and its stockyards) and subsequently have a higher impact on sage-grouse populations (Bui et al. 2010). Additionally, Bui et al. (2010) found that resident ravens that exhibit high territorial behavior have a greater impact on nest success than birds only flying through an area. Resident birds in the Alton/Sink Valley are common and are predicted to have a high impact on bird populations.

Small mammalian mesopredators can also have a distinct negative impact on sage-grouse. Little evidence has been provided on the impact of coyotes on sage-grouse, however fox, badger, raccoon, and skunk have been shown to significantly impact nest and brood-rearing success (Mezquida et al. 2006). The removal of coyotes should be carefully monitored to ensure that lagomorph populations do not increase throughout the area. The lack of coyote predation on lagomorphs can result in higher densities that will potentially attract golden eagles (*Aquila chrysaetos*) into the valley. Golden eagles have been considered to be the most significant predator of adult sage-grouse (Mezquida et al. 2006), and have been observed taking adult sage-grouse in the Alton/Sink Valley area (Personal Communication with Frey 2010).

In a study conducted in Pinedale, Wyoming, 51% of monitored sage-grouse nest sites failed, of which 83% were lost to predation by mesopredators. 47% of all broods failed, all attributed to predation (Bui et al. 2010). Fragmentation or reduced density of sagebrush habitats can also increase exposure of nests and young birds to predators, increasing impacts of predators on sage-grouse survival (Lyon and Anderson 2003).

To control ravens, wildlife services specialist Theresa Wright distributed 1400 poisoned eggs through the area between January-June 2014 (Figure 8). With a 4:1 egg to kill ratio, it is assumed that 350 ravens were removed (**personal communication**). For control of mammalian mesopredators, **Roger Nauer set a trap line along the fence near the alfalfa fields south of Alton (Figure 8). Approximately 20 snares were set along the fence, placed at locations where holes had been dug under the fence by mesopredators. Roger killed 19 coyotes between December 2013 and December 2014. Roger did not report the removal of any other small mammal mesopredators from the area.**

Chicks raised by hens in the valley have been observed in the east valley near the well. While not monitored from the time since hatched, chicks are found with hens throughout the brood-rearing period. With consistent chick counts, it is likely that chick mortality is low. This is likely due to the reduction in predators in the Alton/Sink Valley area.

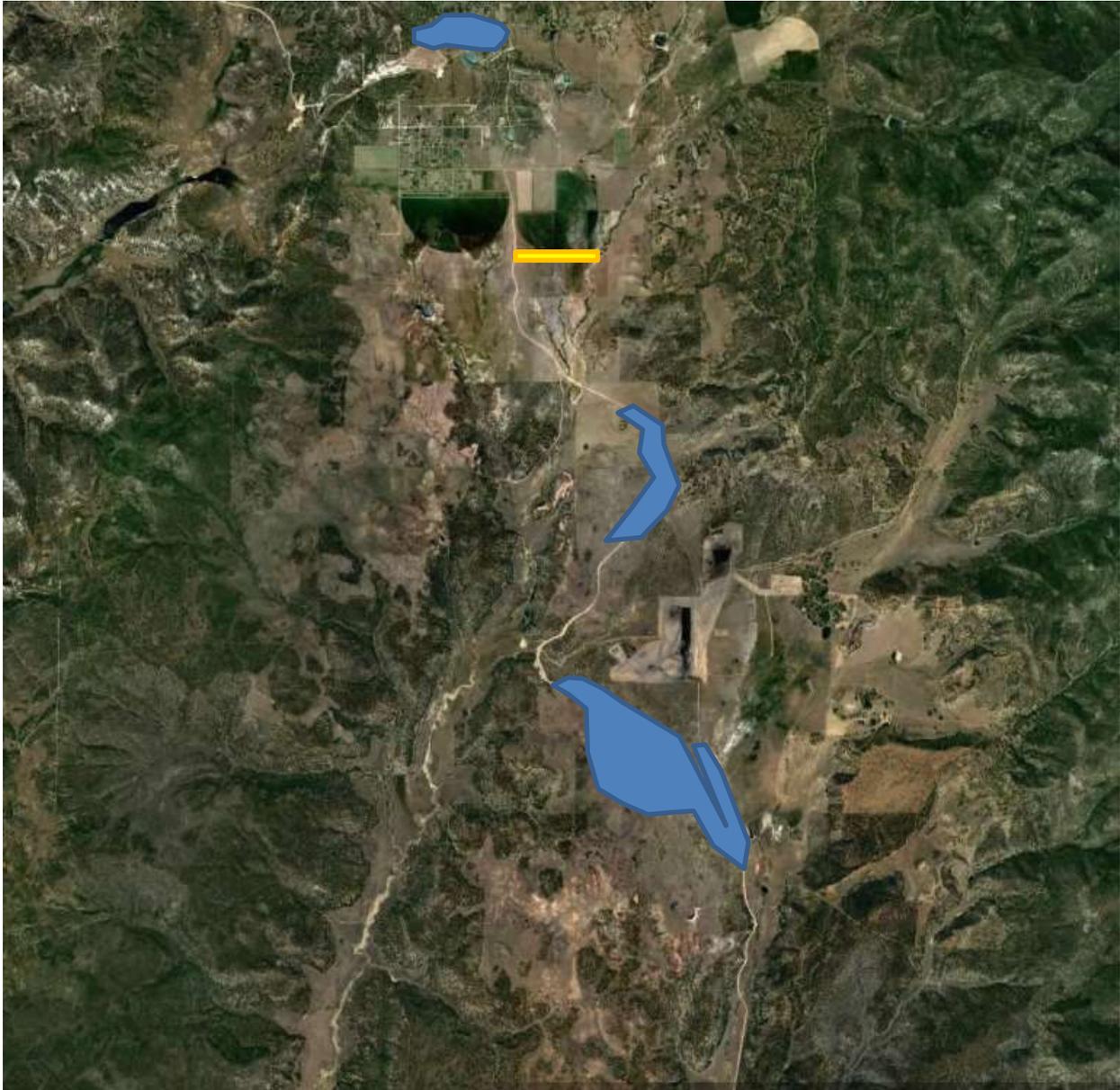


Figure 8. Blue polygons indicate areas where poison eggs were distributed by USDA Wildlife Services for raven control. This includes roadsides near critical habitat and the stock yard near Alton where birds congregate. The yellow polygon represents the location where coyote snares are set and trapped. Approximately 20 snares are set and checked every two days during the trapping season.

## **Participation and Involvement with Local Working Groups**

ACD has attended CCARM bi-monthly meetings to join in discussion and planning for sage-grouse conservation in the Alton/Sink Valley area. The members of this committee provide invaluable feedback that aids in conservation strategy development and habitat improvement planning. Maintaining this cooperation with CCARM has been instrumental in the success of this project. Habitat use and sage-grouse movement patterns are being studied by Nicki Frey. ACD participated in trapping and collaring birds on three occasions during the spring and fall trapping season. As a result of this effort, 4 birds were harnessed with backpack style GPS devices that are currently providing information on bird movement and habitat use.

## **FALL 2014 – WINTER 2015 GOALS, PLANS AND PROPOSALS**

### **Sage-grouse population monitoring**

Bird surveys will be conducted using the standard protocol developed in 2012. Key areas that support intact sagebrush communities will be surveyed monthly. Surveys will be temporarily suspended from February through May to avoid breeding and nesting. Surveys will be conducted at Fords pasture during the winter months (December through February) to search for birds and assess the amount of time they remain in the valley.

The historic lek at Sink Valley, the new lek in the sagebrush flat, the spoils pile, and Fords Pasture will all be surveyed during the breeding season (late February through early April). The number of strutting males will be recorded during each visit. Lek surveys will be coordinated with the Utah DWR to reduce the number of people visiting the leks (to prevent unnecessary disturbance). ACD will additionally continue to support Nicki Frey, USU, and SUU in collaring and monitoring birds.

ACD will continue to support trapping and monitoring of sage-grouse in the valley. Dr. Nicki Frey has collared 1-3 birds in the area with GPS collar technology. She is collecting daily information that highlights bird habitat use and migration behavior. ACD will assist in spotlighting and collaring birds **as recommended by Utah DWR. ACD recommends that Utah DWR carefully assess and determine the appropriate number of birds that should be collared and monitored within the area to prevent potential population declines due to bird losses associated with trapping, collaring and monitoring. Since bird trapping and collaring was terminated in 2009 due to low population numbers, ACD supports a further assessment of these numbers.**

ACD is willing to participate in VHF or GPS collaring as recommended by the UDWR. ACD recommends that project leaders and technicians avoid walking or driving 4-wheelers within it

the sagebrush flat area from February through mid-June. This area is presumed to be critical nesting and early brood-rearing habitat. Excessive human-related activities in this area can potentially flush hens from nests and separate hens from brood. **This can have long-term negative impacts on bird reproductive success within the Alton/Sink Valley area.**

Sound will continue to be monitored each time birds are flushed during monthly surveys. Along with sound, the time of day and coordinate location is also recorded. These data will be used to discern the impact of sound on bird habitat use in relation to mining activities. Decibel readings will be collected at the monitoring stations established in 2014. These data will provide long-term quantification of noise and bird activity. In addition to the regular surveys, we will also record the sound level at the lek and look for bird behavior changes due to noise.

**Sound measurements will also be collected near the underground mining operation starting in 2015. During 2014, sound readings were collected near the area where underground mining will occur, at a set, repeat sampling station within the conservation area. This sample provides baseline information on noise levels pre underground mining. These measurements will continue to be collected throughout the duration of all mining operations in that area. Additional stations can be established near the underground mining area (footprint) if the current station(s) are determined to provide unsatisfactory measurements.**

### **Vegetation Improvements and Monitoring**

Improving habitat for sage-grouse is an important objective to land managers for maintaining or increasing sage-grouse populations. Boyd et al. (2011) provide several examples of effective land management practices that have resulted in greater habitat use by sage-grouse. Dahlgren et al. (2006a, 2006b) found that habitat treatment in the Parker Mountains of south-central Utah resulted in higher sage-grouse densities. They mechanically treated sagebrush using a Dixie harrow or herbicide applications of tebuthiron to reduce decadent or high density sagebrush stands as recommended in the sagebrush guidelines (Connelly et al. 2000). By managing sagebrush to create target vegetation densities and increasing plant community diversity (mosaic patterns), sage-grouse habitat is improved.

Vegetation improvements will continue using the same criteria described in the current mitigation plan. Treatment will be completed in areas recommended by ACD, state and federal consulting entities (NRCS, DWR, DOGM, BLM, and FWS) and CCARM. ACD will treat approximately 250 acres of landscape within the Alton/Sink Valley area. This will continue to honor the commitment between ACD and UDOGM of a 4:1 mitigation to disturbance ratio. ACD will also provide maintenance toward already treated areas by removing young trees, and lopping and scattering limbs and debris from previous PJ harvests. Decadent and high canopy cover of big sagebrush within conservation area will be thinned to create habitat structure suitable for sage-grouse nesting and brood rearing using local cover levels and Connelly et al.

(2000) guidelines. ACD will collaborate with Kevin or Carl Heaton in disking the entire area targeting a 50% kill rate of shrubs. Surviving shrubs respond with higher seed production and greater ephemeral and perennial leaf growth. This also opens surface area for new grass and forb establishment and growth.

Vegetation Monitoring will be conducted using the same protocol established in the current mitigation plan. Vegetation monitoring was not conducted in 2014 but will be conducted in 2015. After initial monitoring, it was determined that sites would be sampled every 1-2 years after treatment, and then every 5 years to detect changes in plant community structure and composition.

Sites that will be monitored will be based on recommendations and discussions with state and federal consulting entities (NRCS, DWR, DOGM, BLM, and FWS) and CCARM. The data collected will be consistent from previous years, consisting of species composition, percent cover, density, and bird use (noted by feathers, tracks, fecal piles, or bird sightings). In the rabbitbrush field, 200m long permanent transects will be located at the same place where the 2013 50m transects were located. Additionally, the same number and size of transects (5) will be located in untreated areas to represent a control group. Data will be collected using the line intercept method as well as the Daubenmire method for vegetation sampling.

### **Predator Control**

Predator control activities will continue to focus on ravens and coyotes. During fall 2014, approximately 100 ravens were sighted flying over the Alton/Sink Valley area in a 4 hour period. Ravens migrate throughout the region allowing local populations to replenish after a removal effort. Subsequently, eggs will be distributed annually by USDA Wildlife Services to reduce raven and crow densities throughout the Alton area, particularly before and during the sensitive periods of nesting (February-May) and early brood rearing (May-July).

ACD will work closely with Wildlife Services to identify optimal egg distribution locations throughout the region and modify this approach to be as effective as possible.

Small mammalian predators will be removed when trapping is most effective. ACD will continue to fund predator control activities (maintaining a funding agreement with Wildlife Services).

Removal of all avian and mammalian predators will be conducted strictly by Wildlife Services.

ACD will work with Wildlife Services to establish harvest permits for ravens that reduce the population of eggs and chicks in the area.

### **Partnership and Collaboration**

ACD will continue to maintain a collaborative partnership with UDWR, CCARM, USU Extension, Southern Utah University, the Heaton family, and other organizations and individuals. ACD will contribute ~~funds for monitoring birds with Nicki Frey~~ \$8,000 toward monitoring that is in

addition to the regular monthly surveys conducted by ACD sage-grouse specialist (Petersen) and the ACD employee sighting reports generated whenever birds are observed. The additional monitoring funds can be used to purchase GPS or VHF collars, coordinate aerial surveys with UDWR, or any other recommended monitoring service. ACD will also continue to provide support for trapping and collaring birds upon request.

## REFERENCES

- Boyd, C. et al. 2011. Looking toward a brighter future for lekking grouse. *Rangelands* 33:2-11.
- Bui, T.D., J.M. Marzluff, and B. Bedrosian. 2010. Common raven activity in relation to land use in western Wyoming: implications for greater sage-grouse reproductive success. *The Condor* 112:65-78.
- Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. *Wildlife Society Bulletin* 28:967-985.
- Dahlgren, D.K., R. Chi, and T.A. Messmer. 2006. Greater sage-grouse response to sagebrush management in Utah. *Wildlife Society Bulletin* 34:975-985.
- Dahlgren, D.K., T.A. Messmer, M.R. Conover, R.H. Schmidt, and J.W. Connelly. Greater sage-grouse brood-rearing habitat manipulation in mountain big sagebrush, use of treatments, and reproductive ecology on Parker Mountain, Utah. M.S. Thesis, Utah State University, Logan Utah.
- Frey, S.N., R. Curtis, and K. Heaton. 2013. Response of a small population of greater sage-grouse to tree removal: implications of limiting factors. *Human-Wildlife Interactions* 7:260-272.
- Lyon, A.G. and S.H. Anderson. 2003. Potential gas development impacts on sage-grouse nest initiation and movement. *Wildlife Society Bulletin* 31:486-491.
- Mezquida, E.T, S.J. Slater, and C.W. Benkman. 2006. Sage-grouse and indirect interactions: potential implications of coyote control on sage-grouse populations. *The Condor* 108:747-759.
- Utah Division of Wildlife Resources. 2009. Utah greater sage-grouse management plan. Utah Department of Natural Resources, Publication 09-17, Salt Lake City, Utah, USA.

## ACKNOWLEDGEMENTS

We appreciate the contribution of many people who invested time and resources for this project including Kirk Nicholes (ACD), Larry Johnson (ACD), Kevin Heaton (USU Extension), Joe Helfrich (UDOGM), Dustin Schaible (UDWR), Rhett Boswell (UDWR), Teresa Wright (USDA WS), Nicki Frey (SUU/USU Extension), and the entire Color-Country Adaptive Resource Management group. The combined effort of these individuals has resulted in successful sage-grouse conservation and habitat improvement.

## APPENDIX A

### Examples of Greater Sage-grouse Habitat Use in Response to Improved Land Management Practices and Application to the Coal Hollow Mine

#### Introduction

Over the past 60 years, greater sage-grouse (*Centrocercus urophasianus*) have experienced declining trends in population density throughout most of the range of the species (Schroeder et al. 2004). This decline has been attributed to impacts from invasive species, livestock grazing, fire, predation and land conversion (Braun et al. 1977). Habitat treatments that improve sage-grouse nesting, brood-rearing and winter range are important to potentially reverse these trends and maintain healthy sage-grouse populations.

Improving habitat for sage-grouse has been an important objective for land managers throughout western North America. Although current literature is rich in studies that evaluate habitat requirements for greater sage-grouse, few describe habitat projects that improve sagebrush habitat quality necessary for sage-grouse reproduction and survival.

The following are a few examples of land management projects and practices that have resulted in enhanced sagebrush habitat conditions and greater use by birds. In 2011, Boyd et al. published a paper in the journal of Rangelands that summarizes examples and stories of successful habitat restoration that have directly improved sage-grouse habitat and population densities throughout the west. These examples have direct application to the Coal Hollow Mine located in Kane County, Utah, where sage-grouse population monitoring and habitat improvement efforts are being conducted to conserve a population of birds living in that area along with active coal mining activities.

#### Examples of Improved Habitat and Increased Bird Use

##### Utah Range Trend

The state of Utah has conducted extensive habitat improvement projects throughout the state designed to improve wildlife habitat, focusing on elk and deer populations. However, these projects also include specific efforts to improve sagebrush communities that benefit sagebrush ecosystems and sage-grouse populations. These sites are monitored through the Utah big game range trend program and results are made available at <http://wildlife.utah.gov/range/>. These data provide a wealth of information regarding plant community recovery and succession following habitat treatments and data that can be compared with the sage-grouse guidelines (Connelly et al. 2000).

Results from Range Trend indicate that habitat is improved with proactive land management strategies that focus on specific wildlife requirements (i.e. sage-grouse). Utah remains a leader in the United States in habitat improvement projects that have resulted in greater habitat condition for sage-grouse and other wildlife species.

#### Habitat Improvement on Parker Mountains

Dahlgren et al. (2006a, 2006b) demonstrated that habitat can be improved with mountain big sagebrush treatments. This research was conducted in the Parker Mountains of South-central Utah where old decadent stands of sagebrush had dominated many of the local sagebrush communities (>40% sagebrush cover). Sage-grouse habitat was enhanced (meeting guidelines established by Connelly et al. (2000) by 1) mechanically treating sagebrush with a Dixie harrow and 2) applying the herbicide tebuthiuron to reduce sagebrush cover and density to meet nesting and brood-rearing requirements. These treatments created sagebrush cover and density levels that were more suitable for year-round use by sage-grouse. Birds have been observed in these treated sites suggesting that restoration efforts can result in greater habitat availability.

#### Deseret Land and Livestock

A long-term management program, established at the Deseret Land and Livestock, has focused on holistic, adaptive management strategies to sustain and improve sagebrush habitats throughout the range (Danvir et al. 2014). This program includes maintaining a complex of sagebrush age classes and understory forbs and grasses using mechanical treatments, thinning projects, and planting efforts. Results of this work include improved wildlife populations, including greater densities of greater sage-grouse and increased lek attendance during the breeding season (Figure 9).

Densities of leks and individual sage-grouse birds is reported to be 12 times higher than typical grazed sagebrush steppe rangelands of northern Utah (Rich County). In addition to improved sagebrush treatments, proper grazing practices also contributed to higher sagebrush quality and forb availability (Danvir 2002).

### Male sage grouse attendance on leks, DLL 1985-2000

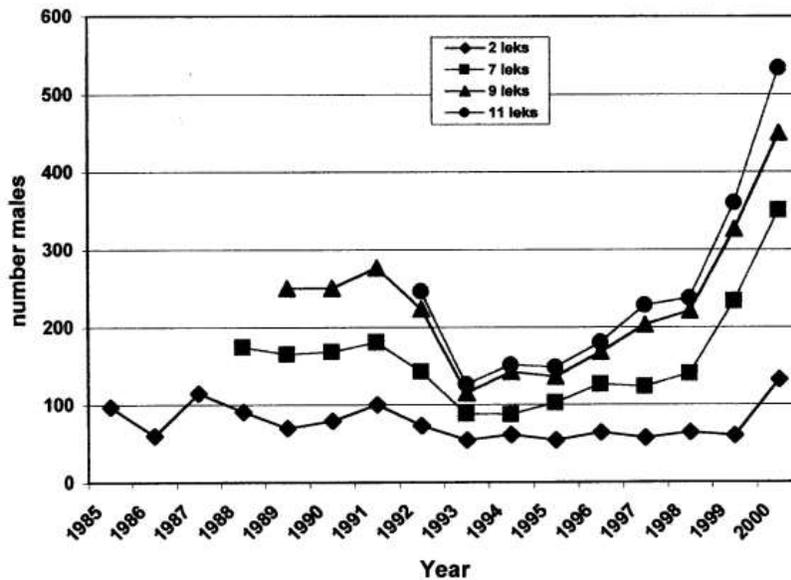


Figure 9. Greater sage-grouse lek counts on the Deseret Land and Livestock region. The increase in attendance coincides with improved sagebrush habitats. This figure was copied from the Danvir 2002 report.

#### Sagebrush Restoration in the Strawberry Valley

Sagebrush habitat improvements have been recorded within the Strawberry Valley area, located in north-central Utah, east of Heber, Utah. Dr. Randy Larsen, Associate Professor at Brigham Young University who conducts sage-grouse related research, stated that the more optimal conditions at Strawberry Valley such as higher elevation (>7,000 ft.) and greater precipitation levels (>20") enhance habitat restoration efforts and experience fewer impacts from invasive species and poor seed establishment (personal communication). Restoration efforts in this region also experience greater grass, forb and shrub establishment and productivity following habitat improvement efforts.

By providing improved sagebrush structure and with the translocation of additional birds to this area, sage-grouse have recovered to densities closer to historic levels. Baxter et al. (2010) found that 100% of translocated birds to the Strawberry area joined with the resident birds and exhibited successful mating and breeding. Male lek attendance after translocation was 4 times that of pre-translocation levels. This success is in part due to high quality habitat and reduced predation through an active predator control program.

Although the Strawberry area has high quality habitat, it is important to recognize that lower elevation, drier sagebrush communities (e.g. Wyoming big sagebrush) may experience lower

vegetation recovery or be hindered by invasive species. These sites often have lower success in sage-grouse habitat and population sustainability.

#### Habitat Improvement in the Western United States

Crawford et al. (2004) found that carefully measured applications of tebuthiuron effectively reduced sagebrush cover locally increasing grass and forb production which can be important for nesting and brood rearing.

Managing sagebrush to create target vegetation densities and increasing plant community diversity (mosaic patterns) has resulted in greater sage-grouse habitat use by providing greater nesting and brood-rearing opportunities for hens and chicks. Additionally, the increased availability of geospatial technology, remote sensing, and landscape ecology can be used to assess habitat characteristics over space and time and link habitat and population dynamics (Crawford et al. 2004).

#### Juniper Removal and Lek Success

Baruch-Mordo et al. (2013) found that sage-grouse leks were less likely to succeed with low to high juniper encroachment (infill) and expansion. They found that population impacts were detected with relatively low level juniper encroachment. They also concluded that no leks remained active in Oregon when tree densities exceeded 4% juniper canopy cover. They suggest that juniper removal and the reduction of juniper encroachment/expansion be used to improve lek attendance and sustain populations over time (Baruch-Mordo et al. 2014).

### **Management Implications and Application to Coal Hollow Mine**

While success stories of sagebrush improvements and subsequent increases in sage-grouse populations within treated habitats are limited in current published literature, several examples provided here demonstrate a concerted and successful effort to improve habitat conditions and increase sage-grouse population densities. Managers responsible for local sage-grouse populations can use the recommendations and strategies provided in these articles and reports to improve habitat and maintain or increase current sage-grouse levels.

#### Application to the Coal Hollow Mine Site

At the Coal Hollow mine site in Kane County, Utah, sage-grouse occupy a mountain big sagebrush/black sagebrush (*Artemisia tridentata* ssp. *vaseyana* / *Artemisia nova*) plant community. The area is characterized as relatively high elevation (over 7,000 ft) with approximately 17" of average annual rainfall. Sage-grouse have been located in this area for decades coinciding with active pinyon (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) infill and expansion, conversion of wildlands to crops and pasture, housing development, and roads. In spite of these natural and human related influences, bird activity has continued to persist within the valley. This includes 4 years of active coal mining activity at the Coal Hollow Mine found in close proximity to important sage-grouse habitat.

Along with active mining operations, sage-grouse continue to occupy and use the Alton and Sink Valley areas throughout the year. Birds have often been sighted directly within mining activity sites such as pits, roads, and spoil piles. For example, in 2011, four males were observed strutting directly on an active spoils pile during the breeding season. Hens have also been observed with young near mining roads and pits.

Restoration efforts are currently being implemented to expand available habitat and improve conditions surrounding the mine site for sage-grouse use. The mine operation has undertaken an active reclamation effort consisting of re-contouring spoil piles, replacing topsoil, and seeding resurfaced areas with seed mixes that target sage-grouse forage species. These include a diversity of native grasses, forbs, and shrubs. These plants will provide quality forage and protection during nesting and brooding periods. In association with higher elevation and precipitation levels (like those of Strawberry and Parker Mountains), we predict the re-establishment of big and black sagebrush over time that will provide quality nesting, brood-rearing and wintering habitat. Aggressive mitigation efforts have been taken to reduce juniper cover near lekking, nesting, and brood-rearing habitats.

In addition to reclamation and mitigation, the mine operator, Alton Coal Development, LLC (ACD), has implemented a predator control and habitat monitoring program. They assist in funding collaring and monitoring of sage-grouse to determine habitat use, population density, and migration patterns.

#### *History of Lek use in Sink Valley*

Greater sage-grouse have been found in the Sink Valley and Alton areas of Kane County, Utah for many generations. This has consisted of breeding activity (at the Sink Valley lek), nesting and brood rearing (likely near Sink Valley but this has been poorly documented), and winter habitat use primarily in Sink Valley and the Alton area. The density of birds reported using the Sink Valley area has fluctuated widely during the time they have been observed. The most accurate estimates of bird densities in this region are from lek counts that were conducted annually by wildlife biologists with the Utah Division of Wildlife Resources (UDWR). Since 1991, lek counts have experienced significant declines in strutting males. Data suggest that there has been an oscillation in male lek attendance over the past 20 years which likely reflects variable sage-grouse occurrence and habitat use within this area (Figure 2).

In 2006, 14 male birds were observed strutting on the Sink Valley lek. However, since that time, the numbers have declined steadily with only 2 birds observed in 2009, 1 bird in 2010, and no sighting of strutting males in 2011. There was concern that the breeding population would not return following several years of low lek attendance and with the beginning of mining activity in the general proximity of the lek. Since mining commenced, the birds have shifted breeding location from the historic lek in Sink Valley to a hillside located in a sagebrush dominated valley approximately 0.55 miles away from this original lek. This “new” lek is 0.35 miles from the

closest mining activity and has supported 12-15 males observed annual over the past 3 breeding seasons. Additionally, 20-60 birds are seen in the valley annually including a number of chicks and young birds that were raised in the area (ACD annual reports 2012-14).

This pattern of behavior indicates that the birds at the Coal Hollow area have shifted lekking locations and that they have the capacity to shift and adapt to local conditions and human-related activities.

### *Reclamation*

Active mitigation activities focused on sage-grouse habitat improvements have included 95 acres of mine site reclamation. These sites have been seeded with a mix of grasses, forbs, and shrubs that will promote sagebrush establishment. Reclamation will continue to be a high priority of mine managers to ensure habitat is provided for long-term habitat and population conservation.

### *Habitat Improvement Accomplishments and Management Plans*

ACD has completed 1000 acres of mitigation related to sage-grouse habitat improvement throughout the area. These acres include pinyon-juniper tree removal, the reduction of rabbitbrush to increase sagebrush establishment and growth, and sagebrush habitat improvement by reducing sagebrush density and cover in a decadent stand of shrubs. ACD has also entered into a contract with the Utah Division of Wildlife Resources through the Utah Watershed Restoration Initiative to fund a 300 acre rabbitbrush removal project and 300 acres of PJ chaining. At the end of these projects, the total mitigation acreage will exceed 1600 acres.

Active habitat restoration and predator control in the Alton area can provide the conditions needed to sustain suitable habitat for sage-grouse reproduction and survival. Population monitoring will be used to track bird population trends and identify any decrease in the population over time.

## REFERENCES

- Baruch-Mordo, S., J.S. Evans, J.P. Severson, D.E. Naugle, J.D. Maetas, J.M. Kiesecker, M.J. Falkowski, C.A. Hagen, and K.P. Reese. 2013. Saving sage-grouse from the trees: a proactive solution to reducing a key threat to a candidate species. *Biological Conservation* 167:233-241.
- Baruch-Mordo, S., J.S. Evans, J.P. Severson. 2014. Conifer removal restores sage-grouse habitat. Sage-grouse Initiative, Science to Solutions. <http://www.sagegrouseinitiative.com/wp-content/uploads/2014/04/Science-to-Solutions-Conifer-Encroachment.pdf>.
- Baxter, R.J., J.T. Flinders, and D.L. Mitchell. 2010. Survival, movements, and reproduction of translocated greater sage-grouse in Strawberry Valley, Utah. *Journal of Wildlife Management* 72:179-186.
- Boyd, C. et al. 2011. Looking toward a brighter future for lekking grouse. *Rangelands* 33:2-11.
- Braun, C.E., T. Britt, and R.O. Wallested. 1977. Guidelines for maintenance of sage grouse habitats. *Wildlife Society Bulletin* 5:99-106.
- Connelly, J.W., M.S. Schroder, A.R. Sands, and C.E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. *Wildlife Society Bulletin* 28:967-985.
- Crawford, J.A., R.A. Olson, N.E. West, J.C. Mosely, M.A. Schroeder, T.D. Whitson, R.F. Miller, M.A. Gregg, and C.S. Boyd. 2004. Ecology and management of sage-grouse and sage-grouse habitat. *Rangeland Ecology and Management* 57:2-19.
- Dahlgren, D.K., R. Chi, and T.A.. Messmer. 2006. Greater sage-grouse response to sagebrush management in Utah. *Wildlife Society Bulletin* 34:975-985.
- Dahlgren, D.K., T.A. Messmer, M.R. Conover, R.H. Schmidt, and J.W. Connelly. Greater sage-grouse brood-rearing habitat manipulation in mountain big sagebrush, use of treatments, and reproductive ecology on Parker Mountain, Utah. M.S. Thesis, Utah State University, Logan Utah.
- Danvir, R.E., W.J. Hopkin, G.E. Simmonds, B. Teichert, S.L. Kearl, J.F. Kimball, R.M. Welch, and A. Aoudie. Sagebrush, sage-grouse, and ranching: a holistic approach. Report from Deseret Land and Livestock, <http://www.deseretlandandlivestock.com/Sagebrush%20sage%20grouse%20and%20ranching%20a%20holistic%20approach.pdf>.

Danvir, R.E. 2002. Sage-grouse ecology and management in Northern Utah sagebrush-steppe: A Deseret Land and Livestock Wildlife Research Report. Deseret Land and Livestock and The Foundation for Quality Resource Management.

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