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Implementing the Candidate Conservation Agreement for Greater Sage-Grouse on the Idaho National Laboratory Site

2016 Full Report

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**Implementation of the Candidate
Conservation Agreement for Greater Sage-Grouse on the
Idaho National Laboratory Site:
2016 Full Report**

February 2017

Quinn R. Shurtliff, Jeremy P. Shive, Amy D. Forman, Jackie R. Hafla, Kurt T. Edwards,
Bryan F. Bybee

*Environmental Surveillance, Education, and Research Program
Wastren Advantage, Inc., 120 Technology Drive, Idaho Falls, ID 83401*



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ACRONYMS

ANOVA	Analysis of variance
BLM	Bureau of Land Management
CCA	Candidate Conservation Agreement
CFA	Central Facilities Area
DOE	U.S. Department of Energy, Idaho Operations Office
ESER	Environmental Surveillance, Education, and Research
GIS	Geographic Information System
GPS	Global Positioning System
IDFG	Idaho Department of Fish and Game
INL	Idaho National Laboratory
LTV	Long-Term Vegetation
MPLV	males per lek visited
NAIP	National Agricultural Imaging Program
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Association
NRF	Naval Reactors Facility
RWMC	Radioactive Waste Management Complex
SGCA	Sage-grouse Conservation Area
UAV	Unmanned Aerial Vehicle
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

EXECUTIVE SUMMARY

This document satisfies the reporting requirement of the *Candidate Conservation Agreement (CCA) for Greater Sage-grouse (Centrocercus urophasianus) on the Idaho National Laboratory (INL) Site*, entered into by the U.S. Department of Energy, Idaho Operations Office (DOE) and the U.S. Fish and Wildlife Service (USFWS) in 2014. The primary purposes of this report are to (1) document DOE's 2016 inventory and monitoring activities and results in support of the CCA, (2) address sage-grouse population and habitat regulatory triggers in the context of those results, and (3) document progress toward achieving CCA objectives associated with the conservation measures. This summary highlights key results and conclusions as they relate to population and habitat triggers, threat monitoring, and implementation of conservation measures.

Population Monitoring

The population baseline on the INL Site is 316 males, which was the number of males counted in 2011 during peak male attendance on 27 active leks within the Sage-grouse Conservation Area (SGCA). The population trigger would be tripped if the three-year average of males on those 27 leks decreased by $\geq 20\%$ (i.e. ≤ 253 males). In 2016, we surveyed the 27 baseline leks (19 of which are currently classified as active), three Idaho Department of Fish and Game survey routes, and all other active leks on the INL Site. Key results from population monitoring are as follows:

- The 3-year average peak male attendance (2014–2016) on the 27 baseline leks was 384 (134% of trigger value), an increase of 13% over averages from 2014 and 2015, and a 17% increase since 2013.
- The number of leks classified as active on the INL Site increased by one in 2016 to 47.
- Peak male attendance on two long-running lek routes (i.e. multi-lek monitoring units) have increased each of the past three years, and a third lek route has been stable. Overall, the combined count of males at peak attendance across the three routes was 50% higher in 2016 than in 2015.

Although the short-term sage-grouse abundance trajectory is good, caution must be exercised when interpreting these results because sage-grouse populations are cyclic over decades.

Habitat Monitoring

The baseline value of the habitat trigger is equivalent to the amount of area within the SGCA that was characterized as sagebrush-dominated habitat at the beginning of 2013. This habitat trigger will trip if more than 15,712 ha (38,824 ac) of sagebrush habitat within the SGCA are converted to a non-sagebrush-dominated vegetation class. To monitor the extent and condition of sagebrush-dominated lands and areas recovering from wildland fire, we surveyed 75 vegetation plots distributed across both habitat types. The following is a summary of wildland fire activity and principle results from habitat monitoring tasks:

- In 2015, no wildland fires burned in the SGCA, so the amount of sagebrush-dominated habitat that affects the habitat trigger remained unchanged. One 2015 fire outside the SGCA burned an estimated 1.5 ha (3.7 ac) of sagebrush habitat. During the past four years, only an estimated 11 acres have burned on the INL Site. That is a lower amount than in any other four-year period since at least the early 1990s (the current annual INL wildfire report contains data dating back to 1994).

- A couple of unburned sagebrush habitat polygons were omitted from the updated sagebrush habitat baseline calculation in 2015. After the area of those polygons was added, the sagebrush habitat baseline value slightly increased to 78,557.5 ha (194,119.8 ac). No losses in sagebrush habitat have been mapped within the SGCA since monitoring was initiated.
- In polygons currently identified as sagebrush habitat, mean sagebrush cover and height were within suggested optimal ranges for breeding and brood-rearing habitat.
- Perennial herbaceous height was at the lower end of its suggested range and perennial herbaceous cover was below guideline recommendations. Low herbaceous cover values, relative to habitat guidelines, do not appear to be a result of poor ecological condition, but rather the effect of soils and climate on the local ecosystem.

Threats Monitoring

Three monitoring tasks described in the CCA were designed to generate baseline data and track indicators of three threats—raven predation, annual grasslands, and infrastructure development. In 2016, we searched infrastructure for active raven nests (raven predation), quantified the cumulative length of wildfire containment lines to identify weedy areas (annual grassland patches), documented two-track linear features within the SGCA and updated sagebrush habitat distribution accounting for minor loss due to borrow source expansions. Key results and conclusions from threat monitoring tasks are listed below:

Raven Predation

- Forty-six active raven nests were observed on INL Site infrastructure in 2016, and raven nests on infrastructure have increased 34% since 2014 (7.5 nests per year). It is unclear what the carrying capacity of breeding ravens is on the INL Site, but it is reasonable to expect that in coming years perhaps two or three times as many raven nests could be supported annually on the INL Site. The effect on sage-grouse of such an increase is unknown.
- A couple of attempts made in 2015 to deter raven nesting on National Oceanic and Atmospheric Administration (NOAA) failed, but new efforts will be made in 2016.

Annual Grasslands

- Environmental Surveillance, Education, and Research (ESER) redefined the objective of Task 7 in 2016 and commenced the first of a three-phase project. We mapped 847.4 km (526.5 mi) of bladed wildfire containment lines across the INL Site. Approximately 310–387 ha (766–957 acres) of vegetation have been affected by containment line construction.

Infrastructure Development

- There were 7.4 km (4.6 mi) of new two-track linear features mapped within the SGCA or sagebrush habitat. There were 24.4 km (15.2 mi) of additional two-track linear features mapped this year, but after further review of the 2013 National Agricultural Imaging Program (NAIP) imagery, they were verified to be present and missed in the 2015 results. When these newly mapped features are combined with 2015 results, an updated total of 529.9 km (329.3 mi) two-track linear features were mapped and the current 2013 ground condition baseline is 3,617.2 km (2,247.6 mi) of two-tracks and paved roads on the INL Site.

- We documented four locations where sagebrush habitat had been removed between the summers of 2013 and 2015 due to expansion of borrow sources. The total area of sagebrush habitat removed was 2.6 ha (6.4 acres), and the largest single expansion was 1.3 ha (3.1 acres).

Implementation of Conservation Measures

Actions were taken or measurable progress was achieved for most of the 13 conservation measures listed in the CCA. The following are highlights from 2016:

- In support of Conservation Measure 1, the ESER program coordinated the planting of approximately 6,000 sagebrush seedlings in and near a priority restoration area during fall 2016. First-year survivorship of seedlings planted in 2015 was estimated at 73-86%.
- ESER participated with BLM in field assessments of a grazing allotment that was under review. This was the first time in recent memory that ESER ecologists had been invited to take part in the permit renewal process, and it represents progress toward improving communication and collaboration with the BLM to ensure that the herbaceous understory on the INL Site is adequately maintained to promote sage-grouse reproductive success (Conservation Measure 6).
- The NOAA attempted to deter raven nesting at two NOAA towers on the INL Site without success. Adjustments to the deterrent design were made and the towers will be monitored again in 2017.
- No measurable progress was achieved for Conservation Measure 7, which aims to cultivate partnerships with other agencies with the intent to encourage investigation of the mechanisms of crested wheatgrass invasion.

Synthesis and Conclusions

Sage-grouse abundance on the INL Site has been trending upward for the past several years, although we must be cautious to interpret the significance of this short-term observation because studies have shown that some sage-grouse populations are cyclic, with a regular periodicity of 6-9 years. Vegetation monitoring continues to provide evidence that sage-grouse habitat is generally in good condition. Additionally, wildland fire activity over the past four years has been low and no sagebrush habitat has been lost within the SGCA due to INL Site activities. Currently, we have no expectation that either the population or habitat triggers will be tripped in the near term unless a large fire burns through sagebrush habitat.

ESER monitoring of potential threats to sage-grouse and sagebrush habitat allows DOE to consider how sage-grouse may be affected in the future by INL Site-specific activities or regional factors. Increasing raven nesting on infrastructure and increased two-track features are issues that DOE could potentially address. However, it is unclear if these threats, at the level that we have documented, impact sage-grouse survivorship or reproductive success. Non-native plant cover was higher than we have observed in recent years, but this could be an artifact of the unusual timing of precipitation that has occurred on the INL Site, rather than an ecological shift. These uncertainties highlight the importance of continued monitoring of threats in addition to sage-grouse abundance and habitat trends.

1. INTRODUCTION, BACKGROUND AND PURPOSE

In October 2014, The U.S. Department of Energy, Idaho Operations Office (DOE) and the U.S. Fish and Wildlife Service (USFWS) entered into a Candidate Conservation Agreement (CCA) for Greater Sage-grouse (*Centrocercus urophasianus*; hereafter sage-grouse) on the Idaho National Laboratory (INL) Site (DOE and USFWS 2014). The CCA stipulates that DOE submit a report annually summarizing results from eight monitoring tasks (Section 11), updating the USFWS on DOE's progress toward achieving stated conservation objectives (Section 10), and providing other relevant information prior to an annual meeting between the two agencies. This report summarizes results from the 2016 inventory and monitoring tasks completed by DOE's Environmental Surveillance, Education, and Research (ESER) Program, and provides other information in support of sage-grouse conservation and the CCA.

The primary purpose of this report is to summarize inventory and monitoring results and conclusions so DOE and USFWS can track population and habitat trends and make informed decisions relative to adaptive regulatory triggers outlined in the CCA. On the INL Site, the two triggers and criteria that define them, which would initiate responsive action by both agencies, are:

- **Population Trigger:** Peak male attendance, averaged over three years on the 27 leks within the SGCA, decreases by 20% or more (i.e., ≤ 253 males) compared with the 2011 baseline of 316 males;
- **Habitat Trigger:** Total area designated as sagebrush habitat within the SGCA is reduced by 20% or more (i.e. $\geq 15,712$ ha [38,824 ac]) of the 2013 baseline of 78,558 ha (194,120 ac).

Information provided here will inform a dialogue between DOE and USFWS as the two agencies cooperate to achieve CCA objectives for sage-grouse conservation on the INL Site. Consistent re-evaluation and analysis of new information will ensure that the CCA continues to benefit sage-grouse on the INL Site, is continuously grounded in the best available science, and retains its value to both signatories.

This document groups related inventory and monitoring task reports into three chapters: Population Trigger Monitoring (Chapter 2), Habitat Trigger Monitoring (Chapter 3), and Threat Monitoring (Chapter 4). Each of these chapters summarizes results of pertinent monitoring tasks outlined in section 11.1 of the CCA. Chapter 5 documents how DOE and its contractors implemented the 13 conservation measures listed in the CCA during 2016. Chapter 6 brings together the main results and conclusions from the eight monitoring tasks and addresses them in light of the ultimate goal of the CCA, which is to conserve sage-grouse. Finally, Chapter 7 outlines the ESER program's work plan for the upcoming year and highlights changes that will be made to the past year's activities.

2. POPULATION TRIGGER MONITORING

In 2013, DOE initiated the following three monitoring tasks designed to track the number of male sage-grouse at active leks and document additional active leks on the INL Site (DOE and USFWS 2014):

- 1) Lek Census and Route Surveys—Surveys of all active leks on the INL Site. These include leks located in and out of the SGCA and leks on the three Idaho Department of Fish and Game (IDFG) survey routes;
- 2) Historical Lek Surveys—Surveys of historical leks on the INL Site to determine if sage-grouse still use those areas;
- 3) Systematic Lek Discovery Surveys—Surveys of poorly sampled regions of the INL Site to discover additional active leks, especially in the SGCA.

Task 1 produces an index of peak male attendance across the 27 leks in the SGCA that were used to establish the baseline value of the population trigger (DOE and USFWS 2014). Task 1 also provides information about abundance trends across the three IDFG lek routes and all other active leks on the INL Site (DOE and USFWS 2014). The purpose of Tasks 2 and 3 is to identify unknown active leks on the INL Site. Our goal is to use information from the three tasks to track population trends and establish new, permanent lek routes on the INL Site before the 2017 lek season (DOE and USFWS 2014).

2.1 Task 1—Lek Census and Route Surveys

2.1.1 Introduction

Task 1 consists of surveying all known active leks on the INL Site, including the 27 baseline leks located in the SGCA and all other known active leks on the INL Site (DOE and USFWS 2014). Leks on three IDFG survey routes (monitored annually since 1999; Fig. 2-1) fall into one of these two categories, but are analyzed separately as well to maintain historical context.

The primary purpose of Task 1 is to provide information to track male attendance trends on the 27 baseline leks within the SGCA, which is crucial for evaluating the population trigger. The baseline value for the population trigger is 316 males, which is the summation of peak male attendance on the 27 leks in the SGCA that were active during 2011 (Fig. 2-1; DOE and USFWS 2014). The trigger would be tripped if the three-year average of peak male attendance at these 27 leks decreases by 20% or more (i.e., ≤ 253 males) relative to the 2011 baseline (DOE and USFWS 2014).

Three lek routes (Tractor Flats, Radioactive Waste Management Complex [RWMC], and Lower Birch Creek) were established on the INL Site by the IDFG in the 1990s and have been monitored annually since 1999 (Fig. 2-1). Many of these leks were included in the suite of 27 baseline leks. Data from these lek routes are valuable as they add an historical perspective to current trends in sage-grouse abundance (Garton et al. 2011, DOE and USFWS 2014). Counts of peak male attendance on lek routes represent a minimum number of breeding males in a local area (Connelly et al. 2003, Garton et al. 2011) and are useful for evaluating abundance trends over time.

In 2016, ESER biologists surveyed 28 active leks (considered active at the beginning of the season) on the INL Site in addition to the SGCA baseline leks (i.e. 55 total leks, Fig. 2-1). These 28 leks were not included in the 2011 baseline value because they were either not within the SGCA (including some leks on IDFG routes), not discovered until after 2011, or they were not sampled every year from 2011 to 2013 (only those

that were regularly monitored were eligible to be included as baseline leks). Now that all active leks on the INL Site are surveyed each year, there is a broad context to evaluate sage-grouse abundance trends and establish new lek routes (DOE and USFWS 2014).

2.1.2 Methods

We surveyed all leks from 21 March to 4 May following field methods used in past years (Shurtliff et al. 2015). Our analysis of historical data from IDFG lek routes, however, differed this year. In past reports, we simply displayed peak male attendance per route from 1999 to present. This method did not account for the increasing number of leks that were visited each year on the route. A more precise approach, which we employed in 2016, was to calculate an annual value for each of the three routes during peak male attendance that represented the mean number of males per lek (or per active lek). This metric is similar to that used by the IDFG for setting sage-grouse hunting bag limits. We were unable to calculate these averages in the past for the Lower Birch Creek route because the ESER database lacked information about the number of leks visited each year prior to 2010 when the IDFG performed the lek route surveys. Recently, we obtained the missing data from the IDFG, so we were able to improve our analysis.

The method described above is more appropriate than a simple comparison of lek route totals across time if lek routes or habitats have changed, or when leks have been added (Connelly et al. 2003). Since 1999, the number of leks visited has increased on the Tractor Flats and RWMC routes, and the routes were expanded periodically to accommodate the new leks. Furthermore, habitat on the Tractor Flats route changed drastically following the 2010 Jefferson fire. In contrast, the survey route on the Lower Birch Creek Route appears to have been unchanged since 2002, and perhaps since 1998. Thus, it would be appropriate to compare lek route counts across years for the Lower Birch Creek route (as we have done in the past), but we chose to analyze the average peak male attendance per lek so results across lek routes would be comparable.

2.1.3 Results and Discussion

SGCA Baseline Leks

We surveyed each of the 27 SGCA baseline leks 3–7 times (\bar{x} =4.9 surveys, SD =1.7; Fig. 2-1). The sum of peak male attendance counts across the 27 leks was 471, a 41% increase from 2015. The three-year mean (2014-2016) is now 384 males, which is 13% higher than last year's 2013-2015 mean (Fig. 2-2), and 152% of the threshold (153 males) that would trigger an automatic action by DOE and the USFWS (DOE and USFWS 2014). The three-year mean has been stable or has increased each of the past three years.

Following the 2016 field season, 19 baseline leks remain classified as active (one was reclassified as inactive). In each of the past four years, at least one baseline lek per year has been reclassified as inactive. These results should not be interpreted as evidence that eight leks have been abandoned in the past four years but rather that six years of data have accumulated for most leks, allowing for more precise lek classifications (Whiting et al. 2014). As noted above, the total number of male sage-grouse attending the active leks is higher than it has been since the baseline was established.

Other Active Leks

We surveyed 30 additional (i.e. non-baseline) active leks 1–7 times (\bar{x} =3.8 surveys, SD =1.5), and serendipitously, discovered one new lek (INL 162; Fig. 2-1). Average peak male attendance was 10.1

males per lek (0–38 males, SD=11.5), down from 10.6 males per lek in 2015 ($n=23$) and 13.2 males per lek in 2014 ($n=20$). The apparent downward trend is a reflection on the size of leks that have been added to the survey list in recent years. For example, the average peak male attendance at nine active leks surveyed in 2016 that were not classified as active in 2015 was 6.4 males.

IDFG Lek Routes

Active leks on IDFG lek routes include some counted as baseline leks, some counted as “other active leks” (see above), and two that are outside the INL Site boundaries. We surveyed each of the IDFG lek routes (Fig. 2-1) six or seven times during the official survey period. Combined peak male attendance across all lek routes was 381, a 50% increase over 2015 counts. Counts on all three lek routes were greater in 2016 than in 2015. On the Tractor Flats route, the 2016 count (115 males) was the greatest since 2010 (119 males), the year the Jefferson Fire burned across the lek route. Peak attendance on the Lower Birch Creek route was the highest recorded since 2007 (133 males in both 2016 and 2007) and higher than any other year since 1999. In addition, a new lek was discovered on the Lower Birch Creek route, resulting from a single observation of five males strutting (Fig. 2-1). On the RWMC route, peak attendance of 133 males was nearly the same as the three highest years in the past ten years (2014: $n=141$, 2011: $n=132$, 2006: $n=135$).

The number of leks surveyed annually on each lek route has increased incrementally over time. From 1999 to 2016, the number of surveyed leks increased from three to seven on the Tractor Flats route, from two to nine on the RWMC route, and from six to ten on the Lower Birch Creek route. The distance surveyed along the Tractor Flats and the RWMC routes has expanded since 1999 as nearby leks were discovered or added to the route, whereas the distance surveyed along the Lower Birch Creek route has been virtually unchanged since 1999. Increased number of leks on the Lower Birch Creek route primarily reflects natural establishment of new leks along the established route (some leks on the other routes were also added in the same way). Because the area surveyed has remained unchanged on the Lower Birch Creek route, it would be appropriate not only to report trends as an average number of males per lek, but also to simply report annual lek route counts for that route. We graphed trends using both methods, and the conclusions are similar. Therefore, we only report trends for the Lower Birch Creek route as an average number of males per lek for consistency in presentation.

Average number of males per lek visited (MPLV) since 1999 has decreased on the Tractor Flats route from 35–45 MPLV (1999-2001) to a low of 7.9 MPLV in 2013 (Fig. 2-3). During the past three years, however, male attendance has increased to 16.4 MPLV, which is the highest level since 2010 (19.8 MPLV). The RWMC lek route has been stable since 2008, ranging from 10.7–15.7 MPLV. The Lower Birch Creek route has exhibited low variability between consecutive years during the past nine years, and after declining from 8.4–6.0 MPLV between 2008 and 2013, the route has steadily increased each of the past three years, reaching 13.3 MPLV in 2016. Only three of the past 18 years have had higher MPLVs than in 2016.

The downward trend on the Tractor Flats route since 1999 likely reflects local impacts of wildland fire on sage-grouse nesting habitat near the lek route. A 164 km² (40,539 acres) fire burned over a lek that was at the northern end of the route in 1999. By 2004, this lek, which was one of five on the route, was vacated. In 2010, the Jefferson fire burned 52% of the lek route (9.7 km) and one more of the six leks that were surveyed annually at that time. Thus, by 2011, a third of the leks that were part of the official route were within a large burned area. No other lek routes had fires that burned over any leks or any part of the lek route.

Taken together, lek route data on the INL Site suggest that the sage-grouse breeding population was stable to increasing between 1999 and 2006, with a peak occurring from 2005–2007. By 2008, male attendance (and presumably abundance) was substantially lower and may have continued to decline through 2012. Male attendance has increased steadily during the past three years.

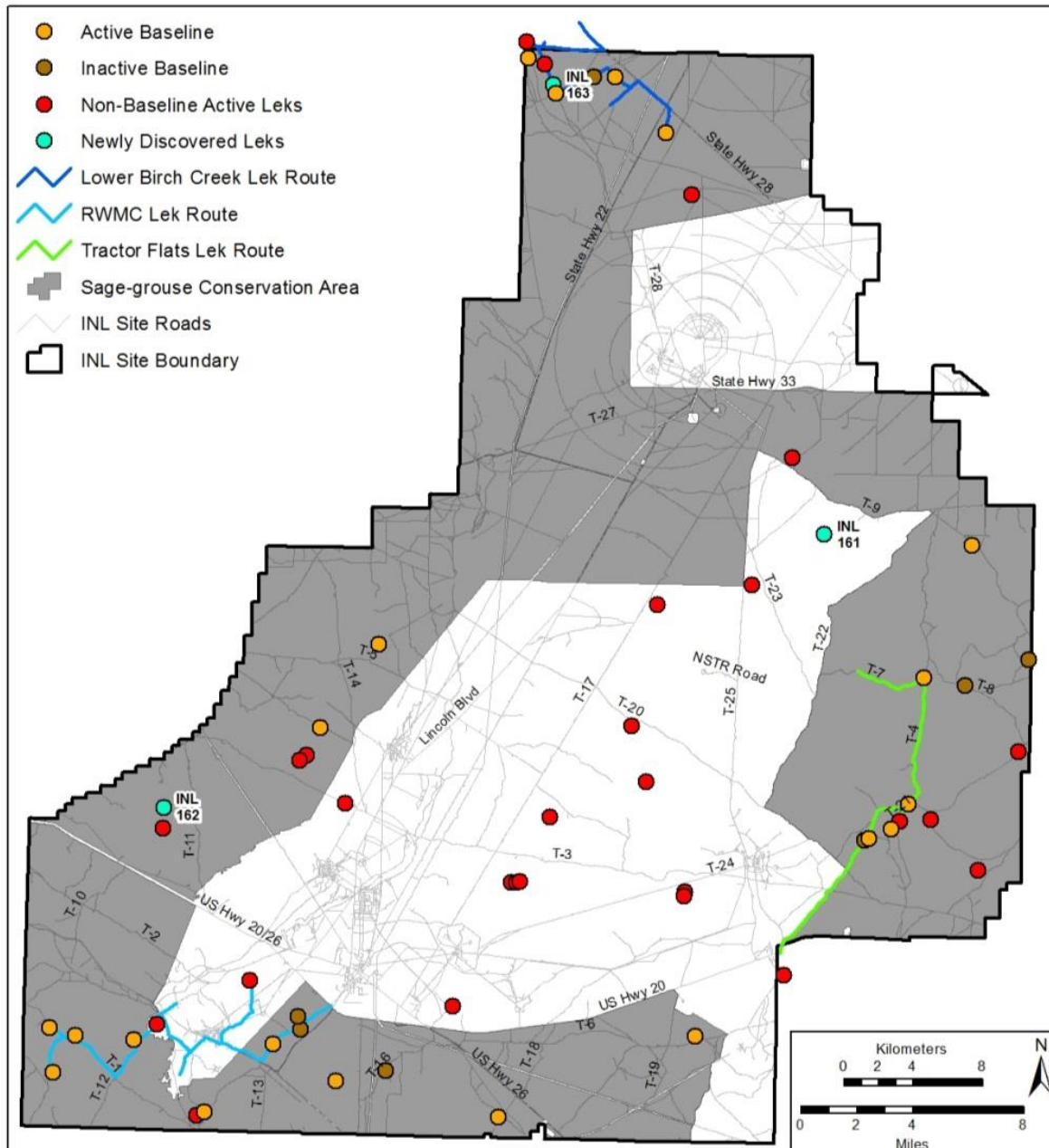


Figure 2-1. Twenty-seven baseline leks (both active and non-active) and other active leks that were surveyed in 2016. One baseline lek was subsequently reclassified as inactive following the surveys. Also shown are three new leks discovered in 2016.

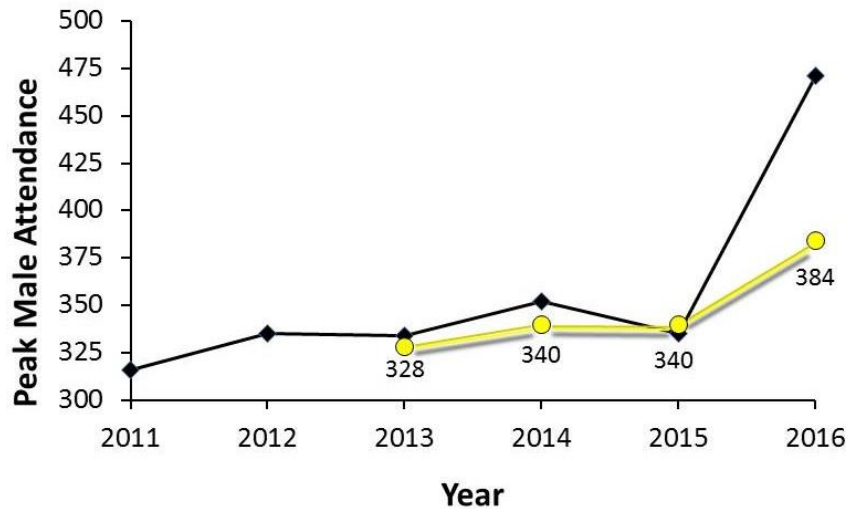


Figure 2-2. Peak male attendance on 27 leks in the SGCA used to calculate the original baseline value. Black diamonds represent annual counts, and yellow dots represent the 3-year running average.

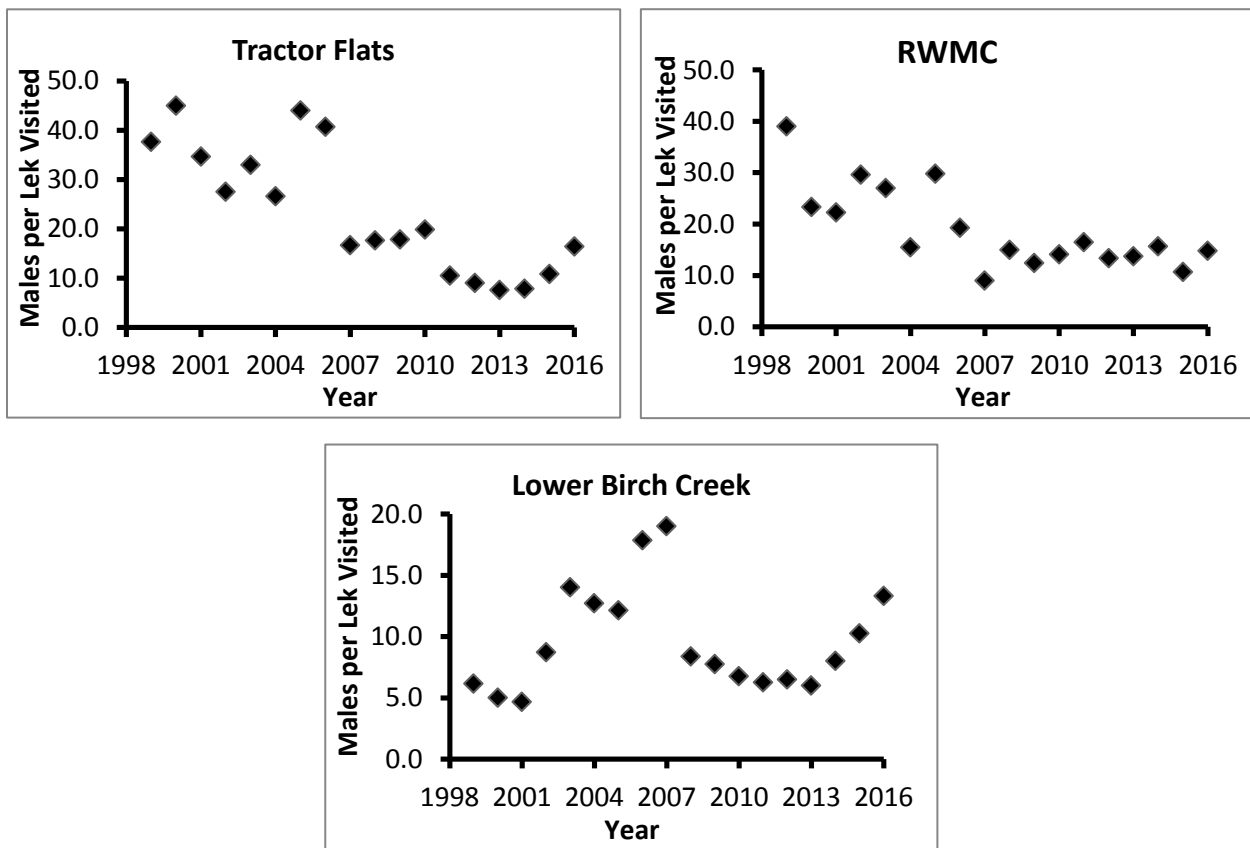


Figure 2-3. Mean number of males per lek surveyed at peak male attendance on three IDFG lek routes from 1999-2016 on the INL Site. The number of leks visited each year increased over time as follows: Tractor Flats (3-7 leks), RWMC (2-9 leks), and Lower Birch Creek (6-10 leks). Note that the Y-axis is at a different scale in the Lower Birch Creek panel.

2.2 Task 2—Historical Lek Surveys

2.2.1 Introduction

During the past several decades, many leks have been documented on the INL Site as a result of surveys and opportunistic observations of displaying sage-grouse (Whiting and Bybee 2011). Prior to 2009, many of these historical lek sites had not been surveyed for nearly 30 years. Since 2009, ESER biologists have revisited a subset of historical leks each spring to determine if they remain active based on a suite of criteria (DOE and USFWS 2014). The objective of Task 2 was to determine which historical leks are active before establishing new lek routes (DOE and USFWS 2014).

2.2.2 Methods

Survey methods and criteria used to designate a historical lek as active or inactive are described elsewhere (Shurtliff et al. 2015, Whiting et al. 2014, Research Procedure 6, 2014). In 2016, we surveyed historical lek sites from 21 March to 3 May (Fig. 2-4).

2.2.3 Results and Discussion

We surveyed all historical leks two times each, both inside ($n=7$) and outside ($n=8$) the SGCA. No sage-grouse were observed on any of these 15 potential lek sites. Following the 2016 surveys, we reclassified ten historical leks as inactive because they had been surveyed at least four years and there was no longer a chance of breeding activity being recorded in at least two out of five years (Whiting et al. 2014). Five historical leks remain, all of which will require one additional survey season before they can be reclassified. Because the status of these five leks remains in question, and because all of these are well outside the SGCA, none of the five leks were considered when we created new lek routes this year (see section 2.5).

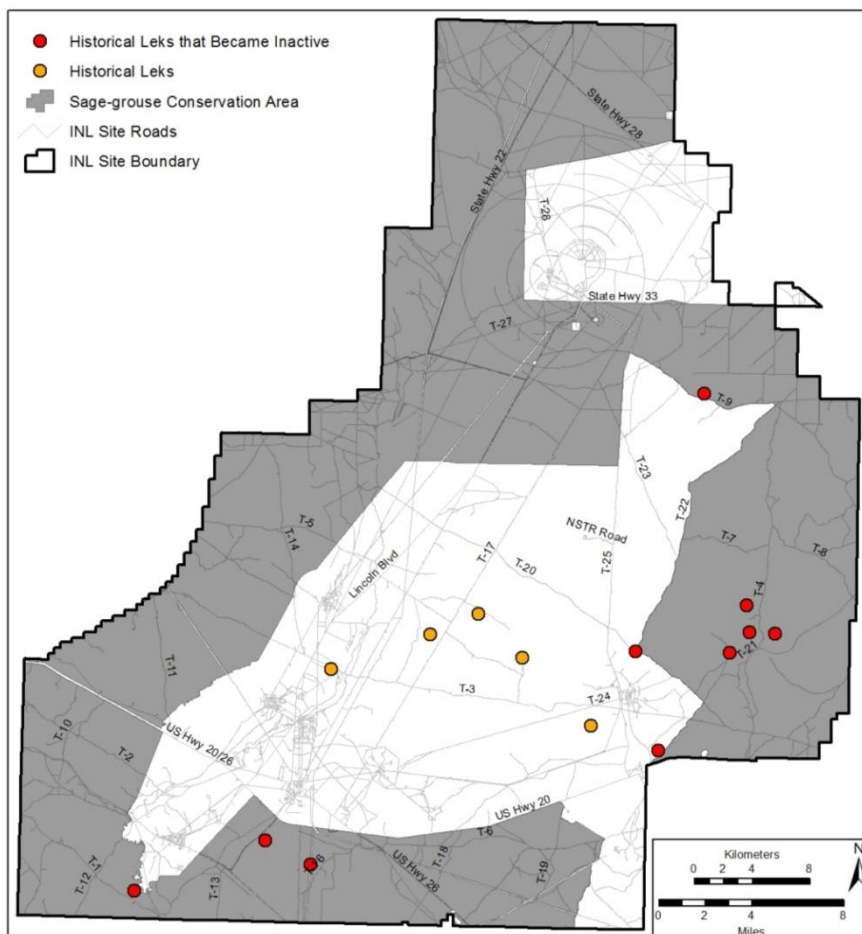


Figure 2-4. Historical leks surveyed in 2016. Those reclassified as inactive following the field season are shown in red.

2.3 Task 3—Systematic Lek Discovery Surveys

2.3.1 Introduction

Known lek sites are few or absent across large portions of the SGCA (Fig. 2-1), even though habitat in these areas often appears to be adequate to support sage-grouse breeding and nesting activities (DOE and USFWS 2014). The objective of Task 3 is to survey suitable sage-grouse habitat within and near the SGCA where no leks are known to exist. Since 2013, ESER has systematically searched for unknown leks each spring. If a lek is discovered, it is included thereafter in ESER’s annual monitoring program.

2.3.2 Methods

Prior to the field season, we designated road- and remote-survey locations in a Geographic Information System (GIS) to which we would drive or hike (Shurtliff et al. 2015). At each point, we listened for lekking sage-grouse using a parabolic microphone as described elsewhere (Shurtliff et al. 2015; Research Procedure 6, 2014).

2.3.3 Results and Discussion

Between 28 March and 3 May, 2016, we completed 85 surveys (66 road, 19 remote) within the northeastern and southeastern sections of the INL Site and discovered one active sage-grouse lek (INL161, Fig. 2-5). After two surveys, the high count on INL161 was 7 males. Since surveys began in 2013, we have discovered five leks through Task 3.

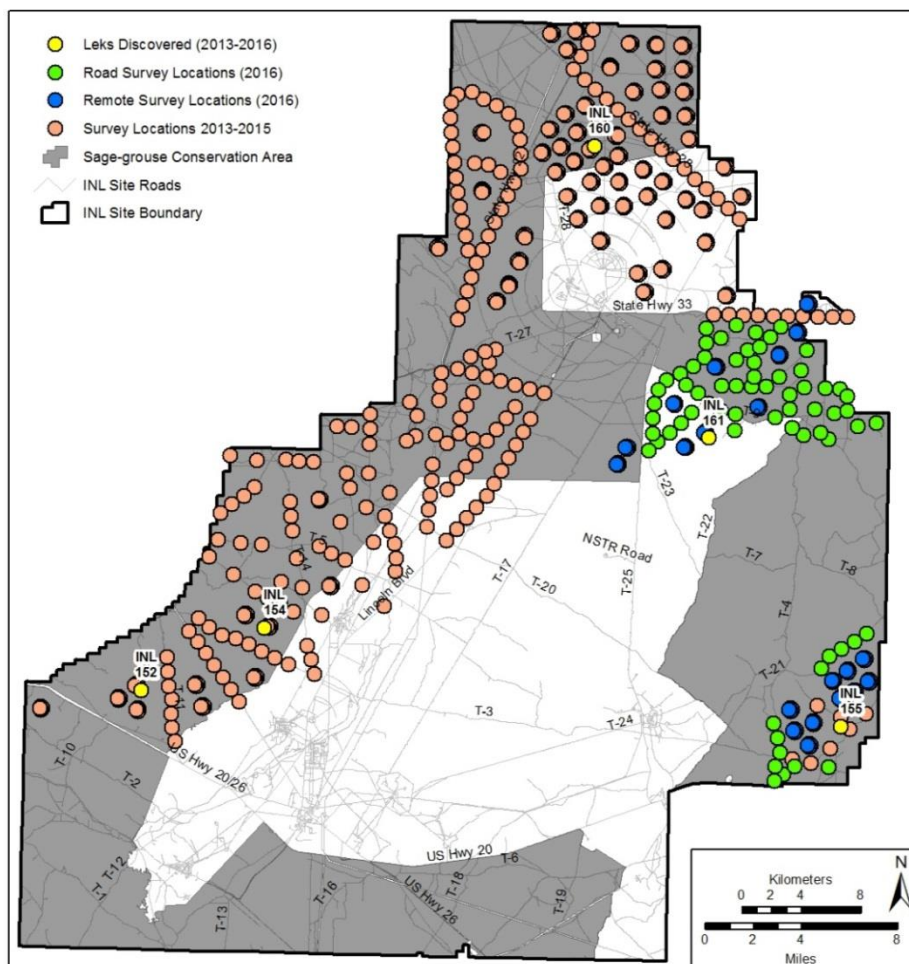


Figure 2-5. Locations of Task 3 surveys conducted since 2013. All active leks discovered as a result of these surveys are indicated by yellow dots.

2.4 Summary of Known Active Leaks and of Changes in Lek Classification

At the end of the 2015 field season, 48 leks were classified as active on or near the INL Site, including two just outside the Site boundaries that are part of the IDFG survey routes. In 2016, two leks were downgraded to inactive status. One was burned over during the 2011 Jefferson fire (Fig. 2-6, northern-most red dot), and no males have been seen at that site since 2013. The other site (southern-most red dot) was formerly classified as an historical lek. Three males and 26 sage-grouse of unknown gender were seen at that site only once in 2014, and no more than one sage-grouse has been observed at that site before or since that day in 2014 during the past five years.

Three new leks were discovered in 2016 (two during discovery surveys and one during an IDFG lek route survey; Fig. 2-1). Thus, the total number of known active leks on or near the INL Site is currently 49 (Fig. 2-6).

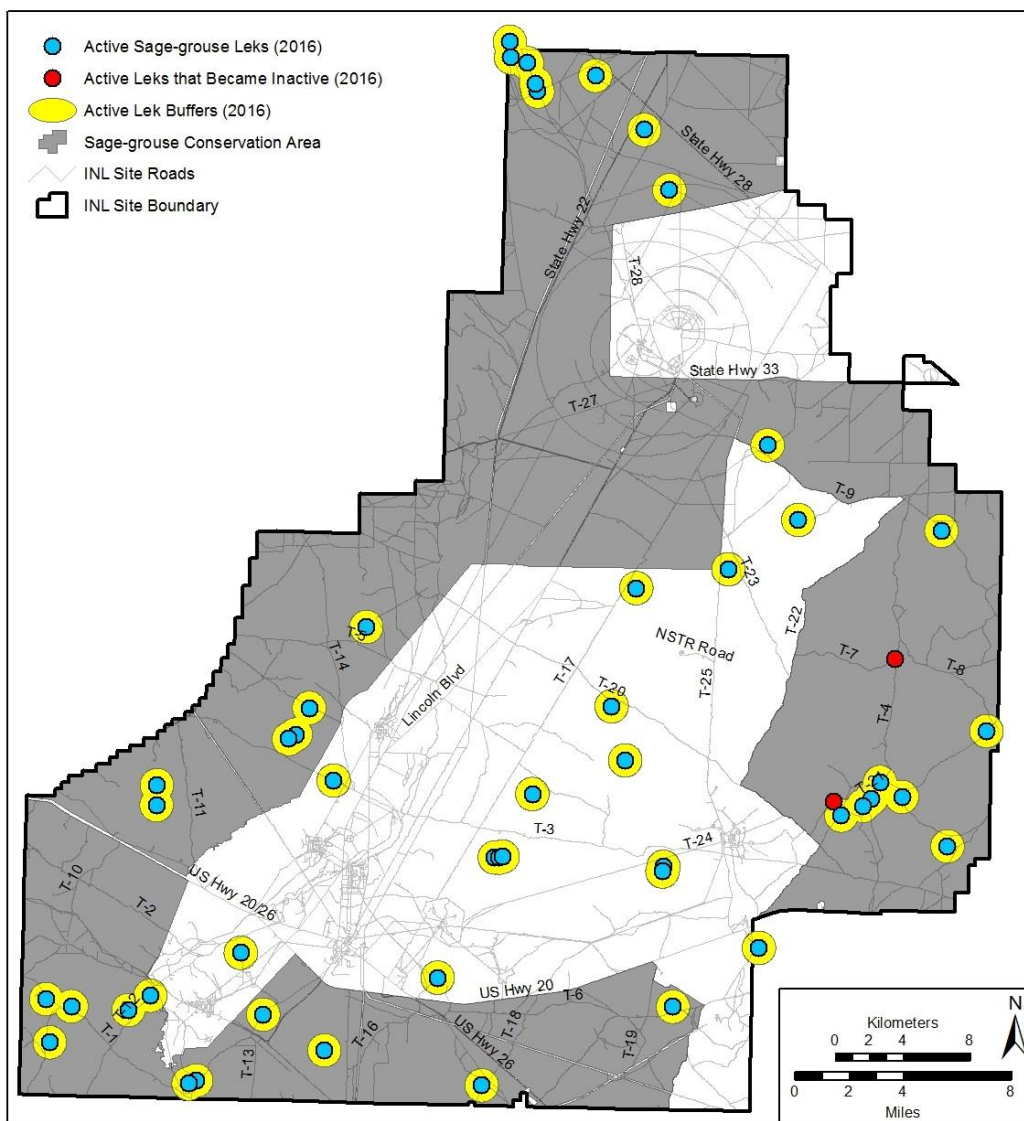


Figure 2-6. Following the 2016 field season, the locations of 49 active leks and two that were reclassified as inactive on or near the INL Site.

2.5 Adaptive Management—New Lek Routes for 2017

The CCA stipulates that following the 2016 field season, DOE would establish (in consultation with the IDFG) at least two new lek routes within the SGCA (Section 9.4.1, DOE and USFWS 2014). The advantage of assigning leks to routes is that route surveys ensure that each group of leks is surveyed in the same order and at roughly the same time relative to sunrise each visit. This temporal consistency is important because the time of morning that leks are visited, even within the traditional two-hour survey period, potentially influences the number of males counted (Fremgen et al. 2016). In addition, lek route data are comparable to regional IDFG data, and route surveys facilitate future repetition by others (Connelly et al. 2003).

Following the 2016 field season, ESER biologists used lek data from the past several years and knowledge of the roads and terrain to create five new lek routes on the INL Site (Fig. 2-7). Nearly all of the 17 leks that are part of these new lek routes are within the SGCA and are currently active. Guidelines provided by the IDFG were followed when establishing lek routes. In 2017, the five new routes and the three traditional IDFG routes will be surveyed (along with all other active leks on the INL Site). Following the 2017 season, DOE and the USFWS will reevaluate what an appropriate population trigger level should be based on new methods of data collection.

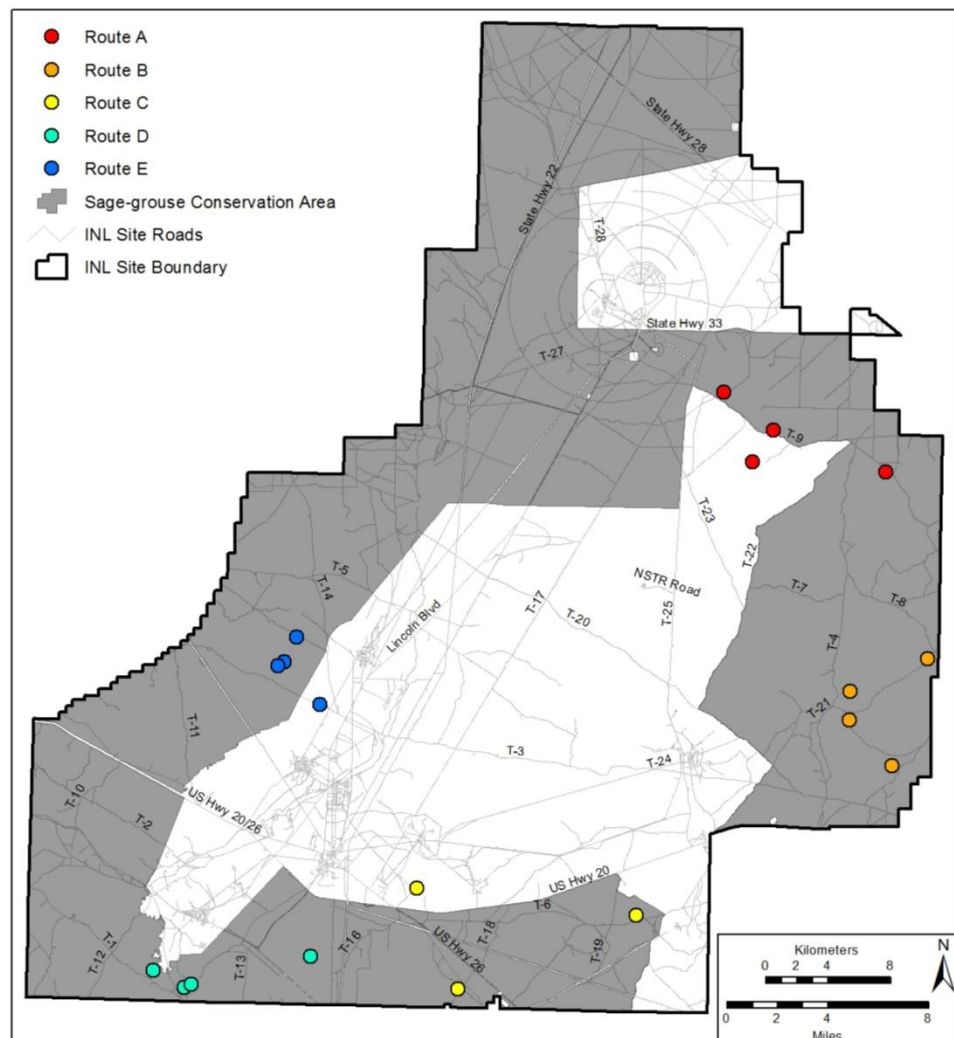


Figure 2-7. New lek routes that will be surveyed in conjunction with the three IDFG routes (Fig. 2-1) and other active leks, beginning in 2017.

3. HABITAT TRIGGER MONITORING

All vegetation-based estimates for sagebrush habitat for the CCA were initially determined using a vegetation map completed in 2010 (Shive et al. 2011). Sagebrush habitat was designated by selecting all map polygons assigned to stand-alone big sagebrush or low sagebrush classes, and all map class complexes where one of the two classes is either a big sagebrush or low sagebrush class. Areas designated as sagebrush habitat will change through time based on gradual changes in vegetation composition and also from abrupt changes caused by wildland fire.

The current baseline value of the habitat trigger is defined as the total area designated as sagebrush habitat within the SGCA at the beginning of 2013, or 78,558 ha (194,120 ac). The trigger will trip if there is a 20% reduction in sagebrush habitat (i.e. a loss of >15,712 ha [38,824 ac]) within the SGCA. If the trigger is tripped, the USFWS will evaluate current habitat management on the INL Site and arrange a meeting with DOE to discuss plans for maintaining compliance with the CCA.

Two monitoring tasks identify vegetation changes across the landscape and assist in maintaining an accurate record of the condition and distribution of sagebrush habitat within the SGCA to facilitate annual evaluation of the habitat trigger:

Task 5: Sagebrush Habitat Condition Trends—Sagebrush habitat quality data will document gains in habitat as non-sagebrush map polygons transition back into sagebrush classes, or when compositional changes occur within sagebrush polygons that may require a change in the assigned map class. This task also allows for ongoing assessment of habitat quality, or condition, within polygons mapped as sagebrush habitat, which facilitates comparisons between sagebrush habitat on the INL Site and sage-grouse habitat guidelines (e.g. Connelly et al. 2000).

Task 6: Monitoring to Determine Changes in Sagebrush Habitat Amount and Distribution—The sagebrush habitat quantity monitoring task is intended to provide an update to the current sagebrush habitat distribution, and primarily deals with losses to sagebrush habitat following events that alter vegetation communities. As updates are made to the map classes (vegetation polygon boundaries), the total area of sagebrush habitat available will be compared to the baseline value established for the habitat trigger to determine status with respect to the habitat threshold.

Together, these two monitoring tasks reflect the original mapping process and provide the basis for maintaining an accurate map and estimate of condition and quantity of sagebrush habitat on the INL Site. For example, if imagery from burned areas suggests there have been changes in vegetation classes or distribution of those classes several years post-burn, sagebrush cover will be assessed using habitat condition monitoring data from plots located within a burned area. Once substantial increases in big sagebrush cover have been identified from either the plot data or the imagery, field-based sampling will be conducted within affected polygons to determine whether it has enough big sagebrush cover over a substantial enough area to redefine the polygon as a big sagebrush class or complex, or whether re-delineating smaller sagebrush-dominated polygons within the burn area is appropriate.

3.1 Task 5—Sagebrush Habitat Condition Trends

3.1.1 Introduction

Characterization and monitoring of sagebrush habitat condition was identified as an integrated component of the CCA monitoring plan to address conservation efforts for sage-grouse on the INL Site. Annual monitoring of sagebrush habitat is necessary to track trends in the condition of habitat available for sage-grouse and to understand the potential for declines in habitat quality associated with threats. Two threats, wildland fire and infrastructure development, were ranked as high-level threats in the CCA. The potential negative effects from annual grasses and other weeds, livestock, and seeded perennial grasses are also important, with each being ranked as a mid-level threat. These five threats are thought to affect sage-grouse populations directly or indirectly through their effects on habitat. The habitat condition monitoring task allows biologists to characterize broad-scale trends in habitat condition over time and to identify annual changes in condition associated with post-fire recovery, surface disturbance, livestock operations, and spread of introduced herbaceous species. Thus, the task enables ESER to monitor threats to sage-grouse habitat and document threat reductions as conservation measures are implemented.

3.1.2 Methods

The habitat condition monitoring task was specifically designed to:

- characterize habitat condition each year,
- relate vegetative characteristics of habitat on the INL Site to conservation goals and/or management guidelines,
- track trends in habitat decline and/or recovery,
- interpret changes to habitat condition within the context of regional vegetation and weather patterns,
- continue to assess progress toward recovery in areas that were lost from current habitat status due to wildland fire or other disturbances,
- understand the effects of various threats on habitat condition,
- provide a link between areas mapped as habitat and the vegetative characteristics of the plant communities in those polygons, and
- inform the process used to update the estimate of sagebrush habitat distribution.

We established a total of 225 plots for the purpose of monitoring sage-grouse habitat condition. All plot locations were selected using a stratified random sampling design (Shurtliff et al. 2016, Appendix B). A subset of 75 of the habitat condition monitoring plots are surveyed annually; about two-thirds of the plots are located in polygons designated as current sagebrush habitat and the remaining plots are located in fire scars where the plant community prior to the wildland fire was thought to include sagebrush habitat. An additional 150 plots are surveyed on a rotational basis with a subset of 50 plots sampled each of three years over the span of five years. The rotational plots are located to increase sample sizes in burned areas, grazing allotments, and areas likely to be impacted by non-native plants.

The data metrics collected at each of the habitat monitoring plots were selected for two purposes. The first is to support basic description and assessment of sage-grouse habitat quality (e.g. Connelly 2000, Table

3). The second is to track trends which allow for characterization of compositional change in vegetation through time, and with respect to potential threats. The habitat data sampled at each plot include: vegetation cover by species, vegetation height for shrubs and herbaceous species, sagebrush density, frequency of juvenile sagebrush occurrence, comprehensive species lists, photographic documentation, sign of use by sage-grouse, indicators of anthropogenic disturbance, and documentation of the current local plant community. A complete description of sample site selection and plot sampling methodology can be found in the study plan and sample protocol for this monitoring project (Shurtliff et al. 2016, Appendix B).

Data Analyses

Plots that are sampled annually are used to track trends in general habitat condition across the INL Site, while rotational plots are used to address specific threats or concerns related to more localized areas (burned areas, grazing allotments, etc.). Formal trend analysis on data collected from the annual plots will begin when data are available for at least five years, or after enough temporal variability has been captured to make those analyses meaningful. Analysis of rotational plots will be completed once every five years, after data collection has been completed on all three subsets (150 total plots).

Data collected in 2016 from annual plots were used to update habitat summary statistics from 2013-2015, facilitating current comparisons between vegetative characteristics of polygons designated as sage-grouse habitat on the INL Site and those recommended for optimal sage-grouse habitat in guidance documents. Analysis of the 2016 data includes an overview of precipitation and the potential effects of precipitation patterns on the 2016 habitat condition monitoring data. The 2016 summary data were informally compared to the summary data from 2013, which will help biologists develop an understanding of the potential magnitude of change in sage-grouse habitat on the INL Site over four years.

Data collected between 2013 and 2015 from rotational plots were used to address progress toward habitat recovery in six specific burned areas, potential effects of livestock on habitat condition in four allotments, and effects of livestock on progress toward habitat recovery in burned areas in three allotments. Data collected from annual plots in 2015 were also used in these analyses to increase the sample size in each burned area and in each allotment as much as possible. We summarized cover by plant species into vegetation functional groups (e.g. shrubs, perennial grasses, introduced forbs, etc.) and made comparisons using those functional groups. Burned areas were compared with unburned habitat and with one another using one-way analysis of variance (ANOVA; Zar 1996); when data were non-normal or assumptions of equal variance were not met, Kruskal-Wallis one-way ANOVAs on rank (Zar 1996) were performed instead. We used Holm-Sidak (Zar 1996) tests for multiple comparisons on parametric ANOVAs and Dunn's Method (Dunn 1964) on non-parametric ANOVAs. The same statistical approach was used to compare functional groups within allotments and areas outside of allotments.

3.1.3 Results and Discussion

General Habitat Condition—Annual Plots

We collected data on 75 annual plots for the fourth time between June and August of 2016 (Figure 3-1). Forty-eight annual plots are located in polygons currently designated as sagebrush habitat (referred to as sagebrush habitat plots hereafter), and 27 are located in polygons where habitat status is currently non-sagebrush dominated (referred to as non-sagebrush plots hereafter). All of the non-sagebrush plots are located in polygons that have burned at least once since 1994 and were thought to have been dominated by sagebrush prior to fire. The sagebrush habitat plots are located in polygons that have not burned in at

least the last 20 years, and many of them have likely not burned for at least a few centuries (Forman et al. 2013).

In 2016, 45 of the 48 annual sagebrush habitat plots were assigned (using a dichotomous key to INL Site plant communities; Shive et al. 2011) to communities characterized by sagebrush dominance (Table 3-1a.). Two plots keyed to communities characterized by the codominance of green rabbitbrush and winterfat, and one keyed to a community characterized by shadscale dominance. Results from 2016 were comparable to 2013 results, with the majority of plots assigned to one of the three big sagebrush communities described on the INL Site. Notable differences between 2013 and 2016 include a shift to keying more plots as being dominated by mixed and/or hybridized big sagebrush subspecies rather than being dominated specifically by Wyoming big sagebrush.

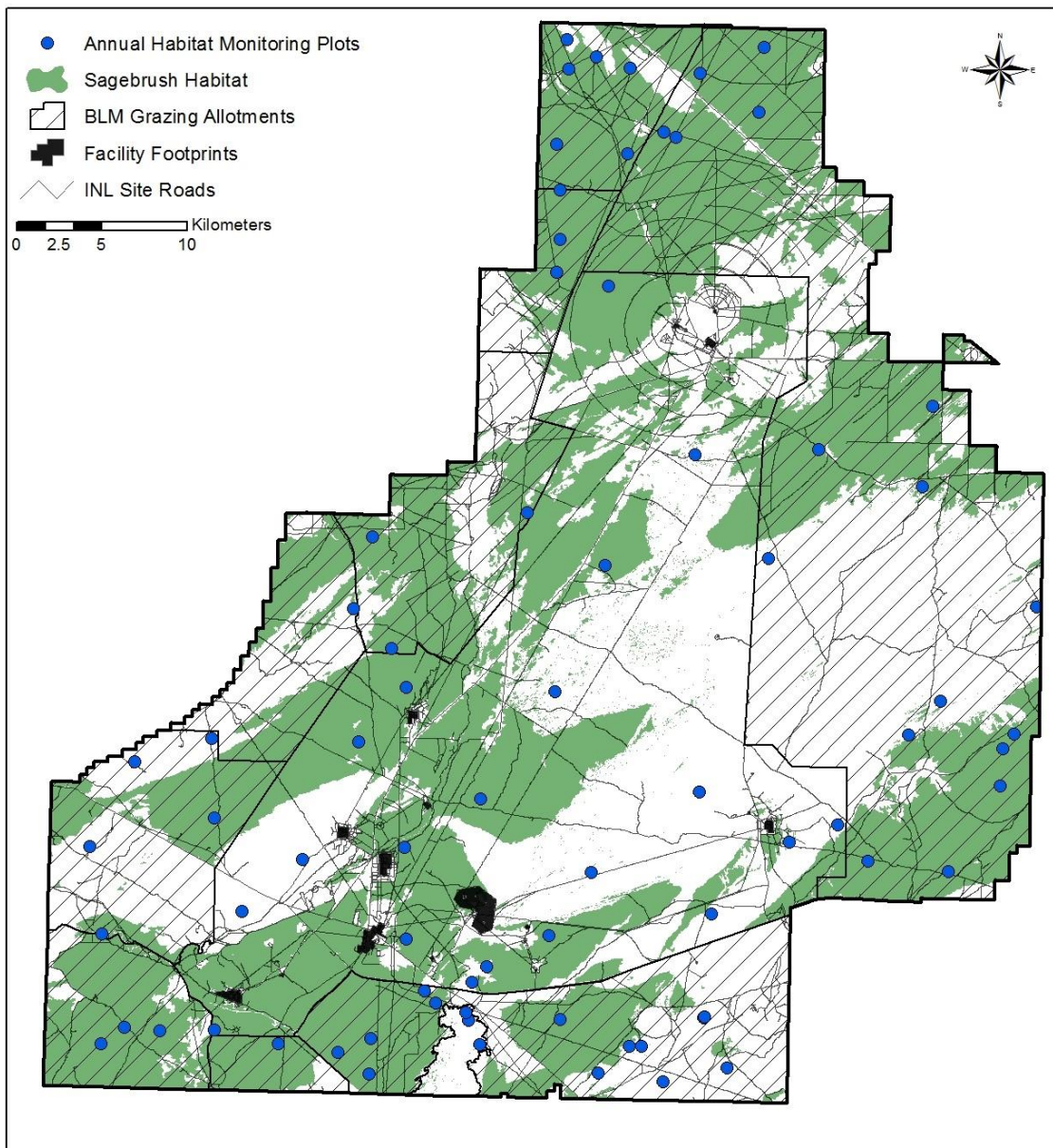


Figure 3-1. CCA sage-grouse habitat condition monitoring plots sampled in 2016 on the INL Site.

Table 3-1a. Results of a dichotomous plant community key (Shive et al. 2011) in 2016 and 2013 for 48 sagebrush habitat condition monitoring plots sampled on the INL Site.

Plant Community	Number of Plots 2016	Number of Plots 2013
Big Sagebrush Shrubland (mixed subspecies)	25	11
Wyoming Big Sagebrush Shrubland	11	25
Three-tip Sagebrush Shrubland	3	3
Low Sagebrush Dwarf Shrubland	2	3
Basin Big Sagebrush Shrubland	2	4
Black Sagebrush/Sandberg Bluegrass Dwarf-shrub Herbaceous Vegetation	2	2
Green Rabbitbrush–Winterfat Shrubland	2	0
Shadscale Dwarf Shrubland	1	0

Of the 27 annual non-sagebrush plots, 12 were assigned to shrublands or shrub herbaceous communities in 2016, and the remaining 15 were assigned to communities which are dominated entirely by herbaceous vegetation (Table 3-1b). With the exception of one plot, green rabbitbrush dominance characterized the plant communities in non-sagebrush habitat plots that were assigned to shrublands or shrub herbaceous communities. The remaining shrubland plot was assigned to a shadscale-dominated plant community. Of the 15 plots assigned to herbaceous vegetation communities, eight were dominated by native, perennial grasses, and the other seven were dominated or co-dominated by introduced grasses in 2016. In general, fewer non-sagebrush plots keyed to herbaceous-dominated communities and more keyed to green rabbitbrush-dominated communities in 2016 than in 2013. The number of plots keying to green rabbitbrush-dominated communities have fluctuated over the past four years, but from 2013 to 2016 the difference is only three plots. The number of plots keying to communities dominated by cheatgrass (*Bromus tectorum*) increased from three in 2013 and 2014 to seven in 2015 and 2016 (see Shurtliff et al. 2016 for 2014 and 2015 data).

Through the first four years of data collection, most of the sagebrush habitat plots keyed to sagebrush-dominated communities and non-sagebrush plots keyed to non-sagebrush dominated shrublands or communities dominated by herbaceous species. Most of the differences among the four field seasons for the sagebrush habitat plots were from the amount of certainty a field crew had in assigning a plant community to dominance by a specific big sagebrush subspecies. Some crews appeared to have greater confidence in selecting a dominant subspecies than others. The phenology of big sagebrush may have also been quite different from one year to the next, making the positive identification of a subspecies easier in some years than in others. Given the probability of morphological hybrids across the INL Site (Shive et al. 2011), this result is not unreasonable. Overall, there was a greater shift among sample years for communities assigned among the non-sagebrush plots. This result reflects the tendency for herbaceous communities to be more immediately responsive to seasonal weather conditions than sagebrush communities.

Table 3-1b. Results of a dichotomous plant community key (Shive et al. 2011) in 2016 and 2013 for 27 non-sagebrush habitat condition monitoring plots sampled on the INL Site.

Plant Community	Number of Plots 2016	Number of Plots 2013
Cheatgrass Semi-natural Herbaceous Vegetation	7	3
Green Rabbitbrush Shrubland	7	6
Indian Ricegrass Herbaceous Vegetation	3	1
Bluebunch Wheatgrass–Sandberg Bluegrass Herbaceous Vegetation	3	2
Green Rabbitbrush/Streambank Wheatgrass (Western Wheatgrass) Shrub Herbaceous Vegetation	2	5
Needle and Thread Herbaceous Vegetation	2	1
Green Rabbitbrush/Bluebunch Wheatgrass Shrub Herbaceous Vegetation	1	3
Shadscale Dwarf Shrubland	1	0
Green Rabbitbrush/Desert Alyssum Shrub Herbaceous Vegetation	1	0
Crested Wheatgrass Semi-natural Herbaceous Vegetation	0	2
Sandberg Bluegrass Herbaceous Vegetation	0	1
Green Rabbitbrush–Winterfat Shrubland	0	1
Tall Tumblemustard–Cheatgrass Semi-natural Herbaceous Vegetation	0	1
Wyoming Big Sagebrush Shrubland	0	1

Several other qualitative variables were collected at each plot to help describe plot context in terms of potential use by sage-grouse and to document any notable anthropogenic impacts, especially as they relate to the threats identified in the CCA. These qualitative data show that in 2016 sage-grouse sign (scat) was present on 15 of the 48 annual sagebrush habitat plots and at least some of the scat appeared to be from the current year on two of those plots. Sage-grouse scat, all from previous seasons, was noted on two of the 27 non-sagebrush plots. Scat was noted on 27 of the sagebrush plots and four of the non-sagebrush plots in 2013. Although scat was present on fewer plots in 2016 than 2013 on both sagebrush habitat and non-sagebrush plots, plots in sagebrush habitat have still experienced more past use than plots in polygons designated as non-habitat. In 2016, about 30% of the plots representing sagebrush habitat contained sage-grouse sign, and nearly 90% of sage-grouse sign documented in 2016 occurred in plots that are located in polygons mapped as current sagebrush habitat.

Active ant mound counts were added to the sample protocol in 2014. In 2016, 28 of the 75 annual habitat condition monitoring plots had active ant mounds at the time of sampling. The maximum number of mounds counted in a single 20m x 20m plot was three. Of the 28 plots with active ant mounds, 16 were sagebrush habitat plots and 12 were non-sagebrush plots. There were no thatch mounds documented on either sagebrush habitat or non-sagebrush plots in 2016. The abundance of crater mounds was slightly higher ($\bar{x}=0.63$) on non-sagebrush plots than on sagebrush plots ($\bar{x}=0.44$). Compared with 2014 (data were not collected for this metric in 2013), ant mounds were detected in more sagebrush habitat plots ($n=8$ in 2014) and about the same number of non-sagebrush plots ($n=13$ in 2014). After three years of data collection for this metric, there doesn't appear to be an identifiable pattern in occurrence of ant mounds. The annual

stability of this estimate and the relationship between it and other biotic and abiotic factors are unknown and can only be elucidated after several years of data are available.

Anthropogenic influence was noted on 15 (20%) of the annual habitat condition monitoring plots in 2016. Livestock manure was present in eight of the 15 plots, and trails were identified in seven of the plots. Tire tracks were identified as the source of disturbance in one plot (livestock manure was also noted in this plot). Fourteen plots with documented anthropogenic influence are located within allotment boundaries. Trails were noted as the disturbance type on the plot located outside of allotment boundaries. This plot is in the interior of the INL Site near a facility that may provide a water source for native ungulates, which would suggest the trails noted during the survey were game trails rather than livestock trails. Overall, about 25% of the plots sampled within allotments and about 5% of plots sampled outside of allotments were noted to have been disturbed. Twelve of the 15 total plots were located in areas currently designated as habitat.

In 2016, absolute cover from sagebrush species averaged about 22% across the annual sagebrush habitat monitoring plots (Table 3-2a), which is only about 1% different from 2013 (Table 3-2b). In non-sagebrush monitoring plots, absolute sagebrush cover averaged approximately 0.25% during 2016. Although this represents an increase over the past four years, sagebrush still contributes very little to total vegetative cover in previously burned, non-sagebrush polygons. The few sagebrush individuals that were present in those plots during the 2016 sample season were shorter, on average, than sagebrush individuals in sagebrush habitat plots (Tables 3-2a). Conversely, average cover and height of perennial grasses and forbs were greater in non-sagebrush plots than in sagebrush habitat plots from 2013 through 2016 (see Shurtliff et al. 2016 for 2014 and 2015 data). Sagebrush density estimated across the annual sagebrush habitat plots was higher in 2016 than in 2013 (Tables 3-2a and 3-2b), but recruitment events on a handful of plots likely skewed the data in 2016. When seven plots with seedling counts outside the historical range of variability are removed, sagebrush density in 2016 was comparable to that of 2013. It was also consistent with the range of density estimates from big sagebrush stands previously sampled to support characterization of sagebrush demography on the INL Site (Forman et al. 2013) as well as density estimates from the Long-Term Vegetation (LTV) Transects (unpublished data).

Table 3-2a. Summary of selected vegetation measurements for characterization of condition of sagebrush habitat monitoring plots and non-sagebrush monitoring plots on the INL Site in 2016. The number marked by an asterisk (*) includes seven plots with notable seedling germination events. Most seedlings in these plots will fail due to self-thinning; the adjusted mean sagebrush density (without the seven high-germination plots) is 3.09 individuals/m².

	Mean Cover (%)	Mean Height (cm)	Mean Density (individuals/m ²)
Sagebrush Habitat Plots (n=48)			
Sagebrush	21.89	49.44	11.41*
Perennial Grass/Forbs	12.64	24.49	
Non-sagebrush Plots (n=27)			
Sagebrush	0.25	39.72	0.08
Perennial Grass/Forbs	23.05	33.65	

Table 3-2b. Summary of selected vegetation measurements for characterization of condition of sagebrush habitat monitoring plots and non-sagebrush monitoring plots on the INL Site in 2013.

	Mean Cover (%)	Mean Height (cm)	Mean Density (individuals/m ²)
Sagebrush Habitat Plots (n=48)			
Sagebrush	20.69	44.87	3.24
Perennial Grass/Forbs	8.08	14.37	n/a
Non-sagebrush Plots (n=27)			
Sagebrush	0.08	29.81	0.05
Perennial Grass/Forbs	18.47	19.41	n/a

Absolute total vegetation cover averaged across sagebrush habitat plots was about 6% higher in 2016 than in 2013 (Table 3-3a). About two thirds of the total vegetation cover was from shrubs in 2016, and nearly 75% of the shrub cover was from *Artemisia* species. Overall, sagebrush contributed 46% of the total vegetation cover on sagebrush habitat plots. Big sagebrush was the most abundant and widespread sagebrush species; however, threetip (*Artemisia tripartita*), black sagebrush (*Artemisia nova*), and low sagebrush (*Artemisia arbuscula*) were locally abundant on the limited number of plots where they each occurred. Mean shrub cover in the sagebrush habitat plots decreased by about 1% from 2013 to 2016, but native perennial grass cover was 4% higher at the end of the same time period. Overall, annual shrub cover remained relatively stable from 2013 to 2016, but perennial grass cover fluctuated from less than 3% in 2014 to more than 11% in 2016. Indian ricegrass (*Achnatherum hymenoides*) was the most abundant perennial grass across the sagebrush habitat plots in 2016; Sandberg bluegrass (*Poa secunda*) was the most abundant perennial grass in 2013. Total cover from introduced species on sagebrush habitat plots was less than 2% in 2013 and was nearly 4% in 2016. Cheatgrass cover has averaged less than 1% absolute cover on the sagebrush habitat plots over the past four years.

Table 3-3a. Mean absolute cover by species for 48 sagebrush habitat monitoring plots on the INL Site in 2016 and 2013. An asterisk (*) Indicates that this species was undetectable using the current sampling methodology in a given sample year.

Plant Species	Absolute Cover (%) 2016	Absolute Cover (%) 2013
Native		
Shrubs		
<i>Artemisia tridentata</i>	17.82	16.75
<i>Chrysothamnus viscidiflorus</i>	5.53	8.59
<i>Artemisia tripartita</i>	1.63	2.33
<i>Artemisia arbuscula</i>	1.58	0.84
<i>Atriplex confertifolia</i>	1.16	0.70
<i>Artemisia nova</i>	0.86	0.77
<i>Krascheninnikovia lanata</i>	0.86	0.45
<i>Linanthus pungens</i>	0.13	0.37

Plant Species	Absolute Cover (%) 2016	Absolute Cover (%) 2013
<i>Eriogonum microthecum</i>	0.08	0.12
<i>Tetradymia canescens</i>	0.06	0.04
Others (n=2, 3)	0.05	0.05
Total Native Shrub Cover	29.76	31.01
Succulents		
<i>Opuntia polyacantha</i>	0.11	0.11
Perennial Graminoids		
<i>Achnatherum hymenoides</i>	2.92	1.30
<i>Elymus elymoides</i>	2.65	0.86
<i>Poa secunda</i>	2.09	2.04
<i>Pseudoroegneria spicata</i>	1.55	1.57
<i>Elymus lanceolatus</i>	0.96	0.74
<i>Hesperostipa comata</i>	0.77	0.35
<i>Pascopyrum smithii</i>	0.36	0.02
<i>Carex douglasii</i>	0.23	0.00
Others (n=0, 1)	*	0.09
Total Native Perennial Graminoid Cover	11.54	6.95
Perennial Forbs		
<i>Schoenocrambe linifolia</i>	0.33	0.01
<i>Phlox hoodii</i>	0.25	0.73
<i>Sphaeralcea munroana</i>	0.24	*
<i>Arabis cobrensis</i>	0.07	*
<i>Penstemon pumilus</i>	0.07	*
<i>Phlox aculeata</i>	0.05	*
Others (n=10, 15)	0.10	0.39
Total Native Perennial Forb Cover	1.10	1.13
Annuals and Biennials		
<i>Lappula occidentalis</i>	0.28	*
<i>Chenopodium leptophyllum</i>	0.21	0.01
<i>Descurainia pinnata</i>	0.18	*
<i>Cordylanthus ramosus</i>	0.08	*
<i>Gilia sinuata</i>	0.08	*
Others (n=6, 0)	0.08	*
Total Annual and Biennial Forb Cover	0.89	0.01
Total Native Cover	43.40	39.20

Plant Species	Absolute Cover (%) 2016	Absolute Cover (%) 2013
Introduced		
Perennial Grasses		
<i>Agropyron cristatum</i>	1.38	1.23
Annuals and Biennials		
<i>Halogeton glomeratus</i>	1.25	0.41
<i>Alyssum desertorum</i>	0.69	0.13
<i>Bromus tectorum</i>	0.51	0.21
Others (n=4,0)	0.02	*
Total Introduced Annual and Biennial Cover	2.47	0.75
Total Introduced Cover	3.86	1.99
Total Vascular Plant Cover	47.25	41.19

In the non-sagebrush plots, only about 20% of total vascular plant cover was from shrubs in 2016 and green rabbitbrush provided more than 90% of the cover from shrubs. Perennial grasses and forbs were responsible for about two thirds of the cover from native species on non-sagebrush plots in 2016. Native herbaceous species were only slightly more abundant than non-native herbaceous species. Bluebunch wheatgrass (*Pseudoroegneria spicata*) has been the most abundant native herbaceous species in all four sample years with about 5% absolute cover. Average absolute cover from native, perennial grasses on non-habitat plots was about double that on sagebrush habitat plots, and cover from introduced herbaceous species was about six times greater on non-habitat plots (Table 3-3b). Cheatgrass has been much more abundant on non-habitat plots than on sagebrush habitat plots in all four sample years. In 2016, cheatgrass cover was particularly high on non-sagebrush plots when compared to the same subset of plots from 2013 (Table 3-3b).

Table 3-3b. Mean absolute cover by species for 27 non-sagebrush monitoring plots on the INL Site in 2016 and 2013. An asterisk (*) indicates that this species was undetectable using the current sampling methodology in a given sample year.

Plant Species	Absolute Cover (%) 2016	Absolute Cover (%) 2013
Native		
Shrubs		
<i>Chrysothamnus viscidiflorus</i>	11.28	9.92
<i>Atriplex confertifolia</i>	0.37	0.21
<i>Artemisia tridentata</i>	0.24	0.07
<i>Tetradymia canescens</i>	0.14	0.26
<i>Gutierrezia sarothrae</i>	0.07	*
<i>Eriogonum microthecum</i>	0.05	0.06
<i>Ericameria nana</i>	*	0.02

Plant Species	Absolute Cover (%) 2016	Absolute Cover (%) 2013
Others (n=2, 2)	0.05	0.05
Total Native Shrub Cover	12.19	10.59
Succulents		
<i>Opuntia polyacantha</i>	0.11	0.05
Perennial Graminoids		
<i>Pseudoroegneria spicata</i>	5.12	4.70
<i>Achnatherum hymenoides</i>	4.01	1.33
<i>Hesperostipa comata</i>	3.84	2.13
<i>Elymus lanceolatus</i>	3.04	2.11
<i>Poa secunda</i>	1.94	3.86
<i>Elymus elymoides</i>	1.59	0.91
<i>Leymus flavescens</i>	0.81	*
<i>Pascopyrum smithii</i>	0.69	0.63
<i>Carex douglasii</i>	0.19	*
Others (n=1, 1)	0.01	0.03
Total Native Perennial Graminoid Cover	21.23	15.70
Perennial Forbs		
<i>Sphaeralcea munroana</i>	0.49	0.02
<i>Phlox hoodii</i>	0.36	0.51
<i>Phlox aculeata</i>	0.27	*
<i>Erigeron pumilus</i>	0.24	0.18
<i>Crepis acuminata</i>	0.17	0.91
<i>Schoenocrambe linifolia</i>	0.07	0.03
<i>Machaeranthera canescens</i>	0.06	0.07
<i>Lomatium triternatum</i>	0.05	*
Others (n=8, 14)	0.12	1.06
Total Native Perennial Forb Cover	1.82	2.77
Annuals and Biennials		
<i>Lappula occidentalis</i>	0.44	*
<i>Eriastrum wilcoxii</i>	0.26	0.08
<i>Descurainia pinnata</i>	0.17	0.01
<i>Mentzelia albicaulis</i>	0.15	0.06
<i>Gayophytum diffusum</i>	0.14	*
<i>Gilia sinuata</i>	0.12	*
<i>Chenopodium leptophyllum</i>	0.07	0.06

Plant Species	Absolute Cover (%) 2016	Absolute Cover (%) 2013
Others (n=6, 1)	0.04	0.03
Total Native Annual and Biennial Cover	1.39	0.24
Total Native Cover	34.91	29.35
Introduced		
Perennial Grasses		
<i>Agropyron cristatum</i>	0.71	0.35
Perennial Forbs		
<i>Carduus nutans</i>	0.04	*
Annuals and Biennials		
<i>Bromus tectorum</i>	16.98	5.41
<i>Halogeton glomeratus</i>	2.38	1.31
<i>Alyssum desertorum</i>	1.95	0.32
<i>Salsola kali</i>	1.93	1.12
<i>Sisymbrium altissimum</i>	0.12	0.14
Others (n=1, 2)	0.00	0.13
Total Introduced Annual and Biennial Cover	23.36	8.42
Total Introduced Cover	24.11	8.77
Total Vascular Plant Cover	59.03	38.12

Vegetation height was summarized by functional group to provide a more complete assessment of vertical structure on the habitat condition monitoring plots (Tables 3-4a and 3-4b). In sagebrush habitat plots, shrub height estimates were from sagebrush species about 70% of the time and sagebrush was the tallest functional group. On non-sagebrush plots shrub height estimates were from other species, primarily green rabbitbrush, more than 90% of the time. It is notable that many non-sagebrush plots did have a substantial shrub component, which provides more vertical structure than herbaceous plant communities that lack shrubs entirely. Because cover from annual species was relatively low on sagebrush habitat plots, most of the herbaceous height in those plots was from perennial grasses, which tend to be taller than annuals. A greater proportion of the herbaceous height estimate (48%) in non-sagebrush plots was from shorter-statured annual species. For both sagebrush habitat plots and non-sagebrush plots, height estimates from annuals were primarily from introduced species in 2016. Overall, mean height for shrubs in both sagebrush habitat and non-sagebrush plots was slightly higher in 2016 than in 2013, and mean height of herbaceous species was considerably higher in 2016.

Table 3-4a. Vegetation height by functional group for 48 sagebrush habitat monitoring plots on the INL Site in 2016 and 2013.

	2016		2013	
	Mean Height (cm)	Proportion of Sample	Mean Height (cm)	Proportion of Sample
Shrubs				
Sagebrush Species	49.44	0.69	44.87	0.82
Other Species	25.33	0.31	26.20	0.18
Herbaceous Species				
Perennial Grasses	26.04	0.64	15.69	0.76
Perennial Forbs	12.07	0.08	7.24	0.14
Annual Grasses	18.58	0.04	7.60	0.04
Annual Forbs	10.38	0.24	3.61	0.06

Table 3-4b. Vegetation height by functional group for 27 non-sagebrush monitoring plots on the INL Site in 2016 and 2013.

	2016		2013	
	Mean Height (cm)	Proportion of Sample	Mean Height (cm)	Proportion of Sample
Shrubs				
Sagebrush Species	39.72	0.07	29.81	0.08
Other Species	28.71	0.93	24.85	0.92
Herbaceous Species				
Perennial Grasses	36.40	0.47	21.15	0.52
Perennial Forbs	12.09	0.06	10.97	0.11
Annual Grasses	18.11	0.28	9.62	0.19
Annual Forbs	10.55	0.20	9.00	0.19

In 2016, sagebrush density ranged from approximately one individual per two square meters to approximately 130 individuals per square meter in the sagebrush habitat plots (Table 3-5a). Seven plots appear to have experienced episodic recruitment events resulting in twenty or more individuals per square meter (the maximum in previous sample years has never been more than 16). Because most individuals counted in those plots were recently germinated (i.e. juveniles), they will likely be lost to self-thinning over the next year. Therefore, we adjusted the mean density to remove short-term outliers. The adjusted mean (without the seven high-germination plots) was comparable to 2013 mean sagebrush density. In the non-sagebrush plots, sagebrush density ranged from zero to a maximum of about one individual per square meter. Juvenile sagebrush frequency is a proportion of the eight density transects in each plot that contain juvenile shrubs. Averaged across all sagebrush habitat plots, juvenile shrubs were present in about one out of every four sample transects. In non-habitat plots, was one juvenile was detected in one sample transect in 2016. Compared with 2013 (Table 3-5b), mean sagebrush density and juvenile frequency values in 2016

were mostly unchanged in non-sagebrush plots. In sagebrush habitat plots, adjusted mean density in 2016 was similar and mean juvenile frequency remained the same.

Table 3-5a. Sagebrush density and juvenile frequency from sagebrush habitat monitoring plots (n=48) and non-sagebrush monitoring plots (n=27) on the INL Site in 2016. The number indicated by an asterisk (*) includes seven plots with notable seedling germination events and most seedlings will fail due to self-thinning; the adjusted mean sagebrush density (without the seven high-germination plots) is 3.09 individuals/m².

	Sagebrush	Non-sagebrush
Mean Density (individuals/m ²)	11.41*	0.08
Minimum Density (individuals/m ²)	0.43	0.00
Maximum Density (individuals/m ²)	130.13	1.20
Mean Juvenile Frequency	0.27	0.00

Table 3-5b. Sagebrush density and juvenile frequency from sagebrush habitat monitoring plots (n=48) and non-sagebrush monitoring plots (n=27) on the INL Site in 2013.

	Sagebrush	Non-sagebrush
Mean Density (individuals/m ²)	3.24	0.05
Minimum Density (individuals/m ²)	0.35	0.00
Maximum Density (individuals/m ²)	16.08	0.33
Mean Juvenile Frequency	0.27	0.02

Precipitation

Total annual precipitation for 2016 was just above average (Figure 3-2). As with several recent years, the timing of precipitation in 2016 deviated markedly from historical patterns (Figure 3-3). Almost half of the total precipitation from 2014 fell in August. Mean August precipitation, calculated from the 64-year Central Facilities Area (CFA) record, is about 14 mm; total August precipitation from 2014 was 102 mm. In 2015, May was abnormally wet, with a total of nearly 60 mm, which is twice the historical monthly average. September and October of 2016 had more than three times average historical precipitation for the same time period and more than half of the annual precipitation fell after the summer growing season. It is also notable that 2013, the first year of data collection for this monitoring task, was the driest year on record with only about ¼ of average annual precipitation. Much of the sampling in 2014 was completed prior to August precipitation, therefore, vegetation on the INL Site experienced drought conditions through most of the 2014 growing season and associated sampling effort. The extreme precipitation events in August 2014 and the abnormally wet May of 2015 were likely reflected in the habitat condition vegetation data collected in 2015, and potentially in 2016.

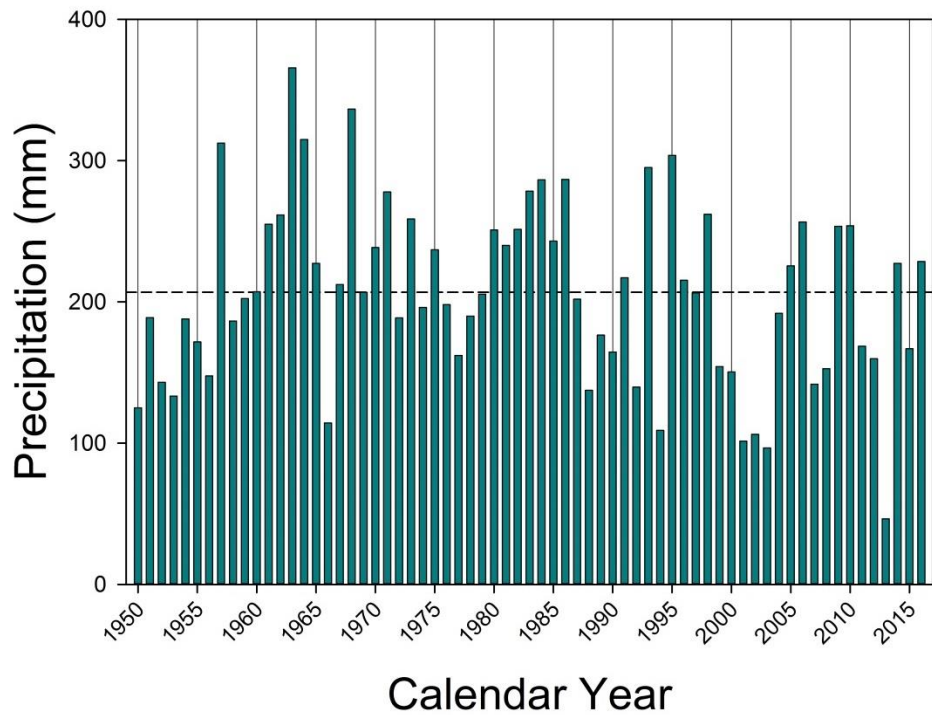


Figure 3-2. Total annual precipitation from 1950 through 2016 at the CFA, INL Site. The dashed line represents mean annual precipitation.

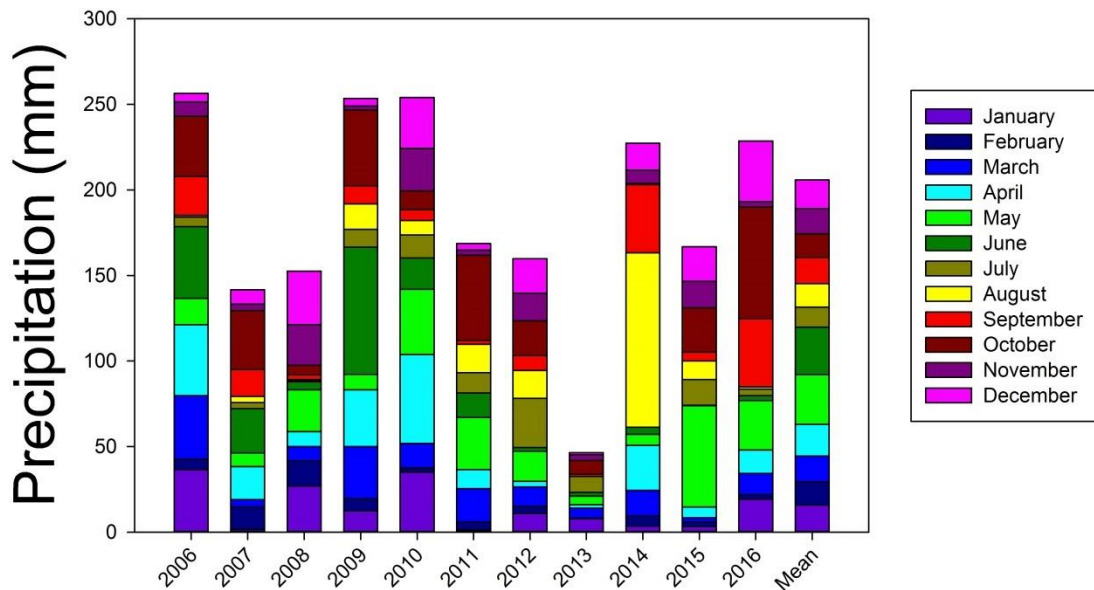


Figure 3-3. Annual precipitation by month from the CFA, INL Site. Mean monthly precipitation includes data from 1950 through 2016.

Assessment of Potential Threats to Habitat—Rotational Plots

We collected data on 150 rotational plots between 2013 and 2015, 50 plots during each sample season (June–August). Data collected from the 75 annual plots during 2015 were also used to assess the potential effects of wildland fire and livestock operations on sagebrush habitat at the INL Site. Rotational plots are distributed such that the number of plots in each burned area, allotment, or combination thereof are roughly proportional to the amount of area they occupy (Figure 3-4 and Figure 3-5). For example, the Twin Buttes Allotment is the largest allotment on the INL site and the 2010 Jefferson Fire resulted in the largest burned area on the INL Site, so there are more plots located in those areas than there are plots located in smaller allotments or burned areas.

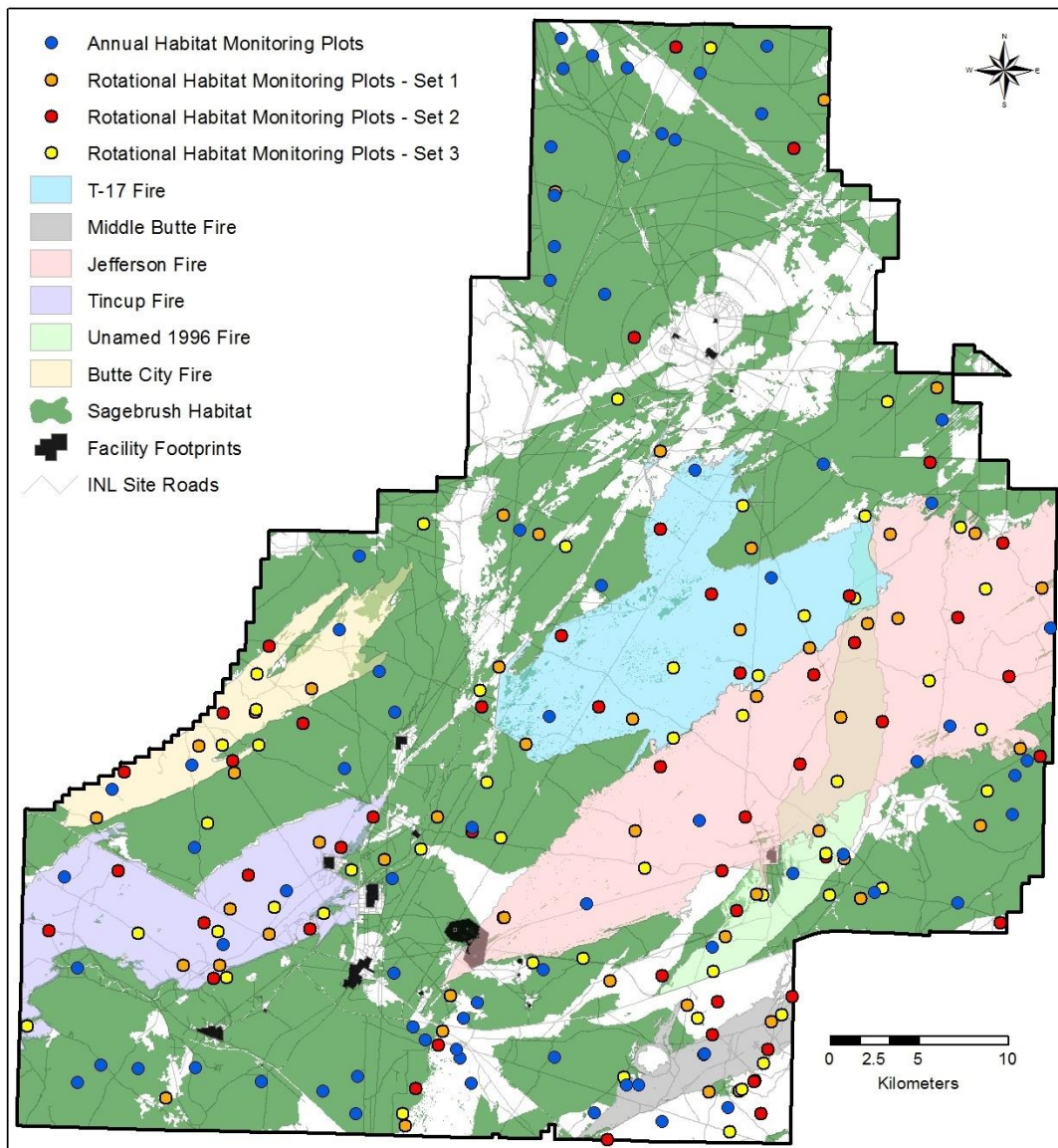


Figure 3-4. Distribution of CCA sage-grouse habitat condition monitoring plots sampled on the INL Site with respect to select areas burned since 1994. Only burned areas containing more than eight plots were used for analysis. Set 1 of the rotational plots was sampled in 2013, set 2 was sampled in 2014, and set 3 and the annual plots was sampled in 2015.

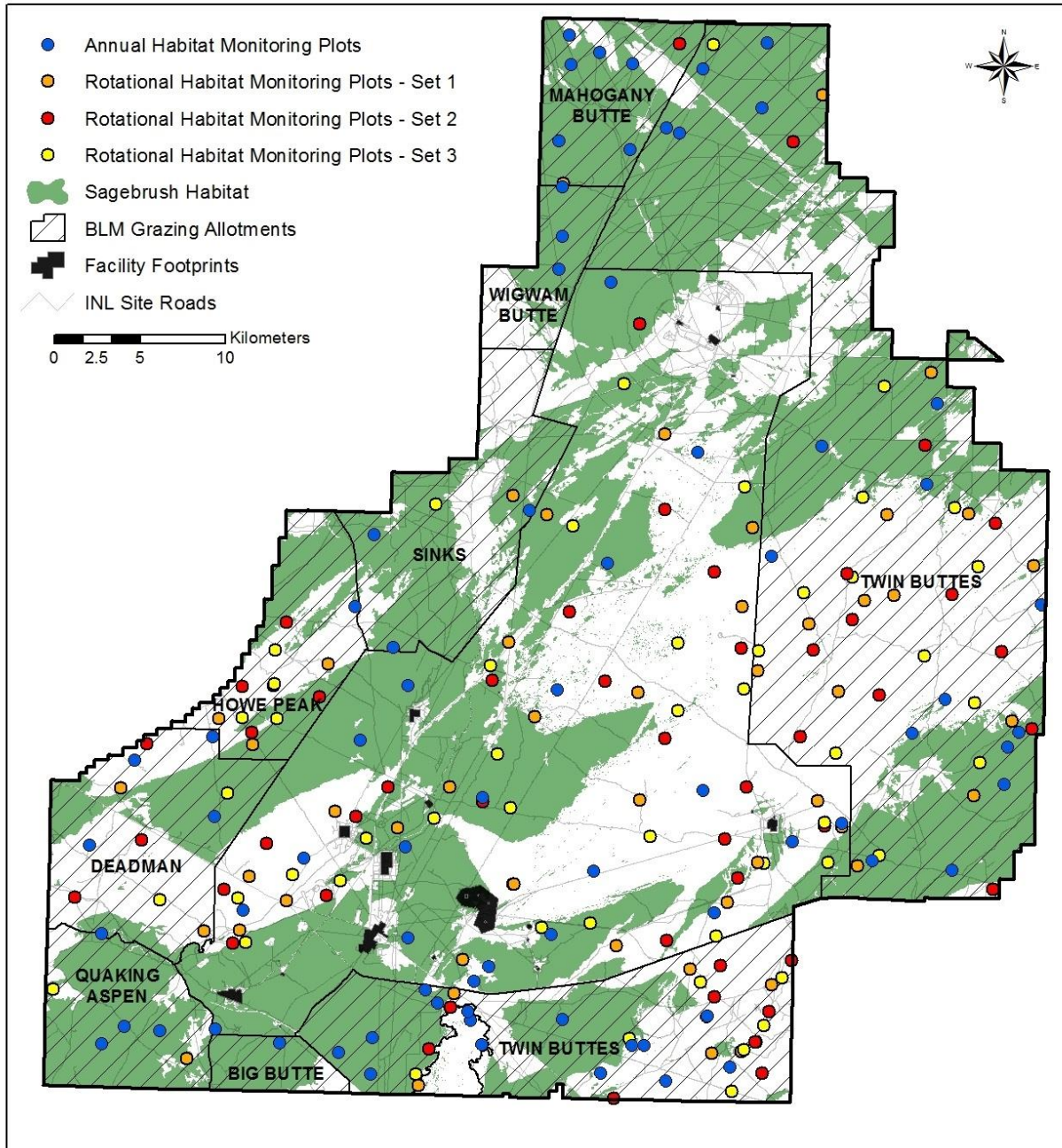


Figure 3-5. Distribution of CCA sage-grouse habitat condition monitoring plots sampled on the INL Site with respect to boundaries of grazing allotments administered by the BLM. Set 1 of the rotational plots was sampled in 2013, set 2 was sampled in 2014, and set 3 and the annual plots were sampled in 2015.

Within the burned areas, there was high variability among fires within the same functional groups and there did not appear to be an effect of time since fire, with the exception of the “other shrubs” functional group. This functional group is dominated by green rabbitbrush and does appear to have greater cover in older burned areas than in areas burned in more recent fires. Sagebrush cover, from all shrubby *Artemisia* species, averaged less than 1% cover in all six burned areas analyzed. Perennial grasses were generally at least twice as abundant in burned areas as in comparable unburned sagebrush habitat, and the

difference was statically significant for all but the 1996 Fire. Cover from non-natives ranged from about 4% in the Tin Cup Fire to nearly 14% in the Middle Butte Fire. The differences between unburned sagebrush habitat and each of the six burned areas were not statistically significant, but high variability among plots in each burned area resulted in low statistical power, so we can't conclude that means are comparable either. Cheatgrass, Russian thistle (*Salsola kali*), and saltlover (*Halogeton glomeratus*) are the most abundant non-native species in both the burned areas and unburned habitat.

Table 3-6. Absolute cover by functional group for annual and rotational plots comparing six burned areas with unburned sagebrush habitat on the INL Site. *Letters indicate significant differences between pairwise comparison at $\alpha \leq 0.05$.

	Unburned (n=95)	1994 Butte City Fire (n=14)	1996 Fire (n=11)	2000 Tin Cup Fire (n=20)	2010 Jefferson Fire (n=32)	2010 Middle Butte Fire (n=9)	2011 T-17 Fire (n=20)
Native							
Sagebrush*	18.37 a	0.09 b	0.11 b	0.14 b	0.09 b	0.06 b	0.02 b
Other Shrubs	9.75	16.39	25.82	13.18	9.46	4.07	6.52
Succulents	0.19	0.04	0.02	0.05	0.04	0	0.21
Perennial Graminoids*	9.07 a	23.16 ab	8.31 a	26.3 b	25.67 b	26.47 b	25.01 b
Perennial Forbs	0.72	2.2	0.99	0.87	0.84	1.87	1.02
Annual and Biennial Forbs	0.35	0.21	0.16	0.89	0.44	0.83	0.1
Total Native Cover	38.45	42.09	35.41	41.43	36.54	33.3	32.88
Introduced							
Perennial Graminoids	1.36	0.54	3.02	1.7	0.56	0	2.47
Perennial Forbs	0	0	0	0	0	0	0
Annual Grasses	0.58	2.22	6.31	1.25	3.42	12.45	0.15
Annual and Biennial Forbs	1.07	1.56	2.96	0.95	6.27	1.09	7.28
Total Introduced Cover*	3.01 a	4.32 a	12.29 a	3.9 a	10.25 a	13.54 a	9.9 a
Total Vascular Plant Cover	41.46	46.41	47.7	45.33	46.79	46.84	42.78

The burned areas from the 1994 Butte City Fire and the 2000 Tin Cup Fire appear to be in relatively good ecological condition. They both have low cover from weedy non-natives and high cover from re-sprouting shrubs and native perennial grasses and forbs. The condition of the burned area from the 1996 Fire does not appear to be as good due to higher cover by non-native annuals and lower cover by native, perennial grasses. High cheatgrass cover is also a concern on the burned area from the 2010 Middle Butte Fire; it should be noted though that native, perennial grass cover is still twice that of non-natives. The burned areas from both the 2010 Jefferson and 2011 T-17 Fires had more than 5% absolute cover from non-native

forbs, primarily Russian thistle and saltlover. However, native herbaceous cover was still at least double that of non-natives in those burned areas.

Some of the differences in post-fire ecological condition are likely due to weather conditions during the first few growing seasons after the fire. For example, higher cover by Russian thistle and saltlover could be driven by higher than average precipitation in late summer and early fall in the years since fire. Both of these species use a photosynthetic pathway that allow them to benefit from late season moisture. Other factors leading to differences in post-fire condition may include; pre-fire condition, soils, topography, available seed bank and natural seed sources, type of land use, etc. Continued monitoring of the rotational plots will be informative for understanding how persistent or ephemeral non-natives are in post-fire plant communities. It is also apparent that natural sagebrush recovery will be very slow and planting sagebrush will be important to hasten recovery of sagebrush habitat on the INL Site.

To address the potential affects of livestock on sagebrush habitat condition at the INL Site, vegetation composition was compared among several allotments and with areas outside of allotments. Because fire changes vegetation composition so markedly, these analyses were divided into comparing allotments and non-allotment areas that are in current sagebrush habitat (Table 3-7a) and comparing allotments and non-allotment areas that are in burned areas (3-7b). In current sagebrush habitat, sagebrush cover was within habitat guidelines for breeding (15-25%) and brood-rearing (10-25%) habitat (Connelly et al. 2000) for three of the four allotments analyzed (Table 3-7a). Sagebrush cover was slightly below minimum recommended cover for breeding habitat in the Sinks allotment. Perennial grass and forb cover was below minimum recommended cover values (15%) in all four allotments analyzed and in the analogous sagebrush habitat plots located outside of allotments as well. Perennial grass cover was lowest on the Sinks allotment, though the difference wasn't statistically significant. Cover by non-natives, including cheatgrass wasn't any higher on any of the allotments than it was in the analogous non-allotment plots (Table 3-7a).

Table 3-7a. Absolute cover by functional group for annual and rotational plots comparing four allotments with areas outside of allotments in unburned sagebrush habitat on the INL Site. *Letters indicate significant differences between pairwise comparison at $\alpha \leq 0.05$.

	No Allotment (n=31)	Twin Buttes (n=38)	Mahogany Butte (n=8)	Quaking Aspen (n=5)	Sinks (n=5)
Native					
Sagebrush*	15.06 a	22.74 a	19.38 a	16.88 a	13.74 a
Other Shrubs	8.58	10.78	7.05	10.60	8.16
Succulents	0.21	0.29	0	0	0
Perennial Graminoids*	11.3 a	7.55 a	7.17 a	8.93 a	4.88 a
Perennial Forbs	0.49	0.79	0.46	0.52	1.35
Annual and Biennial Forbs	0.28	0.37	0.1	0.22	1.55
Total Native Cover	35.92	42.52	34.16	37.15	29.68
Introduced					
Perennial Graminoids	2.24	1.54	0.1	0	0

	No Allotment (n=31)	Twin Buttes (n=38)	Mahogany Butte (n=8)	Quaking Aspen (n=5)	Sinks (n=5)
Perennial Forbs	0	0	0	0	0
Annual Grasses	0.84	0.71	0	0.27	0
Annual and Biennial Forbs	0.89	0.96	1.07	0.05	0.03
Total Introduced Cover*	3.97 a	3.21 a	1.17 a	0.32 a	0.03 a
Total Vascular Plant Cover	39.89	45.73	35.33	37.47	29.71

From analyses comparing allotments and non-allotment areas in recovering burns, mean sagebrush cover remained less than 1% (Table 3-7b). Combined perennial grass and forb cover ranged between 20%-30% and was comparable to values calculated from annual plots (3-2b). Non-native species cover was higher in non-allotment areas than in any of the allotments used for this analysis, but pairwise comparisons indicated that the differences were not statistically significant.

Table 3-7b. Absolute cover by functional group for annual and rotational plots. Means are shown for three allotments and the area outside of allotments in burned and recovering, non-sagebrush vegetation on the INL Site. *Letters indicate significant differences between pairwise comparison at $\alpha \leq 0.05$.

	No Allotment (n=57)	Twin Buttes (n=52)	Howe Peak (n=11)	Dead Man (n=9)
Native				
Sagebrush*	0.06 a	0.58 a	0.12 a	0 a
Other Shrubs	11.06	10.31	16.18	18.83
Succulents	0.11	0.02	0.05	0
Perennial Graminoids*	19.51 a	24.82 a	21.14 a	28.9 a
Perennial Forbs	0.95	1.21	2.54	0.96
Annual and Biennial Forbs	0.4	0.46	0.29	0.17
Total Native Cover	32.09	37.4	40.32	48.86
Introduced				
Perennial Graminoids	2.05	0.42	0.68	0
Perennial Forbs	0	0.01	0	0
Annual Grasses	5.36	3.97	2.62	0.85
Annual and Biennial Forbs	4.63	3.19	1.89	0.61
Total Introduced Cover*	12.04 a	7.59 a	5.19 a	1.46 a
Total Vascular Plant Cover	44.13	44.99	45.51	50.32

Although areas of specific, localized degradation were observed in several allotments (often related to supplemental water, salt locations, and trailing routes), rotational plot summaries didn't indicate broad declines in habitat condition across any of the allotments surveyed. Large areas within several of the allotments on the INL Site are not used by livestock, mostly because they are difficult to access. Signs of livestock use were documented in only 26% of the plots surveyed within allotments. Therefore condition of habitat and areas recovering to habitat are likely as much a consequence of lack of use as they are the specific grazing practices prescribed in allotments on the INL Site. Working with the Bureau of Land Management (BLM) to identify and encourage appropriate grazing practices will continue to be important in those areas that are utilized, so that they don't become weed vectors for adjacent areas with more limited use. Overall, fire appears to have had a greater impact on sagebrush habitat over recent decades than livestock use.

3.1.4 Summary of Habitat Condition

Mean sagebrush cover from annual sagebrush habitat plots, and the sagebrush habitat polygons they represent, is near the upper end of the range suggested for optimal sage-grouse breeding (15-25%) and brood-rearing (10-25%) habitat in arid sites (Connelly et al. 2000). Mean sagebrush height is within the suggested optimal range (40-80 cm). Perennial grass/forb mean height values were above the minimum value recommended (18 cm) in current sage-grouse habitat guidelines (Connelly et al. 2000). Average perennial grass/forb cover on sagebrush habitat plots was about 2.5% lower in 2016 than specified for breeding and brood-rearing habitat (15%), but was much higher than it was on the same plots in 2013, the first year data were collected.

It is difficult to directly compare herbaceous cover values for this monitoring effort to long-term averages across the INL Site because this monitoring effort measures canopy cover, while the LTV effort measures basal cover. Overall trends in herbaceous cover on the LTV plots, indicate that perennial grass and forb cover in good-condition sagebrush steppe on the INL Site are probably always below sage-grouse habitat guidelines, except possibly following a series of years with abnormally high precipitation (Forman et al. 2013). Low herbaceous cover values, relative to habitat guidelines, do not appear to be a result of poor ecological condition, but rather the effect of soils and climate on the local ecosystem (Forman et al. 2013).

Herbaceous functional groups are highly influenced by precipitation, and precipitation for three years prior to and up through most of the 2014 growing season was far below average. Although annual precipitation approximated annual averages in 2014 through 2015, a few abnormally wet months at the end of summer in 2014 and at the end of spring in 2015 affected vegetation on the INL Site during the 2015 growing season. The effects of these precipitation events on herbaceous vegetation may have carried over into 2016 as well. As with perennial herbaceous species, mean cheatgrass cover and cover from all annual species were probably uncharacteristically low in 2014 and were probably much higher than normal in 2015 and 2016. The increases in cheatgrass and Russian thistle between 2014 and 2015 are notable, particularly in the non-sagebrush plots.

Continued monitoring is necessary to improve our confidence that the natural variation of herbaceous plant cover and height within sagebrush habitat that is used by sage-grouse falls outside standard guidelines (Connelly et al. 2003). As we improve our understanding of the natural variation of each functional plant group, especially those which appear to be particularly sensitive to weather, like herbaceous perennials and introduced annuals, we will be better positioned to recognize degraded conditions and take action to ameliorate the problem. Over time, biologists will be able to establish a reasonable "baseline" for

herbaceous species across sage-grouse habitat and non-habitat plots. Characterizing trends in relative species composition will also be an important component of identifying changes in both sagebrush and non-sagebrush habitat, as those changes may reflect responses to stressors and/or the threats identified in the CCA. Increases in introduced annuals, decreases in native perennial forb diversity, increases in crested wheatgrass, and decreases in native, perennial grasses are all trends indicating decreases in habitat condition. All of these compositional changes have the potential to affect the use of an area as habitat and may eventually affect total habitat distribution.

Results from rotational plot analyses indicate that changes in the amount and timing of precipitation over the past decade appear to greatly affect the ecological condition of recovering burned areas. In particular, our data suggest that non-native annual productivity improves with late-summer and early fall precipitation in burned areas. Blew and Forman (2010) found that seasonal changes in precipitation timing may also reduce sagebrush recruitment in burned areas. A combination of increased non-native annual cover and reduced sagebrush recruitment would likely impact the time required for burned areas to develop sagebrush cover sufficient to support sage-grouse. If unusual precipitation events are related to climate change, then climate change may pose a larger concern for post-fire habitat recovery in the short-term than previously thought. For this reason, it will be important to continue to monitor post-fire recovery and to continue to explore strategies for facilitating habitat recovery on the INL Site.

3.2 Task 6—Monitoring to Determine Changes in Sagebrush Habitat Amount and Distribution

3.2.1 Introduction

Loss of sagebrush-dominated habitat has been identified as one of the primary causes of decline in sage-grouse populations (Idaho Sage-grouse Advisory Committee 2006, USFWS 2013). Direct loss of sagebrush habitat has occurred through several mechanisms including wildland fire and infrastructure development. In the future, we expect the total area and extent of sagebrush habitat to change following wildland fires, as new facilities are developed on the INL Site, and as lands recover naturally or are restored following decommissioning of existing facilities. These changes in land cover can be determined using airborne or satellite imagery that is readily available at little or no cost. ESER GIS analysts will compare new imagery as it becomes available with existing land cover data from the most recently completed vegetation classification and mapping project to document changes in the distribution of sagebrush habitat. Ground-based point surveys and changes in species cover and composition documented through the sagebrush habitat condition monitoring data will also provide spatial information to assist with periodic map updates needed to monitor the habitat trigger in the CCA.

A 20% loss of sagebrush habitat from the 2013 baseline has been identified as a conservation trigger in the CCA (DOE-ID and USFWS 2014). The goal of Task 6 is to maintain an updated INL Site vegetation map to accurately document changes in sagebrush habitat area and distribution. This task is designed to document changes in sagebrush habitat following losses due to wildland fire or other disturbances which remove or significantly alter vegetation across the landscape. In addition to documenting losses of sagebrush habitat, this monitoring task will also add additional sagebrush habitat by providing updates to the vegetation map when sagebrush cover increases and warrants a new map class designation, or to refine existing boundaries of vegetation classes when changes in species cover and composition are documented through Task 5. Lastly, this task will conduct post-fire mapping when the fire extent is unknown and will also allow for modifying existing wildland fire boundaries and unburned patches when errors on the ground are observed.

The work accomplished on this monitoring task in 2016 included delineating one small fire that burned in summer of 2015. All previous wildland fires that have burned since the completion of the INL Site vegetation map (Shive et al. 2011) have been updated using more recent high resolution imagery. Vegetation plots were also sampled throughout the extent of the T-17 Fire to provide ground information to assist with the delineation of new vegetation classes within the burned area. There have been five growing seasons since the T-17 Fire burned in 2011, and native vegetation has had ample time to reestablish within the fire boundary. Before new vegetation community boundaries can be delineated, it is typically helpful to collect some field data representative of the diversity of vegetation communities naturally establishing after the fire.

3.2.2 Methods

The process of updating the INL Site vegetation map is a two-step process. The first step is to verify, update, or edit existing wildland fire boundaries using a GIS and remote sensing imagery. Wildland fire boundaries are produced by different contractors or agencies (e.g. BLM) using a variety of methods such as collecting global positioning system (GPS) data on the ground or via helicopter, or through manual delineations using digital imagery. The quality and accuracy of wildland fire boundaries can vary considerably depending on the method used to delineate the boundary. During the development of the most recent INL Site vegetation map (Shive et al. 2011), the actual fire edge was digitized from high resolution imagery to maintain spatial consistency across the map. Before new vegetation class delineations are produced inside the fire boundary, recent mapped boundaries need to be updated or created at the same mapping scale (i.e. 1:12,000) as the original vegetation map. The burned areas represent outdated holes in the vegetation map where new post-fire vegetation boundaries have not been delineated nor have map classes been assigned.

The second step requires an adequate number of growing seasons for vegetation communities to reestablish before recently burned areas are updated with new, remapped vegetation class delineations representative of the post-fire vegetation classes present. All new wildland fires will be sampled to identify the vegetation classes present across the burned area. It can be difficult to assess the vegetation classes that establish immediately after a fire, especially during drought years. We intend to allow for at least two growing seasons, and possibly longer if the years following fire were excessively dry and hindered normal reestablishment of vegetation communities. Field surveys may also commence when a particular map polygon or burned area begins to show sign (i.e. via habitat quality monitoring data) that the current vegetation class may have changed to another class and warrants reassignment. When high resolution imagery becomes available, either through the National Agricultural Imaging Program (NAIP) or from INL Site specific acquisitions, it will be used as the source data layer to delineate new vegetation class boundaries within recent wildland fire boundaries.

Digital Imagery

The U.S. Department of Agriculture sponsors the NAIP, which strives to collect high resolution digital imagery across each state on a 2-5 year return interval. These datasets are made publically available and can be downloaded for free as compressed county mosaics or as uncompressed quadrangles. The uncompressed image data are the original calibrated spectral data that have not been altered to smooth the appearance of the final county-wide mosaicked data product or reduce overall file sizes. The ESER Program relies on the uncompressed, calibrated data for all image delineations and mapping conducted on the INL Site.

In 2015, Idaho NAIP imagery was acquired at 1 m spatial resolution with four spectral bands collected within the color and near-infrared region of the electromagnetic spectrum. The imagery was pre-processed and orthorectified using a Digital Elevation Model to remove distortions caused by terrain relief, and georeferenced to the North American Datum 1983 and Universal Transverse Mercator projection. We downloaded all quadrangles covering the INL Site and surrounding area and created a seamless mosaicked image dataset. The 2015 Idaho NAIP mosaic served as the basemap imagery used to delineate the burned area of a small wildland fire from 2015.

Wildland Fire Mapping

There were no large wildland fires on the INL Site in 2016. But on June 18, 2015 there was one small fire located north of the road, southwest of CFA. This was a human-caused wildland fire named the “268 Fire” that burned prior to the collection of the 2015 Idaho NAIP imagery and therefore was captured in the new imagery. The point coordinates for the general location were provided by the INL Fire Chief, but the actual footprint of the burned area was not mapped. Because the footprint of the burned area was small, we digitized the burned area boundary at 1:1,000 mapping scale. The burned area boundary was overlaid on the current sagebrush habitat layer, and any area where the two layers intersected was removed from the habitat layer.

T-17 Field Sampling

Field sampling locations were manually selected in specific areas using the 2015 NAIP imagery rather than randomly assigning points across the burned area. The goal of the field sampling effort is to document what vegetation classes are returning in areas that look distinct or unique in high resolution imagery. If correlations can be identified between which vegetation class or classes are present and the spectral response recorded by the sensor, the process of delineating new vegetation class boundaries throughout the entire extent of the fire is significantly improved.

At each field sampling location, we used a plot array design to document the vegetation classes present within a localized area. The sampling plot array consists of five subplots; a focal plot and four peripheral plots each separated by 50 m in the four cardinal directions (Fig. 3-6). Each subplot is circular with an 8 m radius representing approximately 200 m². The sampling array is an attempt to collect vegetation class information across an extent that more closely represents the spatial scale vegetation communities are being delineated from the basemap imagery.

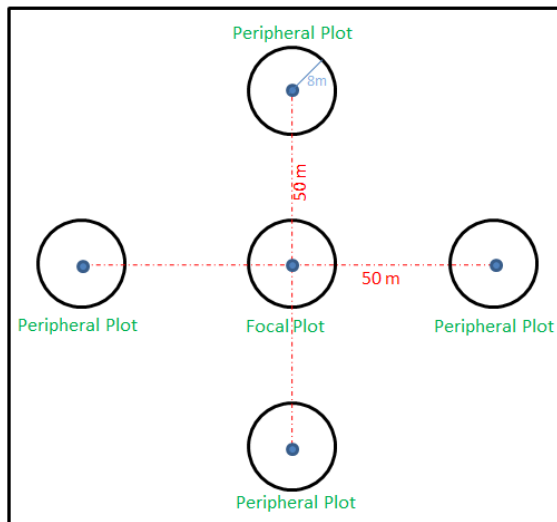


Figure 3-6. A schematic of the field plot array used to sample the vegetation within the T-17 Fire on the INL Site.

Each subplot was assigned to a vegetation class using the class key developed during the INL Site vegetation mapping project (Shive et al. 2011). While assigning each subplot to a vegetation class, we also recorded if the class designation was in agreement with the key. The dichotomous key developed following the original vegetation classification was generated from the statistical analysis of plot data collected in 2008. Occasionally there are unique vegetation communities which do not ‘fit’ the key well because they are isolated and/or in low abundance across the INL Site and were not accounted for in the key. Or, over the past seven years, some new vegetation community types may have begun to emerge following fire coupled with atypical temperature and precipitation patterns.

3.2.3 Results and Discussion

268 Fire Mapping Results

The total area delineated for the 268 Fire was 1.5 ha (3.7 ac). All of the burned area was within a map polygon representing sagebrush habitat (Fig. 3-7). However, the burned area was outside of the SGCA, so the CCA baseline amount of sagebrush habitat remains unchanged.

Even though the minor sagebrush loss was outside the SGCA, it is important to maintain an accurate sagebrush habitat distribution across the entire INL Site in the event the SGCA boundary needs to be modified. If a large wildland fire, such as the Jefferson and T-17 Fires, were to burn a substantial percentage of existing sagebrush habitat within the SGCA, DOE and USFWS may consider altering the current SGCA boundary to include additional sagebrush habitat on the INL Site (i.e. currently outside of the SGCA) to offset losses and reestablish a new baseline under the CCA.

Update to Sagebrush Habitat Baseline Value

After we reported the adjusted baseline value last year (Shurtliff et al. 2016), we discovered that there were a couple of unburned sagebrush habitat polygons within the Jefferson fire that were omitted from the calculation. Once the area of those polygons was added, the sagebrush habitat baseline value slightly increased to 78,557.5 ha (194,119.8 ac) and now represents the most accurate baseline estimate of

sagebrush habitat available. There were no additional losses within the SGCA documented from infrastructure expansion (see Section 4.3).

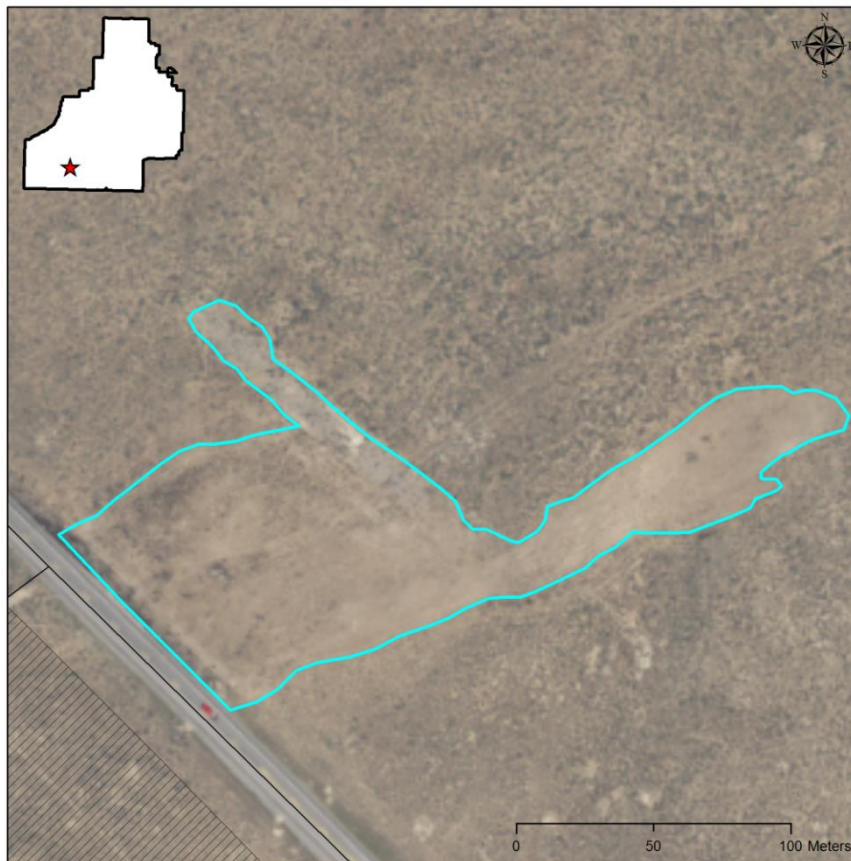


Figure 3-7. The mapped burned area boundary of the 2015 268 Fire on the INL Site. The striped polygon in the lower left corner represents the SGCA boundary.

Maintaining an up-to-date estimate of the amount and distribution of sagebrush habitat on the INL Site is important to support the current CCA (DOE-ID and USFWS 2014). Sagebrush habitat is one of the adaptive regulatory thresholds that will be monitored annually and serves to identify when modification to conservation actions might be required or mitigation is necessary. Therefore, it is important that the established baseline amount of sagebrush habitat and subsequent changes (increases and decreases) are documented accurately and regularly. The baseline value has had two minor updates since the signing of the CCA, but the changes are a result of improving the accuracy of the sagebrush habitat distribution rather than any real changes due to disturbances that caused a loss.

T-17 Fire Field Sampling Results

We sampled 80 plot arrays distributed within the 2011 T-17 Fire (Fig. 3-8). Each plot array contained five subplots, resulting in 400 points of data to document the vegetation classes naturally reestablishing following fire. The vegetation class recorded most often within plot arrays was the Green Rabbitbrush/Streambank Wheatgrass (Western Wheatgrass) Shrub Herbaceous Vegetation class, documented at 146 (36.5%) subplots. The second most abundant class was the Needle and Thread Herbaceous Vegetation class, recorded at 88 (22%) subplots. The majority of plots sampled were dominated by native shrubs and grasses with very few weeds present, suggesting the natural recovery

process is functioning normally and non-native species are not establishing at a rate that should warrant concern at this time.

The most common non-native herbaceous class recorded was the Cheatgrass Semi-natural Herbaceous Vegetation, though it only occurred at 14 (3.5%) subplots. There were also localized sites where non-native vegetation (e.g. Russian thistle [*Salsola kali*]) was abundant and dominated areas such as low-lying playa basins. There were a number of subplots where it was noted that the key did not work well, especially in areas where non-native species are prevalent. This could be an indication that vegetation community types are shifting and new vegetation classes may be defined during the next vegetation classification and mapping update.

Many of the same species are typically present in several different post-fire communities, and individual abundances vary within a matrix of community types across the landscape. Consequently, there was considerable vegetation class variability within the majority of plot arrays sampled within the T-17 Fire. There were only 15 (18.8%) plot arrays where each subplot keyed to the same vegetation class. Of those 15 plot arrays, 10 had all subplots key to the Green Rabbitbrush/Streambank Wheatgrass (Western Wheatgrass) Shrub Herbaceous Vegetation class. The Green Rabbitbrush/Streambank Wheatgrass (Western Wheatgrass) Shrub Herbaceous Vegetation class encompasses a wide range of species within the class description including green rabbitbrush, native bunchgrasses, and rhizomatous grasses. This vegetation class was also the most abundant found within the Jefferson Fire (Shurtliff et al. 2016) and appears to be the most widespread and common within the central burned region of the INL Site.

Now that all of the wildland fire boundaries since 2010 have been updated and representative field data have been collected throughout the recent fires (except for the 2010 Middle Butte Fire area), the next step is to begin updating vegetation class boundaries within burned areas. The INL Site vegetation classification and mapping update process is planned to commence in 2017 with the collection of new field data followed by statistical analysis to determine the vegetation classes now present on the INL Site. The results of the new statistical analysis may define different vegetation classes than those identified during the original analysis in 2008 and 2009.

There have been repeated observations in the field where some non-native species have been found localized in low-lying playas. These new communities were not characterized during the last classification effort because they were not present in the abundances found recently. Using the dichotomous key in these areas forces the user to select from previously defined classes that do not accurately represent what is on the ground. New statistical classifications will be useful for mapping these areas more accurately in the future.

Whereas patches across the landscape that appear to be fairly homogenous in imagery can start to be delineated now, finalizing the delineations and assigning a vegetation class to each polygon would benefit from waiting until the new classification results are determined. This will prevent reassigning new classes in a year, and may also impact how the delineations are made within burned areas. There may be vegetation classes defined previously that will now become a larger more encompassing class where multiple polygons would be merged into one. The alternative scenario could be finer discrimination of single classes resulting in subdividing one larger polygon into a numerous smaller polygons. We plan to wait until the new statistical classification is complete to finish the map updates in regions that have burned and are now outdated.

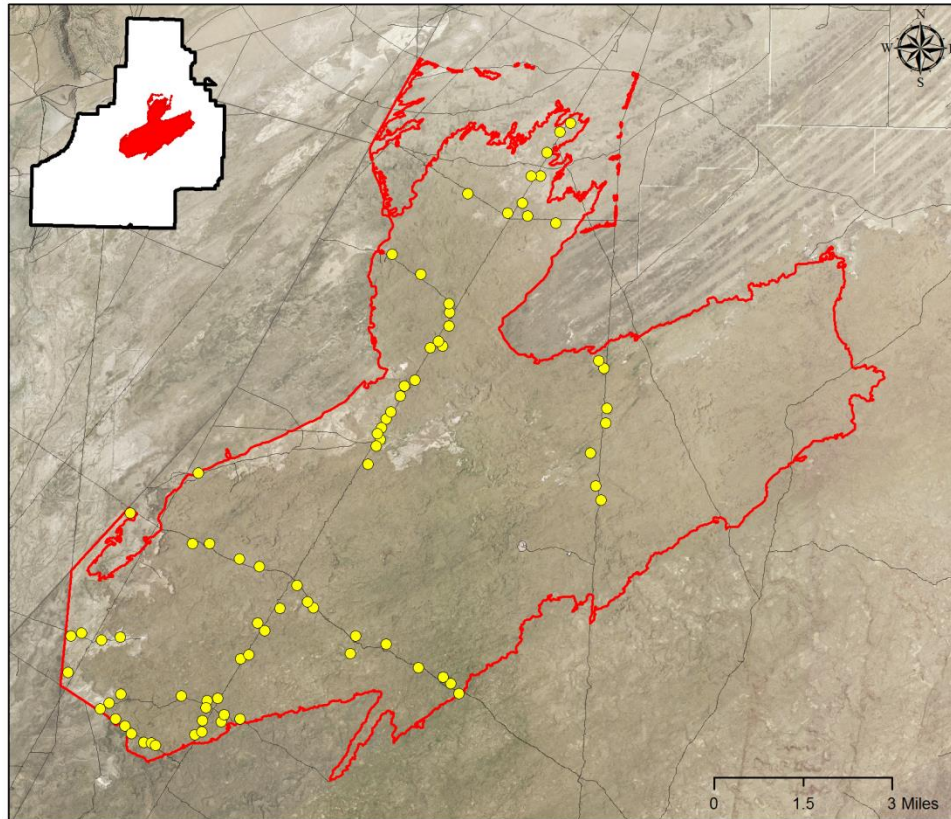


Figure 3-8. The distribution of 2016 field plot arrays (yellow points) sampled within the 2011 T-17 Fire on the INL Site.

4. THREAT MONITORING

The CCA identifies and rates eight threats that impact sage-grouse and its habitats on the INL Site, either directly or indirectly. All threats are addressed to some extent by the 13 conservation measures that DOE is striving to implement (Chapter 5). Task 5, which was reported above (Section 3-1), provides information on the status of sagebrush habitat, but it also monitors potential impacts of wildland fire and livestock threats. Some tasks, however, were designed specifically to gather baseline and continuing information about a threat because associated conservation measures could not be implemented without this *a priori* information. The following sections report on Tasks 4, 7, and 8, which were developed to address the threats of raven predation (Task 4), annual grasslands (Task 7), and infrastructure development (Task 8). Over time, these tasks will provide crucial information needed by DOE to make decisions about how to implement threat reduction measures.

4.1 Task 4—Raven Nest Surveys

4.1.1 Introduction

The common raven (*Corvus corax*, hereafter raven) is native to Idaho and historically constructed nests on natural substrates such as rock ledges and juniper trees. In many areas of the INL Site, these substrates are limited and ravens likely compete with raptors for some of them. Today, most raven breeding pairs on the INL Site nest on anthropogenic structures, primarily power transmission structures (Howe et al. 2014). These territory-holding nest pairs (rather than unmated, non-territorial individuals) may be responsible for the majority of sage-grouse nest depredation (Bui et al. 2010).

In the CCA, DOE committed to support research aimed at developing methods to deter raven nesting on utility structures (*Conservation Measure 10*; DOE and USFWS 2014). Before doing so, it is important to establish where ravens nest in highest density so that actions to deter nesting can be most effective. In addition, the timeframe for initiating Conservation Measure 10 will be influenced by results from inter-annual trend analysis. In other words, if the number of raven nests on infrastructure is stable or decreasing, there would be less impetus for DOE to expend resources to deter nesting. Conversely, if raven use of infrastructure for nesting is increasing, DOE may prioritize commencement of Conservation Measure 10. Finally, annual surveys establish a baseline so that continued monitoring following deterrent installation can address whether actions had an impact on the number of raven nests on transmission structures.

The primary objective of Task 4 is to determine how many active raven nests are supported by anthropogenic structures on the INL Site each year and to evaluate the inter-annual trend. The 2016 season completed three years of surveys and, as a result, we were able to evaluate nesting trends for the first time. In addition, we evaluated distances between nearest nests of both ravens and raptors. This information may provide insight into the home-range size of ravens and the capacity of the landscape on the INL Site to support this species.

4.1.2 Methods

We systematically surveyed all power lines, towers, raptor nesting platforms and facilities on the INL Site that could feasibly support a raven nest, following methods described elsewhere (Shurtliff et al. 2015). Surveys occurred between 31 March and 31 May, 2016. To evaluate the type of power line structures preferred by ravens, we collected information about each structure that supported an active nest by taking

pictures and recording other pertinent information. Summary statistics were generated using SigmaPlot (vs 13.0).

For each survey, we scanned 231 km of transmission lines and 41 km of distribution lines, not including line lengths within substations. Total distances differ from past years because in 2016 we decided it was no longer necessary to survey three distribution lines (two of which consist primarily of single-pole structures without cross arms) where we have not documented any nests since surveys began in 2013 (Fig. 4-1).

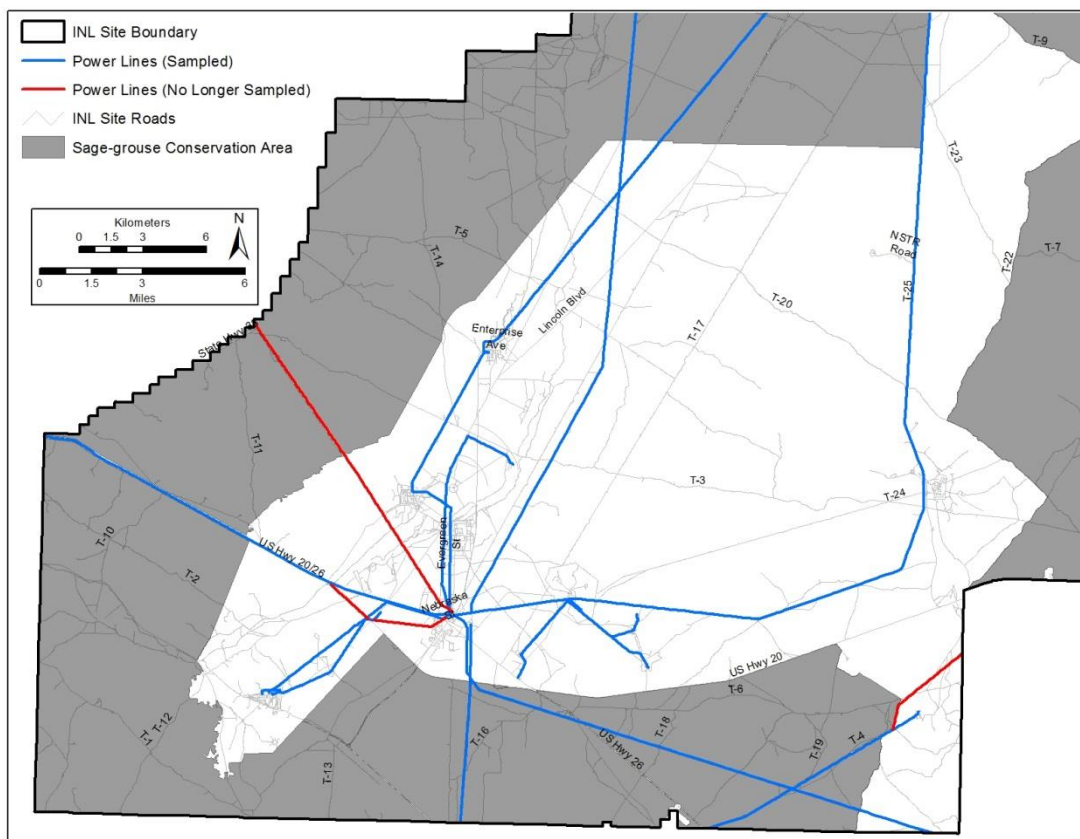


Figure 4-1. The southern portion of the INL Site, highlighting power lines that we no longer survey for raven nests.

Trend Analysis

We recognize that the number of raven nests classified as active each year does not necessarily equal the number of mated pairs on the INL Site that use infrastructure as a nesting substrate. Throughout the two-month survey period, nests may blow down or be abandoned. If a mated pair loses a nest and rebuilds a second nest during the survey period, our sampling method would record two active nests because we are unable to distinguish individual ravens. This artifact of our sampling scheme produces an unknown level of variability that potentially affects the accuracy of raven nest trend data (which is a proxy for raven nesting pairs). To reduce some of this variability, we calculated an adjusted raven nest total. To do this, we examined each power line nest that was initially characterized as active, but later in the nesting season had fallen to the ground (nests on other structures do not typically fall down). For each of these failed nests, we

noted the period during which we collected evidence that the nest was active (e.g. incubation occurred). We assumed that the nest may have fallen at any time following the last recorded active observation. We then examined dates during which activity was recorded at all other active nests within a 6-km radius. If a nest within a 6-km radius was recorded as active for the first time after the last activity was recorded in the failed nest, we assumed that the occupants of the failed nest re-nested at that location. We repeated this process using data from each season from 2014 to 2016.

The 6-km threshold was chosen somewhat arbitrarily, but the intent was to be conservative in our estimate of the number of breeding raven pairs (i.e. a higher number of second nests identified results in a lower estimate of breeding pairs). We considered that the median distance from an active raven nest to the nearest active conspecific nest over the three years of our study ranged from 2.7–3.1 km (see below), and in many cases, the 6-km radius overlapped several raven nests.

Nearest-Nest Analysis

We quantified the straight-line distance from each active raven nest on the INL Site to the nearest active raven and raptor nest using the [Geospatial Modelling Environment software](#) for ArcGIS. We did not include nearest-neighbor distances from nests that were closer to the INL Site boundary than to an on-site nest because we were unable to verify that the nearest nest on the INL Site was closer than an undocumented nest off the INL Site. We also excluded distances between nearest nests when one nest (usually a Swainson's hawk; *Buteo swainsoni*) was established several weeks after the first nest. In those cases, we included the next-nearest nest distance because we assumed that the later nest did not influence where the first nest was established. When a single raven pair presumably established two or more nests, we excluded nearest-nest distances between nests from the same putative breeding pair. However, we calculated distances from each of the shared nests to nearby, non-related nests and included the distance that was the shortest. We did so because a primary objective of this analysis was to understand how close ravens are willing to nest to each other.

Ravens are apparently behaviorally monogamous (Boarman and Heinrich 1999) and probably return to the same territory year after year, particularly if they experience consistent reproductive success (Sergio and Newton 2003). We desired to examine indicators of nesting pair persistence and raven habitat quality across years by overlaying raven nest sites from all years in a GIS and calculating distances from each active nest in 2016 to nearby active raven nests from 2014 and 2015. We assumed that any 2014 or 2015 nest that was near a 2016 active raven nest site was attended by the same breeding pair. We define "near" as half of the mean annual distance between the two nearest raven nests each year. For example, if the nearest two raven nests in each year were on average 1,000 m apart, any nests from 2014 or 2015 that were within 500m of a 2016 nest were considered to have been attended by the same nesting pair. We realize this is a course estimate based on several untested assumptions. However, this examination provides a snapshot of the areas on the INL Site where raven nesting is most persistent.

4.1.3 Results

We observed 46 active raven nests on man-made structures (Table 4-1), 35 of which (76%) were on power line structures. We documented one additional active raven nest off the INL Site on a transmission line structure approximately 850 m southeast of where the line crossed the southern INL Site boundary near the southeastern border. In past years, we have not searched for or recorded nests along power lines extending >550 m outside of INL Site boundaries, so to maintain consistency across years, we did not include this nest in our analysis. However, the powerline is not perpendicular to the boundary, but extends

outward at a narrow angle (Fig. 4-2). As a result, the raven nest was only 200 m from the southern INL Site boundary. Thus, although we did not include nest in our analysis, it is likely that the occupants' territory overlapped parts of the INL Site.

We were unable to confirm nesting activity at 11 nests, though we visited them multiple times throughout the survey period. Two of these unconfirmed nests were on power lines and eight were in ornamental trees or on building platforms at facilities where they are unlikely to fall down even after years of inactivity. Most nests with unconfirmed activity were probably unoccupied this year, though it is possible that we failed to detect nest activity, especially if birds attended and then abandoned nests early in the season.

Facilities

We surveyed the same 11 facilities that were surveyed in 2015, between 31 March and 5 May, 2016 (Table 4-1). In addition, we serendipitously discovered an active raven nest in a structure near the main INL Site entrance southeast of CFA. We have not surveyed this area in previous years because the only structures included a cell phone tower (which is surveyed each year), a couple of small building next to the tower, an open car port, and a rectangle-shaped badging-office building with an unenclosed storage shelter attached to the back. The raven nest was behind the badging office in the only area that would not have been visible when the tower was surveyed. Badging office staff reported in September 2016, that the nest was not present (or at least not active) in 2015, and as far as they were aware, it had not been active previously. Here, we consider the CFA main gate area a new facility and will monitor it as a 12th facility in the future (Table 4-1).

We observed eight active raven nests at the 12 facilities and no more than a single nest at any one facility (Table 4-1). Horizontal platforms attached to buildings and effluent stacks were the primary substrates of choice.

Towers

We surveyed 12 towers at least two times each (range 2-5) from 31 March–19 May, 2016. In 2015, we surveyed 11 towers (Shurtliff et al. 2016). The additional tower surveyed in 2016 was on Filmore road southeast of the Critical Infrastructure Test Range Complex. Though 2016 is the first year that this tower was officially surveyed, in past years we drove by the tower following each nearby power line survey. If the tower had been used as a nesting substrate, it likely would have been observed and recorded.

Ravens built nests on the same two towers within the SGCA that they occupied last year (Shurtliff et al. 2016), which are maintained by the National Oceanic and Atmospheric Association (NOAA; Fig. 4-2). NOAA made attempts prior to the breeding season of 2016 to deter nesting on at least one of these towers by wrapping the top portion with wire, but the ravens simply moved the nest lower. In addition to the two nests on NOAA towers, ravens occupied a nest on a cell phone tower less than 50 m off the INL Site near the northeastern boundary.

Power Lines

We completed four surveys of all transmission and distribution lines on the INL Site that could potentially support a raven nest. The first two surveys occurred from 31 March–3 May, and the second two occurred from 4 May–31 May, 2016. All 35 active raven nests that were on power lines used transmission rather than distribution structures. This includes one nest that was on a large lattice structure used for power grid tests next to a transmission line. Fourteen (40%) of the power line nests were within the SGCA (i.e. the

SGCA bordered at least one side of the nest). Twenty nests were on “Closed H Cable” structures, 12 were on “Sloped H”, one was on an “Open H” structure, one was on a “Hybrid” structure, and one was on the lattice structure mentioned above (Fig. 4-3).

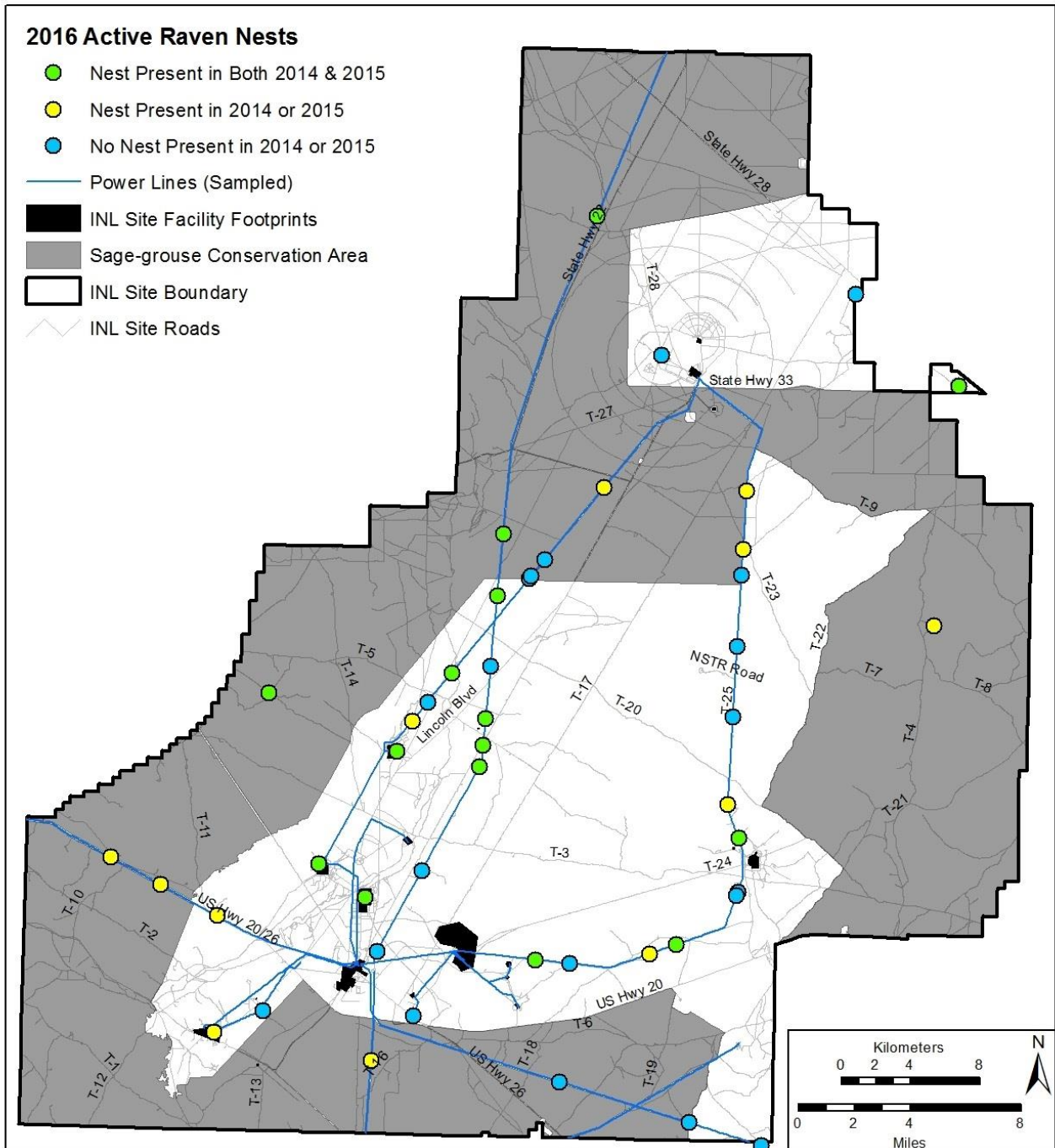


Figure 4-2. Results of 2016 raven nest surveys. Each dot represents an active raven nest in 2016 (unadjusted nest locations). The color of the dot indicates whether an active raven nest was recorded nearby (i.e. within 711 m) in one or more of the past two years.

Table 4-1. Facilities surveyed for raven nests in 2016. The number of days between surveys is indicated, though individual nests with unconfirmed activity statuses were sometimes revisited more frequently.

Facility	# Times Surveyed	Days Between Surveys	Active Raven Nest Confirmed	Substrate Supporting Active Nest
Advanced Mixed Waste Treatment Project	2	19	Yes	Building Platform
Advanced Test Reactor Complex	2	23	Yes	Effluent Stack
CFA Main Gate	1	-	Yes	Building Platform
Experimental Breeder Reactor I (EBR-I)	2	19	Yes	Airplane Engine
Experimental Sheep Station	2	15	Yes	Ornamental Tree
Idaho Nuclear Technology and Engineering Center	2	21	Yes	Effluent Stack
Naval Reactors Facility (NRF)	1*	-	Yes	Effluent Stack
Specific Manufacturing Capability (SMC)/Test Area North (TAN)	2	15	Yes	Building Platform
CFA	2	14	No	N/A
Critical Infrastructure Test Range Complex (CITRC)	2	20	No	N/A
Materials & Fuel Complex /Transient Reactor Test Facility (TREAT)	2	23	No	N/A
RWMC	2	14	No	N/A

* ESER personnel are restricted from entering NRF. Therefore, we initially trained, and then interviewed an NRF representative in the parking lot of the facility and he pointed out where he has seen active raven or owl nests.

Table 4-2. Summary of active raven nests observed on anthropogenic features on the INL Site during 2016.

Species	# Active Nests	Substrate	Within SGCA	Outside SGCA
Common Raven	35	Power Line	14	21
	3	Building Platform	0	3
	3	Effluent Stack	0	3
	3	Tower	2	1
	1	Ornamental Tree	0	1
	1	Other	0	1
Total	46		16	30



Figure 4-3. Transmission pole structures used as nest substrates by ravens in 2016. From Left to Right:(Top) Sloped H, Closed H-Cable, Open H, (Bottom) Hybrid, Lattice.

Raven Nesting Trend

The number of active raven nests documented on INL Site infrastructure increased each year from 2014 to 2016 (Table 4-3). By applying the criteria described under *Methods*, we identified one to six nests each year that likely represented re-nesting attempts after a nest on a transmission structure fell to the ground. Adjusted nest counts increased 34% from 2014–2016, an average of 7.5 nests per year. Nesting on power lines increased at an even higher rate of 43% over three years. Increased observations of nesting occurred both on power line structures and non-linear structures. These adjusted counts of nests constitute an estimate of the number of breeding pairs of ravens that nested on anthropogenic substrates on the INL Site.

The shortest distance between two active raven nests was 1,525 m in both 2014 ($n=26$) and 2015 ($n=28$) (the same two nests had the shortest distance in both years) and 1,216 m in 2016 ($n=41$). Averaging across the three years, the mean shortest distance for this study was 1,422 m ($SD=178$ m). These results exclude distances between nests that were putatively attended by the same breeding pair in the same year. Across all years, the mean distance between nearest-neighbor raven nests was 3,137 m ($n=95$; $\sigma =1,770$ m) and the median distance was 2,760 m.

To examine how areas used for nesting changed from year to year, we used a threshold distance of 711 m (half of 1,422 m, the 3-year mean of shortest distances between nearest-neighbor raven nests—see above). Twenty seven of 44 nests (61%) from 2016 were within 711 m of a raven nest that was active either in 2014 or 2015, and 15 nests (34%) were within 711 m of raven nests in both 2014 and 2015 (Fig. 4-2). In only one instance were nests from 2016 and 2014 within 711 m of each other without a 2015 nest also being within the threshold distance (in that case, the 2015 nest was 740 m from the 2016 nest).

Interactions With Raptors

Because it is unknown if the presence of active raptor nests impacts where ravens establish nests, we evaluated the distance between raven and raptor nests whenever the latter was the absolute nearest nest (i.e. closer than other raven nests). Great-horned owls (*Bubo virginianus*) nested closer to ravens than any other raptor (mean=1,034 m, median=446 m, $n=13$, range 17–2,540 m), though unlike other raptors, all great-horned owl nests were associated with facilities where suitable nest substrates are non-linearly distributed. Particularly interesting is one instance in 2016 of an active raven nest and a great-horned owl nest that were 17 m apart on a pair of old airplane engines. A raven, presumably one of the occupants of the airplane engine nest, was found dead nearby during the survey period and the raven nest was subsequently abandoned.

Hawk nests were nearly always on power line structures or on nest platforms near power lines, and typically there was at least as much distance between nearest-neighbor raven and hawk nests as there was between nearest-neighbor raven nests. During the three years of surveys, two Ferruginous hawk (*Buteo regalis*) nests and two red-tailed hawk (*Buteo jamaicensis*) nests were active at distances ranging from 738 m to 790 m from active raven nests, though in all other instances ($n=16$) where a raven nest's nearest neighbor was a *Buteo* hawk (including Swainson's hawks), nest distances were at least as far apart as raven-raven nests (i.e. >1,216 m).

Table 4-3. Summary of raven nest data collected during surveys of INL Site infrastructure. "Adjusted" data (columns 4-7) represent estimates of the number of breeding pairs of ravens.

Year	Total Active Nests	Adjusted Active Nests	Increase-Active Nests	Total Power Line Nests	Adjusted Power Line Nests	Increase-Power Lines	Nearest Nests (m)	Mean (SD) nest distance (m)
2014	35	29	N/A	29	23	N/A	1,525	3,366 (1,440)
2015	39	38	31%	31	30	23%	1,525	2,803 (1,282)
2016	46	44	16%	35	33	10%	1,216	3,220 (2,200)
Total / Mean	120	111	*34%	95	86	*43%	**1,422	

*Percent increase from 2014 to 2016.

**Mean from 2014 to 2016.

4.1.4 Discussion

The number of documented raven nests on INL Site infrastructure has increased each year by an average of 7.5 nests/year since 2014. Although nest surveys were originally designed to produce an index rather than an actual count of breeding pairs occupying nests on infrastructure, our results suggest that it is feasible to estimate the number of breeding pairs by comparing the timing of nest destruction (presumably from high winds) and of nearby nest construction. Consequently, in the future we will be able to continue to track trends that represent the number of breeding pairs occupying infrastructure-supported nests rather than the less precise measure of active nests (which will fluctuate depending on wind conditions during the spring).

As usual, the vast majority (75%) of active raven nests in 2016 occurred on electrical power transmission structures. However, only half (three of six) of the increased number of breeding pairs, relative to 2015, constructed nests on power lines. The three non-power line nests that represented an increase were on a tower on the east INL Site boundary, a new facility (the badging office), and an old airplane engine at Experimental Breeder Reactor-I. The tower and engine were surveyed in past years, and staff at the badging office reported that they did not see a raven nest at that facility last year. Thus, although transmission structures provide favorable substrates for nesting, ravens continue to show their adaptability to many structural types.

Our results do not necessarily demonstrate that the number of territorial raven pairs is increasing on the INL Site, but that infrastructure is increasingly being used. Ravens also nest on natural substrates where available, including Utah juniper (*Juniperus osteosperma*), rock ledges, and live and dead cottonwoods (*Populus* spp.; Howe et al. 2014). Howe et al. (2014) made substantial efforts to identify all active raven nests both on infrastructure and natural substrates on the INL Site from 2007–2009. During those years, only 22% of raven nests occurred on natural substrates. Thus, it is likely that Task 4 tracks nesting trends of the majority of breeding pairs of ravens on the INL Site. To unequivocally state that the breeding population is increasing on the INL Site, all natural and infrastructure-supported nests should be monitored. Alternatively, Breeding Bird Survey data, which has been collected each June on several INL Site routes for nearly 30 years, could be analyzed to determine if raven abundance on the INL Site is increasing, and if so, at what rate. It would be interesting to compare trends from the Breeding Bird Survey dataset and the current study to see if similar results are obtained.

There is evidence that ravens have been increasingly using infrastructure as nest substrates for nearly a decade. Howe (2012) used different methods, and may not have surveyed all infrastructure as intensively as we did, but from 2007-2009, she recorded 21, 26, and 29 active raven nests on anthropogenic structures (Howe noted that she had limited access to the facilities during 2007, but by 2009 she was confident that all nests on anthropogenic structures had been accounted for). Starting five years later, we recorded 35, 39, and 46 nests on infrastructure (2014-2016; Table 4-3). Although it would be inappropriate to combine the results from the two studies into a single analysis, available evidence suggests that the number of active raven nests (and probably the number of breeding pairs) on the INL Site has been increasing for at least a decade.

Nearly a decade ago, it was estimated that raven populations had increased 300% across the United States since the early 1980s (Sauer 2008), and there are reports of over 1,500% increases in some areas of western North America over a twenty-year period (Boarman 1993). Researchers commonly attribute these trends to food, water, and nesting subsidies associated with humans (Kristan et al. 2004). Anthropogenic subsidies on and off the INL Site probably have contributed to raven reproductive success on the INL Site, but we suspect that other factors not associated with the INL Site or anthropogenic subsidies have driven raven abundance increases. An executive order in 1972 banned systematic poisoning of coyotes and other predators on public lands, which had been supported in the west by the Federal government since 1915 (Dunlap 1986). Poisoned carcasses likely would have had a large impact on scavengers such as ravens (Conover and Roberts 2017). We speculate that increasing raven abundances over the past several decades has been driven by a reduction in widespread poisoning, and exacerbated by increasing anthropogenic subsidies, wildfire, and other habitat fragmentation across the region.

Nearest-Nest Distances

Home range describes an animal's space use, whereas a territory is a defended part of a home range. Home ranges may overlap, but generally territories do not (Bookhout 1996). Raven breeding pairs are territorial and actively challenge conspecific trespassers (Marzluff and Heinrich 1991). Home range has been studied in other environments (e.g. Scarpignato 2011), but we are unaware of information regarding home range or territory size in habitats similar to that found on the INL Site. The nearest-nest analysis in this study, which included 95 nests across three years, provides indirect evidence that raven territories in sagebrush steppe may be at least 600 m radius, assuming the nest is the center of the territory (i.e. two adjacent, non-overlapping territories would have to be at least 1,200 m apart to avoid territorial disputes). In three years, no raven nested closer than 1,216 m from another active raven nest. This information helps us begin to think about the potential carrying capacity on the INL Site of raven breeding pairs, though to do so we must assume that higher densities of ravens would not cause territory sizes to compress. We must also assume that all habitats where infrastructure is present are suitable for raven reproduction. By way of illustration, if raven nests occurred at a mean distance of 1,500 m from other raven nests (roughly the closest nearest-nests in 2014 and 2015) along 200 km of transmission lines, there would be 133 nests scattered across transmission lines on the INL Site (for this example we have excluded distribution lines and 31 km of transmission lines that cross or are near each other). This number does not take into account raven nests at facilities or on towers. Although 133 is a coarse estimate, it is reasonable to suggest that in coming years perhaps two or three times as many raven nests could be supported per year on INL Site infrastructure.

Management Implications and Recommendations

Across the sage-grouse range, predation by ravens is not considered to be limiting population growth. However, evidence is mounting that at on a local scale, raven predation may negatively affect sage-grouse reproductive success and population growth (Bui et al. 2010; Coates and Delehanty 2010; Lockyer et al. 2013). This impact may be in the form of altered incubation behavior by female sage-grouse (which may compromise their ability to secure adequate nutrition) and altered nesting and brood-rearing habitat selection (Coates and Delehanty 2008; Dinkins et al. 2012). The raven nest monitoring task on the INL Site does not directly address potential impacts of raven predation on sage-grouse reproduction. However, ravens are opportunistic foragers and we know that they successfully depredate sage-grouse nests on the INL Site (Howe and Coates 2015). Lek surveys in 2016 suggest that sage-grouse are at their highest abundance in ten years. Perhaps the more relevant question regarding predation is whether raven occupancy on the INL Site could reach high enough levels and impact sage-grouse reproductive success to a degree that they begin to depress the natural population cycles of sage-grouse. We do not know the answer to this question, but DOE and INL contractors have taken measures to address threats posed by raven predation (see Section 5, *Implementation of Conservation Measures*).

At the beginning of 2016, NOAA staff installed some wire mesh at one of its towers in an attempt to prevent ravens from nesting. This attempt was unsuccessful as the ravens simply constructed a nest lower down the tower near a horizontal measuring device. We have noted that ravens appear to require some sort of horizontal structure near their nests so that they may land before hopping into the nest. Thus, there may be ways to take away this opportunity on at least two of the NOAA towers that supported nesting in 2016.

4.2 Task 7—Inventory and Monitoring of Sage-Grouse Habitat for Areas Dominated by Non-Native Annual Grasses

4.2.1 Introduction

Habitat loss due to dominance by non-native grasses, primarily cheatgrass, is a threat to sage-grouse across its range and on the INL Site (DOE and USFWS 2014). Cheatgrass domination generally follows the loss of native herbaceous species, often due to soil disturbance associated with land use activities. In high densities, cheatgrass alters the fire regime by increasing fire frequency, which further reinforces cheatgrass dominance. Increased fire frequency also means that big sagebrush recovery following fire is unlikely, essentially making this loss of sage-grouse habitat permanent. Native perennial grasses and forbs are also unlikely to recover in cheatgrass-dominated areas, resulting in poor ecological condition and function for indefinite periods of time.

Adaptive Management

When CCA Task 7 was developed, the primary goals were to delineate areas affected by anthropogenic disturbance and dominated by cheatgrass within the SGCA, and to identify the source of disturbance that made it possible for cheatgrass to dominate. The premise was that if DOE knew what caused the disturbance, it could reduce or eliminate the stressor or work with partners to do so. In 2016, DOE recognized that Task 7 was not achieving its desired outcome because in nearly all cases during the previous two field seasons, the source of disturbance was undetectable. Thus, DOE could not take action to address the source of weed introduction, and no progress was being made to reduce the threat of annual grasslands to sage-grouse.

To better address the threat of annual grasslands, ESER developed a new objective for Task 7 during 2016, which is to inventory and delineate cheatgrass-dominated areas on wildfire containment lines on the INL Site. When firefighters construct fire containment lines, they remove all or most of the vegetation, leaving swaths of disturbed bare ground that are susceptible to non-native annual grass domination. Many containment lines on the INL Site have not had any post-fire restoration to stabilize the soil and promote native vegetation communities. Consequently, those areas, which are often associated with relatively intact sagebrush and other native plant communities, have the potential to indirectly threaten sage-grouse by reducing habitat productivity and becoming a vector for the spread of non-native annual grasses.

The redefined objective of Task 7 will allow ESER to quantify the effects of a single, known source of anthropogenic disturbance (i.e. containment lines) and to visualize these effects spatially. The new monitoring task will be accomplished in three phases comprising the following activities: 1) delineate the extent and distribution of containment lines on the INL Site; 2) determine the presence and relative abundance of non-native annual grasses and develop a prioritized list of candidate restoration areas; and 3) plan for the treatment and revegetation of prioritized areas, if DOE chooses to pursue that course of action. This knowledge will allow DOE to maximize its conservation impact if the agency chooses to revegetate degraded areas along containment lines.

4.2.2 Methods

Digital Imagery

The goal for Phase 1 of the redesigned Task 7 was to identify and delineate the containment lines bladed on the INL Site during wildland firefighting activities. The distribution of containment lines across the INL

Site is widespread, and the most feasible method to inventory and map them is to use high resolution imagery. The USDA NAIP collects high resolution color-infrared digital imagery normally every two years in Idaho. The first Idaho NAIP image dataset was collected in 2004, and again in 2009, 2011, 2013, and 2015. During the development of the INL Site vegetation map (Shive et al. 2011) the ESER Program contracted a commercial vendor to collect digital imagery across the Site in 2007, with the same or similar specifications as the NAIP data. All of the image datasets were acquired with a spatial resolution of 1 m, except for the 2013 imagery, which was collected at 0.5 m spatial resolution. The image datasets all contained four spectral bands (blue, green, red, and near-infrared), were orthorectified to correct for distortion caused by changes in elevation, and georeferenced to the North American Datum 1983 and Universal Transvers Mercator projection. Each image dataset was imported to an ArcGIS project, which enabled individual datasets to be toggled on and off in the same location while the INL Site was systematically reviewed for containment line presence.

Containment Line Delineations

During the initial review of the imagery, the 2013 NAIP imagery served as the primary basemap dataset used to investigate the current containment line distribution on the INL Site. The 2013 NAIP imagery is not only the highest resolution imagery collected Site-wide, but it is also the most recent data collected since the last major fire in 2012 (i.e. Midway Fire). The 2015 NAIP imagery is a more recent dataset, however it does not include any new fires and only shows the most recent containment lines following a few years of natural vegetation recovery that can occasionally obscure detection. Within a couple growing seasons, vegetation can begin to naturally reestablish and bladed containment lines will start to show signs of vegetation presence. Containment lines bladed a decade or more ago can become difficult to detect in recent imagery, because the disturbed areas start to resemble adjacent unbladed areas, and cannot always be confidently differentiated. Where containment lines were faintly visible in more recent imagery and older image data was used to delineate the bladed areas (Fig. 4-4).

Additional GIS data layers were also used to help guide the review process. All of the wildland fires since 1994 have had polygon data layers created to map their boundaries. Knowing that most fires have containment lines surrounding the burned area, we used mapped edges as a reference point to locate blade lines. Bladed containment lines were not always coincident with the burned edge. In some cases, bladed lines were observed ahead of the burned area because the fire dissipated before reaching it. In other cases, bladed lines were inside the burned area because the fire advanced beyond the initial blading effort.

Two GIS analysts independently marked all observed containment lines during the initial visual evaluation of the imagery time-series. Those locations were reconciled into a single list and a secondary review was conducted to remove duplicates and create a combined list of all individual containment lines. Each containment line was manually delineated as a vector line dataset using a GIS within the range of 1:1,000 to 1:2,000 mapping scale. While digitizing, we tried to follow the general center of each containment line. Because line features were generated rather than polygon features, the entire extent (width) of the bladed area was not mapped. Mapping the total disturbed footprint of bladed soil on the INL Site would take a significant effort and is beyond the scope of this task.

The amount of surface area disturbed was estimated following the assignment of a blade-width variable to each line segment. Blade sizes used on bulldozers at the INL Site range from approximately 12–15 ft wide (Pers. Comm., Eric Gosswiller, INL Fire Chief). Once the draft mapping was complete, each containment line was visually evaluated along the entire length. There are examples where additional spurs or laydown

areas were bladed during the fire-fighting process, creating a single blade width, while the primary line may have been two or more blade-widths wide. At any point along the line where the blade-width was observed to change, the line segment was divided using the Split Tool on the Editor Toolbar. In most cases, a basic visual assessment of the line thickness provided enough information to assign the segment to a blade-width category. GIS staff also measured containment line widths using the standard ArcMap Measure tool to confirm the estimated value entered for each line segment (Fig. 4-5). After the initial blade-widths were assigned to each containment line, a final evaluation was conducted by a single GIS analyst to ensure consistent designations within the dataset.

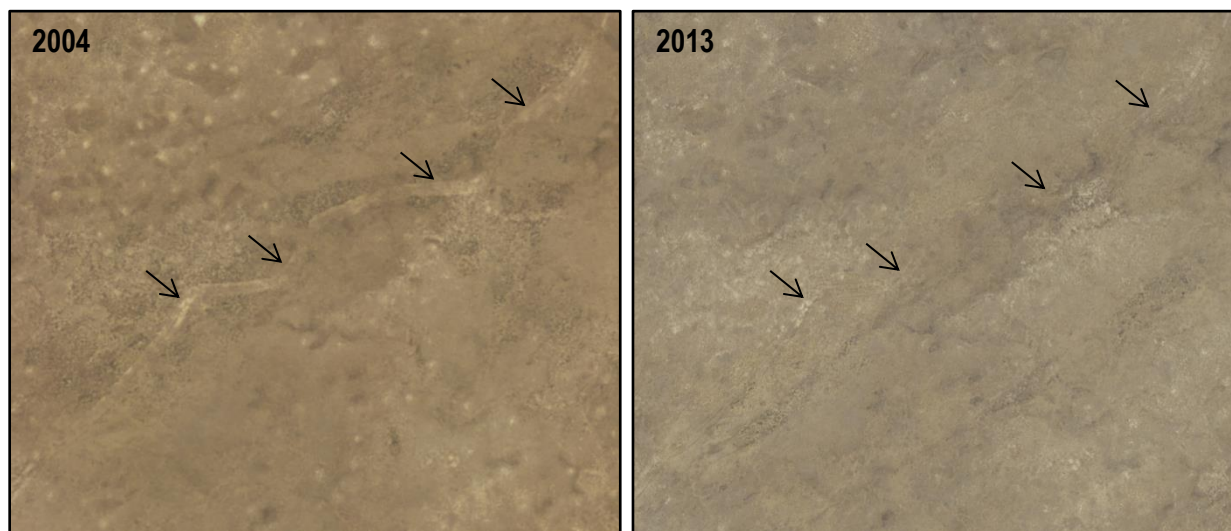


Figure 4-4. Comparison of an example containment line visible in 2004 NAIP imagery, but difficult to see in 2013 NAIP imagery. In this example, the 2004 NAIP imagery was used to manually delineate the line.

4.2.3 Results and Discussion

Phase 1—Mapping Results

We mapped 847.4 km (526.5 mi) of bladed containment lines on the INL Site (Fig. 4-6). Containment lines were created when a bulldozer made a single pass through an area, though it was evident that many times two or more passes were made. The largest percentage of mapped containment lines was single blade-width lines totaling 429.1 km (266.6 mi), representing 50.6% of the total mapped containment line length (Table 4-4). Two-blade-width lines were the second largest percentage with 380.8 km (236.6 mi) of line representing 44.9%. The largest blade-width class mapped was six blades wide (Table 4-4). That particular line segment was located on the northeast side of the INL Site at the agricultural interface where three blade widths were created on each side of an existing two-track road.

We used the lower and upper length of the reported blade-width size range to calculate the estimated area of vegetation removed from containment line construction as 309.9–387.4 ha (765.9–957.4 acres). Although there are areas where the measured blade width is slightly thinner or slightly wider than the known range of blade sizes, the blade width area calculation is a reasonable estimate. Along the length of the entire line segment, it is likely the minor deviations are averaged out and the mean width falls within the reported size range.

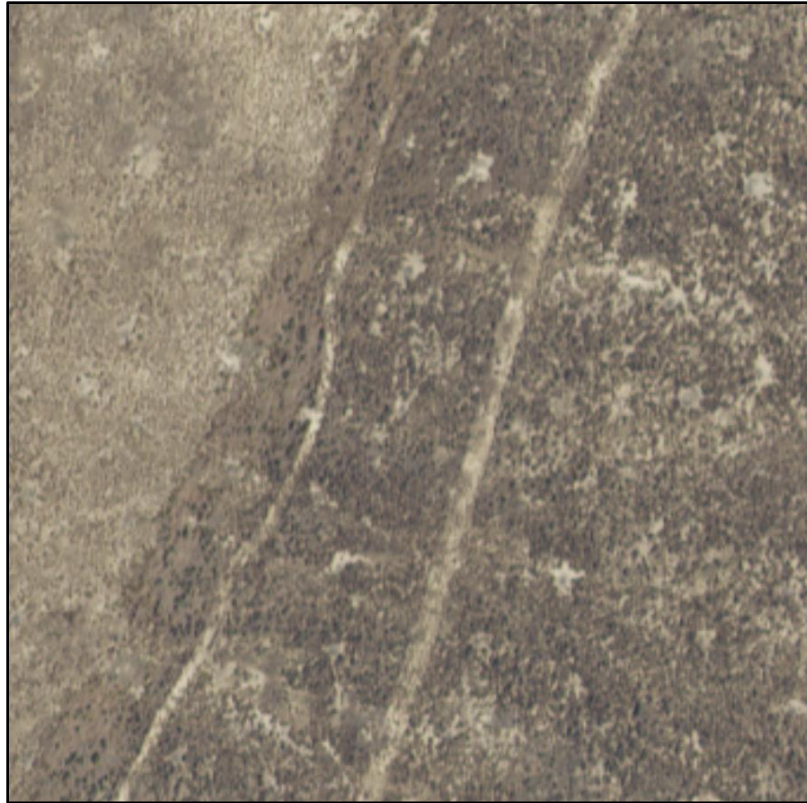


Figure 4-5. Example image subset from 2013 Idaho NAIP showing a single blade-width containment line (left), and a double blade width containment line (right) through a sagebrush shrubland on the INL Site. The burned edge is visible as the area with lighter tones left of the single blade-width containment line.

Table 4-4. Summary statistics for mapped containment lines on the INL Site. The disturbed area range was calculated using 12 ft–15 ft as the estimated blade size used by the INL Site Fire Department.

Blade Width	Distance (km)	Distance (mi)	Disturbed Area Range (ha)	Disturbed Area Range (acres)
1	429.1	266.6	156.9–196.2	387.8–484.8
2	380.8	236.6	139.3–174.1	344.2–430.2
3	34.7	21.6	12.7–15.9	31.4–39.2
4	0.5	0.3	0.18–0.23	0.45–0.56
6	2.3	1.4	0.84–1.1	2.1–2.6
TOTAL	847.4	526.5	309.9–387.4	765.9–957.4

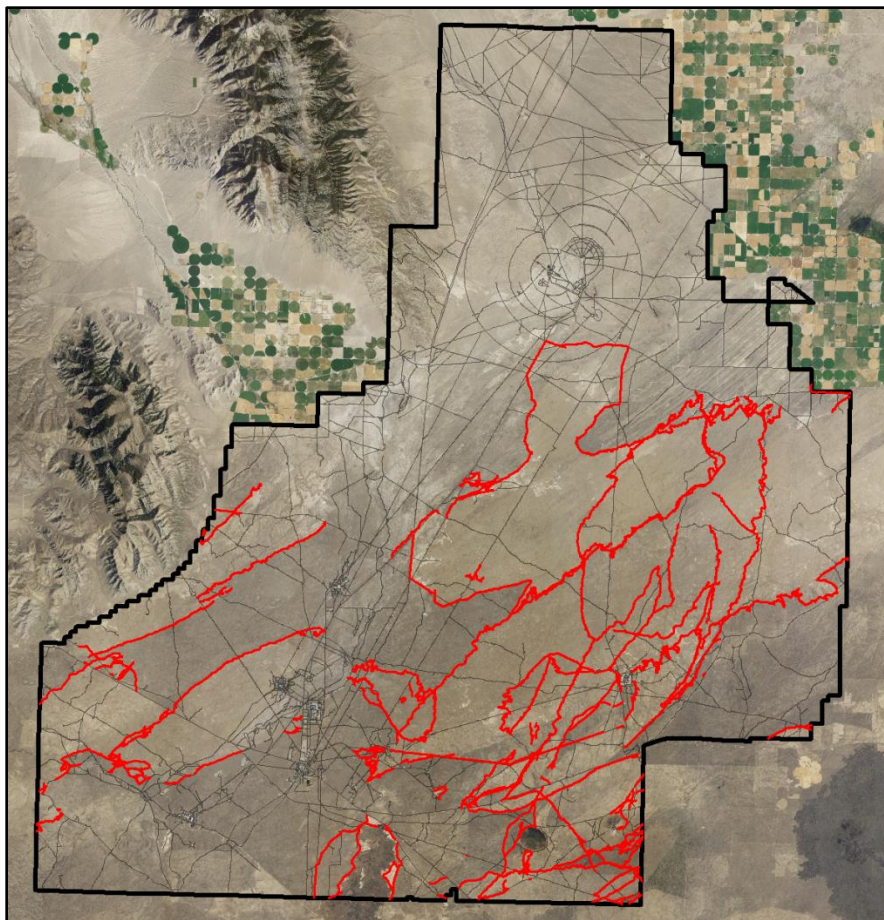


Figure 4-6. Distribution of bladed containment lines (plotted in red) mapped on the INL Site as of fall 2016.

The mapping results represent the majority of bladed containment lines from the most recent large wildland fires, but they are not intended to represent a comprehensive mapping of all containment lines ever bladed on the INL Site. There is a substantial amount of linear features that resemble containment lines in proximity to facilities and other INL Site infrastructure. Many of these features are present in all years of imagery and it is difficult to know whether they were bladed as wildland fire containment lines or for other purposes. There was no Site-wide high resolution imagery collected through the 1990's when numerous large fires burned on the INL Site. Many of those bladed containment lines have had over a decade of natural recovery prior to the first Idaho NAIP image collection, and some are now difficult to detect. The goal of this task is to focus monitoring efforts on disturbed areas of known anthropogenic activities, so if it was unclear whether the linear feature resulted from blading, those features were not mapped and included in the results presented above. Furthermore, lines that are naturally recovering well would not be a high priority for restoration.

Phase 2—Site Selection

Now that bladed containment lines have been mapped and delineated across the INL Site, the next step will be to select sampling locations in 2017. The NAIP imagery is collected during late summer each year, after cheatgrass has senesced and exhibits a reddish-purple color. We will begin using the imagery to

screen potential locations that appear to have cheatgrass present based on color cues. The ESER Program has previously conducted containment line surveys following some wildland fires, and have documented where cheatgrass was found in high density. We will also rely on these previous field survey results to assist with the selection of sites to assess the current status of cheatgrass density along containment lines. The ESER objective is to identify several cheatgrass-dominated sites on containment lines by the end of 2017 that could reasonably be considered for restoration treatments based on a set of criteria (e.g. logistic feasibility).

4.3 Task 8—Monitor Unauthorized Expansion of the Infrastructure Footprint within the SGCA and Other Areas Dominated by Big Sagebrush

4.3.1 Introduction

Infrastructure development is one of the two top threats to sage-grouse on the INL Site (see Table 3 in the CCA [DOE and USFWS 2014]). Infrastructure can promote habitat fragmentation, and construction of new infrastructure nearly always disturbs soil, sometimes drastically. Occasionally, mitigation following the completion of a construction project fails to meet its objectives, and infrastructure requirements may continue to expand as a project moves forward without new structures and disturbances being taken into account. If proper controls are not in place, soil disturbance can facilitate the introduction and spread of invasive weeds, which may increase the risk of wildland fire. Weeds may also replace native plants and reduce plant diversity in localized areas and degrade sage-grouse habitat quality.

Inappropriate vehicle use, such as driving off of existing roads, may also cause habitat degradation in localized areas. Remote sensing imagery shows that the number of roads within grazing allotments on the INL Site has increased over time (unpublished data; Shurtliff et al. 2016). It is likely that most of these roads were established by permittees to strategically distribute water troughs and mineral salt stations, create shortcuts between roads, and avoid areas with deep ruts that might be impassable under wet conditions. Once a new two-track appears, other drivers may follow it, further establishing the new road. Although many named two-track roads are marked with small signs on the INL Site, no official road map has been developed to unambiguously identify authorized roads from unauthorized ones more recently created.

The goal of this monitoring task is to identify where expansion of infrastructure has occurred and document and map all road features within the SGCA and other areas dominated by big sagebrush. In some cases, there has been known authorized expansion at some facilities (e.g. new Materials & Fuel Complex ponds) that was not present when the INL Site vegetation map (Shive et al. 2011) was originally being completed. Other times, there may be observed infrastructure expansion and the ESER Program may not know whether it was authorized or unauthorized activity. Rather than attempt to differentiate between authorized and unauthorized expansions across the INL Site, this task serves as the mechanism to identify and report on new infrastructure and two-track linear features being developed and to update the sagebrush habitat distribution data layer due to changes across the landscape not associated with wildland fires.

This monitoring task is conducted whenever new high resolution imagery that encompasses the entire INL Site becomes available. Currently, this task is reliant on the USDA NAIP, which typically collects aerial digital imagery in Idaho every two years and is made publically available for no cost. The frequency of high resolution NAIP imagery allows DOE to avoid the expensive cost of funding an image acquisition through a commercial vendor specifically to support this task. If high resolution imagery becomes available opportunistically (e.g. INL Site image acquisition following a large wildland fire), that dataset could also be used to monitor infrastructure changes.

Last year, this monitoring task was initiated using the 2013 Idaho NAIP imagery as the most recent INL Site ground conditions imaged and all observed infrastructure expansion was mapped and delineated to establish current baseline conditions (Shurtliff et al. 2016). There was a substantial amount of new two-track linear features mapped last year that were previously omitted from the INL Site roads GIS data layer, and because there was no way of retroactively determining the cause of the new two-tracks, all mapped linear features were considered to be 'grandfathered' in and only further changes to the landscape would be considered expansion. This year marks the first repeat analysis and will provide better insight into the amount of new infrastructure features created on the INL Site in the last two years.

4.3.2 Methods

In late summer of 2015, high resolution multispectral NAIP imagery was collected across the State of Idaho. The image product consists of four spectral bands (blue, green, red, and near-infrared) collected with 1 m spatial resolution. The 2013 Idaho NAIP imagery was acquired at 0.5 m spatial resolution and represents the only time Idaho had NAIP imagery acquired at any resolution other than 1 m.

Two GIS Analysts independently reviewed the 2015 NAIP imagery by systematically zooming into regions of the INL Site and looking for evidence of undocumented surface disturbance throughout the SGCA and also within sagebrush habitat outside of the SGCA. Occasionally the image properties were adjusted to accentuate pixels in an area of interest or add more contrast to help with feature identification. Areas of surface disturbance are most commonly linear features created by the presence of new two-track roads. Anytime a potential location was identified, it was marked for secondary review. The initial locations marked by each analyst were consolidated, and the lead GIS Analyst for this task then determined if the potential expansion was valid and removed all other locations that were dismissed (i.e. livestock or ungulate trails mistaken as two-track linear features).

We also visually scanned the areas around infrastructure and project areas to investigate whether the infrastructure footprint had expanded into areas previously mapped as sagebrush habitat. The sagebrush habitat layer was plotted on the imagery base map, and each facility, borrow source/gravel pit, and known project areas were reviewed for expansion into existing mapped sagebrush habitat. All outdated sagebrush habitat polygons were manually updated using GIS editing tools, which also maintained topology with adjacent polygon boundaries.

4.3.3 Results

We mapped an additional 7.4 km (4.6 mi) of two-track linear features not present in the 2013 NAIP imagery (Fig. 4-7). It is important to consider that while some of the newly observed two-track linear features are truly new, some of the other linear features mapped in the last two years (Shurtliff et al. 2016) may be historic two-track roads that have only recently become recognizable in imagery. There were 24.4 km (15.2 mi) of additional linear features mapped this year, but after cross-referencing them to the 2013 NAIP imagery they were verified to be present (Fig. 4-8). Some of the two-track linear features present in the 2013 NAIP imagery were more easily observed in the newer imagery because of differences in lighting or varying amounts of annual vegetation growth that partially obscured the features previously. In an effort to accurately document and update the baseline conditions, we added all of the linear features which are identifiable in the 2013 imagery and reestablished the baseline reported in 2016 (Shurtliff et al. 2016).

Last year, we reported 505.5 km (314.1 mi) of new two-track linear features that were not included in the most recent INL Site roads data layer. When these newly mapped features are combined with the results from 2015, an updated total of 529.9 km (329.3 mi) of two-track linear features were added that represent the baseline infrastructure distribution (Fig. 4-8).

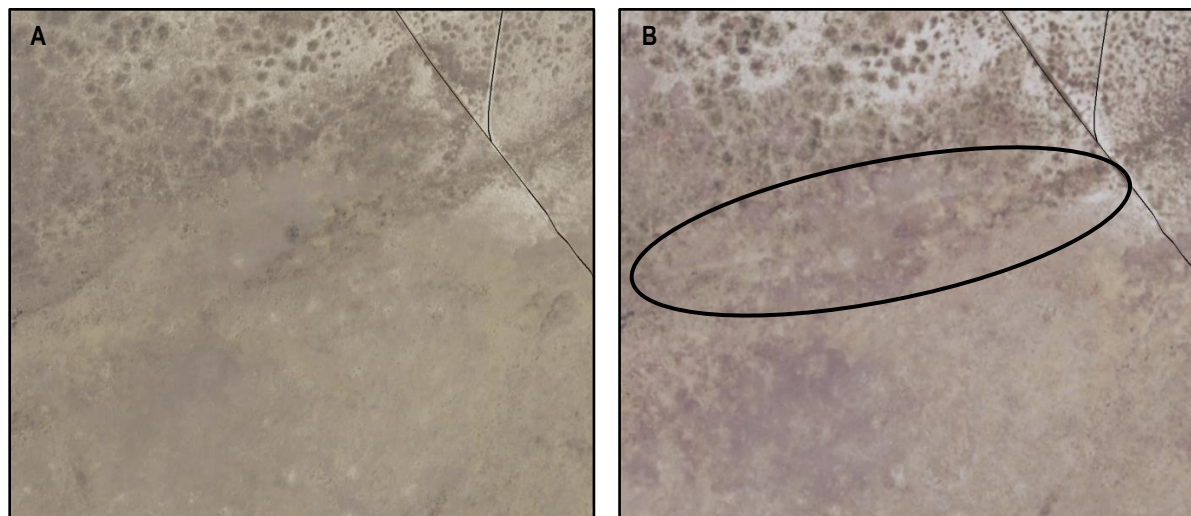


Figure 4-7. Panel A shows a region as it was imaged in 2013. Panel B shows the exact same area imaged in 2015 where a new faint two-track linear feature is now present.

The majority of new linear features are short spurs and short-cuts between two existing two-track roads. The longest individual linear feature mapped was 1.6 km. The only three linear features mapped over 1 km in length all occurred in close proximity to one another on the east side of the INL Site in the Twin Buttes grazing allotment.

Additional linear features were identified on the INL Site during the review process, however only features that are within or partially within either the SGCA or sagebrush habitat were mapped under this monitoring task. We included linear features that are partially within the SGCA and sagebrush habitat because it more accurately represents the expansion of linear features and may provide insights pertaining to the potential source of the expansion.

In addition to a minor increase in two-track linear features, we documented four locations where sagebrush habitat had been removed between the summers of 2013 and 2015 due to expansion of borrow sources. The total area of sagebrush habitat removed was 2.6 ha (6.4 acres; Fig. 4-9), and the largest single expansion was 1.3 ha (3.1 acres). Last year, we reported that one gravel pit (T-12) had been expanded by approximately one half acre, although vegetation had been cleared from the expanded area in 2014 prior to the CCA being signed (Shurtliff et al. 2016, pg. 5-5). Thus, it appears all sagebrush habitat loss resulting from borrow source expansion between the summers of 2013 and 2015 occurred before the CCA was signed in September, 2014, so the “no net loss of sagebrush” clause in the CCA (DOE and USFWS 2014, pg. 54) does not apply to these actions. The sagebrush habitat loss referred to above was outside the SGCA and did not affect the habitat trigger baseline.

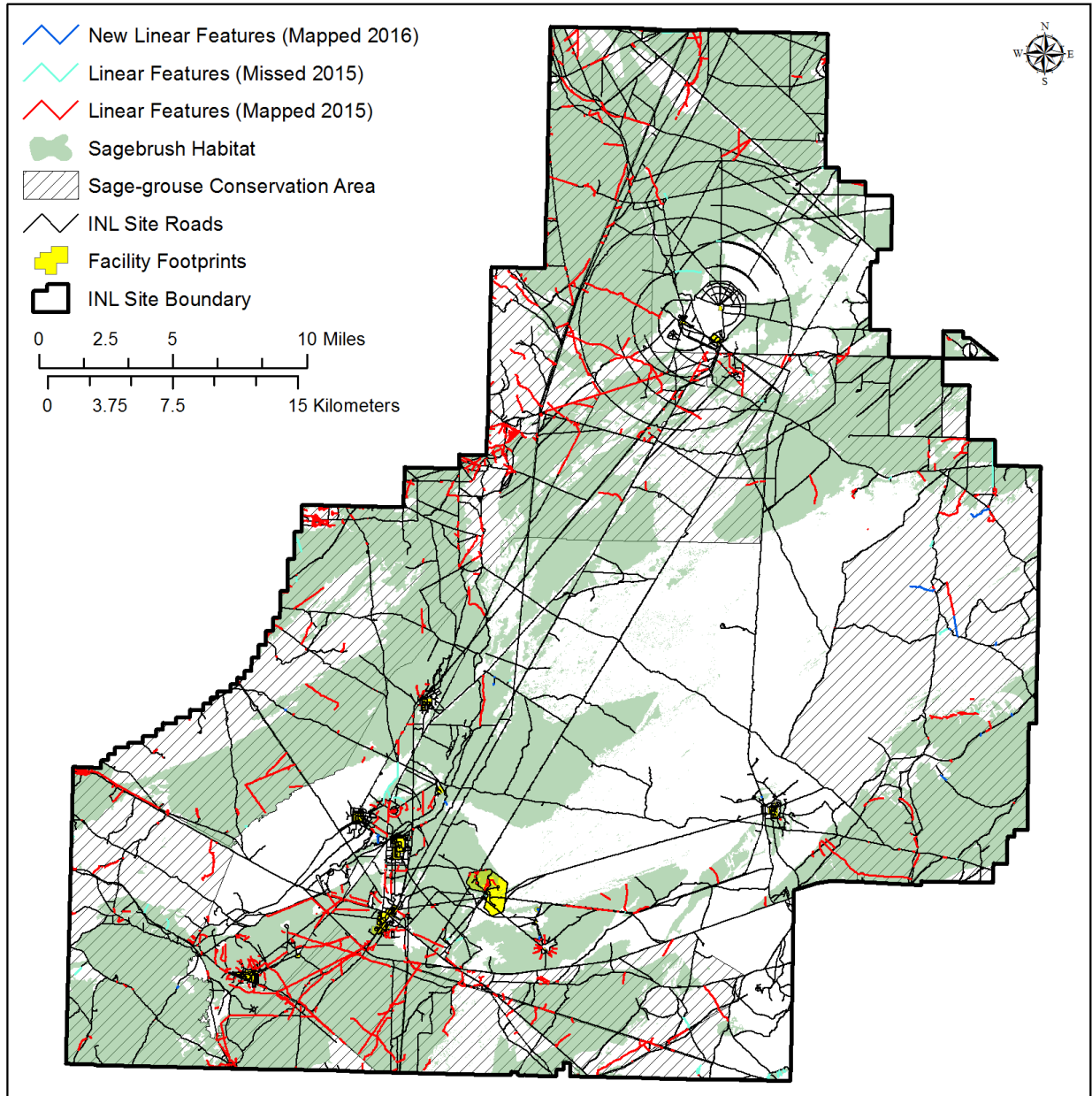


Figure 4-8. Two track linear feature expansion mapping results from 2016 at the INL Site.

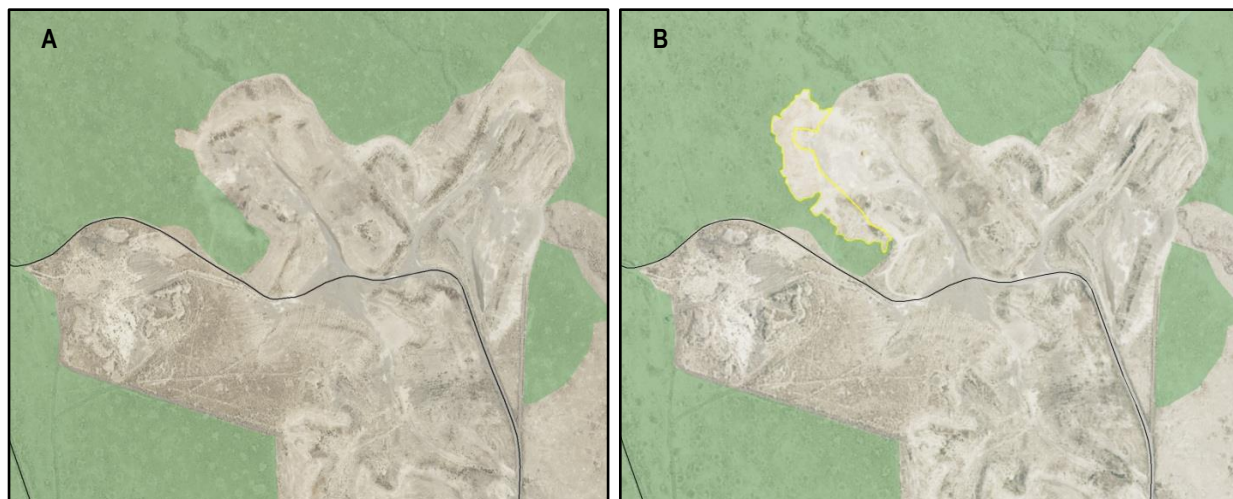


Figure 4-9. Panel A shows the extent of the Specific Manufacturing Capabilities Facility gravel pit in 2013 with sagebrush habitat displayed in a translucent green. Panel B shows the same gravel pit with recent expansions delineated in yellow. The area outlined in yellow has subsequently been removed from the sagebrush habitat layer to maintain a more accurate up-to-date data layer.

4.3.4 Discussion

The 2015 Idaho NAIP imagery specifications are the same as previous years of imaging data except for the 2013 NAIP when the spatial resolution was increased to 0.5 m resolution. This means the 2013 imagery had four times higher spatial resolution and captured fine-scale details that are less obvious in 1 m imagery. The higher resolution 2013 imagery was used for the initial mapping to support this task and develop baseline conditions for future comparisons (Shurtliff et al. 2016). Many of the baseline two-track linear features mapped were already faint and difficult to identify in the 2013 imagery. The new imagery has a coarser resolution which makes detecting faint linear features even more difficult, however the goals of this task are to document infrastructure expansion, and new linear features will be expectedly be hard to identify unless they become a more heavily traveled road.

The large number of two-track linear features mapped in 2015 (Shurtliff et al. 2016) likely represent many years of accumulated unauthorized expansion rather than activities that have occurred in the last few years. The small linear distance of two-track features mapped during this analysis shows that there are still new linear features being created although the rate of increase within a two-year window is likely low. There have not been enough years of monitoring to know whether the length of linear feature expansion reported this year is representative of past rates of expansion.

With the signing of the CCA in 2014, INL Site contractors may be more aware of the potential impacts that off-road travel can have on sagebrush habitat and sage-grouse populations. There is the possibility that as we continue to monitor the Site and report of these expansion that both permittees and Site employees and contractors will know the landscape is being consistently monitored and unauthorized travel off-road is more likely to be documented. And now that there is more frequent interaction with the BLM and indirectly the allotment permittees, it is expected that we will see a reduction in new linear features being created if permittees are knowledgeable and informed about the rules and limitations for off-road travel.

5. IMPLEMENTATION OF CONSERVATION MEASURES

5.1 Summary of 2016 Implementation Progress

Section 10 of the CCA describes eight threats to sage-grouse and its habitats on the INL Site. DOE committed to implement 13 conservation measures to mitigate and reduce these threats where possible. Table 5-1 summarizes action that DOE took in 2016 to ameliorate threats to sage-grouse and its habitats.

Table 5-1. Accomplishments in 2016 for each CCA conservation measure (adapted from Table 5 in the CCA).

Threat:	Wildland Fire
Objective:	Minimize the impact of habitat loss due to wildland fire and firefighting activities.
Conservation Measures:	1) Prepare an assessment for the need to restore the burned area. Based on that assessment, DOE would prepare an approach for hastening sagebrush reestablishment in burned areas and reduce the impact of wildland fires > 40 ha (99 acres).
Conservation Measure 1—Accomplishments in 2016:	
<p><u>BURN ASSESSMENT</u>—Two fires burned on the INL Site in 2016, impacting approximately seven acres (6.7 acres and <¼ acre). Both had origins next to public highways and were apparently human-caused (Unpublished wildland fire statistics summary for 2016; Eric Gosswiller, INL Fire Chief). Because the fires were small, no post-fire assessment or sagebrush reestablishment was required.</p> <p>Only an estimated 11 acres have burned on the INL Site during the past four years in seven separate incidents. Fewer acres have burned during the current four-year period than in any other four-year period since at least the early 1990s (the current annual INL wildfire report contains data dating back to 1994).</p> <p>Associated Conservation Actions that Address the Wildland Fire Threat:</p> <p><u>NOTE TO INL SITE EMPLOYEES</u>—On July 7, 2016, Eric Gosswiller, INL fire chief, sent a note (via i-notes) informing all INL Site employees that Stage II fire restrictions were now in place. As part of the email, links were provided to the sage-grouse and the sagebrush planting vignettes.</p> <p><u>SAGEBRUSH PLANTINGS</u>—ESER planted 6,000 sagebrush seedlings in and near a priority restoration area (See Section 5.2).</p>	
Threat:	Infrastructure Development
Objective:	Avoid new infrastructure development within the SGCA and 1 km of active leks, and minimize the impact of infrastructure development on all other seasonal and potential habitats on the INL Site.
Conservation Measures:	2) Adopt BMPs outside facility footprints for new infrastructure development. 3) Infrastructure development within the SGCA or within 1 km (0.6 mi) of an active lek will be avoided unless there are no feasible alternatives.

Conservation Measure 2—Accomplishments in 2016:	
<p><u>INL ADHEARANCE TO BMPs</u>—(1) Spinning deflectors were installed on the High Frequency Sounder antenna guy wires at Water Reactor Research Test Facility, replacing old, weathered deflectors; (2) New power poles installed at the High Frequency Test Bed and at the Smart Grid Test Bed were equipped with anti-perch devices.</p> <p>When evaluating options and designing the Smart Grid Test Bed (which is outside of the SGCA, but would damage sagebrush) National & Homeland Security added new overhead circuits (double hung) on existing or replaced poles, reducing the need to install new poles. This design and decision process minimized disturbance to sagebrush, other vegetation, and the landscape and reduced the potential number of new raptor perches. (Pers. Comm., Robert A. Montgomery, National & Homeland Security 10/17/16).</p>	
Conservation Measure 3—Accomplishments in 2016:	
<p><u>INSTALLATION OF MONITORING WELLS</u>— The U.S. Geological Survey (USGS) installed two new monitoring wells outside facility fences in 2016. Both were originally sited within the SGCA, though neither was within 1 km of a lek. One well (USGS 144) near CFA was deliberately placed near a power line so as to be in an area excluded from the SGCA. Nonetheless, sagebrush was destroyed when the well pad was created (Pers. Comm., Roy Bartholomay, USGS INL Project Chief, Idaho Falls; 25 Oct. 2016). To mitigate the loss, USGS will fund reciprocal sagebrush planting to ensure no net loss occurs. (Betsy Holmes, DOE Environmental Resource Officer, Idaho Falls, 28 Dec. 2016).</p> <p>Another well was installed six miles northeast of Materials & Fuel Complex within the 2010 Jefferson Fire scar. No sagebrush was near the well pad. (Pers. Comm., Roy Bartholomay, 25 Oct. 2016).</p>	
Threat:	Annual Grasslands
Objective:	Maintain and restore healthy, native sagebrush plant communities.
Conservation Measures:	4) Inventory areas dominated or co-dominated by non-native annual grasses, work cooperatively with other agencies as necessary to identify the actions or stressors that facilitate annual grass domination, and develop options for eliminating or minimizing those actions or stressors.
Conservation Measure 4—Accomplishments in 2016:	
<p><u>INVENTORY</u>—See Section 4.2 of this report.</p>	
Threat:	Livestock
Objective:	Limit direct disturbance of sage-grouse on leks by livestock operations and promote healthy sagebrush and native perennial grass and forb communities within grazing allotments.
Conservation Measures:	<p>5) Encourage BLM to seek voluntary commitments from allotment permittees and to add stipulations during the permit renewal process to keep livestock at least 1 km away from active leks until after May 15 of each year. Regularly provide updated information to BLM on lek locations and status to assist in this effort.</p> <p>6) Communicate and collaborate with BLM to ensure that the herbaceous understory on the INL Site is adequately maintained to promote sage-grouse reproductive success and rangeland improvements follow guidelines in the 2006 State Plan and the current agreement.</p>
Conservation Measure 5—Accomplishments in 2016:	
<p><u>LIVESTOCK ON LEKS</u>—Livestock or evidence of livestock were observed on or near leks during April and early May, 2016. On April 18, a large band of sheep was seen on or</p>	

<p>approaching an active lek (INL 6) east of the Birch Creek channel on the northern end of the INL Site. On April 21, technicians observed a myriad of tire and sheep tracks on an active lek. From May 2-5, cows and salt licks were observed on or within 100m of active leks on three different occasions. Reports of livestock on or near leks in 2016 was higher than ESER has recorded since 2012, though livestock-related observations remain relatively infrequent, as over 200 individual lek surveys were completed at active lek sites in 2016.</p> <p>When DOE reports to the BLM that livestock have been seen on or near leks during the sage-grouse breeding season, BLM staff immediately notify livestock operators and ask them to move the livestock. Assuming that repeat occurrences are not common, this process may be the most feasible way to minimize disturbance of sage-grouse on leks by livestock during the breeding season. In regard to establishing terms and conditions for livestock use during the permit renewal process, BLM has focused on restricting concentrated livestock use in proximity of leks, such as camps, water hauls, or temporary corrals (Pers. Comm., Bret Herres, Rangeland Management Specialist, BLM, Nov. 17, 2016).</p> <p><u>UPDATED INFORMATION TO BLM</u>—ESER provided updated lek maps to the BLM by Feb. 1, 2016.</p> <p>Conservation Measure 6—Accomplishments in 2016:</p> <p><u>INVOLVEMENT DURING PERMIT RENEWAL PROCESS</u>—An assessment of resource conditions relative to Idaho Standards for Rangeland Health began in the Wigwam Butte and Mahogany Butte grazing allotments in 2016. An ESER ecologist attended one of the field assessments and had a good discussion with a BLM representative. Following the assessment, DOE sent a note to the BLM requesting that the agency send DOE the scope of proposed activities once they are developed so that the INL Land Use Committee and ESER staff can review them in light of the CCA and the forthcoming Conference Report (Jack Depperschmidt, National Environmental Policy Act [NEPA] Compliance Officer [DOE], Oct. 25, 2016).</p> <p>Wigwam Butte assessment/evaluation was completed in November of 2016 and found that, overall, allotment conditions are meeting applicable rangeland health standards. Mahogany Butte assessment/evaluation is ongoing. Through the process, several data gaps were identified and additional information is needed to complete the document (Pers. Comm., Bret Herres, Nov. 17, 2016).</p>	
Threat:	Seeded Perennial Grasses
Objective:	Maintain the integrity of native plant communities by limiting the spread of crested wheatgrass.
Conservation Measures:	7) Cultivate partnerships with other agencies to investigate the mechanisms of crested wheatgrass invasion so that effective control strategies can be developed.
<p>Conservation Measure 7—Accomplishments in 2016:</p> <p><u>CULTIVATE PARTNERSHIPS</u>—No measurable progress has been made on this conservation measure.</p>	
Threat:	Landfills and Borrow Sources
Objective:	Minimize the impact of borrow source and landfill activities and development on sage-grouse and sagebrush habitat.
Conservation Measures:	8) Eliminate human disturbance of sage-grouse that use borrow sources as leks (measure applies only to activities from 6 p.m. to 9 a.m., March 15–May 15, within 1 km of active leks). 9) Ensure that no net loss of sagebrush habitat occurs due to new borrow pit or landfill development. DOE accomplishes this measure by: <ul style="list-style-type: none"> • avoiding new borrow pit and landfill development in undisturbed sagebrush habitat, especially within the SGCA;

	<ul style="list-style-type: none"> ensuring reclamation plans incorporate appropriate seed mix and seeding technology; implementing adequate weed control measures throughout the life of an active borrow source or landfill.
Conservation Measure 8—Accomplishments in 2016:	
<p><u>ELIMINATE HUMAN DISTURBANCE</u>—All users of borrow pits are informed of seasonal time-of-day restrictions through Form 450.AP01 (Gravel/Borrow Source Request), which must be completed before any work begins in the pits. In addition, in early March of each year, an email notification is sent to all approved users in the pits to inform them of the restrictions. In 2016, Battelle Energy Alliance conducted periodic surveillance of operations in the pits throughout the year and did not observe any violations of the restrictions (Pers. Comm., Brenda Pace, INL Borrow Source Coordinator; 10/25/2016).</p> <p>Fluor Idaho initiated a considerable source material study at the Spreading Areas A and B (ICP-16-002). Several sage-grouse leks are located in and near the Spreading Areas as identified in the original CCA. Project personnel followed the conservation measures and guidelines from the CCA including the seasonal time-of-day restrictions (Pers. Comm., Wendy Savkranz, NEPA Technical Lead [Fluor Idaho], 1/10/2017).</p>	
Conservation Measure 9—Accomplishments in 2016:	
<p><u>NO NET LOSS OF SAGEBRUSH AT BORROW PITS AND LANDFILLS</u>—No new borrow pits were developed or existing pits expanded at the INL Site in 2016; however, Environmental Checklist INL-16-036 allowed expansion of the CFA landfill. The CFA Landfill Complex, which is approximately 35 acres and is within the approved landfill footprint, has undisturbed native vegetation. However, it is outside the SGCA and is co-located with existing infrastructure (Pers. Comm., Jenifer Nordstrom, NEPA Technical Lead [INL], 10/13/16; Brenda Pace, INL Borrow Source Coordinator; 10/25/2016).</p> <p>Sitewide Facilities and Operations did not report any activities that would have disturbed the SCGA or altered vegetation near a landfill that was not covered by an approved Environmental Checklist during 2016 (Steven Christensen, Site-wide Facilities and Operations Manager, 10/25/2016).</p>	
Threat:	Raven Predation
Objective:	Reduce food and nesting subsidies for ravens on the INL Site.
Conservation Measures:	<p>10) Support research to develop methods for deterring raven nesting on utility structures.</p> <p>11) Instruct the INL to include an informational component in its annual Environment, Safety, and Health training module by January 2015 that teaches the importance of eliminating food subsidies to ravens and other wildlife near facilities.</p>
Conservation Measure 10—Accomplishments in 2016:	
<u>SUPPORTING RESEARCH</u>	
<ul style="list-style-type: none"> Dr. Kirk Clawson, Director of the NOAA Air Resources Laboratory, had his staff install hardware cloth near the top of one of the 50 ft NOAA towers that held a raven nest in 2015. Ravens did not nest where the cloth was installed, but instead built a nest lower down (about 25 ft above the ground) on the tower near a solar panel arm. It is probable that having a good perch site, such as the solar panel, is important to ravens when choosing a nest location. Towards the end of 2016, NOAA staff removed the nest and lowered the solar panel to about 6 ft. above the ground. Early in 2016, INL Power Management installed a commercial nest deterrent on a single-pole distribution structure near Critical Infrastructure Test Range Complex that had supported a raven or raptor nest in past years. No nesting occurred on the structure during 2016. 	
Conservation Measure 11:	

	<ul style="list-style-type: none"> • Training described in Conservation Measure 11 was developed and implemented in 2015. This training will be perpetually delivered as part of an annual refresher course for INL employees. • Fluor Idaho developed a Company Environmental Requirement (CER-107) that prohibits feeding of wildlife and incorporated this requirement into a company-wide procedure. Fluor Idaho also sent e-mail (IClIPs) communication to all employees to not feed wildlife, citing the Sage Grouse CCA that requires eliminating food subsidies to ravens and other wildlife near facilities (Pers. Comm, Shawn Rosenberger, Environmental Engineer [Fluor Idaho], 1/11/2017).
Threat:	Human Disturbance
Objective:	Minimize human disturbance of sage-grouse courtship behavior on leks and nesting females within the SGCA and 1 km Lek Buffers.
Conservation Measures:	<p>12) Seasonal guidelines (March 15 –May 15) for human-related activities within 1 km Lek Buffers both in and out of the SGCA (exemptions apply—see section 10.9.3):</p> <ul style="list-style-type: none"> • Avoid erecting portable or temporary towers, including Meteorological, SODAR, and cellular towers. • Unmanned aerial vehicle (UAV) flights conducted before 9 a.m. and after 6 p.m. will be programmed so that flights conducted at altitudes < 305 m (1,000 ft) will not pass over land within 1 km of an active lek. • Detonation of explosives > 1,225 kg (2,700 lbs) will only occur at the National Security Test Range from 9 a.m.–9 p.m. • No non-emergency disruptive activities allowed within Lek Buffers March 15–May 15. <p>13) Seasonal guidelines (April 1–June 30) for human-related activities within the SGCA (exemptions apply—see section 10.9.3):</p> <ul style="list-style-type: none"> • Avoid non-emergency disruptive activities within the SGCA. • Avoid erecting mobile cell towers in the SGCA, especially within sagebrush-dominated plant communities.
<p>Conservation Measure 12—Accomplishments in 2016:</p> <p>TOWERS—No portable or permanent towers were erected within the SGCA or within 1 km of active leks by the research and development division of the INL during the sage-grouse breeding season (15 March–15 May) in 2016 (Pers. Comm., Robert A. Montgomery, Program Environmental Lead for Research and Development; 10/17/2016; Richard Watson, Laboratory Space Coordinator, National & Homeland Security Division of the INL; 10/17/2016).</p> <p>UNMANNED ARIAL VEHICLES</p> <ul style="list-style-type: none"> • A provision was added to the work control document for operating UAVs requiring a 1-km clearance, both horizontal and vertical, to active leks during the breeding season between 6 p.m. and 9 a.m. (Pers. Comm., Robert A. Montgomery, 10/18/16). • No Environmental Checklists were completed for activities involving UAVs (Pers. Comm., Jenifer Nordstrom, 10/13/16). <p>EXPLOSIVES—No explosives >1,225 kg were detonated outside the seasonal guidelines in 2016 (Pers. Comm., Desiree Saupe, Materials and Physical Security Department Engineer, National and Homeland Security, 10/28/16).</p> <p>AVOID NON-EMERGENCY DISRUPTIVE ACTIVITIES—All Environmental Checklists for projects with the potential to disrupt lek activity contain conditions that include time-of-day restrictions (Pers. Comm., Jenifer Nordstrom, 10/13/16).</p> <p>Conservation Measure 13—Accomplishments in 2016:</p> <p>TOWERS—No portable or permanent towers were erected within the SGCA by the research and development division of the INL during the sage-grouse breeding season (15 March–15 May) in 2016 (Pers. Comm., Robert A. Montgomery, 10/17/2016; Richard Watson, 10/17/2016).</p>	

5.2 Reports on Projects Associated with Conservation Measures

5.2.1 Conservation Measure #1—Sagebrush Seedling Planting for Habitat Restoration on the INL Site

Introduction

The objective of Conservation Measure 1 is to minimize the impact of habitat loss due to wildland fire and firefighting activities (Table 5-1). Although no wildfires >40 ha (99 acres) have burned on the INL Site since 2012, DOE began implementing an annually recurring task in 2015 that would facilitate planting at least 5,000 sagebrush seedlings each fall in priority restoration areas on the INL Site (DOE and USFWS 2014, Section 9.4.4). Planting sagebrush seedlings annually is a proactive measure that will hasten the reestablishment of sage-grouse habitat lost during past fires.

The ESER program oversees the planting of sagebrush seedling and monitors survivorship to evaluate the effectiveness of the task. Our approach is to plant 80 sagebrush seedlings per acre, resulting in a coverage of ≥ 62.5 acres (25 ha) per year (Shurtliff et al. 2016).

Methods

Containerized sagebrush seedlings were grown from seed collected in 2014 on the INL Site. Information about the companies subcontracted to grow and plant seedlings, and details about procedures followed during the planting process, are described elsewhere (Shurtliff et al. 2016). The area we chose for restoration in 2016 was adjacent to the 2015 planting, south of the rest stop on Hwy 26 (Figure 5-1). Less than half of the planted area fell within a Priority Restoration Area (Shurtliff et al. 2016), but we felt justified

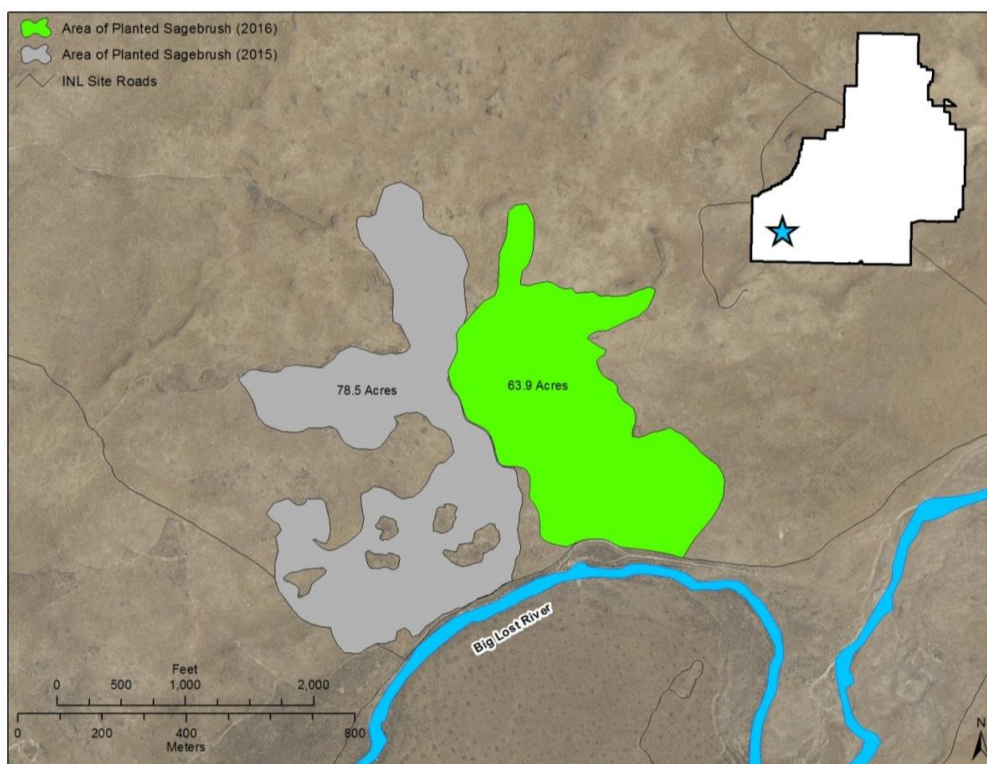


Figure 5-1. Areas planted with big sagebrush seedlings in 2015 and 2016. The star on the inset map shows the general location of the plots.

in choosing the site because of its proximity to the 2015 planting site, the SGCA, and the adjacent restoration area, the good ecological condition of the area, and favorable logistics.

Seedling survivorship was monitored by evaluating the condition of individual seedlings one year after planting. In fall 2015, we collected sub-meter GPS locations for > 10% of seedlings following planting. In August 2016, we revisited $\geq 10\%$ of seedlings (randomly selected from marked individuals) and determined if each seedling was healthy, stressed, or dead, and whether seeds had been produced (Figure 5-2). After five years, seedlings will again be revisited and longer-term survivorship assessed.



Figure 5-2. Examples of sagebrush seedling conditions. From left to right: healthy, stressed, and dead.

Results and Discussion

We planted approximately 6,000 seedlings on 63.9 acres (25.9 ha; ~94 seedlings per acre) from 24 October to 29 October, 2016 in the southwestern part of the INL Site (Figure 5-1) and marked the locations of 737 (~12%) seedlings for future monitoring. Substantial rain fell before and during planting, creating favorable conditions for seedling growth and development. On the INL Site, typical sagebrush density in sage-grouse habitat is one to three plants per square meter, meaning that an acre normally contains 4,000–12,000 sagebrush plants. The intent of the sagebrush seedling task is not to plant sagebrush at densities that typify sage-grouse habitat, but rather to establish sagebrush seed sources in priority areas to shorten the time interval between a fire and the reestablishment of sage-grouse habitat.

To assess 2015 seedling survivorship and condition, we revisited 501 sagebrush seedlings in August 2016. We relocated 428 seedlings, of which 129 (30%) were healthy, 238 (56%) were stressed, and 61 (14%) were dead (Fig. 5-3). Thus, 86% of seedlings that we relocated survived the first year. Eight of the dead plants were located within areas devoid of vegetation near ant mounds (western harvester ants, genus *Pogonomyrmex*) and it is possible that these seedlings were killed by ants (Soulé and Knapp 1996).

We were unable to locate 63 of the seedlings marked in 2015. Given the accuracy of our GPS units, it is likely that many of these missing seedlings did not survive, though we may have missed some live

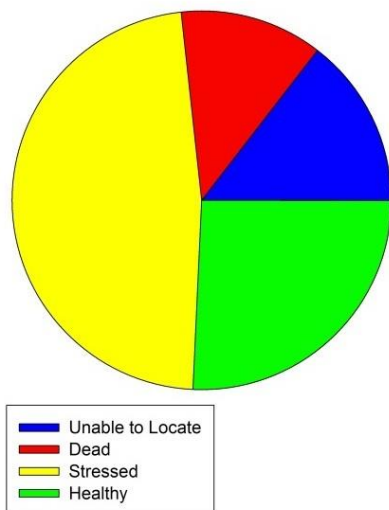


Figure 5-3. Conditions of sagebrush seedlings planted in fall 2015, as documented one year later. The graph on the left includes a category for the 63 seedlings that we were unable to relocate. The graph on the right shows proportions where non-relocated seedlings are assumed to have died.

seedlings, especially if they were stressed and in areas with relatively high grass and forb cover. A conservative assessment would assume these 63 seedlings did not survive, lowering our estimate of seedling survivorship to 73%. ESER will revisit these seedlings again five years post-planting to refine estimates of survivorship and to evaluate the success of this project in hastening the return of sagebrush to the landscape.

Precipitation patterns from fall 2015 to fall 2016 were not characteristic of a good recruitment year. Although fall and spring precipitation was above or near average, the summer growing season was far below average (Figure 3-3). This lack of moisture during summer can stress young plants, and is probably responsible for the high numbers of stressed plants we observed, as well as some of the seedling deaths. Though some of the stressed seedlings may perish in upcoming years, young sagebrush plants experience the highest mortality during the first year (Dettweiler-Robinson et al. 2013). In a review of 18 projects where containerized sagebrush seedlings were planted and survivorship was measured after one year, researchers found that seven projects (39%) reported survivorship of at least 73% (range= 73–94%, mean= 79%). Thus sagebrush establishment following the 2015 planting on the INL Site was higher than may be expected given the dry summer conditions.

One of the reasons DOE chose to plant seedlings over a relatively small area each year rather than to drill or broadcast sagebrush seeds over a much larger area is because successful seed germination and establishment are affected by several climatic factors, including timing and amount of precipitation (Young et al. 1990, Boudell et al. 2002). The suite of factors that facilitate successful germination of seed and establishment of new plants fluctuates from year to year (Colket 2003; Forman et al. 2013), and in many years, few or no seeds may germinate and survive the summer (Brabec et al. 2015). DOE’s decision to plant containerized seedlings instead of broadcasting or drill-planting seeds will continue to be justified as long as high survivorship of seedlings is consistently achieved, particularly during years in which establishment following seeding would be expectedly low.

6. SYNTHESIS AND ADAPTIVE MANAGEMENT RECOMMENDATIONS

6.1 Sage-Grouse and Sagebrush Habitat Trends

Sage-grouse abundance has been trending upward on the INL Site for the past several years. On two of the three IDFG lek routes, peak male attendance increased successively each of the past three years, and the three-year running average across the 27 baseline leks has been steady or increased each year since 2013. Simultaneously, wildland fire has been nearly absent from the INL Site landscape since 2012, marking the longest period of time since 1994 (when comprehensive fire statistics were first recorded) where <12 acres total burned. Although a few small fires burned an estimated 11 acres in the past four years, no sagebrush habitat within the SGCA has been impacted. Habitat has also remained in relatively high condition in terms of both sagebrush and herbaceous cover and height.

These positive short-term results and the wildland fire report are encouraging and should not be discounted; however, it is important to interpret this information within the context of long-term population and climatic cycles. Studies in Wyoming have shown that sage-grouse populations exhibit regular periodicity of 6-9 years (Fedy and Aldridge 2011, Fedy and Doherty 2011), similar to other grouse species (Williams et al. 2004). Lek route data are insufficient to allow us to evaluate if sage-grouse abundance on the INL Site fluctuates cyclically. If it does, the apparently positive gains made in the past three or four years may not represent the true, long-term subpopulation trajectory.

The lack of wildland fire can probably best be explained as a consequence of above- or nearly-average annual precipitation and unusual seasonal precipitation patterns. In each of the past three years, the INL Site experienced above-average late summer and fall precipitation. When conditions become drier, the likelihood of larger wildland fires will increase. DOE's approach of planting sagebrush seedlings annually even when no additional sagebrush habitat has been lost demonstrates the agency's foresight, because it will take decades before the planted areas become habitat for sage-grouse.

6.2 Threats Assessment

This year, we detected more than 7 km of two-track linear features on the INL Site that were created between 2013 and 2015. It is unclear if this amount of expansion is typical, because this year's analysis of 2015 imagery was the first to be performed since we established baseline infrastructure features from 2013 imagery (Shurtliff et al. 2016). In the next few years, continued monitoring via Task 8 will allow us to answer two fundamental questions—are new two-track linear features regularly being created on the INL Site, and at what rate? These answers will help DOE determine whether the threat to sage-grouse habitat from infrastructure expansion is significant on the INL Site. It is worth noting, however, that it is easier to document if a threat is expanding or contracting than to quantify the effects of the threat on what ultimately matters for the conservation of sage-grouse: the impact of the threat on sage-grouse survival or reproductive success.

We documented increasing numbers of ravens using INL Site infrastructure to support nesting. Although raven occupancy will probably continue to increase, the more critical issue is whether raven occupancy on the INL Site could reach levels and impact sage-grouse reproductive success to a degree that they begin to depress sage-grouse population growth potential above otherwise natural levels. Results from raven nest monitoring suggest that CCA Conservation Measure 10, wherein DOE committed to support research aimed at deterring raven nesting on power lines, remains relevant.

Non-native plant cover in 2015 and 2016 was much higher than we have observed in recent years. High cover values may be an artifact of the unusual timing of precipitation that has occurred on the INL Site, rather than an ecological shift. If precipitation patterns more closely approximate historical seasonal timing in the future, the observed increases in non-native plant cover may be reversed. Continued data collection will be useful for determining whether cover by non-natives is trending upward, fluctuating around a flat value, or fluctuating around an upward trend.

7. WORK PLAN FOR 2017

The following table describes activities or changes that are planned for the upcoming year. The purpose of this table is to highlight upcoming activities and analyses that will be different than the regular annual activities associated with each task.

Task	Schedule and Changes for 2017
1. Lek Surveys	<ul style="list-style-type: none"> Survey eight lek routes, including five new routes. All other active leks will be monitored as well.
2. Historical Lek Surveys	<ul style="list-style-type: none"> Five historical leks remain unclassified and will be surveyed again in 2017, perhaps for the last time under Task 2.
3. Systematic Lek Discovery Surveys	<ul style="list-style-type: none"> Survey sagebrush habitat south of Highway 20 on the INL Site, primarily in sagebrush habitat within the SGCA.
4. Raven Nest Surveys	<ul style="list-style-type: none"> Repeat efforts to deter raven nesting on two NOAA towers occupied in 2015 and 2016. Potentially initiate a research project aimed at testing the effectiveness of raven nest deterrents on transmission structures.
5. Sagebrush Habitat Condition Trends	<ul style="list-style-type: none"> Sample all annual monitoring plots (n=75). Explore analytical approach to trend analyses as five years of data will be available after 2017 data collection.
6. Monitoring to Determine Changes in Sagebrush Habitat Amount and Distribution	<ul style="list-style-type: none"> Collect field data within the 2010 Midway Fire. Begin mapping draft updates to the vegetation class boundaries within recent wildland fires.
7. Inventory and Monitoring of Sage-grouse Habitat for Areas Dominated by Non-native Annual Grasses.	<ul style="list-style-type: none"> Field crews will survey locations identified in a 2016 GIS exercise to (1) determine the presence and abundance (or relative abundance) of non-native annual grasses and (2) develop a prioritized list of candidate restoration areas for future restoration activities.
8. Monitoring Unauthorized Expansion of the Infrastructure Footprint within the SGCA and Other Areas Dominated by Big Sagebrush	<ul style="list-style-type: none"> No planned activities for 2017. Update again after 2017 Idaho NAIP imagery becomes available in early 2018.

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