Environmental Surveillance, Education, and Research Program
January 2019
VFS-ID-ESER-CCA-051

# IMPLEMENTING THE CANDIDATE CONSERVATION AGREEMENT FOR GREATER SAGE-GROUSE ON THE IDAHO NATIONAL LABORATORY SITE:

# 2018 FULL REPORT

THIS PAGE INTENTIONALLY LEFT BLANK

VFS-ID-ESER-CCA-051

# Implementation of the Candidate Conservation Agreement for Greater Sage-Grouse on the Idaho National Laboratory Site: 2018 Full Report

January 2019

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

*Environmental Surveillance, Education, and Research Program*
*Veolia Nuclear Solutions – Federal Services, 120 Technology Drive, Idaho Falls, ID 83401*

***Prepared for:***

**U.S. Department of Energy, Idaho Operations Office**
**Environmental Surveillance, Education, and Research Program**
**Contract No. DE-NE-0008477**

# Table of Contents

## FIGURES

# TABLES

## ACKNOWLEDGEMENTS

Front cover illustration was created by Alana Jensen, and Brande Hendricks assisted with document formatting. Bill Doering and Doug Halford reviewed a draft of this report and provided helpful suggestions for improvement. Seasonal technicians who assisted in collecting field data in 2018 were Aurora Bayless-Edwards, Emma Casselman, Mikayla Eager, Ellie Johnson, Levi Lindley, Amanda Reynolds, Matthew Sheffer, Alaysha Whitworth, and Anna Williams. We recognize how much effort and perseverance it takes to collect field data and we appreciate the crews' dedicated efforts.

## RECOMMENDED CITATION

Shurtliff, Q.R., K.N. Kaser, J.R. Hafla, J.P. Shive, A.D. Forman, K.T. Edwards, and B.F. Bybee. 2019. Implementing the Candidate Conservation Agreement for Greater Sage-Grouse on the Idaho National Laboratory Site: 2018 Full Report. Environmental Surveillance, Education, and Research Program; Veolia Nuclear Solutions – Federal Services, Idaho Falls, ID. Report #VFS-ID-ESER-CCA-051.

# ACRONYMS

| | |
|---|---|
| BEA | Battelle Energy Alliance, LLC |
| BLM | Bureau of Land Management |
| CCA | Candidate Conservation Agreement |
| DOE | U.S. Department of Energy, Idaho Operations Office |
| ESER | Environmental Surveillance, Education, and Research Program |
| GIS | geographic information system |
| GPS | global positioning system |
| IDFG | Idaho Department of Fish and Game |
| INL | Idaho National Laboratory |
| LTV | Long-Term Vegetation |
| MFC | Materials and Fuels Complex |
| MPLS | males per lek surveyed |
| NAIP | National Agricultural Imaging Program |
| NOAA | National Oceanic and Atmospheric Association |
| OSC | Idaho Governor's Office of Species Conservation |
| RWMC | Radioactive Waste Management Complex |
| SGCA | Sage-grouse Conservation Area |
| USFWS | U.S. Fish and Wildlife Service |

# 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 in 2014. The primary purposes of this report are to (1) document DOE's 2018 inventory and monitoring activities and results in support of the CCA, (2) address greater sage-grouse (hereafter 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 executive summary highlights key results and conclusions as they relate to population and habitat triggers, threat monitoring, and implementation of conservation measures.

## Population Monitoring

The sage-grouse population trigger baseline for the INL Site equals the number of males counted in 2011 during peak male attendance on 27 active leks within the Sage-grouse Conservation Area (SGCA) (i.e., 316 males). The population trigger will be tripped if the three-year running average of males on those 27 leks (hereafter, baseline leks) decreases ≥20% (i.e., ≤253 males). In 2018, we surveyed baseline leks, six lek routes, all other active leks on the INL Site, and a few inactive leks that had not been surveyed for several years. Key results from population monitoring are as follows:

- Peak male attendance summed across baseline leks was 365 males—an 11% decrease from 2017. The three-year average (2016–2018) increased slightly (2.5%) to 416 males and has increased or been equal to the previous year each of the past five years. Sage-grouse abundance is often cyclic, and we predict this trend will shift downward beginning next year.
- The number of leks classified as active on and near the INL Site decreased from 45 in 2017 to 44 in 2018.
- Male attendance on six lek routes was on average 9.5% lower (range +9% to -24%) than in 2017.

## 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 there is a reduction of ≥20% (15,712 ha [38,824 ac]) of sagebrush habitat within the SGCA. Total sagebrush habitat area and distribution are monitored using aerial imagery and a geographic information system. To monitor the condition of sagebrush-dominated lands and areas recovering from wildland fire, we surveyed 125 vegetation plots distributed across both habitat types. The following is a summary of results from habitat distribution and condition monitoring tasks:

- The distribution of sagebrush habitat remains mostly unchanged in 2018. There were no large fires that affected sagebrush habitat in the SGCA and there were no substantive losses from infrastructure development or other disturbance (see details below).
- Until now, general guidelines have been used to assess local habitat condition; however, experts recommend developing more site-specific standards to evaluate the status of local habitat condition. We have developed local means based on five years of habitat data that provide a frame of reference specifically for local habitat condition for both habitat types.

- In polygons currently identified as sagebrush habitat, mean sagebrush cover and height were within suggested optimal ranges for breeding and brood-rearing habitat and are comparable to local means. Perennial herbaceous height and cover were above guideline recommendations and considerably above local means, but were likely at the upper end on their normal range of variability due to recent precipitation patterns.
- In areas recovering from wildland fire, native species have remained stable, appearing not to be affected by cheatgrass as it has increased cover over the past six years. It is unclear whether this increasing pattern will continue or if this is a fluctuation resulting from anomalous precipitation events.

**Threat Monitoring**

Two CCA monitoring tasks were designed to generate baseline data and track indicators for specific threats to sage-grouse and its habitat—raven predation and infrastructure development. Key results and conclusions from these tasks are listed below. A third task that addressed cheatgrass was suspended in 2018 because DOE concluded there is currently no cost-effective way to directly reduce cheatgrass dominance at a meaningful scale within sagebrush habitat on the INL Site.

*Raven Predation*—Raven nesting on INL Site infrastructure and in ornamental trees was approximately 5% higher in 2018 than in 2017, and a trend is beginning to emerge that suggests raven nesting on these structures is neither increasing nor decreasing. Most facilities, and an increasing number of towers, supported raven nests in 2018. As a result, DOE broadened the scope of Conservation Measure 10 to encourage contractors and agencies to take steps to deter raven nesting wherever it is reasonably feasible, and not just focus on deterring nesting on power lines.

*Infrastructure Development*—We mapped eight polygons where infrastructure expansion removed a total of 2.3 ha (5.6 ac) of sagebrush habitat during the past two years. We also mapped 9.6 km (6 mi) of new linear features located within the SGCA and/or existing sagebrush habitat.

**Wildland Fire and Sagebrush Restoration**

Approximately 8 ha (20 ac) were reportedly burned on the INL Site in 2018. Because the area was less than 40 ha (99 ac), DOE did not prepare a burned area assessment. An estimated 12.5 ha (31 ac) have burned on the INL Site during the past six years in 13 separate incidents. Fewer acres have burned in the last six years than during any other equivalent period dating back to at least 1988.

The annual effort to restore sagebrush in previously burned areas resulted in nearly 25,000 sagebrush seedlings being planted across 59 ha (146 ac)—the largest planting since the initiative began. We estimate that 58% seedlings planted in 2017 survived their first year.

**Population and Habitat Triggers—Summary**

The three-year running average of sage-grouse peak male attendance on baseline leks is now 164% of the population trigger threshold. The current value of 416 males would have to drop below 253 males to trip the trigger. Thus, it is unlikely the trigger will be tripped in the near term.

Estimated sagebrush habitat within the SGCA is currently 78,555 ha (194,114 ac). Infrastructure development reduced this value slightly (loss of 2.3 ha [5.6 ac]) in 2018; however, the change was minor, resulting in a decrease of total sagebrush habitat in the SGCA by less than 0.1%.

## Synthesis and Conclusions

Sage-grouse abundance trends on the INL Site have been generally consistent with State-wide trends in Idaho for the past five years. Since 2013, when the Environmental Surveillance, Education, and Research Program began monitoring threats and habitat condition indicators in support of the CCA, only a minor amount of sagebrush has been lost to wildland fire or infrastructure development, and the number of raven pairs nesting on infrastructure appears to be stable. Cheatgrass cover is continuing to increase, but not at the expense of native herbaceous cover. Taken together, we conclude that region-wide drivers, rather than INL Site-specific factors, are predominately influencing sage-grouse abundance on the INL Site.

## Adaptive Management

In 2018, DOE and U.S. Fish and Wildlife Service agreed to several adjustments to the CCA. Substantive additions and changes include:

- Updated threats ratings;
- Addition of a best management practice to address infrastructure development;
- Suspension of a measure aimed at directly reducing cheatgrass (which we now view as impractical) in favor of a renewed emphasis on measures that address wildland fire and infrastructure development, which are threats that promote the spread of non-native annual grasses and forbs;
- A directive for the Environmental Surveillance, Education, and Research Program to educate INL Site contractors about the negative consequences of using crested wheatgrass in seed mixes; and
- Broadened scope for Conservation Measure 10 to encourage contractors and agencies to take steps to deter raven nesting wherever it is reasonably feasible, and not just focus on deterring nesting on power lines.

# 1.0 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 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 document, produced by DOE's Environmental Surveillance, Education, and Research Program (ESER), satisfies these reporting requirements.

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: The three-year running average of peak male attendance, summed across 27 leks within the Sage-grouse Conservation Area (SGCA), falls below 253 males—a 20% decrease from the 2011 baseline of 316 males;
- Habitat Trigger: Total area designated as sagebrush habitat within the SGCA falls below 62,846 ha (155,296 ac)—a 20% drop from the 2013 baseline of 78,558 ha (194,120 ac).

This report informs a continuing 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 ensures 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 report 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 chapter summarizes results of pertinent monitoring tasks outlined in Section 11.1 of the CCA. Chapter 5 documents how DOE and its contractors implemented conservation measures listed in the CCA during the past year. Chapter 6 brings together the main results and conclusions from all activities performed during the past year in light of the ultimate goal of the CCA, which is to conserve sage-grouse. This final chapter also details changes and updates to the CCA that have been approved by both signatories during the past year, and it outlines the upcoming CCA annual work plan (Section 6.3).

# 2.0 POPULATION TRIGGER MONITORING

## 2.1 Task 1—Lek Counts and Lek Route Surveys

### 2.1.1 Introduction

In 2013, DOE initiated a sage-grouse population monitoring task (Task 1) designed primarily to track peak male attendance on all active leks on the INL Site (DOE and USFWS 2014). Task 1 enables ESER to estimate long-term breeding population trends and to maintain accurate records of active lek locations. Annually, Task 1 includes surveys of (1) active and inactive leks on six lek routes, (2) all other active leks not assigned to a lek route, (3) inactive baseline leks (see below), and (4) a subset of inactive leks visited approximately once every five years.

Counts from 27 leks located in the SGCA (hereafter, baseline leks) were originally used as the basis for the population trigger (DOE and USFWS 2014). These leks are surveyed annually, either individually or as part of a lek route. The baseline value for the population trigger is 316 males—the summation of peak male attendance in 2011 when all baseline leks were active (Figure 2-1; DOE and USFWS 2014). The population trigger will be tripped if the three-year running average of peak male attendance at these baseline leks falls below 253 (a 20% decrease from the 2011 value) (DOE and USFWS 2014).

To evaluate long-term trends, we annually survey six lek routes and calculate each route's peak male attendance. In 2017, we established three new routes. The other three (Tractor Flats, Radioactive Waste Management Complex [RWMC], and Lower Birch Creek) were established by the Idaho Department of Fish and Game (IDFG) in the 1990s and have been surveyed annually since 1999 (Figure 2-1). Many baseline leks are assigned to these six routes, but we analyze lek route data separate from the baseline lek data. The reason is because lek route data are more useful than single-lek counts for trend analysis, as they address some of the confounding issues regarding sage-grouse movement among leks (Connelly et al. 2003). Additionally, the three lek routes established in the 1990s provide a historical perspective on current trends of sage-grouse abundance that could not be obtained simply by examining summed counts from the baseline leks (Garton et al. 2011, DOE and USFWS 2014).

### 2.1.2 Methods

We conducted surveys of individual leks and lek routes from March 16 to May 10 following standard ESER protocols (Shurtliff et al. 2015). For trend analysis (based on IDFG lek routes), we generated a value for each route representing the number of males per lek surveyed (MPLS) on the day that the route count was highest (Shurtliff et al. 2017).

### 2.1.3 Results and Discussion

**SGCA Baseline Leks**

We surveyed each of the baseline leks 2–7 times ($\bar{x}$=5.5 surveys, SD=1.7; Figure 2-1) in 2018. The sum of peak male attendance across the baseline leks was 365, an 11% decrease from 2017. Despite this decrease in peak counts, which followed a 13% decrease last year (Shurtliff et al. 2018), the three-year (2016–2018) running average of peak male attendance on baseline leks increased 2.5% over the 2017 running average, to 416 males (Figure 2-2). The three-year average is now 164% of the threshold (253 males) that would trigger predetermined action by DOE and the USFWS (DOE and USFWS 2014). The three-year average has been stable or has increased in each of the past five years; however unless peak male attendance across the baseline leks increases by ≥29% in 2019, the three-year average will begin to decline next year.

None of the baseline leks became inactive in 2018, marking the first time in six years that an active baseline lek was not reclassified. Currently, 17 of the 27 baseline leks are considered active.

### Other Non-Route Leks

We surveyed 27 additional (i.e., non-baseline) active leks 3–8 times ($\bar{x}$=5.3 surveys, SD=1.5, Figure 2-1). Average peak male attendance was 9.6 males per lek (range: 0–25 males, SD=7.9), down from 12.1 males per lek in 2017. We downgraded one lek (INL38) to inactive status that was within the boundaries of a 2011 wildland fire. The lek was first surveyed in 2005 and reached a peak of 15 males in 2012. No males have been recorded at this lek since 2014.

We surveyed 15 inactive leks two times each that were neither baseline leks nor part of lek routes. These leks were included as part of the ESER effort to resurvey each inactive lek approximately once every five years. Most of these inactive leks had not been visited for four or five years, although two were surveyed in 2016 or 2017. We did not record observations of male sage-grouse at any of the leks, so each will retain its inactive status.

### Lek Routes

We surveyed each of the six lek routes 5–7 times ($\bar{x}$=6.2 surveys, SD=1.0) during the official IDFG survey period (Figure 2-1, Table 2-1). On the IDFG routes, the MPLS values were lower than the past two years (Figure 2-3). On the Tractor Flats route, the 2018 MPLS was 11% lower than 2017 and 35% lower than 2016. On the Lower Birch Creek route, the 2018 MPLS was 24% lower than 2017 and 25% lower than 2016. On the RWMC route, the 2018 MPLS was 5% lower than 2017 and 20% lower than 2016. The RWMC route experienced a 16% drop in absolute numbers of males from 2017 to 2018, but we surveyed one less lek in 2018, which lessened the MPLS decline. All three IDFG lek routes had similar or slightly higher MPLS values in 2018 compared to 2015.

The 2018 MPLS values for the three new lek routes compare to 2017 values as follows: Frenchman's Cabin route dropped 22%, West T-3 route dropped 4%, and T-9 route increased 9%. Although the number of leks surveyed on each of these routes was the same as 2017, we completed one additional survey of West T-3 and three additional surveys of T-9 compared to last year (Table 2-1). Logistical constraints in 2017 reduced the survey effort, as we surveyed three new lek routes while completing historical lek survey and discovery lek survey tasks (Shurtliff et al. 2018) (Table 2-1). The greater survey effort in 2018 for West T-3 and T-9 routes may explain why the West T-3 route had the lowest documented MPLS decline and the T-9 route had only recorded MPLS increase among the six routes.

We downgraded two route leks to inactive status and upgraded two route leks to active status following the 2018 field season. One downgraded lek, INL143, served as a satellite display area on the Tractor Flats route, and was first surveyed in 2009. We never observed more than six males on this location. Another downgraded lek was INL158 on the RWMC route. Here, three males were observed displaying only once in 2014, but none have been recorded since. One upgraded lek was INL16 on the Tractor Flats route. This is an historical location where sage-grouse displaying on the north side of a two-track road were recorded separately from those displaying a few hundred meters away on the south side. Surveyed since 1995, no males were recorded on INL16 from 2011–2015. Each year since 2015, 1–10 males were recorded. The second upgraded lek was INL35 on the Frenchman's Cabin route. We recorded up to 10 males at this location in 2016 and 2018, but prior to 2016, we had not observed two or more males since 2012.

**Table 2-1. 2018 data from Idaho National Laboratory Site lek routes.**

| Lek Route | Highest Single-Day Count | Total Leks Surveyed | Males / Lek Surveyed (MPLS) | Occupied Leks* | Males / Occupied Lek* | Surveys Conducted |
|---|---|---|---|---|---|---|
| Tractor Flats | 74 | 8 | 9.3 | 3 | 24.7 | 7 |
| Radioactive Waste Management Complex | 94 | 8 | 11.8 | 6 | 15.7 | 7 |
| Lower Birch Creek | 100 | 9 | 11.1 | 6 | 16.7 | 6 |
| West T-3 | 47 | 4 | 11.8 | 3 | 15.7 | 5 |
| T-9 | 39 | 4 | 9.8 | 3 | 13.0 | 7 |
| Frenchman's Cabin | 36 | 3 | 12.0 | 3 | 12.0 | 5 |

*For the purpose of this analysis, leks on routes are considered occupied if two or more males were observed displaying during the current-year survey. This is different from an active lek designation that DOE's Environmental Surveillance, Education, and Research Program uses to characterize leks on the Idaho National Laboratory Site, which is based on five years of data.

The Tractor Flats and Lower Birch Creek lek route data suggest that the breeding population of sage-grouse on the INL Site may have peaked from about 2005 to 2007, with a subsequent, albeit lower, peak approximately 10 years later. The RWMC route does not have a cyclic signature, but appears to have slowly declined over the past 20 years. It may be natural for long-term sage-grouse abundance to be cyclic (Fedy and Aldridge 2011). Thus, the recent downturn in male attendance on most of our lek routes is not unexpected. Based on the previous 20 years of data, we may expect to see sage-grouse numbers slowly decline for several years.

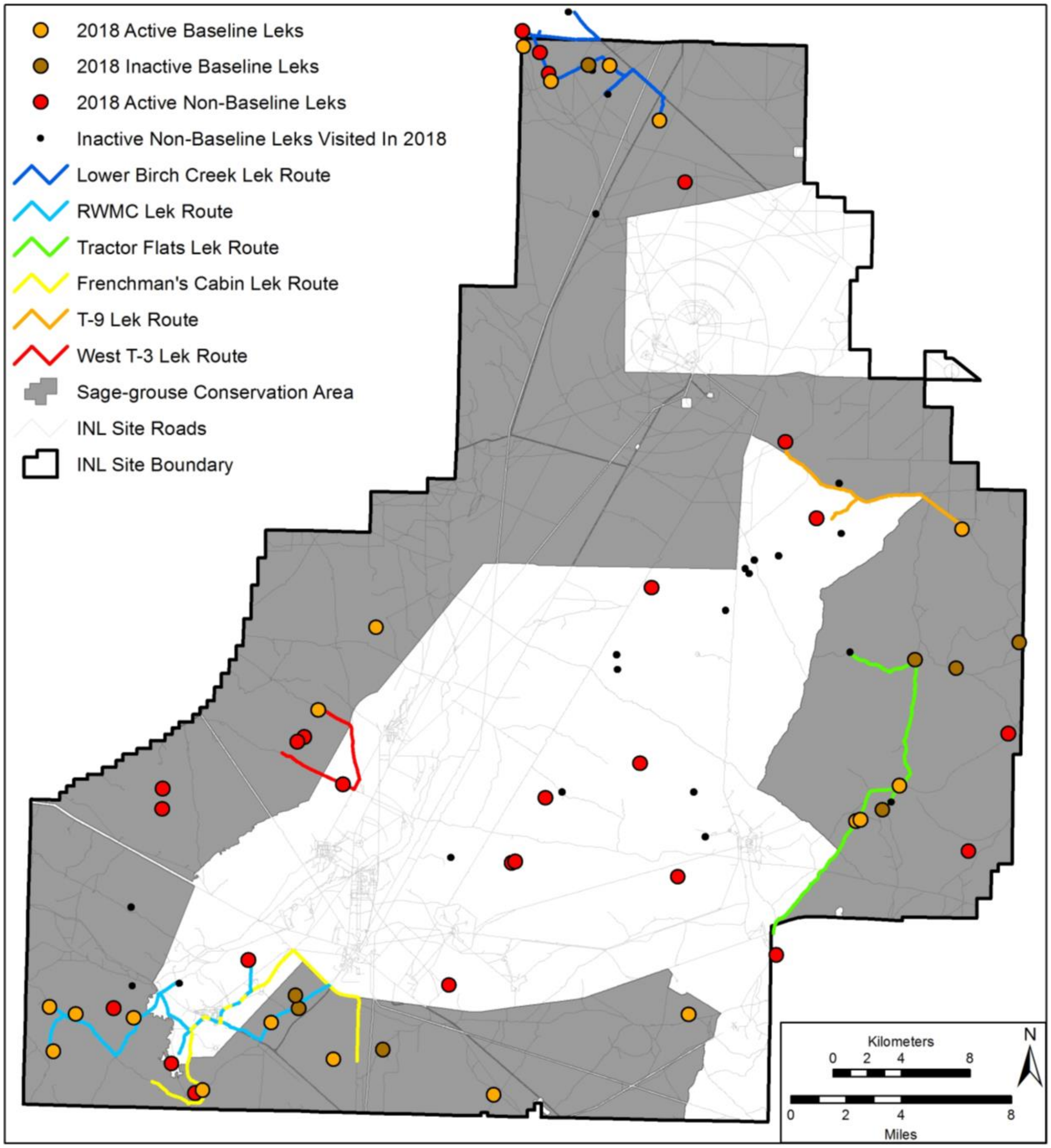


**Figure 2-1. An overview of greater sage-grouse leks surveyed on the Idaho National Laboratory Site in 2018. Lek activity designations (active vs. inactive) refer to lek statuses when surveys commenced in March 2018.**

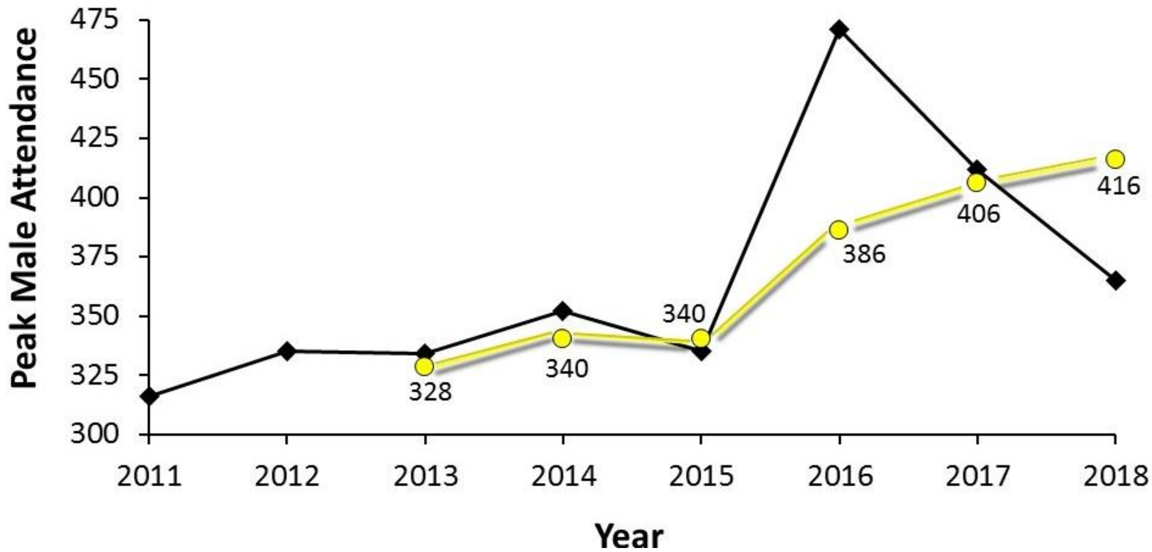


**Figure 2-2. Peak male attendance of greater sage-grouse from 2011–2018 on the 27 leks in the Sage-Grouse Conservation Area associated with the population trigger. Black diamonds represent annually summed peak male attendance values for each lek, and yellow circles (values displayed) represent the three-year running average.**

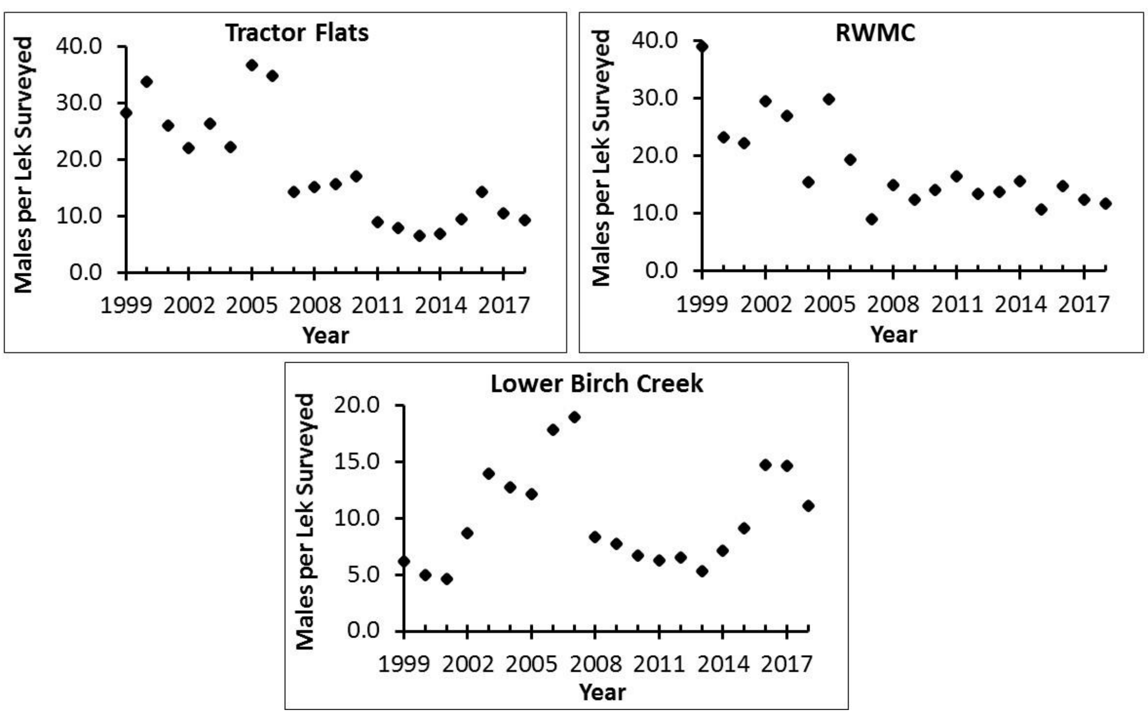


**Figure 2-3. Mean number of Males Per Lek Surveyed during peak male attendance on three Idaho Department of Fish and Game lek routes from 1999–2018 on the Idaho National Laboratory Site. The number of leks surveyed each year increased over the displayed time period as follows: Tractor Flats (4–8 leks), Radioactive Waste Management Complex (RWMC; 2–9 leks), and Lower Birch Creek (6–9 leks). Values for 2016 and 2017 in the Lower Birch Creek panel are slightly different than in last year's report because we corrected an error (nine instead of 10 leks were surveyed). Note that the Y-axis is at a different scale in the Lower Birch Creek panel.**

## 2.2 Summary of Known Active Leks and of Changes in Lek Classification

Before the 2018 field season, 45 leks were designated active on or near the INL Site, including two just outside the Site boundaries that are part of the IDFG survey routes. After the field season, three leks were downgraded from an active to inactive status, and two leks were upgraded to active status (Figure 2-4). Thus, the total number of known active leks on or near the INL Site is currently 44 (Figure 2-5).

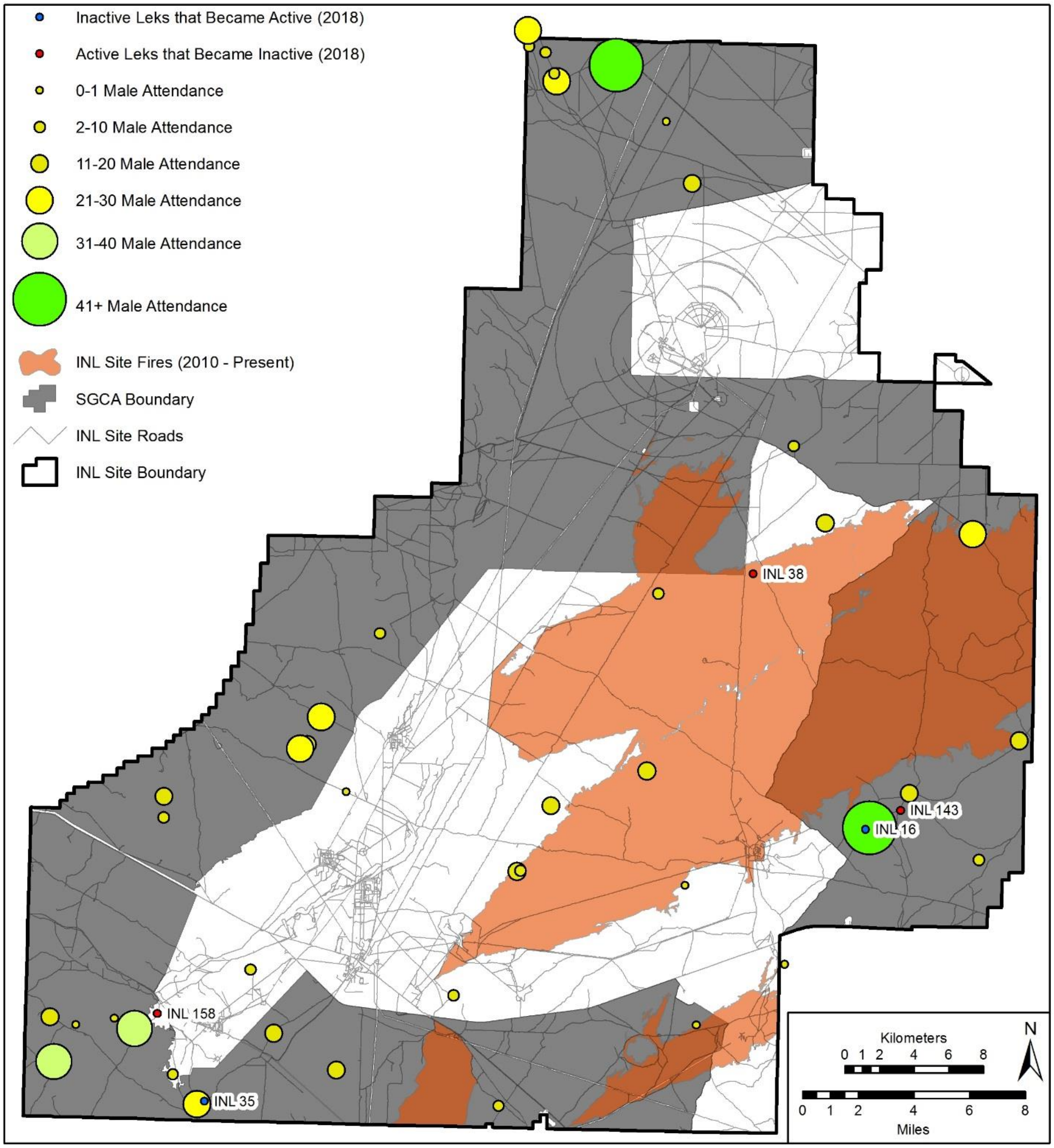


**Figure 2-4. Locations and relative size of active leks on the Idaho National Laboratory Site based on 2018 peak male attendance. Symbol size reflects attendance only and does not represent the spatial extent of the lek site nor the 1-km lek buffers. Leks recharacterized as active or inactive following the 2018 field season are uniquely designated.**

## 2.3 Adaptive Management

The CCA states that following the establishment of new lek routes and the first year of data collection, DOE and the USFWS would meet to discuss whether summing maximum male counts across all lek routes "represents a reasonable new baseline for the population trigger" (DOE and USFWS 2014, pg. 36). Thus, the signatories agreed to consider whether the interim population trigger that has been in place since the CCA was signed should be replaced with a more commonly accepted form of tracking sage-grouse abundance (i.e., lek route counts). During the annual CCA Stakeholder Meeting in February 2018, DOE and the USFWS discussed this issue and concluded that for now, the CCA should maintain the population trigger as the sum of peak male attendance at baseline leks. After an updated Bureau of Land Management (BLM) Land Use Plan is released, the two parties will revisit the issue.

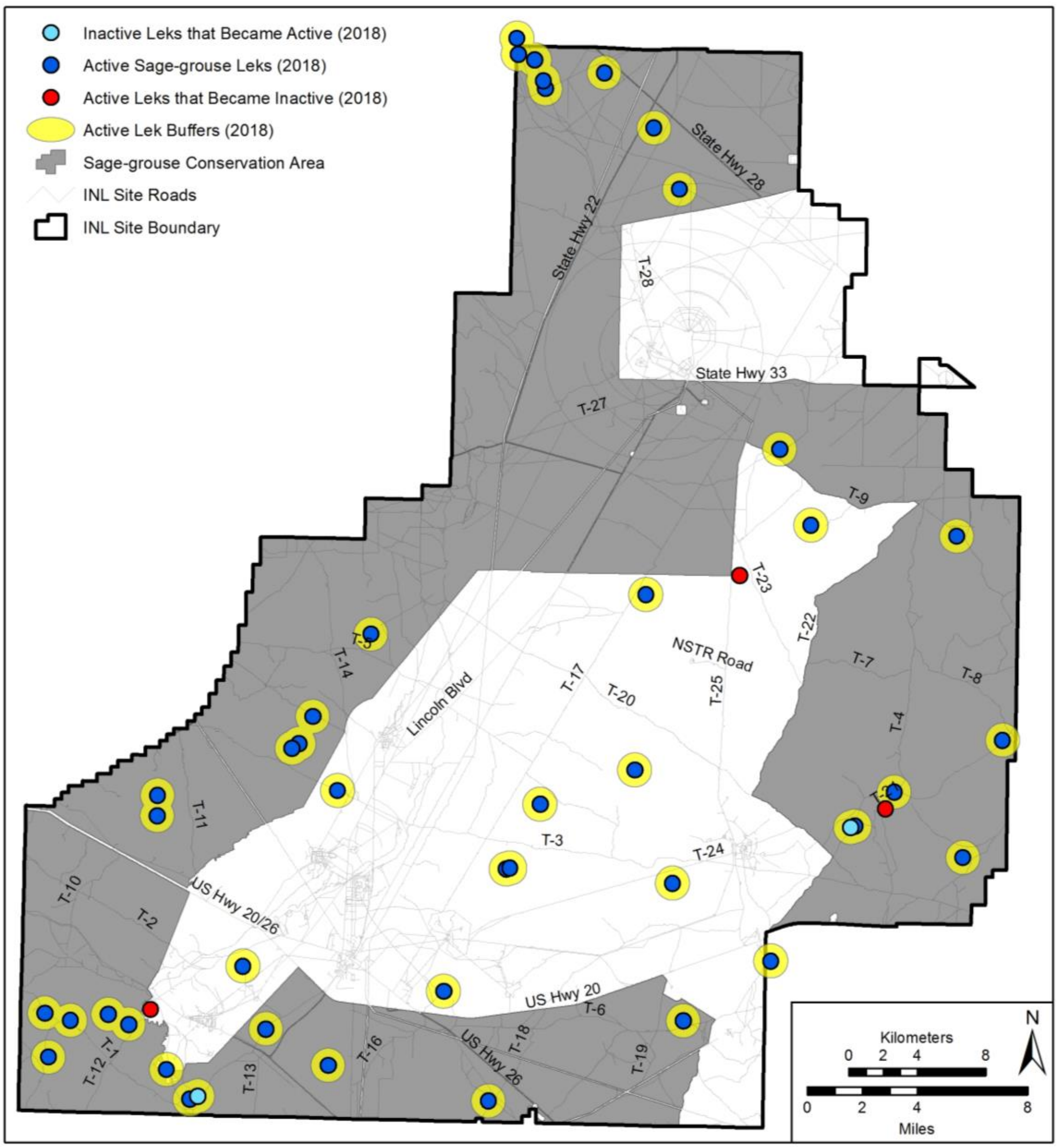


**Figure 2-5. Locations of 44 active leks and three leks reclassified as inactive on or near the Idaho National Laboratory Site. The two leks reclassified as active (light blue) were within 500 m of other active leks.**

# 3.0 HABITAT TRIGGER MONITORING

All vegetation-based estimates of sagebrush habitat distribution 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 was 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 baseline value of the habitat trigger is defined as the total area designated as sagebrush habitat within the SGCA at the beginning of 2013 (DOE and USFWS 2014). Currently, this baseline value is estimated at 78,558 ha (194,120 ac). Although no real changes in the amount of sagebrush habitat within the SGCA have been recorded since the CCA was signed, the habitat trigger baseline value was increased twice following improved fine-scale mapping of recent fires (Shurtliff et al. 2016, 2017). Based on updated habitat estimates, the trigger will be tripped if there is a loss of >15,712 ha (38,824 ac) within the SGCA (i.e., a 20% reduction in sagebrush habitat). If the trigger is tripped, the USFWS will ask DOE to take action to mitigate the loss of habitat.

Two monitoring tasks are designed to 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**—This task provides information to support ongoing assessment of habitat condition within polygons mapped as sagebrush habitat and facilitates comparison of current-year sagebrush habitat on the INL Site with average site-specific values. Data collected to support this task may also be used to document gains in habitat as non-sagebrush map polygons transition back into sagebrush classes, or to document losses when compositional changes occur within sagebrush polygons that may require a change in the assigned map class.

**Task 6: Monitoring to Determine Changes in Sagebrush Habitat Amount and Distribution**—This task is intended to provide an update to the current sagebrush habitat distribution map, and primarily deals with losses to sagebrush habitat following events that alter vegetation communities. As updates are made to 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 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 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 area to redefine the polygon as a 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. Wildland fire was ranked as a high-level threat in the CCA. The potential negative effects from annual grasses and other weeds, infrastructure development, and seeded perennial grasses are also important, with each being ranked as a mid-level threat. The threat of livestock is ranked as low. These five threats are thought to affect sage-grouse populations directly and 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.

The habitat condition monitoring task was specifically designed to allow biologists to:

- characterize the vegetative aspect of 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.

Until now, we have compared habitat characteristics measured on the INL Site to the general guidance provided by Connelly et al. (2000). However, variation within sagebrush habitat across its range makes it difficult to apply regional standards to specific locations. Connelly et al. (2000) encourages using local habitat condition data as a way to fill knowledge gaps and estimate better values from which to base adaptive management recommendations. Over the past five years, we have been collecting habitat monitoring data and will begin using those data to develop average local habitat condition values for the INL Site. As a continued effort, we will assess whether the average values used this year are ecologically defensible and/or meaningful and continue to explore developing the most appropriate guidelines for the INL Site based on local data.

### 3.1.2 Methods

#### Sampling

In 2013, 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 habitat condition monitoring plots are surveyed annually; about two-thirds of the plots are located in map polygons designated as current sagebrush habitat and the remaining plots are located in burned areas 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.). Current habitat condition and trends in plant species or functional groups that have the potential to affect overall habitat condition are summarized and reported each year using annual plots. Analysis of rotational plots are completed once every five years, after data has been collected on all three plot subsets (150 total plots). The most recent analysis of rotational plots was completed in 2016 (see Shurtliff et al. 2017 for details).

In conjunction with this sample period, we generated local habitat condition values for several habitat condition metrics, which are intended to provide a site-specific standard and replace more general habitat condition guidelines (Connelly et al. 2000, Connelly et al. 2011). Local habitat condition values were derived from data collected on the 75 annual plots from 2013-2017. Overall, the previous five years are a reasonable time period to establish local habitat condition values as this timeframe contains years with below and above average annual precipitation. Precipitation during the five years used to calculate local habitat condition values also represents a range of seasonal conditions including: the driest year on record, a year with snow pack much higher than average, typical wet springs, and fall seasons with above average precipitation. Variation in precipitation before and during the collection of local habitat condition data includes dramatic fluctuations in herbaceous abundance, as well as the 2-5 year lag time of vegetation responses previously noted on the INL Site (Anderson and Inouye 2001). Data collected in 2018 from annual plots were compared to the newly developed local habitat condition values, facilitating comparisons between current vegetative characteristics of polygons designated as sage-grouse habitat on the INL Site to data collected previously within sagebrush habitat.

Trend analysis on cover data for vegetation functional groups, first presented in 2017 (Shurtliff et al. 2018), were updated to include data collected from 2013 through 2018. These data provide a starting point for trend analyses, though results should be interpreted cautiously because enough temporal variability has probably not been captured to consider the resulting trends representative of the natural range of variation. Analysis of the 2018 data also includes an overview of precipitation and the potential effects of precipitation patterns on the 2018 habitat condition monitoring results. In addition, vegetation trends over the past six years were interpreted with respect to associated precipitation patterns and within the context of Long-Term Vegetation data (LTV) trends on the INL Site.

### 3.1.3 Results and Discussion

**Current Habitat Condition**

We collected data on 125 plots between June and August of 2018; sampling was completed for the sixth time on 75 annual plots and the second time on 50 rotational plots (Figure 3-1). Results will focus only on annual plots for this report. 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 2018, all 48 annual sagebrush habitat plots were assigned to a vegetation class using a dichotomous key developed in 2018 for an update to the INL Site Vegetation Map (unpublished data). In 2018, all of the sagebrush habitat plots were assigned to a sagebrush dominated vegetation classes (Table 3-1a). Of the sagebrush habitat plots dominated by sagebrush, 65% were dominated by big sagebrush (*Artemisia tridentata)*, 23% were co-dominated by big sagebrush and a mix of other shrub species, and 13% were assigned to classes dominated by low sagebrush (*Artemisia arbuscula)* or black sagebrush (*Artemisia nova*).

Of the 27 annual non-sagebrush plots, 44% were assigned to mixed shrub grassland communities, 29% were assigned to grasslands, and 26% were assigned to shrublands (Table 3-1b). Shrublands, mixed shrub grassland, and ruderal (weedy) shrubland plant communities were dominated by green rabbitbrush with the exception of one plot, which keyed to a salt desert shrubland. The herbaceous component of all of the plots assigned to mixed shrub grasslands was primarily from native perennial grasses. However, 75% of plots assigned to grasslands were dominated by nonnative annual grasses.

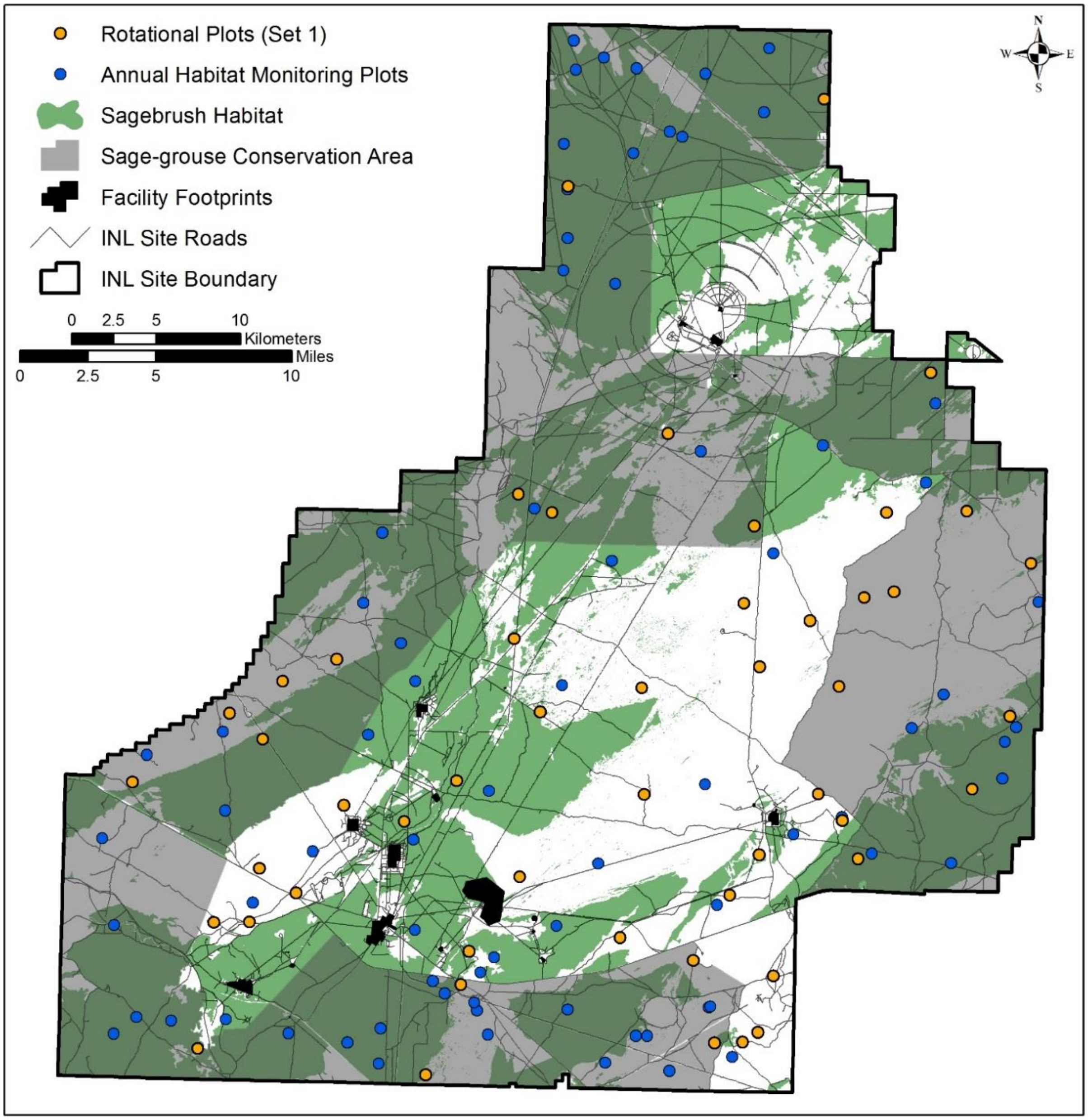


**Figure 3-1. CCA sage-grouse habitat condition monitoring plots sampled in 2018 on the Idaho National Laboratory Site.**

**Table 3-1a. Results of a dichotomous plant community key (unpublished data) for 48 sagebrush habitat condition monitoring plots sampled on the Idaho National Laboratory Site in 2018.**

| Vegetation Class | Number of Plots 2018 |
|---|---|
| Big Sagebrush Shrubland | 31 |
| Big Sagebrush – Green Rabbitbrush (Threetip Sagebrush) Shrubland | 11 |
| Low Sagebrush Shrubland | 4 |
| Black Sagebrush Shrubland | 2 |

**Table 3-1b. Results of a dichotomous plant community key (unpublished data) for 27 non-sagebrush habitat condition monitoring plots sampled on the Idaho National Laboratory Site in 2018.**

| Vegetation Class | Number of Plots 2018 |
|---|---|
| Green Rabbitbrush / Sandberg Bluegrass – Bluebunch Wheatgrass Shrub Grassland | 9 |
| Green Rabbitbrush / Desert Alyssum (Cheatgrass) Ruderal Shrubland | 6 |
| Cheatgrass Ruderal Grassland | 6 |
| Green Rabbitbrush / Thickspike Wheatgrass Shrub Grassland | 3 |
| Western Wheatgrass Grassland | 2 |
| Shadscale Saltbush – Winterfat Shrubland | 1 |

A couple 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 variables are sage-grouse sign and anthropogenic influences. These data show that in 2018 sage-grouse sign was present on 9 of the 48 (19%) annual sagebrush habitat plots. Sage-grouse scat was at least one year or older on these plots. This is down from 2017, where scat was recorded at 20 out of 48 (41%) plots. Sage-grouse scat wasn't noted on any of the 27 non-sagebrush plots. Plots in sagebrush habitat have generally experienced more use over the past six years than plots in non-habitat. Anthropogenic influence was noted on 11 (15%) of the annual habitat condition monitoring plots in 2018, and ten of them were located in areas currently designated as sagebrush habitat. Livestock manure was present in nine plots, and tire tracks and litter were identified in the remaining two plots. Two plots with documented anthropogenic influence were located outside allotment boundaries. A plot located near Central Facilities Area was reported to have litter. The other plot is located on the edge of an allotment and trails were documented.

Overall, the average local habitat condition values for sagebrush habitat do not differ drastically from general, regional guidelines (Connelly et al. 2000, Table 3); sagebrush cover and height are within the recommended range (10-15%, 30-80cm, respectively), herbaceous cover is lower than the recommended range (≥15%), and herbaceous height is at the lower end of the recommended range (> 18cm). In 2018, absolute cover from sagebrush species averaged about 24% across the annual sagebrush habitat monitoring plots, which is slightly higher than the average local habitat condition values developed this year (Table 3-2a, Table 3-2b). Sagebrush still contributes very little to total vegetative cover in previously burned, non-sagebrush plots. On non-sagebrush monitoring plots, absolute sagebrush cover in 2018 was comparable to the baseline, averaging approximately 0.3% and 0.2%, respectively (Table 3-2a, Table 3-2b). Sagebrush individuals that were present in the non-sagebrush plots were shorter, on average, than sagebrush individuals on sagebrush habitat plots (Tables 3-2a). Conversely, average cover and height of perennial grasses and forbs was greater on non-sagebrush plots than on sagebrush habitat plots. Perennial grass/forb height was 11 cm above baseline on sagebrush habitat plots, but still not as high as on non-sagebrush plots. Non-sagebrush plot perennial grass/forb height was 8 cm over the average local habitat condition value. Sagebrush density averaged across the annual sagebrush habitat plots was lower than the average local habitat condition values (Tables 3-2a and 3-2b). It was also consistent with the range of density averages 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 LTV Transects (unpublished data).

Absolute total vegetation cover averaged across sagebrush habitat plots was higher (69%) than the average local habitat condition values (45%, Table 3-3a). About half of the total vegetation cover was from shrubs, and nearly 75% of the shrub cover was from *Artemisia* species. Sagebrush contributed 34% of the total vegetation cover on sagebrush habitat plots. Big sagebrush was the most abundant and widespread sagebrush species; however, threetip sagebrush (*Artemisia tripartita*), black sagebrush, and low sagebrush were locally abundant on the limited number of plots where they each occurred. Overall, total shrub cover remained relatively stable compared to the average local habitat condition values (30% for both), although perennial grass cover (19.5%) was much higher than the average local habitat condition values (9%). Sandberg bluegrass (*Poa secunda)* was the most abundant native, perennial grass contributing 22% of total perennial graminoid cover. Sandberg bluegrass was above the average local habitat condition values; it increased from 2% absolute cover to 7% absolute cover. Bottlebrush squirreltail (*Elymus elymoides*) was also increased from 2% to over 6% absolute cover. On the other hand, total cover from introduced species on sagebrush habitat plots was above the average local habitat condition values, increasing 3% to12%. Desert alyssum (*Alyssum desertorum*) and cheatgrass were the largest contributors to the departure from average local habitat condition values. Cheatgrass cover was substantially higher than the baseline, increasing from about 1% to over 7%.

**Table 3-2a. Summary of selected vegetation measurements for characterization of condition of sagebrush habitat monitoring plots and non-sagebrush monitoring plots on the Idaho National Laboratory Site in 2018.**

| 2018 | Mean Cover (%) | Mean Height (cm) | Mean Density (individuals/m$^2$) |
|---|---|---|---|
| **Sagebrush Habitat Plots (n=48)** | | | |
| **Sagebrush** | 23.65 | 47.59 | 3.55 |
| **Perennial Grass/Forbs** | 21.21 | 31.90 | |
| **Non-sagebrush Plots (n=27)** | | | |
| **Sagebrush** | 0.27 | 48.91 | 0.07 |
| **Perennial Grass/Forbs** | 24.97 | 38.51 | |

**Table 3-2b. Average local habitat condition values of selected vegetation measurements for characterization of condition of sagebrush habitat monitoring plots and non-sagebrush monitoring plots on the Idaho National Laboratory Site. Average local habitat condition values were generated from 2013–2017 data.**

| Average (2013-2017) | Mean Cover (%) | Mean Height (cm) | Mean Density (individuals/m²) |
|---|---|---|---|
| **Sagebrush Habitat Plots** | | | |
| **Sagebrush** | 21.27 | 47.81 | 5.19 |
| **Perennial Grass/Forbs** | 10.26 | 20.70 | |
| **Non-sagebrush Plots** | | | |
| **Sagebrush** | 0.22 | 33.54 | 0.07 |
| **Perennial Grass/Forbs** | 19.97 | 29.77 | |

**Table 3-3a. Mean absolute cover (%) by species for 48 sagebrush monitoring plots on the Idaho National Laboratory Site in 2018. Average local habitat condition values cover (%) was generated from five years of monitoring data (2013–2017) on the sagebrush habitat monitoring plots. An asterisk (*) Indicates that this species was undetectable using the current sampling methodology in a given sample year.**

| Plant Species | Average Local Habitat Condition Cover (%) | Absolute Cover (%) 2018 |
|---|---|---|
| **Native** | | |
| **Shrubs** | | |
| *Artemisia tridentata* | 17.41 | 19.29 |
| *Chrysothamnus viscidiflorus* | 6.64 | 6.07 |
| *Artemisia tripartita* | 1.80 | 1.92 |
| *Artemisia arbuscula* | 1.16 | 1.52 |
| *Atriplex confertifolia* | 0.95 | 1.01 |
| *Artemisia nova* | 0.90 | 0.92 |
| *Krascheninnikovia lanata* | 0.72 | 0.62 |
| *Linanthus pungens* | 0.22 | 0.29 |
| *Eriogonum microthecum* | 0.10 | 0.08 |
| Others (**n**=3,4) | 0.10 | 0.08 |
| **Total Native Shrub Cover** | **29.99** | **31.81** |
| **Succulents** | | |
| *Opuntia polyacantha* | **0.10** | **0.10** |
| **Perennial Graminoids** | | |
| *Elymus elymoides* | 2.15 | 6.30 |
| *Poa secunda* | 2.03 | 7.18 |
| *Achnatherum hymenoides* | 1.85 | 2.07 |
| *Pseudoroegneria spicata* | 1.21 | 1.77 |

| Plant Species | Average Local Habitat Condition Cover (%) | Absolute Cover (%) 2018 |
|---|---|---|
| *Elymus lanceolatus* | 0.80 | 1.25 |
| *Hesperostipa comata* | 0.51 | 0.63 |
| *Pascopyrum smithii* | 0.21 | 0.11 |
| *Carex douglasii* | 0.11 | 0.18 |
| Others (**n**=1,1) | 0.02 | 0.00 |
| **Total Native Perennial Graminoid Cover** | **8.88** | **19.50** |
| *Perennial Forbs* | | |
| *Phlox hoodii* | 0.47 | 0.24 |
| *Schoenocrambe linifolia* | 0.24 | 0.66 |
| *Sphaeralcea munroana* | 0.12 | 0.15 |
| *Erigeron pumilus* | 0.04 | 0.06 |
| *Astragalus filipes* | 0.03 | 0.16 |
| *Phlox longifolia* | 0.03 | 0.12 |
| *Eriogonum ovalifolium* | 0.02 | 0.06 |
| *Pteryxia terebinthina* | 0.02 | 0.05 |
| *Astragalus lentiginosus* | 0.01 | 0.07 |
| *Ipomopsis congesta* | 0.00 | 0.05 |
| Others (**n**=11,20) | 0.13 | 0.10 |
| **Total Native Perennial Forb Cover** | **1.11** | **1.71** |
| **Annuals and Biennials** | | |
| *Lappula occidentalis* | 0.34 | 0.76 |
| *Descurainia pinnata* | 0.27 | 0.67 |
| *Cordylanthus ramosus* | 0.15 | * |
| *Chenopodium leptophyllum* | 0.08 | 0.01 |
| Others (**n**=5,13) | 0.14 | 0.03 |
| **Total Annual and Biennial Forb Cover** | **0.99** | **1.47** |
| **Total Native Cover** | **41.07** | **54.59** |
| **Introduced** | | |
| **Perennial Grasses** | | |
| *Agropyron cristatum* | **1.34** | **2.24** |
| **Annuals and Biennials** | | |
| *Alyssum desertorum* | 1.08 | 4.19 |
| *Bromus tectorum* | 1.02 | 7.37 |
| *Halogeton glomeratus* | 0.74 | 0.52 |
| *Sisymbrium altissimum* | 0.00 | 0.29 |

| Plant Species | Average Local Habitat Condition Cover (%) | Absolute Cover (%) 2018 |
|---|---|---|
| Others (**n**=1,6) | 0.03 | 0.02 |
| **Total Introduced Annual and Biennial Cover** | **2.87** | **12.39** |
| **Total Introduced Cover** | **4.21** | **14.63** |
| **Total Vascular Plant Cover** | **45.28** | **69.22** |

On the non-sagebrush plots in 2018, about 13% of absolute plant cover was from shrubs, compared to the average local habitat condition values of about 11% (Table 3-3b). Green rabbitbrush provided almost 92% of the cover from shrubs, which is consistent with the average local habitat condition values. Perennial grasses and forbs remained stable, providing the majority of cover from native species (about 64%). Sandberg bluegrass was the most abundant native herbaceous species. Average absolute cover from native perennial grasses on non-habitat plots remained greater than on sagebrush habitat plots (Table 3-3a, Table 3-3b). Non-native herbaceous species were slightly more abundant than native herbaceous species when averaged across non-sagebrush plots. Cover from introduced herbaceous species was two times greater than the average local habitat condition values (Table 3-3b). Desert alyssum cover was also about double average local habitat condition values cover. Cheatgrass has been much more abundant on non-habitat plots than on sagebrush habitat plots. In 2018, cheatgrass cover was almost three times higher than baseline on non-habitat plots; increasing from about 13% absolute cover to nearly 36% absolute cover.

**Table 3-3b. Mean absolute cover (%) by species for 27 non-sagebrush monitoring plots on the Idaho National Laboratory Site in 2018. Average local habitat condition cover (%) was generated from five years of monitoring data (2013–2017) on the non-sagebrush sagebrush habitat monitoring plots. An asterisk (*) indicates that this species was undetectable using the current sampling methodology in a given sample year.**

| Plant Species | Average Local Habitat Condition Cover (%) | Absolute Cover (%) 2018 |
|---|---|---|
| **Native** | | |
| **Shrubs** | | |
| *Chrysothamnus viscidiflorus* | 10.72 | 11.93 |
| *Atriplex confertifolia* | 0.33 | 0.32 |
| *Artemisia tridentata* | 0.21 | 0.27 |
| *Tetradymia canescens* | 0.18 | 0.27 |
| *Eriogonum microthecum* | 0.07 | * |
| *Linanthus pungens* | 0.03 | 0.06 |
| *Krascheninnikovia lanata* | 0.02 | 0.06 |
| *Gutierrezia sarothrae* | 0.02 | 0.05 |
| Others (**n**=2,2) | 0.04 | 0.04 |
| **Total Native Shrub Cover** | **11.62** | **13.00** |
| **Succulents** | | |

| Plant Species | Average Local Habitat Condition Cover (%) | Absolute Cover (%) 2018 |
|---|---|---|
| *Opuntia polyacantha* | **0.10** | **0.12** |
| **Perennial Graminoids** | | |
| *Pseudoroegneria spicata* | 4.82 | 5.21 |
| *Poa secunda* | 3.01 | 5.83 |
| *Hesperostipa comata* | 2.68 | 2.65 |
| *Achnatherum hymenoides* | 2.45 | 2.37 |
| *Elymus lanceolatus* | 2.08 | 1.32 |
| *Elymus elymoides* | 1.42 | 2.28 |
| *Pascopyrum smithii* | 0.84 | 2.67 |
| *Leymus flavescens* | 0.58 | 1.35 |
| *Carex douglasii* | 0.08 | * |
| Others (**n**=0,2) | 0.03 | * |
| **Total Native Perennial Graminoid Cover** | **17.98** | **23.69** |
| **Perennial Forbs** | | |
| *Phlox hoodii* | 0.40 | 0.30 |
| *Sphaeralcea munroana* | 0.31 | 0.15 |
| *Crepis acuminata* | 0.29 | 0.09 |
| *Erigeron pumilus* | 0.15 | 0.10 |
| *Phlox aculeata* | 0.11 | * |
| *Phlox longifolia* | 0.10 | 0.00 |
| *Machaeranthera canescens* | 0.07 | 0.03 |
| *Schoenocrambe linifolia* | 0.07 | 0.04 |
| *Astragalus filipes* | 0.06 | 0.03 |
| *Astragalus lentiginosus* | 0.01 | 0.39 |
| Others (**n**=9,18) | 0.17 | 0.15 |
| **Total Native Perennial Forb Cover** | **1.75** | **1.28** |
| **Annuals and Biennials** | | |
| *Lappula occidentalis* | 0.26 | 0.39 |
| *Descurainia pinnata* | 0.11 | 0.47 |
| *Mentzelia albicaulis* | 0.09 | 0.06 |
| *Eriastrum wilcoxii* | 0.09 | 0.02 |
| *Cryptantha scoparia* | 0.02 | 0.17 |
| Others (**n**=4,11) | 0.12 | 0.04 |
| **Total Native Annual and Biennial Cover** | **0.67** | **1.16** |
| **Total Native Cover** | **32.12** | **39.25** |

| Plant Species | Average Local Habitat Condition Cover (%) | Absolute Cover (%) 2018 |
|---|---|---|
| **Introduced** | | |
| **Perennial Grasses** | | |
| *Agropyron cristatum* | **0.59** | **0.83** |
| **Perennial Forbs** | | |
| *Carduus nutans* | **0.01** | * |
| **Annuals and Biennials** | | |
| *Bromus tectorum* | 13.48 | 35.75 |
| *Salsola kali* | 1.78 | 0.24 |
| *Alyssum desertorum* | 1.40 | 3.08 |
| *Halogeton glomeratus* | 1.22 | 0.06 |
| *Sisymbrium altissimum* | 0.21 | 1.70 |
| *Descurainia sophia* | 0.06 | 0.11 |
| Others (**n**=2,3) | 0.02 | 0.02 |
| **Total Introduced Annual and Biennial Cover** | 18.17 | 40.97 |
| **Total Introduced Cover** | **18.78** | **41.80** |
| **Total Vascular Plant Cover** | **50.90** | **81.06** |

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). On sagebrush habitat plots, heights were from sagebrush species more than 70% of the time and sagebrush was the tallest functional group. Both results are consistent with average local habitat condition values. All herbaceous species functional groups were on average, taller than the average local habitat condition values. When considered as a proportion of the sample, annual grasses and forbs were sampled more frequently when compared to average local habitat condition values, but average height remained stable.

On non-sagebrush habitat plots, shrub height measurements were from species other than sagebrush, primarily green rabbitbrush, more than 92% of the time. The height of both sagebrush and other shrub species were taller when compared to average local habitat condition values. 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. All herbaceous functional groups were taller than average local habitat condition values for the non-sagebrush plots. When considering the proportion of the sample, both perennial grasses and forbs decreased slightly compared to average local habitat condition values. Annual forbs were nearly twice as tall when compared to the baseline; however, they comprised less than 10% of the sample. This suggests that annual forbs were more robust, but occurred less frequently. In addition, the proportion of annual grasses sampled doubled compared to the average local habitat condition values and the height measurements were slightly taller.

**Table 3-4a. Vegetation height by functional group for 48 sagebrush habitat monitoring plots on the Idaho National Laboratory Site in 2018. Average local habitat condition data for height (cm) was generated from five years of monitoring data (2013–2017) on the sagebrush habitat monitoring plots.**

| | Average Local Habitat Condition Values | | 2018 | |
|---|---|---|---|---|
| | Mean Height (cm) | Proportion of Sample | Mean Height (cm) | Proportion of Sample |
| **Shrubs** | | | | |
| Sagebrush Species | 47.81 | 0.72 | 47.59 | 0.71 |
| Other Species | 25.57 | 0.28 | 27.12 | 0.29 |
| **Herbaceous Species** | | | | |
| Perennial Grasses | 22.49 | 0.67 | 33.52 | 0.54 |
| Perennial Forbs | 9.98 | 0.12 | 14.43 | 0.05 |
| Annual Grasses | 18.96 | 0.04 | 19.26 | 0.16 |
| Annual Forbs | 9.09 | 0.17 | 10.89 | 0.25 |

**Table 3-4b. Vegetation height by functional group for 27 non-sagebrush monitoring plots on the Idaho National Laboratory Site in 2018. Average local habitat condition data for height (cm) was generated from five years of monitoring data (2013–2017) on the non-sagebrush habitat monitoring plots.**

| | Average Local Habitat Condition Values | | 2018 | |
|---|---|---|---|---|
| | Mean Height (cm) | Proportion of Sample | Mean Height (cm) | Proportion of Sample |
| **Shrubs** | | | | |
| Sagebrush Species | 33.54 | 0.08 | 48.91 | 0.08 |
| Other Species | 26.82 | 0.92 | 29.57 | 0.92 |
| **Herbaceous Species** | | | | |
| Perennial Grasses | 31.49 | 0.55 | 39.79 | 0.41 |
| Perennial Forbs | 11.64 | 0.06 | 12.24 | 0.02 |
| Annual Grasses | 16.96 | 0.25 | 18.06 | 0.48 |
| Annual Forbs | 10.94 | 0.15 | 21.09 | 0.09 |

On the sagebrush habitat plots, sagebrush density ranged from approximately one individual per square meter to approximately 15 individuals per square meter (Table 3-5). On the non-sagebrush plots, sagebrush density ranged from zero to a maximum of about one individual per square meter. Mean density for sagebrush habitat plots was lower than the average local habitat condition values, and mean density for non-sagebrush plots was unchanged in 2018. Juvenile sagebrush frequency is a proportion of the eight density transects on each plot that contain juvenile shrubs. Averaged across all sagebrush habitat plots, juvenile shrubs were present on one out of every two sample transects, which is slightly higher than the average local habitat condition values. In non-sagebrush plots, juveniles were recorded on three transect, in three plots in 2018, which is comparable to the average local habitat condition values. Overall, sagebrush density and juvenile frequency relatively stable in both sagebrush and non-sagebrush habitat plots.

**Table 3-5. Sagebrush density and juvenile frequency from sagebrush habitat monitoring plots (n=48) and non-sagebrush monitoring plots (n=27) on the INL Site in 2018. Average local habitat condition data for density (individual/m²) and juvenile frequency was generated from five years of monitoring data (2013–2017) on sagebrush habitat and non-sagebrush monitoring plots.**

| | Sagebrush | | Non-sagebrush | |
|---|---|---|---|---|
| | Average Local Habitat Condition Values | 2018 | Average Local Habitat Condition Values | 2018 |
| **Mean Density (individuals/m²)** | 5.19 | 3.55 | 0.07 | 0.07 |
| **Minimum Density (individuals/m²)** | 0.43 | 0.75 | 0.00 | 0.00 |
| **Maximum Density (individuals/m²)** | 47.60 | 14.60 | 0.74 | 0.80 |
| **Mean Juvenile Frequency** | 0.38 | 0.55 | 0.02 | 0.01 |

### Precipitation

Over the last decade there have been several years with well below average precipitation and those dry years have departed farther from the mean than wet years (Figure 3-2, Forman and Hafla 2018). Historically, the wettest season generally occurred during April, May and June months on the INL Site (Figure 3-3). From 2013 through 2017, however, some of the wettest months of the year occurred in late summer and fall, a shift that deviates from long-term averages (Figure 3-2) and would certainly favor some plant species and functional groups over others (e.g., annual grasses).

Total annual precipitation for 2018 was above average and May was the wettest month of the year (Figure 3-2). The first year of data collection for Task 5, 2013, 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. Almost half of the total precipitation from 2014 fell in August. Mean August precipitation, calculated from the 67-year Central Facilities Area record, is about 13 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. Snowpack through the winter of 2016/2017 was much higher than average and is reflected in the December 2016 through February 2017 precipitation data. In 2018, May had the second highest recorded precipitation since 1957 of 103 mm, which is three times the average. However, late fall of 2017 through the beginning of spring in April was well below the normal averages for those months.

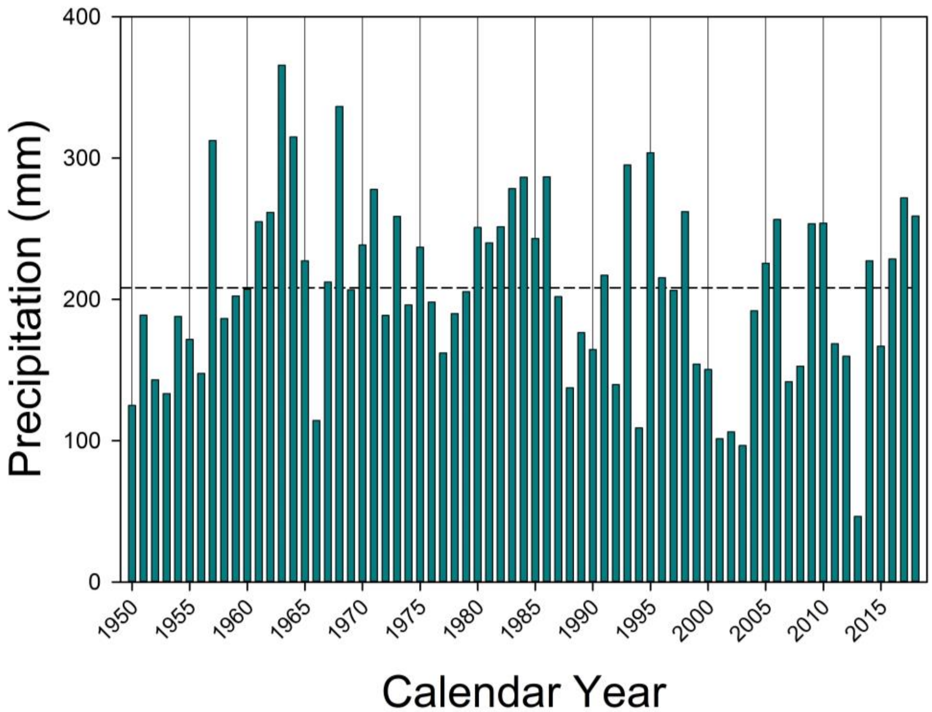


**Figure 3-2. Total annual precipitation from 1950 through 2018 at the Central Facilities Area, Idaho National Laboratory Site. The dashed line represents mean annual precipitation.**

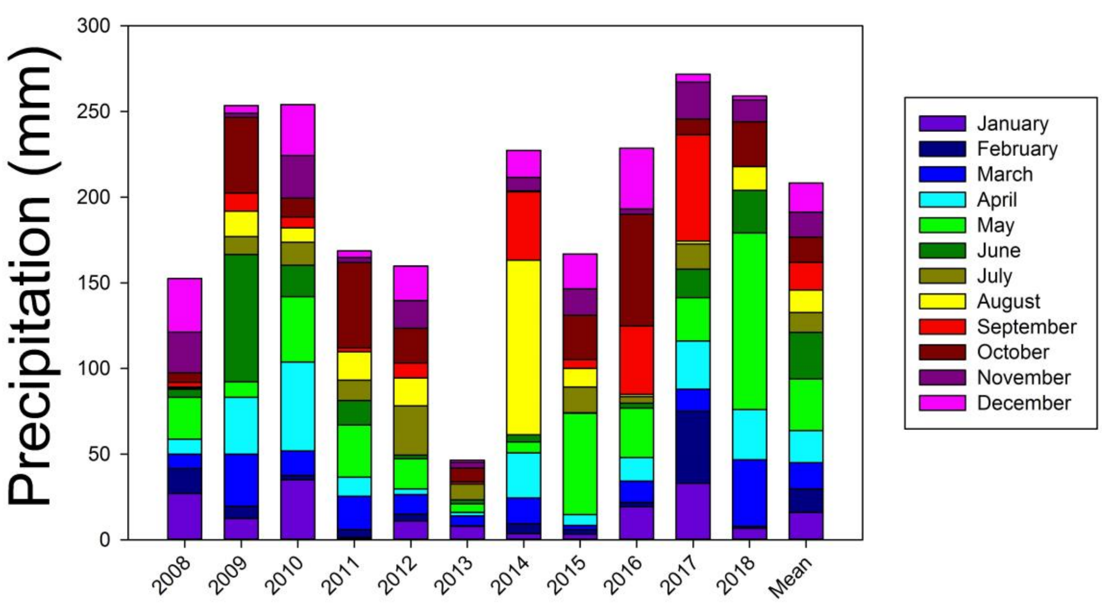


**Figure 3-3. Annual precipitation by month from the Central Facilities Area, Idaho National Laboratory Site. Mean monthly precipitation includes data from 1950 through 2018.**

## Habitat Condition Trends

From 2013 through 2018, sagebrush cover and cover from all other shrub species has remained stable (Figure 3-4a) on sagebrush habitat plots. Native perennial grass cover has increased substantially over the past six years and native annual and biennial forbs increased slightly in 2017 but decreased to previous cover levels in 2018. Cover from introduced species (Figure 3-4b) on sagebrush habitat plots has been low relative to native species, but introduced species do trend upward over the sample period (Figure 3-4b).

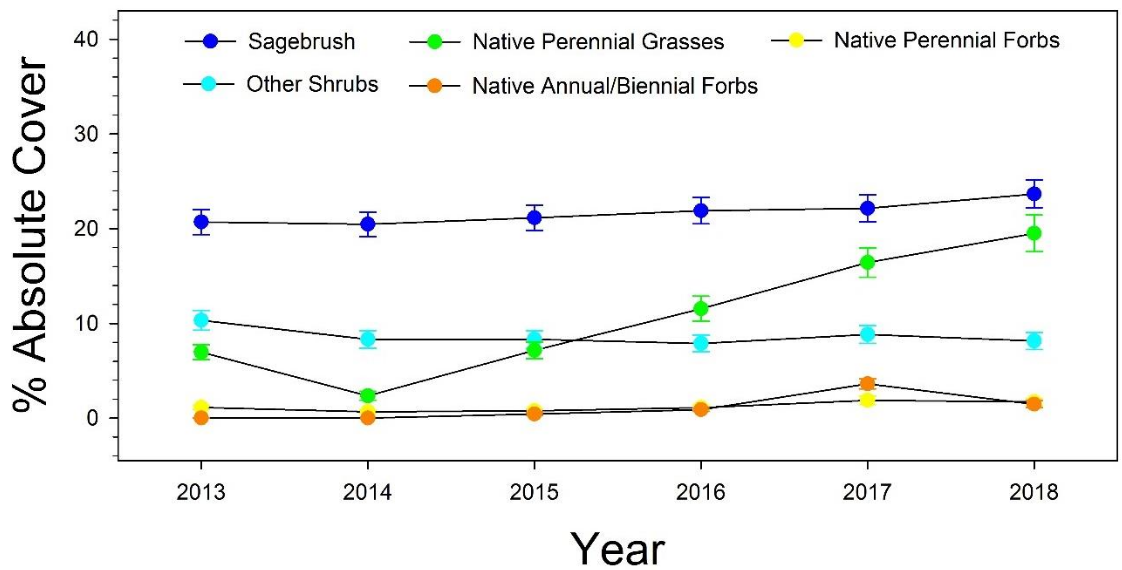


**Figure 3-4a. Mean cover from functional groups of native species in sagebrush habitat plots (n=48) on the Idaho National Laboratory Site from 2013 through 2018. Error bars represent ± 1 SE.**

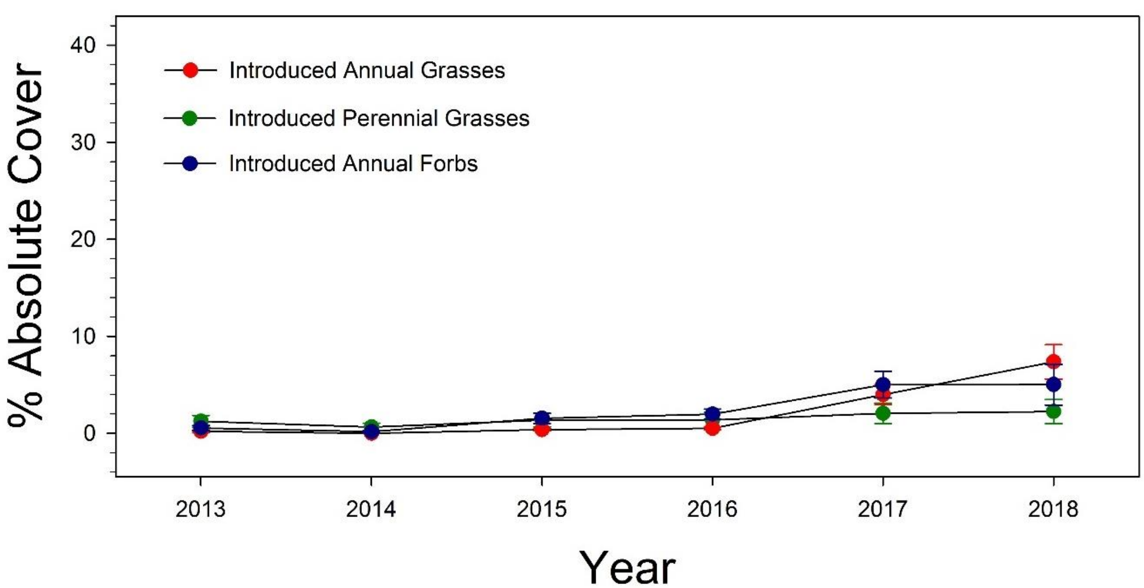


**Figure 3-4b. Mean cover from functional groups of introduced species in sagebrush habitat plots (n=48) on the Idaho National Laboratory Site from 2013 through 2018. Error bars represent ± 1 SE.**

On non-sagebrush monitoring plots, cover from shrubs, primarily green rabbitbrush, has been stable from 2013 to 2018 (Figure 3-5a), and has been comparable to cover from the same functional group on sagebrush habitat monitoring plots (Figure 3-4a). Native perennial grass cover increased notably from 2014 to 2015 and has remained at about 20% since 2015. Cover from introduced annual forbs also increased from 2014 to 2015 and has remained at about the same cover level since 2015 (Figure 3-5b). The most substantial change in cover on the non-sagebrush plots through the sample period is from cheatgrass (Figure 3-5b). Cheatgrass increased from about 3% absolute cover in 2013 to about 35% absolute cover in 2018.The recent increase of cheatgrass cover does not appear to be at the expense of species in other functional groups.

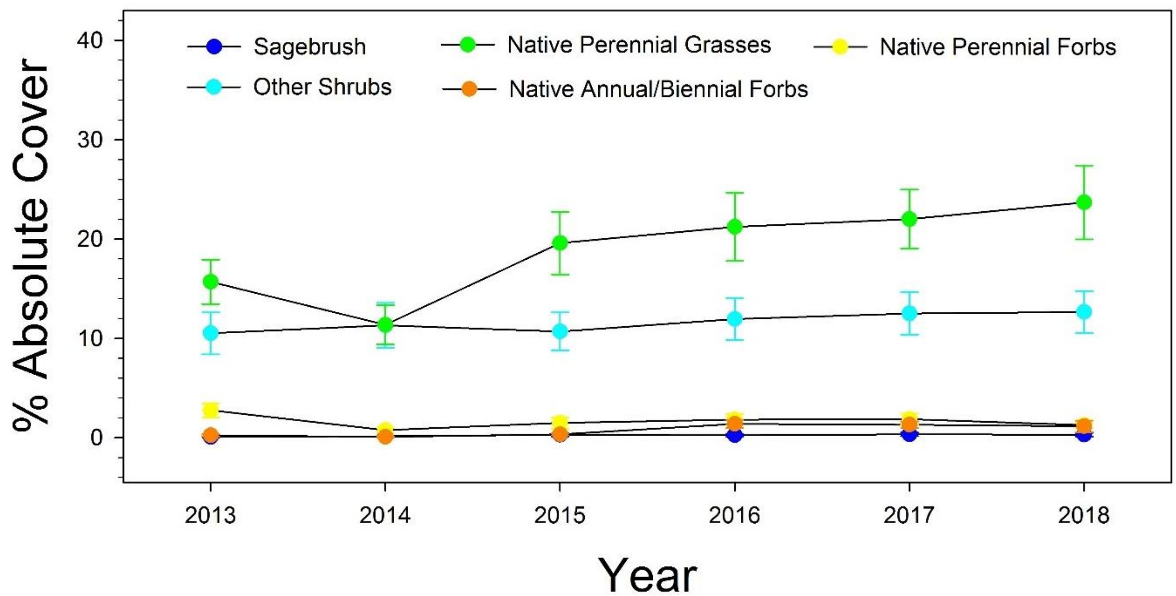


**Figure 3-5a. Mean cover from functional groups of native species in non-sagebrush habitat plots (n=27) on the Idaho National Laboratory Site from 2013 through 2018. Error bars represent ± 1 SE.**

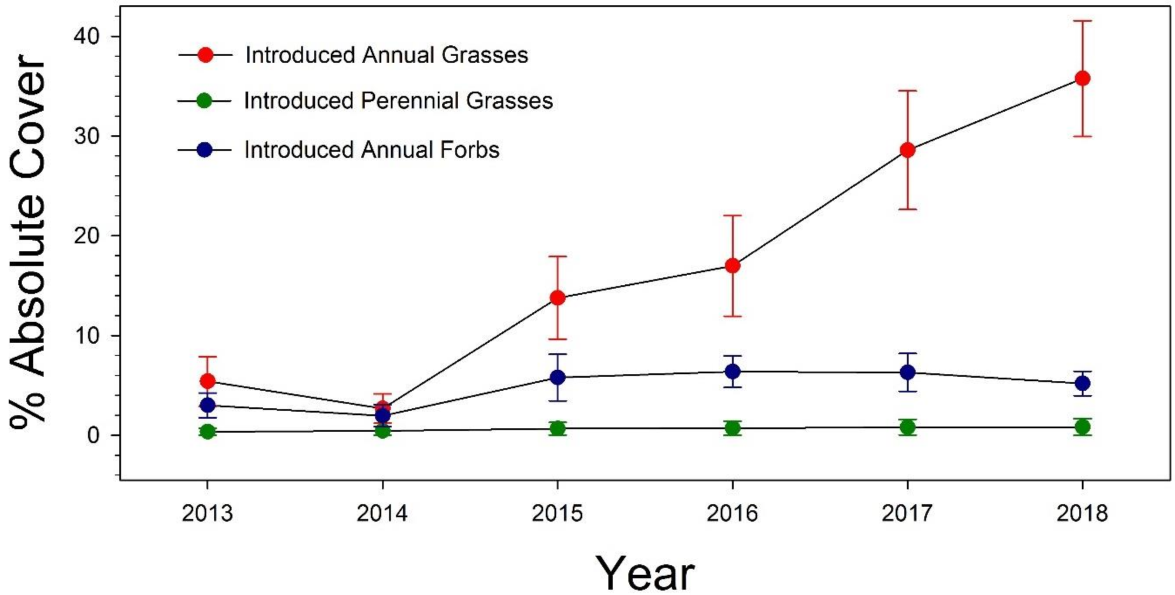


**Figure 3-5b. Mean cover from functional groups of introduced species in non-sagebrush habitat plots (n=27) on the Idaho National Laboratory Site from 2013 through 2018. Error bars represent ± 1 SE.**

### 3.1.4 Summary of Habitat Condition

Beginning this year, we have developed local habitat condition values for several metrics that will be utilized to assess sagebrush habitat quality on the INL Site. For the past five years we have assessed sagebrush habitat to regional guidelines; however, regional guidelines provide very general recommendations that are often inappropriately applied to the local habitat scale. The development of local standards are recommended (Connelly et al. 2000) and we have used INL Site habitat condition data from 2013 – 2017 to generate local habitat condition guideline values for vegetation cover, vegetation height, and sagebrush density. These new INL Site local habitat condition guideline values are representative and incorporate data across a range of spatial and temporal condition including local weather patterns, vegetation classes, and land uses. The new local habitat condition values will allow biologists to more confidently interpret habitat condition across the INL Site. However, these data represent a limited point in time where INL Site vegetation are likely not centered within their range of variability. Therefore, we will continue to interpret the local habitat condition values with caution when determining departures from these values which define the condition of habitat on the INL Site.

Average local habitat condition values of sagebrush cover from annual sagebrush habitat plots 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). Average local habitat condition values for sagebrush height is also within the suggested optimal range (40-80 cm). Perennial grass/forb height and cover values were above the minimum value recommended (18 cm) in current sage-grouse habitat guidelines (Connelly et al. 2000). 2018 mean sagebrush cover from annual sagebrush habitat plots have remained stable since the beginning of the monitoring program. Perennial herbaceous height and cover values were above the average local habitat condition values for both sagebrush habitat plots and non-sagebrush habitat plots. Sagebrush habitat plots show an increase in introduced herbaceous species cover which may suggest local sagebrush habitat may be less resistant to cheatgrass. The sharp increase in cheatgrass cover values in non-sagebrush habitat plots over the six-year sample period should be noted (Figure 3-5b). Cheatgrass results from this monitoring task should be interpreted with caution because it is unclear, based on this relatively short-term dataset, whether this trend is directional or the result of recent weather-mediated fluctuations.

Weather patterns during this monitoring effort have been highly variable, and herbaceous functional groups are highly influenced by precipitation. Precipitation during the 2014 growing season were 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. The above average snowpack of the winter of 2016/2017 and the second highest recorded precipitation in May of 2018 provided ample spring moisture, for two growing seasons, benefiting herbaceous species. As with perennial herbaceous species, mean cheatgrass cover and cover from all annual species was probably uncharacteristically low in 2014 and was probably higher than normal from 2016 through 2018. Because more of the vegetation cover on non-sagebrush (i.e., previously burned) plots is from herbaceous species, they appear to be more responsive to precipitation and less stable in terms of total cover and species composition from one year to another.

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, but we can reasonably extrapolate trends for general functional groups. Overall trends in herbaceous cover on the LTV plots indicate that perennial grass and forb cover is at the high end of its range of variability on the INL Site (Forman and Hafla 2018). Although the recent increase in cheatgrass on monitoring plots for this task is concerning, especially in the burned non-sagebrush habitat plots, longer-term data from the LTV show both upward and downward trends in cheatgrass abundance from one time period to another. The LTV data also indicate that cheatgrass occurrence is just as spatially variable as it is temporally variable. Cheatgrass cover actually decreased from about 5% average cover to about 1.5% average cover between the 2011 and 2016 LTV sample periods (Forman and Hafla 2018). The threat of cheatgrass to sagebrush habitat should not be underestimated, but six years of annual sagebrush habitat plot trend data are likely not enough to fully understand the nuances of invasion dynamics.

## 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 on the INL Site 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 geographic information system (GIS) analysts will routinely compare new imagery as it becomes available with existing land cover data from the most recently completed vegetation classification and mapping project. Ground-based point surveys and changes in plant species cover and composition documented through Task 5 (Section 3.1) 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 2013baseline has been identified as a conservation trigger in the CCA (DOE-ID and USFWS 2014). The purpose 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 map the addition of 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 map errors are observed on the ground.

### 3.2.2 Methods

Maintaining the INL Site vegetation map following wildland fire 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., Bureau of Land Management) 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), actual fire edges were digitized from high resolution imagery to maintain spatial consistency across the map. Before new vegetation class delineations are produced inside fire boundaries, 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.

### 3.2.3 Results and Discussion

There were 5 small wildland fires documented near or on the INL Site in 2018 (Unpublished wildland fire statistics summary for 2018; Eric Gosswiller, INL Fire Chief). The “Highway 33 Fire” was a collection of 19 small roadside fires that burned off Site to the west and likely didn’t impact any sagebrush habitat. The “Portland Fire” was a roadside fire that burned near a borrow source in sagebrush habitat, but was estimated at only 0.5 acre in size. The “Highway 20 Fire” was a small roadside fire (< 0.5 acre) that burned outside of sagebrush habitat. The “Birch Fire” was a lightning-caused fire and burned about 3 acres in sagebrush habitat near Birch Creek. The “Clark County Fire” burned less than 0.25 acre and no location information was available to determine if it was in sagebrush habitat. The losses of sagebrush habitat were minimal and once new NAIP imagery is collected in 2019, we will update any sagebrush habitat polygons where sagebrush was lost because of fire.

Currently, the sagebrush habitat baseline value is estimated at 78,558 ha (194,120 ac). Although no real changes in the amount of sagebrush habitat within the SGCA have been recorded since the CCA was signed, the habitat trigger baseline value was increased twice following improved fine-scale mapping of recent fires (Shurtliff et al. 2016, 2017). The sagebrush habitat baseline value remained basically unchanged in 2018 except for the very minor losses reported in the Task 8 Infrastructure Expansion section below (see Section 4.2.3). Infrastructure expansion removed 2.3 ha (5.6 ac) of sagebrush habitat resulting in a current estimated amount of 78,555.2 ha (194,114.2 ac), which is less than 0.01% change from baseline.

# 4.0 THREAT MONITORING

The CCA identifies and rates eight threats that potentially impact sage-grouse and its habitats on the INL Site, either directly or indirectly. All threats are addressed to some extent by conservation measures DOE is striving to implement (Section 5). The potential impacts of wildland fire and livestock on sage-grouse habitat are assessed by Task 5 (Section 3.1). Other threats are addressed by tasks designed specifically to develop a baseline and provide continuing information about a threat, because associated conservation measures cannot be implemented without this *a priori* information. The following sections report on Tasks 4 and 8, which were developed to address the threats of raven predation (Task 4) 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.

In previous years, we also reported in this section results from Monitoring Task 7, which was designed to identify a prioritized list of potential cheatgrass treatment areas on wildland fire containment lines. The intent was that DOE would then be able to take action (via Conservation Measure 4) to reduce the extent and density of cheatgrass. In consultation with ESER, DOE has concluded there is currently no cost-effective way to directly reduce cheatgrass dominance at a meaningful scale within sagebrush habitat on the INL Site. We will continue, however, to monitor the abundance and spatial distribution of cheatgrass on the INL Site through Monitoring Tasks 5 and 6 (see Section 6.2.4). This information, when coupled with other ecological data collected regularly on the INL Site, will allow DOE and USFWS to continue to evaluate changes to the cheatgrass threat and to respond appropriately where feasible. Furthermore, although no task will be aimed directly at reducing cheatgrass abundance, the potential impact of cheatgrass will be reduced to the extent that DOE successfully implements measures restricting the occurrence or impact of wildland fire and infrastructure development.

## 4.1 Task 4—Raven Nest Surveys

### 4.1.1 Introduction

During the last century, common raven (*Corvus corax*, hereafter raven) abundance has greatly increased throughout the historic range of sage-grouse (Larsen and Dietrich 1970, Andrén 1992, Engel and Young 1992, Boarman et al. 1995, Sauer et al. 2011), and in recent years, increasing raven densities have been negatively associated with sage-grouse nest success and lek trends (Bui et al. 2010, Coates and Delehanty 2010, Dinkins et al. 2016, Peebles et al. 2017, Coates et al. 2018). In studies that implicated raven density or predation in reduced sage-grouse nest success, it is likely that other interacting factors contributed to declines. For example, loss and degradation of concealment cover due to non-native annual grasses, wildland fire, or infrastructure development, when combined with effects of raven predation or presence, may negatively affect sage-grouse nest success. Whereas some sage-grouse population limiting factors can be difficult or impossible to arrest (e.g., drought, cheatgrass spread), reducing nesting subsidies for ravens is one action that DOE may be able to address.

Today, most raven breeding pairs on the INL Site nest on anthropogenic structures including electric power transmission lines, towers, and building platforms, with transmission line structures supporting the most nests (Howe et al. 2014; Shurtliff et al. 2018). 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). Later, this scope broadened into a commitment from DOE to work with INL contractors and others to opportunistically reduce raven nesting on any anthropogenic structure, including power lines, towers and structures at facilities (Sec. 6.2.7). DOE continues to recognize the value of research that would improve its ability to deter nesting on power lines, but it also recognizes that some raven nesting on towers and at facilities could be deterred by simple methods employed at appropriate times. Hence, it now encourages ESER and contractors to seek opportunities, and where appropriate to collaborate together or with the National Oceanic and Atmospheric Administration (NOAA), to reduce the suitability of any structure that has been previously used for nesting to support a nest in the future.

To accomplish the original design of Conservation Measure 10 (i.e., to support research on nest deterrents), and to support the broadened scope, ESER established and continues to implement a raven nest monitoring task (Task 4) by which nearly all infrastructure on the INL Site are monitored throughout much of the raven nesting period. The purpose of the task is three-fold: (1) to determine how many raven nests are supported each year by anthropogenic structures on the INL Site so that we may evaluate inter-annual trends; (2) to identify structures or stretches of power line favored by ravens for nesting year after year, which may be candidates for retrofitting; and (3) to allow us to evaluate the effectiveness of deterrents after they are installed.

Task 4 is also useful for purposes outside of the primary objectives listed above. For example, we are able to quantify distances between nearest nests of both ravens and raptors (raptor nests are also recorded during surveys), because this information provides insight into the home-range size of ravens and, consequently, the capacity of the landscape on the INL Site to support an increasing number or nesting ravens.

### 4.1.2 Methods

Between April 2 and June 1, 2018, we systematically surveyed all power lines (transmission lines=231 km, distribution lines=37 km), towers, raptor nesting platforms and facilities on the INL Site that had been surveyed the previous year (Shurtliff et al. 2018), following methods described elsewhere (Shurtliff et al. 2015). All power line segments were surveyed four times, with each survey being separated by at least 14 days. Facilities, towers, and other infrastructure were surveyed at least twice, primarily in April. If a nest was seen on a structure, but its activity level could not be confirmed, we revisited the nest again before the next formal survey commenced. As a result, nests that remained unconfirmed throughout the nesting season were visited twice as often as nests with confirmed activity. This level of effort increased our confidence at the end of the season that remaining unconfirmed nests had not been occupied by ravens during the breeding season.

#### Trend Analysis

The number of raven nests classified as active each year is an index of the number of mated pairs on the INL Site that use infrastructure as a nesting substrate. Throughout the two-month survey period, nests occasionally blow down or are abandoned. If a mated pair loses a nest and rebuilds a second nest during the survey period, our sampling method records two active nests. This artifact of our sampling scheme produces an unknown level of variability that potentially affects the accuracy of raven nest trend data. To reduce this variability, we calculated an adjusted raven nest total as described elsewhere (Shurtliff et al. 2017).

#### Nearest-Nest Analysis

To indirectly examine how closely territory-holding raven pairs are willing to nest (and thus to estimate how many pairs potentially could be sustained on the INL Site), we first identified all raven nests within 2 km of each other. For each nest, we used a GIS measuring tool at a set scale (1:2,000) to manually calculate the distance to the nearest raven nest and, if a raptor nest was closer, to the nearest raptor nest. We did not count nests as "nearest" unless occupant activities from both nests overlapped temporally. 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.

### 4.1.3 Results

We observed 45 active raven nests on man-made structures or in trees associated with facilities along survey routes. Thirty-three of the 45 nests were on power line structures, all of which were transmission or lattice structures. We merged two pairs of power line-based nests, (N104/N344 and N69/N410), because they met our criteria of having been likely occupied by the same nesting pair (Shurtliff et al. 2017). Thus, the total number of active raven nests (i.e., adjusted total) was 43, with 31 (72%) of those on power lines (Tables 4-1, 4-2).

At 26 locations, we were unable to confirm whether a nest was active or inactive. If we do not observe the nest occupied or maintained by a bird (i.e., active), or if we lack positive evidence the nest is unoccupied (i.e., nest progressively degrades or falls to the ground), we cannot rule out that the nest was active, at least temporarily. Such nests are therefore classified as "unconfirmed". Fourteen of the 26 unconfirmed nests were on building platforms, ornamental trees, or raptor platforms – structures that can support inactive nests for many years. On transmission lines, where nests are susceptible to being blown off during high winds, we failed to confirm activity status for 10 nests. Each of these nests were observed once or twice (typically in April), but were missing during subsequent surveys. Three of the 10 nests were probably inactive remains from 2017 nests (although it is possible that the 2017 nests blew down and were rebuilt in the same location in 2018), but seven were new in 2018. It is likely that several of these nests that appeared in 2018 were built by ravens or raptors and abandoned soon thereafter. Two unconfirmed nests were first observed on 11 May and were present through the end of the survey. Although no birds were seen at either nest, these two nests are the most likely of the 26 unconfirmed nests to have been occupied by ravens or raptors for more than a few days.

#### 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 April 2–27, and the second two occurred from May 4–June 1, 2018. All 31 raven nests associated with power lines were on transmission rather than distribution structures. Eighteen nests were on "Closed H Cable" structures, 11 were on "Sloped H", and two were on "Hybrid" structures (see Shurtliff et al. 2017 for pictures of structures).

#### Facilities

We surveyed the same 13 facilities in 2018 that were surveyed in 2017, between April 4 and May 2, 2018, and documented eight active raven nests at seven facilities (Table 4-1). The two nests assigned to a single facility included one nest inside the fence of the Materials and Fuels Complex (MFC) and one nest on the nearby Transient Reactor Test Facility (nests were ~1,194 m apart).

**Table 4-1. Summary of active raven nests (adjusted) on the Idaho National Laboratory Site, observed on anthropogenic features within and without the Sage-Grouse Conservation Area (SGCA) during 2018 surveys. Those on the border of the SGCA were counted as being within the SGCA.**

| # Active Nests | Substrate | Within SGCA | Outside SGCA |
|---|---|---|---|
| 31 | Power Line | 14 | 17 |
| 6 | Building Platform | 0 | 6 |
| 1 | Effluent Stack | 0 | 1 |
| 4 | Tower | 2 | 2 |
| 1 | Ornamental Tree | 0 | 1 |
| **Totals 43** | | **16** | **27** |

**Table 4-2. Facilities surveyed for raven nests in 2018. The number of days between surveys is indicated, although 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/Radioactive Waste Management Complex | 2 | 14 & 15[a] | Yes | Building Platform |
| Central Facilities Area Main Gate | 2 | 14 | Yes | Building Platform |
| Critical Infrastructure Test Range Complex | 2 | 17 | No | N/A |
| Experimental Breeder Reactor I | 2 | 14 | Yes | Building Platform |
| U.S. Sheep Experiment Station | 2 | 19 | No | N/A |
| Idaho Nuclear Technology and Engineering Center | 2 | 15 | Yes | Effluent Stack |
| Materials and Fuel Complex /Transient Reactor Test Facility | 2 | 14 | Yes (2 nests) | Building Platform |
| Naval Reactors Facility (NRF) | 2[b] | 16 | Yes | Ornamental Tree |
| Specific Manufacturing Capability/Test Area North | 2 | 22 | Yes | Building Platform |
| Advanced Test Reactor Complex | 2 | 14 | No | N/A |
| Central Facilities Area | 2 | 15 | No | N/A |
| Highway Department | 2 | 19 | No | N/A |

[a]Due to scheduling constraints, we do not always survey the two facilities that adjoin each other on the same day.

[b] Environmental Surveillance, Education, and Research personnel are restricted from entering the NRF. Therefore, several years ago we trained an NRF representative, and he reports to ESER two times each season on his raven nest observations.

### Towers

We surveyed six towers twice, four towers three times, and one tower four times between April 3 and May 9, 2018. We conducted extra surveys (i.e., >2) when a nest was present on a tower and the activity level of that nest remained unknown after two surveys.

In 2018, ravens maintained active nests on two cellular phone towers located near the INL Site boundary and on two meteorological towers operated by NOAA (Figure 4-1; Table 4-2). We confirmed that ravens nested on the NOAA towers on the west and east side of the INL Site each of the past five years and four years, respectively. The cellular phone tower on the northeast boundary has supported an active raven nest for the past three years, whereas 2018 was the first year a raven nest has been recorded on the cellular phone tower near the southeast boundary.

### Nesting Trends

The number of active raven nests (adjusted) on the INL Site was 5% higher in 2018 than in 2017 (Figure 4-2) and was one less than the high count in 2016.

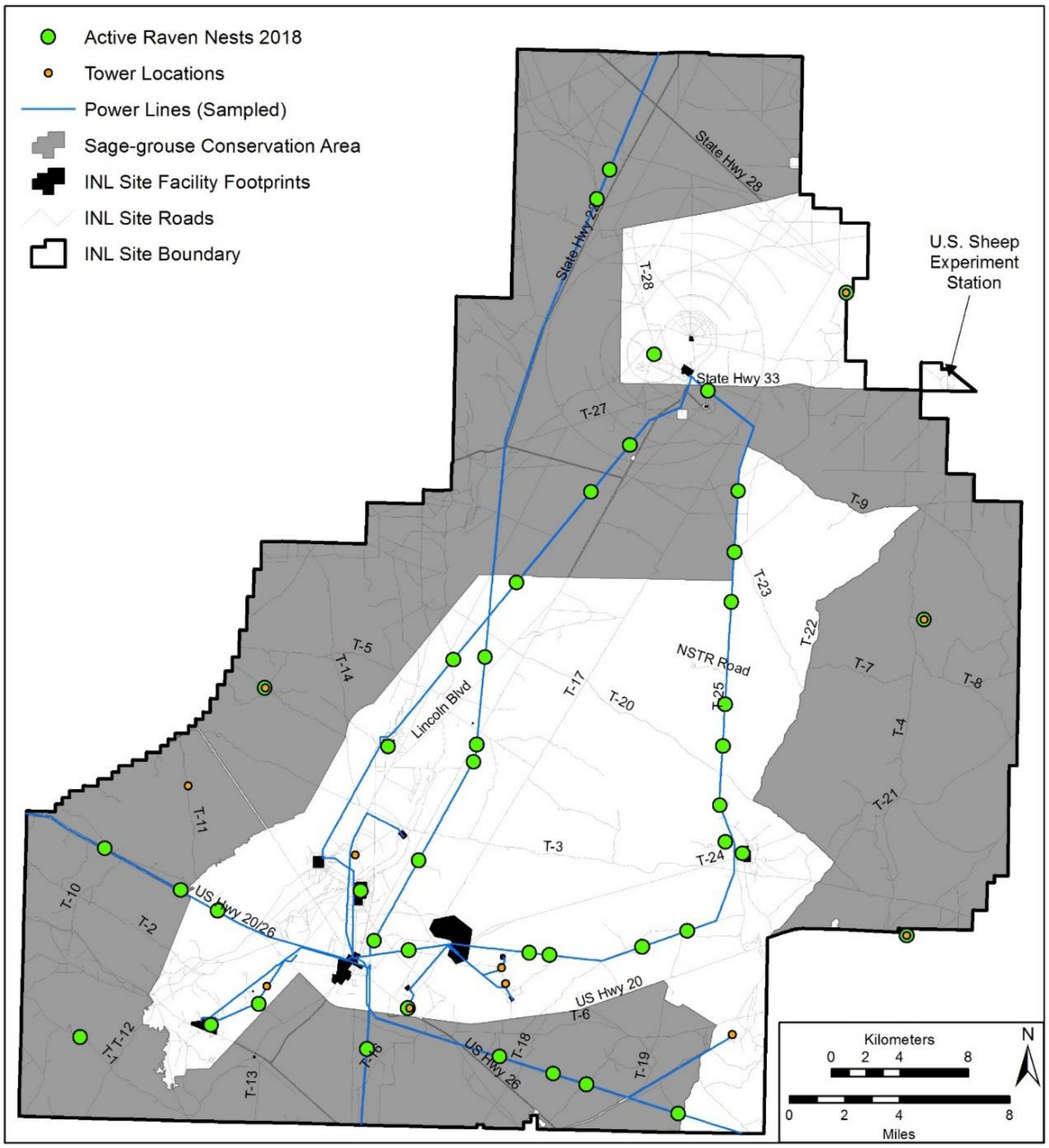


**Figure 4-1. Results of 2018 raven nest survey. Raven nests displayed represent adjusted nest locations (*n*=43).**

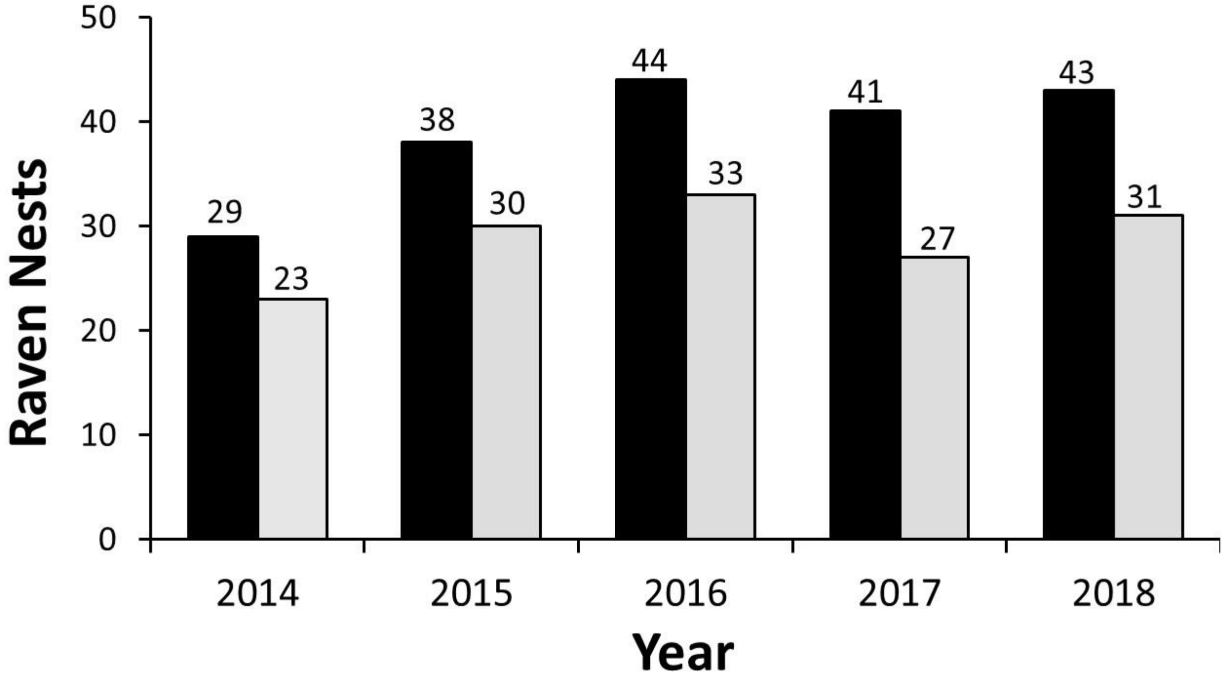


**Figure 4-2. Adjusted number of raven nests observed on Idaho National Laboratory Site infrastructure. Black bars represent total nest counts and gray bars represent nests on power lines.**

### Nest Distances

*Raven–Raven*

The nearest two raven nests for which we had records of concurrent attendance were estimated at 1,033 m apart. Two other pairs of active nests were each less than 1,200 m apart, and a total of five pairs of active raven nests were within 2,000 m of another active raven nest.

*Raven–Raptor*

In ten instances, a raven nest was closer to a concurrently active raptor nest than to another raven nest. In these instances, ravens nested 305–411 m from great-horned owl (*Bubo virginianus*), Swainson's hawk (*Buteo swainsoni*), and unidentified *Buteo* hawk nests, 599–1,340 m from red-tailed hawk (*Buteo jamaicensis*) nests (*n*=4), and 731–761 m from ferruginous hawk (*Buteo regalis*) nests (*n*=2).

**Table 4-3. Summary of raven infrastructure nest survey data since full surveys began on the Idaho National Laboratory Site in 2014. "Adjusted" data (columns 3–4, 6–7) are indexes of breeding pairs of ravens after accounting for nests that blew down and were likely rebuilt by the same nesting pair. The distance between the two closest, concurrently active raven nests is listed in the last column.**

| Year | Total Active Nests Observed | Adjusted Active Nests | Change from past year (Adjusted) | Total Power Line Nests Observed | Adjusted Power Line Nests | Change from past year (Power lines) | Nearest Nests (m) |
|---|---|---|---|---|---|---|---|
| 2014 | 35 | 29 | N/A | 29 | 23 | N/A | 1,525 |
| 2015 | 39 | 38 | 31% | 31 | 30 | 23% | 1,525 |
| 2016 | 46 | 44 | 16% | 35 | 33 | 10% | 1,216 |
| 2017 | 43 | 41 | –7% | 28 | 26 | –21% | 378* |
| 2018 | 45 | 43 | 5% | 33 | 31 | 15% | 1,033 |

*Nearest nests may have American crow nests, erroneously classified as ravens (see Discussion).

### 4.1.4 Discussion

The adjusted number of raven nests recorded on the INL Site was 5% higher in 2018, compared to 2017, and is nearly identical to the peak number observed in 2016. Given that the number of nests has fluctuated by only three during the past three years, we tentatively conclude that raven use of anthropogenic substrates for nesting on the INL Site is stable. Monitoring for a greater number of years will increase our confidence in accurately detecting the true trend.

#### Nesting at Facilities and on Towers

During 2018, ravens nested at the same facilities as in 2017, with three exceptions. No raven nests were observed at the Critical Infrastructure Test Range Complex this year, nor at the U.S. Sheep Experiment Station (Sheep Station; Table 4-2). However, for the first time since surveys began, we documented a raven nest at the MFC (Shurtliff et al. 2018).

The lack of raven nests at the Sheep Station is a notable contrast to last year's report of three raven nests at that facility (Shurtliff et al. 2018). We speculate, however, that some if not all three of the 2017 nests were in reality occupied by American crows (*Corvus brachyrhynchos*). In 2018, we confirmed that a nest at the Sheep Station was occupied by crows, noting the smaller size of the nest and the defensive posturing of adult crows when approached. Later, we considered that the area near Mud Lake and the Sheep Station is the only area on the INL Site where American crows are regularly observed during annual Breeding Bird Surveys (ESER, unpublished Breeding Bird Survey data, 1985-2018), and crow nests have never been documented elsewhere on the INL Site during Task 4 nest surveys. Finally, we never documented raven nests closer than 1,216 m before last year, yet last year we reported that the three raven nests at the Sheep Station were separated by merely 377 m and 421 m. For these reasons, we conclude it is likely that one or more nests attributed to ravens in 2017 were occupied by crows.

If all three raven nests from the Sheep Station had been attributed to crows, the 2017 raven nest total would have been 38 (Figure 4-2). Thus, the 2018 raven nest count would be 13% higher than in 2017. Regardless of whether the Sheep Station nests were occupied by crows or ravens, our results suggest that the number of raven nests on anthropogenic substrates has been stable on the INL Site for at least the past three years. If ravens indeed occupied fewer nests in 2017 than were reported, our current conclusion of a stable trend would extend to the past four years.

DOE does not own any of the weather monitoring or cellular service towers occupied by ravens in 2018, and therefore it cannot make a unilateral decision to install nest deterrents. ESER continues to work with NOAA to improve the placement of hardware cloth on its two towers, which have been used for nesting for several years. Hardware cloth installed by NOAA technicians last year did not adequately cover the most likely nesting sites on the towers, but NOAA intends to add more hardware cloth at the end of 2018.

### Nearest-Nest Distances

Previously, we concluded that raven nesting pairs may not tolerate another raven nest within 1,200 m of their own nest on the INL Site (Shurtliff et al. 2017). Our conclusion was based on data from the first three years of raven nest surveys, during which time we had not observed any two raven nests closer than 1,216 m (Table 4-3). In 2017, we observed a cluster of what we thought were three active raven nests at the Sheep Station, with nest-pair distances measured at 377 and 421 m. As explained above, we now question whether one or more of those nests recorded as being occupied by ravens were actually maintained by American crows. If two nests were erroneously assigned, the nearest raven nest pair in 2017 on the INL Site would have been 1,841 m apart (Shurtliff et al. 2018).

The minimum distance between two concurrently active raven nests in 2018 was slightly less than previously observed (excluding the 2017 cluster of nests), and less than the 1,200 m hypothesized threshold established by past surveys. In 2018, three nest pairs were closer than 1,200 m, with the minimum being 1,033 m apart. Although these distances are slightly less than past observations, they fail to reject the hypothesis that intraspecific competition for resources among ravens is one of the drivers responsible for the spatial distribution for nests on the INL Site. The same level of competition apparently does not apply between ravens and raptors, as nearest-nest distances were much lower, regardless of the raptor species.

### Management Implications

Conservation Measure 10 in the CCA specifically identifies utility structures as the target for nest deterrent experiments because most raven nests on anthropogenic structures are on transmission line structures. Since the CCA was signed however, a number of factors have reduced the priority of this conservation measure relative to other ongoing or potential actions that can or could be taken to address threats to sage-grouse. For example, during the January 2017 meeting between the USFWS and DOE, the USFWS emphasized that addressing wildland fire and invasive weeds is the highest priority for the USFWS region-wide. Another factor reducing the priority of Conservation Measure 10 is that most power line sections that support raven nests are outside the SGCA. A recent study in Nevada found that sage-grouse reproductive success was impacted up to 12.5 km from a transmission line when raven abundance was high (Gibson et al. 2018). However, we know of no regional studies in habitats similar to the INL Site where impacts from ravens have been assessed on sage-grouse. Until home range or other movement data from nesting ravens become available in a landscape analogous to the INL Site, we will be unable to determine the degree to which sage-grouse nests in the SGCA are threatened by resident ravens. Thus, understanding raven behavior may be a more important priority than installing nest deterrents because the latter would be a much greater cost and could potentially be unnecessary if most nest-tending ravens don't forage in the SGCA.

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

### 4.2.1 Introduction

Infrastructure development is now considered a medium-ranked threat to sage-grouse on the INL Site (see Section 6.2.1). Infrastructure promotes habitat fragmentation, and construction of new infrastructure nearly always disturbs soil. If proper controls are not in place, soil disturbance can facilitate the introduction and spread of invasive weeds, which in turn can increase the risk of wildland fire. Weeds may also replace native plants and reduce plant diversity in localized areas, which impacts habitat condition.

Prior to the start of an INL Site construction project that may affect undeveloped land, a NEPA analysis is conducted on the portion of land slated for the project. Evidence from remotely sensed images of the INL Site spanning over a decade suggests that sometimes infrastructure footprints expand beyond what was originally authorized during the NEPA review. Thus, there is a possibility that an unplanned impact to sagebrush habitat and other native plant communities could occur following infrastructure development. Occasionally, mitigation following the completion of a construction project fails to meet its objectives. If no overarching plan for mitigation is developed, infrastructure requirements may continue to slowly expand as a project moves forward, without new structures and disturbances being taken into account.

Inappropriate vehicle use associated with trespass and livestock grazing management can also cause habitat degradation in localized areas. Remote sensing imagery shows that the number of linear features (e.g., two-track roads) on the INL Site, especially within grazing allotments, continues to increase since the establishment of baseline condition for this monitoring task (unpublished data; Shurtliff et al. 2017). It is likely that most of these two-tracks 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 a new unauthorized 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.

The U.S. Department of Agriculture NAIP collects digital imagery across the State of Idaho every two years. The publically available image dataset product consists of four spectral bands (blue, green, red, and near-infrared) usually collected at 1 m spatial resolution. Occasionally a State will contribute additional funds to have higher resolution imagery collected across the entire State. The 2013 Idaho NAIP imagery was acquired at 0.5 m spatial resolution and that dataset was used to establish the baseline for this monitoring task (Shurtliff et al. 2016). The availability of high resolution imagery collected across Idaho every two years, at no cost to the user, provides an invaluable tool to monitor the INL Site landscape and identify changes over time using a GIS.

The primary goal of this task is to update sagebrush habitat distribution by identifying where expansion of infrastructure has removed sagebrush habitat within the SGCA and other areas of existing sagebrush habitat. In some cases, there has been approved expansion at facilities (e.g., new MFC ponds) that was not present when the INL Site vegetation map was originally being completed (Shive et al. 2011). And because the estimated amount of sagebrush habitat is generated from the vegetation map by cross-walking all classes dominated by sagebrush, there are regions currently mapped as sagebrush habitat which are not reflective of recent ground conditions and need to be updated periodically.

An important secondary goal of Task 8 is to continually monitor the increase in linear features (e.g., two-track roads) across the INL Site landscape, specifically within sagebrush habitat and the SGCA. Newly created linear features can provide vehicle access to formerly undisturbed areas. This can serve as a vector for non-native species, and can also result in direct disturbance to sagebrush habitat by damaging or removing sagebrush. When numerous two-tracks begin to appear in areas previously void of road access, it can serve as an early indication that further habitat degradation is possible.

### 4.2.2 Methods

The GIS analysis workflow for this task includes three main steps: (1) download new aerial imagery when available and mosaic a new basemap dataset, (2) review the entire INL Site and mark potential infrastructure expansions and new linear features, and (3) delineate all new infrastructure footprints and digitize linear features, and then modify sagebrush habitat polygons where expansion has removed sagebrush.

Throughout the summer of 2017, high resolution multispectral digital imagery was collected across the State of Idaho through the NAIP program. This imagery was the standard NAIP dataset with four spectral bands collected at 1 m spatial resolution.

Two GIS Analysts systematically zoomed into regions of the INL Site and looked for evidence of surface disturbance throughout the SGCA and also within sagebrush habitat outside of the SGCA. Occasionally, image properties were adjusted to accentuate pixel values in an area of interest or add more contrast to help with feature identification. The image review process occurred at fine map scales so minor changes on the landscape (e.g., a new set of vehicle two tracks) were detected. We visually scanned around facilities, borrow source/gravel pits and new project areas to investigate whether the infrastructure footprint has expanded and now overlaps regions previously mapped as sagebrush habitat. Areas of surface disturbance most commonly observed were linear features created by the presence of new two-track roads. Anytime a potential location was identified, it was marked for secondary review.

Once each GIS Analyst had thoroughly reviewed the entire INL Site, all potential infrastructure expansion locations were reconciled into a single list for final review. The lead analyst investigated each marked location and determined if the feature warranted delineation. Whenever infrastructure expansion removed sagebrush habitat, or linear features were observed, the area of disturbance and total linear distance was manually delineated. The new polygon and line features were managed within an ESRI File Geodatabase to maintain area and length statistics. All outdated sagebrush habitat polygons were manually updated using GIS editing tools which maintained topology with adjacent polygon boundaries.

### 4.2.3 Results

There were eight polygons mapped where infrastructure expansion removed sagebrush habitat. All of the expansions were minor with a total combined area of 2.3 ha (5.6 ac) of sagebrush loss. Three of the polygons mapped were new project footprints (i.e., cleared pads; Figure 4-3), two were small roadside expansions of disturbed area near vehicle pullouts, and three polygons (including two of the largest) were associated with livestock management where new water troughs were installed within the Quaking Aspen grazing allotment. The water troughs are evident in areas where livestock have congregated previously, and there was likely always local loss of sagebrush within those areas that was never removed because of the original mapping scale of the vegetation map. Now it appears the process of water trough installation, or more localized use by livestock, has expanded the disturbed footprint and warranted the removal from sagebrush habitat (Figure 4-4).

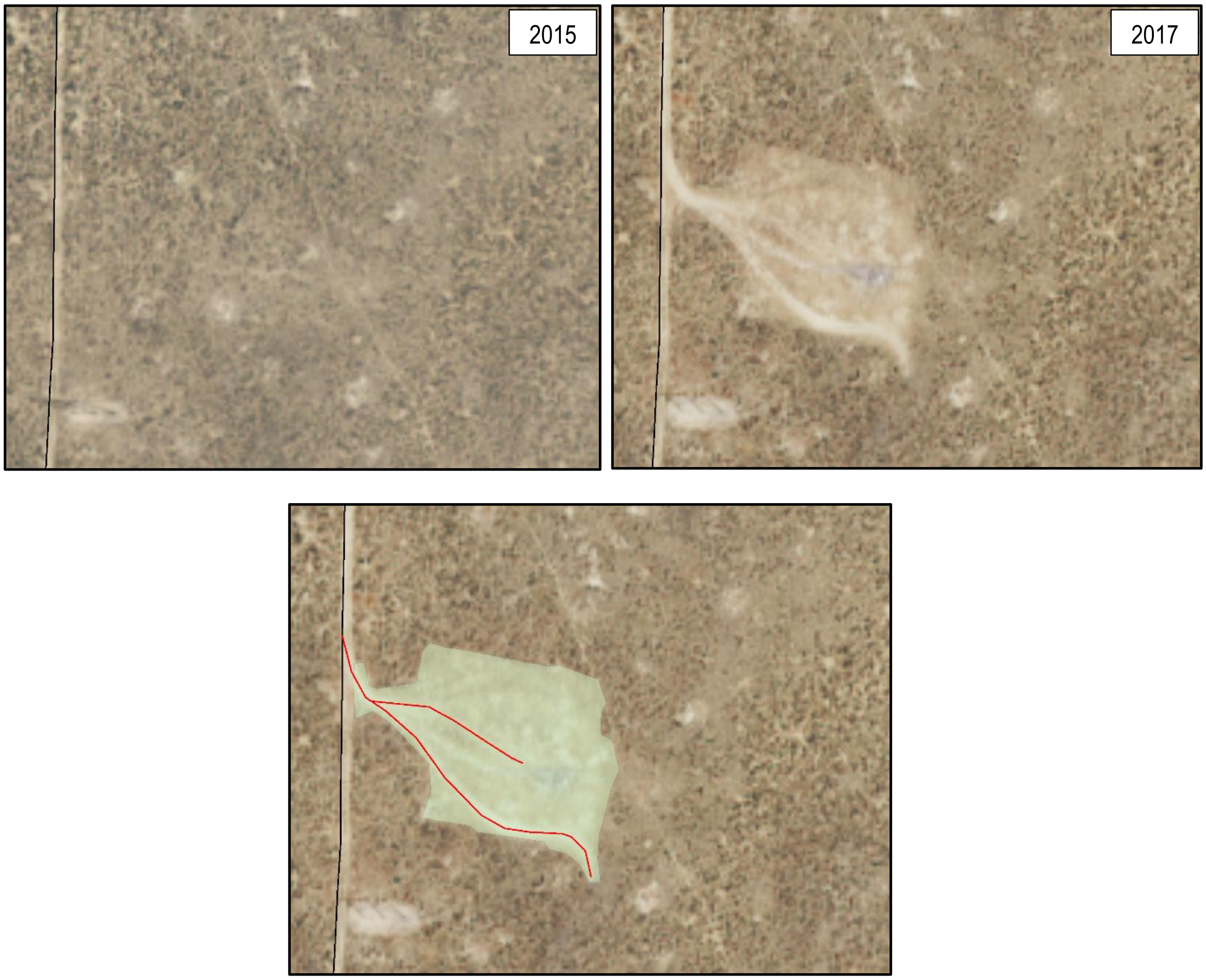


**Figure 4-3. The upper left image shows an example of an area on the Idaho National Laboratory Site in 2015. The upper right image shows the same location in 2017 after a new project footprint has removed sagebrush habitat. The bottom image shows the area mapped as sagebrush loss with a transparent green overlay and also includes two new two-track segments mapped and reported below. The entire area within the image extent was previously mapped as sagebrush habitat.**


**Figure 4-4. The upper left image shows an example of an area on the Idaho National Laboratory Site used by livestock permittees in 2015. The upper right image shows the same location in 2017 after four water troughs were installed. The bottom image shows the area mapped as sagebrush loss with a transparent green overlay. The entire area within the image extent was previously mapped as sagebrush habitat.**

We mapped 9.6 km (6 mi) of new linear features located within the SGCA and/or existing sagebrush habitat (Figure 4-5). The longest single linear feature mapped was 1.6 km (1 mi) and represents an extension to an existing road just north of the Jefferson Fire near the eastern side of the Site. Coincidentally the second longest linear feature was 1.3 km (0.8 mi) and serves as a shortcut between two existing roads right next to the longest linear feature previously described. There was also an additional 2.7 km (1.7 mi) of linear features mapped this year, but after cross-referencing these features with the previous 2015 NAIP dataset, we recognized that these features were present but were missed during the last review process (Figure 4-5). The NAIP imagery is collected across numerous days throughout the summer with the goal of producing cloud free images. Subsequently, the sun elevation angle will differ between image tiles and the shadows cast by lower sun angles sometimes help illuminate linear features better improving our ability to detect them (see Figure 4-6 as an example of illumination differences). It is important to consider that while some of the newly observed two-track linear features are actually new, some of the other linear features mapped previously (Shurtliff et al. 2016, Shurtliff et al. 2017) may be historic two-track roads that have only recently become recognizable in imagery.

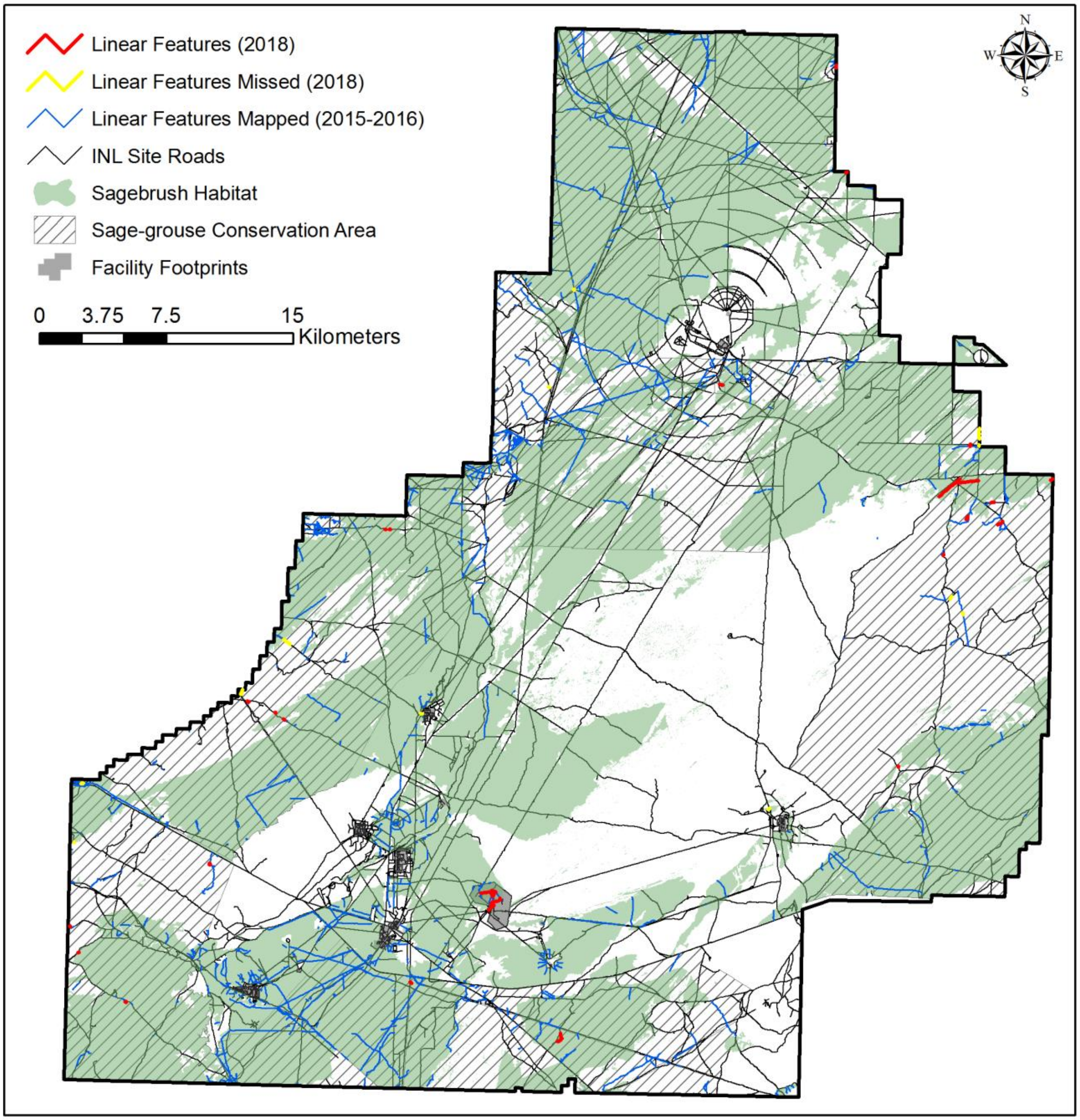


**Figure 4-5. Two track linear feature expansion within the Sage-Grouse Conservation Area or existing sagebrush habitat mapped in 2018 at the Idaho National Laboratory Site.**

The majority of new linear features mapped consisted of small spurs from existing two-track roads mapped previously, or side loops off existing two-tracks that may have been created to avoid standing water and mud along low spots in the road (Figure 4-6). A considerable amount of new linear features were associated with the Smart Grid project at the Critical Infrastructure Test Range Complex, but the majority of disturbance occurred outside of sagebrush habitat and the SGCA, and the area disturbed was already mitigated for by contributing the sagebrush seedling planting program coordinated by the ESER Program. Additional linear features were identified on the INL Site in 2018; however, only features that are within or partially within either the SGCA or sagebrush habitat were included in this report. The linear features not reported here are maintained in a geodatabase which may assist with future creation an updates to an authorized road layer for the INL Site.

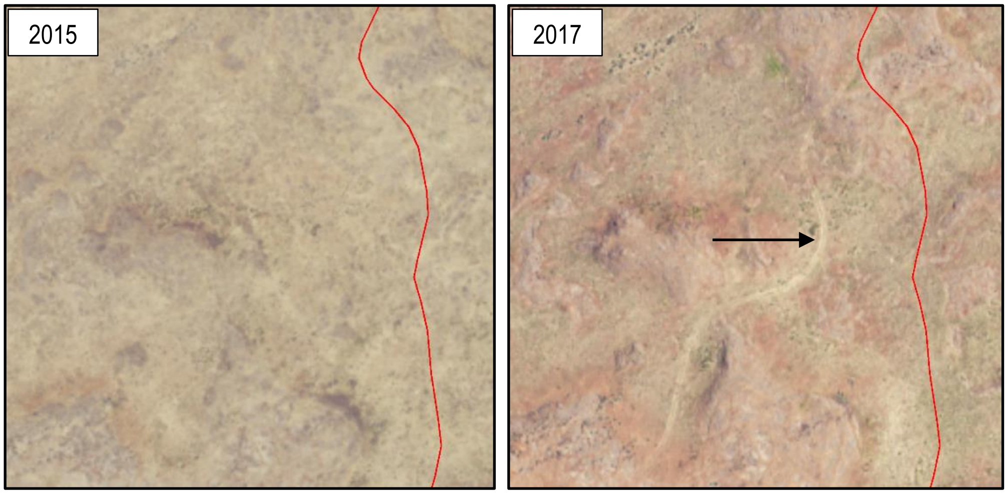


**Figure 4-6. The upper left image shows an example of an area on the Idaho National Laboratory Site within the Jefferson Fire burned area where a previously mapped two-track road appeared in a region without any prior road access. The upper right image shows the same location in 2017 where an addition spur was added.**

### 4.2.4 Discussion

The large number of two-track linear features mapped as the baseline in 2015 (Shurtliff et al. 2016) likely represented many years of accumulated unauthorized expansion rather than activities that have occurred in the last few years since the signing of the CCA. The much smaller linear distances of two-track features mapped during this analysis in 2016 and 2018 shows that the rate of increase within a two-year window remains fairly low. However, the total distance of linear features mapped in 2018 is a 2.2 km (1.4 mi) increase compared to the mapping results reported in 2016. And in some cases there are new two-track spurs being created that branch from other two-track roads which were likely unauthorized to begin with (Figure 4-6). This ever growing network of linear features may pose a threat to long-term sagebrush habitat condition as the likelihood of non-native species introduction into more pristine habitat, and the probability of wildfire from increase vehicle use in the backcountry becomes a legitimate concern. While these disturbances may seem insignificant compared to the total area of the INL Site, continuous cumulative impacts over time should be considered a bigger concern and monitored closely.

Many of the new linear features and accompanying sagebrush loss has occurred within BLM grazing allotments. While it is difficult to identify the cause of the observed expansion, because the majority of the SGCA is spatially coincident with grazing allotments boundaries, the installation of water troughs visible in imagery suggests at least some of the impacts result from permittee actions. Further interaction and open dialogue with the BLM may help reduce the loss of additional sagebrush habitat and minimize the creation of new two-track roads in the future.

# 5.0 IMPLEMENTATION OF CONSERVATION MEASURES

## 5.1 Summary of 2018 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. Table 5-1 summarizes DOE's actions during the past year to ameliorate threats to sage-grouse and its habitats.

**Table 5-1. Accomplishments in 2018 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, U.S. Department of Energy, Idaho Operations Office (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 2018:**<br>BURN ASSESSMENT— Approximately 8 ha (20 ac) were reported burned on the INL Site in five wildland fire incidents during 2018 (Unpublished wildland fire statistics summary for 2018; Eric Gosswiller, INL Fire Chief). This number is based on estimates made at incident sites. However, our cursory examination of fire locations using updated INL Site boundaries in a GIS suggests one fire estimated at 6.7 ha (16.5 ac) may not have burned onto the INL Site. In 2020, we will confirm the actual area burned using NAIP imagery. Because the reported fires were small, no post-fire assessment or sagebrush reestablishment was required. An estimated 31 acres have burned on the INL Site during the past six years in 13 separate incidents. Fewer acres have burned in the last six years than during any other six-year period dating back to at least 1988.<br>**Associated Conservation Actions that Addressed the Wildland Fire Threat:**<br>SAGEBRUSH PLANTINGS—ESER planted ~25,000 sagebrush seedlings in the Jefferson Fire scar (See Section 5.2).<br>FOLLOW-UP AFTER FIRES— About three miles of containment lines were constructed in 2018, all of which were re-contoured following the fire. At an October 29, 2018 Post-Season meeting of the INL Site Wildland Fire Management Committee, the committee agreed to implement the following actions to minimize the impacts of fires in 2018:<br>• Facility and Site Services will post signs to prohibit vehicle travel on the rehabilitated containment lines;<br>• Facility and Site Services will add the three miles of containment lines to the annual noxious weed and invasive species management control areas to control noxious weeds and map the locations. | |
| **Threat:** | Infrastructure Development |
| **Objective:** | Avoid new infrastructure development within the SGCA and 1 km (0.6 mi) 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 Best Management Practices outside facility footprints for new infrastructure development.<br><br>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—Implementation of Best Management Practices in 2018:** | |

- National and Homeland Security (N&HS) constructed a power grid test pad (Obsidian Test Pad) adjacent to an existing 138kV overhead power line (OHL) near the Bode Test Site. The Obsidian Test Pad is about 400 ft. X 400 ft. To reduce the potential for noxious weeds, the test pad was cleared, grubbed, and backfilled with gravel. The test pad is co-located with infrastructure.
- The U.S. Geological Survey (USGS) constructed a monitoring well (USGS-147) within the Sage Grouse Conservation Area (SGCA). The USGS made use of existing roads and sited the well adjacent to established roads. The area disturbed for borehole coring and drilling was about 250 ft. x 250 ft. The Environmental Checklist for the project stated that the project must avoid destroying sagebrush habitat and must re-establish sagebrush in acreages equal to or greater than acreages lost by project activities. Drilling did not occur prior to June 30th. After drilling, disturbance at the site is limited to the area needed to drive a truck and generator for sampling.
- To protect Wireless Test Bed (WTB) equipment from livestock at Crater Butte, a removable electric fence was installed around the Crater Butte WTB site. The project installed T-posts around the top of Crater Butte to support the fence. T-posts remain in place to reduce disturbance that would occur if T-posts were placed for every test, while the fence wire is removed when testing is not in being performed. The T-posts will be removed when the location is no longer required for testing. Marking the fence was not required.
- National and Homeland Security installs nest deterrents on dead-end and corner power poles during maintenance activities as funds allowed.

**Conservation Measure 3—Accomplishments in 2018:**

- During construction of the Obsidian Test Pad cited described above, the Circuit 56 13.8kV OHL was extended from the end of the Bode Test Pad to the new Obsidian Test Pad approximately ¼ mile to the north, but this line was not within a 1 km lek buffer area.
- A livestock grazing permittee proposed to install a fence within the SGCA in the southwestern part of the INL Site. The proposed fence line would parallel a highway and be within an Idaho Department of Transportation right of way. The installation process would require mowing the vegetation, including sagebrush. DOE discussed the issue with the USFWS in May, 2018, and the parties agreed that the vegetation community adjacent to a highway is poor-quality sage-grouse habitat, so active restoration to compensate for the lost sagebrush would be unnecessary (especially because sagebrush would likely return naturally within a few years). Furthermore, the USFWS agreed that this was a reasonable approach because the project is covered under a grazing permit issued by BLM for work to be performed in the state right of way, and the state had already issued a permit for the fence to be installed. The shared conclusion of DOE and USFWS is that DOE does not have responsibility in the action.

| | |
|---|---|
| **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 2018:**

See Section 6.2.4.

| | |
|---|---|
| **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:** | 5) Encourage the Bureau of Land Management (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.<br><br>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 that rangeland improvements follow guidelines in the BLM Land Use Plan and the CCA. |

**Conservation Measure 5—Accomplishments in 2018:**

UPDATED INFORMATION TO BLM—ESER provided updated lek maps to the DOE in January 2018 so they could be forwarded to the BLM. However, in a May 2018 meeting including BLM, DOE, and ESER staff, the BLM said that the maps ESER prepared in January were probably not useful for permittees because they were zoomed in too much and had inadequate reference points. Next year, ESER will change the format of the maps and allow BLM staff to view early drafts and provide suggestions.

**Conservation Measure 6—Accomplishments in 2018:**

COMMUNICATION & COLLABORATION—BLM, DOE, and ESER met in their annual meeting in May 2018. No allotment assessments were scheduled for 2018, but the meeting allowed for a regular forum for communication and sharing.

RANGELAND IMPROVEMENTS:

- During summer 2018, ESER discovered that wildlife escape ramps had not been installed in a relatively new multi-trough watering system located a few hundred meters from a large lek on the RWMC lek route. A BLM employee verified that ramps were missing and promised that they would be installed before livestock are turned out in spring 2019. The Big Lost River flooded this area throughout most of the 2018 lekking season, so the troughs were probably never filled (email communication between Quinn Shurtliff and Jordan Hennefer, August 13, 2018).
- A livestock grazing permittee proposed to install a fence in the southwestern part of the INL Site. Details provided under Conservation Measure 3.

| | |
|---|---|
| **Threat:** | Seeded Perennial Grasses |
| **Objective:** | Maintain the integrity of native plant communities by limiting the spread of crested wheatgrass. |
| **Conservation Measure:** | 7) Inform INL contractors about negative ecological consequences resulting from crested wheatgrass, and persuade them to rehabilitate disturbed land using only native seed mixes that are verified to be free of crested wheatgrass contamination. |

**Conservation Measure 7–Accomplishments in 2018:**

- DOE, ESER, and Battelle Energy Alliance, LLC, met to discuss revising current revegetation guidelines to ensure they accurately reflect this conservation measure. Specific recommendation included removing crested wheatgrass from seed planting rate examples and making the language in reference to avoiding the planting of non-natives more specific. An additional recommendation about ensuring crested wheatgrass seed is not included as a seed mix contaminant was also discussed.
- All NEPA reviews that included a recommendation for revegetation specified the use of native seeds only and all seed mix recommendations provided by ESER were native seed mixes.

| | |
|---|---|
| **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).<br>9) Ensure that no net loss of sagebrush habitat occurs due to new borrow pit or landfill development. DOE accomplishes this measure by:<br>• avoiding new borrow pit and landfill development in undisturbed sagebrush habitat, especially within the SGCA;<br>• ensuring reclamation plans incorporate appropriate seed mix and seeding technology;<br>• implementing adequate weed control measures throughout the life of an active borrow source or landfill. |

**Conservation Measure 8—Accomplishments in 2018:**

ELIMINATE HUMAN DISTURBANCE—All borrow source users were informed of the seasonal time-of-day restrictions through the Environmental Checklist, email, and Form 450.AP01 (Gravel/Borrow Source Request), which must be completed prior to using gravel or borrow sources. Time-of-day restrictions are also listed in INL's Road Maintenance Procedure (LST-822) and (if necessary) during spring snow removal activities covered in PLN-592. Facility and Site Services also has the ability to barricade the entrances to the Adams and T-12 pits to prevent human disturbance during seasonal restrictions.

**Conservation Measure 9—Accomplishments in 2018:**

Expansion of onsite borrow sources and landfills is limited to footprints approved in Appendix C of the Spent Nuclear Fuel Environmental Impact Statement (EIS) (DOE/EIS-0203) or the EA for Silt/Clay Development and Use (DOE-EA-1083). INL Facilities and Site Services personnel assist in the identification of approved footprints.

| | |
|---|---|
| **Threat:** | Raven Predation |
| **Objective:** | Reduce food and nesting subsidies for ravens on the INL Site. |
| **Conservation Measures:** | 10) DOE will work with INL contractors and the National Oceanic and Atmospheric Administration to opportunistically reduce raven nesting on power lines and towers and at facilities.<br>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. |

**Conservation Measure 10—Accomplishments in 2018:**

- In 2015, the USFWS reviewed and agreed with a cooperative agreement between the ESER contractor, INL, and N&HS to install nest deterrents only on dead-end and corner poles and not install any nest or perch deterrents on other poles. These deterrents are installed during the performance of maintenance activities as funds allow.
- NOAA staff planned to add an additional layer of wire mesh in summer 2018 to two of its towers on the INL Site that ravens have occupied for the past several years (Pers. Comm., Adam Haggerty, NOAA Electronics Technician; May 2018). Wire mesh has been installed previously, but it did not cover the entire top eight to ten feet of the tower where ravens tend to nest. ESER will monitor the towers in 2019 to learn if these latest efforts are effective.

**Associated Conservation Actions that Addressed the Raven Predation Threat:**

- ESER sought out researchers interested in working on the INL Site to study raven movements and the effects of nest deterrents on those movements. During the autumn of 2018, the team of researchers worked with ESER to submit a grant proposal to the Office of Species Conservation. This effort is fully supported by DOE.

**Conservation Measure 11:** Completed

| | |
|---|---|
| **Threat:** | Human Disturbance |
| **Objective:** | Minimize human disturbance of sage-grouse courtship behavior on leks and nesting females within the SGCA and 1 km (0.6 mi) Lek Buffers. |

| | |
|---|---|
| **Conservation Measures:** | 12) Seasonal guidelines (March 15–May 15) for human-related activities within 1 km (0.6 mi) Lek Buffers both in and out of the SGCA (exemptions apply—see Section 10.9.3):<br>• Avoid erecting portable or temporary towers, including Meteorological, SODAR, and cellular towers.<br>• Unmanned aerial vehicle 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 (0.6 mi) of an active lek.<br>• 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.<br>• No non-emergency disruptive activities allowed within Lek Buffers March 15–May 15.<br>13) Seasonal guidelines (April 1–June 30) for human-related activities within the SGCA (exemptions apply—see Section 10.9.3):<br>• Avoid non-emergency disruptive activities within the SGCA.<br>• Avoid erecting mobile cell towers in the SGCA, especially within sagebrush-dominated plant communities. |

**Conservation Measures 12 and 13—Accomplishments in 2018:**

TOWERS—No meteorological, SODAR, or cellular towers were erected in the SGCA or within 1 km of leks. Temporary towers associated with WTB activities were erected on previously disturbed areas (roads, pullouts, parking areas, etc.) and were not erected within any lek buffer area.

EXPLOSIVES—No explosives >1,225 kg were detonated outside seasonal guidelines in 2018.

UNMANNED AERIAL VEHICLES— Seasonal restrictions on vertical distances above leks for UAV operations are found in EC INL-16-149 “Unmanned Aerial Vehicle Operations.”

DISRUPTIVE ACTIVITIES—INL ES&S personnel are not aware of any non-exempt disruptive activities within lek buffers during 2018. As noted in Sections 2 and 3 above, the U.S. Geological Survey (USGS) proposed to construct a monitoring well (USGS-147) in the Sage Grouse Conservation Area (SGCA), but it was not within 1 km of a lek. Drilling began after June 30 to minimize impacts to nesting sage-grouse hens within the area.

**Associated Conservation Actions that Addressed the Human Disturbance Threat:**

- DOE postponed conducting an inspection of a bridge over the Big Lost River in early May 2018 because this action would have required diverting river flows into the Spreading Areas, possibly inundating an active lek.

## 5.2 Reports on Projects Associated with Conservation Measures

### 5.2.1 Conservation Measure #1—Sagebrush Seedling Planting for Habitat Restoration

#### *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 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. In addition, Battelle Energy Alliance, LLC (BEA) has committed to mitigate the loss of sagebrush associated with project activities where sagebrush may be damaged. For every acre impacted, BEA will contribute funds to replant 946 seedlings and the seedlings will be grown and planted concurrently with DOE's seedlings. DOE will first seek restoration sites from within the priority restoration areas; however, this may not always be practical due to logistical constraints.

In 2018, ESER received a grant through the Idaho Governor's Office of Species Conservation (OSC) to increase the number of seedlings planted in burned habitat. The grant provides a one-time opportunity to substantially increase DOE's level of habitat restoration effort. It was awarded based on an in-kind match from DOE, which was met by an increase in DOE's planting effort and providing ESER labor to facilitate growing and planting the seedlings funded by OSC.

The ESER program oversees the planting of sagebrush seedlings from all sources and monitors survivorship to evaluate the effectiveness of the task for DOE and BEA. Our aim is to plant at least 80 sagebrush seedlings per acre, resulting in a coverage of ≥25 ha (63 ac) per year (Shurtliff et al. 2016), although the acreage planted can be highly variable due to weather conditions, topography, planting conditions, travel, and planter abilities. Typical sagebrush density planting rates 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 this sagebrush restoration 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.

#### *Methods*

Two greenhouses were used to grow containerized sagebrush seedlings. Seedlings were grown from seed collected on the INL Site. The seedlings funded by DOE were grown from seed collected in 2014 and the seedlings funded by OSC were grown from seed collected in 2017. Information about growing the seedlings, and details about procedures followed during the planting process, are described elsewhere (Shurtliff et al. 2016).

The area we chose for restoration in 2018 was adjacent to the area planted in 2017, on the southeastern edge of the Jefferson Fire, a central INL location, north of Highway 26 (Figure 5-1). This area is within the SGCA as well as within the priority restoration area (Shurtliff et al. 2016). We also chose this site to diversify our planting areas across the INL Site, because of the proximity to sage grouse leks, and to allow DOE and IDFG to begin rehabilitation on the Jefferson Fire.

Survivorship of seedlings planted in fall 2017 was monitored by revisiting and evaluating the condition of individual seedlings one year after planting. During the fall 2017 planting, we collected sub-meter GPS locations for nearly 20% of the seedlings planted. In August 2018, we revisited approximately 10% of seedlings planted (randomly selected from marked individuals) and determined if each seedling was healthy, stressed, or dead, and provided comments when necessary (Figure 5-2). After five years, seedlings will again be revisited and longer-term survivorship will be assessed.

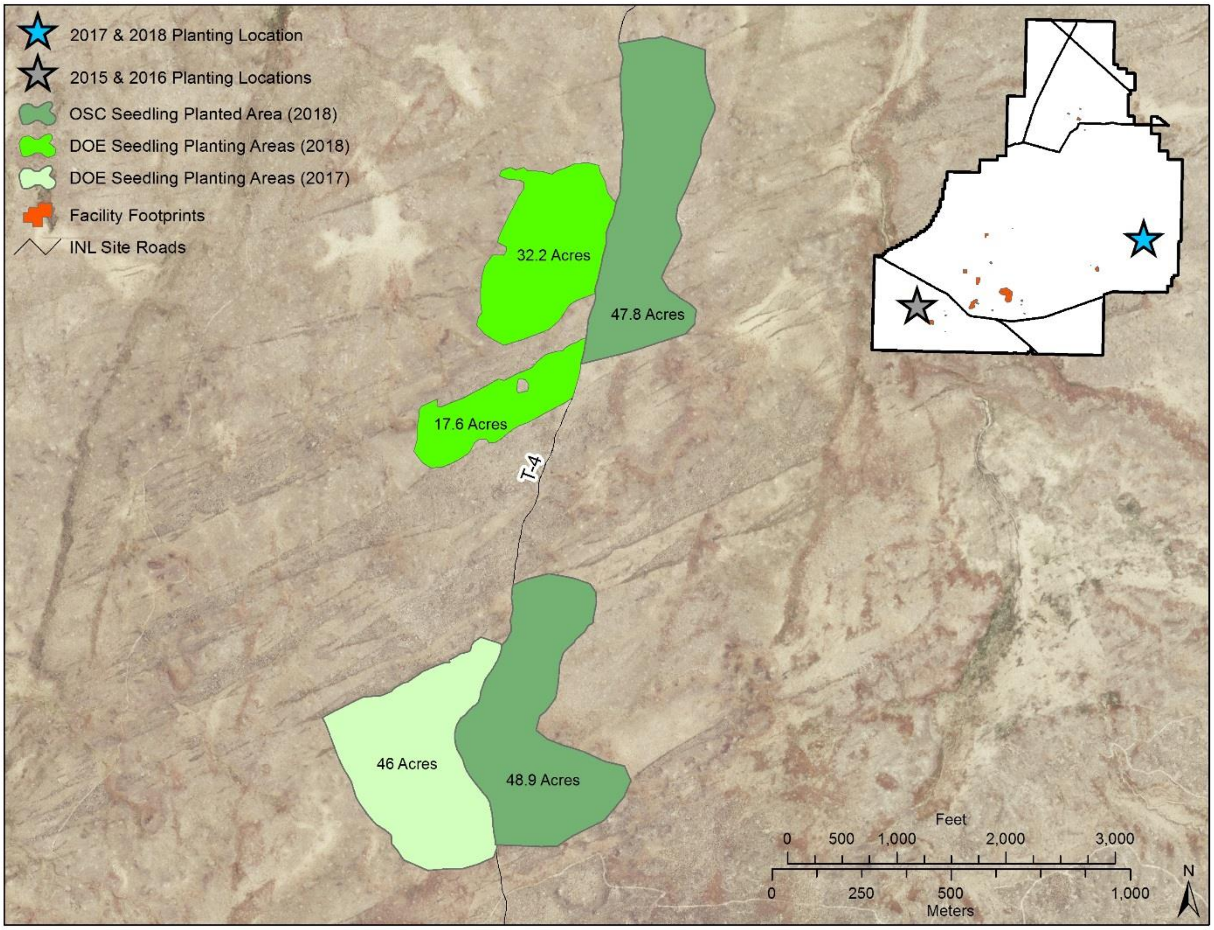


**Figure 5-1. Areas planted with big sagebrush seedlings in 2017 and 2018. The 2017 planting was revisited to assess one-year survivorship in 2018.**

### *Results and Discussion*

We planted approximately 9,000 seedlings on 20.2 ha (49.8 ac) or ~446 seedlings per ha (181 seedlings per ac) from October 8 to October 13, 2018 in the east central part of the INL Site (Figure 5-1). We marked the locations of 1,530 (~17%) seedlings for future monitoring. In addition to the 9,000 seedlings planted with DOE funding, the OSC grant allowed ESER to plant an additional 15,625 seedlings on 39.1 ha (96.7 ac) or ~400 seedlings per ha (162 seedlings per ac) from October 15-16, 2018 (Figure 5-3). These seedlings were also planted in the Jefferson Fire, just north and east of the DOE planting (Figure 5-1). We marked 300 (1.9%) for future monitoring. Although the INL Site had a relatively dry summer and early fall, rain fell two days during the first week of planting, creating favorable conditions for seedling growth and development.

There were no seedlings planted to mitigate potential sagebrush loss by BEA project activities in 2018. Over the past four years, a total of 42,000 seedlings have been planted from all funding sources (Fig 5-3). Sagebrush restoration has now been initiated on 135.5 hectares (334.9 acres).

**Figure 5-2. Examples of sagebrush seedling conditions. From left to right: healthy, stressed, and dead. Photos courtesy of Kristin Kaser, 2018.**

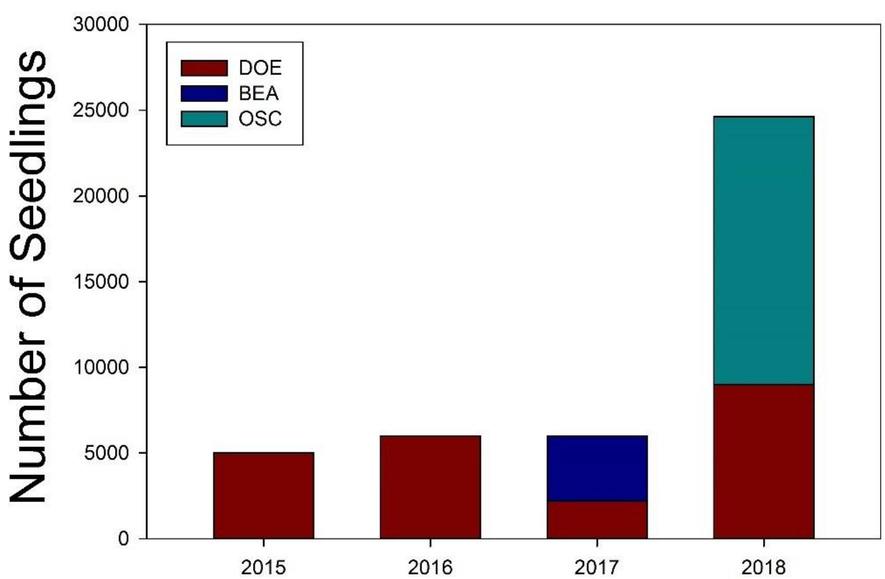


**Figure 5-3. Funding sources and the associated number of seedling planted for sagebrush restoration efforts on the INL Site from 2015-2018.**

To assess 2017 seedling survivorship and condition, we revisited 597 sagebrush seedlings in August 2018. Of the original 597 marked seedlings, 316 (53%) were healthy, 33 (6%) were stressed, 67 (11%) were dead, and 181 (30%) were missing (Figure 5-4). Assuming the missing seedlings were dead, a total of 58% of the seedlings survived the first year. For comparison, in 2017 we revisited 497 seedling locations and recorded 240 (48%) healthy, 66 (13%) stressed, 26 (5%) dead, and 165 (33%) missing. Therefore, the one-year survivorship was 62%. In 2016 we revisited 501 seedlings and recorded 129 (26%) healthy, 238 (48%) stressed, 61 (12%) dead, and 73 (15%) missing, which translates to 73% survivorship (Figure 5-4) (Shurtliff et al. 2017).

The number of missing seedlings was almost identical between 2017 and 2016, and twice as much (percent value) as 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 seedlings, especially if they were stressed and in areas with relatively high grass and forb cover. A conservative assessment would assume the missing seedlings did not survive. However, it is notable that most of the revisited seedlings that were found were labeled as healthy. ESER will revisit all locations again, even those marked as missing, 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.

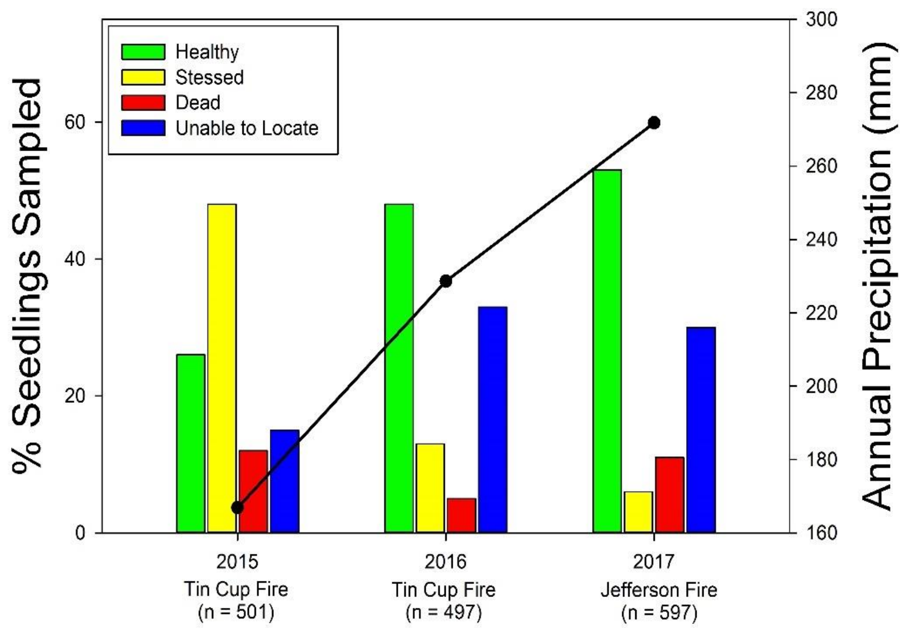


**Figure 5-4. One year post planting survivorship monitoring results. Results from three years of sagebrush seedling survivorship monitoring. Survivorship data for year was colulated following field surveys conducted the next year post planting. The black line indicates total precipitation for the year. The fire location indicates the general location of the area planted and n= total number of seedlings revisited.**

Precipitation patterns from fall 2017 to fall 2018 were characteristic of a good recruitment year. Although the winter was fairly dry, March through May were uncharacteristically wet, which would have been ideal for early spring growth for the seedlings. The summer growing season was slightly below average (Figure 3-3). Despite the lack of moisture during summer, the majority of the plants relocated were labeled as being healthy (76%) and very few were stressed or dead (8% and 16% respectively). Young sagebrush plants experience the highest mortality during the first year (Dettweiler-Robinson et al. 2013). In a review of 24 projects where containerized sagebrush seedlings were planted and survivorship was measured after one year, researchers reported first year survival of stock ranged from 14% to 94% (median = 59%, weighted average=57%) (Dettweiler-Robinson et al. 2013). Thus, sagebrush establishment one year post planting on the INL Site is at or above average even when the missing plants are considered dead.

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 is 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 in old burns 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 low (Figure 5-5). When the INL Site experiences another wildland fire of tens or hundreds of acres, DOE may experiment with planting sagebrush seeds in the newly burned area using mechanical methods. The seeding project would help DOE determine if such methods can be successful supplements and/or alternatives to annual sagebrush seedling planting efforts immediately following a fire.

**Figure 5-5. An example of a typical seedling root mass after one season of growth in a conetainer and tools of the trade: hoedad and treebag.**

# 6.0 SYNTHESIS AND ADAPTIVE MANAGEMENT RECOMMENDATIONS

## 6.1 Sage-Grouse and Sagebrush Habitat Trends

Sage-grouse abundance across Idaho was approximately 18% lower in 2018 compared to 2017, and has declined for the past two years. Prior to these declines, state-wide lek counts had increased for three consecutive years (Unpublished data, personal communication with Ann Moser, Wildlife Staff Biologist, IDFG; Dec. 4–5, 2018). Lek route observations on the INL Site are generally consistent with these results (Figure 2-3). It is well established that sage-grouse populations typically oscillate on 6- to 10-year cycles (Rich 1985, Fedy and Aldridge 2011, Coates et al. 2018), and both INL Site and state-wide data over the past ten years approximate this cyclic pattern. If future monitoring reveals that sage-grouse abundance on the INL Site continues to track regional trends, we could conclude that region-wide factors (e.g., broad-scale wildland fires or precipitation patterns) are likely driving sage-grouse trends (Coates et al. 2017). Alternatively, INL Site lek count trends could begin to deviate from regional trends, in which case we would assume local conditions are predominately affecting sage-grouse trends.

The CCA monitoring program does not include an experimental component, nor does it employ population modeling analyses that would identify factors likely to be governing observed patterns of lek count fluctuations. Consequently, only obvious negative associations between lek counts and one or more threats would potentially qualify as support of a hypothesis that threats identified in the CCA are currently impacting sage-grouse on the INL Site. As we consider results from the past six years of lek, habitat and threats monitoring, we do not find such obvious associations. Loss of sagebrush due to wildland fire or infrastructure development has been virtually zero (although new two-track roads have been increasing), and raven nesting (at least on infrastructure) may be stable. Cheatgrass cover is continuing to increase, but not at the expense of native herbaceous cover, which has been relatively high during the past few years of above-average precipitation. We believe other threats, including livestock grazing (Shurtliff et al. 2017), human disturbance, and landfills/borrow sources have negligible effects on current sage-grouse trends. We recognize that when factors negatively impact sage-grouse reproductive success, effects on lek counts are often not immediate, sometimes requiring several sage-grouse generations to manifest (Holloran et al. 2010). We also recognize that additive effects from threats, both direct and indirect, can reduce sage-grouse abundance even when no single factor is culpable. For these reasons, DOE continues to monitor leks, habitat plots, and threats, and to take action where it is feasible to reduce impacts of the latter.

## 6.2 Changes made to the CCA in 2018

The following changes to the CCA were discussed by DOE and USFWS during the 2018 CCA stakeholders meeting, held in Idaho Falls in February. All changes described below were later approved by DOE in 2018.

### 6.2.1 Adjust Threat Ratings

For the first time since the CCA was signed, we revisited the ratings we assigned to threats that potentially affect sage-grouse and its habitats on the INL Site (see pp. 44-46 of the CCA). During this reevaluation, ESER adjusted what we perceive as the current level of threats. We now consider *Livestock* to be a low threat, *Raven Predation* to be a low threat, and *Infrastructure Development* to be a medium threat (Table 6-1).

**Table 6-1. Updated threat ratings as they apply to Greater Sage-Grouse and its habitats (i.e., sagebrush communities) on the Idaho National Laboratory Site. Compare to Table 3 in the original Candidate Conservation Agreement (DOE and USFWS 2014).**

| Threat | Current INL Site Rating | 2014 INL Site Rating | Justification for Rating Change |
|---|---|---|---|
| Wildland Fire | High | High | N/A |
| Annual Grasslands | Medium | Medium | N/A |
| Human Disturbance | Medium | Medium | N/A |
| Infrastructure Development | Medium | High | It no longer makes sense for infrastructure to be rated as high as wildland fire. Upon signing the CCA, U.S. Department of Energy, Idaho Operations Office pledged to minimize the effects of infrastructure development on sage-grouse and its habitats, especially in the SGCA. Contractors now require project leaders to complete an Environmental Checklist before a project may proceed. This process ensures best management practices and other relevant conservation measures from the CCA have been taken into account during project planning. |
| Seeded Perennial Grasses | Medium | Medium | N/A |
| Landfills and Borrow Sources | Low | Low | N/A |
| Livestock | Low | Medium | Data from habitat monitoring plots showed no significant difference in primary indicators of habitat quality between plots inside and outside grazing allotments. Therefore, we have no evidence that livestock grazing is negatively affecting sagebrush habitat on the INL Site (Shurtliff et al. 2018). |
| Raven Predation | Low | Medium | We have learned through the raven nest monitoring task that most raven nests are outside the Sage-grouse Conservation Area (SGCA). One assumption we made is that ravens do not travel regularly into the SGCA to forage. If future studies find that ravens travel far enough to regularly forage within the SGCA and that they are negatively influencing sage-grouse, the threat rating may need to be adjusted again. |

### 6.2.2 Change Wording to Allow Greater Flexibility When Planting Sagebrush Seedlings

The CCA states, "If it becomes necessary for DOE to actively restore sagebrush to a vegetation community (e.g., mitigation following wildland fire), DOE will select restoration sites from within the Priority Restoration Areas" (pg. 40). The weather in October when sagebrush seedlings are planted is variable, and ESER has found that if precipitation falls during the week that plantings are scheduled, it can be extremely difficult to access previously-identified planting sites within Priority Restoration Areas. Therefore, the language on page 40 of the CCA shall be changed to:

> **"If it becomes necessary for DOE to actively or passively restore sagebrush to a vegetation community (e.g., mitigation following wildland fire), DOE will first seek restoration sites from within the Priority Restoration Areas; however, this may not always be practical due to logistical constraints."**

### 6.2.3 Add a Best Management Practice to Conservation Measure 2 (Addresses Infrastructure Development

Since 2015, DOE has provided annual funds to ESER to plant sagebrush seedlings in areas prioritized for restoration and to monitor seedling survivorship. To acknowledge this process, the following will be added to the list of best management practices that comprise Conservation Measure 2 (CCA, pp. 54–55):

**“Establish a centralized, all-inclusive sagebrush restoration capability to support restoration of areas where sagebrush removal or destruction is unavoidable.”**

### 6.2.4 Defer Activities on Conservation Measure 4 and Focus Resources on Conservation Measures 1 and 2 to Address Cheatgrass.

Annual grasslands, especially those comprised of cheatgrass, continue to threaten sage-grouse habitat on the INL Site. After the CCA was signed, ESER inventoried areas dominated by cheatgrass (primarily in the SGCA) and attempted to identify stressors that facilitated cheatgrass domination. When it became apparent that stressors were impossible to identify in most cases, DOE shifted its focus to a known vector of cheatgrass spread—wildland fire containment lines. For two years, ESER identified and mapped containment lines visible through remotely-sensed imagery and prioritized a list of candidate restoration areas. Concurrent with these efforts, cheatgrass cover expanded greatly across many parts of the INL Site, aided by favorable precipitation patterns. Although DOE remains committed to the objective of Conservation Measure 4 (CCA pg. 57), which is to “maintain and restore healthy, native sagebrush plant communities,” DOE recognizes there is currently no cost-effective way to directly reduce cheatgrass spread and dominance at a meaningful scale within sagebrush habitat on the INL Site. Therefore, DOE will no longer pursue Conservation Measure 4 nor the associated Task 7. Instead, it will redirect resources toward achieving Conservation Measures 1 and 2, which are designed to address the wildland fire and infrastructure development threats. These threats exacerbate the annual grassland problem, so to the extent they are moderated, the annual grassland threat will be reduced. The ESER Program will continue to monitor cheatgrass abundance through CCA Task 5 (pg. 79) and will regularly evaluate if the threat of annual grasslands is increasing. Additionally, DOE is aware of ongoing experiments in Idaho to control cheatgrass using bacterial soil amendments. If researchers report positive results, DOE may consider testing soil amendments on the INL Site.

### 6.2.5 Update Conservation Measure 6 (Addresses Livestock)

Currently, Conservation Measure 6 (CCA, pg. 59) states that DOE should “communicate and collaborate with BLM to ensure…that rangeland improvements follow guidelines in the 2006 State Plan and this CCA.” The 2006 State Plan is no longer a guiding document for the BLM. Therefore, the phrase “2006 State Plan” shall be replaced with **“BLM Land Use Plan.”**

### 6.2.6 Change Conservation Measure 7 (Addresses Seeded Perennial Grasses)

Conservation Measure 7 (CCA, pg. 61) currently reads, “cultivate partnerships with other agencies to investigate the mechanisms of crested wheatgrass invasion so that effective control strategies can be developed.” This measure shall be changed to:

> **“Inform entities performing work at the INL Site about negative ecological consequences resulting from crested wheatgrass, and encourage them to rehabilitate disturbed land using only native seed mixes that are verified to be free of crested wheatgrass contamination.”**

The paragraph supporting Conservation Measure 7 shall be replaced with the following:

> **"When consulted about a revegetation project, ESER and/or DOE will explain the negative consequences of planting crested wheatgrass. Even if contractors commit to use only native seed, DOE recognizes that it is possible seed mixes could be contaminated with crested wheatgrass seed. Therefore, DOE will request that contractors take steps to verify that crested wheatgrass is not a contaminant in any native seed mix."**

### 6.2.7 Change Conservation Measure 10 (Addresses Raven Predation)

The objective of Conservation Measure 10 (CCA, pg. 65) is to reduce nesting subsidies for ravens. The measure states that DOE will "support research that aims to develop methods for deterring raven nesting on utility structures." When first drafted, the measure was focused primarily on developing means to keep ravens from nesting on power lines. While power lines remain the favored anthropogenic substrate for nesting by ravens, ESER documents many raven nests each year at INL Site facilities and on towers (especially those owned by the National Oceanic and Atmospheric Administration). Going forward, DOE intends to opportunistically deter nesting on any anthropogenic substrate. Therefore, the Conservation Measure shall be changed to:

> **"DOE will work with INL contractors and the National Oceanic and Atmospheric Administration to opportunistically reduce raven nesting on power lines and towers and at facilities. "**

## 6.3 Work Plan for Upcoming Year

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 2018 |
|---|---|
| 1. Lek Counts and Lek Route Surveys | • We will continue to monitor all active leks and a rotational subset of inactive leks. |
| 4. Raven Nest Surveys | • No changes to the surveys are anticipated. |
| 5. Sagebrush Habitat Condition Trends | • Sample all annual monitoring plots (*n*=75) and set 2 of the rotational plots (*n*=50).<br>• Update annual habitat condition analyses and continue to explore trend analyses.<br>• Continue to explore and develop new local means using locally-collected data to step away from regional recommendation values from Connelly et al. (2000). |
| 6. Monitoring to Determine Changes in Sagebrush Habitat Amount and Distribution | • No work to be conducted on this task inside recently burned areas until the new vegetation community classification and map is completed in 2019. New wildland fires will be mapped when imagery becomes available to document sagebrush habitat loss as needed. |
| 8. Monitoring Expansion of the Infrastructure Footprint within the SGCA and Other Areas Dominated by Big Sagebrush | • No planned activities for 2019. This task will be updated again after the 2019 Idaho NAIP imagery becomes available in 2020. |

# 7.0 LITERATURE CITED

Anderson, J. E., and R. S. Inouye. 2001. Landscape-scale changes in plant species abundance and biodiversity of a sagebrush steppe over 45 years. Ecological Monographs 71:531-556.

Andrén, H. 1992. Corvid density and nest predation in relation to forest fragmentation: a landscape perspective. Ecology 73:794–804.

Boarman, W. I., R. J. Camp, M. Hagan, and W. Deal. 1995. Raven abundance at anthropogenic resources in the western Mojave Desert, California. Report to Edwards Air Force Base, California. National Biological Service, Riverside, California, USA.

Boudell, J. E., S. O. Link and J. R. Johansen. 2002. Effect of soil microtopography on seedbank distribution in the shrub-steppe. Western North American Naturalist 62:14-24.

Brabec, M. M., M. J. Germino, D. J. Shinneman, D. S. Pilliod, S. K. McIlroy and R. S. Arkle. 2015. Challenges of establishing big sagebrush (*Artemisia tridentata*) in rangeland restoration: effects of herbicide, mowing, whole-community seeding, and sagebrush seed sources. Rangeland Ecology & Management 68:432-435.

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

Coates, P. S. and D. J. Delehanty. 2010. Nest predation of greater sage-grouse in relation to microhabitat factors and predators. Journal of Wildlife Management 74:240-248.

Coates, P. S., B. G. Prochazka, M. A. Ricca, G. T. Wann, C. L. Aldridge, S. E. Hanser, K. E. Doherty, M. S. O'donnell, D. R. Edmunds, and S. P. Espinosa. 2017. Hierarchical population monitoring of greater sage-grouse (*Centrocercus urophasianus*) in Nevada and California—identifying populations for management at the appropriate spatial scale. Open-File Report 2017-1089, Reston, Virginia.

Coates, P. S., B. G. Prochazka, M. A. Ricca, B. J. Halstead, M. L. Casazza, E. J. Blomberg, B. E. Brussee, L. Wiechman, J. Tebbenkamp, and S. C. Gardner. 2018. The relative importance of intrinsic and extrinsic drivers to population growth vary among local populations of greater sage-grouse: an integrated population modeling approach. The Auk 135:240-261.

Colket, E. C. 2003. Long-term vegetation dynamics and post-fire establishment patterns of sagebrush steppe. MS Thesis, University of Idaho, Moscow. 154 pg.

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin 28:967-985.

Connelly, J. W., K. P. Reese, and M. A. Schroeder. 2003. Monitoring of Greater sage-grouse habitats and populations. College of Natural Resources Experiment Station publication No. 979, University of Idaho, Moscow, Idaho, 49 pp.

Connelly, J. W., E. T. Rinkes, and C. E. Braun. 2011. Characteristics of Greater Sage-Grouse habitats: a landscape species at micro- and macroscales. Pages 69-83 in ST Knick, and J. W. Connelly, editors. Greater sage-grouse: ecology and conservation of a landscape species and its habitats (Studies in avian biology; no. 38). University of California Press, Berkeley, California, USA.

Department of Energy, Idaho Operations Office (DOE), and U.S. Fish and Wildlife Service (USFWS). 2014. Candidate conservation agreement for greater sage-grouse (*Centrocercus urophasianus*) on the

Idaho National Laboratory Site. DOE/ID-11514, U.S. Department of Energy Idaho Operations Office, Idaho Falls, Idaho. www.id.energy.gov/eser/DOC/Candidate%20Conservation%20Agreement.pdf.

Dettweiler-Robinson, E., J. D. Bakker, J. R. Evans, H. Newsome, G. M. Davies, T. A. Wirth, D. A. Pyke, R. T. Easterly, D. Salstrom and P. W. Dunwiddie. 2013. Outplanting Wyoming big sagebrush following wildfire: stock performance and economics. Rangeland Ecology & Management 66:657-666.

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

Engel, K. A., and L. S. Young. 1992. Daily and seasonal activity patterns of common ravens in southwestern Idaho. Wilson Bulletin 104:462–471.

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

Forman, A. D., J. R. Hafla, and R. D. Blew. 2013. The Idaho National Laboratory Site long-term vegetation transects: understanding change in sagebrush steppe. Environmental Surveillance, Education, and Research Program, Gonzales-Stoller Surveillance, LLC, Idaho Falls, ID. GSS-ESER-163. http://idahoeser.com/Publications_Ecology.htm#GIS.

Forman, A. D. and J. R. Hafla. 2018. The Idaho National Laboratory Site Long-Term Vegetation Transects: Updates through 2016. Environmental Surveillance, Education, and Research Program, Idaho Falls, ID, VSF-ID-ESER-LAND-003.

Garton, E. O., J. W. Connelly, C. A. Hagen, J. S. Horne, A. Moser, and M. A. Schroeder. 2011. Greater Sage-Grouse population dynamics and probability of persistence. Pp. 293-381 in Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and Its Habitats (S. T. Knick, and J. W. Connelly, eds.). University of California Press, Berkeley, California.

Gibson, D., E. J. Blomberg, M. T. Atamian, S. P. Espinosa, and J. S. Sedinger. 2018. Effects of power lines on habitat use and demography of greater sage-grouse (Centrocercus urophasianus). Wildlife Monographs 200:1-41.

Howe, K. B., P. S. Coates and D. J. Delehanty. 2014. Selection of anthropogenic features and vegetation characteristics by nesting Common Ravens in the sagebrush ecosystem. The Condor 116:35-49.

Idaho Sage-grouse Advisory Committee. 2006. Conservation Plan for the Greater Sage-grouse in Idaho.

Larsen, K. H., and J. H. Dietrich. 1970. Reduction of a raven population on lambing grounds with DRC-1339. Journal of Wildlife Management 34:200–204.

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

Rich, T. 1985. Sage grouse population fluctuations: evidence for a 10-year cycle. Idaho BLM Technical Bulletin 85-1.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2011. The North American Breeding Bird Survey, Results and Analysis 1966–2010. Version 12.07.2011. U.S. Geological Survey Patuxent Wildlife Research Center, Laurel, MD, USA.

Shive, J. P., A. D. Forman, K. Aho, J. R. Hafla, R. D. Blew, and K. T. Edwards. 2011. Vegetation community classification and mapping of the Idaho National Laboratory Site. Environmental

Surveillance, Education, and Research Program Report, Gonzales-Stoller Surveillance LLC, Idaho Falls, ID. GSS-ESER-144. http://idahoeser.com/Publications_Ecology.htm#GIS.

Shurtliff, Q. R., A. D. Forman, J. C. Whiting, J. P. Shive, J. R. Hafla, K. T. Edwards, R. D. Blew. 2015. 2014 monitoring report in support of the candidate conservation agreement for greater sage-grouse on the Idaho National Laboratory Site. DOE/ID-11527. Gonzales-Stoller Surveillance, LLC, Idaho Falls, ID. January 2015. http://idahoeser.com/Publications_Wildlife.htm.

Shurtliff, Q. R., A. D. Forman, J. P. Shive, J. R. Hafla, K. T. Edwards, and R. D. Blew. 2016. Implementing the Candidate Conservation Agreement for Greater Sage-Grouse on the Idaho National Laboratory Site: 2015 Full Report. Environmental Surveillance, Education, and Research Program, Gonzales-Stoller Surveillance, LLC, Idaho Falls, ID. GSS-ESER-199. http://idahoeser.com/Publications_Wildlife.htm.

Shurtliff, Q. R., J. P. Shive, A. D. Forman, J. R. Hafla, K. T. Edwards, and B. F. Bybee. 2017. Implementing the Candidate Conservation Agreement for Greater Sage-Grouse on the Idaho National Laboratory Site: 2016 Full Report. Environmental Surveillance, Education, and Research Program, Wastren Advantage, Inc., Idaho Falls, ID. WAI-ESER-206.

Shurtliff, Q. R., J. P. Shive, A. D. Forman, J. R. Hafla, K. T. Edwards, and B. F. Bybee. 2018. Implementing the Candidate Conservation Agreement for Greater Sage-Grouse on the Idaho National Laboratory Site: 2017 Full Report. Environmental Surveillance, Education, and Research Program, Wastren Advantage, Inc., Idaho Falls, ID. WAI-ESER-213.

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

Young, J. A., R. A. Evans and D. Palmquist. 1990. Soil surface characteristics and emergence of big sagebrush seedlings. Journal of Range Management 43:358-367.

# APPENDIX A.

A complete list of all species documented on the 75 annual habitat monitoring plots (48 sagebrush plots and 27 non-sagebrush plots) in 2018. Nomenclature follows the U.S. Department of Agriculture PLANTS National Database (2018).

| Scientific Name | Common Name |
|---|---|
| *Achnatherum hymenoides* | Indian ricegrass |
| *Achnatherum thurberianum* | Thurber's needlegrass |
| *Agropyron cristatum* | crested wheatgrass |
| *Allium textile* | textile onion |
| *Alyssum desertorum* | desert alyssum/ desert madwort |
| *Arabis cobrensis* | sagebrush rockcress |
| *Arabis holboellii* | Holboell's rockcress |
| *Arabis lignifera* | desert rockcress |
| *Arenaria franklinii* | Franklin's sandwort |
| *Artemisia arbuscula* | low sagebrush/ little sagebrush |
| *Artemisia nova* | black sagebrush |
| *Artemisia tridentata* | big sagebrush |
| *Artemisia tridentata* Nutt. ssp. *tridentata* | basin big sagebrush |
| *Artemisia tridentata* Nutt. ssp. *wyomingensis* | Wyoming big sagebrush |
| *Artemisia tripartita* | threetip sagebrush |
| *Astragalus calycosus* | Torrey's milkvetch |
| *Astragalus curvicarpus* | curvepod milkvetch |
| *Astragalus filipes* | basalt milkvetch |
| *Astragalus geyeri* | Geyer's milkvetch |
| *Astragalus lentiginosus* | freckled milkvetch |
| *Astragalus purshii* | woollypod milkvetch |
| *Atriplex confertifolia* | shadscale saltbush |
| *Atriplex falcate* | sickle saltbush/ Nuttall saltbush |
| *Balsamorhiza sagittata* | arrowleaf balsamroot |
| *Bromus arvensis* | field brome |
| Bromus tectorum | cheatgrass |
| *Calochortus bruneaunis* | Bruneau mariposa lily |
| *Camissonia minor* | small evening primrose |
| *Carduus nutans* | nodding plumeless thistle/ musk thistle |
| *Carex douglasii* | Douglas' sedge |
| *Castilleja angustifolia* | northwestern Indian paintbrush |
| *Chaenactis douglasii* | Douglas' dustymaiden |
| *Chamaesyce glyptosperma* | ribseed sandmat |
| *Chenopodium album* | lambsquarters |
| *Chenopodium leptophyllum* | slimleaf goosefoot/ narrowleaf goosefoot |
| *Chrysothamnus viscidiflorus* | yellow rabbitbrush/ green rabbitbrush |
| *Cordylanthus ramosus* | bushy bird's beak |
| *Crepis acuminata* | tapertip hawksbeard |

| Scientific Name | Common Name |
|---|---|
| *Cryptantha circumscissa* | cushion cryptantha |
| *Cryptantha interrupta* | Elko cryptantha |
| *Cryptantha scoparia* | Pinyon Desert cryptantha |
| *Delphinium nuttallianum* | upland larkspur/ twolobe larkspur |
| *Descurainia pinnata* | western tansymustard |
| *Descurainia sophia* | herb sophia |
| *Elymus elymoides* | bottlebrush squirreltail |
| *Elymus lanceolatus* | thickspike wheatgrass |
| *Eriastrum wilcoxii* | Wilcox's woollystar |
| *Ericameria nana* | dwarf goldenbush |
| *Ericameria nauseosa* | rubber rabbitbrush/ gray rabbitbrush |
| *Erigeron filifolius* | threadleaf fleabane |
| *Erigeron pumilus* | shaggy fleabane |
| *Eriogonum caespitosum* | matted buckwheat |
| *Eriogonum microthecum* | shrubby buckwheat/ slender buckwheat |
| *Eriogonum ovalifolium* | cushion buckwheat |
| *Erodium cicutarium* | redstem stork's bill |
| *Escobaria missouriensis* | Missouri foxtail cactus |
| *Gayophytum diffusum* | spreading groundsmoke |
| *Grayia spinose* | spiny hopsage |
| *Gutierrezia sarothrae* | broom snakeweed |
| *Halogeton glomeratus* | saltlover |
| *Hesperostipa comata* | needle and thread grass |
| *Ipomopsis congesta* | ballhead gilia |
| *Iva axillaris* | povertyweed |
| *Krascheninnikovia lanata* | winterfat |
| *Lactuca serriola* | prickly lettuce |
| *Lappula occidentalis* | flatspine stickseed |
| *Lepidium densiflorum* | common pepperweed |
| *Lepidium perfoliatum* | clasping pepperweed |
| *Leymus cinereus* | basin wildrye |
| *Leymus flavescens* | yellow wildrye |
| *Linanthus pungens* | granite prickly phlox |
| *Lomatium dissectum* | fernleaf biscuitroot |
| *Lomatium foeniculaceum* | desert biscuitroot |
| *Lupinus argenteus* | silvery lupine |
| *Lygodesmia grandiflora* | largeflower skeletonplant |
| *Machaeranthera canescens* | hoary tansyaster |
| *Mentzelia albicaulis* | whitestem blazingstar |
| *Oenothera caespitosa* | tufted evening primrose |
| *Oenothera pallida* | pale evening primrose |
| *Opuntia polyacantha* | plains pricklypear |
| *Packera cana* | woolly groundsel |

| Scientific Name | Common Name |
|---|---|
| *Pascopyrum smithii* | western wheatgrass |
| *Penstemon cyaneus* | blue penstemon |
| *Phacelia glandulifera* | sticky phacelia |
| *Phacelia hastata* | silverleaf phacelia |
| *Phlox aculeate* | sagebrush phlox/ pricklyleaf phlox |
| *Phlox hoodii* | Hood's phlox/ spiny phlox |
| *Phlox longifolia* | longleaf phlox |
| *Pleiacanthus spinosus* | thorn skeletonweed |
| *Poa secunda* | Sandberg bluegrass |
| *Pseudoroegneria spicata* | bluebunch wheatgrass |
| *Psoralidium lanceolatum* | lemon scurfpea |
| *Pteryxia terebinthina* | turpentine wavewing |
| *Purshia tridentata* | antelope bitterbrush |
| *Salsola kali* | Russian thistle |
| *Schoenocrambe linifolia* | flaxleaf plainsmustard |
| *Sisymbrium altissimum* | Jim Hill mustard/ tall tumblemustard |
| *Sphaeralcea munroana* | Munro's globemallow/ whitestem globemallow |
| *Sporobolus cryptandrus* | sand dropseed |
| *Stanleya viridiflora* | green princesplume |
| *Stenotus acaulis* | stemless mock goldenweed |
| *Taraxacum officinale* | common dandelion |
| *Tetradymia canescens* | spineless horsebrush |
| *Tetradymia spinosa* | shortspine horsebrush |
| *Townsendia florifer* | showy Townsend daisy |
| *Zigadenus venenosus* | meadow deathcamas |

USDA, NRCS. 2017. The PLANTS Database (http://plants.usda.gov, December 6, 2017). National Plant Data Team, Greensboro, NC 27401-4901 USA.