INL/RPT-22-65559

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

January 2022

2021 Full Report

Idaho National Laboratory

INL is a U.S. Department of Energy National Laboratory operated by Battelle Energy Alliance, LLC

INL/RPT-22-65559

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Prepared for the
U.S. Department of Energy
DOE Idaho Operations Office

EXECUTIVE SUMMARY

In 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 the benefit of greater sage-grouse (*Centrocercus urophasianus*) on the Idaho National Laboratory (INL) Site. The primary purposes of the current report are to (1) document 2021 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.

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 2021, we surveyed all baseline leks. In addition, we surveyed six lek routes, all other active leks on the INL Site, and 20 inactive leks that had not been surveyed for one to four years. Key results from population monitoring are as follows:

- Peak male attendance summed across baseline leks was 227 males—the same number observed in 2020. The three-year average (2019–2021) on these leks declined 15% to 253 males, placing this value exactly at the population trigger threshold. During the 2022 field season, the number of males observed on baseline leks must be 34% greater than in 2021 (i.e., 304 males) to avoid tripping the population trigger.
- Male attendance summed across six lek routes totaled 222, a 1% decline from the 2020 count of 225 males.
- Two leks were downgraded to inactive status, and the current number of known active leks on and near the INL Site is 38—the lowest count since 2010.

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 (*Artemisia* spp.) 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, areas recovering from wildland fire, and potential effects from habitat threats, we surveyed 75 annual vegetation plots distributed across both habitat types and 150 vegetation plots distributed proportionately between livestock allotments and wildland fire footprints over three sampling seasons (2018–2020). The following is a summary of results from habitat distribution and condition monitoring tasks:

- In polygons currently identified as sagebrush habitat, the mean cover for sagebrush and perennial herbaceous functional groups was near or above baseline cover values and height estimates were within or near baseline. Trend analyses using functional group cover estimates indicated native perennial grasses remained near the upper end of their normal range of variability. Sagebrush cover slightly fluctuated, but it was unlikely ecologically meaningful. While cover from introduced annual functional groups remained low, non-native crested wheatgrass (*Agropyron cristatum*) has been fractionally but steadily increasing.

- In areas that are not considered sagebrush habitat because they are recovering from wildland fire, the annual mean for cover estimates of sagebrush and perennial herbaceous functional groups were slightly greater than baseline. Heights for sagebrush were taller while perennial grasses and forbs were shorter in 2021 than baseline. Trend analyses for native species indicated their cover remained within normal ranges. Non-native crested wheatgrass cover was consistent during the drier conditions over the past two years while cheatgrass (*Bromus tectorum*) cover was lower, as it can significantly fluctuate in response to weather conditions.
- Livestock allotments and wildland fire footprints were assessed for potential effects as threats to habitat condition. Although areas with localized degradation were observed in allotments, result summaries did not indicate broad declines in habitat condition across any of the allotments surveyed. It appears that wildland fires have a greater immediate impact on sagebrush habitat condition than livestock. Overall, habitats recovering from wildland fire are likely affected by changes in precipitation amount and timing which could prolong the development of sagebrush habitat sufficient to support sage-grouse and lead to greater non-native cover.

Threat Monitoring

Wildland Fire—The East Butte Fire burned 2.4 ha (5.9 ac) on the INL Site in 2021. No sagebrush habitat was affected, and no bulldozer lines were created.

Raven Nest Surveys—Thirty-eight active common raven (*Corvus corax*) nests were observed on power lines, at facilities, and on other infrastructure across the INL Site in 2021—a 15% increase over 2020 and the second consecutive year of increased nest observations. This count is the median value across eight years of surveys. Although there is no evidence that raven occupancy of infrastructure is increasing generally, more raven nests were recorded at facilities than in the previous seven years.

Infrastructure Expansion— No work was conducted on this task in 2021 because new high-resolution imagery was unavailable for the INL Site prior to reporting.

Conservation Measures Associated with Habitat Restoration

In response to the 2019 Sheep Fire and several 2020 fires, INL continued implementing post-fire recovery plans in 2021. Noxious weed control efforts were ongoing along containment lines and within the larger burned footprints. To control cheatgrass within the Sheep Fire burned areas, preemergent herbicide was applied on approximately 9.7 ha (24.0 ac) in 2021. Stakeholders assisted in acquiring sagebrush seed and DOE aerially applied the seed to about 3,116 ha (7,700 ac). Unfortunately, precipitation was low in 2020 and 2021 and during extensive surveys in August of each year, no seedlings were found that could be attributed to the aerial seeding.

Approximately 45,000 sagebrush seedlings provided by the INL were planted in 2021 within the Sheep Fire area and 38,750 seedlings provided by the Idaho Department of Fish and Game were planted within the Jefferson Fire area. Monitoring revealed that less than 1% of seedlings planted in 2020 survived, in part because of low precipitation. Approximately 56% of seedlings planted in 2016 were still alive after five years.

Synthesis and Conclusions

Sage-grouse lek counts on INL Site baseline leks declined 52% from 2016 to 2020 and remained unchanged from 2020 to 2021. Similarly, State and regional lek counts from 2016 to 2019 declined substantially; however, counts on these leks have stabilized or rebounded slightly during the past two years. Overall, there is no evidence lek count trends on the INL Site are different than regional and state trends. Although sage-grouse numbers are relatively low now, it is possible that broad-scale climatic and environmental factors that have historically resulted in cyclic population trends in Idaho are contributing to the declines regionally. If so, we would expect to see lek counts on the INL Site stabilize and begin to increase in the next few years.

The increasing frequency of wildfire, which is enhanced by the invasion and dominance of cheatgrass, continues to be the dominant threat to sage-grouse habitat regionally and throughout the western portion of the species' range. Habitat monitoring on the INL Site confirmed that burned areas were less resistant to invasion of cheatgrass and other non-native vegetation relative to adjacent intact sagebrush habitats. Furthermore, abundance of non-natives fluctuated to a greater degree in burned areas, likely driven by precipitation levels and timing. Fortunately, intact sagebrush habitat on the INL Site appears to be resistant to cheatgrass dominance and is generally in good condition. The U.S. Department of Energy and its contractors continue to take steps to protect remaining sagebrush communities and expand sagebrush habitat by planting and seeding sagebrush. Other potential threats—raven nesting population (indicated by number of nests on infrastructure) and livestock—appear to be minor or at least to have not increased over that past eight years.

Adaptive Management

No changes are proposed to the CCA.

Changes Made to the CCA in 2021

The USFWS and DOE made no changes to the CCA or associated monitoring tasks in 2021.

ACKNOWLEDGEMENTS

This report was authored by staff from the Natural Resources Group. Quinn R. Shurtliff served as document editor, wrote the section on greater sage-grouse (2.1), and managed and reported on raven nest monitoring (Section 4.1). Kristin N. Kaser authored the sagebrush habitat condition trend section (3.1), provided corresponding quantitative data analyses, and managed associated seasonal field crews. Jeremy P. Shive wrote sections describing changes to sagebrush habitat amount and distribution (3.2) and monitoring of the infrastructure footprint for expansion (4.2). Sue J. Vilord gathered updates from stakeholders and assembled a table listing progress made on CCA conservation measures (Section 5.1.1). Amy D. Forman reported on post-fire recovery planning, implementation, and monitoring (Section 5.2.1). Colby J. Kramer coordinated sagebrush seedling planting and monitoring and authored the associated section (5.2.2). Bryan F. Bybee participated in and coordinated greater sage-grouse lek surveys. Kurt T. Edwards supported all authors and task managers by archiving data and providing quality assurance and control, generating data queries, and producing figures. Brande M. Hendricks assisted with document formatting.

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RECOMMENDED CITATION

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ACRONYMS

ANOVA	analysis of variance
ATRC	Advanced Test Reactor Complex
BEA	Battelle Energy Alliance, LLC
BLM	Bureau of Land Management
CCA	Candidate Conservation Agreement
DOE	U.S. Department of Energy, Idaho Operations Office
EA	Environmental Assessment
ESER	Environmental Surveillance, Education, and Research Program
GIS	geographic information system
HMA	Habitat Management Area
IDFG	Idaho Department of Fish and Game
INL	Idaho National Laboratory
MFC	Materials and Fuels Complex
MPLS	males per lek surveyed
NAIP	National Agricultural Imagery Program
NEPA	National Environmental Policy Act
RHLLW	Remote-Handled Low-Level Waste
SGCA	Sage-grouse Conservation Area
USFWS	U.S. Fish and Wildlife Service
WFMC	Wildland Fire Management Committee

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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 includes monitoring tasks designed to track sage-grouse abundance and habitat indicators, key threats, and conservation measures intended to reduce these threats. The current report, produced by DOE's Environmental Surveillance, Education, and Research Program (ESER), now the Battelle Energy Alliance, LLC (BEA) Natural Resources Group (hereafter Natural Resources Group), documents year-end results of CCA monitoring tasks and DOE and INL contractor activities associated with CCA conservation measures. A summary of monitoring results from this report is provided each January to the USFWS and can be found under the heading *Sage-grouse Reports* at https://idahoeser.inl.gov/publications.html.

A primary purpose of this report is to update sage-grouse population and habitat trends as they apply to adaptive regulatory triggers established in the CCA. If a regulatory trigger is tripped, a responsive action by DOE and USFWS will be initiated (DOE and USFWS 2014, Section 9.4.3). The two triggers and criteria that define them are:

- Population Trigger: The three-year running average of peak male attendance, summed across 27 leks within the Sage-grouse Conservation Area (SGCA). This trigger will trip if the average 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. This trigger will trip if total area 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 grounded in the best available science, and retains its value to both signatories.

Related monitoring tasks are grouped into three sections: Population Trigger Monitoring (Section 2), Habitat Trigger Monitoring (Section 3), and Threat Monitoring (Section 4). Section 5 reports how DOE and contractors implemented conservation measures listed in the CCA during the past year. Section 6 synthesizes results from all monitoring tasks and discusses results and their implications in context of regional trends, and future management directions. This section also documents changes and updates to the CCA that have been approved by both signatories during the past year and outlines the upcoming CCA annual work plan.

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2.0 POPULATION TRIGGER MONITORING

2.1 Task 1—Lek Counts and Lek Route Surveys

2.1.1 Introduction

In 2013, a sage-grouse population monitoring task (Task 1—CCA Section 11.1.1) was developed to track abundance trends on the INL Site and provide information to DOE and USFWS regarding the direction of trends relative to the population trigger threshold. Counts from 27 leks located in the SGCA (hereafter, baseline leks) are the basis of the population trigger (Figure 2-1; 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 sum of peak male attendance in 2011 when all baseline leks were classified active. 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).

In addition to baseline lek counts, six lek routes are surveyed annually—three that have been surveyed since the late 1990s and three that were established in 2017—to evaluate long-term sage-grouse abundance trends. Surveying a cluster of leks in the same order and on the same day (i.e., lek routes) reduces some of the confounding issues inherent in surveys of individual leks; thus, lek route data are considered more suitable for tracking abundance trends across relatively small spatial extents than data from individual lek surveys (Connelly et al. 2003, DOE and USFWS 2014). Data from these routes continue to build on more than two decades of sage-grouse monitoring on the INL Site, providing context to interpret short-term results derived from baseline lek monitoring. The CCA stipulated that following completion of historical lek surveys and lek discovery surveys, additional lek routes would be established, and the basis for the population trigger would be converted from baseline leks to lek routes. This proposal is currently under consideration.

Finally, Task 1 includes rotational surveys of inactive leks that are not included in annual baseline lek and lek routes surveys. The goal is to revisit all leks classified as inactive at least once every five years to determine if sage-grouse have reoccupied the sites. This, and other monitoring activities described above, help maintain accurate records of the number and location of active leks on the INL Site.

2.1.2 Methods

Field Methods

Lek counts begin on or soon after March 20 and end after the first week of May when male counts on all lek routes are less than the seasonal peak. Lek counts occur from 30 minutes before until 90 minutes after sunrise, and only during reasonably clear and calm weather (i.e., no precipitation and winds <12 miles per hour). If sage-grouse are present at a lek, an observer tallies the number of visible males three or four times over a five- to 10-minute period. The highest tally is recorded as the lek count for the day. Visits to single leks are separated by at least seven days, and lek routes are visited every seven to 10 days. The primary goal each year is to survey all known active leks on the INL Site and lek routes (including inactive leks on routes) ≥4 times, inactive baseline leks ≥3 times, and inactive leks not assigned to lek routes or designated as baseline leks (i.e., rotational surveys) ≥2 times.

Thirty-eight active and inactive leks are assigned to lek routes, and each route consists of three to 10 leks (Figure 2-1). During each survey, all leks on the route are visited on the same day and in the same order. Three traditional routes have been surveyed annually since the mid-1990s (Lower Birch Creek, Tractor Flats, and Radioactive Waste Management Complex), and three newly established routes have been surveyed since 2017 (West T-3, T9, and Frenchmans Cabin[1]). Tractor Flats and Lower Birch Creek routes each include a lek located off the INL Site within 0.5 km of the boundary.

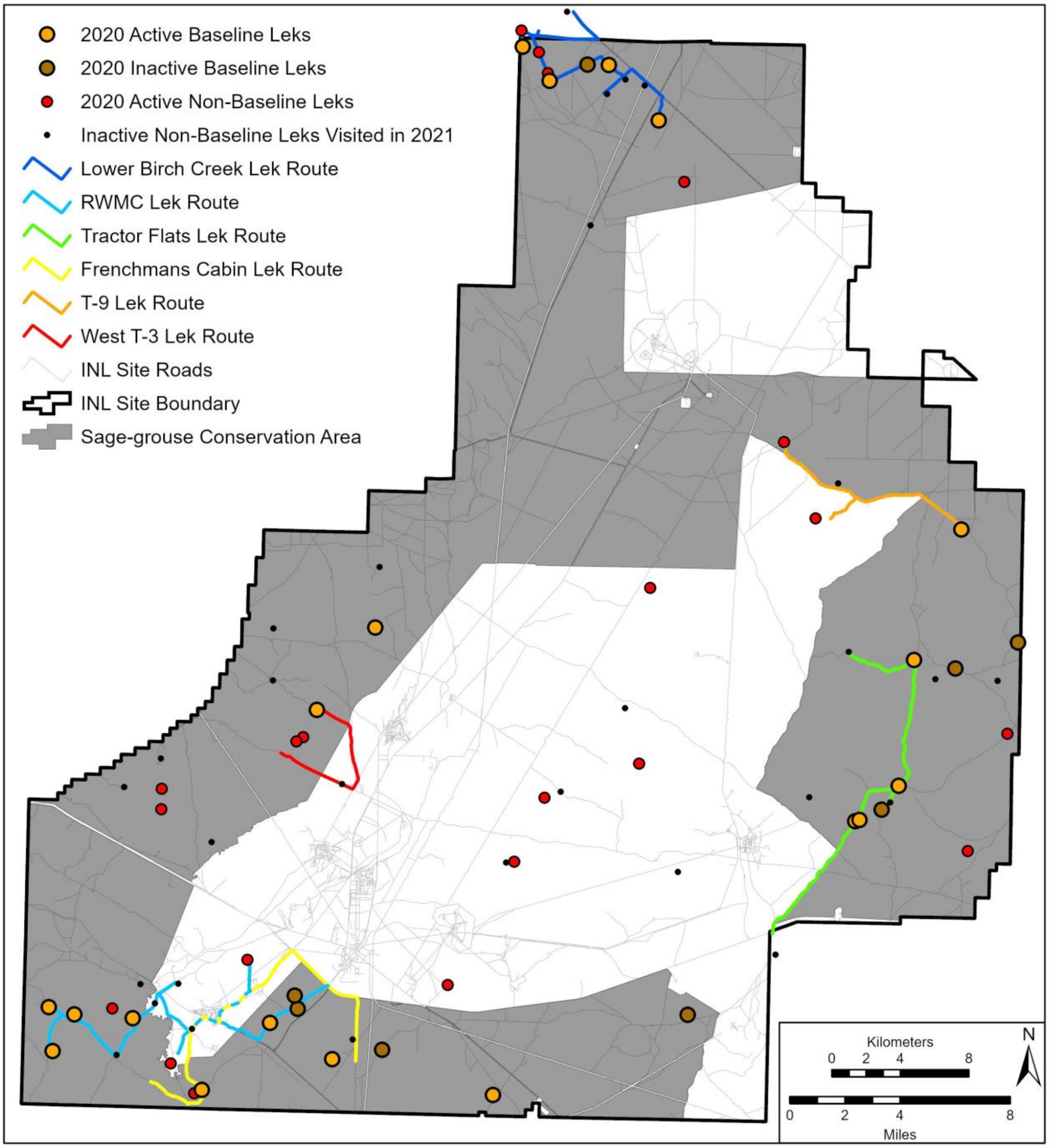

Figure 2-1. An overview of sage-grouse leks surveyed on the Idaho National Laboratory Site in 2021. Lek activity designations (active vs. inactive) refer to lek status at the end of 2020.

[1] "Frenchmans Cabin" is a recognized map feature by the U.S. Board on Geographic Names and is not misspelled.

Lek Status

We classify a lek active if two or more male sage-grouse were observed displaying on the lek at least two of the previous five years (Connelly et al. 2000*a*, Whiting et al. 2014). Leks that do not meet these criteria are classified inactive. Following each field season, we examine data from the past five years for each lek and adjust its activity status as necessary.

To ensure the list of active leks remains up to date, we visit inactive leks that are not one of the baseline or route leks on a rotational basis. We also survey other inactive leks as requested by the Idaho Department of Fish and Game (IDFG). The total number of inactive leks visited each year ranges from 13 to 20. Our aim is to visit each inactive, non-baseline lek at least once every five years to determine if its status has changed.

Analysis

We calculate separate summary statistics for baseline leks and lek routes, although 19 baseline lek counts contribute to both summaries. Separating the two summaries is necessary because some baseline leks are isolated and therefore counted singly, whereas others are part of lek routes (Figure 2-1).

To evaluate current male sage-grouse abundance relative to the critical threshold of 253 males, we identify peak male attendance on each baseline lek (i.e., the highest male count recorded during any visit after March 20) and sum those counts across all 27 leks. This annual count is then averaged with the preceding two years to produce a three-year running average—the population trigger metric (DOE and USFWS 2014).

We assess long-term abundance trends by examining the number of males per lek surveyed (MPLS) for each of the six lek routes. This is done by identifying annual peak male attendance for each route (i.e., the highest number of males observed on a route in a single morning) and dividing the total by the number of leks visited, including inactive leks.

2.1.3 Results and Discussion

SGCA Baseline Leks

Lek surveys occurred from March 22 through May 7, 2021 (hereafter, the field season), and we surveyed each of the 27 baseline leks three to seven times ($\bar{x}$ = 5.2 surveys, SD = 1.4). Peak male attendance was 227—the same number observed in 2020 (Figure 2-2). This value remains the lowest recorded since monitoring began in 2011 and is 52% lower than the number observed in 2016. Prior to 2021, annual baseline lek counts had declined four consecutive years, reaching a level 52% lower than the peak in 2016 and 28% below the 2011 value. Upon completion of the 2021 field season, 17 baseline leks were classified active, a reduction of two since 2020.

The three-year (2019–2021) running average of peak male attendance on baseline leks declined 15.4% to 253 (SD = 44.5), placing this value exactly at the population trigger threshold (Figure 2-2). Results from 2021 represent the third consecutive year of double-digit percent declines and the lowest average number of males observed since calculations began in 2013. During the 2022 field season, the number of males observed on baseline leks must be 34% greater than in 2021 (i.e., 304 males) to avoid a further decline in the three-year average that would trip the population trigger.

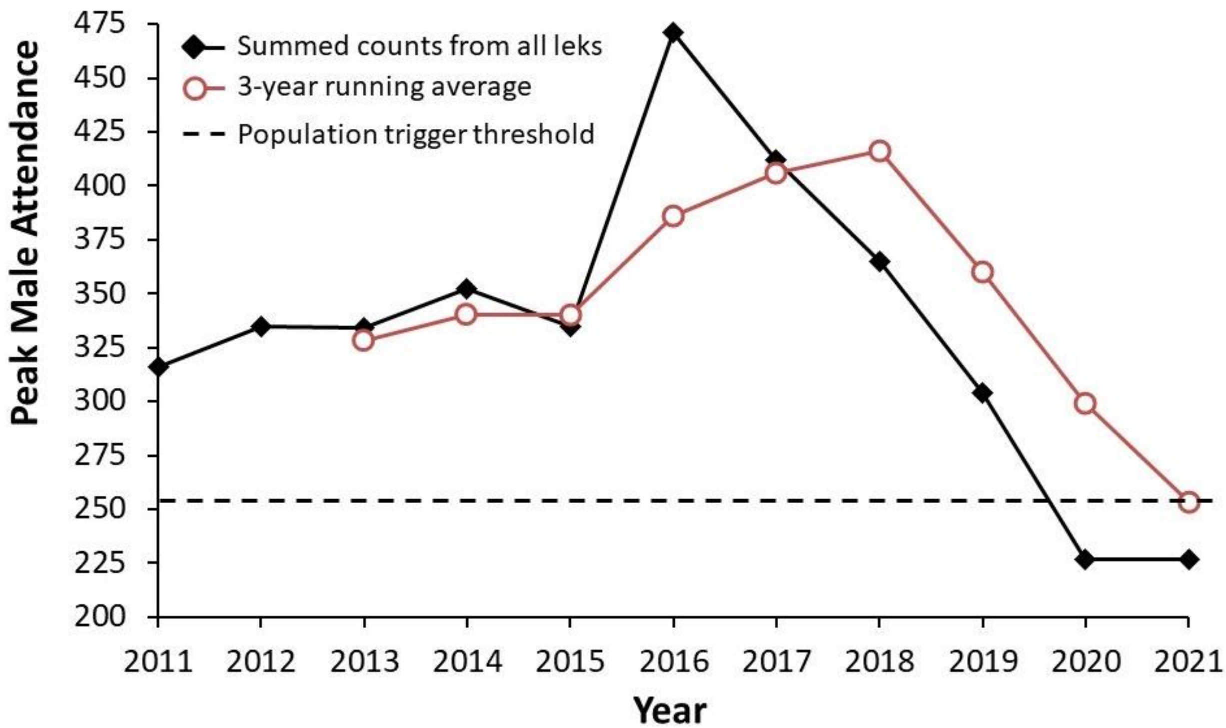

Figure 2-2. Peak male attendance of greater sage-grouse at 27 leks in the Sage-grouse Conservation Area—the basis for the population trigger. The population trigger would trip if the 3-year running average falls below the dashed line.

Lek Routes

We surveyed lek routes five to seven times each (Table 2-1). The sum of peak male attendance across all routes was 222 males, a 1% decline from the 2020 count of 225 males. Males per lek surveyed were equal to or higher than MPLS values in 2020 on four routes, including the RWMC route, which more than doubled (MPLS in 2020 = 3.1; in 2021 = 6.3). The greatest reduction in male attendance was on the Lower Birch Creek route, where counts were nearly 62% lower than in 2020 (MPLS in 2020 = 7.6; in 2021 = 2.9; Shurtliff et al. 2022).

All route surveys adhered to survey procedures with the following three exceptions. The fifth survey on the Tractor Flats route was conducted six days rather than seven after the previous survey. The count on this fifth survey was 31% lower than the peak count that had been recorded approximately two weeks earlier. We included this survey in the data summary (Table 2-1) because we assumed the shortened interval between surveys did not affect the peak route count. For logistical reasons, one inactive lek on the RWMC route and one inactive lek on the Tractor Flats route were not visited during one survey. Because not all leks were visited, these two surveys were excluded from the data summary (Table 2-1). Counts on these days were lower than the seasonal route peaks, and it is unlikely additional males would have been counted on the route, because sage-grouse have not been observed on the two unvisited leks since 2016 and 2003, respectively.

Rotational Surveys of Inactive Leks

In addition to routine surveys of active and inactive baseline and route leks, we visited 20 inactive leks, two times each, to verify if they remained unoccupied. Fifteen of these had not been visited since 2017, and the remaining five were most recently surveyed in 2019 or 2020. No sage-grouse were observed at any of these leks, so each will retain its inactive status and will be visited again in five years or less.

Table 2-1. Lek Route data from 2021 surveys on the Idaho National Laboratory Site and multi-year means for each route.

Lek Route	2021 Peak Count	Multi-Year Mean* (Range; SE)	Leks Surveyed	Males / Lek Surveyed (MPLS)	MPLS % Change from 2020	Occupied Leks[†]	Surveys Performed
Tractor Flats	51	70.8 (53–115; 5.8)	8	6.4	−8.6	4	5
Radioactive Waste Management Complex	57	101.3 (28–141; 11.0)	9	6.3	103.2	3	5
Lower Birch Creek	29	83.1 (48–133; 10.0)	10	2.9	−61.8	1	5
West T-3	19	28.5 (2–49; 11.6)	4	4.8	0.0	3	7
T-9	38	34.8 (31–39; 1.7)	4	9.5	22.6	2	7
Frenchmans Cabin	28	31.3 (15–46; 6.5)	3	9.3	24.0	2	7
Total	222		38				

*For the first three routes, the 10-year mean (2011–2020) is displayed; for the last three, it is a 4-year mean (2017–2020).

[†] Leks on routes are considered occupied if two or more males were observed displaying during the current year's survey. This is different from an active lek designation that BEA's Natural Resources Group uses to characterize leks on the Idaho National Laboratory Site, which is based on five years of data. Here, we report the number of leks occupied on the day the route count peaked.

Changes of Lek Status

Following the 2021 field season, leks INL 1 and INL 112 were downgraded to inactive status (Figure 2-3), reducing the count of known active leks on or near the INL Site to 38. This is the lowest number of active leks documented in a single year since 2010 when 34 leks were known to be active. Lek INL 1 is on the Lower Birch Creek lek route, and INL 112 is on the RWMC lek route (Figure 2-1). Both are baseline leks within the SGCA. From 1996 to 2016, sage-grouse were consistently observed on INL 1 (mean of 11 males per year [SD = 7.8], reaching an all-time peak of 38 males in 2007. Likewise, an annual mean of 11 males were observed at INL 112 from 2011–2018 (range 1 – 23; SD = 8.4).

When sage-grouse populations are high, small satellite leks (usually <15 males) commonly form near large leks (Connelly et al. 2003). As populations decline, these satellite leks may be abandoned and breeding displays confined to the larger leks (Dalke 1963). Emmons and Braun (1984) found that the number of active leks increased as the sage-grouse population increased, but the relationship between population size and number of leks may be only loosely correlated (Connelly et al. 2000*b*). Given the decrease in lek counts on the INL Site in recent years, the reduction in the number of active leks is not unexpected.

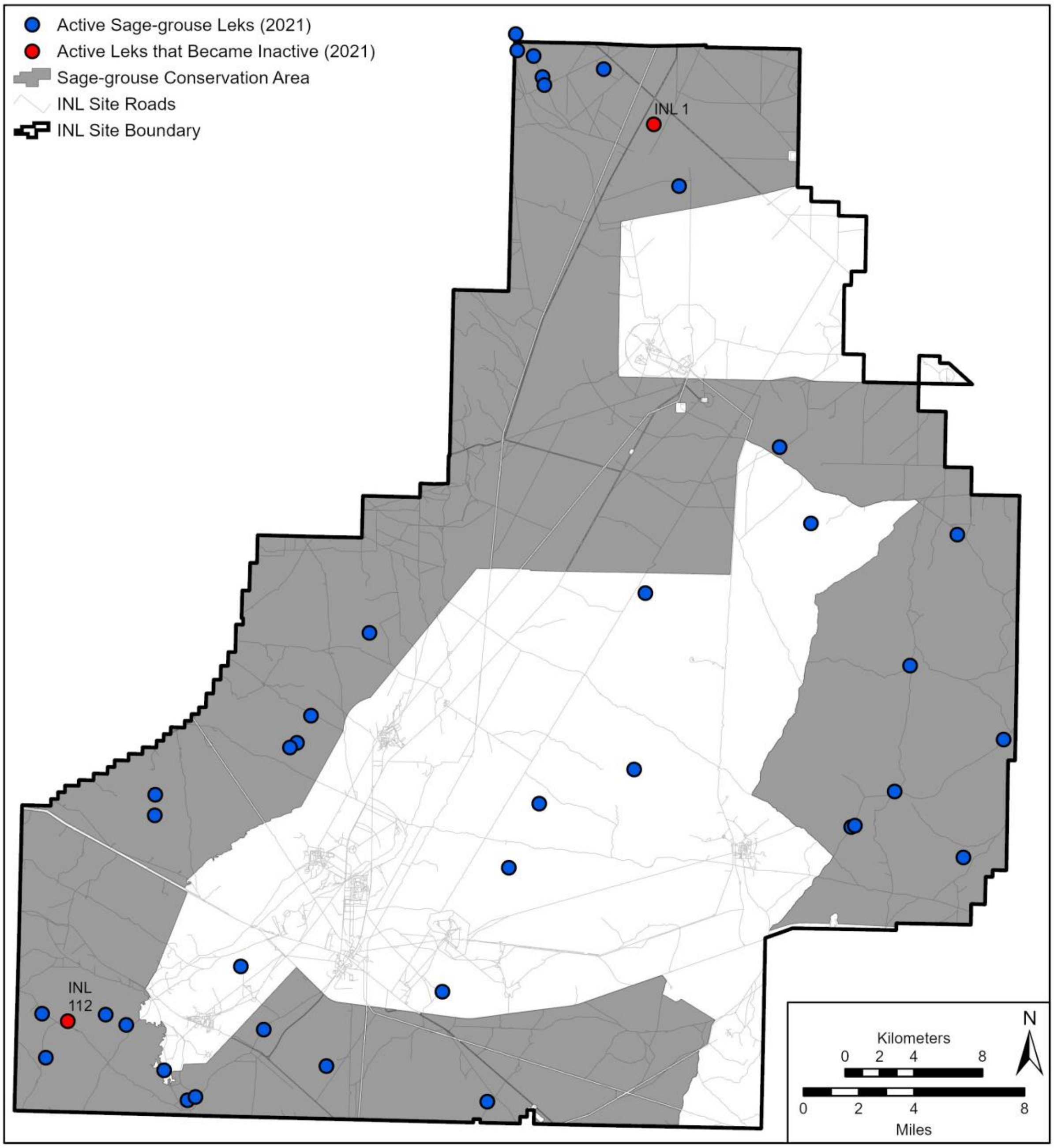

Figure 2-3. Map of all known active leks on or near the Idaho National Laboratory Site following the 2021 field season and lek status update. Both leks with a status change are baseline leks.

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 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). This baseline value is estimated at 78,558 ha (194,120 ac). The habitat trigger baseline value was adjusted from the original value following improved fine-scale mapping of fires and other disturbance that occurred prior to signing the CCA (Shurtliff et al. 2016, 2017). Based on baseline 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 compensate for 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 site-specific expected 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, imagery from burned areas may suggest there have been changes in vegetation classes or distribution of those classes several years post-burn, or sagebrush cover may be assessed using habitat condition monitoring data from plots located within that 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 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. Livestock operations is also recognized as a potential threat to sage-grouse on the INL Site and is ranked as a low-level threat. 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 component 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.

3.1.2 Methods

Sampling

In 2013, we established 225 vegetation sampling plots for the purpose of monitoring sage-grouse habitat condition on the INL Site. All sage-grouse habitat condition monitoring plot locations were selected using a stratified random sampling design (Shurtliff et al. 2016). A subset of 75 plots are surveyed annually (hereafter annual plots), about two-thirds of which are located in map polygons designated as current sagebrush habitat (hereafter sagebrush habitat plots). The remaining one-third of the annual plots are in burned areas, where the plant community prior to the wildland fire was thought to include sagebrush habitat (hereafter non-sagebrush plots). An additional 150 plots are surveyed on a rotational basis (hereafter rotational plots) with a subset of 50 plots sampled each of three years over the span of five years. The rotational plots are used to increase sample sizes and are located in burned areas, grazing allotments, and areas likely to be impacted by non-native plants.

The data metrics collected at each of the sage-grouse habitat condition monitoring plots were selected to facilitate characterization of general habitat condition (Connelly et al. 2000*a*). The main purpose of collecting and summarizing these metrics is to support basic description and assessment of sage-grouse habitat quality (Shurtliff et al. 2019). The data are also used to track trends, which allows for characterization of compositional change in vegetation through time, and aids in assessing the effects of potential threats on habitat quality. Data metrics 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

Annual plots are used to assess and characterize habitat condition each year, while rotational plots increase sample sizes to address specific threats or concerns related to localized areas (burned areas, grazing allotments, etc.). Analysis of habitat condition in burned areas and livestock allotments are completed once every five years, after data have been collected on all three rotational plot subsets. The first analyses were completed in 2016 (Shurtliff et al. 2017) and this report contains the second iteration of results for potential effects of habitat threats.

Data analyses for annual plots are two-fold; they include comparing annual habitat condition against baseline values and evaluating trends in habitat condition through time. Annual cover and height values of several vegetative functional groups (e.g., shrubs, grasses, forbs) and of sagebrush density and juvenile frequency are compared to baseline values. Trend analyses utilize cover data for plant functional groups from data collected over nine years (2013–2021) to assess changes in vegetative composition through time. In addition to vegetation-based analyses, a summary of precipitation and the potential effects of precipitation patterns on the habitat condition monitoring data are included.

From 2013 through 2017, annual plot summaries were used to compare habitat condition on the INL Site to general regional guidelines (Connelly et al. 2000*a*). Beginning in 2018, we transitioned to using locally derived habitat condition baseline values to evaluate the current year's habitat condition data. These baseline values were collected over five years (2013–2017) from the 75 annual plots. The baseline values (hereafter baseline) provide a more accurate estimation for evaluating annual habitat condition than generalized regional guidelines due to the large variation across the diverse sagebrush steppe ecosystem (Connelly et al. 2000*a*).

To evaluate trends in vegetative functional groups over the past nine years, cover data were analyzed using one-way repeated measure of analysis of variance (ANOVA; Zar 1999) to ascertain statistical significantly differences between years within each functional group type. Repeated measure tests assume that all samples within a sample group experienced the same treatment over time, resulting in a balanced statistical design (Aho 2013). Treatments were defined in this monitoring effort as either a sagebrush habitat plot or non-sagebrush plot. Since 2019, five sagebrush plots have burned and they were reassigned to non-sagebrush habitat status. To maintain balance in the statistical design, data collected from those plots prior to burning were classified as sagebrush habitat whereas data collected after burning were then classified as non-sagebrush. Sample sizes were still more than adequate for meaningful interpretation of statistical results (Zar 1999). Significance was determined at the $\alpha = 0.05$ level and multiple comparisons were evaluated using the pairwise multiple comparison Holm-Sidak method to determine minimum significant difference between groups (Šidák 1967). Only cases where both ANOVA and Holm-Sidak results were significant were reported because some comparisons had significant ANOVA results, but there was no discernable significance between groups after the Holm-Sidak method was applied.

Data collected between 2018 and 2020 from 150 rotational plots and data collected in 2020 on 75 annual plots were used to address progress toward habitat recovery in seven specific burned areas, potential effects of livestock on habitat condition in four allotments, and effects of livestock on progress toward habitat recovery in burned areas in three allotments. We summarized cover by plant species into vegetation functional groups (e.g., shrubs, perennial grasses, introduced forbs, etc.) and made comparisons using those functional groups. Burned areas were compared with unburned habitat and with one another using ANOVAs (Zar 1996); when data were non-normal or assumptions of equal variance were not met, Kruskal-Wallis one-way ANOVAs on rank (Zar 1996) were performed instead. We used Holm-Sidak (Zar 1996) tests for multiple comparisons on parametric ANOVAs and Dunn's Method (Dunn 1964) on non-parametric ANOVAs. The same statistical approach was used to compare functional groups within allotments and areas outside of allotments.

3.1.3 Results and Discussion

Current Habitat Condition

We collected data on 75 annual plots from June 1 through July 22, 2021. Additionally, data have been collected on 150 rotational plots. These rotational plots are subdivided into three sets of 50. A single set was collected per growing season from 2018–2020. This first section of this report focuses on results from the 75 annual plots and a later section includes results from the rotational plots analyses. The annual plots are divided into two subgroups. There are 43 sagebrush habitat plots located within current sagebrush habitat polygons and 32 non-sagebrush plots located within polygons where sagebrush has been lost to wildland fire (Figure 3-1). The sagebrush habitat plots are 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). All the non-sagebrush plots have burned at least once since 1994 and have the potential to recover to sagebrush habitat. The 2020 Telegraph Fire burned over two sagebrush plots. The habitat status of those plots was reassigned to non-sagebrush habitat prior to 2021 sampling and analysis and are reflected in the sample sizes listed above.

Annual Habitat Condition Summary

Annual values for absolute cover, height, and sagebrush density were compared to baselines to evaluate the current status of potential sage-grouse habitat on the INL Site (Table 3-1a, Table 3-1b). Within sagebrush plots, absolute cover for sagebrush species was slightly higher than baselines and perennial grass/forb cover was also greater than baseline in 2021. Sagebrush density was below baseline in 2021. While sagebrush heights were nearly equal to baseline, perennial grasses and forbs heights were lower than baselines. Within non-sagebrush plots, cover and density for sagebrush species and herbaceous functional groups were above baselines in 2021. While sagebrush species height were taller than baseline, perennial grass/forb height were shorter when compared to baseline.

Cover: Sagebrush Habitat Plots

Absolute cover by species is organized by nativity and vegetative functional groups (Table 3-2a). In 2021, total absolute cover on sagebrush habitat plots was higher than baseline. Overall, native functional groups contributed substantially more cover than introduced functional groups and native shrubs was the most abundant functional group. Absolute shrub cover in 2021 was comparable to baseline, but relative cover of shrubs was lower in 2021 because absolute cover of native grasses was higher than baseline. The native perennial graminoid functional group was the second most abundant functional group in 2021 and the remaining native functional classes were below baseline cover values contributing less relative cover. Introduced functional groups, including cheatgrass, provided little absolute cover on sagebrush habitat plots in 2021.

Within native shrubs, sagebrush species (*Artemisia* spp.) comprised more than two thirds of the functional group and absolute cover in 2021 was slightly greater than baselines. Big sagebrush (*Artemisia tridentata*) remains the most abundant sagebrush species, but threetip sagebrush (*A. tripartita*) and black sagebrush (*A. nova*) were locally abundant on the limited number of plots where each occurred. Low sagebrush (*A. arbuscula*) was not recorded in 2021 and likely reflected the challenges identifying the subtle differences between sagebrush species based on morphological characteristic during extremely low precipitation conditions. The second most abundant shrub species was green rabbitbrush (*Chrysothamnus viscidiflorus*). Lastly, shadscale saltbush (*Atriplex confertifolia*) and winterfat (*Krascheninnikovia lanata*) were present but contributed minor cover.

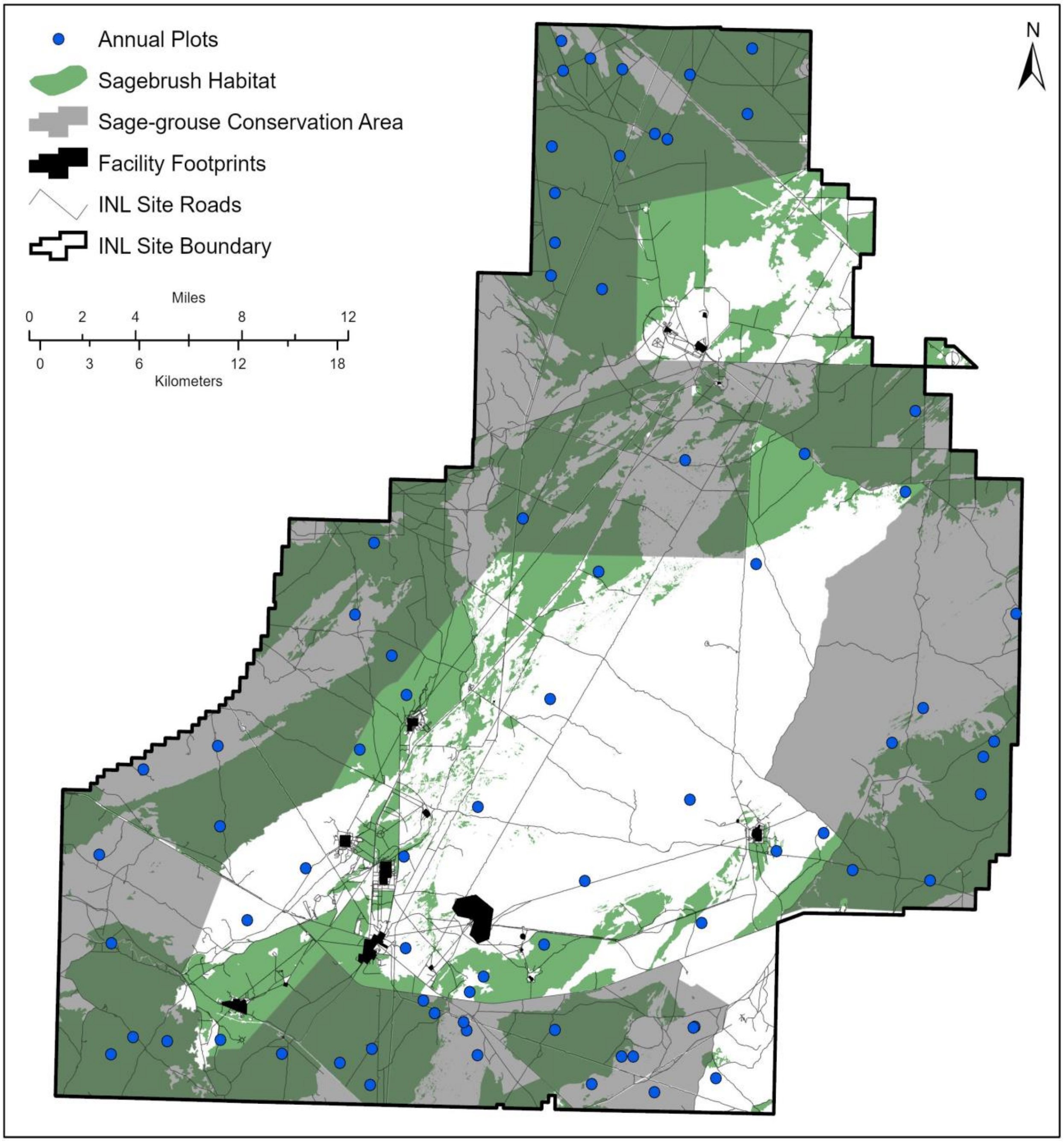

Figure 3-1. The 75 annual sage-grouse habitat condition monitoring plots sampled on the Idaho National Laboratory Site in 2021 to support the Candidate Conservation Agreement. Annual plots are displayed over sagebrush habitat and Sage-grouse Conservation Area polygons.

Table 3-1a. Summary of vegetation measurements for characterization of condition of sagebrush habitat monitoring plots and non-sagebrush plots on the Idaho National Laboratory Site in 2021.

2021 Summary			
Sagebrush Habitat Plots (*n* = 43*)	Mean Cover (%)	Mean Height (cm)	Mean Density (individuals/m^2)
Sagebrush	24.56	46.27	2.63
Perennial Grass/Forb	21.42	17.44	
Non-sagebrush Plots (*n* = 32*)	Mean Cover (%)	Mean Height (cm)	Mean Density (individuals/m^2)
Sagebrush	0.78	46.87	0.11
Perennial Grass/Forb	21.19	23.86	
*indicates sample size difference from past sampling efforts.			

Table 3-1b. Baseline values of selected vegetation measurements for characterization of condition of sagebrush habitat and non-sagebrush monitoring plots on the Idaho National Laboratory Site. Baseline values were generated from five years of data (2013–2017).

Baseline Summary						
Sagebrush Habitat Plots (*n* = 48)	Mean Cover (%)	SE	Mean Height (cm)	SE	Mean Density (individuals/m^2)	SE
Sagebrush	21.27	± 0.33	47.81	± 0.98	5.19	± 1.80
Perennial Grass/Forb	9.99	± 2.53	20.70	± 3.67		
Non-sagebrush Plots (*n* = 27)	Mean Cover (%)	SE	Mean Height (cm)	SE	Mean Density (individuals/m^2)	SE
Sagebrush	0.22	± 0.05	33.54	± 1.94	0.07	± 0.01
Perennial Grass/Forb	19.73	± 2.17	29.58	± 3.81		

Within the sagebrush habitat plots, Sandberg bluegrass (*Poa secunda*) and bottlebrush squirreltail (*Elymus elymoides*) were the most abundant species within the native perennial graminoid functional group and made up two thirds of the group's vegetation composition in 2021 (Table 3-2a). These two grasses are also the most abundant grasses contributing to the baseline cover values. Bluebunch wheatgrass (*Pseudoroegneria spicata*) cover values were consistent with baseline absolute cover values and thickspike wheatgrass (*Elymus lanceolatus*) was more than twice as abundant in 2021 compared to baseline, though it tends to be a minor component of the understory when averaged across plots.

The 2021 total absolute cover from introduced species remained much lower than native species, mirroring baseline cover values for introduced functional groups. The most abundant non-natives were crested wheatgrass (*Agropyron cristatum*) and cheatgrass (*Bromus tectorum*). Crested wheatgrass contributed to more than half of the vegetation composition for introduced species because it was more than double its baseline, and all other species fell well below their baseline cover values. Cheatgrass accounted for nearly all vegetation cover in the annuals and biennials functional group, but absolute cover remained low in 2021.

Table 3-2a. Absolute cover (%) for observed species within 43 annual sagebrush habitat plots. Baseline absolute cover values are compared to 2021 absolute cover values by species and functional groups. Baseline values were generated from five years of data (2013–2017).

Plant Species[†]	Baseline (%) (*n*=5)	Absolute Cover (%) 2021
Native		
Shrubs		
Artemisia tridentata	17.41	21.28
Chrysothamnus viscidiflorus	6.64	4.47
Artemisia tripartita	1.80	2.34
Artemisia arbuscula	1.16	*
Atriplex confertifolia	0.95	1.10
Artemisia nova	0.90	0.93
Krascheninnikovia lanata	0.72	0.44
Linanthus pungens	0.22	0.30
Eriogonum microthecum	0.10	0.05
Tetradymia canescens	0.04	0.05
Ericameria nauseosa	0.02	0.03
Others (*n* = 2, 0)	0.03	*
Total Native Shrub Cover	29.99	31.01
Succulents		
Opuntia polyacantha	0.10	0.06
Perennial Graminoids		
Elymus elymoides	2.15	7.70
Poa secunda	2.03	4.32
Achnatherum hymenoides	1.85	1.83
Pseudoroegneria spicata	1.21	1.61
Elymus lanceolatus	0.80	1.80
Hesperostipa comata	0.51	0.24
Pascopyrum smithii	0.21	*
Carex douglasii	0.11	0.23
Others (*n* = 1,0)	0.02	*
Total Native Perennial Graminoid Cover	8.88	17.73
Perennial Forbs		
Phlox hoodii	0.47	0.52
Schoenocrambe linifolia	0.24	<0.00
Sphaeralcea munroana	0.12	*
Erigeron pumilus	0.04	0.03
Astragalus filipes	0.03	0.05
Arabis cobrensis	0.02	0.00
Astragalus lentiginosus	0.01	<0.00
Ipomopsis congesta	<0.00	*
Others (*n* = 22, 7)	0.18	0.09
Total Native Perennial Forb Cover	1.11	0.70

Table 3-2a. (continued).

Annuals and Biennials		
Lappula occidentalis	0.34	*
Descurainia pinnata	0.27	*
Cordylanthus ramosus	0.15	*
Chenopodium leptophyllum	0.08	*
Others (*n* = 13, 0)	0.14	*
Total Annual and Biennial Forb Cover	0.99	*
Total Native Cover	41.07	49.51
Introduced		
Perennial Grasses		
Agropyron cristatum	1.34	2.98
Annuals and Biennials		
Alyssum desertorum	1.08	<0.00
Bromus tectorum	1.02	0.91
Halogeton glomeratus	0.74	0.07
Others (*n* = 7, 1)	0.03	*
Total Introduced Annual and Biennial Cover	2.87	0.98
Total Introduced Cover	4.21	3.97
Total Vascular Plant Cover	45.28	53.47

***** Species that were undetectable using the current sampling methodology.

† Appendix A provides a complete species list with scientific and common names.

Table 3-2b. Absolute cover (%) for observed species within 32 annual non-sagebrush plots. Baseline values are compared to 2021 absolute cover values by species and functional groups. Baseline values were generated from five years of data (2013–2017).

Plant Species†	Baseline Absolute Cover (%)	2021 Absolute Cover (%)
Native		
Shrubs		
Chrysothamnus viscidiflorus	10.72	9.68
Atriplex confertifolia	0.33	0.36
Artemisia tridentata	0.21	0.75
Tetradymia canescens	0.18	0.12
Eriogonum microthecum	0.07	0.02
Gutierrezia sarothrae	0.02	0.10
Artemisia tripartita	0.01	0.03
Others (*n* = 3, 2)	0.08	0.09
Total Native Shrub Cover	11.62	11.14
Succulents		
Opuntia polyacantha	0.10	0.07

Table 3-2b. (continued).

Perennial Graminoids		
Pseudoroegneria spicata	4.82	3.97
Poa secunda	3.01	3.84
Hesperostipa comata	2.68	1.70
Achnatherum hymenoides	2.45	1.70
Elymus lanceolatus	2.08	3.52
Elymus elymoides	1.42	2.70
Pascopyrum smithii	0.84	1.39
Leymus flavescens	0.58	0.67
Carex douglasii	0.08	0.01
Others (*n* = 2, 1)	0.03	0.04
Total Native Perennial Graminoid Cover	17.98	19.55
Perennial Forbs		
Phlox hoodii	0.40	0.31
Sphaeralcea munroana	0.31	0.04
Crepis acuminata	0.29	0.06
Erigeron pumilus	0.15	0.05
Phlox aculeata	0.11	*
Phlox longifolia	0.10	0.06
Machaeranthera canescens	0.07	*
Schoenocrambe linifolia	0.07	*
Astragalus filipes	0.06	0.03
Pteryxia terebinthina	0.01	0.06
Astragalus lentiginosus	0.01	0.04
Others (*n* = 17, 9)	0.17	0.08
Total Native Perennial Forb Cover	1.75	0.72
Annuals and Biennials		
Lappula occidentalis	0.26	<0.00
Descurainia pinnata	0.11	<0.00
Mentzelia albicaulis	0.09	0.04
Eriastrum wilcoxii	0.09	<0.00
Others (*n* = 12, 3)	0.14	0.09
Total Native Annual and Biennial Cover	0.67	0.15
Total Native Cover	32.12	31.63
Introduced		
Perennial Grasses		
Agropyron cristatum	0.59	0.64
Perennial Forbs		
Carduus nutans	0.01	*
Others (*n* = 0, 1)	*	<0.00
Total Introduced Perennial Cover	0.60	0.92

Table 3-2b. (continued).

Annuals and Biennials		
Bromus tectorum	13.48	7.30
Salsola kali	1.78	1.51
Alyssum desertorum	1.40	0.05
Halogeton glomeratus	1.22	0.10
Sisymbrium altissimum	0.21	0.09
Descurainia sophia	0.06	*
Tragopogon dubius	0.01	*
Lactuca serriola	*	0.02
Others (*n* = 1, 0)	0.01	*
Total Introduced Annual and Biennial Cover	18.17	9.08
Total Introduced Cover	18.78	10.00
Total Vascular Plant Cover	50.90	41.62

* Species that were undetectable using the current sampling methodology.

† Appendix A provides a complete species list with scientific and common names.

Within the native perennial graminoid functional group, Sandberg's bluegrass and bluebunch wheatgrass were the most abundant species in 2021. Sandberg's bluegrass, thickspike wheatgrass, and bottlebrush squirreltail had greater cover than baseline. Other grass species had lower cover in 2021 than their baseline cover values like bluebunch wheatgrass, Indian ricegrass (*Achnatherum hymenoides)*, and needle-and-thread grass (*Hesperostipa* comata). Within the shrub functional group, green rabbitbrush was the most abundant species contributing 86% of the relative cover. Although there were small contributions from other shrub species, these recovering habitats are often defined by the presence of this shrub because it can resprout easily after wildland fire.

Total cover from the introduced annuals and biennials functional group in 2021 was half that of baseline cover values. In both baseline and 2021 values, cheatgrass is by far the most abundant species in this functional group. Cheatgrass cover was below baseline value in 2021 and has decreased substantially over the last three seasons, from 36% absolute cover in 2018, to 9% absolute cover in 2021. Cheatgrass is a self-pollinating winter annual. It grows during seasons when native plants are typically dormant providing it a head start, but it is still an annual species and fluctuates in abundance in response to variable annual environmental conditions.

Vegetation Height: Sagebrush Habitat Plots

The vegetation height metric provides an assessment of vertical structure by functional group in sagebrush habitat and non-sagebrush plots (Tables 3-3a and 3-3b). Sagebrush species were the individuals measured most frequently within the shrub functional groups in sagebrush habitat plots. They were recorded three out of every four individual shrubs sampled, as indicated by the proportion of the sample measured. On average, sagebrush species were nearly twice as tall as the other species of shrubs within the shrub functional groups. Perennial grass species were the tallest group and encountered nearly nine out of 10 times compared to the combined remaining herbaceous functional groups. All herbaceous functional groups were comparatively shorter than baseline height while shrub functional groups are nearly equal to baseline height.

Table 3-3a. Vegetation height by functional group for 43 annual sagebrush habitat plots on the Idaho National Laboratory Site in 2021. Baseline values are compared to functional groups for height (cm) and were generated from five years of data (2013–2017).

Sagebrush Habitat Plots	Baseline		2021	
Functional Group	Mean Height (cm)	Proportion of Sample	Mean Height (cm)	Proportion of Sample
		Shrubs		
Sagebrush	47.81	0.72	46.27	0.74
Other Species	25.57	0.28	25.31	0.26
		Herbaceous		
Perennial Grasses	22.49	0.67	18.11	0.88
Perennial Forbs	9.98	0.12	6.54	0.05
Annual Grasses	18.95	0.04	10.51	0.06
Annual Forbs	9.09	0.17	5.6	<0.00

Table 3-3b. Vegetation height by functional group for 32 annual non-sagebrush plots on the Idaho National Laboratory Site in 2021. Baseline values are compared to functional groups for height (cm) and were generated from five years of data (2013–2017).

Non-sagebrush Plots	Baseline		2021	
Functional Group	Mean Height (cm)	Proportion of Sample	Mean Height (cm)	Proportion of Sample
		Shrubs		
Sagebrush	33.54	0.08	46.87	0.07
Other Species	26.82	0.92	25.37	0.93
		Herbaceous		
Perennial Grasses	31.49	0.55	24.75	0.72
Perennial Forbs	11.64	0.06	8.29	0.04
Annual Grasses	16.96	0.25	13.49	0.20
Annual Forbs	10.94	0.15	8.55	0.03

Vegetation Height: Non-sagebrush Plots

Shrub height measurements were mainly collected from non-sagebrush shrub species, primarily green rabbitbrush, within the shrub functional groups (Table 3-3b). The average height for non-sagebrush shrubs was similar to baseline height values, while the few sagebrush species recorded were taller than baseline. Perennial grasses provided most of the available vertical structure on non-sagebrush plots and were the individuals sampled most frequently within the herbaceous functional groups. Average height values for all herbaceous functional groups were shorter in 2021 than baseline height values.

Sagebrush Density

In sagebrush habitat plots, sagebrush density was lower in 2021 than baseline while sagebrush density was slightly higher in non-sagebrush plots when compared to the non-sagebrush plot density baseline (Table 3-4). On the sagebrush habitat plots, sagebrush density ranged from less than one individual per square meter to approximately six individuals per square meter. On the non-sagebrush plots, sagebrush density ranged from zero to a maximum of one individual per square meter. Juvenile shrub frequency in 2021 on sagebrush habitat plots was below baseline. Juvenile shrub frequency on non-sagebrush plots was lower by half in 2021 compared to baseline juvenile frequency values; about one out of every 100 transects contained juveniles. Although mean sagebrush density in non-sagebrush plots was slightly above baseline, it still represents a low density of sagebrush. Overall, the densities and frequencies of sagebrush were lower than baseline in 2021.

Table 3-4. Sagebrush density (individual/m^2) and juvenile frequency from sagebrush habitat monitoring plots (n = 43) and non-sagebrush monitoring plots (n = 32) on the Idaho National Laboratory Site in 2021 compared to baseline values. Baseline values were generated from five years of monitoring data (2013–2017).

Sagebrush Density	Sagebrush Habitat Plots		Non-sagebrush Plots	
	Baseline	2021	Baseline	2021
Mean Density (individuals/m^2)	5.19	2.63	0.07	0.11
Minimum Density (individuals/m^2)	0.43	0.80	0.00	0.00
Maximum Density (individuals/m^2)	47.60	6.45	0.74	1.05
Mean Juvenile Frequency	0.38	0.08	0.02	0.01

Precipitation

Precipitation data for this report are summarized from the 70-year Central Facilities Area (CFA) Thermoscreen records (https://niwc.noaa.inl.gov/Climate.htm). Annual precipitation has been summarized by calendar year in previous reports; however, in this report we summarized precipitation by water year to better evaluate water available to vegetation through the growing season. Water year is calculated by summing annual precipitation from October 1 through September 30 of the following year. The water year is denoted by the year it ends. For example, the year ending September 30, 2021 is the “2021” water year. Over the last two decades, there have been several years with precipitation well below average and those dry years have departed farther from the mean than wet years (Figure 3-2, Forman and Hafla 2018). Seasonality of precipitation has also departed from long term-averages since habitat condition monitoring to support the CCA began. Historically, the wettest months generally occurred during April, May, and June on the INL Site (Figure 3-3). However, from 2013 through 2019 some of the wettest months of the year occurred in August, September, and October. The change in distribution of precipitation throughout the year has departed from the means for the last several years and the difference from the long-term precipitation patterns would certainly favor some plant species and functional groups over others.

In 2021, total annual precipitation was about half the yearly average (Figure 3-3). The winter and spring months, except for March, were below average and the lack of precipitation extended well into the summer months through the peak growing season, but August received nearly three times the typical precipitation. Semi-arid plant species are adapted to surviving with limited resources. Species within different plant functional groups rely on different life history strategies to compete for water and nutrients in extreme conditions. Less precipitation early in the water year likely affected early spring biennials and annuals more than perennials because they require spring moisture to complete their life cycles. Although native perennial plants are well adapted to short periods of harsh conditions and cover did not appear to be substantially effected by two years of below average precipitation, prolonged drought conditions may eventually affect the abundance of native perennials.

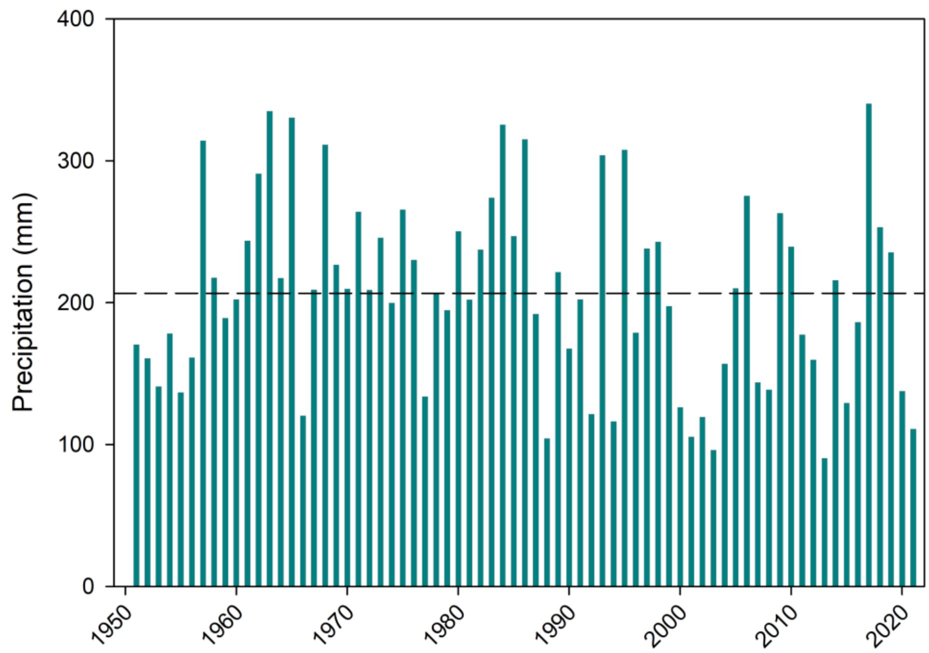

Figure 3-2. Annual water-year precipitation (October–September) from 1951 through 2021 at the Central Facilities Area, Idaho National Laboratory Site. The dashed line represents mean annual precipitation (206 mm).

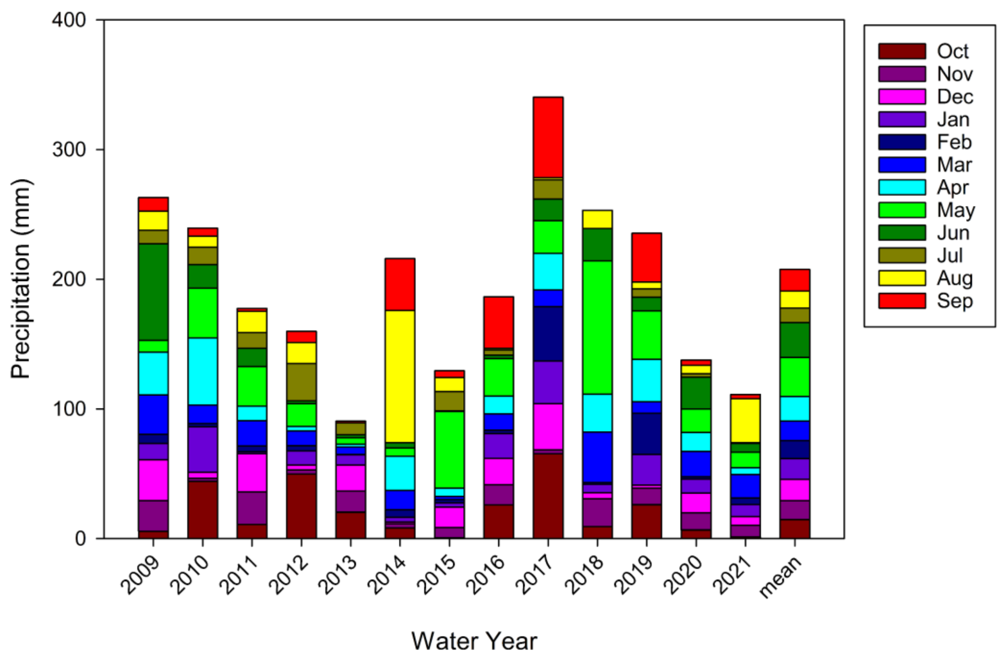

Figure 3-3. Annual water-year precipitation (October–September) by month from the Central Facilities Area, Idaho National Laboratory Site. Mean monthly precipitation includes data from 1951 through 2021 (206 mm).

Habitat Condition Trend Analyses

Sagebrush Habitat Plots

From 2013–2021, absolute cover within sagebrush habitat plots remained consistent for native perennial forbs and sagebrush (Figure 3-4a). Non-sagebrush shrub cover continues to exhibit minor fluctuations, but these variations from the mean are unlikely ecologically meaningful. Native perennial grasses trended upward for several years in response to favorable weather events and remain near their upper range of variability. Native perennial grasses had significantly greater cover in 2021 than in 2013, 2014, and 2015 ($p<0.01$) (Table 3-5a). Native annual and biennial forbs have decreased since 2017, likely in response to lower total precipitation over the past four years (Figure 3-3). Native annual and biennial forbs had significantly less cover in 2020 than 2018 and 2019 ($p<0.01$) and were below detectable limits in 2021 (Table 3-5a).

Total cover from introduced species on sagebrush habitat plots has been much lower than total cover for native species throughout the monitoring period (Figure 3-4b). Introduced perennial grass cover has remained low since monitoring efforts began in 2013. Although cover from introduced annual forbs and grasses has fluctuated more from one year to another, it is likely responding to weather events and available soil water. Introduced annual forbs had significantly less cover in 2021 and 2020 than in 2017, 2018, and 2019 ($p<0.01$). Additionally, introduced annual grasses had significantly less cover in 2021 and 2020 than in 2018 ($p<0.01$) and 2019 ($p<0.02$) (Table 3-5b).

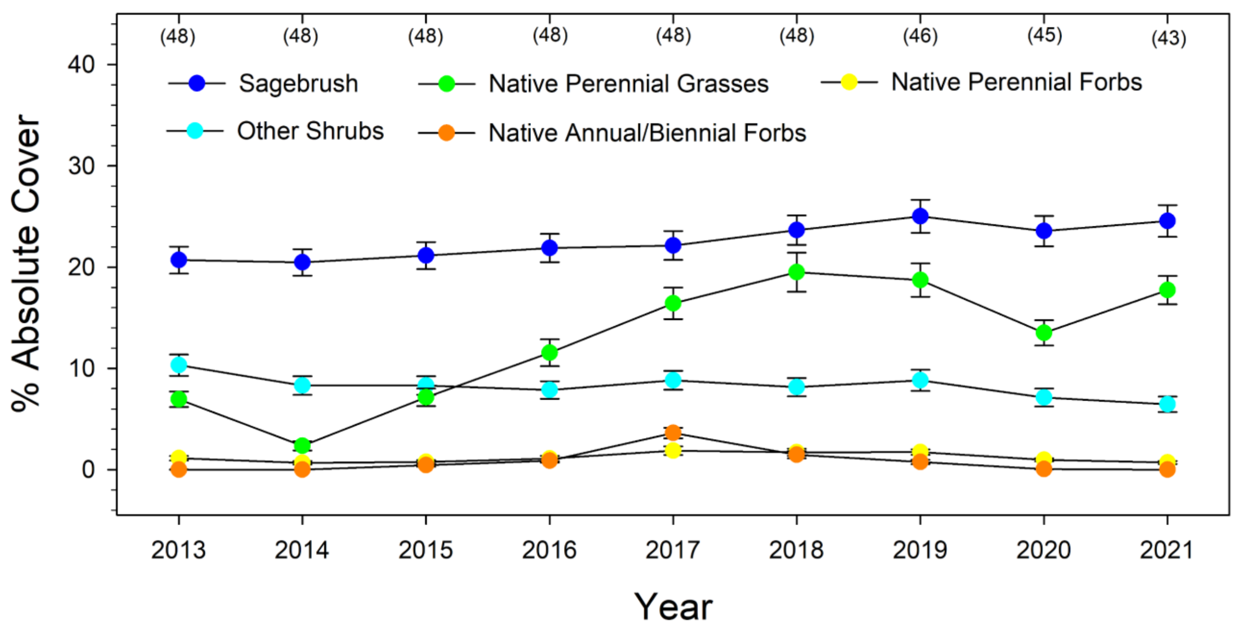

Figure 3-4a. Mean absolute cover (%) from functional groups of native species in sagebrush habitat plots on the Idaho National Laboratory Site from 2013 through 2021. Error bars represent ± 1 SE. Tick marks along the top denote sample size.

Table 3-5a. Mean cover (%) from functional groups of native species in sagebrush habitat plots on the Idaho National Laboratory Site from 2013 through 2021. Minimum Significant Difference is reported for each functional group using Holm-Sidak method for pairwise comparisons.

Sagebrush Habitat Plots: *Native Species* Mean Cover (%)					
Year	Sagebrush	Other Shrubs	Native Perennial Grasses	Native Perennial Forbs	Native Annual/Biennial Forbs
2013	20.692	10.316	6.951	1.130	0.00563
2014	20.463	8.311	2.351	0.673	0.000
2015	21.134	8.310	7.144	0.768	0.434
2016	21.887	7.871	11.541	1.100	0.891
2017	22.140	8.826	16.426	1.875	3.619
2018	23.655	8.154	19.496	1.713	1.469
2019	25.019	8.827	18.725	1.734	0.758
2020	23.564	7.118	13.502	0.972	0.0451
2021	24.559	6.455	17.729	0.703	0.000
Minimum Significant Difference	N/A	2.996	4.590	1.201	1.409

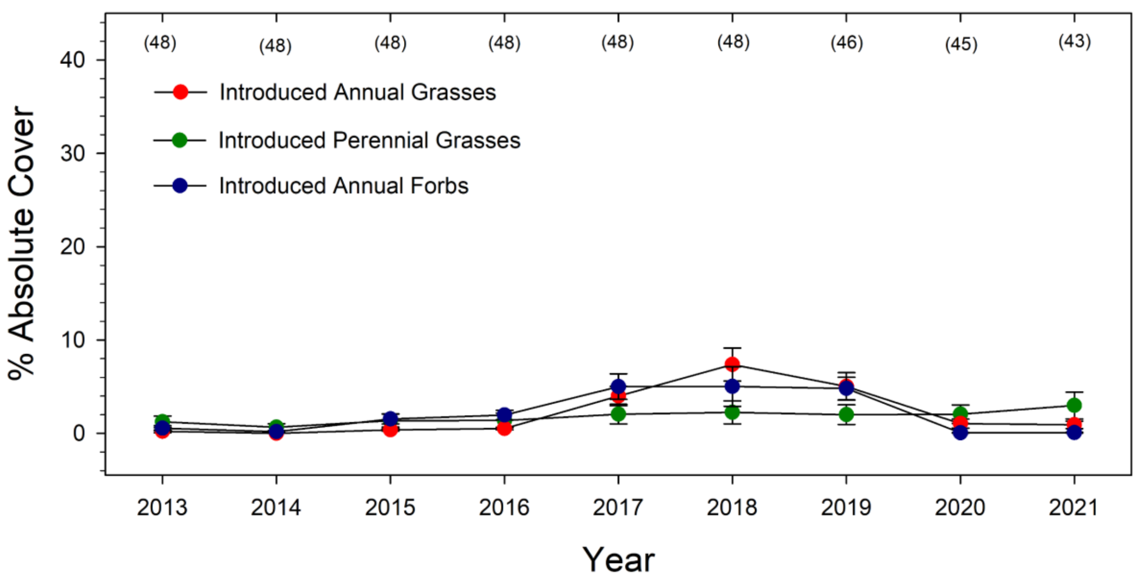

Figure 3-4b. Mean cover from functional groups of introduced species in sagebrush habitat plots on the Idaho National Laboratory Site from 2013 through 2021. Error bars represent ± 1 SE. Tick marks along the top denote sample size.

Table 3-5b. Mean cover (%) from functional groups of introduced species in sagebrush habitat plots on the Idaho National Laboratory Site from 2013 through 2021. Minimum Significant Difference is reported for each functional group using Holm-Sidak method for pairwise comparisons.

Sagebrush Habitat Plots: *Introduced Species* Mean Cover (%)			
Year	Introduced Perennial Grasses	Introduced Annual Grasses	Introduced Annual Forbs
2013	1.235	0.211	0.543
2014	0.656	0.000	0.179
2015	1.368	0.372	1.542
2016	1.383	0.510	1.964
2017	2.057	3.998	5.010
2018	2.242	7.369	5.022
2019	2.004	5.024	4.800
2020	2.052	1.044	0.0602
2021	2.983	0.912	0.0705
Minimum Significant Difference	N/A	3.626	3.336

Non-sagebrush Plots

Within the native functional groups, perennial grasses and non-sagebrush shrub species, predominantly green rabbitbrush, remain the most abundant functional groups on non-sagebrush plots (Figure 3-5a). Native perennial, biennial, and annual forbs along with sagebrush species are the least abundant functional groups. Native annual and biennial species cover trended downward in 2021 but there was no significance between sample years. Native perennial forbs were significantly lower in 2021 than in 2013 ($p<0.01$) (Table 3-6a).

Cover of introduced perennial grasses remained consistent through dry conditions this year (Figure 3-5b). Introduced annual forbs decreased from last season but no sample years could be isolated for which significant differences occurred (Table 3-6b). Cheatgrass is the only introduced annual grass species found on the INL Site. It was near 5% absolute cover in 2013, reached a high of 36% in 2018, but has since decreased to 7% in 2021 (Figure 3-5b). Cheatgrass cover was significantly lower in 2021 than in 2017, 2018, and 2019 ($p<0.01$, Table 3-6b). Annual species are sensitive to total annual precipitation and to seasonal distribution of precipitation which is evident in dramatic cover fluctuations from one year to the next.

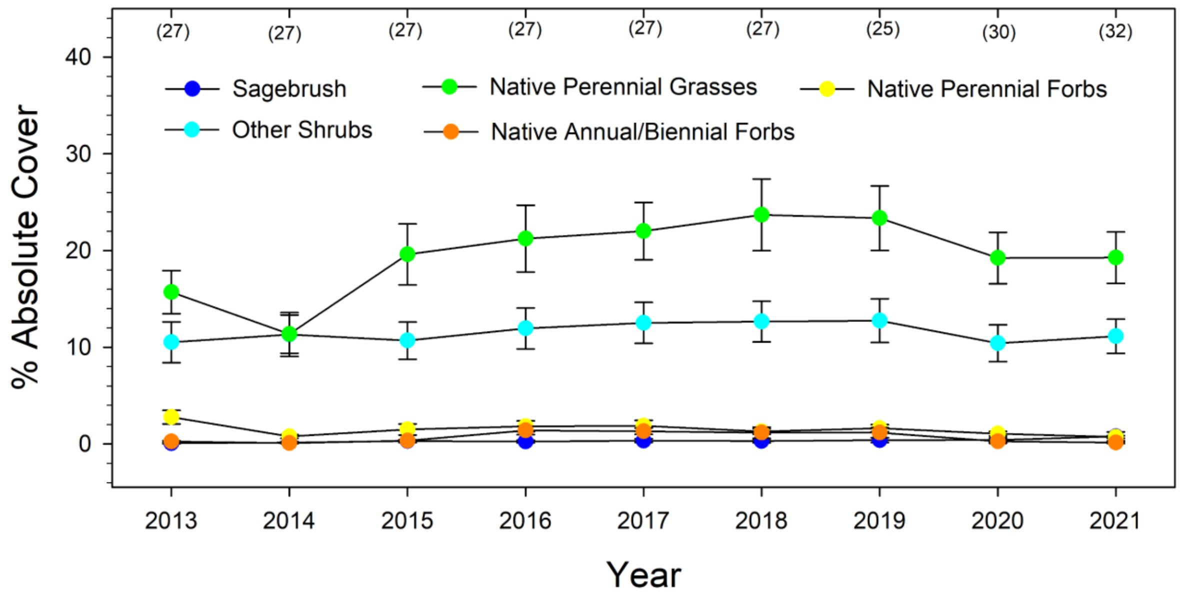

Figure 3-5a. Mean cover from functional groups of native species in non-sagebrush habitat plots on the Idaho National Laboratory Site from 2013 through 2021. Error bars represent ± 1 SE. Tick marks along the top denote sample size.

Table 3-6a. Mean cover (%) from functional groups of native species in non-sagebrush plots on the Idaho National Laboratory Site from 2013 through 2021. Minimum Significant Difference is reported for each functional group using Holm-Sidak method for pairwise multiple comparisons.

Non-sagebrush Plots: *Native Species* Mean Cover (%)					
Year	Sagebrush	Other Shrubs	Native Perennial Grasses	Native Perennial Forbs	Native Annual/Biennial Forbs
2013	0.0763	10.515	15.704	2.766	0.239
2014	0.149	11.319	11.364	0.771	0.0915
2015	0.297	10.692	19.600	1.495	0.335
2016	0.251	11.934	21.228	1.824	1.390
2017	0.343	12.515	22.004	1.878	1.312
2018	0.308	12.654	23.688	1.284	1.161
2019	0.394	12.738	23.347	1.634	1.170
2020	0.397	10.420	19.229	1.061	0.257
2021	0.781	11.139	19.263	0.723	0.141
Minimum Significant Difference	N/A	N/A	N/A	1.995	N/A

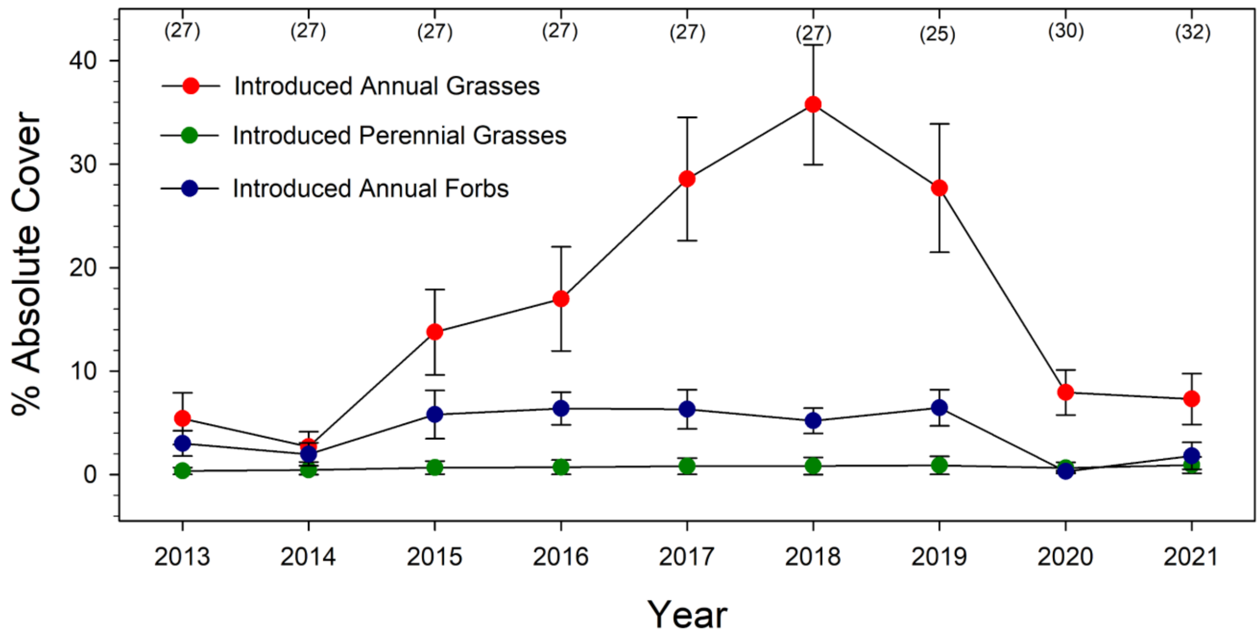

Figure 3-5b. Mean cover from functional groups of introduced species in non-sagebrush habitat plots on the Idaho National Laboratory Site from 2013 through 2021. Error bars represent ± 1 SE. Tick marks along the top denote sample size.

Table 3-6b. Mean cover (%) from functional groups of introduced species in non-sagebrush plots on the Idaho National Laboratory Site from 2013 through 2021. Minimum Significant Difference is reported for each functional group using Holm-Sidak method for pairwise multiple comparisons.

Non-sagebrush Plots: *Introduced Species* Mean Cover (%)			
Year	Introduced Perennial Grasses	Introduced Annual Grasses	Introduced Annual Forbs
2013	0.354	5.409	3.010
2014	0.437	2.684	1.961
2015	0.663	13.766	5.792
2016	0.709	16.977	6.386
2017	0.807	28.575	6.305
2018	0.833	35.757	5.193
2019	0.888	27.678	6.454
2020	0.643	7.935	0.296
2021	0.915	7.301	1.811
Minimum Significant Difference	N/A	18.779	N/A

Assessment of Potential Threats to Habitat

Vegetation sampling for 150 rotational plots was completed between 2018 and 2020, 50 plots during each sample season (June–August). Data collected from the 75 annual plots during 2020 were also used to assess the potential effects of wildland fire and livestock opperations on sagebrush habitat at the INL Site. Rotational plots are distributed such that the number of plots in each burned area, allotment, or combination thereof are roughly proportional to the amount of area they occupy (Figure 3-6, Figure 3-7). For example, the Twin Buttes Allotment is the largest allotment on the INL site and the 2010 Jefferson Fire resulted in one of the largest burned areas on the INL Site, so there are more plots located in those areas than there are plots located in smaller allotments or burned areas. During data collection, the 2019 Sheep Fire burned a fifth of the vegetaion monitoring plots in the interior of the INL Site. A portion of these plots were sagebrush habitat while the others were recovering from previous wildland fires. Of the 150 rotational plots, just two plots were unable to be sampled due to the Sheep Fire. Our analyses accounted for the dynamic habitat status of each vegetation monitoring plot due to wildland fire activity.

Wildland Fire Threat Analysis

Within the burned areas, there was high variability among fires of abundance within the same functional groups and there did not appear to be an effect of time since fire, with the exception of the “other shrubs” funtional group (Table 3-7). This functional group is dominated by green rabbitbrush and cover does appear to be greater in older burned areas than in areas burned in more recent fires. There was a statistically significant difference in sagebrush cover, from all shrubby *Artemisia* species, in unburned sagebrush habitat when compared to all burned areas. This is expected as wildand fire kills sagebrush and it does not resprout.

The results from the fire analyses indicate the 2011 T-17 Fire and the 1996 Fire appear to be recovering to relatively good ecological condition. Cover from native species was relatively high in the T-17 Fire and most of that cover was from perennial grasses. The T-17 Fire also had relatively low cover from non-natives when compared to total vascular plant cover. In the 1996 Fire, non-native cover was low and the cover of non-sagebrush shrubs, primarily green rabbitbrush, and native perennial grasses are similar to sagebrush habitat. When sagebrush species are removed from the landscape, other shrub species likely perform similar function and are important in recovering habitats until sagebrush returns.

Ecological condition can be assessed by comparing compostition of the plant community in terms of the ratio of native to introduced herbaceous species. Because the cover of introduced species nearly equals the cover from native herbaceous species in the 2000 Tin Cup Fire and the 2010 Jefferson Fire, the plant communities in these wildland fires appear to be in less than optimal condition. The Sheep Fire is recovering with mostly native species, but it is unlikely that the trajectory of invasive species is accurately captured within this dataset collected one growing season post wildland fire. Historical INL Site data sets indicate that introduced species are often reduced in abundance for the first few years post-fire (Forman and Hafla 2018) and our annual trend analyses indicate non-native cover can greatly fluctuate if favorable weather conditions present in recovering habitat (Figure 3-5b).

Some of the differences in post-fire ecological condition are likely due to weather conditions during the first few growing seasons after the fire. For example, low annual precipitation in the year since the Sheep Fire burned are reflected in both perennial and introduced annual herbaceous cover values. Other factors leading to differences in post-fire condtion may include; pre-fire condition, soils, topography, avaliable seed bank and natural seed sources, type of land use, etc. Continued monitoring of the rotational plots will be informative for understanding how persistant or ephemeral non-natives are in post-fire plant communites. It is also apparent that natural sagebrush recovery will be very slow and planting sagebrush will be important to hasten recovery of sagebrush habitat on the INL Site.

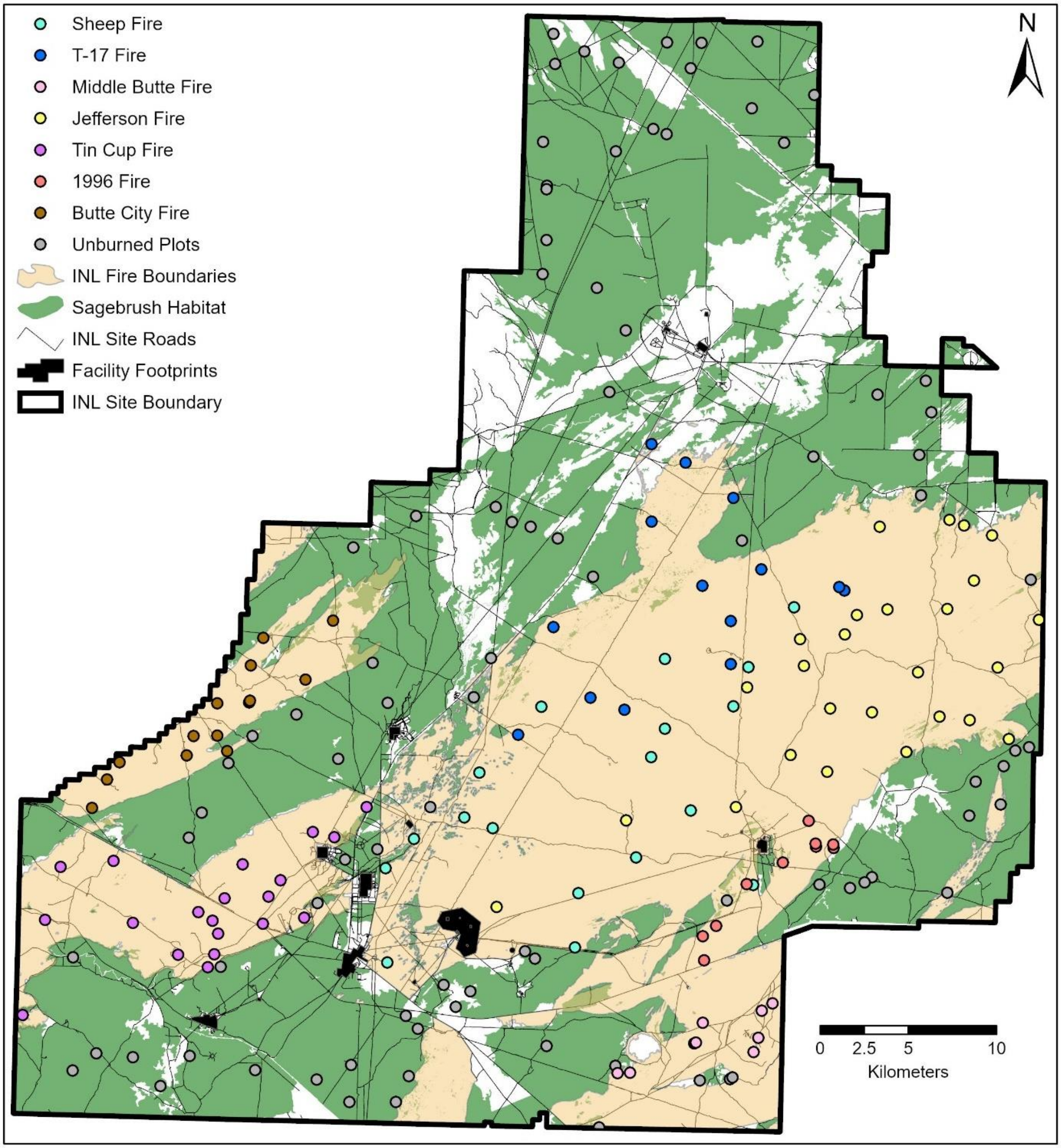

Figure 3-6. Distribution of sage-grouse habitat condition monitoring plots sampled on the Idaho National Laboratory Site with respect to select areas burned since 1994. Only burned areas containing more than eight plots were used for analysis. Rotational plots were collected over a three year period in subsets of 50 plots per season from 2018 – 2020 and data used for analyses from 75 annual plots were collected in 2020.

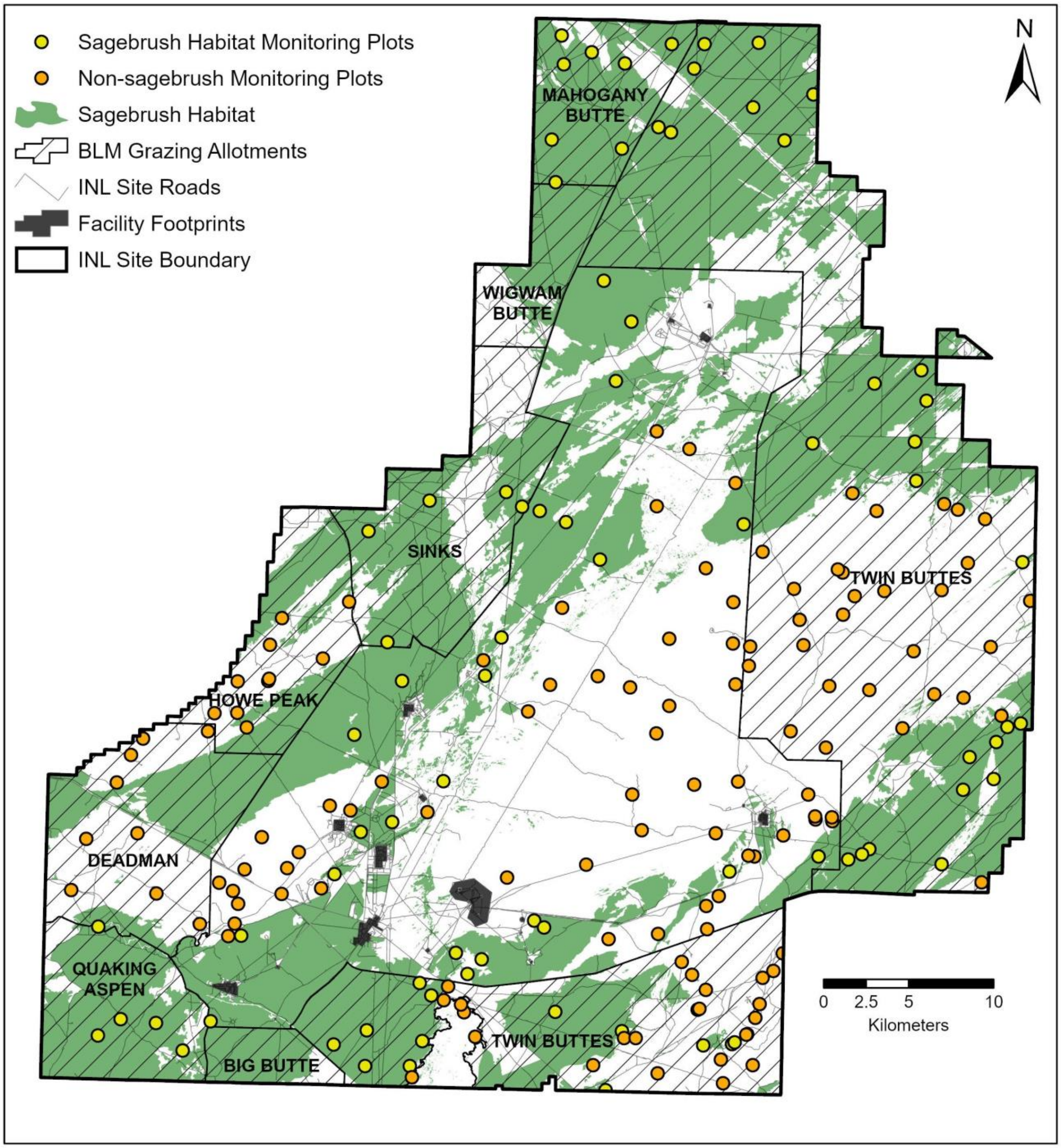

Figure 3-7. Distribution of sage-grouse habitat condition monitoring plots sampled on the Idaho National Laboratory Site with respect to boundaries of grazing allotments administered by the Bureau of Land Manangement. Data on rotational plots were collected over a three year period in subsets of 50 plots per season from 2018–2020 and data used for analyses from 75 annual plots were collected in 2020.

Table 3-7. Absolute cover by functional group for annual and rotational plots comparing seven burned areas with unburned sagebrush habitat on the Idaho National Laboratory Site. Letters (a, b) indicate significant differences between pairwise comparison at $\alpha \leq 0.05$.

	Unburned (*n* = 89)	1994 Butte City Fire (*n* = 14)	1996 Fire (*n* = 10)	2000 Tin Cup Fire (*n* = 20)	2010 Jefferson Fire (*n* = 27)	2010 Middle Butte Fire (*n* = 9)	2011 T-17 Fire (*n* = 14)	2019 Sheep Fire (*n* = 17)
Native								
Sagebrush*	21.13 a	0.27 b	0.17 b	0.58 b	0.22 b	0.15 b	0.10 b	0.00 b
Other Shrubs	8.29	16.56	23.58	12.22	10.55	9.34	9.84	3.26
Succulents	0.20	0.09	0.00	0.07	0.10	0.04	0.22	0.00
Perennial Graminoids*	16.10 b	23.36 ab	18.50 b	29.00 ab	31.79 ab	32.18 ab	42.27 a	20.10 b
Perennial Forbs	1.17	2.76	0.59	2.69	1.54	2.70	3.70	0.96
Annual and Biennial Forbs	0.56	0.03	0.28	0.53	0.33	0.09	2.26	0.84
Total Native Cover	47.45	43.06	43.10	45.09	44.54	44.50	58.38	25.15
Introduced								
Perennial Graminoids	2.10	1.89	0.07	2.57	0.63	0.01	1.25	1.53
Perennial Forbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Annual Grasses	3.20	16.27	8.29	17.38	18.50	13.19	9.39	2.68
Annual and Biennial Forbs	1.18	5.90	1.58	10.17	9.62	4.14	3.38	0.54
Total Introduced Cover*	6.47 b	24.06 a	9.94 ab	30.11 a	28.75 a	17.34 ab	14.02 ab	4.75 b
Total Vascular Plant Cover	53.92	67.12	53.04	75.20	73.29	61.85	72.40	29.90

Livestock Use Threat Analysis: Sagebrush Habitat Condition

To address sagebrush habitat in areas grazed by livestock at the INL Site, vegetation compostion was compared among several allotments and with areas outside of allotments (Figure 3-7). Because fire changes vegetation composition so markedly, these analyses were divided into comparing allotments and non-allotment areas that are in current sagebrush habitat (Table 3-8a) and comparing allotments and non-allotment areas that are in burned areas (Table 3-8b). In current sagebrush habitat, three of the four allotments had mean cover values of sagebrush species (Table 3-8a) that were above the baseline values (Table 3-1b; 21% ± 0.33) . Sagebrush cover was below the baseline cover value in the Sinks allotment and in the analagous sagebrush habitat plots located outside of allotments. Perennial grass and forb cover was above baseline cover values (Table 3-1b;10% ± 2.53) in all four allotments and in analagous non-allotment plots as well (Table 3-8a). Perennial grass cover was lowest on the Twin Buttes allotment, though the difference wasn't statistically significant. Cover by non-natives, including cheatgrass, wasn't higher on any of the allotments than it was in the analogous non-allotment plots (Table 3-8a).

Table 3-8a. Absolute cover by functional group for annual and rotational plots comparing four allotments with areas outside of allotments in unburned sagebrush habitat on the Idaho National Laboratory Site. *Letters indicate significant differences between pairwise comparison at $\alpha \leq 0.05$.

	Non Allotment (*n* = 24)	Twin Buttes (*n* = 38)	Mahogany Butte (*n* = 8)	Quaking Aspen (*n* = 5)	Sinks (*n* = 5)
Native					
Sagebrush*	18.03 a	24.32 a	23.33 a	22.55 a	16.22 a
Other Shrubs	6.50	8.69	7.40	12.63	4.05
Succulents	0.35	0.23	0.07	0.00	0.00
Perennial Graminoids*	16.50 a	13.94 a	18.11 a	17.76 a	20.83 a
Perennial Forbs	1.05	0.93	0.60	1.29	1.47
Annual and Biennial Forbs	0.94	0.55	0.45	0.11	0.03
Total Native Cover	43.36	48.67	49.94	54.33	42.58
Introduced					
Perennial Graminoids	3.69	2.58	0.00	0.00	0.00
Perennial Forbs	0.00	0.00	0.00	0.00	0.00
Annual Grasses	1.99	4.79	0.00	4.25	0.03
Annual and Biennial Forbs	1.87	0.53	0.66	0.17	0.05
Total Introduced Cover*	7.55 a	7.90 a	0.66 a	4.41 a	0.08 a
Total Vascular Plant Cover	50.91	56.56	50.60	58.74	42.66

Livestock Use Threat Analysis: Non-sagebrush Habitat Condition

From analyses comparing allotments and non-allotment areas in recovering burns, mean sagebrush cover remained less than 1% (Table 3-8b). Combined perennial grass and forb cover ranged between 29% to 33% and was greater than the baseline value (Table 3-2b; 19.73% ± 2.17). Non-native species cover was higher in the Howe Peak allotment than in any of the allotments and analagous non-allotments used for this analysis, but pairwise comparisons indicated that the differences were not statistically significant. Cheatgrass comprised three quarters of non-native species cover within non-allotment areas, Twin Buttes, and Howe Peak and nearly half of the introduced cover for the Deadman Allotment. The introduced annual and biennial species functional group consisted mainly of desert alyssum, tall tumblemustard, and yellow salsify (*Tragopogon dubius)*.

Table 3-8b. Absolute cover by functional group for annual and rotational plots. Means are shown for three allotments and the area outside of allotments in burned and recovering, non-sagebrush vegetation on the INL Site. *Letters indicate significant differences between pairwise comparison at $\alpha \leq 0.05$.

	No Allotment (n = 62)	Twin Buttes (n = 52)	Howe Peak (n = 10)	Deadman (n = 9)
Native				
Sagebrush*	0.17 a	0.90 a	0.37 a	0.00 a
Other Shrubs	10.59	14.52	15.05	17.44
Succulents	0.07	0.06	0.11	0.01
Perennial Graminoids*	24.86 a	30.16 a	22.87 a	30.28 a
Perennial Forbs	1.98	1.68	2.98	3.02
Annual and Biennial Forbs	0.87	0.34	0.04	0.93
Total Native Cover	38.54	47.66	41.42	51.69
Introduced				
Perennial Graminoids	2.21	0.56	2.65	0.00
Perennial Forbs	0.00	0.00	0.00	0.00
Annual Grasses	13.88	13.12	18.55	7.02
Annual and Biennial Forbs	5.55	4.64	6.15	8.08
Total Introduced Cover*	21.63 a	18.32 a	27.35 a	15.10 a
Total Vascular Plant Cover	60.18	65.98	68.77	66.79

Although areas of specific, localized degradation were observed in several allotments (often related to supplemental water, salt locations, and trailing routes), rotational plot summaries did not indicate broad declines in habitat condition across any of the allotments surveyed. Large areas within several of the allotments on the INL Site are not used by livestock, mostly because they are difficult to access. Signs of livestock use were documented in only 13% of the plots surveyed within allotments. Therefore condition of habitat and areas recovering to habitat are likely as much a consequense of lack of use as they are the specific grazing practices prescribed in allotments on the INL Site. Working with Bureau of Land Management (BLM) on grazing practices will continue to be important in those areas that are utilized, so that they don't become weed vectors for adjacent areas with more limited use. Overall, fire appears to have had a greater immediate impact on sagebrush habitat than livestock use but concentrated livestock use of recovering habitat likely facilitates patches of invasive species.

3.1.4 Summary of Habitat Condition

For sagebrush habitat plots, 2021 vegetation cover and height values were near or above baseline for sagebrush species and perennial forb and grass functional groups. Mean sagebrush density in 2021 was below baseline, likely due to low juvenile recruitment rates, as seen in lower-than-average juvenile frequency. Nearly all introduced vegetation functional group cover was below baseline in 2021 except for non-native crested wheatgrass which was twice baseline. In non-sagebrush plots, 2021 sagebrush species and perennial grass and forb cover were above baseline, but sagebrush species and perennial grass and forb functional group height was shorter than baseline. Non-native cover, particularly from cheatgrass, has fluctuated over the past five years while crested wheatgrass remains within its narrow range of variability.

Vegetation metrics from sagebrush habitat and non-sagebrush plots reflected a decrease in precipitation in 2021 when compared to previous years. Total precipitation was about half of the 70-year average and decreases in vegetation cover were recorded for multiple plant functional groups in 2021. Native perennial functional groups are likely more resistance to drought conditions where ephemeral annual functional groups are less robust. Perennials have adaptations to withstand stressful semi-arid deserts and are less likely to respond to short-term weather conditions. Conversely, annuals wait for favorable conditions to complete their life cycle rather than adapting to the harsh environmental conditions, so their abundance often changes in response to short-term weather events. The decrease in cover from all annual functional groups, most notably introduced annual grasses like cheatgrass, is not surprising as low precipitation likely disproportionately affected annuals over other functional groups. The most recent Long-Term Vegetation study updated by Forman and Hafla (2018), suggests cheatgrass is capable of large upward and downward fluctuations in abundance in response to weather patterns.

For intact sagebrush shrubland vegetation, there have been no directional trends observed in most native and introduced functional groups. Native perennial grasses is one exception; cover for this functional group has more than doubled since monitoring began and remains at its upper range of variability. Non-sagebrush plant communities had dramatic fluctuations of cheatgrass cover while native functional groups remained consistent and within normal ranges. Cheatgrass has been a minor component of INL Site plant communities for several decades; however, cheatgrass appears to become much more abundant and more likely to dominate herbaceous plant communities post-fire (Forman and Hafla 2018). Patterns from this dataset are consistent with other local studies conducted on the INL Site. This indicates non-sagebrush areas are likely more susceptible to dominance from cheatgrass as it is widely distributed across the INL Site, occurring in all plant communities, but rarely dominating within intact sagebrush habitat. Sagebrush plant communities are likely more resistant to cheatgrass dominance than recovering habitats, a pattern that is particularly evident in years with weather patterns that favor the invasive non-native annual grass.

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

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

3.2.1 Introduction

Loss of sagebrush-dominated habitat has been identified as one of the primary causes of decline in sage-grouse populations (Idaho Sage-grouse Advisory Committee 2006, USFWS 2013). Direct loss of sagebrush habitat 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. Changes in land cover can be determined using airborne or satellite imagery that is readily available at little or no cost. Natural Resource Group geographic information system (GIS) analysts routinely compare new imagery as it becomes available with results from the most current vegetation classification and mapping project. Ground-based point surveys and changes in plant species cover and composition documented through Task 5 (Section 3.1) are also used to provide spatial information to assist with periodic map updates needed to monitor the habitat trigger in the CCA.

A 20% loss of sagebrush habitat from the 2013 baseline has been identified as a conservation trigger in the CCA (DOE-ID and USFWS 2014). The purpose of Task 6 is to maintain and update the INL Site vegetation map to accurately document changes in sagebrush habitat area and distribution. This task documents changes in sagebrush habitat following losses due to wildland fire or other disturbances that remove or significantly alter vegetation across the landscape. In addition to documenting losses of sagebrush habitat, this monitoring task also maps the addition of sagebrush habitat when sagebrush cover increases within a mapped polygon and warrants a new vegetation map class designation, or to refine existing vegetation map class boundaries when changes in species cover and composition are documented through Task 5 (Section 3.1). Lastly, this task supports post-fire mapping when the fire extent is unknown and allows for modifying existing wildland fire boundaries and unburned patches of vegetation when mapping errors are observed on the ground.

3.2.2 Methods

The process of maintaining the INL Site vegetation map following wildland fire involves two steps. The first step is to verify, update, or edit existing wildland fire boundaries using a GIS and remote sensing imagery. Wildland fire boundaries are produced by different contractors or agencies (e.g., BLM) using a variety of methods such as collecting Global Positioning System 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 burned area extent. Prior to delineating new vegetation class boundaries within the burned area, the mapped fire boundaries first need to be generated at similar mapping scales as the original vegetation map to maintain consistency in the dataset.

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 recovering post-fire classes. New wildland fires are sampled to identify the vegetation classes present across the burned area to assist with the mapping update. It can be difficult to assess which vegetation classes establish immediately after a fire, especially during drought years. We allow for a few growing seasons before identifying and delineating post-fire communities, and possibly longer if the years following fire were excessively dry and hinder normal reestablishment of vegetation communities. Field surveys also commence when a map polygon or burned area begins to show signs (i.e., via habitat condition monitoring data) that the current vegetation class has changed to another class and warrants reassignment. When it becomes available, either through the National Agricultural Imagery Program (NAIP) or from INL Site specific acquisitions, high resolution imagery is used as the source data layer to delineate new vegetation class boundaries within recent wildland fire boundaries.

The mapped wildland fire boundaries are used to directly calculate losses in sagebrush habitat. ArcGIS geoprocessing tools are used to clip and remove areas mapped as sagebrush habitat that have recently burned. In addition to documenting losses from wildland fire, any loss of sagebrush habitat from infrastructure expansion is also included in the summary of total sagebrush habitat removed. See Section 4.2 for additional details regarding methods and results from infrastructure expansion mapping.

3.2.3 Results and Discussion

There was one small fire that occurred on the INL Site in 2021. The East Butte Fire burned on September 8 and was located in a grassy area on the butte. The fire did not require dozer lines and was suppressed with hand tools and water lines. The fire was deemed controlled that day and declared out on September 9. The total burned area was estimated to be 2.4 ha (5.9 ac) and did not remove any sagebrush habitat.

The total area of sagebrush habitat in the SGCA on the INL Site remains unchanged from 2020 with 77,486 ha (191,472.1 ac). The sagebrush habitat outside of the SGCA is considered a “conservation bank” that could be incorporated into the SGCA to replace lost sagebrush habitat resulting from wildland fire or new infrastructure development (DOE and USFWS 2014). The current estimated area of sagebrush habitat remaining outside the SGCA also remains unchanged with 28,284.1 ha (69,891.5 ac).

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4.0 THREAT MONITORING

The CCA identifies and rates eight threats that potentially impact sage-grouse and its habitats on the INL Site. Most threats are addressed by conservation measures DOE has implemented or continues to implement (see Section 5.0). Some threats require monitoring to understand the extent of the problem and to establish baseline evidence so the success of interventions, once implemented, can be evaluated. These include, wildland fire and subsequent habitat recovery, livestock, raven predation, annual grasslands, and infrastructure development. The impacts of wildland fire and livestock on sage-grouse habitat are assessed once every five years, including in this report (Section 3.1). Raven predation and infrastructure development are addressed in Sections 4.1 and 4.2. Although annual grasslands are recognized as a medium-level threat to sage-grouse on the INL Site (DOE and USFWS 2014), cheatgrass control is currently being addressed as a component of post-fire restoration by the INL Wildland Fire Management Committee (WFMC). Continued monitoring of the abundance and spatial distribution of cheatgrass (Section 3.1) through CCA habitat condition monitoring is necessary to continue to understand the abundance of cheatgrass in areas that have not recently burned.

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 count trends (Bui et al. 2010, Dinkins et al. 2016, Peebles et al. 2017, Coates et al. 2018, Coates et al. 2020). High raven densities likely increase predation on sage-grouse clutches where the two species co-occur, but it is probably the combination of raven predation and other factors, such as poor concealment cover or adverse weather during the brooding period, that contribute to negative reproductive results for sage-grouse in some areas (Coates 2007, Peebles et al. 2017). For this reason, raven predation alone is not considered a high-level threat to sage-grouse on the INL Site or across its range (Shurtliff et al. 2019, Federal Register 2010). Unlike the primary threats of wildland fire and conversion to exotic plant monocultures, which are costly to address, reducing nesting opportunities for ravens as a strategy for lowering pressure on sage-grouse reproductive success is relatively low-cost strategy that could have localized positive effects.

Most raven breeding pairs on the INL Site nest on anthropogenic structures including towers, building platforms, and electric power transmission structures, with the latter supporting the most nests (Howe et al. 2014; Shurtliff et al. 2018). When the CCA was signed, DOE's efforts to reduce nesting subsidies for ravens was focused on supporting research aimed at developing methods to deter raven nesting on utility structures (*Conservation Measure 10*, DOE and USFWS 2014). By 2018, nest monitoring had revealed that many ravens nested perennially at INL Site facilities and on towers and that some of these nest sites could be retrofitted with minimal effort to deter nesting. Consequently, the language of this conservation measure was broadened to include a commitment by DOE to work with INL contractors and the National Oceanic and Atmospheric Administration to reduce raven nesting on power lines, towers, and at facilities (Shurtliff et al. 2019).

To support the original design of Conservation Measure 10 and the broadened scope, nearly all infrastructure on the INL Site is monitored during the core raven nesting period under CCA Monitoring Task 4. Our primary objective is to determine how many raven nests are built on INL Site infrastructure each year and to track the nesting trend so DOE may be alerted if numbers increase.

4.1.2 Methods

We surveyed power lines, towers, and raptor nesting platforms, and systematically searched structures and ornamental trees at INL Site facilities that could potentially support a raven nest. Surveys were performed between April 1 and June 4, 2021, and we allowed at least 14 days between repeat surveys. During April and the first few days of May, surveys commenced approximately 1.5–2.0 hours after sunrise (following sage-grouse lek surveys) and typically concluded by early afternoon. After sage-grouse lek surveys were completed for the year on May 7 (see Section 2.1.3), raven nest surveys were performed between sunrise and late afternoon. Inclement weather did not restrict survey activity if roads were passable, as we assumed ravens would display nest-tending behaviors regardless of weather conditions.

Nest Status

When a stick nest was observed on a structure, we identified the associated corvid or raptor species, if present, and determined if the nest was active. Nests were classified active if one or more of a breeding pair were observed incubating (i.e., sitting in the nest bowl), perched on or near the nest, carrying nesting materials to the nest, or engaging in other behavior that suggested they were tending or defending the nest. Presence of eggs or chicks also confirmed the activity status of a nest, and adults were always observed in these cases to confirm the species identify. A single positive observation was sufficient for a nest to be classified active, with one exception. If the only observation was of one or more birds perched on the same structure as the nest, but not on the nest, two observations of this type on separate days were required to classify the nest active.

After each complete survey of INL Site infrastructure, we revisited most unconfirmed nests before the next survey commenced to verify the nest's status. Some unconfirmed nests at facilities were not revisited because it was logistically difficult to reschedule an escort (six fenced facilities require such) or because they were dilapidated and on structures that protected them from being blown off by strong winds. Due to the extra visits, nests remaining unconfirmed at the end of the field season were potentially visited twice as often as nests with confirmed activity, increasing our confidence that they were not occupied by ravens during the breeding season.

Power Lines

We surveyed power lines four times, twice in April and twice in May, whereas facilities and towers were surveyed only twice, primarily in April. The difference in survey effort is an historical artifact because the primary purpose of the monitoring task when it was initiated was to find and track nests on power lines as a precursor to testing the effectiveness of nest deterrents on those structures (DOE and USFWS 2014).

For logistical purposes, power lines were divided into survey sections where they intersected convenient access roads. We surveyed the same power lines (transmission = 231 km [144 mi], distribution = 37 km [23 mi]) on the INL Site that were surveyed 2017–2020 (e.g., Shurtliff et al. 2018). In 2014 and 2015, surveys occurred along an additional 49 km (30 mi) of distribution lines, but these sections were removed from survey routes in 2016 when it became clear that ravens would be unable to maintain a nest on the structures because they were primarily comprised of single cross arms (Shurtliff et al. 2017). In 2017, an additional 4.3 km (2.7 mi) of distribution line was removed from survey routes for the same reason (Shurtliff et al. 2018).

We surveyed power-line segments by driving along utility access or other nearby roads and scanning frequently for nests through binoculars. When a nest was observed, the location was recorded and an activity status was assigned as described above. After each nest was observed for the first time in the season, its presence and activity status were documented on each subsequent power line survey, even if the nest was no longer present.

Facilities

We surveyed 13 facilities, defined as any non-linear feature that includes at least one building. In 2021, we expanded our search of the Advanced Test Reactor Complex (ATRC) to include the nearby

Remote-Handled Low-Level Waste (RHLLW) Facility. The RHLLW consists of a building and a large gantry crane that was installed prior to the 2018 field season[2]. To be consistent with other facility surveys, we do not report the RHLLW as a separate facility because it is in close proximity (~500 m) to the ATRC.

Towers

Many towers that could support a raven nest are within facility footprints and are searched during facility surveys. If a nest is observed on a tower at a facility, it is reported as a facility-based nest. Conversely, towers outside facilities are surveyed as discrete structures and we report nest observations on these structures separately. We routinely survey 12 towers outside of facilities at least twice during the field season—more often when nest status remains undetermined. Most of these towers support cellular network or meteorological equipment and are comprised of lattice structure that could conceivably support nests. One tower site on top of East Butte consists of a cluster of towers, only some of which could support a nest. In previous years, we mistakenly reported that we surveyed only 11 towers (e.g., Shurtliff et al. 2020). In fact, we survey 12 towers each year, but one that has never been occupied by a raven nest was not included in the annual summary of survey effort. Thus, our survey effort of towers has remained unchanged across years.

Three towers are outside but near the INL Site boundary. One, northwest of the U.S. Sheep Experiment Station (Figure 4-1), is approximately 40 m (44 yd) outside the boundary. Two others are near the southeastern border immediately north of U.S. Highway 20, the farthest of which is approximately 400 m (437 yd) outside the boundary. Because ravens that occupy these towers likely forage on the INL Site, we include them in the surveys.

Renest Attempts

The number of raven nests classified as active each year can be used as 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 on power-line structures occasionally blow down. If a mated pair loses one or more nests and rebuilds on nearby structures during the survey period, our sampling method would record an active nest at each location, because we are unable to distinguish individual ravens. This artifact of our sampling scheme produces an unknown level of variability that potentially reduces the accuracy of raven nest trend results. To reduce this variability, we adjusted the number of raven nests considered active as in past years (e.g., Shurtliff et al. 2017) by examining each nest on a power-line structure that was initially characterized as active, but later in the nesting season had fallen to the ground. For each of these failed nests, we noted the period during which we collected evidence that the nest was active. We assumed that the nest may have fallen at any time following the last recorded active observation. We then examined dates during which activity was recorded at all other active nests within a 6–km (3.7 mi) radius. If a nest within this radius was recorded as active for the first time after the last activity was recorded of the failed nest, we assumed that the occupants of the failed nest renested at that location. All results reported below are based on the last occupied nest in a merged pair or trio. In 2020, we mistakenly based results on the first occupied nest (the previous three years [2017–2019] were based on the last occupied nest). The only effect from this error is that one additional power-line nest would have been reported in the SGCA in 2020.

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[2] Personal communication, November 11, 2021, Anne Dustin, MFC Environmental Support, INL

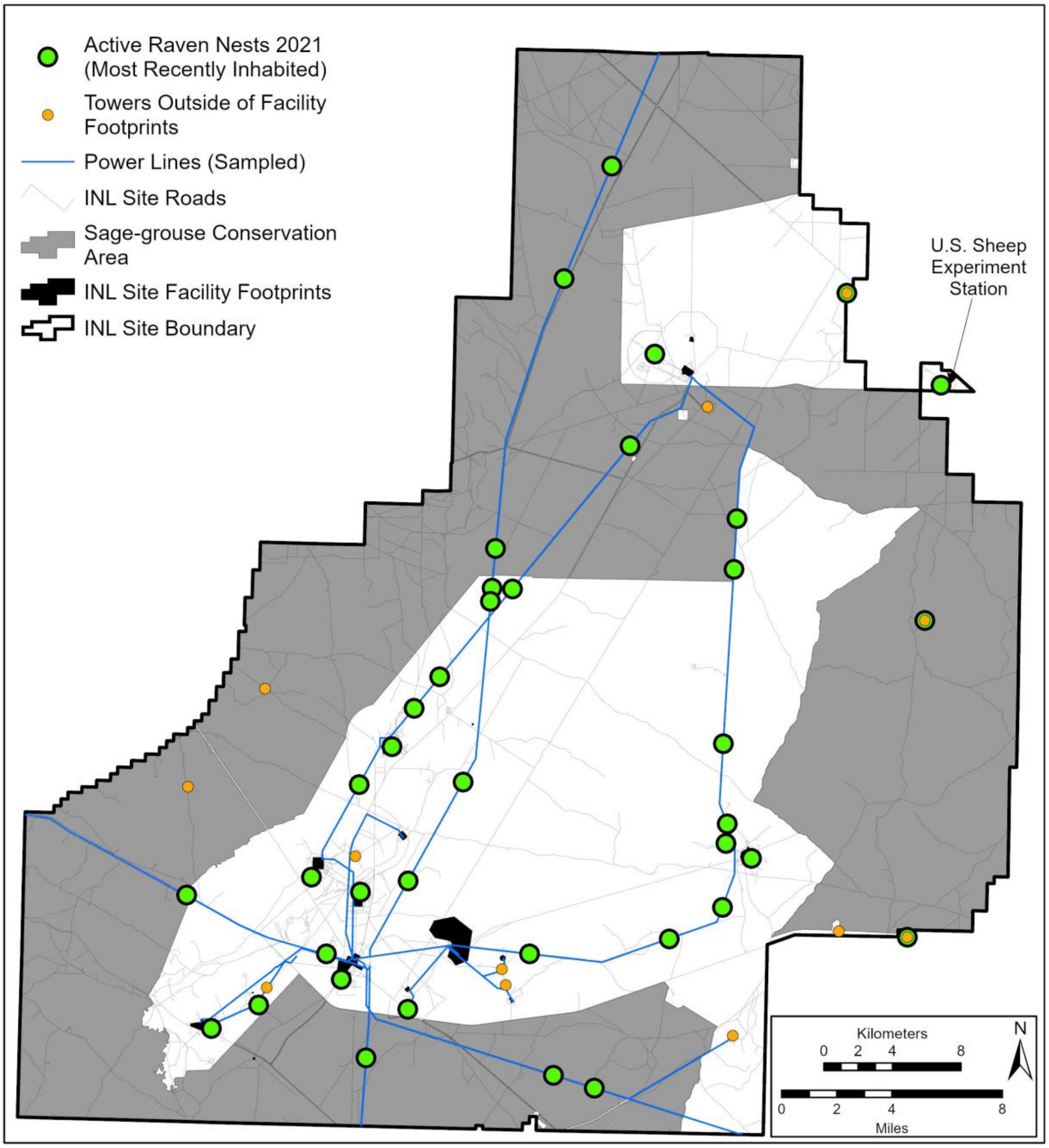

Figure 4-1. Results of the 2021 raven nest survey depicting active raven nests on infrastructure searched annually, after accounting for nests that were assumed to have been occupied by the same breeding pair.

The 6-km threshold was chosen somewhat arbitrarily, but our intent was to have the threshold large enough to encompass the entire breeding territory of nest occupants, as we assumed breeding pairs are likely to renest within their territory (Skarphédinsson et al. 1990). We also wanted to be conservative in our estimate of the number of breeding pairs (i.e., a higher number of second nests identified results in a lower estimate of breeding pairs). When we first developed this method (Shurtliff et al. 2017), we chose 6 km as the threshold after considering that the median distance from an active raven nest to the nearest active conspecific nest over the previous three years had been 2.7–3.1 km (1.7–1.9 mi). Although it is unknown how large raven breeding territories are in sagebrush steppe or how far they move to renest after losing a nest, a 6-km radius typically overlaps several raven nests on the INL Site, and therefore we felt the distance is reasonable given our assumptions and objectives.

4.1.3 Results and Discussion

Overview

Between April 1 and June 4, 2021, we documented 38 active raven nests on anthropogenic structures or in trees associated with facilities (i.e., adjusted total), after accounting for renest attempts. Twenty-four nests (63%) were on power-line structures (Table 4-1; Figure 4-2), and 10 of these (42%) were in the SGCA or at its boundary (i.e., within 75 m). The proportion of power-line nests in the SGCA was fewer than in 2020 when 62% (*n* = 13) were in the SGCA.

Table 4-1. Summary of active raven nests (adjusted) on the Idaho National Laboratory Site, observed on anthropogenic structures during 2021 surveys. Nests within 75 m of the Sage-Grouse Conservation Area (SGCA) boundary were counted as being inside the SGCA.

# Active Nests	Structure	Inside SGCA	Outside SGCA
24	Power Line	10	14
7	Building Platform	0	7
1	Effluent Stack	0	1
4	Tower	1	3
1	Ornamental Tree	0	1
1	Other	0	1
Totals 38		11	27

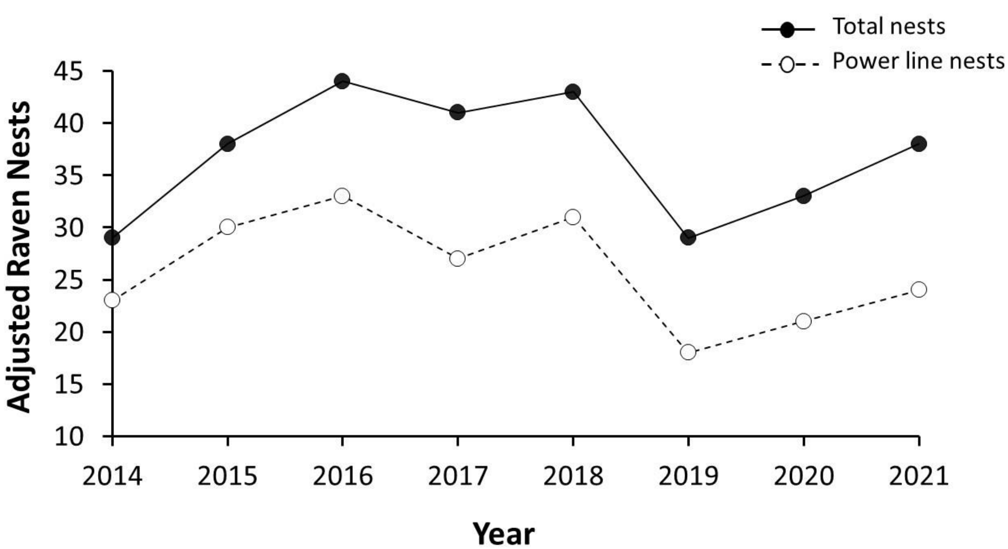

Figure 4-2. Raven nests observed on Idaho National Laboratory Site infrastructure (adjusted values).

Renest Attempts

Fifty-one raven nests were initially classified active, including 35 nests on power transmission structures (none on distribution structures). After examining nests on power lines, we merged seven pairs of nests that met the criteria of likely having been occupied by the same breeding pair after one nest in each pair was destroyed. All but one of these nests were on power lines (a putative 2nd nest was on a structure at the Central Facilities Area). Two additional trios of nests were reduced to a single representative nest per trio because the three nests in each group met the criteria for having been occupied by the same nesting pair. In total, 13 raven nests presumed to represent renest attempts by 11 raven pairs were eliminated from the dataset.

We merged two sets of nests at facilities. These did not strictly meet the criteria used for merging nests on power lines, because at facilities nests rarely are dislodged from their substrate unless removed by humans. However, circumstantial evidence strongly suggested one nest in each pair was abandoned prior to the appearance of a nearby active nest, and therefore it was likely that both nests were occupied by the same breeding pair. This is the first time evidence of renesting has been observed at facilities. At EBR-1, ravens were observed once building a nest on a large engine, but no other activity was recorded at that nest. Later, ravens were observed incubating on a nest 17 m away on another engine. We concluded a single raven pair was likely associated with both nests. In another instance, two nests were assumed to be occupied by the same breeding pair at the ATRC and the RHLLW facility. A raven at ATRC was first observed incubating in an ornamental tree prior to commencement of nearby work that produced a relatively high amount of human activity. During two subsequent visits, no evidence of nest activity was observed. One month after the initial nest activity was documented, an incubating raven was observed 680 m to the southwest at RHLLW. This nest remained active until the end of the field season.

We were surprised by the high number of raven nests merged in 2021 as a result of nest disappearance, because from 2014–2020 we merged an average of only 2.9 nests per year (range = 1–6; SD = 1.7). To learn if wind speed is correlated with the high numbers of failed nests, we examined wind data collected at 15 m above the ground at the Central Facilities Area Mesonet Station (http://niwc.noaa.inl.gov/Climate.htm). On April 8, 2021, peak wind speed reached 101.4 kilometers per hour (kph; 63.0 miles per hour [mph]) and two days later on April 10, peak wind speed was even higher at 105.9 kph (65.8 mph). Wind speeds on these two days were higher than on any day in April since surveys began. In previous years (2014–2020), the peak wind speed in April ranged from 72.9–97.5 kph (45.3–60.6 mph; mean 87.9 kph [54.6 mph]; SD = 7.7 kph [4.8 mph]). The high winds occurred early in the raven nesting season after we had surveyed nearly all power lines on the INL Site once. We suspect the force of the wind occurring on two days during the time when many nests were being built resulted in an unusually high number of previously recorded nests falling to the ground.

Facilities

Surveys of facilities occurred April 2–May 13, 2021. Unlike past years, we present results for 12 rather than 13 facilities (Table 4-2). This is not because our survey effort changed, but because we combined results for two facilities that are inside the same fenced area (Advanced Mixed Waste Treatment Project and Radioactive Waste Management Complex). This change does not affect the analysis, but improves consistency in reporting, as other discrete facilities that are near each other are reported as a single facility.

We documented 11 active raven nests at 10 of the 12 facilities (Table 4-2), including a nest at the Central Facilities Area where none have been documented previously. This is the highest number of raven nests documented at facilities. Since 2017, when all facilities currently surveyed were searched for the first time (i.e., most, but not all facilities were surveyed prior to 2017), we have never confirmed more than nine raven nests at facilities in a single year. One apparent exception was in 2017 when 11 nests were reported at facilities; however, the following year we concluded two of those were likely American crow (*C. brachyrhynchos*) nests (Shurtliff et al. 2019).

Table 4-2. Summary of raven nest survey effort and results at Idaho National Laboratory Site facilities in 2021.

Facility	# Times Surveyed	Days Between Surveys	Active Raven Nest Confirmed	Substrate Supporting Active Nest
Advanced Mixed Waste Treatment Project / Radioactive Waste Management Complex	2	32	Yes	Building Platform
Advanced Test Reactor Complex / Remote-Handled Low-Level Waste Facility	2	16	Yes	Crane
Central Facilities Area	2	15	Yes	Pipe
Central Facilities Area Main Gate	2	17	Yes	Building Platform
Critical Infrastructure Test Range Complex	2	14	No	N/A
Experimental Breeder Reactor I	3	18	Yes	Building Platform
Highway Department	2	14	No	N/A
Idaho Nuclear Technology and Engineering Center	2	21	Yes	Effluent Stack
Materials and Fuels Complex / Transient Reactor Test Facility	2	29	Yes (2 nests)	Building Platform, Tower
Naval Reactors Facility	2[a]	14	Yes	Building Platform
Specific Manufacturing Capability / Test Area North	2	18	Yes	Building Platform
U.S. Sheep Experiment Station	2	14	Yes	Ornamental Tree

[a] Environmental Surveillance, Education, and Research personnel were restricted from entering the NRF. A Naval Reactors Facility representative reported to ESER two times each season on raven nest observations.

Towers

We searched towers outside facilities 2–4 times each. Eighty-five percent of visits were in April, but occasional revisits to nests with unconfirmed status occurred through June 4. In total, we observed three active raven nests on towers outside facility footprints (Figure 4-1). This count does not include a nest on a tower near the Materials and Fuels Complex perimeter fence, because the tower is considered to be within the facility extent (Table 4-1). Ravens have nested on at least two of the three towers occupied in 2021 every year since 2016, despite efforts by the National Oceanic and Atmospheric Administration to deter nesting on one of them.

One additional active raven nest was incidentally observed on a tower that is not part of our annual surveys; consequently, the nest was not included in the final count of INL Site raven nests. The tower is approximately 1,800 m (1,969 yd) north of the Idaho Nuclear Technology and Engineering Center and approximately 400 m (437 yd) northeast of a tower that is searched for nests annually.

Unconfirmed Nest Status

The status and occupants of 28 nests remained unconfirmed at the close of the survey period. Ten of these nests were on structures such as building platforms and ornamental trees where they are not easily dislodged by wind and can therefore remain unmaintained for many years. In all cases, we were unable to directly observe the nest bowl and verify if eggs were present. Eighteen nests were on transmission lines, and only one of those could have potentially remained from 2020. The other 17 were obviously built in

2021, either because they appeared after the first survey of the season or because no nest was on the structure at the end of the 2020 field season. Fourteen of the 17 nests were observed only once, and they fell to the ground or otherwise disappeared prior to the next visit. Only one of the 18 transmission-line nests remained intact until the beginning of June when surveys ceased. Thus, all or nearly all transmission-line nests for which we were unable to determine the occupant species represent failed or abandoned nests by an unknown species.

Comparison to Past Years

Overall, active raven nests recorded on all infrastructure associated with the INL Site was 15% higher in 2021 than 2020, and 31% higher than the multi-year low in 2019 (Figure 4-2). Across the eight years of surveys, the 2021 count is the median value.

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 considered a medium-ranked threat to sage-grouse on the INL Site (see Section 6.2.1 in Shurtliff et al. 2019). 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 National Environmental Policy Act (NEPA) analysis is conducted on the proposed footprint of 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, soil stabilization or revegetation following the completion of a construction project fails to meet its objectives. If no overarching plan for soil stabilization is developed, infrastructure may continue to slowly expand without new structures and disturbances being considered as new or additional scope.

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, has continued to increase since the establishment of baseline condition for this monitoring task (unpublished data; Shurtliff et al. 2020). It is likely that many 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 availability of high resolution imagery collected across Idaho, 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 U.S. Department of Agriculture NAIP collects digital imagery across the State of Idaho every two years. The publicly available image dataset product consists of four spectral bands (blue, green, red, and near-infrared) usually collected at 1 m spatial resolution. Occasionally, the State will contribute additional funds to have higher resolution imagery collected. 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 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. For example, there has been approved expansion at facilities (e.g., Materials and Fuels Complex [MFC] ponds) that was not present when the INL Site vegetation map was originally completed (Shive et al. 2011). Because the estimated amount of sagebrush habitat is generated from the vegetation map by combining all classes dominated by sagebrush, areas like these currently mapped as sagebrush habitat are not reflective of current 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 four 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, (3) delineate all new infrastructure footprints and digitize linear features, and (4) modify sagebrush habitat polygons where infrastructure expansion has removed sagebrush.

Two GIS analysts systematically zoom into regions of the INL Site and look for evidence of surface disturbance throughout the SGCA and within sagebrush habitat outside of the SGCA. Occasionally, image properties are adjusted to accentuate pixel values in an area of interest or add more contrast to help with feature identification. The image review process occurs at fine map scales so minor changes on the landscape (e.g., a new set of vehicle two-tracks) are more easily detected. Geographic information system analysts visually scan around facilities, borrow sources and new project areas to investigate whether the infrastructure footprint has expanded and now overlaps regions previously mapped as sagebrush habitat. Anytime a potential location is identified by an analyst, it is marked for a secondary review.

Once each GIS analyst thoroughly reviews the entire INL Site, all potential infrastructure expansion locations are reconciled into a single list for final review. The monitoring task lead investigates each marked location and determines if the feature warrants delineation. Whenever infrastructure expansion removes sagebrush habitat, or linear features are observed, the area of disturbance and total linear distance are manually delineated using editing tools within a GIS. The new polygon and line features are managed within an ESRI File Geodatabase to maintain accurate area and length statistics. Lastly, all sagebrush habitat polygons are manually updated using GIS editing tools to create the most current sagebrush distribution on the INL Site, which is then used to evaluate current habitat status against the baseline (see Section 3.2).

4.2.3 Results and Discussion

There was no work conducted on this task in 2021 because no new high-resolution imagery was available for the INL Site prior to reporting. The U.S. Department of Agriculture NAIP program collected high resolution imagery across the State of Idaho during the summer of 2021 and those data are typically made available the following spring or early summer. Once we download and process the new 2021 NAIP imagery, we will systematically review the INL Site for expansion of linear features and losses of sagebrush habitat due to facility or project footprint expansions, and those results will be presented in 2022.

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5.0 IMPLEMENTATION OF CONSERVATION MEASURES

5.1 Summary of 2021 Implementation Progress

The CCA identifies eight threats to sage-grouse and its habitats on the INL Site, and it outlines 13 conservation measures designed to mitigate and reduce these threats. The agreement also articulates DOE's desire to achieve no net loss of sagebrush due to infrastructure development. The following table (Table 5-1) summarizes actions and accomplishments associated with each conservation measure that DOE, contractors, and stakeholders achieved during 2021 to reduce threats to sage-grouse and its habitats on the INL Site. Sagebrush loss, if any, is documented under Conservation Measure 2 with a description of contractor plans and current activities to mitigate those losses.

Table 5-1. Accomplishments in 2021 for each CCA conservation measure.

<table>
<tr><td>Threat:</td><td>Wildland Fire</td></tr>
<tr><td>Objective:</td><td>Minimize the impact of habitat loss due to wildland fire and firefighting activities.</td></tr>
<tr><td>Conservation Measures:</td><td>1) Prepare an assessment for the need to restore the burned area. Based on that assessment, DOE would prepare an approach for hastening sagebrush reestablishment in burned areas and reduce the impact of wildland fires >40 ha (99 ac).</td></tr>
<tr><td colspan="2">Conservation Measure 1—Accomplishments in 2021:

<u>BURN ASSESSMENT</u>— A single 2.4 ha (5.9 ac) [3] wildfire occurred on the INL Site in 2021. Dozer lines were not necessary or practical to control this fire. Due to the size of the fire, no recovery plan will be developed.

<u>RECOVERY PLANNING</u>—Post-fire recovery plans were developed for four of the 2020 fires (Section 5.2.1).

<u>SAGEBRUSH REESTABLISHMENT</u>—INL planted approximately 45,000 seedlings within the Sheep Fire area to support habitat restoration efforts. In addition, DOE, ESER, and INL collaborated with IDFG to plant 38,750 sagebrush seedlings to speed up habitat recovery in portions of the Jefferson Fire. Weed control efforts continue in recently burned areas. A subset of sagebrush seedlings planted in 2020 and 2016 were revisited in 2021, and 1-year and 5-year survivorship assessed (Section 5.2.2)

Associated Conservation Actions that Addressed the Wildland Fire Threat:

<u>POST FIRE ADAPTIVE MANAGEMENT</u>—Areas within the Twin Buttes, and Deadman grazing allotments that were burned by the 2019 Sheep Fire, and 2020 Telegraph and Lost River Fires remained closed to grazing during the 2021 grazing season (Personal Communication with Jordan Hennefer, Rangeland Management Specialist, BLM, 11/02/2021). This concludes the required 2-year closure for the Sheep Fire that occurred in the Twin Buttes Allotment.</td></tr>
</table>

[3] Unpublished wildland fire statistics summary for 2021; Eric Gosswiller, INL Fire Chief.

Table 5-1. (continued).

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. 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 2021:

Multiple projects in 2021 adopted and implemented best management practices outside facility footprints to minimize the impacts to both seasonal and potential habitats on the INL Site.

The following infrastructure projects were designed so that the total distance of habitat edge caused by construction activities is minimized.

- Test Area North-691 maintenance and vehicle-storage building (Environmental Compliance Permit [ECP] INL-20-035) was sited immediately adjacent to the Specific Manufacturing Capability fence.
- A construction support yard to the east of the MFC (ECP INL-21-042) was sited between the MFC facility fence and the perimeter road.
- Power line testing along the Power Grid Test Bed at INL (ECP INL-20-116 R1) took place along the new line adjacent to existing linear features and areas that have already been disturbed.

The following infrastructure projects were co-located with existing infrastructure and/or were sited in areas dominated by non-native grasses and other exotic species.

- The Unmanned Aerial System Testing project (ECP INL-19-089 R2) sited a new parking space in areas dominated by crested wheatgrass.
- Weather installations on Highways 20, 26, 33, and 93 (ECP INL-20-093) sited their locations based on avoiding impact to sagebrush and placed them in areas dominated by non-natives such as crested wheatgrass.
- The MFC parking lot expansion and reconfiguration (ECP INL-19-088 R2) placed excess soil from project activities in old borrow sources dominated by crested wheatgrass and plan on revegetating the areas beginning in 2022.
- B2-TR-600 RRTR Trailer Relocation (ECP INL-19-049 R1) mowed the surrounding area dominated by non-natives as a fire break.
- Power line testing on Circuit 56 (ECP INL-19-054 R1) sited a new parking area based on the dominance of crested wheatgrass.

Best Management Practices employed by INL Power Management Activities 2021 (ECP INL-21-067) included the installation of perch deterrents and eliminating nesting opportunities where possible.

The projects, Temporary Wind Tower and Ambient Air Monitoring (ECP INL-17-108 R3) and Weather installations on Highways 20, 26, 33 and 93 (ECP INL-20-093), appropriately marked guy wires and fences to render them more conspicuous and minimize the risk of in-flight collisions by sage-grouse and other birds.

Conservation Measure 3—Accomplishments in 2021:

Table 5-1. (continued).

The Carbon Free Power Project (CFPP) Site Characterization (ECP INL-19-067 R4) was the only project to initiate infrastructure development within the SGCA in 2021. After reviewing alternative footprints, DOE was consulted on the preferred siting location. This consultation was followed-up with consultation with the USFWS on how to mitigate risks to sage-grouse.	
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.~~ DISCONTINUED (See Section 6.2.4, Shurtliff et al. [2019]).
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 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. 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 and Disturbances in 2021: PERMIT RENEWAL—The Environmental Assessment (EA) for the Grazing Permit Renewal for the Twin Buttes Allotment (DOI-BLM-ID-I010-2020-0032-EA) has been finalized and a Finding of No Significant Impact issued for the proposed action. However, the EA is under legal appeal and a resolution is not expected until Spring 2022. The Preferred Alternative includes adjusting the season of use to include year-long grazing to occur on the allotment and to convert fall/winter use to spring use with spring grazing beginning on March 1 rather than April 1. The Preferred Alternative in the EA also defined a 1 km exclusion buffer for camping, temporary corrals, or watering from an occupied lek as well as prohibited creating new roads, bed grounds or watering sites without prior authorization. UPDATED INFORMATION TO BLM—DOE submitted shapefiles to BLM containing all active leks on the INL Site during January of 2021. **Conservation Measure 6—Accomplishments in 2021:** COMMUNICATION & COLLABORATION—Due to the Covid-19 pandemic, the annual meeting among BLM, DOE, and ESER staff did not occur in 2021. However, ESER provided field support to identify locations for a proposed fence in the Deadman allotment that would keep cattle out of the Big Lost River channel, and to discuss methods such as seeding or fencing, to improve conditions within the Mahogany Butte Allotment and to protect a culturally sensitive area. DOE and BLM continued to collaborate on updating their memorandum of understanding for management of land currently occupied by the INL Site. DOE, ESER, and INL supported BLM in scoping restoration efforts on a section of Birch Creek where herbaceous understory has been lost and erosion is of concern. INL and BLM have also collaborated on spraying noxious weeds in infested areas of the INL Site.	

Table 5-1. (continued).

<table>
<tr><td colspan="2">RANGELAND IMPROVEMENTS—DOE supported a 2019 decision by BLM to permit installation of an underground pipe to maintain water troughs in the Deadman and Quaking Aspen allotments and to construct a fence in the Deadman Allotment. An EA (DOI-BLM-ID-I010-2021-0008-EA) for the project has been completed but is now under legal appeal. The water distribution portion of the project, if authorized, will allow for a more reliable water source, resulting in better livestock distribution and less road traffic. The fencing portion of the project will restrict cattle from entering the Big Lost River channel and culturally sensitive areas (Personal Communication with Jordan Hennefer, Rangeland Management Specialist, BLM, 11/2/2021). Part of the EA also indicates that new structures will be sited no closer than 1 km to an occupied sage-grouse lek.</td></tr>
<tr><td>Threat:</td><td>Seeded Perennial Grasses</td></tr>
<tr><td>Objective:</td><td>Maintain the integrity of native plant communities by limiting the spread of crested wheatgrass.</td></tr>
<tr><td>Conservation Measure:</td><td>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.</td></tr>
<tr><td colspan="2">Conservation Measure 7—Accomplishments in 2021:
When ESER (now the INL Natural Resources Group) assists projects by recommending a project specific native perennial seed mix list for revegetation work, they exclude non-native crested wheatgrass from any recommendation.</td></tr>
<tr><td>Threat:</td><td>Landfills and Borrow Sources</td></tr>
<tr><td>Objective:</td><td>Minimize the impact of borrow source and landfill activities and development on sage-grouse and sagebrush habitat.</td></tr>
<tr><td>Conservation Measures:</td><td>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 [0.6 mi] of active leks).
9) Ensure that no net loss of sagebrush habitat occurs due to new borrow pit or landfill development. DOE accomplishes this measure by:
• avoiding new borrow pit and landfill development in undisturbed sagebrush habitat, especially within the SGCA;
• ensuring reclamation plans incorporate appropriate seed mix and seeding technology;
• implementing adequate weed control measures throughout the life of an active borrow source or landfill.</td></tr>
<tr><td colspan="2">Conservation Measure 8—Accomplishments in 2021:
INL complied with seasonal and time-of-day restrictions associated with sage grouse. Per “Idaho National Laboratory Gravel/Borrow Pits (Overarching) Environmental Checklist” (EC INL-14-045), projects must complete Form 450.AP01, “Gravel/Borrow Source Request Form,” before removing gravel. This form reminds gravel-pit users of restrictions in place to protect sage-grouse. Projects must also submit, in writing to Environmental Support and Services personnel, that they complied with the directives in this EC. Adams Boulevard, Lincoln Boulevard, Monroe Boulevard, Ryegrass Flats, T-12, and T-28 South are covered by this EC.
Conservation Measure 9—Accomplishments in 2021:
No new borrow pits or landfills were opened in 2021. Facilities and Site Services reports that T-12 was closed for all use in the spring of 2021, and there are no plans to reopen it in the near future. Expansion of existing 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). Any expansion of gravel or borrow</td></tr>
</table>

Table 5-1. (continued).

pits that would disturb surface soil or vegetation also requires a survey of cultural resources by Cultural Resource Management Office and biological resources by ESER, now the Natural Resources Group. 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. 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 2021: INL Power Management operates and maintains 209 km (130 mi) of overhead power lines. New power lines go through the EA or ECP process to determine whether nesting deterrents are required. When Power Management performs maintenance on distribution overhead lines, they install nesting deterrents in the form of avian protection devices on each structure as the engineer and linemen see fit. There are approximately five different types of avian protection devices available for install. Per the Facilities and Site Services Program Environmental Lead, Power Management installed avian protection on 124 structures in FY 2021. Power Management replaces transmission structures based on age and deterioration by installing prefabricated metal crossarms in place of the existing wooden crossarms. The new crossarms are inherently nesting deterrents because only one beam is available for birds to build on (instead of two). In FY 2021, Power Management installed 20 new transmission-line cross arms. **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): • Avoid erecting portable or temporary towers, including meteorological, SODAR, and cellular towers. • 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. • Detonation of explosives >1,225 kg (2,700 lb) will only occur at the National Security Test Range from 9 a.m.–9 p.m. • No non-emergency disruptive activities allowed within Lek Buffers March 15–May 15. 13) Seasonal guidelines (April 1–June 30) for human-related activities within the SGCA (exemptions apply—see Section 10.9.3): • Avoid non-emergency disruptive activities within the SGCA. • Avoid erecting mobile cell towers in the SGCA, especially within sagebrush-dominated plant communities.
Conservation Measures 12 and 13—Accomplishments in 2021:	

Table 5-1. (continued).

Due to COVID-19 there were few detonations at the National Security Test Range (NSTR) this spring. All CCA requirements were met, and restrictions were followed.
The Carbon Free Power Project site is located within the SGCA. All non-emergency disruptive activities associated with site characterization activities met seasonal guideline requirements in the CCA. All unmanned aerial vehicle flights conducted at the Unmanned Aerial System runway met all CCA requirements by conducting flights above 305 m (1,000 ft) if flying after 6 p.m. and before 9 a.m. No meteorological, sound detection and ranging, or other cell towers were erected within 0.6 miles of a sage-grouse lek or within the SGCA during 2021.

5.2 Reports on Projects Associated with Conservation Measures

Since the CCA was signed, DOE, INL, and ESER have implemented activities on an as-needed or recurring basis to reduce the impact of wildland fire to sage-grouse habitats and to support the objective of Conservation Measure 1 (Appendix A).

5.2.1 Conservation Measure 1—Post-fire Recovery Planning, Implementation, and Monitoring

Background

The threat level of wildland fire was ranked as high in the CCA (DOE and USFWS 2014) and wildland fire is one of the top threats to sage-grouse across their range (Federal Register 2010). Wildland fire impacts sage-grouse habitat by removing sagebrush and by making the recovering plant community less resistant to invasion and dominance by non-native weeds like cheatgrass (Connelly et al. 2011, Bradley 2010). Annual grasslands were independently ranked as medium-level threat to sage-grouse in the CCA. Cheatgrass is currently the primary introduced annual grass of concern on the INL Site. Although it can become dominant under a variety of conditions, post-fire plant communities are particularly susceptible (see Section 3.1), making the threats of wildland fire and cheatgrass interrelated.

Wildland fire on the INL Site was relatively infrequent prior to 1994; only a few large fires were known to have occurred or could be seen in imagery prior to that time (Shive et al. 2011). Over the past 25 years, several large fires (>40 ha [>99 ac]) have burned across the INL Site. Potential effects of wildland fire on natural resources were initially addressed in the Wildland Fire Management Plan and EA (DOE 2003), which was drafted after four notable fires. The CCA represented the next major effort to address the effects of wildland fire on natural resources and it included a conservation measure by which DOE committed to prepare an assessment evaluating the need for post-fire restoration and present options for hastening sagebrush reestablishment on fires larger than 40 ha (99 ac; Table 5-1).

After the CCA was signed, the INL Site did not experience any wildland fires meeting the conservation measure criteria for nearly five years. In 2019, the Sheep Fire burned more than 40,000 ha (98,842 ac), which prompted development of the first ecological resources recovery plan for the INL Site since the CCA was signed. The recovery plan was designed to address the CCA wildland fire conservation measure and to comply with the INL Wildland Fire EA (DOE 2003). The INL WFMC directed ESER to prepare an assessment of ecological impacts and a fire recovery plan. This plan was phased for implementation over five years and allowed the WFMC flexibility in prioritizing recovery actions based on available funding and other wildland fire management priorities.

Several natural resource recovery goals were identified within the Sheep Fire Ecological Resources Post-Fire Recovery Plan (Forman et al. 2020) These recovery goals incorporated results of the ecological impacts assessment and they were organized into four primary recovery objectives: 1) soil stabilization for erosion and weed control on containment lines immediately post-fire, 2) cheatgrass and noxious weed control within the larger burned area, 3) native herbaceous recovery, and 4) sagebrush habitat restoration. A number of treatment options were provided within each recovery objective to achieve natural resource recovery goals. The structure and organization of the plan, as well as the process of prioritizing treatment actions were useful to the WFMC. Therefore, subsequent post-fire ecological recovery plans continue to utilize this framework. This section of the report contains a summary of the fire recovery plans, ongoing restoration actions, and initial monitoring results for all wildland fires requiring ecological resource recovery plans within the past five years.

2020 – Multiple Fires

Fire Summary and Implementing Lessons Learned

In 2020 there were five wildland fires on the INL Site larger than 1000 m^2 (¼ ac) and they ranged in size from 11.0 ha (27.1 ac) to 677.9 ha (1,675.1 ac). Only three of the five fires were large enough to meet the wildland fire conservation measure criteria; however, the WFMC requested an ecological assessment and fire recovery plan for four of the fires. The 11.0 ha (27.1 ac) fire was included because it was partially in the SGCA, it was designated as sagebrush habitat prior to the fire, and containment lines (i.e., soil disturbance) were used to control it. The four 2020 wildland fires for which the WFMC requested an ecological assessment and fire recovery plan were the Howe Peak Fire, the Telegraph Fire, the Lost River Fire, and the Cinder Butte Fire (Figure 5-1). These fires were ignited between July 2, 2020 and August 18, 2020 and all were controlled and/or contained within a few days of ignition. Two of the fires were caused by lightning and two were human caused. All four of these fires were partially or entirely within the SGCA and sagebrush habitat was lost in three of the four fires. See Forman et al. (2021) for a more thorough description of the 2020 INL Site fires, including discussion of timing, conditions, location, fire boundaries, and estimates of sagebrush habitat lost.

Compared to past INL Site fires and other regional fires that ignited and burned under similar conditions, the amount of area impacted by the 2020 fires was relatively small. In general, the INL Wildland Fire EA and associated plan incorporates a balanced fire management approach that ensures, to the extent possible, the protection of improved laboratory assets in a manner that minimizes effects on natural, cultural, and biological resources. As sagebrush habitat continues to be lost and protecting remaining habitat becomes increasingly important, the INL Fire Department and WFMC have continued to increase emphasis on maintaining sagebrush habitat by avoiding further losses. In 2020, the INL Fire Department applied substantial effort implementing lessons learned during the Sheep Fire and substantially improved their coordination and deployment of dozer/support resources. Specifically, the Fire Department added a new dozer boss function to improve containment line construction and invested in a tactical tender that allowed firefighters to engage the initial attack more aggressively, but also safely. These measures proved effective in improving fire suppression performance during the initial attack period and in minimizing fire size. The INL Fire Department also appreciated the assistance received from BLM and other support agencies in aggressively addressing fires on the INL Site.

Emergency Stabilization, Noxious Weed Control, and Post-Fire Restoration Planning

During the fall of 2020, the INL completed emergency stabilization actions on the fires that burned earlier that year. These actions included recontouring containment lines on the fires where they were used, reseeding containment lines with native grass seed, and spraying noxious weeds, especially in disturbed soils on and around containment lines. Additionally, ESER completed an ecological resources post-fire recovery plan for four fires (Forman et al. 2021), as requested by the WFMC. The post-fire recovery plan for the 2020 fires included an assessment the ecological impacts of four 2020 fires and it addressed the same four primary recovery objects as the Sheep Fire Ecological Resources Post-Fire Recovery Plan. The post-fire recovery plan for the 2020 fires also included several options for meeting recovery objectives and an implementation approach that can be phased based on restoration priorities and available funding.

The WFMC met to review the 2020 post-fire ecological recovery plan and prioritized several of the restoration options provided therein. All but one emergency stabilization action associated with Objective 1 had been completed prior to finalization of the plan. The only remaining Objective 1 recommendation was monitoring temporary fire suppression access roads for natural recovery and considering signage and replanting if necessary. This recommendation will require evaluation after a few growing seasons to determine whether it is necessary. Additional post-fire recovery actions prioritized by the committee included noxious weed treatment throughout the burned areas of each fire and sagebrush seedling planting to expedite habitat recovery in the Telegraph Fire.

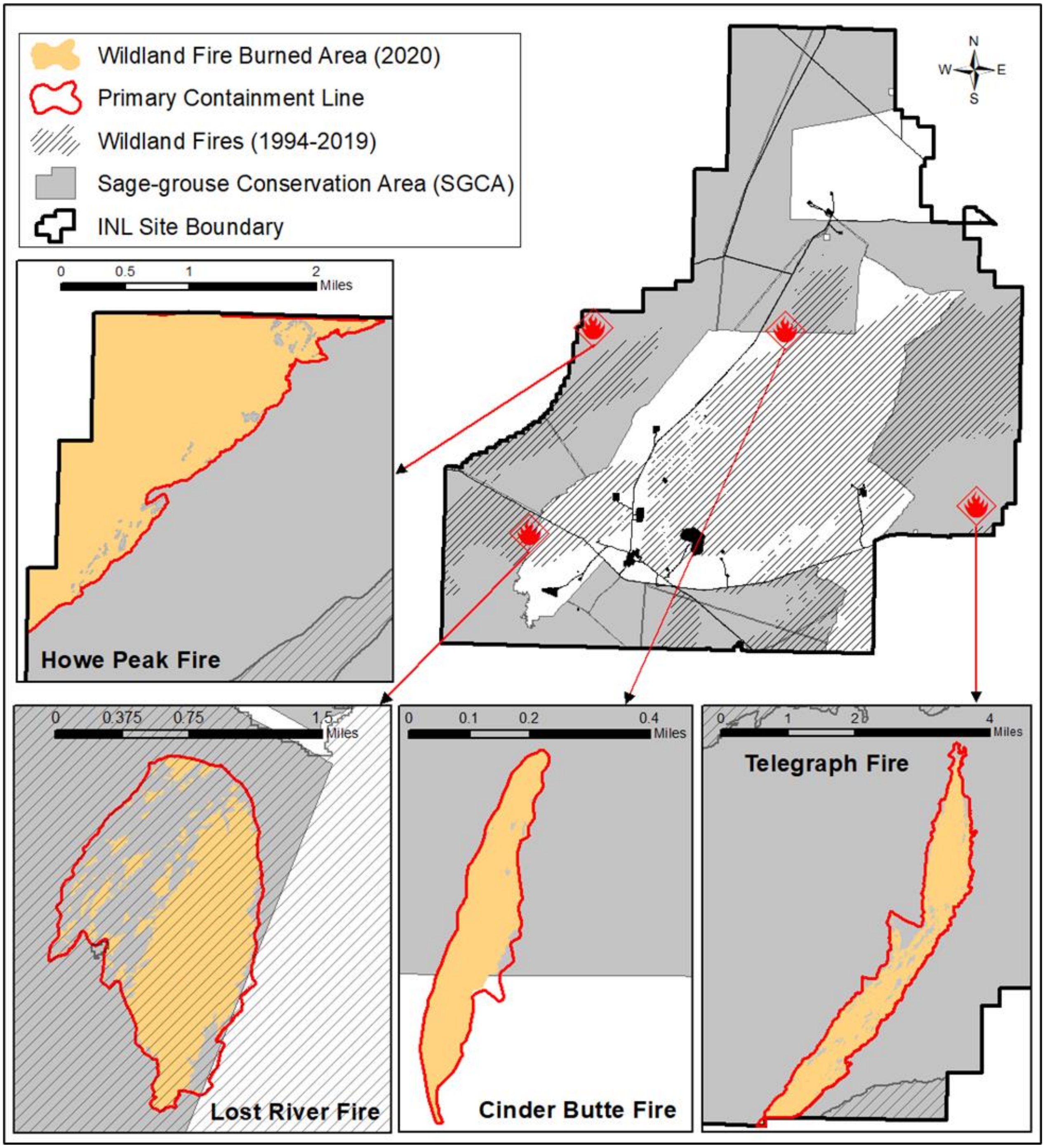

Figure 5-1. Four of the wildland fires that burned on the Idaho National Laboratory Site in 2020 shown with all major wildland fires since 1994 and the boundary for the Sage-grouse Conservation Area.

In 2021, incidental noxious weed locations were recorded in Howe Peak and Lost River fires by habitat monitoring personnel, and several weeds were sprayed with an appropriate chemical by certified applicators along T-2, in the area burned by the Lost River Fire. Spraying efforts focused on rush skeletonweed (*Chondrilla juncea*) because it was identified as being of particular concern by neighboring stakeholder agencies. Musk thistle is also widespread throughout post-fire plant communities at the INL

Site and was addressed during the 2021 growing season as well. There were no specific recommendations related to cheatgrass treatment made in the 2020 Post-Fires Ecological Recovery Plan. Cheatgrass was a substantial component of the plant community prior to wildland fire in two of the 2020 fires, increasing the risk of post-fire cheatgrass dominance. Cheatgrass treatment was not recommended in the Howe Peak Fire because areas at high risk of post-fire cheatgrass dominance are adjacent to agricultural properties that would be impacted by inadvertent chemical drift. In the Lost River Fire, the areas at high risk of post-fire cheatgrass dominance are used regularly by livestock. Livestock water and supplements would need to be moved before cheatgrass treatment would be feasible at this location.

Sagebrush Habitat Restoration

The area burned in the Telegraph Fire was dominated by sagebrush with a diverse, native understory prior to the fire. It is also in proximity to an active sage-grouse lek and was used extensively by collared sage-grouse pre-fire (BLM unpublished data). Two unimproved roads bisect the burned area, which provides access for planters (Figure 5-2). Planting sagebrush, where logistically feasible, would improve habitat value in proximity to the active lek, would provide some habitat connectivity across the burned area, and could shorten natural recovery times in areas adjacent to the planting by increasing potential seed sources. Because of current herbaceous conditions or the context of the area surrounding the fire, sagebrush seedling planting is not likely to make a substantial impact toward improving sagebrush habitat, increasing habitat connectivity, or reducing habitat recovery time on the Howe Peak Fire, Lost River Fire, and the Cinder Butte Fire. See Forman et al. (2021) for more detailed discussion.

Sagebrush seedling planting on the Telegraph Fire is scheduled for October 2022 and local seed collection was completed in November 2021 for seedlings to be started in the greenhouse during spring 2022. Planters are limited to roughly 400–500 m (0.25–0.31 mi) from a road. The unimproved roads that bisect the burned area were buffered by 400 m (0.25 mi) to determine the amount of area within this fire that would be accessible, which resulted in an area of 106.4 ha (263 ac). Averaged over the past few years, planters hired to install sagebrush on the INL Site have been planting at a rate of 388 seedling/ha (157 seedlings/ac). At this planting rate, approximately 41,300 seedlings can be planted in the Telegraph Fire (Figure 5-2).

2019 - Sheep Fire

Fire Summary and Post-fire Restoration Planning

The lightning-caused Sheep Fire started on July 22, 2019 in a remote region of the INL Site. It was 100% contained by the afternoon of July 26 and burned an estimated 40,403 ha (99,839 ac) based on aerial imagery collected the following September. A post-fire ecological resources recovery plan was developed and the WFMC prioritized several recovery actions addressing emergency stabilization, noxious weed control, areas at high risk for cheatgrass dominance, and hastening the recovery of sagebrush habitat. For details about the Sheep Fire, the post-fire ecological assessment, and the recovery options recommended to facilitate wildland fire recovery, see Forman et al. (2020). In 2021, ongoing recovery actions included noxious weed control, pre-emergent herbicide application for cheatgrass, and sagebrush habitat restoration.

Emergency Soil Stabilization and Noxious Weed Control

The INL began addressing soil stabilization and noxious weed control on the Sheep Fire containment lines during the fall of 2019. These actions are prescribed by the INL's Wildland Fire EA (DOE 2003), so they were initiated prior to completion of the Sheep Fire Ecological Resources Post-Fire Recovery Plan. Recontouring efforts were completed on the Sheep Fire containment lines in 2020. An equipment laydown area used to support Sheep Fire emergency response was visited to assess natural recovery in 2020 and was determined to require additional treatment. Noxious weed control on the containment lines began as part of emergency stabilization efforts and will continue as part of an ongoing noxious weed control program across the INL Site.

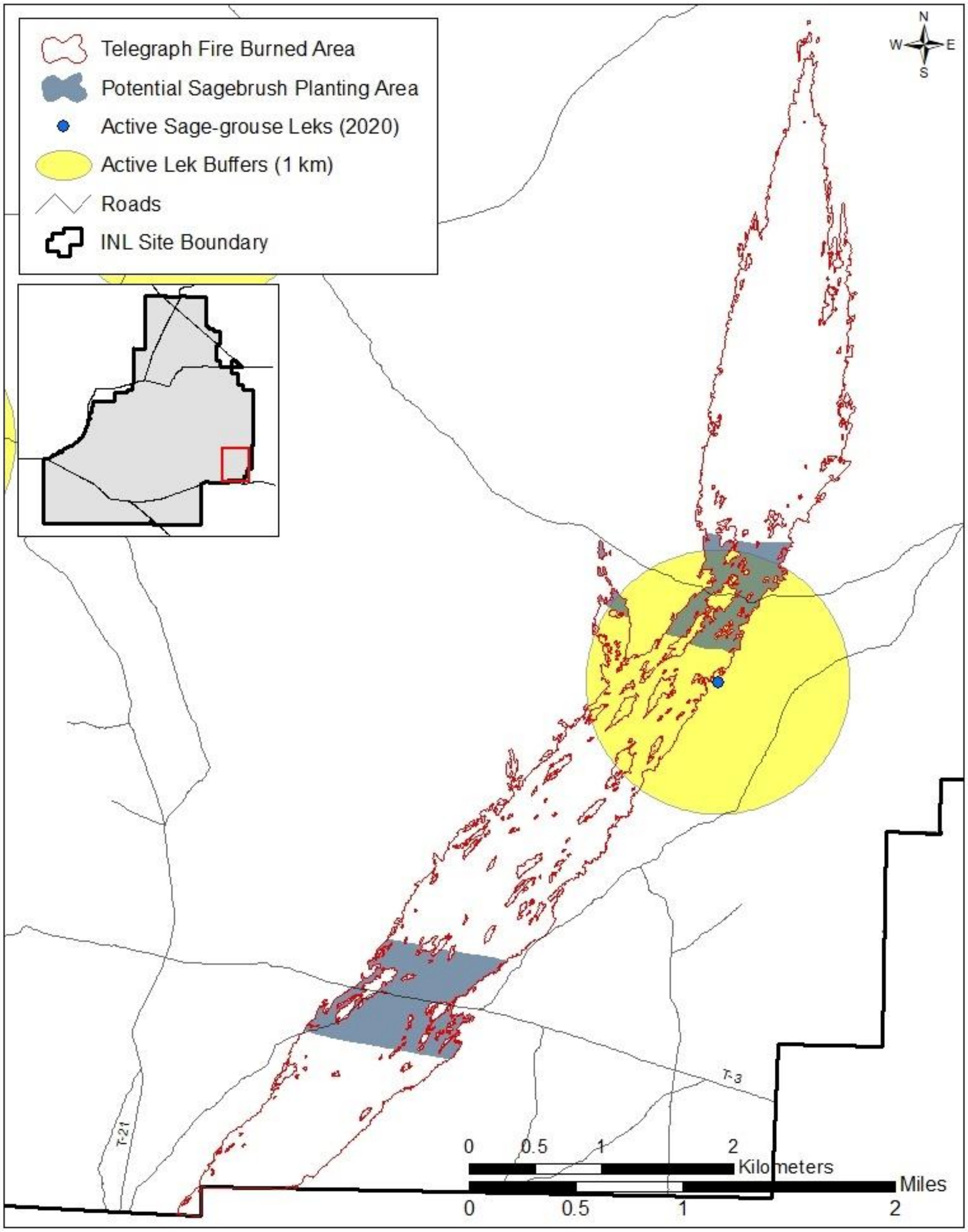

Figure 5-2. Areas proposed for sagebrush seedling planting within the 2020 Telegraph Fire on the Idaho National Laboratory Site.

Noxious weed control is an annual land management task across the INL Site; however, the Sheep Fire burned area was a primary focus area in 2020 and 2021. Ongoing noxious weed control will be implemented through the Sheep Fire Ecological Resources Post-Fire Recovery Plan and other INL Site weed control programs. During a post-Sheep Fire scoping meeting in 2019, local stakeholders raised a concern about rush skeletonweed invading recently burned areas on the INL Site as this noxious weed is becoming increasingly problematic in adjacent rangelands. ESER collected incidental data on noxious weed locations throughout the Sheep Fire in 2020 and 2021. These data were transmitted to INL for inclusion in their noxious weed treatment plan and many were sprayed via backpack and from truck-mounted hose applicators along existing T-roads.

Cheatgrass Control

ESER was funded by the WFMC to monitor areas at high risk of cheatgrass invasion during the summer of 2020 using a rapid assessment sampling approach to prioritize areas that would benefit from pre-emergent herbicide application. The Sheep Fire Ecological Resources Post-Fire Recovery Plan identified approximately 4,347 ha (10,741 ac) that had a substantial cheatgrass component prior to the Sheep Fire. Optimal application areas would have enough cheatgrass to warrant control measures and enough remnant native perennials to facilitate desirable herbaceous recovery after herbicide application. Much of the area identified in the recovery plan was sampled during August 2020 to verify suitability of conditions for treatment.

Results from ground-based monitoring were used to identify four approximately 809 ha (2,000 ac) polygons meeting the criteria for herbicide application. The polygons were prioritized so that the area most likely to respond well to treatment will be sprayed first and additional areas can be added as funding allows. Details regarding sampling, criteria for prioritization, and treatment recommendations can be found in the Sheep Fire Ecological Resources Post-Fire Monitoring Report (Forman et al. 2020). Using the recommendations made in the monitoring report, the INL began addressing processes and work controls necessary to perform this type of work and sprayed some initial test patches in 2021.

Additional NEPA evaluation will be required before pre-emergent chemicals can be aerially applied to cheatgrass at the INL Site. However, Facilities and Site Services (F&SS) applied Indaziflam (Esplanade SC©) to high priority cheatgrass treatment areas within the Sheep Fire footprint. The application was completed along either side of two-track roads using a truck-mounted tank and boom. In September 2021, cheatgrass was sprayed in a swath extending 20 feet on each side of the road for a total of 8 km (5 mi) along sections of T-3 and T-24, resulting in 9.7 ha (24.0 ac) receiving application. Though restrictions on off-road travel prevented applying chemical throughout the entire prioritized treatment area with a vehicle, sufficient area was treated to test the use of the chemical and application methodology and evaluate their efficacy.

Sagebrush Habitat Restoration

Based on stakeholder input and involvement, DOE agreed to collaboratively pursue aerial sagebrush seeding on portions on the Sheep Fire during the winter of 2019/2020. The seeding was completed across a target area of approximately 10,100 ha (25,000 ac) in and adjacent to the SGCA. Monitoring for germination and establishment of sagebrush in the seeded areas was included in the 2020 monitoring plan and results were used to determine if there were areas of poor establishment where additional planting with sagebrush seedlings should be considered. A total of 58.7 km (36.5 mi) of 20 m (66 ft)-wide belt transects, or an area of 117.4 ha (290.1 ac) was surveyed for sagebrush seedling establishment in late August 2020. There were no sagebrush seedlings observed that could be attributed to the aerial seeding. In 2021, approximately 45 km (28.0 mi) of 20 m (66 ft) -wide belt transects, or an area of 90 ha (222.4 ac) was revisited to assess whether any seedling establishment may have occurred during the second growing season post-planting. Again, no seedlings that could be attributed to the aerial seeding effort were located. Additional details about the aerial seeding can be found in the Sheep Fire Ecological Resources Post-Fire Monitoring Report (Forman et al. 2020).

Precipitation during 2020 and 2021 were well below long-term averages and precipitation timing in both years was not conducive to seedling germination and establishment. See Section 3.1.3 for a summary of recent precipitation patterns. The inherent uncertainty associated with aerial seeding combined with unfavorable precipitation patterns likely led to poor conditions for successful sagebrush restoration. The Sheep Fire Ecological Resources Post-Fire Recovery Plan suggested replanting areas where seed did not establish with seedlings and that seedlings should be placed strategically where they can provide the greatest habitat benefit. Seedlings can be used to improve high priority habitat and/or habitat connectivity. The WFMC directed ESER to develop a plan for planting sagebrush seedlings in high priority restoration areas on the Sheep Fire in 2021 and 2022.

To address poor establishment following the aerial seeding effort, six areas were identified as a high priority for sagebrush seedling planting in the Sheep Fire (Figure 5-3). The proposed planting sites were selected based on CCA priority restoration areas, logistics and access, ecological condition of the recovering herbaceous plant community, and agency stakeholder input. See Kramer et al. (2021) for a more detailed discussion about how planting sites were selected. In 2020, approximately 18 kg (40 lb.) of hand-stripped seed material was collected in October and shipped to a U.S. Forest Service Seed Extractory for cleaning and storage. The seed was grown in the greenhouse in 2021 and a total of 45,000 seedlings were planted in the Sheep Fire in October 2021. Approximately 15,000 seedlings were planted in each of proposed planting areas 1, 2, and 3 (Figure 5-3). Section 5.2.2 contains additional information about planting rates and site conditions.

Another 20.9 kg (46 lb) of sagebrush seed were collected and shipped to the Seed Extractory in November 2021. This seed will be used for growing 45,000 seedlings to be planted in the remaining three proposed planting locations in the Sheep Fire, and for the 41,300 seedlings to be planted in the proposed planting area within the Telegraph Fire (see discussion above). All seedlings will be started in a commercial greenhouse in the spring of 2022 and will be outplanted during October of the same year.

General Programmatic Changes to Facilitate Treatment and Improve Ecological Recovery

Emergency wildland fire response and associated soil stabilization actions are addressed in the INL Wildland Fire EA (DOE 2003); however, many of the post-fire recovery options presented in the Sheep Fire Ecological Resources Post-Fire Recovery Plan and the 2020 Fires Ecological Post-Fire Recovery Plan are not. Currently each non-emergency post-fire recovery action is subject to additional NEPA review. Although this approach was adequate at the time the EA was signed, there have been changes in fire frequency and land cover over the past twenty years, making this approach to wildland fire recovery less effective. A much larger portion of the INL Site has burned since the INL Wildland Fire Environmental Assessment was implemented and the resulting vegetative changes across the INL landscape may require different fire preparedness and suppression strategies than have been used in the past. The amount of sagebrush habitat lost over the past few decades also results in an increased importance of protecting remaining sagebrush habitat.

Given the changing ecological conditions at the INL Site and the number of post-fire recovery actions that were recommended by the WFMC after the Sheep Fire and the 2020 Fires, the INL is evaluating the need to update their wildland fire recovery approach and associated NEPA evaluation. An update would facilitate a more comprehensive and efficient response in fire suppression and in post-fire restoration in the future. The INL Fire Department and the Natural Resources Group have been tasked with scoping the fire management and ecological restoration tools they would like to consider using in response to future fires. The Fire Department has identified several actions, or alternatives they would like evaluated in the updated EA. The action most relevant to sagebrush habitat distribution is a proposal to develop fire breaks to interrupt the continuity of fuels and to provide strategic locations from which to deploy suppression tactics.

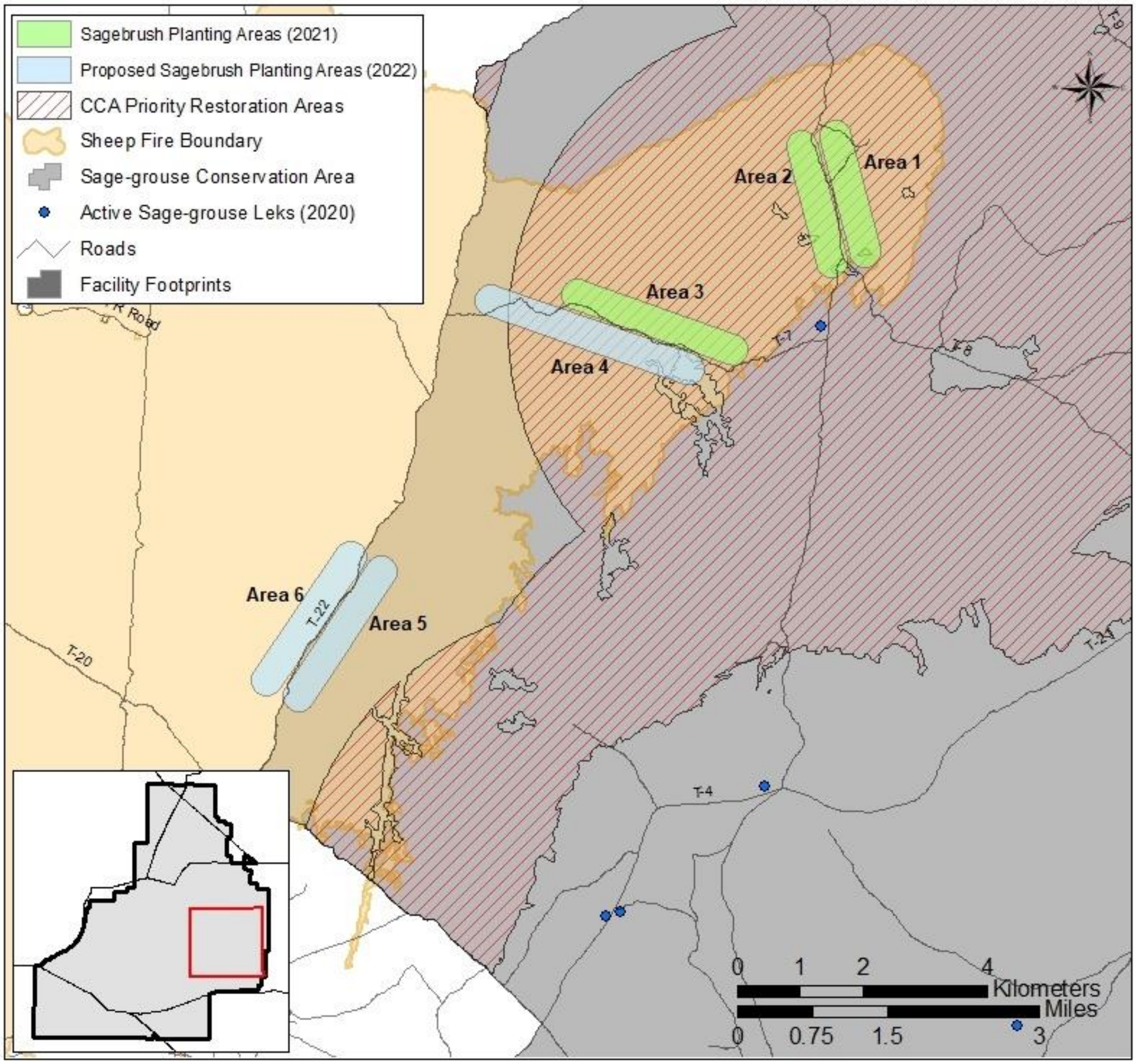

Figure 5-3. Proposed sagebrush seedling planting areas on the Sheep Fire at the Idaho National Laboratory Site and criteria used to identify prioritization. Areas are prioritized as Area 1 being highest priority and Area 6 being lowest priority.

The INL Natural Resources Group is developing an outline for a generalized post-fire ecological resources recovery plan that will include all post-fire restoration actions that should be considered to improve post-fire recovery, including emergency post-fire stabilization and ongoing habitat restoration. The restoration options identified in the plan will be evaluated as possible alternatives in the updated EA. Restoration activities that are not currently covered by NEPA will be considered in the updated EA and may include, but are not limited to: aerial cheatgrass treatment, aerial and mechanical sagebrush seed application, and using Utility Terrain Vehicles to increase the area accessible for sagebrush seedling planting. Not all actions would be appropriate on all fires and an evaluation of post-fire ecological impacts will still be required to determine which actions may be appropriate for each fire. However, developing a generalized plan that has been evaluated through the NEPA process will substantially improve the options available and the efficiency of implementing them.

5.2.2 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 (see Table 5-1, Section 5.1). The CCA includes three related strategies for addressing sagebrush habitat loss. The first is annual baseline seedling planting to address legacy habitat loss from fires that occurred prior to signing the CCA. The second strategy is developing a post-fire ecological recovery plan that includes reestablishing sagebrush lost due to recent wildland fires. The final strategy for minimizing sagebrush habitat losses on the INL Site includes compensatory mitigation for infrastructure development. In addition to wildland fires becoming more frequent, the INL Site has seen the development of more infrastructure due to larger new projects and expansion of existing projects. To address potential impacts from infrastructure development on sagebrush habitat distribution, DOE has a no-net-loss sagebrush habitat goal. It states that for every acre of sagebrush or potential sagebrush habitat impacted, BEA will contribute funds to replant approximately 1000 seedlings as compensatory mitigation due to infrastructure development. Seedlings from all funding sources are grown concurrently and planted in priority restoration areas identified in the CCA and in post-fire ecological recovery plans.

The INL Natural Resources Group oversees the planting of sagebrush seedlings from all sources and monitors survivorship to evaluate the effectiveness of the task. The goal of restoration is to plant at least 80 sagebrush seedlings per acre, although the actual planting rate can be highly variable due to weather conditions, topography, planting conditions, travel, planter ability, and number of seedlings being planted. Typical sagebrush density planting rates in sage-grouse habitat is one to three plants per square meter, meaning that a hectare normally contains 9,884–29,652 sagebrush plants (4,000–12,000 per acre; Chambers 2016). 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 over larger priority areas to shorten the time interval between a fire and the reestablishment of sagebrush habitat.

Methods

Desert Sage Farms LLC, located in Oakley, ID, provided 45,000 sagebrush seedlings grown from seed collected on the INL Site in 2020. Additionally, IDFG provided 38,750 sagebrush seedlings grown by North Fork Native Plants, located in Rexburg, ID, using seed collected near Mud Lake, ID in 2020. Information about growing the seedlings, and details about procedures followed during the planting process, are described in the Sheep Fire Sagebrush Seedling Planting Plan (Kramer et al. 2021) as well as the 2015 CCA Annual Report (Shurtliff et al. 2016). In 2021, a total of 83,750 seedlings were planted on 391.6 ha (967.7 ac) over four days by MP Forestry of Medford, OR (Figure 5-4).

Although potential planting sites are located in the priority restoration areas to the greatest extent possible, other practical factors often determine the final site selection. Logistical constraints, such as accessibility due to weather and road condition, may also be factors in selecting seedling locations. The areas chosen for restoration in 2021 were near the eastern boundary of the INL within areas burned during either Jefferson Fire or Sheep Fire (Figure 5-5). These areas are within the SGCA as well as within the priority restoration area identified in the 2014 CCA (DOE and USFWS 2014). These sites were chosen to continue establishing a more contiguous sagebrush corridor, because of its proximity to sage-grouse leks, and to continue rehabilitation on the Jefferson Fire and the Sheep Fire. For more information on planting site selection and planting methods see the Sheep Fire Sagebrush Seedling Planting Plan (Kramer et al. 2021).

Figure 5-4. Planting crew from MP Forestry planting big sagebrush (*Artemisia tridentata)* seedlings on the Idaho National Laboratory Site during October 2021.

In addition to planting seedlings in 2021, survivorship of seedlings planted in fall 2020 was determined by revisiting and evaluating the condition of individual seedlings one year after planting. During the fall 2020 planting, we collected roughly 500 sub-meter global positioning system locations of the seedlings planted. In August 2021, we revisited those seedlings and determined if each seedling was healthy, stressed, or dead (Figure 5-6). After five years, seedlings will again be revisited, and longer-term survivorship will be assessed.

In order to evaluate longer-term survivorship, seedlings planted in the fall of 2016 were revisited in the fall of 2021. During the fall of 2016, we collected sub-meter global positioning system locations roughly 500 seedlings planted and assessed the initial survivorship in the fall of 2017. In August of 2021, we revisited those same seedling locations again, regardless if they were determined missing or dead on the initial revisit. We assessed whether each seedling was healthy, stressed, missing, or dead five years post-planting.

Results and Discussion

On October 12–15, 2021, 83,750 sagebrush seedlings were planted on 391.6 ha (967.7 ac), resulting in a seedling density of ~212 seedlings/ha (~86 seedlings/ac) along T-4 and T-7 (Figure 5-5). For the 45,000 seedlings grown by Desert Sage Farms, LLC, we marked the locations of 521 seedlings for future monitoring. For the 38,750 seedlings provided by IDFG, we marked the locations of 487 seedlings for future monitoring. Planting conditions were favorable for seedling establishment with temperatures staying just above freezing, rain and snow throughout the week, and an observed wetting front reaching 4-6 inches throughout most of the planting areas.

Sagebrush restoration on the INL has now been initiated on 610 ha (1,507.4 ac). Over the past six years, a total of 155,750 seedlings have been planted from multiple funding sources, including DOE, BEA, the Idaho Governor's Office of Species Conservation, and IDFG.

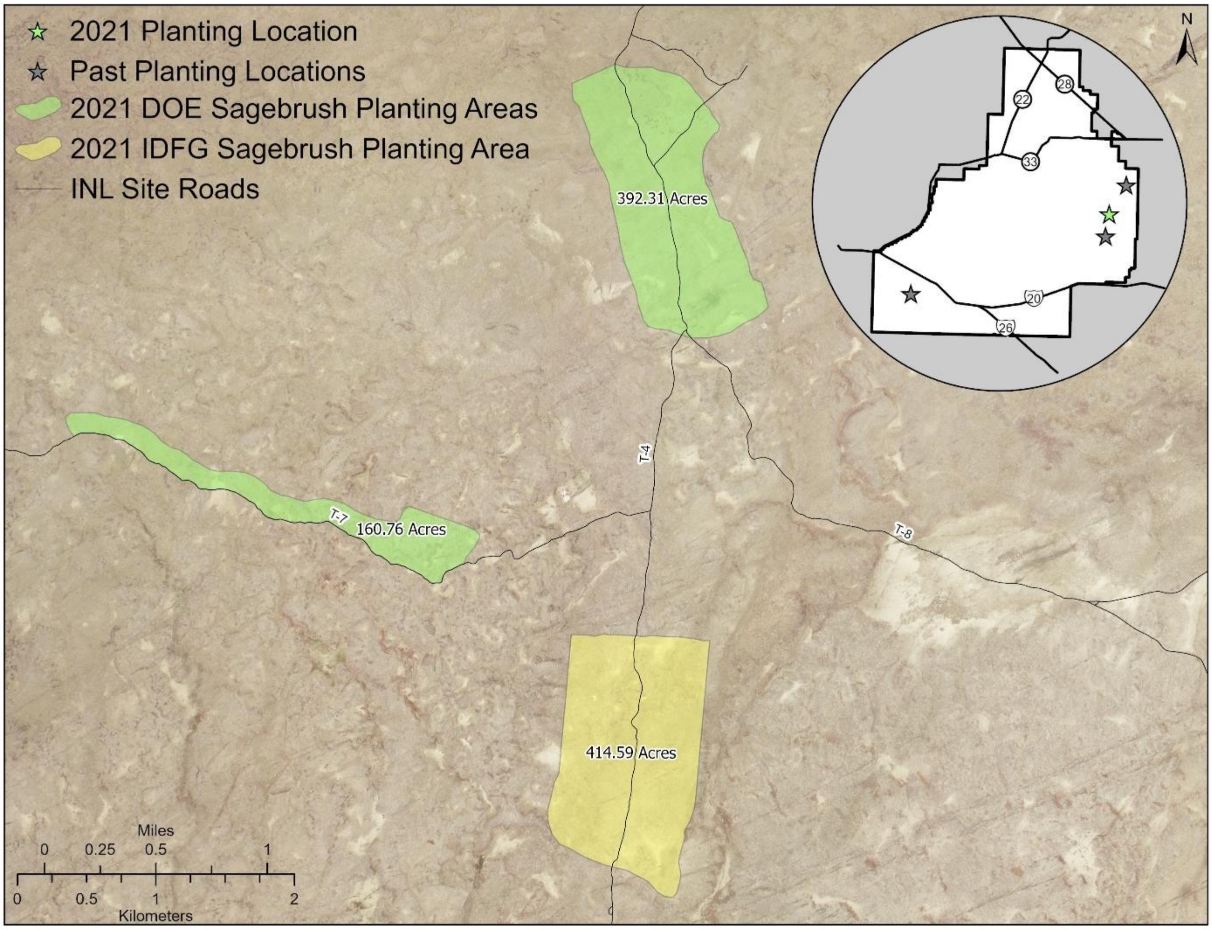

Figure 5-5. Areas planted with big sagebrush (*Artemisia tridentata)* seedlings in 2021 with reference to previous years plantings on the Idaho National Laboratory Site.

Figure 5-6. Examples of sagebrush seedling health conditions. Left: dead seedling. Right: healthy seedling.

To quantify 2020 seedling survivorship and condition, we revisited 540 sagebrush seedlings in early August 2021. Survivorship surveys found 0 (0%) seedlings were healthy, 2 (0.3%) were stressed, 66 (12.2%) were dead, and 472 (87.5%) were missing (Figure 5-7). Assuming the missing seedlings were dead, less than one percent (0.37%) of the seedlings survived the first year. For comparison, years 2015-2020 are shown in Figure 5-7.

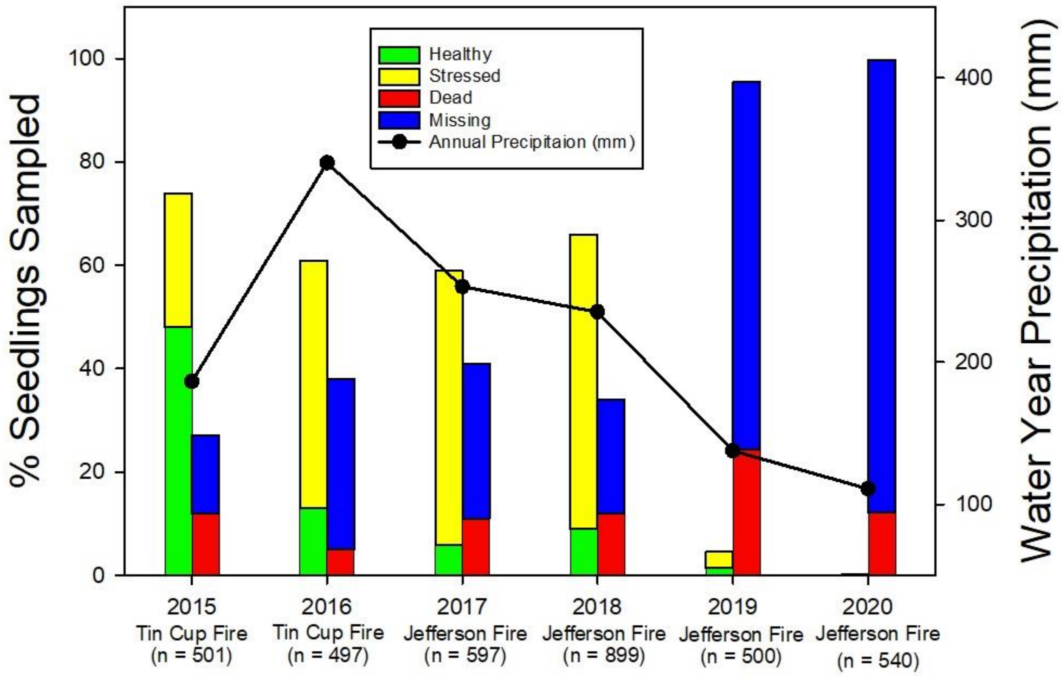

Figure 5-7. Sagebrush seedling survivorship one year after planting on the Idaho National Laboratory Site. The yellow and green bar represents the observed living seedlings. The blue and red bar represents seedlings presumed to be dead. The black line and dots indicate the fluctuations in water year precipitation levels. Water year is calculated as precipitation received in October of the planting year to September of the following year.

As shown in Figure 5-7, the water year precipitation associated with the 2019 and 2020 seedling plantings was substantially lower than previous planting years. In 2020, precipitation was atypical in both timing and amount, and it was the driest water year since the first planting in 2015. Winter, spring, and summer precipitation were not ideal for helping the seedlings to establish. While the cause of low survivorship is ultimately unknown due to many variables, low precipitation would appear to be a large contributing factor to the low survivorship of the 2019 and 2020 seedlings. Additional factors impacting survivorship of the 2019 and 2020 plantings may include an abnormally hard freeze that occurred a few days after planting in both years and the possibility of sheep grazing occurring immediately post-planting in both years.

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, prior to the two low precipitation years of 2019 and 2020, sagebrush establishment one-year post planting on the INL Site was above average, even when the missing plants are considered dead, with an average survivorship of 64.75% (2015–2018). It is unfortunate that the 2019 and 2020 planting has deviated from this trend of successful plantings, but it can provide an opportunity to better inform the planting process and allow us to explore new techniques or approaches to increase the success of future planting efforts. With the size and favorable conditions of the 2021 sagebrush planting, this percentage of survivorship can be expected to increase significantly.

Longer-term survivorship of seedlings planted in fall 2016 was also assessed in early August 2021. To quantify 2016 seedling survivorship and condition, we revisited the same 499 seedlings that were previously revisited in August of 2017. We relocated 282 seedlings, of which 254 (50.9%) were healthy, 23 (4.6%) were stressed, and 5 (1%) were dead. This means over the last 5 years, 277 (55.5%) of the marked seedlings survived. In addition to revisiting seedlings for condition and survivorship, we took note of individuals that have begun developing reproductive structures. Several of the observed surviving seedlings have developed reproductive structure. Some seedlings were noted to have several smaller sagebrush individuals surrounding them, which suggests, recruitment of seedlings is occurring around the planted individuals providing a seed source. This evidence supports the chosen method of planting at a density to establish sagebrush seed sources in priority areas to shorten the time interval between a fire and the reestablishment of sage-grouse habitat (Shurtliff et al. 2016).

One of the reasons DOE continues to plant seedlings over a relatively small area each year, rather than 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). The decision from DOE 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. However, alternative seedling/planting methods are being used and evaluated to determine if such methods can be successful supplements and/or alternatives to the current annual sagebrush seedling planting efforts (Forman et al. 2020).

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6.0 SYNTHESIS AND ADAPTIVE MANAGEMENT RECOMMENDATIONS

6.1 Sage-Grouse and Sagebrush Habitat Trends

The IDFG manages sage-grouse populations in Idaho by dividing all sage-grouse habitats into four Conservation Areas and distinguishing areas within the Conservation Areas as Priority or Important Habitat Management Areas (HMAs; Governor's Sage-grouse Task Force 2012). Lek route data are monitored each year to determine trends in these areas and to monitor populations across the state.

Much of the INL Site falls within Priority and Important HMAs in the Desert and Mountain Valleys Conservation Areas (Figure 6-1). Similar to results from baseline leks on the INL Site (Figure 2-2), total male counts on lek routes in these four HMAs dropped precipitously (−47% to −56%) from 2016 to 2019. The following year (2020), Desert Priority and Important HMAs dropped an additional 17% and 11%, respectively, slightly less than the 25% decline recorded on the INL Site (Shurtliff et al. 2021). In contrast, the Mountain Priority and Important HMAs increased 9% and 24%, respectively, in 2020. In 2021, results were mixed for these HMAs (Desert Priority = 29%, Desert Important = −11%, Mountain Priority = 14%, Mountain Important −2%) while baseline lek counts on the INL Site remained unchanged. Statewide, lek counts dropped across all HMAs from 2016 to 2019, but rebounded 2.5% in 2020 and another 13% in 2021 (Moser 2021).

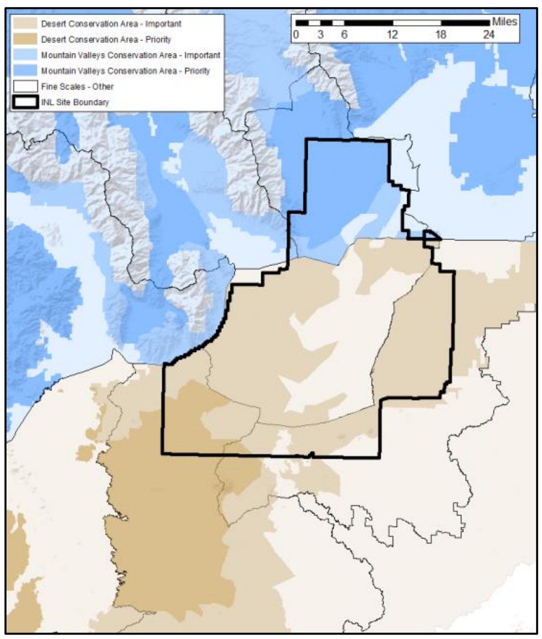

Figure 6-1. An overlay of the INL Site boundary onto two Idaho Conservation Areas (Desert and Mountain Valleys), with emphasis on Important and Priority Habitat Mangement Areas within each. Figure was adapted from Ellsworth et al. (2019).

The decline observed on INL Site baseline leks from 2016 to 2019 is similar to state and regional trends, although it should be noted that baseline leks on the INL Site are analyzed differently by INL than state-wide lek routes are by IDFG (Moser 2021, Shurtliff et al. 2022). All but three active baseline leks on the INL Site are within the Desert Conservation Area (Figure 2-1 and 6-1), so naturally the decline observed on the INL Site in 2020 did not differ greatly from counts in that Conservation Area. The discrepancy between state and INL Site lek trends in 2021, relative to 2020, are interesting but not surprising, especially in light of mixed results observed at the regional HMA level. We understand that deviations in lek attendance are influenced by multiple variables, and we have not identified any specific factors that would suggest leks on the INL Site are exhibiting a different trend currently.

Wildfire continues to be a dominant threat to sage-grouse habitats in the western portion of the species' range, especially when coupled with regional cheatgrass-driven fire regimes (Balch et al. 2013). Fortunately, intact sagebrush habitat on the INL Site appears to be resistant to cheatgrass dominance and is generally in good condition; however, data from adjacent burned areas indicate habitats are less resistant to invasion and can facilitate fluctuations in non-native species abundance during variable environmental conditions. The INL is considering updating its wildland fire recovery approach and associated NEPA evaluation, which would likely result in more comprehensive and efficient responses to wildfire by the fire department and more tools available for post-fire habitat restoration. The DOE continues to provide significant resources to reduce post-fire habitat degradation and hasten the return of sagebrush where fires have burned during the past two years.

Other threats monitored on the INL Site that can potentially reduce sage-grouse reproductive success include improper livestock grazing (Boyd et al. 2014) and raven predation (Coates et al. 2020). Regarding the first, we continue to find no apparent decline or increase in habitat quality measures between areas inside or outside of grazing allotments (Shurtliff et al. 2017, INL 2022). These findings suggest habitat condition in livestock allotments may be just as likely from logistical constraints and uneven utilization as much as prescribed grazing practices, underscoring the importance of continuing to work with the BLM and to continue monitoring potential threats to sage-grouse habitat condition. It remains unknown what impact breeding ravens have on sage-grouse nest success on the INL Site, but the number of raven nests on infrastructure, which probably represent the majority of breeding pairs (Howe et al. 2014), does not appear to have increased over the past eight years.

During the period after the 2012 Midway Fire and prior to the 2019 Sheep Fire, little sagebrush habitat was lost to wildland fire, but lek counts declined 52% between 2016 and 2021. At least three possible mechanisms could be responsible individually or cumulatively for this decline. First, sage-grouse populations could be experiencing a lag effect (Ricca and Coates 2020) from loss of sagebrush habitat caused by the Jefferson, T-17, and previous fires. Second, large regional fires in recent years (e.g., Grassy Ridge Fire, Indian Butte Fire) have eliminated sagebrush from thousands of hectares, potentially reducing the sage-grouse carrying capacity of the region (Swenson et al. 1987, Connelly et al. 2000, Crawford et al. 2004). Lastly, recent declines in sage-grouse populations could be driven or exacerbated by broad-scale climatic and environmental factors that have historically resulted in cyclic population trends in Idaho (Rich 1985, Row and Fedy 2017). If regional sage-grouse abundance is naturally cyclic, and if regional threats do not overwhelm that trajectory to break the cycle, lek counts may stabilize and increase in the next few years. Indeed, virtually unchanged lek counts observed on the INL Site in 2021 coupled with mixed signals of lek count trends regionally and two consecutive years of increasing counts across the state may be signaling the beginning of an upswing in regional and state sage-grouse populations.

6.2 Proposed Changes

No changes to the CCA were proposed in 2021, but two proposals made in 2019 are still being considered by the USFWS. The first proposal was that the basis of the population trigger be changed from 27 SGCA baseline leks to the six lek routes, or perhaps to all active leks (either in the SGCA or the entire INL Site). The CCA stated that signatories would consider a change to the current "interim population trigger" once new lek routes were created. The second proposal was to update the estimated area of sagebrush habitat in the SGCA, which is the basis for the habitat trigger. ESER updated the INL Site vegetation classification and map in 2019, resulting in a refined estimate of sagebrush habitat in 2011 that was 8% lower than the original estimate.

6.3 Adopted Changes

The USFWS and DOE made no changes to the CCA or associated monitoring tasks in 2021.

6.4 Work Plan for Upcoming Year

The following table (Table 6-1) describes activities or changes that are planned for the upcoming year. The purpose of this table is to highlight activities and analyses that will be different than the regular annual activities associated with each task.

Table 6-1. ESER work plan for 2021.

Task	Schedule and Changes for 2021
1. Lek Counts and Lek Route Surveys	• 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). • Update annual habitat condition analyses. • Continue to explore cover trend analyses.
6. Monitoring to Determine Changes in Sagebrush Habitat Amount and Distribution	• No work to be conducted on this task inside recently burned area until these regions have a few years to naturally reestablish. 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	• Idaho NAIP imagery will be available in 2022, and we will systematically review the INL Site to document evidence of expansion of linear features and losses of sagebrush habitat from new project footprints and expansions.

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APPENDIX A.

Table A-1. A complete list of all species documented on the 75 annual habitat monitoring plots (43 sagebrush plots and 32 non-sagebrush plots) in 2021. Nomenclature follows the U.S. Department of Agriculture PLANTS National Database (2021).

Scientific Name	Common Name
Achnatherum hymenoides	Indian ricegrass
Agropyron cristatum	crested wheatgrass
Allium acuminatum	Hooker's onion/ tapertip onion
Allium textile	textile onion
Alyssum desertorum	desert alyssum/ desert madwort
Arabis cobrensis	sagebrush rockcress
Arabis holboellii	Holboell's rockcress
Artemisia nova	black sagebrush
Artemisia tridentata	big sagebrush
Artemisia tridentata Nutt. ssp. tridentata	basin big sagebrush
Artemisia tripartita	threetip sagebrush
Astragalus calycosus	Torrey's milkvetch
Astragalus curvicarpus	curvepod milkvetch
Astragalus filipes	basalt milkvetch
Astragalus lentiginosus	freckled milkvetch
Astragalus purshii	woollypod milkvetch
Atriplex confertifolia	shadscale saltbush
Atriplex falcata	sickle saltbush/ Nuttall saltbush
Bassia scoparia	kochia/ summer cypress/ burningbush
Bromus tectorum	cheatgrass
Calochortus bruneaunis	Bruneau mariposa lily
Carex douglasii	Douglas' sedge
Castilleja angustifolia	northwestern Indian paintbrush
Chaenactis douglasii	Douglas' dustymaiden
Chenopodium album	lambsquarters
Chenopodium leptophyllum	slimleaf goosefoot/ narrowleaf goosefoot
Chondrilla juncea	rush skeletonweed
Chrysothamnus viscidiflorus	yellow rabbitbrush/ green rabbitbrush
Comandra umbellata	bastard toadflax
Crepis acuminata	tapertip hawksbeard
Cryptantha circumscissa	cushion cryptantha
Cryptantha interrupta	Elko cryptantha
Cryptantha scoparia	Pinyon Desert cryptantha
Delphinium andersonii	Anderson's larkspur/ desert larkspur
Delphinium nuttallianum	upland larkspur/ twolobe larkspur
Descurainia pinnata	western tansymustard
Descurainia sophia	herb sophia
Elymus elymoides	bottlebrush squirreltail

Table A-1. (continued).

Elymus lanceolatus	**thickspike wheatgrass**
Eriastrum wilcoxii	Wilcox's woollystar
Ericameria nauseosa	rubber rabbitbrush/ gray rabbitbrush
Erigeron pumilus	shaggy fleabane
Eriogonum caespitosum	matted buckwheat
Eriogonum microthecum	shrubby buckwheat/ slender buckwheat
Eriogonum ovalifolium	cushion buckwheat
Gayophytum diffusum	spreading groundsmoke
Grayia spinosa	spiny hopsage
Gutierrezia sarothrae	broom snakeweed
Halogeton glomeratus	saltlover
Hesperostipa comata	needle and thread grass
Ionactis alpina	Lava aster
Ipomopsis congesta	ballhead gilia
Krascheninnikovia lanata	winterfat
Lactuca serriola	prickly lettuce
Lappula occidentalis	flatspine stickseed
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
Machaeranthera canescens	hoary tansyaster
Mentzelia albicaulis	whitestem blazingstar
Oenothera caespitosa	tufted evening primrose
Opuntia polyacantha	plains pricklypear
Orobanche fasciculata	clustered broomrape
Packera cana	woolly groundsel
Pascopyrum smithii	western wheatgrass
Penstemon cyaneus	blue penstemon
Penstemon pumilus	Salmon River beardtongue
Penstemon radicosus	matroot penstemon
Phacelia glandulifera	sticky phacelia
Phacelia hastata	silverleaf phacelia
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

Table A-1. (continued).

Salsola kali	**Russian thistle**
Schoenocrambe linifolia	flaxleaf plainsmustard
Sisymbrium altissimum	Jim Hill mustard/ tall tumblemustard
Sphaeralcea munroana	Munro's globemallow/ whitestem globemallow
Stanleya viridiflora	green princesplume
Stenotus acaulis	stemless mock goldenweed
Tetradymia canescens	spineless horsebrush
Tetradymia spinosa	shortspine horsebrush
Townsendia florifer	showy Townsend daisy
Tragopogon dubius	yellow salsify
Zigadenus venenosus	meadow deathcamas

USDA, NRCS. 2021. The PLANTS Database (http://plants.usda.gov, November 9, 2020). National Plant Data Team, Greensboro, NC 27401-4901 USA.