Bureau of Land Management
Greater Sage-Grouse Habitat Assessment Summary Report for the Beatys Butte Fine-Scale Assessment Area, Southern Oregon and Northern Nevada

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Bureau of Land Mangement

Lakeview District Office, Lakeview Oregon

Executive Summary

In this Habitat Assessment Summary Report, habitat for the Greater Sage-Grouse (*Centrocercus urophasianus*; hereafter sage-grouse) is described at three spatial scales nested within one-another (Figure 1). At the mid-scale (second-order), the analysis focused on the Western Great Basin population area (Population Number 31 in USFWS 2013), which comprises almost all of the US Department of Interior (DOI), Bureau of Land Management (BLM) Lakeview district, as well as portions of Burns and Vale districts, Oregon. The fine-scale analysis (third order) examined the Beatys Butte home range portion of the Western Great Basin population area. The site-scale (fourth order) analyzed data collected at Assessment, Inventory, and Monitoring (AIM) plots (MacKinnon et al. 2011) within the Oregon portion of the fine-scale boundary to rate the sage-grouse seasonal habitat indicators listed in the Oregon Greater Sage-Grouse Approved Resource Management Plan Amendment (ARMPA)(BLM 2015) Habitat Objectives Table 2-2 (included herein at Appendix A). While the mid- and fine-scale analysis includes all land ownerhships, the site-scale analysis includes only BLM lands, except that leks were assessed on all land ownerships.

Habitat at the mid-scale is suitable for sage-grouse due to the presence of large, occupied and contiguous patches of connected sagebrush and associated vegetation. At the fine-scale, habitat is suitable, because anthropogenic disturbance is low and seasonal use areas are well-connected. Seasonal habitat availability does not appear to be limiting. However, 46 of 148 leks within the Oregon portion of the Beatys Butte fine-scale analysis area were rated marginal or unsuitable. For the breeding habitat, upland summer/late brood-rearing habitat, and the winter habitat, 74.1 percent, 88.1 percent, and 93.9 percent, respectively, of the area was suitable. Overall, riparian summer/late brood-rearing habitat was suitable. All seasonal habitat types met the objective in the ARMPA (BLM 2015) Habitat Objectives Table (Appedix A) for percent of seasonal habitat meeting a majority of the desired conditions.

The BLM will use the Habitat Assessment Summary Report to inform Land Health Assessments and Land Health Evaluations associated with land use authorizations within the assessment area, as required by BLM Instruction Memorandum 2016-144 (BLM 2016). The site-scale analysis relied on a limited number of ground-based plots in Oregon (n=66) sampled in the first year of a 5-year design (2016-2020). After five years a proportion of the plots will be re-measured to establish trends. This habitat assessment will be periodically updated as new data, analyses, and other information become available (e.g. as sub-populations across the range are better defined and site-scale plots in Nevada are assessed).

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1.0 Introduction

Bureau of Land Management (BLM) field offices that manage habitat for Greater Sage-Grouse (*Centrocercus urophasianus*)(hereafter sage-grouse) are required to use the Sage-Grouse Habitat Assessment Framework (HAF)(Stiver et al. 2015) to rate habitat suitability at multiple scales and to summarize the findings in a Habitat Assessment Summary Report. The purpose of the HAF is "to empower managers to implement project-level actions that make sense at landscape scales" (Stiver et al. 2015, p. 5). The Summary Report is one of several sources of information the BLM will use to inform the wildlife and special status species habitat quality land health standard(s) when completing Land Health Assessments and Land Health Standard(s) evaluation (H-4180-1; DOI 2001) and associated National Environmental Policy Act documentation(40 CFR 1500-1508).

In this Habitat Assessment Summary Report (hereafter Summary Report), the fine-scale analysis (third order) examines suitability of the Beatys Butte home range of sage-grouse (Figure 1) occurring within the larger mid-scale (second order) area that corresponds closely with the Western Great Basin population (population number 31 in USFWS 2013). The mid-scale area includes seven Oregon Priority Areas for Conservation (PAC): Picture Rock, Tucker Hill, Warner's, Beatys Butte, Dry Valley-Jack Mountain, Steens, and Pueblo-South Steens. In Nevada and California, the mid-scale area includes Vya, Sheldon, Black Rock, Pine Forest, Massacre, and Buffalo-Skedaddle population management units. The fine-scale analysis area is located within the Western Great Basin Sagebrush Focal Area (BLM 2015), one of four remaining large intact expanses of sagebrush habitat, connecting south-central Oregon with northwest Nevada (Knick and Hanser 2011).

The site-scale (fourth order) analyzes seasonal habitat suitability within the Oregon portion of the fine-scale habitat analysis area. Site-scale data and suitability determinations for Nevada were not available for the Summary Report. Site-scale indicators and threshold values for suitable habitat are displayed in the Oregon Greater Sage-Grouse Approved Resource Management Plan Amendment (ARMPA)(BLM 2015) and in Appendix A of this Summary Report. The ecological potential of sites and drought are taken into account when interpreting habitat conditions recorded at the site-scale. Site-scale data was obtained from ground-based plots located on BLM land ownership, except leks were assessed on all land ownerships using remotely sensed data and other information provided to the BLM habitat assessment team.

2.0 Methods

2.1 Data Sources

The BLM assessment team selected the mid- and fine-scale boundaries, the seasonal habitat delineations, and the data sources used in this assessment (Table 1).

Table 1: Data sources used in the mid-scale, fine-scale, and site-scale assessments. Agencies providing data include: Bureau of Land Management (BLM), Oregon Department of Fish and Wildlife (ODFW), Nevada Division of Wildlife (NDOW), US Fish and Wildlife Service (USFWS), the Institute for Natural Resources (INR), U.S. Department of Energy (DOE), US Geological Survey (USGS) and The Nature Conservancy (TNC).

Data	Source	Mid-Scale	Fine-Scale	Site-Scale
Existing Vegetation Types (EVT)	LANDFIRE 1.4.0	X	X	
Biophysical Settings (BpS)	LANDFIRE 1.4.0	X	X	
Sage-grouse lek locations[1]	ODFW, NDOW	X	X	
Sage-grouse Telemetry[2]	ODFW, BLM, NDOW	X	X	
Anthropogenic Features	BLM	X	X	
Oregon Seasonal Habitat Model	BLM, INR		X	
California Seasonal Habitat Model	BLM, NDOW		X	
NLCD Shrubland Sagebrush Cover	USGS			X
Hart Mountain Vegetation	USFWS, DOE			X
GTRN Roads and Highways	BLM			X
Hart Mountain Roads	USFWS			X
Fences (High risk, Moderate Risk)	TNC			X
Structures (Meteorological and Communication Towers)	BLM			X
Tall Woody Vegetation Cover Class	INR, TNC			X

[1] Leks with at least one male sage-grouse observed from 2007-2016. California leks were included in the NDOW dataset. [2] Telemetry data provided by the BLM Lakeview District used in spatial products. NDOW telemetry used to inform delineations by Nevada/California BLM.

2.2 Assessment, Inventory, and Monitoring (AIM)

AIM protocols were used to measure habitat indicators at the site-scale. MacKinnon et al. (2011) described the core terrestrial indicators and methods. In additional to these core methods, supplemental protocols were implemented, including visual obstruction, sagebrush shape, and sage-grouse preferred forb diversity and availability.

The AIM approach is based on a statistically valid survey design that includes a spatially balanced random sample (Taylor et al. 2014). The establishment of plots in probabilistic sampling framework allows estimates to be calculated for specific indicator values (e.g., sagebrush cover), over various areas of interest, with known confidence levels. Each plot has a sample weight based on the original sample design. Plots from multiple sample designs can be merged together to provide statistically valid estimates. AIM indicator data were used to rank plots as suitable, marginal or unsuitable, for site-scale analysis. Each plot's suitability ranking was then weighted to determine the proportion of suitable area in each sage-grouse seasonal habitat.

The AIM sample designs are five year designs; 20 percent of the total numbers of plots are planned to be sampled each year from 2016 to 2020. In 2016, 66 plots were sampled in the Oregon portion of the Beatys Butte fine-scale analysis area. After five years, a proportion of all plots measured in 2016-2020 will be re-measured to establish trends in vegetative condition.

2.3 Sage-Grouse Habitat Assessment Framework (HAF)

The HAF (Stiver et al. 2015) provides a structured approach to rate indicators of seasonal habitat suitability at multiple scales. Indicators vary with the order or scale of sage-grouse habitat selection and season of use. Mid-scale is second order, fine-scale is third order, and site-scale is fourth order. The three scales are nested within one-another (Figure 1).

Data forms for rating indicators are provided in the HAF (Stiver et al. 2015). The BLM adjusted the site-scale indicator values and data forms during the ARMPA planning process to reflect sub-regional ecological potential. The Oregon BLM State Office established indicator values for marginal and unsuitable ratings following procedures set forth in the HAF and BLM Instructional Memorandum (IM) 2016-144. Completed forms for all scales are located at the BLM Lakeview District Office, Lakeview, Oregon.

2.4 Mid-Scale (Second Order)

A mid-scale assessment describes habitat characteristics that are linked to bird dispersal capabilities (Stiver et al. 2015). The BLM delineated the mid-scale boundary using topographic features, telemetry data, modelled resistance data, and expert knowledge from state wildlife agency and BLM personnel.

Mid-scale indicators include habitat availability, patch size and number, patch connectivity, linkage area characteristics, landscape matrix and edge effects, and anthropogenic disturbances. Each habitat indicator is explained below.

2.4.1 Habitat Availability

Three metrics were used to assess habitat suitability within the mid-scale habitat assessment area; area of occupied habitat, area of potential habitat, and area of non-habitat. Occupied habitat includes occupied suitable areas, defined in the HAF as all sagebrush and associated plant communities known to be used by sage-grouse within the last 10 years. Potential habitat includes areas that are currently unoccupied and may be currently suitable (i.e., in a sagebrush community or sagebrush associated plant community) or are currently unsuitable/marginal but have the potential for occupancy in the foreseeable future (<100 years) through succession or restoration. Non-habitat includes all other land cover types.

Suitable and potential habitat types were identified using two land cover data sets. The LANDFIRE 1.4.0 existing vegetation (EVT) data set was reclassified into sagebrush communities, sagebrush associated communities, and non-habitat to identify areas with currently suitable habitat (Appendix B, Table 1). The LANDFIRE 1.4.0 biophysical settings (BpS) data set was reclassified to identify areas that could potentially support sagebrush and sagebrush associated communities in the future (Appendix B, Table 2). Both reclassifications were based on BLM guidance (2015, Appendix D, Table 4) with minor state-specific modifications as described in Appendix B, Table 2. The reclassified EVT and BpS data sets were merged, to include areas of EVT not captured in BpS, to more accurately represent potential habitat.

Occupied areas were identified by combining multiple sage-grouse observation data sets including, four mile buffers of recently active leks, and a 99-percent kernel density analysis of sage-grouse telemetry locations from studies in southern Oregon and northern Nevada (A. Titolo, personal communication, June 6, 2017). In Oregon, leks had observed male attendance between 2007-2016. In Nevada and California, leks had a 2016 lek status of active or pending. Additional areas of known occupancy were hand-digitized, from telemetry data that was not included in the kernel density analysis, or based on expert knowledge from BLM-California field staff (M. Oyarzun, personal communication, May 25, 2017).

The occupancy data was intersected with the currently suitable habitat layer and potential habitat layer to determine how much of each habitat designation was occupied and unoccupied.

2.4.2 Patch Size & Number

Two metrics were used to assess habitat patches; mean size of occupied habitat patches, and number of occupied patches. Habitat patches were defined according to select environmental variable criteria found in Knick et al. (2013). Environmental variables were selected from the study based on two considerations; the same or an updated version of the data source for the variable was readily available, and the variable was found to be significant in the study. Habitat patches were mapped by applying land cover criteria to the EVT and ESRI street map premium data using a 5-km radius (≈78.54 km^2) moving window analysis that identified areas that met the land cover criteria in Table 2. The 78.54 km^2 area corresponds to the area within which Knick et al. (2013) found significant relationships between environmental variables and lek presence.

Table 2: Thresholds for inclusion of a focal area in sage-grouse habitat patch availability. Each 78.54 km^2 moving window had to meet these land cover values to be defined as a patch.

Variable	**Percent Land Cover**
Sagebrush Land Cover	> 79
Developed Areas Land Cover (urban and suburban areas)	<3
Interstates/Highways	0

Patches were mapped 10 km beyond the mid-scale boundary to reduce artificial truncation of patches caused by analysis bounds and to provide a more complete representation of the landscape pattern; however, patches were clipped to the mid-scale boundary to calculate mean patch size and number of patches. Occupied patches were determined by intersecting the occupancy layer mentioned above with the habitat patches.

2.4.3 Patch Connectivity

One metric was used to assess patch connectivity; mean distance to nearest occupied patch. Shortest Euclidean distance between every adjacent pair of occupied patches was mapped and measured, and summary statistics of those distances were calculated.

2.4.4 Linkage Area Characteristics

Three metrics were used to assess linkage area characteristics; percent suitable, percent marginal, and percent unsuitable land cover in the linkage areas. A linkage area is the area between habitat patches through which sage-grouse may travel.

To calculate these metrics, the EVT data set was reclassified into suitable, marginal, and unsuitable classes (Appendix B, Table 1) and was then clipped to represent only the areas between patches (i.e., patches were erased from the landcover). Reclassification was guided by the methods used in Jones et al. (2015). The percentage of the linkage area in each suitability class was calculated and the resulting map was assessed.

2.4.5 Landscape Matrix and Edge Effect

Two metrics were used to assess the landscape matrix and edge effect: mean percent positive and mean percent negative patch edges. Edge was defined as areas within 5 km of the habitat patches. Positive, negative, and neutral values for this metric reflect the inference that, the cover type or land use immediately adjacent to a habitat patch can positively or negatively affect the quality of that patch's suitability as sage-grouse habitat (Stiver et al. 2015).

To calculate these metrics, the EVT data set was reclassified into positive, negative and neutral classes (Appendix B, Table 3). Neutral values accounted for classes that could not be determined as having either a positive or negative effect on patch suitability. The percent of positive, negative and neutral classes was calculated for the analysis area.

2.4.6 Anthropogenic Disturbance

Three metrics were used to assess anthropogenic disturbance; density of linear disturbance features, density of point disturbance features, and area of non-habitat inclusions (area-based disturbance features) within occupied patched. Occupied habitat patches, as described above, were intersected with the BLM Disturbance Compilation dataset to calculate the density and area of disturbance features within them. BLM *(*2015, Appendix D) describes the disturbance feature types and data sources included in the disturbance dataset.

2.5 Fine-Scale (Third Order)

The fine-scale assessment characterizes sage-grouse seasonal habitat use within a home range(s) (Stiver et al. 2015). As with the mid-scale boundary, the BLM delineated the fine-scale boundary using topographic feature, telemetry data, modelled resistance data, and expert knowledge from the state wildlife agency and BLM personnel. The fine-scale boundary is located entirely within the mid-scale boundary.

Fine-scale suitability indicators include seasonal habitat availability, seasonal use area connectivity, and anthropogenic disturbances. The suitable habitat dataset, the potential habitat dataset, and the occupancy dataset developed for the mid-scale analysis were used in the fine-scale analysis.

2.5.1 Seasonal Habitat Availability

Six metrics were used to assess seasonal habitat availability at the fine-scale, including area of both occupied and potential breeding, summer, and winter habitat. Two existing sage-grouse seasonal habitat models, one which covered Oregon Greater sage-grouse range (Henderson 2016) and one which spanned northern California and Nevada (M. Oyarzun 2017), were combined with expert knowledge to create seasonal habitat maps for each season. In Oregon, the seasonal habitat model was combined with expert knowledge to create more generalized seasonal habitat areas. In California/Nevada, the seasonal habitat model was combined with expert knowledge near the Sheldon Wildlife Refuge to account for gaps in model coverage, but otherwise remained unchanged.

Seasonal habitat was identified as occupied or unoccupied/unknown occupancy by intersecting each seasonal habitat dataset with the occupancy dataset. Additionally, the amount of existing suitable habitat, potential habitat and non-habitat was calculated by intersecting the seasonal use areas with the habitat availability datasets used in the mid-scale analysis. Specifically, areas with the following occupancy and suitability rating were calculated for each season: occupied suitable habitat, occupied potential habitat, occupied non-habitat, unknown occupancy suitable habitat, unknown occupancy potential habitat, and unknown occupancy non-habitat.

2.5.2 Seasonal Use Area Connectivity

Three metrics were used to assess seasonal use connectivity: breeding to summer overlap, summer to winter overlap, and winter to breeding overlap. The metrics were calculated by overlaying the two seasons and taking the ratio of the amount of edge between both seasons to the total area of the seasons combined.

2.5.3 Anthropogenic Disturbance

Three metrics were used to assess anthropogenic disturbance; density of linear disturbance features, density of point disturbance features, and area of non-habitat inclusions (area-based disturbance features) within the fine-scale boundary. The fine-scale boundary was intersected with the BLM Disturbance Compilation dataset to calculate the density and area of disturbance features within the home range. BLM *(*2015, Appendix D) describes the disturbance feature types and data sources included in the disturbance dataset. Buffers were not applied to disturbance feature types.

2.6 Site-Scale (Fourth Order)

The BLM Interdisciplinary Team (IDT) used the HAF methodology to assess the site-scale suitability ratings based on the indicators and threshold values listed in the ARMPA (BLM 2015) Habitat Objectives Table (Appendix A). Indicator values for breeding habitat, upland summer/late brood-rearing habitat, and winter habitat were extracted from AIM data collected in 2016. Only plots within a delineated seasonal habitat, measured at the appropriate time of year, were rated. Seasonal habitats and associated periods of use defined in the ARMPA (BLM 2015) Habitat Objectives Table (Appendix A) are breeding season from March 1-June 30, brood-rearing and summer season from July 1-October 31, and winter season from November 1-February 28.

Suitable habitats provide the proper protective cover, food, and security from predators, in order to survive and reproduce. Marginal habitats include some of the appropriate components required to support sage-grouse; however, habitat conditions are lacking certain criteria and/or the quality is lower than that of suitable habitat. Typically, survival and reproduction are considered lower in marginal habitats than in suitable habitats. Unsuitable habitats may be missing appropriate indicators although there may be the potential for the habitat to provide necessary life requirements in the future (Stiver et al. 2015).

The proportion of suitable habitat area within each season was calculated, using site-scale suitability ratings, to illustrate the overall suitability of seasonal habitat within the Beatys Butte fine-scale assessment area. To accomplish this, the BLM National Operations Center (NOC) ran post stratification/point weighted calculations in a custom script developed in R (R Core Team 2017) and generated proportional area estimates of suitability with an 80 percent confidence interval for the sample frame(s) within each seasonal habitat delineation.

Suitability of leks in the Oregon portion of the Beatys Butte fine-scale assessment area were rated either on the ground (25 leks) during 2017 lek monitoring or through remote analysis (122 leks) in ArcMap (ESRI) using a 3-km buffer around each lek and applicable data sources (Table 1). Indicators included availability of sagebrush cover within 100 meters, proximity of detrimental land uses, and proximity of trees or other tall structures. Suitability ratings for all leks located on Hart Mountain National Antelope Refuge were reviewed by a USFWS refuge biologist and revised if current habitat conditions did not match the analysis in ArcMap. Most common revisions were due to discrepancies in the presence or amount of juniper in the analysis area, or in the management of the roads on the Refuge. (i.e., seasonal road closures near leks implemented to reduce disturbance).

Riparian summer habitat suitability was based on assessment of riparian stability and sage-grouse preferred forb availability. While availability of sagebrush cover is an indicator of riparian habitat in Stiver et al (2015), it was not included in Oregon because there is no known or published correlation of the indicator with riparian area habitat suitability. Additionally, perennial herbaceous cover was considered an indicator in mesic riparian habitat (Appendix A). The Palmer Drought Index (NOAA 2017; available at https://www.ncdc.noaa.gov/temp-and-precip/drought/weekly-palmers/maps) was accessed to determine the long term meteorological conditions during the time of site assessment.

For riparian stability, a BLM IDT conducted Proper Functioning Condition (PFC) assessments on 17 sites within late brood-rearing habitat in the spring and summer of 2017. All sites were lakebeds or waterholes. No wet meadows were assessed. Lentic PFC was assessed following the process described in BLM (2003). Only data collected in 2017 was used in the assessment because the HAF recommends using only current PFC data. One spring site was assessed using the HAF, but had no PFC assessment associated with it.

Preferred forb availability and diversity was assessed concurrently with riparian stability. Plant species were documented at that time. Preferred forbs (Mousseaux 2017) in the low, medium, or high palatability group were then tallied to estimate species richness of sage-grouse preferred forbs. The relative availability was taken into account based on how common or rare forbs were in the transition area between the shore and upland.

The BLM IDT determined whether each riparian area assessed had greater than or equal to 50 percent perennial herbaceous cover by ocular estimation. Professional judgement was used to determine if cover was unsuitable or marginal, if there appeared to be less than 50 percent perennial herbaceous cover. A cover estimate was recorded at some sites. Other sites only had cover reported as either unsuitable, low marginal, marginal, or high marginal.

Distance of sagebrush cover to mesic riparian areas is an indicator for summer/late brood-rearing habitat suitability in the HAF (Stiver et al. 2015). Since this not a habitat objective in Oregon, it was not weighed heavily in a suitability decision. Distance to suitable sagebrush cover (10% to 25% canopy cover) indicated in the USGS data layer (Xian et al. 2015) to the nearest riparian polygon edge was estimated using the measure tool in ArcGIS (ESRI)). If at least one-half of the riparian polygon was within 100 meters of suitable sagebrush cover, the indicator was considered suitable.

3.0 Results and Discussion

3.1 Mid-Scale (Second Order)

There are 47,514 km^2 (11.7 million acres) in the mid-scale area. Approximately 41 percent of the mid-scale area is occupied habitat, 38 percent is potential habitat, and 21 percent is non-habitat (Figure 2). There is a large amount of unoccupied habitat in the north portion of the analysis area.

Mean size of occupied habitat patches is 2,437 km^2 (602,276 acres) (n=12 patches: median=260.5 km^2; min=104 km^2; max=11,717 km^2) (Figure 3). Three patches that extend over the northern border were clipped to the mid-scale boundary; thus, the mean patch size statistic may under-report what is actually available on the landscape. Highway 140 divides an otherwise contiguous occupied habitat area into two large patches (>10,000 km^2). The size of patches decreases toward the southern end of the mid-scale area. About 62 percent of total area is in occupied patches. The only unoccupied patch (270 km^2) is in the north.

Most occupied patches are adjacent or very close (<8 km) to other occupied patches, indicating a high degree of connectivity. However, the straight line or Euclidean distance recorded in this analysis does not consider possible barriers between patches (e.g., major roads and forest cover) that can impact or prevent sage-grouse movement. The one unoccupied patch in the north is relatively close to an occupied patch and adjacent to occupied area. The largest distances (≥11 km) between habitat patches are in the southern one-third of the mid-scale area, where several distinct and disjointed patches occur. Wisdom et al. (2011) noted habitat fragmentation in the Western Great Basin population area increases to the south and west.

Suitability of the habitat between patches for movement of sage-grouse was based on the land cover types found in the linkage areas. About one-third of the matrix between patches is unsuitable for sage-grouse movement, due primarily to conifer cover and human development. Pinyon-juniper cover generally increases with elevation and on north and east facing slopes. The smallest habitat patches are largely surrounded by marginal and unsuitable habitat. Given the large size of occupied habitat patches and the minimal median distance between patches (6.4 km), the amount of unsuitable linkage areas is a minor concern.

The amount of positive (sagebrush and associated vegetation classes) and negative (all other classes) edge within 5 km (3.1 miles) of patches was about equal (38%). About 24 percent of edge effects within the mid-scale analysis area were neutral. Negative edge was primarily along habitat patches in Nevada south and east of the large occupied habitat patch in this area. Topographic and vegetation (conifers) features serve as a limiting edge to sage-grouse habitat. Invasive weeds, fire, and juniper encroachment are the greatest threats to the Western Great Basin population (USFWS 2013). The Rush Fire in 2012 burned a total of 1,280 km^2 (315,557 acres) of sagebrush in California and Nevada, including most of the largest leks and important nesting habitats in the area. Prior to the Rush Fire, the population was considered well-connected (USFWS 2013).

Roads and transmission lines across the occupied habitat patches result in a moderate density (0.41 km/km^2) of linear feature disturbance (Figure 4). The majority (97%) of this disturbance is from surface streets including roads with minor use, as well as some roads on the Sheldon-Hart National Wildlife Complex that are closed seasonally to protect sensitive resources, such as active leks. Knick et al (2013) reported density of secondary roads within 5 km of active leks (n=3,184) in Western states averaged 0.67 km/km^2. A major power transmission line (>700 kV) runs from north to south through the approximate center of the mid-scale analysis area. Lower voltage lines are found in the habitat patches at the south and north ends of the area. There are 21-point features (e.g., windmills, communication towers, and other vertical structures), one mine and one geothermal development inside the habitat patches.

The BLM's interdisciplinary team reviewed the mid-scale indicator values and determined the analysis area was suitable, because landscapes have connected mosaics of sagebrush shrublands that allow for bird dispersal and movements between seasonal use areas. Anthropogenic disturbances that can disrupt dispersal and cause mortality are generally not widespread within the largest mosaics of sagebrush shrublands.

3.2 Fine-Scale (Third Order)

There are 7,444 km^2 (1.8 million acres) within the fine-scale habitat analysis area. Approximately 90 percent of the breeding habitat is occupied and 9 percent is potentially occupied; 90 percent of the summer habitat is occupied and 10 percent is potential; and 89 percent of the winter habitat is occupied and 10 percent is potential (Figures 5-7). Additionally, 94 percent of the occupied breeding habitat (4,212 km^2), 92 percent of occupied upland summer/late brood-rearing habitat (3,568 km^2), and 94 percent of occupied winter habitat (4,046 km^2) is in suitable sagebrush communities listed in Appendix B, Table 1. As the vast majority (>90%) of all seasonal habitat is occupied and suitable sagebrush plant communities, seasonal habitat availability does not appear to be limited.

The seasonal use areas overlap more than 70 percent and allow for unrestricted movement among habitats; therefore, seasonal use area connectivity was considered suitable. Sage-grouse telemetry studies in the fine-scale analysis area indicate sage-grouse on Beatys Butte allotment are migratory from lek and nesting areas to summer grounds and move considerable distances (>14 km) to winter habitats (Crawford and Carver 2000). Seasonal habitat mapping was based in part on telemetry data from these studies.

The density of linear features (i.e., transmission lines, highways, major roads, and railroads) across the fine-scale assessment area is 0.34 km/km^2 . There is one point feature or site (i.e., communication sites, mineral sites, wind turbines, meteorological towers, geothermal sites, landfills, and gravel pits) in the fine-scale area. These densities indicate an overall low occurrence of anthropogenic features across the assessment area.

The BLM team reviewed these metrics and agreed that the data indicate that the fine-scale habitat is suitable, because the home range has connected seasonal use areas, and anthropogenic features that can disrupt seasonal movements or cause mortality are generally absent or not widespread.

3.3 Site-Scale (Fourth Order)

Site-scale habitat suitability assessments are summarized as a proportion of surveyed plots within the seasonal habitat range for lek habitat and riparian summer/late brood-rearing habitat. For breeding habitat, upland summer/late brood-rearing habitat, and winter habitat, suitability assessments are summarized as a proportion of the seasonal habitat area within a known area of inference, calculated using sample design weights. Site-scale results are presented below by seasonal habitat type and summarized in Table 3. The assessments are based on a total of 66 AIM plots measured in the first year (2016) of the five-year sample design.

Table 3: Summary of site-scale sage-grouse habitat suitability ratings and proportional area estimates (80% confidence interval) for seasonal habitat types in the Beatys Butte fine-scale habitat analysis area, Oregon. Proportional area estimate is based on unequal weighting of plots.

Seasonal Habitat	**Number of Leks, Plots or Sites**			**Proportional Area Estimate**		
	Suitable	**Marginal**	**Unsuitable**	**Suitable**	**Marginal**	**Unsuitable**
Breeding (Lekking)	102 leks	38 leks	8 leks	NA	NA	NA
Breeding (Nesting/Early Brood-rearing)	28 plots	5 plots	1 plot	74.1% CI [63.7, 84.5]	19.3% CI [10.3, 28.4]	6.5% CI [0, 13.2]
Upland Summer/Late Brood-rearing	6 plots	1 plots	0 plots	88.1% CI [75.5, 100]	11.9% CI [0, 24.5]	0%
Riparian Summer/Late Brood-rearing	14 sites	3 sites	1 site	NA	NA	NA
Winter	43 plots	2 plots	0 plots	93.9% CI [89.3, 98.5]	6.1% CI [1.5, 10.7]	0%

3.3.1 Lek Security

A total of 229 leks are located within the Beatys Butte fine-scale habitat analysis area. For this analysis, 148 leks in the Oregon portion were assessed using the lek security indicators listed in Appendix A. In 2017, the ODFW classified 23 of the leks as occupied and 112 as pending; the other 13 leks were classified as unoccupied (ODFW 2017 [shapefile]). The BLM determined 69 percent of the leks in

Oregon were suitable, 26 percent were marginal, and 5 percent were unsuitable (Table 3). A large proportion (87%) of the occupied leks were suitable. No occupied leks were rated unsuitable. An occupied lek is a regularly visited lek that has had ≥1 male counted in one or more of the last seven years. A pending lek has not been counted regularly in the last seven years and includes both occupied pending and unoccupied pending, therefore sage-grouse may or may not have been present at the last visit (L. Foster, personal communication, January 04, 2018).

Sagebrush cover within 100 meters of leks was generally suitable. The primary factor resulting in a marginal or unsuitable habitat rating was conifer encroachment. The majority of leks negatively impacted by juniper were located in the west-central part of the fine-scale area. Proximity to detrimental land uses or anthropogenic features such as roads, fences, and wind/communication towers also influenced suitability. In most cases, however, proximity to roads or fences only reduced suitability to marginal rating due to mitigating effects of topography, flight diverters on fences, and minimal traffic volume or seasonal road closures.

3.3.2 Nesting and Early Brood-Rearing Habitat

In the area of inference for breeding season habitat suitability ratings (Figure 8), 74.1 percent was suitable, 19.3 percent was marginal, and 6.5 percent was unsuitable (Table 3). Site-scale indicators suggest the primary factor resulting in a marginal or unsuitable habitat rating was the lack of grasses and forbs. The areas lacking perennial grass and/or forb cover are typically found in areas of limited site potential. Therefore, site improvement for sage-grouse may be constrained by ecological site potential. To some degree the proximity of western juniper (*Juniperus occidentalis*) to the plot may impact breeding habitat suitability, but proximity of trees is not a breeding season habitat indicator in Appendix A and, therefore, was not considered in the suitability rating.

3.3.3 Upland Summer and Late Brood-Rearing Habitat

In the area of inference for upland summer and late brood-rearing habitat suitability ratings (Figure 9), approximately 88.1 percent was suitable and 11.9 percent was marginal. Site-scale indicators sampled at six of seven plots showed the seasonal habitat to be suitable and to be providing sage-grouse with required vegetation characteristics. Sample size was low in comparison to the other seasonal habitats sampled. Additional sample plots would increase confidence in the estimate.

3.3.4 Riparian Summer and Late Brood-Rearing Habitat

Lentic sites were assessed at 18 locations within the Beatys Butte fine-scale analysis area (Figure 10). The majority of sites (78%, n=14; Table 3), including the two largest (Jack Lake and Long Lake) were suitable; thus, overall riparian brood-rearing habitat also was suitable.

All sites assessed were in PFC, indicating riparian stability was suitable (Table 4); overall suitability of the sites closely reflected that rating. Proper Functioning Condition is a stronger indicator of long-term lentic system health and stability than the presence of sage-grouse preferred forbs. Several of the preferred forbs that tend to be found in lentic sites are early successional facultative riparian species that are tolerant of disturbance and may be more common in degraded sites. Preferred forb availability is likely to be a more important factor in assessing upland brood-rearing habitat suitability.

Preferred forb availability and diversity at the site was the primary factor influencing the overall suitability rating of marginal and unsuitable riparian summer and late brood-rearing habitat (Table 4).

Although juniper presence is not an indicator of riparian summer habitat suitability in Appendix A, juniper likely influences use of late summer brood-rearing areas by sage-grouse or their survival rates during that time period. Sage-grouse exhibit high avoidance of areas with greater than 10% canopy cover and areas with scattered juniper pose the greatest predation risk (Coates et al. 2017). Lower survival rates in an area that would otherwise support the species may indicate marginal habitat quality. One of 14 suitable sites may have an increased risk of predation compared to the other suitable sites because juniper surrounded about one-third of the waterbody. Moreover, the one unsuitable site and one of 3 marginal sites were surrounded by juniper in an advanced stage of succession, much of it on steep slopes. These sites may never be suitable due to the surrounding habitat.

Finally, it would be prudent to examine sage-grouse riparian brood-rearing habitat indicators within a much greater number of lentic sites, in addition to lotic sites in the Beatys Butte fine-scale assessment area, to better characterize the overall condition of this important habitat. We acknowledge that the sample size is low and concentrated in one portion of the Beatys Butte assessment area (Figure 10), which reduces confidence in the results.

Table 4: Suitability proportions of individual riparian summer / late brood-rearing indicators.

Habitat Type and Indicator	# of Lentic Sites within Fine-Scale	Percent Suitable (No. sites)	Percent Marginal (No. sites)	Percent Unsuitable (No. sites)	Primary Positive Indicator(s)	Primary Negative Indicator(s)
Riparian Summer / Late Brood-Rearing	18	78 (14)	17 (3)	5 (1)	Riparian Stability	Preferred Forb Availability
Riparian Stability (PFC)	17	100 (17)	0	0	N/A	N/A
Preferred Forb Availability	18	33 (6)	28 (5)	39 (7)	N/A	N/A
Herbaceous Cover	18	78 (14)	22 (4)	0	N/A	N/A

3.3.5 Winter Habitat

Approximately 94 percent of the winter season habitat in the area of inference was suitable, and 6 percent was marginal (Figure 11). Site-scale indicators of winter habitat sampled at 43 of 45 plots suggested seasonal habitat was within suitable ranges.

According to weather statistics for Lake County in 2016, the average number of days with 2.54 cm (one inch) or more of snow was 15. There was little reliable data available to determine snow depth. Snow depth is extremely variable; a major storm can bury the majority of the sagebrush for multiple days. Snow depth varies considerably from week to week, area to area, and year to year. More variables confounding snow depth include rain shadows, wind, and elevation. Natural Resources Conservation

Science (NRCS) Snotel sites measure snow depth, but most sites are at high elevations and do not correlate well with lower elevations or wind-blown ridges that sage-grouse typically use in winter.

High snow depth variability within the landscape, and the months and/or years, creates an inability to determine snow depth accurately at AIM sample sites. This assessment may determine that winter habitat is suitable in low snow years, but may not be in high snow years. The assessment team could not determine whether the sagebrush height indicator is as reliable as the sagebrush cover indicator. In heavy snow years, sage-grouse move to windblown areas, such as ridge tops, where low sagebrush is above snow depth.

4.0 Conclusion

4.1 Limiting Habitat Types

The Western Great Basin population is part of a stronghold for sage-grouse (that includes Management Zones III, IV, and V) because range-wide it contains one of only four remaining large intact expanses of sagebrush habitat, and connects south-central Oregon with northwest Nevada, with most of the sagebrush dominated landscape in Oregon (Knick and Hanser 2011). In the Oregon portion of the mid-scale area, greater than 80 percent of the historical sage-grouse habitat remains intact (Hagen 2011), and the highest sage-grouse densities in the state have been recorded here.

In this analysis, we found approximately 41 percent of the mid-scale area is occupied habitat, 38 percent is potential habitat, and 21 percent is non-habitat (Figure 2). There is a large amount of unoccupied habitat in the north portion of the analysis area, and habitat fragmentation increases to the south and west. As the vast majority (>90%) of all occupied seasonal habitat is suitable sagebrush plant community, habitat availability at fine-scale does not appear to be limited. At site-scale, all seasonal habitats met the desired condition values identified in the ARMPA (BLM 2015) Habitat Objectives Table (Appendix A) for the percent of seasonal habitat meeting a majority (≥70%) of the desired conditions. However, the low number of summer riparian sample sites (n=18) relative to the total size of the fine-scale area and the distribution of these sites did not provide high confidence in the estimate. Additional lentic sites should be sampled, as well as riparian brood-rearing habitat indicators within lotic sites in the Beatys Butte fine-scale habitat assessment area to better characterize the overall condition of this important habitat for sage-grouse.

There were a large number of leks (n=148) in the Oregon fine-scale area, although 13 were unoccupied and the status of 109 was pending in 2017. One-third of the leks were rated marginal or unsuitable, due primarily to conifer encroachment. Juniper encroachment is a primary threat to the Beatys PAC and, more broadly, to the Western Great Basin sage-grouse population (USFWS 2013).

Forb availability in late brood-rearing habitat is especially important to sage-grouse chicks; forbs represent a major component of the diet during summer (Pyke et al. 2015). Drut (1994) reported concentrated use by sage-grouse broods in and near lakebeds and meadows where forb availability was greater than in random sites during the late brood-rearing season. Sage-grouse home ranges are larger in Jackass Creek, north of Beatys Butte, than on Hart Mountain reflecting differences in forb availability and chick diets between areas. Crawford and Carver (2000) noted that females took their broods during summer to areas moister than generally available; forbs were available longer in these locations. In the

BLM analysis of upland summer/late brood-rearing habitat, 63 percent of the habitat contained suitable cover of perennial grass and forbs, suggesting this seasonal habitat component may be limiting in the fine-scale habitat analysis area. Again, however, sample size was low (7 plots).

4.2 Population Trends

The mid-scale habitat analysis area addressed in this Summary Report corresponds closely to, but not exactly with, the boundaries of the Western Great Basin population (USFWS 2013). During 1965 to 2007, the population estimate generally fluctuated between 3,000 and 10,000 males (Garton et al 2011). In 2013, the estimated minimum population size was 1,934 males (SE = 212), which represented a 69 percent decline from the 2007 population estimate of 6,327 males (SE = 1,345) and approximately 16 percent of average values counted in the 1970s and 1980s (Garton et al 2015).

The Oregon portion of the Western Great Basin population area includes almost all of the Lakeview BLM District. The estimated spring sage-grouse population (total males and females) in the Lakeview District in 2017 was 5,921 individuals (95% CI: 5,397 – 6,444 individuals)(ODFW 2017). While 2017 marked the first population decline in the previous three years, the 5-year average population trend was positive (0.2%) for the first time since 2006. Observed male attendance at complexes counted in both 2003 and 2017 dropped 38 percent. However, average lek complex size (males per lek) has remained stable in the Lakeview District since 1980 (ODFW 2017). Across Oregon, average males per lek has declined slightly (0.06%) each year since 1965 (WAFWA 2015).

The Oregon portion of the fine-scale analysis area primarily includes the Beatys Butte PAC. ODFW delineated Oregon 20 PACs based on Sage-Grouse Core Areas that encompass approximately 90 percent of known breeding populations of sage-grouse on 38 percent of the species' range. As such, Oregon PACs do not represent individual populations. Beatys Butte is the largest (3,403 km^2) of the 20 PACs in Oregon and has the largest number of known leks (154). The 5-year mean population estimate in 2017 was 1,078 males. The population appears to have peaked in 2006 at 2,444 individuals. Male attendance at leks has declined 23.8 percent since 2003 (ODFW 2017). Thus, population decline is less in the Beatys Butte area than in the surrounding mid-scale analysis area in Oregon.

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6.0 Literature Cited

Boyd C.S., D.D. Johnson, J.D. Kerby, T.J. Svejcar, and K.W. Davis. 2014. Of grouse and golden eggs: can ecosystems be managed within a species based regulatory framework? J Rangeland Ecol and Management 67(4):358-368.

Bureau of Land Management. 2001. Handbook 4180-1 Rangeland Health Standards. USDI Bureau of Land Management, Washington, D.C.

Bureau of Land Management. 2003. Riparian Area Management: A user guide to assessing proper functioning condition and supporting science for lentic areas. Technical Reference 1737-16. USDI Bureau of Land Management, National Business Center, Denver, Colorado.

Bureau of Land Management. 2015. Oregon greater sage-grouse approved resource management plan amendment. Oregon/Washington State Office, Portland, USA.

Coates, P.S., B.G. Prochazka, M.A. Ricca, K.B. Gustafson, P. Ziegler, and M.L. Casazza. 2017. Pinyon and juniper encroachment into sagebrush ecosystems impacts distribution and survival of Greater Sage-Grouse. Rangeland Ecology & Management 70: 25-38.

Connelly, J.W., S.T. Knick, M.A. Schroeder, and S.J. Stiver. 2004. Conservation assessment of Greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies. Unpublished report. Cheyenne, WY.

Crawford, J. A., and L. A. Carver. 2000. Habitat use by sage grouse on the Beatys Butte allotment. Oregon State University. Final Report. Corvallis, USA.

Drut M.S., J.A. Crawford, and M.A. Gregg. 1994. Brood habitat use by sage grouse in Oregon. Great Basin Naturalist 54(2): 170-176.

Garton, E.O., J.W. Connelly, J.S. Horne, C.A. Hagen, A. Moser, and M.A. Schroeder. 2011. Grear Sage-Grouse population dynamics and probability of persistence. Pp. 293-381 *in* S.T. Knick and J.W. Connelly (eds). Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology (vol. 38). University of California Press, Berkeley, CA

Garton, E.O., A.G. Wells, J.A. Baumgardt, and J.W. Connelly. 2015. Greater Sage-Grouse population dynamics and probability of persistence. Final report to Pew Charitable Trusts.

Henderson, E. 2015. Greater Sage-Grouse Seasonal Habitat Mapping in Southwest Oregon. Institute for Natural Resources, Oregon State University.

Jones, A., M. Schindel, and S. Scott. 2015. Mapping Habitat Connectivity for Grater Sage-Grouse in Oregon's Sage-Grouse Conservation Partnership (SageCon) Assessment Area. Produced by The Nature Conservancy (Portland, Oregon), in partial fulfillment of BLM Cooperative Agreement L12AC20615.

Knick, S.T. and S.E. Hanser. 2011 Connecting pattern and process in greater sage-grouse populations and sagebrush landscapes. Pp. 383-406 *in* S.T. Knick and J.W. Connelly (eds). Greater Sage-

Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology (vol. 38). University of California Press, Berkeley, CA.

MacKinnon, W.C., J.W. Karl, G.R. Toevs, J.J. Taylor, M.Karl, C.S. Spurrier, and J.E. Herrick. 2011. BLM core terrestrial indicators and methods. Tech Note 440. U.S. Department of Interior, Bureau of Land Management, National Operations Center, Denver, CO.

Mousseaux, M. 2017. List of sage grouse forbs by preference group (Rosentreter). Oregon State Office, Portland, OR.

NOAA, National Centers for Environmental Information. 2017. Weekly Palmer Drought Indices [Data Files]. Retrieved from https://www.ncdc.noaa.gov/temp-and-precip/drought/weekly-palmers/maps.

Oregon Department of Fish and Wildlife (ODFW). 2017. Oregon Greater Sage-Grouse population monitoring: 2017 annual report. Oregon Department of Fish and Wildlife, Hines, OR.

Oyarzun M., Northern California District BLM. 2017 Greater Sage-Grouse Seasonal Habitat [Shapefiles].

Pyke, D.A., J.C. Chambers, M. Pellant, S.T. Knick, R.F. Miller, J.L. Beck, P.S. Doescher, E.W. Schupp, B.A. Roundy, M. Brunson, and J.D. McIver. 2015. Restoration handbook for sagebrush steppe ecosystems with emphasis on greater sage-grouse habitat-part 1. Concepts for understanding and applying restoration. U.S. Geological Survey, Reston, Virginia, USA.

R Core Team. 2017. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. Vienna, Austria. https://www.R-project.org.

Severson, J.P., C.A. Hagen, J.D. Maestas, D.E. Naugle, J.T. Forbes, and K.P. Reese. 2016. Effects of conifer expansion on greater sage-grouse nesting habitat selection. The Journal of Wildlife Management 81: 86-95.

Stiver, S.J., E.T. Rinkes, and D.E. Naugle. 2010. Sage-grouse habitat assessment framework. U.S. Bureau of Land Management. Unpublished Report. U.S. Bureau of Land Management, Idaho State Office, Boise, Idaho.

Stiver, S.J., E.T. Rinkes, D.E. Naugle, P.D Makela, D.A. Nance, and J.W. Karl. 2015. Sage-Grouse Habitat Assessment Framework: A Multi-scale Assessment Tool. Technical Reference 6710-1. Bureau of Land Management and Western Association of Fish and Wildlife Agencies, Denver, CO.

Taylor, J.J., E.J. Kachergis, G.R. Toevs, J.W. Karl, M.R. Bobo, M. Karl, S. Miller, and C.S. Spurrier. 2014. AIM-Monitoring: A Component of the BLM Assessment, Inventory, and Monitoring Strategy. Technical Note 445. U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO.

U.S. Department of Interior (DOI). 2001. Rangeland Health Standards. Handbook H-4180-1. Bureau of Land Management, Washington, D.C.

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

Western Association of Fish and Wildlife Agencies (WAFWA). 2015. Greater sage-grouse population trends: an analysis of lek count databases 1965-2015. Western Association of Fish and Wildlife Agencies, Cheyenne, WY

Wisdom M.J., C.W. Meinke, S.T. Knick and M.A. Schroeder. 2011. Factors associated with extirpation of sage-grouse. Pp. 451-474 *in* S.T. Knick and J.W. Connelly (eds). Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology (vol. 38). University of California Press, Berkeley, CA.

Xian, G., Homer, C. Rigge, M., Shi, H., and D. Meyer. 2015. Characterization of shrubland ecosystem components as continuous fields in the northwest United States, Remote Sensing of Environment, v. 168, p. 286-300.

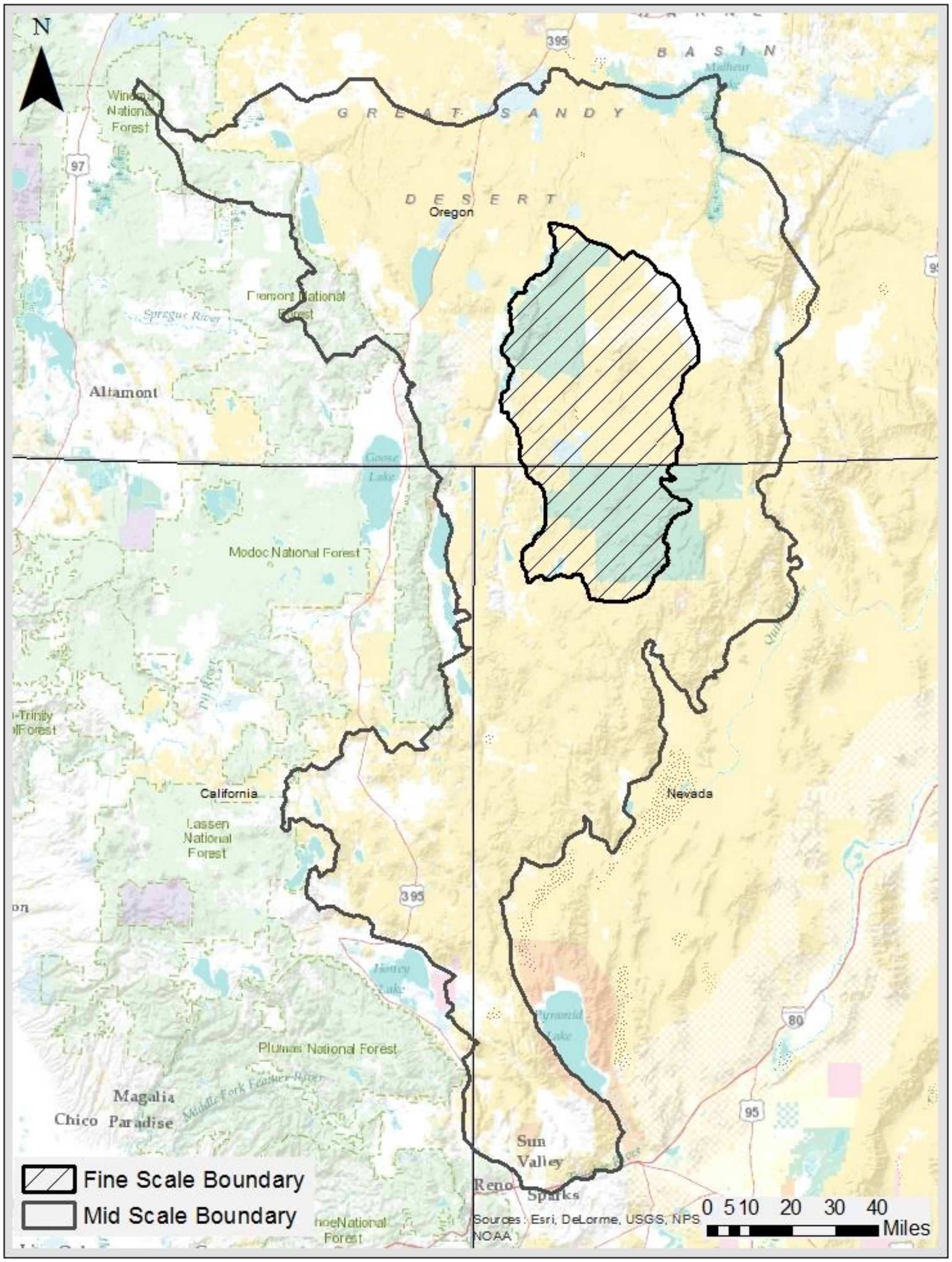

Figure 1. Greater sage-grouse mid- and fine-scale analysis areas with the location of the allotment indicated. The Sheldon-Hart National Wildlife Refuge complex comprises over 35% of the fine-scale area.

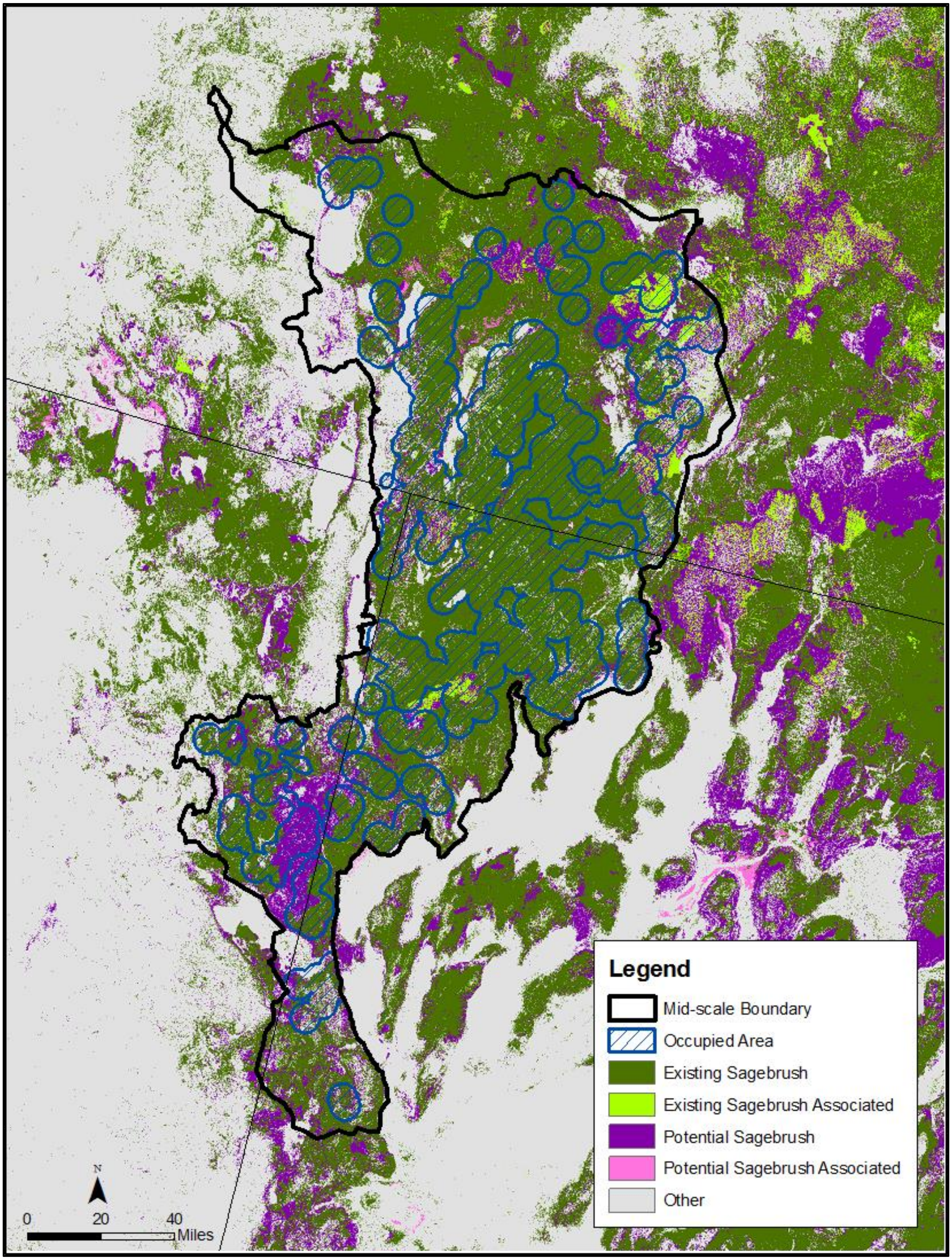

Figure 2. Mid-scale habitat availability.

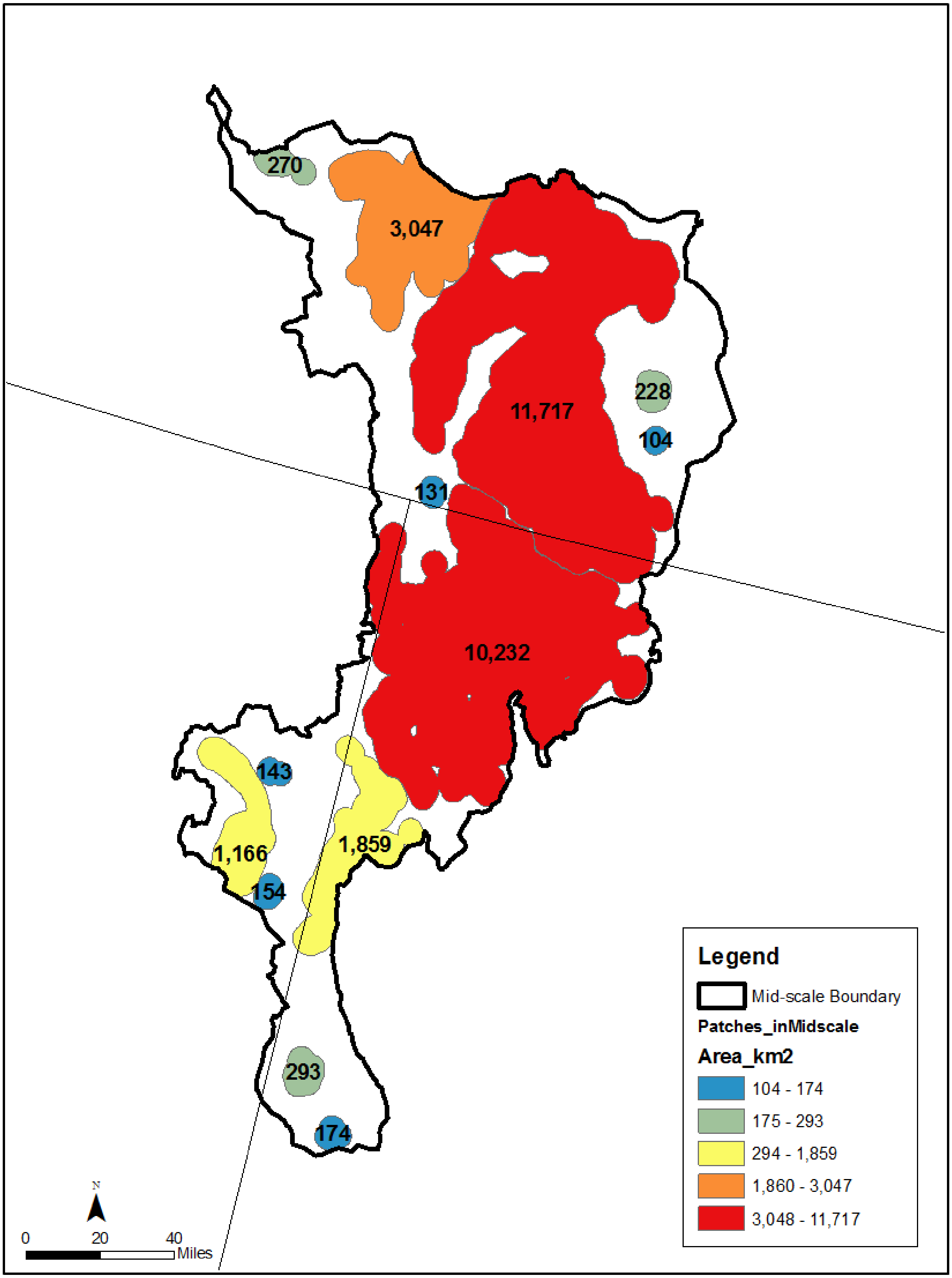

Figure 3. Map of occupied habitat patches within the mid-scale.

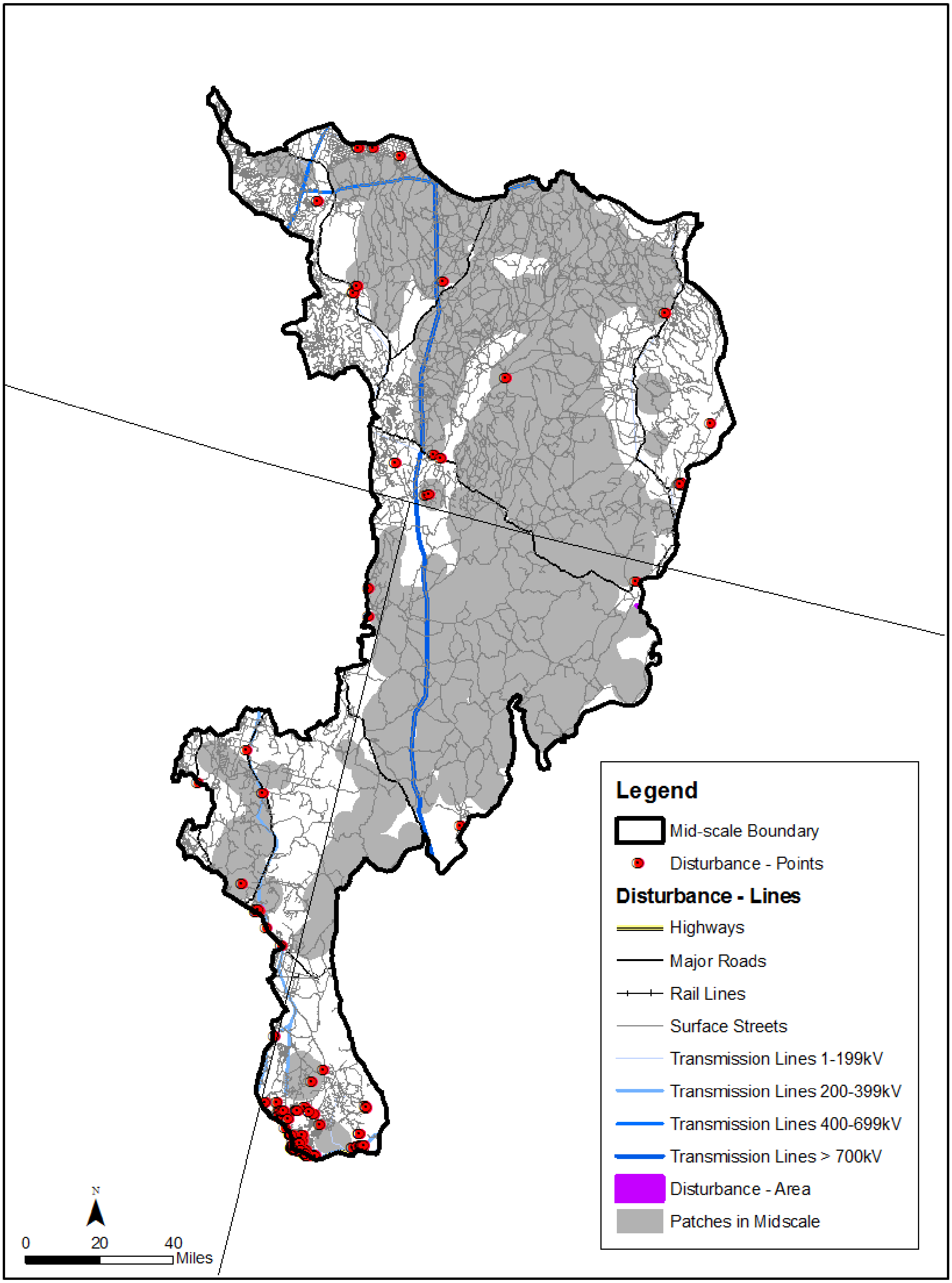

Figure 4. Mid-scale anthropogenic disturbances.

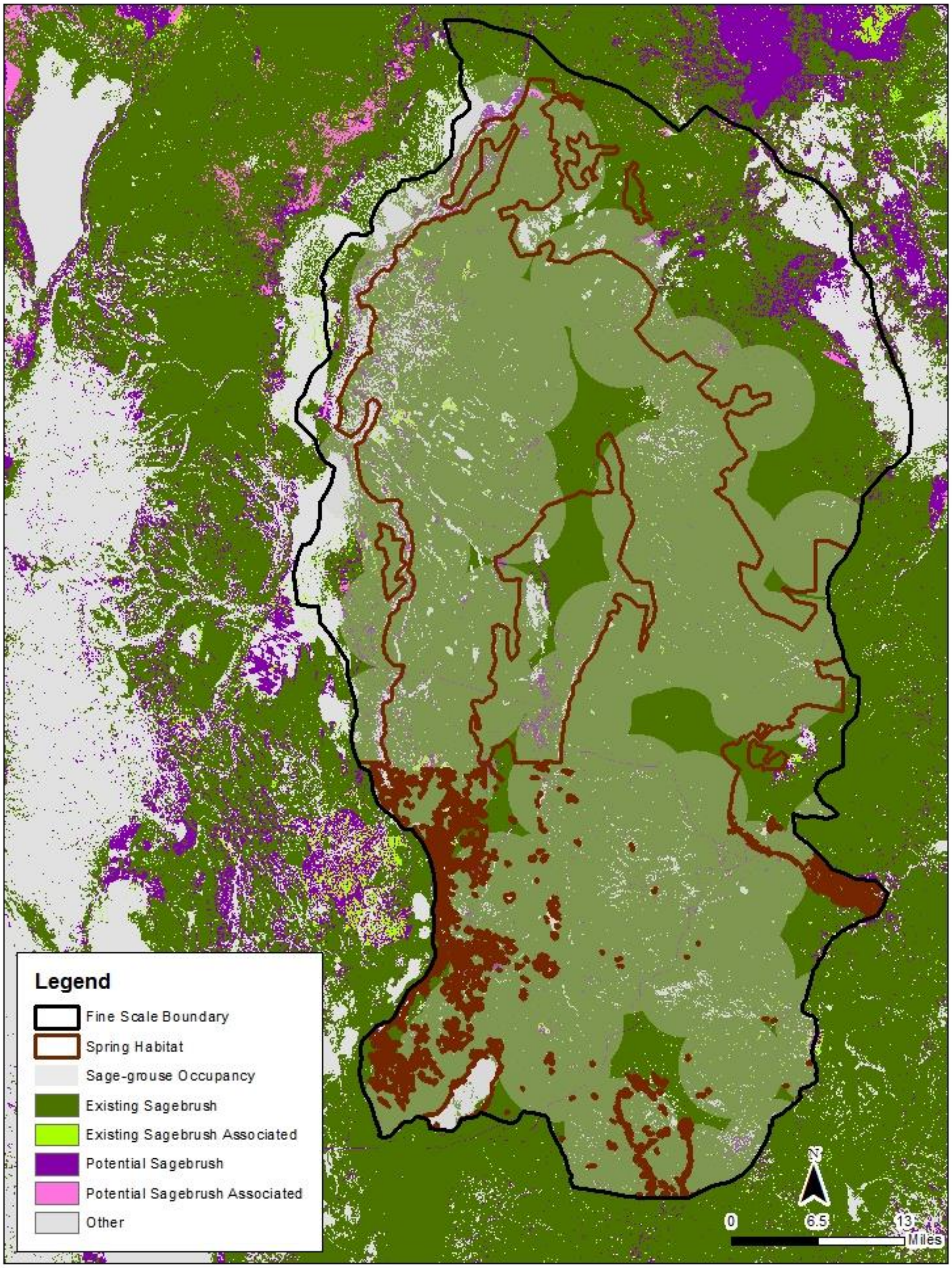

Figure 5. Breeding season habitat availability in the Beatys Butte fine-scale analysis area.

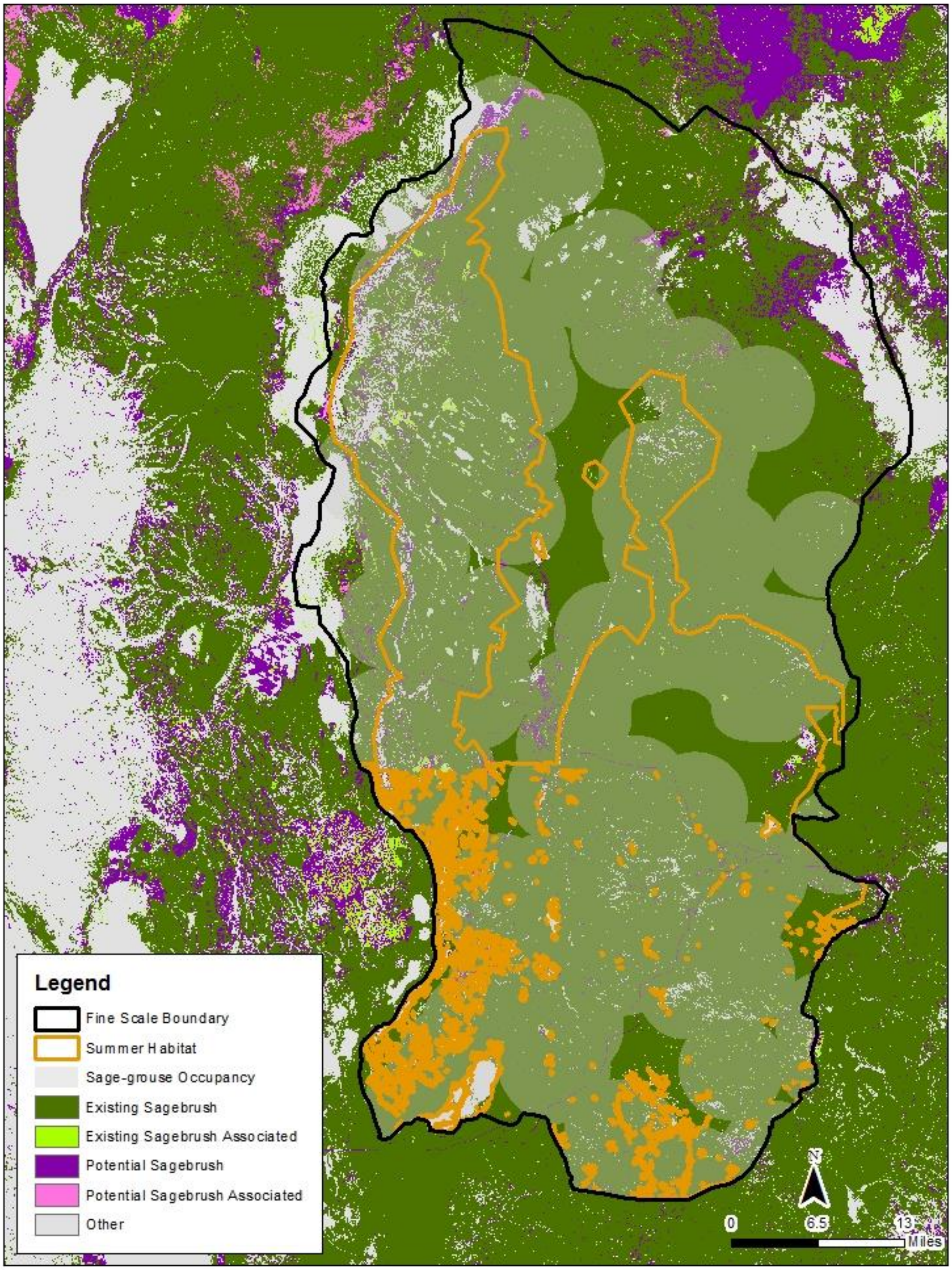

Figure 6. Upland summer/late brood-rearing season habitat availability in the Beatys Butte fine-scale analysis area.

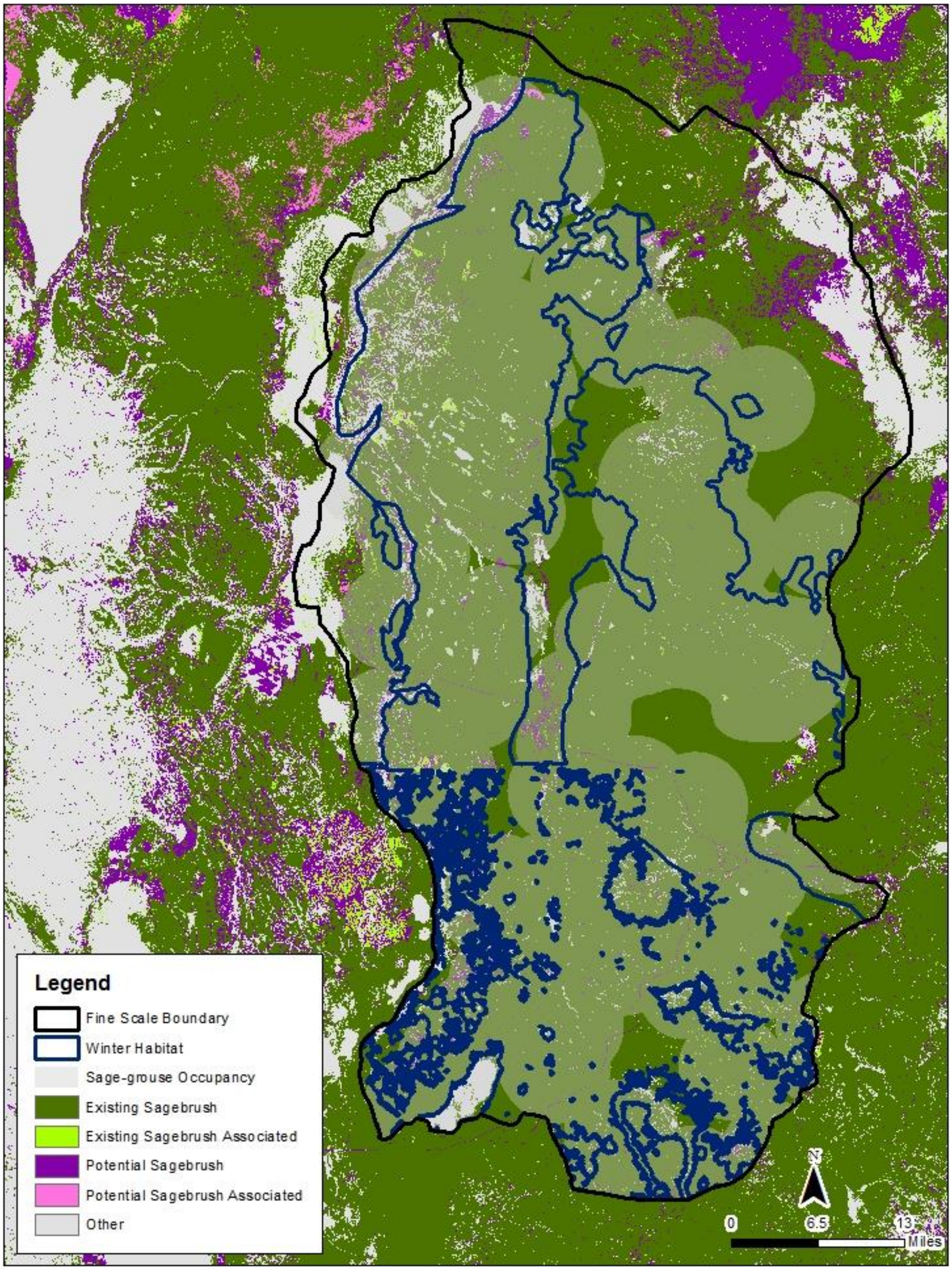

Figure 7. Winter season habitat availability in the Beatys Butte fine-scale assessment area.

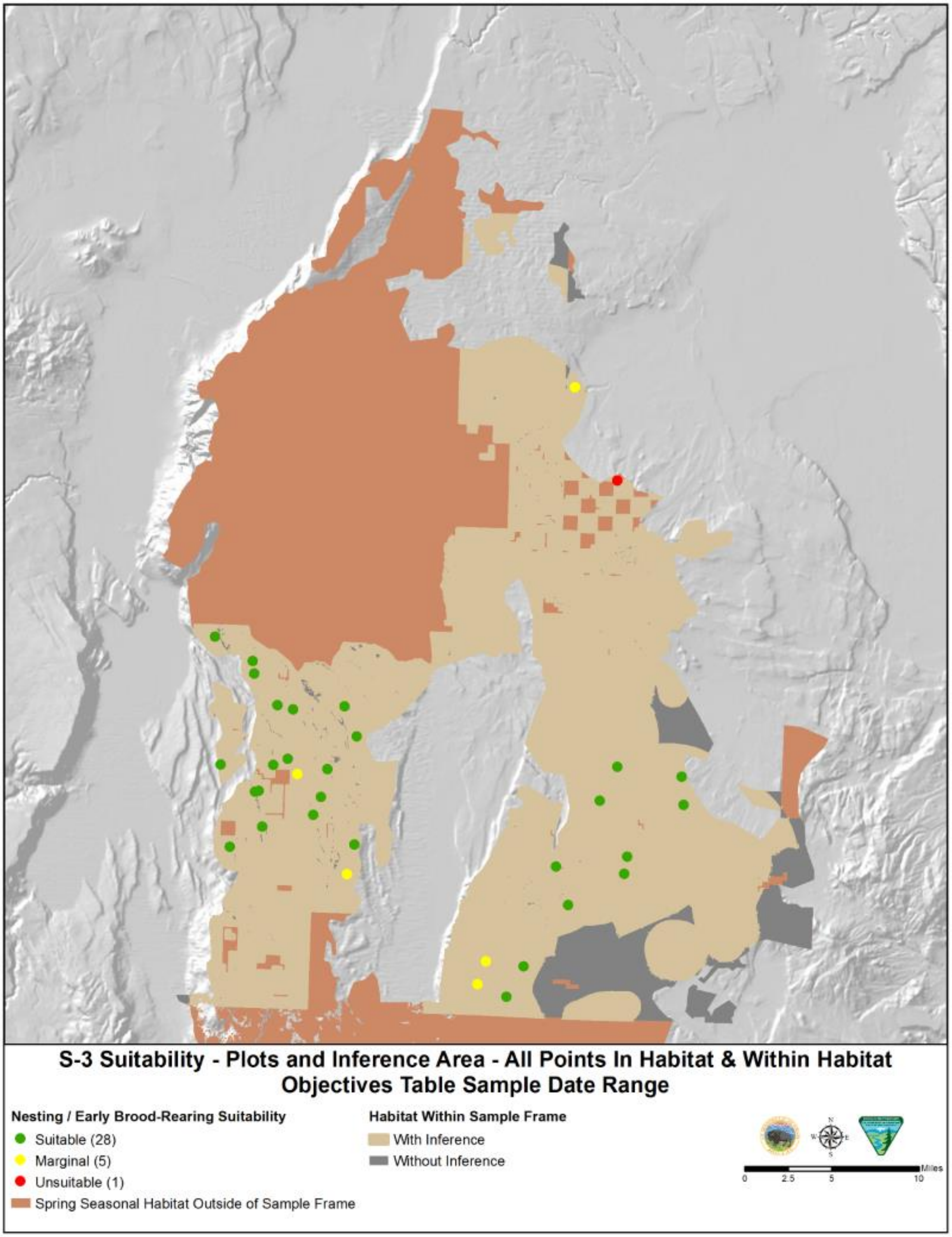

Figure 8. Site-scale suitability ratings and area of inference (66.7%) for breeding season habitat in the Beatys Butte fine-scale assessment area.

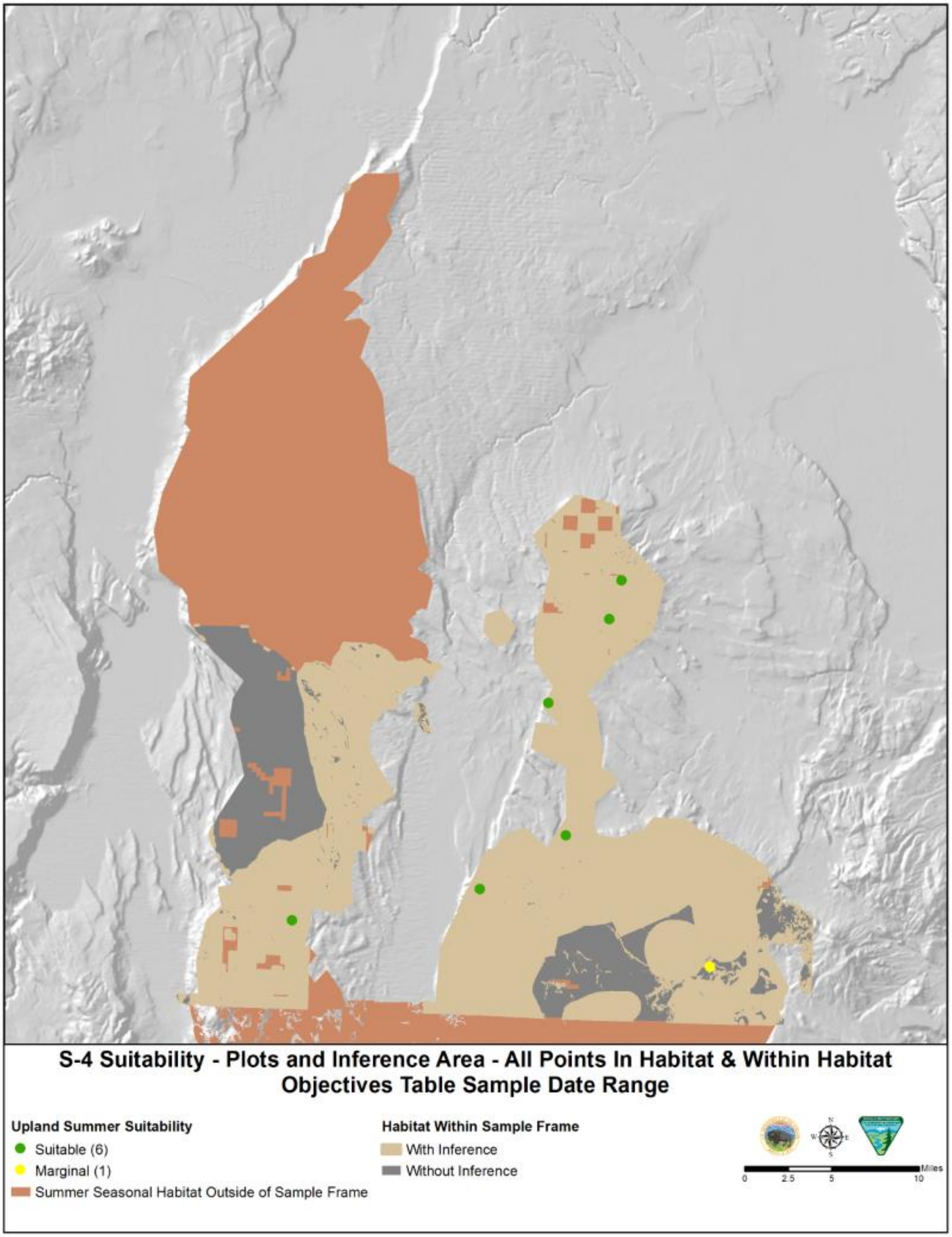

Figure 9. Site-scale suitability ratings and area of inference (42.2%) for upland summer/late brood-rearing season habitat in the Beatys Butte fine-scale assessment area.

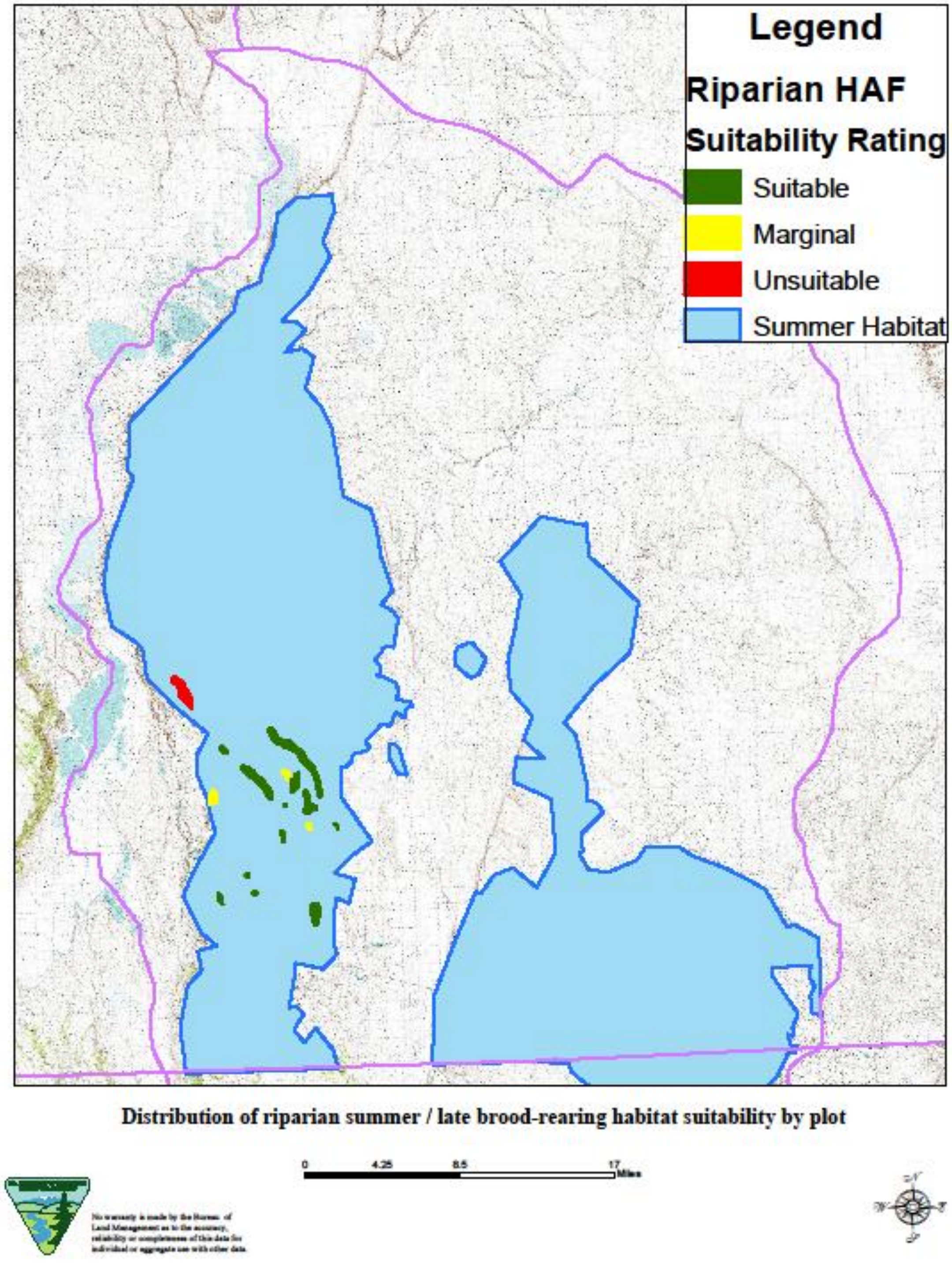

Figure 10. Distribution of areas assessed for riparian/late brood-rearing season habitat suitability in the Beatys Butte fine-scale assessment area.

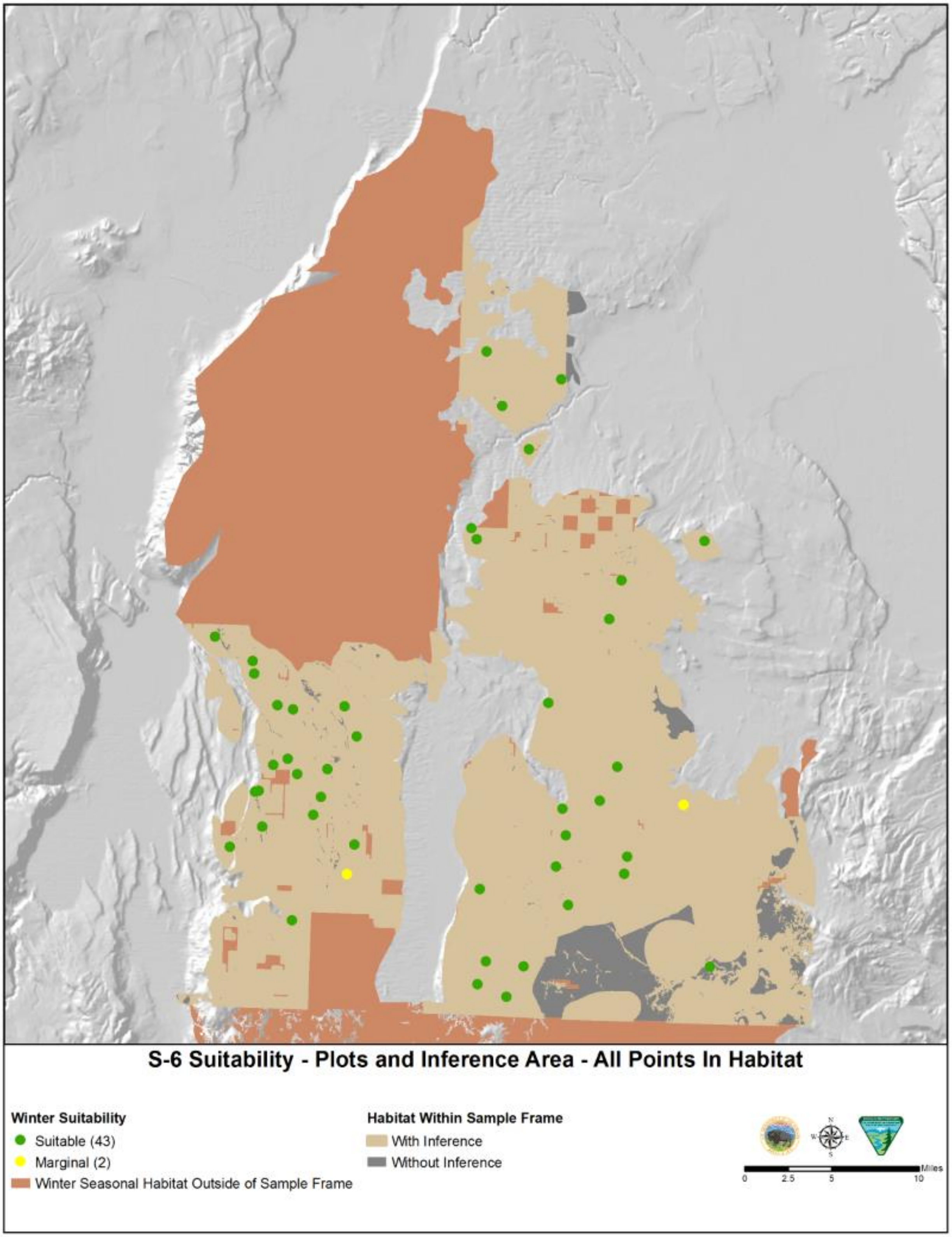

Figure 11. Site-scale suitability ratings and area of inference (77.3%) for winter season habitat in the Beatys Butte fine-scale assessment area.

7.0 Appendices

Appendix A. ARMPA (BLM 2015) Habitat Objectives Table 2-2

Table 2-2
Habitat Objectives for Greater Sage-grouse

Attribute	Indicators	Desired Condition (Habitat Objectives)	Reference
Breeding Including Lekking, Pre-nesting, Nesting, and Early Brood Rearing (Seasonal Use Period March 1 – June 30			
Lek Security	Proximity of trees or other tall structures	No conifers or tall structures within 1.0 mile of lek center, and confer cover less than 5% within 4.0 miles of lek, excluding old trees, culturally significant, actively used by special status species, and old growth juniper stands.	Connelly et al. 2000; Fresse 2009; Baruch-Mordo et al. 2013; Knick et al. 2013
	Proximity of sagebrush to leks	Lek has adjacent sagebrush cover	Connelly et al. 2000
Cover	Sagebrush cover (%)	10 to 25	Doescher et al. 1986; Gregg et al. 1994; Hanf et al. 1994; Coggins 1998; Crawford and Carver 2000; Bates and Davies 2014; BLM 2015a
	Sagebrush height (inches) Arid sites (warm-dry) Mesic sites (cool-moist)	 11 to 31 15 to 31	Gregg et al. 1994; Hanf et al. 1994; Coggins 1998; Crawford and Carver 2000; Freese 2009.
	Predominant sagebrush shape	Spreading	Connelly et al. 2000
	Perennial grass cover (such as bunchgrass) (%) Arid sagebrush Warm-dry Shallow-dry Mesic sagebrush Cool-moist Warm-moist	 10 to 30 10 to 25 20 to 45 20 to 50	Gregg at al. 1994; Coggins 1998; Crawford and Carver 2000; Freese 2009; NRCS 2015; Bates and Davies 2014; Jon Bates, USDA ARS, pers.comm. 2/10/2015; BLM 2015a; BLM 2015b
	Perennial grass and forb height (inches, including residual grasses) – most important and appropriately measured in nest areas; excludes shallow-dry sites[1] Arid sites (warm-dry) Mesic sites (cool-moist)	 ≥ 7 ≥ 9	Gregg et al. 1994; Hanf et al. 1994; Crawford and Carver 2000; Hagen et al. 2007; Jon Bates, USDA ARS, pers.comm. 2/10/2015

Table 2-2
Habitat Objectives for Greater Sage-grouse

Attribute	Indicators	Desired Condition (Habitat Objectives)	Reference
	Perennial forb cover (%)[2] Arid sagebrush Warm-dry Shallow-dry Mesic sagebrush Cool-moist Warm-moist	 2 to 10 2 to 10 6 to 12 5 to 15	Drut 1992; Drut et al. 1994; Crawford and Carver 2000; Freese 2009; NRCS 2015; Bates and Davies 2014; BLM 2015a; Jon Bates, USDA ARS, pers.comm. 2/10/2015; BLM 2015b
Food	Preferred forb diversity and availability	Preferred forbs are common with 5 to 10 species present[2]	Hanf et al. 1994; Crawford and Carver 2000; Freese 2009; Bates and Davies 2014; BLM 2015a; Jon Bates, USDA ARS, pers.comm. 2/10/2015
Available Suitable Habitat (Landscape Context)	% of seasonal habitat within 4.0 miles of leks meeting a majority of the desired conditions Arid sagebrush Mesic sagebrush	 70 (55-85) 75 (60-90)	Connelly et al. 2000; Karl and Sadowski 2005; Evers 2010; Hagen 2011; NRCS 2015
Brood-rearing/Summer Including Late-brood Rearing, Summering, and Early Autumn (Seasonal Use Period July 1- October 31)			
Cover	Sagebrush cover (%)	10 to 25	Doescher et al. 1986; Drut et al. 1994; Connelly et al. 2000; Crawford and Carver 2000; Bates and Davies 2014; Jon Bates, USDA ARS, pers.comm. 2/10/2015
	Sagebrush height (inches)	15 to 31	Gregg et al. 1994; Hanf et al. 1994; Crawford and Carver 2000; Freese 2009
	Perennial herbaceous (grass and forbs) cover (%) Arid sagebrush Warm-dry Shallow-dry Mesic sagebrush Cool-moist Warm-moist Riparian[3]	 15 to 30 10 to 25 20 to 45 30 to 55 ≥ 50	Drut et al. 1994; Bates and Davies 2014; NRCS 2015; BLM 2015b; Jon Bates, USDA ARS, pers.comm. 2/10/2015
	Riparian areas/mesic meadows	Majority of areas are in PFC	Stiver et al. 2010, or as updated
Food	Upland and riparian perennial forb availability	Preferred forbs are common with 5 to 10 species present[4]	Hanf et al. 1994; Freese 2009; Bates and Davies 2014; BLM 2015b; Jon Bates, USDA ARS, pers.comm. 2/10/2015

Table 2-2
Habitat Objectives for Greater Sage-grouse

Attribute	Indicators	Desired Condition (Habitat Objectives)	Reference
Available Suitable Habitat (Landscape Context)	% of seasonal habitat within 4.0 miles of leks meeting a majority of the desired conditions Arid sagebrush Mesic sagebrush	 70 (55-85) 75 (60-90)	Connelly et al. 2000; Karl and Sadowski 2005; Evers 2010; Hagen 2011; NRCS 2015
Winter Including Late Autumn and Winter (Seasonal Use Period November 1 – February 28)			
Cover and Food	Sagebrush cover above snow (%)	≥ 10	Willis 1990 (in Hagen 2011); Bruce 2011
	Sagebrush height above snow (inches)	≥10	Willis 1990 (in Hagen 2011); Bruce 2011
Available Suitable Habitat (Landscape Context)	% of wintering habitat meeting a majority of the desired conditions Arid sagebrush Mesic sagebrush	 70 (55-85) 85 (68-100)	Connelly et al. 2000; Karl and Sadowski 2005; Evers 2010; NRCS 2015

[1]Perennial grass and forb minimum height may not be achievable in years with below normal precipitation. Other indicators of desired condition may still render the site suitable, however.
[2] In very dry years, forb cover and availability may not be at the desired condition, and in certain plant associations such as Wyoming big sagebrush/Needle and Thread, these indicators may rarely be achieved even in years with normal precipitation.
[3] Riparian includes swales, wet meadows, and intermittent/ephemeral streams.
[4]Sage-grouse preferred forbs are listed in Appendix I.

Appendix B. LANDFIRE Reclassifications for existing and potential Greater Sage-Grouse

Table B- 1. LANDFIRE 1.4.0 Existing Vegetation (EVT) classes used to reclassify the landscape for the mid-scale metrics for Edge Effect. This reclassification represents vegetation classes that are suitable, marginal, and unsuitable for movement by sage-grouse. Unsuitable vegetation classes are numerous and not included. Classes in green are suitable for movement by sage-grouse, and classes in yellow are marginal (Walz 2017). Table headings are from the LANDFIRE 1.4.0 EVT dataset.

EVT Code	EVT Class Name	Edge Class	Linkage Class	Dominat Species Group (EVT_GP_N)
3065	Columbia Plateau Scabland Shrubland	Positive	Suitable	Desert Scrub
3079	Great Basin Xeric Mixed Sagebrush Shrubland	Positive	Suitable	Low Sagebrush Shrubland and Steppe
3080	Inter-Mountain Basins Big Sagebrush Shrubland	Positive	Suitable	Big Sagebrush Shrubland and Steppe
3123	Columbia Plateau Steppe and Grassland	Positive	Suitable	Grassland and Steppe
3124	Columbia Plateau Low Sagebrush Steppe	Positive	Suitable	Low Sagebrush Shrubland and Steppe
3125	Inter-Mountain Basins Big Sagebrush Steppe	Positive	Suitable	Big Sagebrush Shrubland and Steppe
3126	Inter-Mountain Basins Montane Sagebrush Steppe	Positive	Suitable	Big Sagebrush Shrubland and Steppe
3127	Inter-Mountain Basins Semi-Desert Shrub-Steppe	Positive	Suitable	Desert Scrub
3220	Artemisia tridentata ssp. vaseyana Shrubland Alliance	Positive	Suitable	Big Sagebrush Shrubland and Steppe
3081	Inter-Mountain Basins Mixed Salt Desert Scrub	Neutral	Suitable	Salt Desert Scrub
3082	Mojave Mid-Elevation Mixed Desert Scrub	Neutral	Suitable	Desert Scrub
3084	North Pacific Montane Shrubland	Neutral	Suitable	Deciduous Shrubland
3086	Rocky Mountain Lower Montane-Foothill Shrubland	Neutral	Suitable	Deciduous Shrubland
3088	Sonora-Mojave Mixed Salt Desert Scrub	Neutral	Suitable	Salt Desert Scrub
3106	Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	Neutral	Suitable	Deciduous Shrubland
3153	Inter-Mountain Basins Greasewood Flat	Neutral	Suitable	Greasewood Shrubland
3210	Coleogyne ramosissima Shrubland Alliance	Neutral	Suitable	Blackbrush Shrubland
3211	Grayia spinosa Shrubland Alliance	Neutral	Suitable	Desert Scrub
3001	Inter-Mountain Basins Sparsely Vegetated Systems	Neutral	Marginal	Sparse Vegetation
3002	Mediterranean California Sparsely Vegetated Systems	Neutral	Marginal	Sparse Vegetation

EVT Code	EVT Class Name	Edge Class	Linkage Class	Dominat Species Group (EVT_GP_N)
3003	North Pacific Sparsely Vegetated Systems	Neutral	Marginal	Sparse Vegetation
3004	North American Warm Desert Sparsely Vegetated Systems	Neutral	Marginal	Sparse Vegetation
3006	Rocky Mountain Alpine/Montane Sparsely Vegetated Systems	Neutral	Marginal	Sparse Vegetation
3067	Mediterranean California Alpine Fell-Field	Neutral	Marginal	Alpine Dwarf-Shrubland, Fell-field and Meadow
3068	North Pacific Dry and Mesic Alpine Dwarf-Shrubland or Fell-field or Meadow	Neutral	Marginal	Alpine Dwarf-Shrubland, Fell-field and Meadow
3071	Sierra Nevada Alpine Dwarf-Shrubland	Neutral	Marginal	Alpine Dwarf-Shrubland, Fell-field and Meadow
3083	North Pacific Avalanche Chute Shrubland	Neutral	Marginal	Deciduous Shrubland
3097	California Mesic Chaparral	Neutral	Marginal	Chaparral
3098	California Montane Woodland and Chaparral	Neutral	Marginal	Chaparral
3099	California Xeric Serpentine Chaparral	Neutral	Marginal	Chaparral
3103	Great Basin Semi-Desert Chaparral	Neutral	Marginal	Chaparral
3105	Northern and Central California Dry-Mesic Chaparral	Neutral	Marginal	Chaparral
3108	Sonora-Mojave Semi-Desert Chaparral	Neutral	Marginal	Chaparral
3135	Inter-Mountain Basins Semi-Desert Grassland	Neutral	Marginal	Grassland
3136	Mediterranean California Alpine Dry Tundra	Neutral	Marginal	Dry Tundra
3137	Mediterranean California Subalpine Meadow	Neutral	Marginal	Alpine Dwarf-Shrubland, Fell-field and Meadow
3138	North Pacific Montane Grassland	Neutral	Marginal	Grassland
3139	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Neutral	Marginal	Grassland
3140	Northern Rocky Mountain Subalpine-Upper Montane Grassland	Neutral	Marginal	Grassland
3142	Columbia Basin Palouse Prairie	Neutral	Marginal	Grassland
3145	Rocky Mountain Subalpine-Montane Mesic Meadow	Neutral	Marginal	Alpine Dwarf-Shrubland, Fell-field and Meadow
3164	Rocky Mountain Wetland-Herbaceous	Neutral	Marginal	Western Herbaceous Wetland
3169	Northern Rocky Mountain Subalpine Deciduous Shrubland	Neutral	Marginal	Deciduous Shrubland

EVT Code	EVT Class Name	Edge Class	Linkage Class	Dominat Species Group (EVT_GP_N)
3171	North Pacific Alpine and Subalpine Dry Grassland	Neutral	Marginal	Grassland
3219	Inter-Mountain Basins Sparsely Vegetated Systems II	Neutral	Marginal	Sparse Vegetation
3221	Mediterranean California Sparsely Vegetated Systems II	Neutral	Marginal	Sparse Vegetation
3222	Rocky Mountain Alpine/Montane Sparsely Vegetated Systems II	Neutral	Marginal	Sparse Vegetation
3293	Snow-Ice	Neutral	Marginal	Snow-Ice
3294	Barren	Neutral	Marginal	Barren
3181	Introduced Upland Vegetation-Annual Grassland	Negative	Marginal	Introduced Annual Grassland
3182	Introduced Upland Vegetation-Perennial Grassland and Forbland	Negative	Marginal	Introduced Perennial Grassland and Forbland
3183	Introduced Upland Vegetation-Annual and Biennial Forbland	Negative	Marginal	Introduced Annual and Biennial Forbland
3184	California Annual Grassland	Negative	Marginal	Introduced Annual Grassland
3960	Western Cool Temperate Orchard	Negative	Marginal	Agricultural-Orchard
3961	Western Cool Temperate Vineyard	Negative	Marginal	Agricultural-Vineyard
3963	Western Cool Temperate Row Crop - Close Grown Crop	Negative	Marginal	Agricultural-Row Crop-Close Grown Crop
3964	Western Cool Temperate Row Crop	Negative	Marginal	Agricultural-Row Crop
3965	Western Cool Temperate Close Grown Crop	Negative	Marginal	Agricultural-Close Grown Crop
3966	Western Cool Temperate Fallow/Idle Cropland	Negative	Marginal	Agricultural-Fallow/Idle Cropland
3967	Western Cool Temperate Pasture and Hayland	Negative	Marginal	Agricultural-Pasture and Hayland
3968	Western Cool Temperate Wheat	Negative	Marginal	Agricultural-Wheat
3969	Western Cool Temperate Aquaculture	Negative	Marginal	Agricultual-Aquaculture
3980	Western Warm Temperate Orchard	Negative	Marginal	Agricultural-Orchard
3981	Western Warm Temperate Vineyard	Negative	Marginal	Agricultural-Vineyard
3983	Western Warm Temperate Row Crop - Close Grown Crop	Negative	Marginal	Agricultural-Row Crop-Close Grown Crop
3984	Western Warm Temperate Row Crop	Negative	Marginal	Agricultural-Row Crop
3985	Western Warm Temperate Close Grown Crop	Negative	Marginal	Agricultural-Close Grown Crop

EVT Code	EVT Class Name	Edge Class	Linkage Class	Dominat Species Group (EVT_GP_N)
3986	Western Warm Temperate Fallow/Idle Cropland	Negative	Marginal	Agricultural-Fallow/Idle Cropland
3987	Western Warm Temperate Pasture and Hayland	Negative	Marginal	Agricultural-Pasture and Hayland
3988	Western Warm Temperate Wheat	Negative	Marginal	Agricultural-Wheat
3151	California Central Valley Riparian Forest and Woodland	Neutral	Unsuitable	Western Riparian Woodland and Shrubland
3152	California Montane Riparian Systems	Neutral	Unsuitable	Western Riparian Woodland and Shrubland
3154	Inter-Mountain Basins Montane Riparian Forest and Woodland	Neutral	Unsuitable	Western Riparian Woodland and Shrubland
3156	North Pacific Lowland Riparian Forest and Shrubland	Neutral	Unsuitable	Red Alder Forest and Woodland
3157	North Pacific Swamp Systems	Neutral	Unsuitable	Western Red-cedar-Western Hemlock Forest
3158	North Pacific Montane Riparian Woodland and Shrubland	Neutral	Unsuitable	Western Riparian Woodland and Shrubland
3159	Rocky Mountain Montane Riparian Forest and Woodland	Neutral	Unsuitable	Western Riparian Woodland and Shrubland
3160	Rocky Mountain Subalpine/Upper Montane Riparian Forest and Woodland	Neutral	Unsuitable	Western Riparian Woodland and Shrubland
3161	Northern Rocky Mountain Conifer Swamp	Neutral	Unsuitable	Spruce-Fir Forest and Woodland
3251	Rocky Mountain Montane Riparian Shrubland	Neutral	Unsuitable	Western Riparian Woodland and Shrubland
3252	Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	Neutral	Unsuitable	Western Riparian Woodland and Shrubland
3255	Inter-Mountain Basins Montane Riparian Shrubland	Neutral	Unsuitable	Western Riparian Woodland and Shrubland
3292	Open Water	Neutral	Unsuitable	Open Water

Table B-2. LANDFIRE 1.4.0 Biophysical Settings codes and LANDFIRE 1.4.0 Existing Vegetation codes that were used to define existing Sage-Grouse habitat (in green, Existsing Sagebrush and Existing Sagebrush Associated), and potential Sage-Grouse habitat (in purple, Potential Sagebrush and Potential Sagebrush Assocaited). This includes State specific modifications to the tavle in the Greater Sage-Grouse Monitoring Framework. The columns labeled "Suitable GRSG Seasonal Habitat" are classes each State selected as suitable for their State. The reclassifications were used in both mid-scale and fine-scale habitat availability metrics.

Ecological Systems from LANDFIRE to use in Calcuating Percent Sagebrush														
						Suitable GRSG Seasonal Habitat								
Ecological Systems	**BPS Code**	**BPS Reclass**	**EVT**	**EVTClass**	**EVT Fuel**	**MT**	**WY**	**CO**	**UT**	**ID**	**NV**	**OR**	**FS**	**FC**
Colorado Plateau Mixed Low Sagebrush Scrubland	10640		3064		2064				X				X	X
Columbia Plateau Scabland Shrubland	10650	22	3065	12	2065					X		X		
Great Basin Xeric Mixed Sagebrush Shrubland	10790	21	3079	11	2079	X			X	X	X	X	X	X
Inter-Mountain Basins Big Sagebrush Shrubland	10800	21	3080	11	2080			X	X	X	X	X	X	X
Inter-Mountain Basins Big Sagebrush Shrubland - Basin Big Sagebrush	10801		3080		2080				X	X	X	n/a	X	X
Inter-Mountain Basins Big Sagebrush Shrubland - Wyoming Big Sagebrush	10802		3080		2080	X		X	X	X			X	X
Inter-Mountain Basins Mat Saltbrush Shrubland	10660		3066		2066				X					
Inter-Mountain Basins Mixed Salt Desert Scrub	10810		3081		2081				X					
Inter-Mountain Basins Mixed Salt Desert Scrub - North	10812		3081		2081									
Inter-Mountain Basins Mixed Salt Desert Scrub - South	10811		3081		2081									
Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	10720		3072		2072	X			X				X	
Columbia Plateau Low Sagebrush Steppe	11240	21	3124	11	2124					X	X	X	X	X
Inter-Mountain Basins Big Sagebrush Steppe	11250	21	3125	11	2125	X			X	X	X	X	X	X
Inter-Mountain Basins Montane Sagebrush Steppe	11260	21	3126	11	2126			X	X	X	X	X	X	X
Inter-Mountain Basins Montane Sagebrush Steppe - Low Sagebrush	11262		3126		2126				X				X	X
Inter-Mountain Basins Montane Sagebrush Steppe - Mountain Big Sagebrush	11261		3126		2126				X	X			X	X
Northwestern Great Plains Mixedgrass Prairie	11410		3141		2141	X								
Northwestern Great Plains Shrubland	10850		3085		2085	X								
Western Great Plains Sand Prairie	11480		3148		2148	X								
Western Great Plains Floodplain Systems	11620		3162		2162	X								
Northern Rocky Mountain Foothill Conifer Wooded Steppe	11650		3165		2165								X	
Columbia Plateau Steppe and Grassland	11230	22	3123	12	2123					X	X	x	X	
Inter-Mountain Basins Semi-Desert Shrub-Steppe	11270	22	3127	12	2127				X	X	X	x	X	X
Inter-Mountain Basins Semi-Desert Grassland	11350		3135		2135				X				X	
Rocky Mountain Lower Montane-Foothill Shrubland								X	X					
Rocky Mountain Lower Montane-Foothill Shrubland - No True Mountain Mahogany								X	X					
Rocky Mountain Lower Montane-Foothill Shrubland - True Mountain Mahogany								X	X					
Rocky Mountain Gambel Oak-Mixed Montane Shrubland								X	X					
Rocky Mountain Gambel Oak-Mixed Montane Shrubland - Patchy								X	X					
Rocky Mountain Gambel Oak-Mixed Montane Shrubland - Continuous								X	X					
Inter-Mountain Basins Curl-Leaf Mountain Mahogany Woodland and Shrubland								X	X					
Artemisia tridentata ssp. vaseyana Shrubland Alliance	3220	21	3220	11								x		

Notes	
OR selected 9 classes to be included from EVT and BPS (in grey)	11 Existing Sagebrush
They are reclassified, as shown by colors and codes, into HAF classes (purples and gre	12 Existing Sagebrush Associated
The two classes with red check boxes were added by Glenn and Louis	21 Potential Sagebrush
Original classes for sagebrush monitoring framework have green check boxes	22 Potential Sagebrush Associated