Greater Sage-grouse Wildfire, Invasive Plant Species, and Conifer Encroachment Assessment

Humboldt-Toiyabe National Forest

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Introduction

The Greater Sage-grouse (GRSG) (*Centrocercus urophasianus)* is the largest grouse species in North America. They are currently found in 11 western states and two Canadian provinces. They are dependent on a variety of shrub steppe habitats throughout their life cycle, particularly sagebrush. They exhibit strong site fidelity to areas even when habitat conditions are degraded and no longer valuable to the species (USFWS 2013).

The Greater Sage-grouse Conservation Objectives Team (COT) report (USFWS 2013a) and other scientific publications identify wildfire and conversion of sagebrush habitat to invasive annual grass-dominated vegetative communities as two of the primary threats to the sustainability of GRSG in the western portion of the species range (BLM 2014).

Chambers et al. (2014) indicate that several studies have found that a key indicator for the continued presence of viable populations of GRSG is the proportion of sagebrush-dominated land cover required by these birds. Without the required amount of sagebrush, some populations have been extirpated from areas within the species range. GRSG habitat loss and fragmentation as a result of wildfire, invasive plant establishment and conifer encroachment are considered to be major challenges in the conservation of the species.

Large, high severity wildfires in sagebrush-dominated ecosystems result in the temporary and sometimes permanent loss of habitat for GRSG. Wildland fire is by far the greatest, most immediate, and profound threat to GRSG habitat in the Great Basin, yet is an important and dynamic environmental factor in the Great Basin. Annual invasive grasses are prone to frequent, recurring wildland fire. This type of fire is a major disturbance mechanism and is frequently, but not exclusively, a catalyst to the establishment of these invasive plant species.

Invasive annual grasses also contribute to habitat loss by reducing habitat quality for GRSG, especially in areas where frequent wildfire has resulted in a shift from a sagebrush ecosystem to annual grassland. In these cases, habitat loss can be virtually irreversible.

Conversely, successful fire suppression has led to the lack of intermittent, low intensity fire in large areas of GRSG habitat. Lack of intermittent, low intensity fire has allowed conifers to expand into sagebrush landscapes, which in turn decreases overall habitat suitability for sage-grouse.

Conifer encroachment, particularly by pinon pine and juniper species, in sagebrush ecosystems has exacerbated the reduction of GRSG habitat. Conifer encroachment impacts habitat quality by shading out perennial native grasses and forbs which provide forage for GRSG especially during brood rearing of chicks. The physical height of the conifers also provide nesting and perching habitat for predators of GRSG. The presence of conifers adjacent to sagebrush ecosystems also alters fire regimes for these areas (Chambers et al. 2014).

To address these concerns, the Bureau of Land Management (BLM) and the United States Forest Service (Forest Service) have committed to completing wildfire, invasive annual grasses, and conifer encroachment assessments in GRSG habitat.

As part of the United States Fish and Wildlife Service's (USFWS) decision to not list GRSG as a threatened or endangered species, the Forest Service and BLM amended some Land and Resource Management (Land Use) Plans. These amended Land Use plans require some Forest Service units to develop and implement new or revised mechanisms in order to conserve and restore GRSG habitat on

their managed lands (BLM 2015). These assessments are part of the national strategy to aid in the conservation of GRSG across the western United States involving multiple federal, state, and private lands.

This assessment will support the USFWS goal to promote the long-term conservation of GRSG and their habitat by maintaining viable, connected, and well-distributed populations and habitats across their range, through threat mitigation, conservation of key habitats, and restoration activities. It is based on national and local datasets and is a landscape level spatial analysis using the best and most recent data available. This document does not include any type of decision, but is intended to provide guidance for the Humboldt-Toiyabe National Forest in prioritizing treatments for fire, invasive annual grasses and conifer encroachment across GRSG habitat.

Purpose

The purpose of the Humboldt-Toiyabe National Forest Wildfire, Invasive Plant Species, and Conifer Encroachment Assessment is to identify opportunities to address the major threats to GRSG and its habitat on the Humboldt-Toiyabe National Forest (hereafter, HTNF, or the Forest). This assessment will provide a list of findings, recommendations, and considerations to protect, maintain, and enhance GRSG habitat. To meet these goals, the conservation objectives, measures and options have been extrapolated from the USFWS 2013 COT report to compare how the findings and recommendations from this assessment will contribute to reduction of the threats (Appendix S).

The BLM conducted its own assessment of threats to GRSG habitat. It focused mostly on BLM-managed lands and evaluated GRSG habitat primarily through the lens of resistance and resiliency to sagebrush habitat loss. That process, and the different objectives and focus of this assessment, is described in detail later in this document. This assessment complements the BLM's FIA process, by incorporating other data layers to more fully describe and prioritize GRSG habitat on lands managed by the HTNF.

This assessment will provide a consistent, repeatable, spatial landscape prioritization process, to identify areas of resistance to invasive annual grasses and resilience to disturbance principles (as described in Chambers et al. 2014). The assessment prioritizes GRSG habitat on a comparative basis (importance) relative to the level or magnitude of the threat for five focal program areas: fire operations, fuels management, invasive species, conifer encroachment, and restoration activities (including both Burned Area Emergency Rehabilitation (BAER) and non-BAER restoration work conducted post-fire). The intent of this landscape prioritization is to help inform where management actions and out-year program planning would be most advantageous for the forest to conserve, protect, and enhance GRSG habitat in the context of the specific identified threats.

We recognize that invasive species other than annual grasses (e.g., primarily cheatgrass) and conifer encroachment are threats to sagebrush ecosystems. However, for the purposes of developing this assessment, invasive annual grass species are only taken into account as they pertain to a wildland fire feedback loop (Appendix B-F).

This assessment provides a direct link to the Vegetation Dynamics Development Tool (VDDT) that was performed through the Land and Resource Management Plan (LRMP) amendment process. It will compare results of the modeling and a summary of findings from this assessment to assist the Forest in determining an out-year program of work.

This assessment also provides a summary of the BLM-led Fire and Invasive Assessment Team (FIAT) process and will display the results of that assessment specific to the HTNF in an appendix. The assessment process will also expand upon the BLM-led FIAT concepts to incorporate the remaining habitat across the Forest. Subsequent program and resource management planning for GRSG habitat on the Forest should be developed with and incorporate the results of this analysis.

This process will summarize the major threats as identified in the USFWS 2013 COT report, characterize the existing conditions, incorporate the results of the BLM-led FIAT effort, and recommend management opportunities for fire operations, fuels management, conifer encroachment, invasive annual grasses, and restoration…

Location

The Humboldt-Toiyabe National Forest (HTNF) is comprised of six Ranger Districts and a National Recreation Area: Austin-Tonopah, Bridgeport, Carson, Ely, Mountain City-Ruby Mountains-Jarbidge, and Santa Rosa Ranger Districts, and the Spring Mountains National Recreation Area (SMNRA). Portions of all Ranger Districts on the HTNF are included in this analysis, with the exception of the Carson and Bridgeport districts and the SMNRA. Both the Bridgeport and Carson Ranger Districts have GRSG habitat, however these areas support the Bi-State distinct population segment (DPS) of Greater Sage-grouse. In 2013, the USFWS proposed to list the Bi-State DPS of GRSG as threatened under the Endangered Species Act (ESA) (75 FR 13910). In May of 2015 the USFWS made the finding that listing under the ESA was not warranted and withdrew the proposed rule to list the Bi-State DPS in California and Nevada as threatened (80 FR 59857). This population is considered to be genetically unique and it occurs within western Nevada and portions of eastern California. A separate amendment to the HTNF's LRMP was prepared to address management for this distinct population of GRSG. Because of this decision, areas supporting that population are addressed separately and are not included in this analysis.

The SMNRA is not included for analysis because there is no identified GRSG habitat there and the SMNRA is outside the historic and current range of GRSG.

Table 1 displays the breakdown of GRSG habitat based on local geospatial data; habitat management areas (HMA) which are further segmented into priority, general, and other; and sagebrush focal areas, as determined by the LRMP amendment process (BLM 2015). Local habitat data are based on habitat and GRSG use across the HTNF as collected by local biologists. See Existing Conditions section for the definition of different habitats.

Threats

Issue #1, Fire

Fire (both lightning-caused and human-caused) in sagebrush ecosystems is one of the primary risks to GRSG habitat because of increases in fire frequency and intensity in the last decade. High intensity fires typically result in mortality to sagebrush plants and because most sagebrush species are not fire resistant, it can take decades for sagebrush communities to recover. This results in long term GRSG habitat loss and habitat fragmentation across most of the species range. Fire also contributes to the

positive feedback loop between exotic invasive annual grasses and fire frequency as mentioned above. Furthermore, the replacement of native perennial bunchgrass communities by invasive annuals is a primary contributing factor to increasing fire occurrence in sagebrush ecosystems.

Issue #2, Non-native, Invasive Annual Plant Species

The increase in mean fire frequency has been facilitated by the incursion of invasive annual grasses, primarily cheatgrass (*Bromus tectorum)* and medusahead (*Taeniatherum caput-medusae*,) into sagebrush ecosystems (Billings 1994; Miller and Eddleman 2001). Exotic annual grasses and other invasive plants also alter habitat suitability for GRSG by reducing or eliminating native forbs and grasses essential for food and cover (75 FR 13910, and references therein). Annual grasses and noxious perennials continue to expand their range, facilitated by ground disturbances, including wildfire (Miller and Eddleman 2001), improper grazing (Young *et al.* 1972, 1976), agriculture (Benvenuti 2007), and infrastructure associated with energy development (Bergquist *et al.* 2007). Management of this threat is two-pronged: (1) control, or stopping the spread of invasive annual grasses, and (2) reduction or elimination of established invasive annual grasses.

Issue #3, Conifer Encroachment

GRSG are negatively impacted by the expansion of coniferous woodlands in their habitats, even if the underlying sagebrush habitat remains (Freese et al. 2009). GRSG avoid these areas of expansion (Casazza et al. 2011) and as coniferous woodlands increase in abundance and size, the basic habitat quality for sage-grouse diminishes, as does the sheer quantity and in some cases, the connectivity of habitat.

BLM-Led FIAT Process

The Interagency Fire and Invasive Species Assessment Team (FIAT) developed a two-step process to identify priorities for treatment/actions in order to conserve GRSG habitat. Step 1a identifies important Priority Areas for Conservation (PACs), focal habitats, and emphasis areas. Step 1b identified potential management strategies to conserve or restore focal habitats threatened by wildland fires, invasive annual grasses, and conifer encroachment. FIAT's Step 2 is the completion of Forest and Grassland level GRSG Wildland Fire & Invasive Species Assessments. The Bureau of Land Management (BLM) issued an instruction memorandum in August 2014 that guided interagency partners in completing Step 2 of the wildfire and invasive species assessments for five priority landscapes in GRSG habitats, which incorporated small portions of the Humboldt-Toiyabe National Forest. The three threats—wildfire, invasive annual grasses, and conifer encroachment have been analyzed for implementing management strategies or conservation activities for habitat restoration, fuels management, fire operations, and post fire rehabilitation. Suggested frameworks on how to complete these specific assessments are addressed in an appendix in each Forest Land and Resource Management Plan Amendment Final Environmental Impact Statement (FEIS). More information on the FIAT process can be obtained on line at the following link.
http://www.blm.gov/wo/st/en/prog/more/sagegrouse/documents_and_resources.html

The BLM-led FIAT Step 1a, 1b, and Step 2 focused on Focal and Emphasis areas based on Breeding Bird Density, Sagebrush Landscape Cover, and warm and dry soil temperature and moisture regimes as the baseline for the Step 2 analysis. Appendix O contains of summary of identified actions of this BLM-led FIAT effort. That appendix is organized by project planning areas and a full description of

those actions can be referenced in the final Northern Great Basin FIAT report and the final Southern Great Basin FIAT report, both of which can be accessed online at the following link. http://www.blm.gov/wo/st/en/prog/more/sagegrouse/documents_and_resources.html. Maps of these areas are contained in Appendix P, Q, R.

It is important to note that the landscape prioritization process that is used in this USFS assessment follows a different prioritization process than what the BLM-led effort used. The process utilized in this assessment is a quantitative, repeatable process that took into consideration the different levels of threat, all habitat classification layers, and resistance and resilience classifications across the Forest to help inform the prioritization and implementation of actions to conserve, enhance and protect GRSG habitat. The BLM-led process assigned a priority value of 1, 2, or 3 and did not take into account all of the GRSG habitat.

The prioritization process in this analysis should not be treated as an absolute and should serve as a guiding process for which to prioritize areas for the protection, treatment, or restoration. It is recognized that there are many differing site-specific variables that exist which cannot be accounted for in this process. These variables include budgets, cooperator participation or interests, multiple ignitions with competing values, as well as many others.

Existing Conditions

Analysis Area

On the Humboldt-Toiyabe NF (HTNF), GRSG habitat in shrubland areas consists of Wyoming big sagebrush (*Artemisia tridentata* spp. *wyomingensis*), mountain big sagebrush (*Artemisia tridentata* spp. *vaseyana*), basin big sagebrush (*Artemisia tridentata* spp. *tridentata*), low or dwarf sagebrush (*Artemisia arbuscula*), black sagebrush (*Artemisia nova*), fringed sagebrush (*Artemisia frigida*), and silver sagebrush (*Artemisia cana*). GRSG have also been found to use meadows and riparian vegetation on the HTNF. Riparian corridors tend to provide connectivity between sagebrush communities providing movement for GRSG from one area to another. A list of vegetation types can be found in Appendix A of this document.

The analysis area was defined using several habitat datasets developed by various agencies including US Fish and Wildlife Service (USFWS), BLM, Nevada Department of Wildlife (NDOW) and the HTNF. USFWS identified priority GRSG habitat by developing Priority Areas for Conservation (PAC) (USFWS 2013). Within this dataset are areas identified as Focal Areas which are "strongholds" for GRSG and are considered to be the most important for GRSG persistence. The GRSG Record of Decision provided these areas with higher levels of protection across the species' range and were also identified specifically for fire, invasive annual grasses and conifer encroachment assessments (BLM 2015).

The data sets are based on population density as well as habitat criteria important to the species' continued existence. Both the BLM and NDOW data used for this assessment was developed through multiple stages. It was initially completed by BLM in coordination with NDOW and was later refined in subsequent stages by NDOW. The final GRSG habitat map was based in part on habitat suitability modeling conducted by the U.S. Geological Survey (Coates et al 2014). A detailed description of the different habitat datasets used to delineate the analysis area can be found in the Methodology section of this document.

The HTNF habitat data, or local data, consist of the different GRSG habitat types delineated across the Forest based on site specific data and local knowledge. It supplements the USFWS, BLM and NDOW habitat data and consists of breeding/nesting, brooding/summer and connectivity habitat. The total acreage of GRSG habitat included for analysis on the Humboldt-Toiyabe, using all datasets, and without any overlapping acres, is 2,948,386 acres.

Table 1 GRSG Habitat Acres by District

Ranger Districts	Sage brush Focal Areas (SFA)[4]	Habitat Management Areas[1]			Nevada Department of Wildlife (NDOW)[2]			HTNF Local Data[3]	
		Priority Habitat	General Habitat	Other Habitat	Core Habitat	Priority Habitat	General Habitat	Breed/ Nest Brood Habitat	Connectivity Areas
Austin	0	91,033	300,295	150,691	92,711	309,632	155,408	614,072	4,666
Ely	0	36,271	155,207	86,107	42,260	174,502	86,107	337,472	3,734
Jarbidge	176,608	176,413	114	5,633	100,150	42,732	45,420	201,615	854
Mountain City	218,138	337,193	73,842	44,160	281,608	112,426	93,356	455,561	5,795
Ruby Mountains	0	81,794	64,635	124,311	110,307	91,431	124,963	288,828	7,252
Santa Rosa	171,432	178,145	39,402	60,019	176,885	44,053	65,248	273,822	7,252
Tonopah	0	91,241	162,220	150,110	99,797	178,464	145,677	504,841	4480
Grand Total*	**566,178**	**992,090**	**795,715**	**621,031**	**903,718**	**953,638**	**719,774**	**2,676,211**	**34,033**

***Habitat totals shown here may not match the total of habitat disclosed in the ROD for the GRSG Conservation EIS since other habitat types beyond those shown here were disclosed and analyzed in the EIS. In addition, some overlap of areas may occur between the management areas displayed here, so there is some double-counting of areas in some cases.**

Vegetation

Current Conditions

GRSG habitat on the HTNF is composed primarily of shrubland vegetation which accounts for 61% of the analysis area. Shrubland vegetation consists of mountain big sagebrush, dwarf (low) sagebrush, Wyoming big sagebrush, and basin big sagebrush. Riparian and herbaceous vegetation is found across 4% of the analysis area. The analysis area also includes areas of non-Sage-grouse habitat such as coniferous forest types which occur across 4%, and hardwood types which occur across 5% of the analysis area. Woodland vegetation, in the form of mountain mahogany and pinyon-juniper covers approximately 26% of the analysis area. Other vegetation types consist of very limited areas of upland herbaceous communities, isolated aspen stands, and sub-alpine vegetation. Approximately 2% of the analysis area is sparsely- or non-vegetated areas.

Data used to determine vegetation types were derived from the Vegetation Classification, Mapping and Quantitative Inventory (VCMQ) spatial data layer developed by the US Forest Service (USFS) Remote

[1] Nevada Habitat Management Areas NVCA_GRSG_AltG_Proposed. Data compiled 3/27/16.
[2] Nevada Department of Wildlife: NV_MgmtCategories_March 2015. Lek count data and lek activity classified from the 2014 breeding season.
[3] Local data is a compilation of local data compiled on 1/7/2016.
[4] Data compiled October 2015 from SFA_Draft_January_2015_Final_Dis

Sensing Applications Center (RSAC) in 2004. This dataset is derived from imagery taken in 2000 and is indicative of vegetative conditions during that time. It is the best and most recent data available at the time this analysis was conducted. The dataset is at a landscape level and there may be areas where vegetation conditions are not exactly representative of existing conditions on the ground. This is especially true in cases where conifer forest (non-GRSG habitat) overlaps with both national and local GRSG habitat data. It is recommended when planning a treatment based on this assessment, a site visit be conducted to confirm the vegetation type and the need for treatment. In the future, it is expected that vegetation datasets will be updated, revised, or changed resulting in a more accurate assessment of vegetation types. As those changes occur, it should be noted that this assessment's results may require validation when planning treatments.

Historical Range of Variation

Distribution of plant communities is guided by several ecological factors, including: soil type, precipitation, temperature, elevation, and the dynamics among wildlife and neighboring plant species. Natural disturbances, primarily fire in this sagebrush-steppe ecosystem, have historically maintained a balance among the plant communities, resulting in a diverse mosaic of plant community types, in various stages of development. Ecosystem balance in the analysis area was altered with the arrival of settlers in the mid-1800s. Land use practices put new pressures on sagebrush vegetation, resulting in reduced fine fuels which carry fire. This reduction in fine fuels brought an initial reduction in fire frequency and size, which along with favorable climatic conditions, initiated the expansion of coniferous woodlands at higher elevations (Miller and Eddleman 2001; Miller et al. 2011). The introduction of invasive annual grasses, particularly cheatgrass, resulted in a regional increase in the volume and continuity of fine fuels throughout lower elevation sagebrush habitats. As a result, there was an increase in fine fuels which contributed to a cheatgrass/fire cycle that causes greater fire frequency and larger fires, with shorter fire return intervals on sagebrush sites. This increase in fire disturbance is a key factor contributing to a reduction of sagebrush cover.

Vegetation Dynamics Development Tool (VDDT)

A regional evaluation of GRSG habitat trends was performed for the GRSG LRMP amendment process specific to each sub-regional Environmental Impact Statement using the Vegetation Dynamics Development Tool (VDDT, copyright 1995-2003, ESSA Technologies, Vancouver, BC). The VDDT model was used to project sage-grouse habitat conditions into the future to estimate the treatments necessary to maintain desired conditions (desired conditions being 70% of analysis area meeting 10-30% sagebrush cover). The model accounted for natural and background disturbances equal to historical averages and vegetation treatment rates. The modeling indicated desired conditions could be maintained within the Forest by performing 202,000 ac/10yrs mechanical conifer removal, 0 ac/10yrs conifer removal by prescribed fire, and 43,000 ac/10yrs of native grass restoration. Table 2 displays treatment acres within the forest. Note that the VDDT analysis provides general guidance for treatment rates at the landscape scale, but it would be appropriate for actual treatment rates to be adjusted for variations in conditions obtained by more refined or more current data, or by local knowledge. More information concerning the VDDT analysis can be found in the Nevada Sub-region GRSG Environmental Impact Statement/Land Use Plan Amendment.

Table 2 VDDT Modeling Specific to the Humboldt-Toiyabe National Forest

Treatment	Mechanical [1]	Prescribed Fire [2]	Native Grass Restoration [3]
Treatment Rate (acres/10 years)	202,000	0	43,000

[1]Removal of conifers that have invaded sagebrush including Low density encroachment that is 10% or less and reducing sagebrush cover in areas over 30% canopy cover.
[2]Acres are those that are greater than 30% sagebrush canopy cover and/or invaded by 10% or greater conifer.
[3]Acres presently dominated by annual grasses that could be improved by herbicide application and seeding of perennial vegetation.

Conifer Encroachment

Conifer encroachment is another key threat to sage grouse habitat at higher elevations in the analysis area. Pinyon pine and juniper are the primary conifer species of concern for sage-grouse habitat, but there are some lessor amounts of expansion by other conifer species. Although pinyon and juniper species are the primary tree species threatening GRSG habitat, the expansion of other species into GRSG habitat create the same or similar negative impacts. In this context, conifer encroachment refers to the fact that conifer species in general, particularly pinyon pine (hereafter, simply "pinyon") and juniper species, are expanding beyond their historical range as a result of several factors including historic livestock overgrazing, climate change, and effective fire suppression. Studies have found that the extent of pinyon and juniper woodlands have increased two to six times since the late 1800s, with most of that area seeing canopy closure within the next 50 years (Miller et al. 2008). As pinyon and juniper species expand into sagebrush-steppe habitats used by GRSG, they effectively out-compete the understory of sagebrush species, native grasses, and forbs that provide cover and forage for sage-grouse causing elimination and fragmentation of habitat. It should be noted that GRSG will avoid areas of pinyon-juniper expansion even when the understory vegetation state would otherwise be considered desirable habitat (Casazza et al. 2011, Baruch-Mordo 2013).

The degree of conifer encroachment is categorized according to Phases. Phase I stands are in early stage encroachment, with young scattered trees, less than 10% canopy cover, and intact sagebrush and understory vegetation. Phase II is mid-level encroachment, where trees co-dominate with sagebrush, and understory grasses and herbaceous plants begin to decline. Phase III stands are at the late stage of encroachment, with high tree density and shrubs beginning to disappear. Mapping of conifer encroachment in the analysis area shows a total of 1,390,247 acres of active encroachment. A map is included in Appendix M. Table 3, below shows the breakdown of encroachment acres by phase class, ranger district and totals.

Table 3 Acres of Conifer Encroachment*: Relative Density of Conifer Cover.

Ranger Districts	Phase I	Phase II	Phase III	Grand Total
Austin	173,863	129,847	148,409	452,119
Ely	139,090	108,423	63,122	310,634
Jarbidge	38,772	12,380	6,326	57,478
Mountain City	50,421	13,244	9,167	72,832
Ruby Mountains	105,554	30,660	10,127	146,341
Santa Rosa	0	0	0	0

Ranger Districts	Phase I	Phase II	Phase III	Grand Total
Tonopah	169,965	76,785	104,093	350,843
Grand Total	**677,664**	**371,340**	**341,243**	**1,390,247**

***** *Conifer encroachment refers to encroachment by all species of conifer. Pinyon and juniper are the dominant species within the analysis area, with lesser components of other conifer species involved.*

In general terms, if the Forest was to develop a 10 year plan to restore these landscapes to their natural condition, approximately 139,025 acres of conifer treatment would need to be scheduled each year based on the sum total of acres across the Forest where conifer encroachment has occurred. However, as per guidelines in the Greater Sage-grouse Record of Decision for Nevada (ROD), these treatments should be focused almost entirely in areas of Phase I and Phase II encroachment which would equate to 104,900 acres of treatment per year. The ROD guidelines state that areas with more advanced encroachment (Phase III) should only be authorized to create movement corridors, connect habitats, or reduce the potential for catastrophic fire. Any treatments performed should also be prioritized according to habitat quality and resistance and resilience designation.

The above addresses the existing condition and is based on a ten year program of work. The dynamic nature of plant community succession needs to be understood for the Forest to develop a long term approach. This can be accomplished by modeling plant community succession over a 50 year planning horizon as was completed with the LPMP amendment process.

The combination of known acres of conifer encroachment, with what can be expected in the future is helpful in developing a long term plan for managing habitat. In order to understand future needs and program of work, results of the VDDT analysis as described above was contrasted to the existing condition. VDDT Modeling output helps to establish a range for not only managing the encroachment in the existing condition, but to establish the maintenance of 70% of identified habitat in 10 – 30% sagebrush cover over the next 50 years. Model output suggests that 20,200 acres of mechanical treatment of conifer encroachment should be implemented annually (202,000 acres per decade).

The overlay of currently known Phase I conifer encroachment (677,664 acres, Table 3) coupled with VDDT analysis encroachment (Table 2) indicates that a range of 13,350 - 20,200 acres of mechanical treatments of Phase I encroachment per year for the next 50 years would help to improve and maintain habitat objectives.

Furthermore, the overlay of currently known Phase II conifer encroachment (371,340 acres, Table 3) indicates that approximately 7,400 acres of prescribed burning treatments of Phase II encroachment per year for the next 50 years would help to improve and maintain habitat objectives.

In order to maximize the effectiveness of treatments in all phases of encroachment, it is recommended to refer to the results of the prioritization analysis for conifer encroachment (Table 4). Acres displayed in this table are results from the spatial analysis carried out to derive a spatial output of prioritization for conifer encroachment treatment areas where GRSG habitat is the highest quality, resistance and resilience is highest, and encroachment phase is lowest. Appendix D displays the same information in a map format.

Table 4: Acres of conifer encroachment by phase and treatment priority class.

Treatment Priority	Phase I	Phase II	Phase III	Grand Total
Very Low	7,716	100,714	67,481	175,911
Low	167,142	27,485	21,196	215,823
Moderate	267,804	208,601	246,515	722,920
High	184,639	26,032	4,302	214,974
Very High	50,363	8,509	1,749	60,620
Grand Total	**677,664**	**371,340**	**341,243**	**1,390,248**

Invasive Plant Species

Invasive plant species are increasing on the landscape, which is degrading and converting GRSG habitat to unsuitable habitat. While noxious weeds are also a known and serious problem on the Forest, this assessment focuses on invasive annual grasses.

Invasive Annual Grasses

One of the primary effects of invasive species on sagebrush ecosystems is their amplifying effect on the intensity and frequency of fire. Annual grasses like cheatgrass and medusahead, can create heavy and continuous fine fuel loads that propagate frequent wildfires resulting in the loss of sagebrush. These aggressive annual invasive grasses can convert perennial-dominated sagebrush ecosystems to annual-dominated systems (Chambers et al 2014a), and can result in a nonnative annual grass and fire feedback loop. This can lead to the conversion of sagebrush shrublands to annual grasslands (Davies 2011). Once an area has crossed the threshold to an annual invasive grassland state, it becomes virtually impossible to transition back to a sagebrush and perennial plant dominated landscape. Annual invasive grasses are a primary threat to GRSG habitat; however, other invasive plant species also threaten sage-grouse habitat by degrading habitat quality. Invasive forbs are often some of the hardest invasive plants to manage, can dominate large areas, and can increase post-fire due to their fire resistance, persistent seedbanks, prolific seed production, and rooting characteristics, as stated in the Invasive Plant Management and Greater Sage-grouse Conservation: A Review and Status Report with Strategic Recommendations for Improvement (Ielmini et al 2015).

A breakdown of the modeled potential of annual invasive grass-infested acres on the HTNF within GRSG habitat analysis area is displayed in Table 5.

Table 5 Estimated Acres of Modeled Potential for Annual Invasive Grass Infestation

Ranger Districts	Potential Light Infestation	Potential Moderate Infestation	Potential Heavy Infestation	Grand Total
Austin	27,748	272,970	238,341	539,059
Ely	0	51,088	175,652	226,740
Jarbidge	26,245	91,987	15,840	134,072
Mountain City	96,859	266,972	42,808	406,639
Ruby Mountains	3,341	91,312	34,710	129,363
Santa Rosa	109,168	47,240	37,900	194,308
Tonopah	8,610	135,957	243,272	387,838
Grand Total	**271,971**	**957,527**	**788,522**	**2,018,019**

Preventing spread of existing infestations and establishment of new infestations is key in the effort to control invasive species. Creating local weed wash stations along with developing aggressive weed-washing requirements for off-forest vehicles coming onto the forest, could help control invasives. Developing more mindful grazing practices like holding livestock before they first come onto the forest or before transferring them from weed infested areas to un-infested areas while ensuring that utilization standards are adequate and are being met for each pasture would also help limit the spread of invasive plants.

Noxious and Invasive Plants

Based on HTNF spatial data, the Forest is currently treating 43 noxious and invasive species occurring on the entire forest; of these, only 15 occur within the GRSG analysis area. A complete table of known invasive species locations on the HTNF within the GRSG habitat is located in Appendix V. Invasive species data include both treatment and inventory data, but they may not include all areas where invasives are established. There are known cheatgrass and medusahead infestations on the forest. Additional surveys would be needed to locate site specific infestations for project level analysis. Modeled potential for invasive annual grass presence and the level of infestation was determined using the Resistance and Resilience matrix from Chambers et al (2014), for the HTNF within the GRSG habitat analysis area. Estimated acres of potential infestations derived from the model total approximately 2,018,019 acres. The estimated infested acres make up about 68% of the GRSG habitat on the Forest. Different priorities indicate areas where efforts may be prioritized for invasive plants presence surveys.

The HTNF treated approximately 5,570 acres of noxious and invasive species in 2015 within the sage-grouse analysis area. Treatment of noxious and invasive species decreases invasive infestations by decreasing habitat degradation from invasive plant infestations and decreasing increased fire threat, thus improving GRSG habitat. Treatment of invasives also benefits GRSG habitat by reducing the threat of further invasive expansion. On the HTNF, data indicate that inventories and areas treated for noxious and invasive plant species occur mainly along road ways and riparian areas where there is a high rate of spread. Thistles—including nodding plumeless thistle, Canada thistle, yellowspine thistle, bull thistle and Scotch cottonthistle—make up the majority of the treated acres within the GRSG analysis area. Appendix V contains the breakdown of acres infested by invasive species and treated for invasives within the GRSG analysis area.

Due to the continual expansion and establishment of invasive species throughout the landscape, increased efforts should be made to minimize negative impact of invasive plant species, especially invasive annual grasses, on GRSG habitat. Invasive species, particularly cheatgrass, could be targeted for treatment with herbicides, biological agents, native bacterium, and even with trained livestock grazing during key plant development stages. This would result in reducing existing infestations, creating a favorable impact. Increasing the current herbicide treatment program and then following up with reseeding areas, where feasible, would not only decrease infestation size but would improve GRSG habitat by increasing the opportunity for diverse native plant species. Developing a seed bank, specific to the HTNF GRSG habitat, could provide locally appropriate native seed for seeding after fire, other disturbance, or for reseeding areas after spraying. This would reduce the impacts of disturbances and invasive infestations on GRSG habitat, thus improving GRSG habitat. Actions that could aid long term GRSG habitat improvement are described in detail in the Invasives Findings and Recommendations section of this document.

The Forest currently has identified approximately 2,018,019 acres of GRSG habitat that likely is infested to some degree with cheatgrass as a component of the plant community. If the Forest were to target various eradication techniques over a ten year span, that would likely involve treating approximately 201,800 acres and potential seeding with native perennial plants annually. Biological control could potentially complement herbicide treatments.

As with conifer encroachment above, the modeled potential of annual invasive grass infestations (2,018,019 acres) coupled with VDDT modeling of annual invasive species (Table 2) indicates that a range of 43,000 – 201,800 acres of spraying and potential seeding with native perennial plants per year for the next 50 years would help to improve and maintain habitat objectives. Areas of potential infestation should be evaluated on a project by project basis to determine if these efforts would be effective at improving the GRSG habitat by significantly decreasing the potential for invasive annual grasses. Even with these efforts, it is recognized that some areas could not be returned to a native state.

Fire Operations

The Humboldt-Toiyabe National Forest has a fire season that can be characterized as being typical of the Great Basin, starting in July, peaking in August and tapering off as the summer transitions into the cooler, lower sun angle months of late September and early October. Much of this landscape can be characterized as being high elevation desert, receiving little to no precipitation throughout the summer months. There is empirical evidence of regular, large wildfires on the Forest, some of which occur in GRSG habitat. Past fire records indicate that from 1996 through 2014, there were just under 500,000 acres of wildland fire on the Forest.

Much of the Forest where GRSG habitat occurs is sparsely populated and has limited access. Travel times to some of the GRSG habitat, especially in the backcountry, can exceed three hours, and in some cases more. A combination of fire behavior that is characteristic of grass and brush fuels, lengthy response times, and delayed fire reports lead to larger wildfires. These conditions often times dictate a larger firefighting organization and higher level of incident command qualifications. Response times can be enhanced through increased road maintenance, and use of mobile devices to both facilitate quicker response times to areas of concern through the use of geo-referenced map products. These can especially be helpful for out of area resources. Increased road maintenance levels not only facilitate faster response times but, provide for fuel breaks to compartmentalize the landscape which will reduce

the spread and intensity of wildfire across the landscape. The Forest has identified approximately 476 miles of road network that could be beneficial for fire suppression operations.

There are various assets stationed across the Forest (Table 6) and cooperative agreements with other federal, state, and local resources to respond to wildland fire incidents. The program consists of dedicated, preparedness funded assets such as a helicopter, a Wildland Fire Module, and fire engines. The Humboldt-Toiyabe NF and other cooperative resources are dispatched to new incidents under a "closest forces" concept from the Ely, Central Nevada, and Elko Interagency Dispatch Centers. The Dispatch Centers are responsible for dispatching firefighting resources to fires on federal and state lands located in the eastern part of Nevada. A cooperative agreement is in place that involves four federal agencies (Bureau of Indian Affairs (BIA), USFS, USFWS, & BLM), a state agency (Nevada Division of Forestry), and the Sho-Pai Tribe (Duck Valley Reservation). They dispatch firefighting resources and facilitate incident support for all of eastern Nevada's public lands. Local and rural fire departments also assist in the protection of Public Lands and are in turn assisted by Federal and State Cooperators.

Table 6 Forest Duty Stations and Resources by Zone.

Zone	Resource	Number	Type	Staffing	Location
SMNRA	Engine	2	4	5 day, 5 people	Cold Creek/Kyle Canyon
	Engine	2	3	5 day, 5 people	Kyle Canyon/Mountain Springs
	Engine	3	7	5 day, 1 people	Indian Springs/Kyle Canyon Mountain Springs
Bridgeport RD	Helicopter	1	3	7 day, 10 people	Bridgeport
	Engine	1	3	5 day, 5 people	Bridgeport
	Engine	2	6	5 day, 5 people	Bridgeport/Topaz
	Engine	2	7	5 day, 1 person	Bridgeport/Topaz
Carson RD	Engine	3	4	5 day, 5 people	Galena/
	Engine	1	4	5 day, 5 people	Markleeville
	Engine	1	4	5 day, 5 people	Jacksvalley
	Engine	1	3	5 day, 5 people	Markleeville
	Engine	3	7	5 day, 1 person	Sparks/Carson/Minden
Mountain City/Ruby Mountain/Jarbidge/Santa Rosa RDs	Engine	1	4	5 day, 5 person	Elko

Zone	Resource	Number	Type	Staffing	Location
Austin/Tonopah/Ely RDs	WFM	1	NA	5 people, 5 days	Ely
	Engine	1	6	5 people, 5 days	Austin
	Engine	2	7	5 day, 1 person	Ely/Austin

There is a recognized shortage of staffing on the Forest by various Forest officials. It is felt that ability to respond to fire is less than optimal, leadership is spread thinly, and in some cases, coverage could be improved through re-establishment of positions at various duty stations would help to fill in "gaps".

With the added amount of GRSG habitat and resultant complexity, the interagency fire program management (IFPM) complexity rating should be raised to "high". This increase in complexity should increase staffing levels across the Forest.

The Forest has three comprehensive fire operating plans covering GRSG habitat across the Forest. They are the Ely, Central Nevada and the Elko Interagency Dispatch Centers. Each includes a National Fire Danger Rating System (NFDRS) plan based on a network of remote automated weather stations (RAWS). Each Agency (BLM, USFS, USFWS, BIA and State) must maintain an appropriate level of preparedness to meet wildland fire management objectives, the conservation of GRSG habitat being one of many. This is accomplished in the area of GRSG habitat on the Humboldt-Toiyabe NF through the Elko Interagency Dispatch Center Fire Danger Operating and Preparedness Plan.

Preparedness is based upon the assessment of fuels and weather conditions and utilizes the NFDRS. The Fire Danger Operating Plan (FDOP) documents the management of the Interagency Fire Weather System, and incorporates NFDRS fire danger modeling into fire management decisions. In addition, this plan combines an Operating Plan with a Preparedness Plan for the Humboldt-Toiyabe National Forest and the various cooperators. Direction for development of a Fire Danger Operating and Preparedness Plan can be found in the BLM/USFS Standards for Fire and Aviation Operations and Forest Service Manual 5120. The plan is intended to simplify the decision-making process for agency administrators, fire managers, dispatchers, agency cooperators, and firefighters by establishing agency planning and dispatch levels using the best available scientific methods and historical weather/fire data and understanding various values-at-risk, such as GRSG habitat.

Fire danger indices are calculated from weather and fuels observations gathered from Remote Automated Weather Stations (RAWS). The Forest, in cooperation with the BLM, maintain a network of RAWS stations that are representative of fuels and fire weather conditions to assess fire danger across the agency ownerships and any cooperative response areas. This comprehensive network is made up of 36 RAWS stations across the dispatch areas of responsibility.

The Forest Service and BLM RAWS network reports weather data for a variety of Fire Danger Rating Areas (FDRA). They serve as a primary compartment for NFDRS applications. A FDRA is characterized by having similar features such as vegetation composition and abundance, fuel type, weather patterns, climate, growing season, and historical fire occurrence. Subsequently, the RAWS sites that are representative of these various FDRAs are combined into what are known as special interest group (SIG). The Fire Zone is geographically divided into three FDRAs; west, central, and east. In short, the SIG provides redundancy as well as the ability to weigh data if desired, based on personal knowledge of the various components that make up an FDRA.

In review of the current NFDRS, it was determined that there is adequate fire weather information in the sagebrush communities across the Forest. At this time, there is no need to establish additional RAWS stations as they relate to sagebrush communities.

Based on current capacity there is a need to increase staffing across the Forest when conditions exceed certain thresholds. Those thresholds are well established in the NFDRS within the Ely, Central Nevada and Elko Interagency Dispatch Center Fire Danger Operating and Preparedness Plans. A list of available resources is identified in Table 6. It is recognized that GRSG habitat of any kind is threatened from fire for only a portion of the year. Increasing the fire operations capacity for anything more than that defined season would be of little to no value to protecting habitat.

Looking at fire records and indices, it is reasonable to make a determination that the BI breakpoints correlate well with multiple fire days and large fire days. Those days are defined by the Forest as any one day having two or more fires totaling 100 or more acres.

Because of the additional emphasis of GRSG habitat protection, it would be reasonable to request severity funding as Burning Index (BI) values approach the lower range of adjective rating "high", or approximately 61.When zone and Forest Duty Officers feel it necessary, additional resources would be ordered through the Great Basin Coordination Center to ensure the Forest was adequately staffed in light of the GRSG habitat that is threatened by fire.

Fuels Management

It is recognized that, while sagebrush community succession can lead to habitat degradation, so too does fire of most any kind, except in the narrowest of circumstances. Prescribed fire may be useful for achieving biological objectives; however, reintroducing fire is a complex task (Agee 1996). Consequently, any habitat alterations using prescribed fire should be well justified and carefully planned. Herbicide (e.g., Johnson et al. 1996) or mechanical treatments to enhance vegetative features may be more appropriate than prescribed fire because they provide faster recovery of sagebrush (Watts & Wambolt 1996). More importantly, conservation and management of unburned areas are critical to maintain habitat features necessary for GRSG reproduction and survival.

The Forest has pre-identified relative risk classifications (red, green) to help inform the decision making process where wildfire can be managed for LRMP objectives. This approach can be considered in areas where there is an identified need to improve GRSG habitat. Areas that are currently in Phase II or Phase III density conifer encroachment should consider a managed fire approach if site specific conditions warrant.

Fuels treatments across the Forest as they relate to GRSG habitat are limited in their scope and are primarily associated with the wildland urban interface (WUI). Future planning actions within the WUI and GRSG intermix are currently in process, and are expected to continue in the near future.

One potential approach in the WUI/GRSG intermix that can meet the needs and benefit both WUI, and GRSG objectives is to focus treatments on fine fuels reduction, reduction of conifer encroachment, and restoration of native species characteristic of the historic fire regime. Treatments such as this will benefit firefighter and public safety through the reduction in potential fireline intensities, as well as enhance GRSG habitat through the reduction of fine fuels (annual invasive grasses), reduction of conifer encroachment and the restoration of native species.

Shaded fuel breaks in the timber, sagebrush ecotone could be strategically placed based on fire history, fire frequency, and professional judgement to mitigate fire spread from timber type into GRSG habitat.

The concept of a fuel break is simple. By providing areas of reduced fuel loading; reduced fire intensity can be created. In addition to reducing fire intensity, fuel breaks increase fireline construction rates, reduce the fire retardant coverage level required to effectively coat vegetation and provide for points of access and travel for ground-based firefighters. The lighter fuels, often grasses, associated with fuel breaks also provide opportunities for indirect fireline construction through backfire or burn-out operations to consume fuel ahead of the spread of the main fire.

The successful use of fuel breaks as a fire control feature is often connected to the timing of fire suppression actions. During direct fireline construction, air tankers and helicopters can support ground firefighters to effectively control fire spread along established fuel breaks. A 2011 study on the role of fuel breaks on three national forests in southern California indicates that firefighter access was the only variable studied which directly improved the effectiveness of a fuel break. The study concluded that access for firefighters to initiate tactical operations was the most influential variable regarding the effectiveness of fuel breaks (Syphard et al., 2011). This study was completed for the southern California chaparral type ecosystem; however there are similarities in fire behavior that can generally be related to GRSG habitat fuel types.

There are fire behavior models such as FlamMap and Wildfire Analyst that might be employed to better define efficacy of fuel breaks. This is beyond the scope of this assessment and level of definition, but are tools that could be applied to mid-level analysis at the Forest level, helping to further focus attention on problematic fire behavior and its threat GRSG habitat. In review of the GRSG habitat across the forest, opportunities exist to improve protection of GRSG habitat and facilitate fire suppression actions. Due to the remote locations and inaccessible terrain, a network of fuel breaks has been identified using the existing road network within or near GRSG habitat. Existing roads were identified because of the ability to utilize the road surface as a barrier to fire spread and the ability to improve suppression response time as a result of increased road maintenance. Both factors potentially provide beneficial impacts to limiting the amount of wildfire in GRSG habitat. Approximately 476 miles of the existing road network improvements have been identified. The potential road improvements could include: blading, 20 miles on the Austin District; brushing 61 miles on the Ely District, brushing/blading 396 miles spread out on the Austin, Jarbidge, Mountain City, Santa Rosa, and Tonopah Districts. Preference for scheduling the implementation of these actions should be given to areas of high fire occurrence and high fire threat.

Methodology

General Process

Adaptive Management Services Enterprise Team (AMSET) assembled an Interdisciplinary Team representing Wildlife, Range, Invasive Species, Fire Ecology, GIS, and Fire Management to conduct this assessment for the Forest with the purpose as stated above. To complete this process, there were a series of collaborative meetings held on the forest.

The intent of the first meeting was to identify the issues, seek out local knowledge, and obtain local data to help inform the process and introduce the AMSET team members to their forest counterparts. Once local and other data was obtained, a landscape prioritization process was developed utilizing a threat-based approach that integrated different habitat layers, Resistance and Resilience concepts, invasive species, conifer encroachment, and fire threat.

A landscape prioritization process was developed to help inform the decision making process based on the level of threat and concern for each of the following program emphasis areas; fire operations, fuels management, conifer encroachment, invasive species, and finally restoration/BAER.

The second and third meetings were designed to present the landscape prioritization process and outcome to refine the methodology and calibrate the results. Through management-led discussions and questions, participants designed and discussed potential opportunities and management actions based on the landscape prioritization to conserve, protect and enhance habitat for each of the program emphasis areas. The result of this meeting led to the findings and evaluation of potential opportunities upon which this assessment is based.

Landscape Prioritization (Putting it all Together)

Data Layers Used in Determining Landscape Priorities

Resistance and Resilience Layer

The cornerstone of this assessment is based on recent scientific research on resistance and resilience of Great Basin ecosystems (Chambers et al. 2014). Resistance and resilience in this context refers to an area's ability to resist invasive annual grass establishment or expansion, and also how successfully the area recovers from disturbances (such as fire). Resistance and resilience as defined by Chambers et al is derived by combining sagebrush canopy cover and sub-soil moisture and temperature regimes.

The USFWS-sponsored project with the Western Association of Fish and Wildlife Agencies (WAFWA) assembled an interdisciplinary team to provide additional information on wildland fire and invasive plants and to develop strategies for addressing these threats. This interagency collaboration between rangeland scientists, wildland fire specialists, and GRSG biologists resulted in the development of a strategic, multi-scale approach for employing ecosystem resilience and resistance concepts to manage threats to sage-grouse habitats from wildland fire and invasive annual grasses (Chambers et al. 2014). Table 7 is a representation of acres per district of the resistance and resilience classifications as adopted from Chambers et al. A map of the Resistance and Resilience is contained in Appendix N.

Table 7 Acres of Resistance and Resilience Rating by District within the GRSG Analysis Area

Ranger Districts	1A-Low Cover, High Resistance	1B-Mod Cover, High Resistance	1C-High Cover, High Resistance	2A-Low Cover, Moderate Resistance	2B-Mod Cover, Moderate Resistance	2C-High Cover, Moderate Resistance	3A-Low Cover, Low Resistance	3B-Mod Cover, Low Resistance	3C-High Cover, Low Resistance
Austin	65,916	63,038	378	127,730	241,633	27,748	16,181	94,429	31,337
Ely	107,275	44,827	0	42,774	42,768	0	46,667	86,212	2,419
Jarbidge	30,804	51,009	8,937	15,840	76,415	26,245	0	0	0
Mountain City	79,149	78,759	17,604	22,750	165,256	96,859	3,706	16,352	22,694
Ruby Mountains	29,033	201,731	1,375	8,557	88,385	3,341	42	26,111	2,326

Ranger Districts	1A-Low Cover, High Resistance	1B-Mod Cover, High Resistance	1C-High Cover, High Resistance	2A-Low Cover, Moderate Resistance	2B-Mod Cover, Moderate Resistance	2C-High Cover, Moderate Resistance	3A-Low Cover, Low Resistance	3B-Mod Cover, Low Resistance	3C-High Cover, Low Resistance
Santa Rosa	2,940	94,054	5,217	324	16,855	109,168	0	37,576	24,595
Tonopah	98,174	52,825	0	44,767	79,611	8,610	33,131	165,374	56,346
Grand Total	**413,291**	**586,243**	**33,510**	**262,741**	**710,923**	**271,971**	**99,727**	**426,054**	**139,718**

Appendix T was developed to guide the landscape prioritization process for relative resilience to disturbance and resistance to invasive annual grasses by soil temperature and moisture regime and sagebrush landscape cover. Appendix T complements Table 2 on page 20 of Chambers et al. (2014).

West Wide Risk Assessment

The West Wide Wildfire Risk Assessment (Oregon Department of Forestry et al. 2013) approached the wildfire problem from a risk perspective and developed an appropriate model for all the western states. In turn, it can be used for looking at smaller scales such as geographic areas and forests/grasslands. The findings were compiled in a narrative with a large dataset (geospatial files) made available for this assessment.

The full suite of available data, reports and narratives of the West Wide Risk Assessment are contained within the project file for this assessment including all spatial files. Appendix U contains a list of available spatial files. This information can be used at the local planning level to analyze and assess the landscape; to enhance communication and collaboration across all land ownership, but more importantly contains many data sets such as flame length, suppression difficulty, rate of spread and many other variables that can be used to help inform fire suppression strategies, tactics, and fuels management projects within GRSG habitat.

For the purpose of this assessment two of the data layers were selected to help inform and characterize the existing condition and landscape prioritization. They are Fire Occurrence Areas (FOA) and Fire Threat Index (FTI). Following is a brief description and summary of that information.

Fire Occurrence Areas

A Fire Occurrence Area (FOA) is an area where the probability of each acre igniting is the same (Oregon Department of Forestry et al. 2013). Graphically, if one were to locate the point location for historic ignitions on a map of a FOA, the points would appear to be equally spaced. This data layer is a surface grid of calculated mean ignition rates that represent the probability of a wildland fire igniting. It was developed using the historical fire ignition data. Resultant fire ignition rates are measured in fires per 1,000 acres. Table 8 shows the number of acres of each habitat type by probability of fire ignition within the analysis area. Appendix H is a map of the FOA.

Table 8 Acres of GRSG Habitat within Fire Occurrence Areas

	Fire Occurrence Area Rating					
Ranger Districts	**Very Low**	**Low**	**Moderate**	**High**	**Very High**	**Grand Total**
Austin	215	594,733	56,682	15,943	0	667,573
Ely	2,141	249,399	79,218	32,869	2,155	365,783
Jarbidge		167,636	34,679	6,876	0	209,191
Mountain City	1,660	418,629	69,923	10,983	0	501,196
Ruby Mountains	2,299	251,425	74,969	28,940	307	357,940
Santa Rosa	10,048	243,230	22,085	3,994	0	279,356
Tonopah	576	502,869	28,545	5,965	0	537,954
Grand Total	**16,938**	**2,427,921**	**366,100**	**105,571**	**2,462**	**2,918,993**

While the mathematical probability of a fire occurring on any one acre within GRSG habitat is relatively low as compared to the remainder of the forest, FOA is one of several inputs and a necessary component in the determination of the Fire Threat Index as described below.

Fire Threat Index

Fire Threat Index (FTI) (Oregon Department of Forestry et al. 2013) is calculated as a number greater than zero (0) but less than or equal to one (1) and was further refined to identify adjective ratings of very low to very high. The process used to calculate fire threat relies on the analytical methods that would be used to calculate the probability of an acre burning. The FTI integrates the probability of an acre igniting and fire suppression effectiveness relationships. Due to some necessary assumptions, mainly fuel homogeneity, it is not the true probability. However, since all areas within the analysis area have this value determined consistently, it allows for comparison and ordination of areas as to the likelihood of an acre burning. The process of determining fire threat includes three primary components:

- Fire Occurrence
- Fire Behavior
- Fire Suppression Effectiveness

To calculate FTI, the expected size of a fire needs to be estimated to facilitate estimating the probability of an acre burning. To do this, it was necessary to develop relationships between fire spread rates and the expected final fire size. The inputs to this relationship are the expected fire behavior and a measure of suppression effectiveness of fire protection forces. Fires are assumed to have initial attack response under a full suppression philosophy. For each Weather Influence Zone, the fire occurrence reports were used to develop initial relationships. Via a calibration process, final relationships were developed. Following calibration for a Weather Influence Zone, the predicted annual acres burned are similar to the historic expected acres burned which were developed from the fire occurrence reports. The following Table 9 shows a summary of the FTI to GRSG habitats associated with this assessment. Appendix G displays a map of the FTI.

Table 9 Acres of GRSG Habitat by Fire Threat Index

Ranger Districts	Very Low	Low	Moderate	High	Very High	Grand Total
Austin	48,277	537,259	72,311	9,707	0	667,555
Ely	23,868	238,471	73,293	21,156	1,876	358,664
Jarbidge	2,372	40,031	23,828	50,004	92,943	209,178
Mountain City	10,161	107,587	54,079	163,757	165,542	501,127
Ruby Mountains	8,124	28,091	67,858	152,827	100,982	357,882
Santa Rosa	78,559	190,800	8,953	534	457	279,302
Tonopah	57,834	425,672	51,141	3,282	0	537,929
Grand Total	**229,195**	**1,567,911**	**351,462**	**401,268**	**361,801**	**2,911,636**

Fire Threat Index (FTI)

Fire Threat Index (Appendix G) as described above, was selected as a means to inform the landscape prioritization process.

Habitat Data

Habitat Management Areas

- **Priority Habitat Management Area (PHMA)** - lands identified as having the highest value to maintaining sustainable GRSG populations. The boundaries and management strategies for PHMA are derived from and generally follow the Preliminary Priority Habitat boundaries and the core areas as modeled by Coates et al. (2014). Areas of PHMA largely coincide with areas identified as Priority Areas for Conservation in the COT report. (Note Sagebrush Focal Areas (SFAs) are a subset of this management area.)
- **General Habitat Management Area (GHMA**) - lands where some special management would apply to sustain GRSG populations. The boundaries and management strategies for GHMA are derived from and generally follow the Preliminary General Habitat boundaries and the priority areas as modeled by Coates et al. (2014).
- **Other Habitat Management Area (OHMA)** - lands previously identified as unmapped habitat that are within the planning area and contain seasonal or connectivity habitat areas. With the generation of updated modeling data the areas containing characteristics of unmapped habitat were identified as general areas (Coates et al. 2014) and are now referred to as OHMAs.

Sagebrush Focal Areas (SFAs) – Are a subset of the priority habitat management areas and represent "strongholds" for the species. The SFAs have the highest densities of the species, and other criteria important for the persistence of the species.

Population and Breeding Habitat – Areas identified where sufficient breeding habitat remains to support generally stable or increasing nesting population trends since the 1900's and areas where breeding habitat remains but are relatively small and isolated with nesting populations that have been stable or decreasing since the early 1900's. It was developed to assist land managers in making decisions for conservation of GRSG. The data was developed by BLM and state wildlife agencies.

Local Habitat – Areas identified through the collection of data by Humboldt-Toiyabe NF biologists based on observations and other data sources. It includes:

- Breeding/Nesting habitat
- Brood rearing/Summer habitat
- Connectivity habitat including riparian areas and meadows

Invasive Plant Species

Because there was limited invasive annual grass spatial data for the HTNF, the Resistance and Resilience Matrix (Chambers et al. 2014) was used along with recent fire history (Appendix L) to model potential locations and intensities of annual invasive grass infestations. Potential annual invasive grass infestations within the GRSG analysis area on the Humboldt-Toiyabe NF were modeled using the following methodology: from the resistance and resilience spatial data: 2A, 2B, 2C, 3A, 3B, and 3C polygons were selected. To this fire history polygons from 2006 to the present that were larger than 300 acres were added. This spatial layer provides a forest landscape scale representation of modeled potential annual invasive grass infestations within the GRSG analysis area within the HTNF.

The HTNF has inventoried invasive plant species and treated invasive plant species infestation GIS data. From these spatial layers, treated and inventoried invasive plant infestation acres within the analysis area were determined.

Conifer Encroachment

Conifer encroachment within GRSG habitat was based on the USGS canopy cover layer (USGS, 2016). Conifer encroachment phases I, II, and III were defined according to canopy cover percent, where Phase I was defined for areas $\leq$ 10%, Phase II for areas 10-30%, and Phase III for areas >30%. This dataset was clipped to the analysis area boundary (Appendix M).

Process

The intent of this landscape prioritization was to determine, at the forest level, where management actions and out-year program planning could be most advantageous for the forest to conserve, protect, and enhance GRSG habitat based on the threat of wildfire, invasive annual species, conifer encroachment and to identify opportunities for restoration activities. This approach is a consistent, repeatable process that incorporated all mapped GRSG habitat to represent the program emphasis areas; fire operations, fuels management, invasive species, conifer encroachment, and restoration. A graduated scale of suggested priorities from very low to very high was produced for this assessment specific to each of the program emphasis areas. Future management actions should consider this prioritization process when responding to incidents, designing and implementing treatments, and conducting BAER work resulting from wildfire.

Geographic Information System (GIS) was used to process and merge all data layers together that are applicable for each of the program emphasis areas (Table 10). Priorities were then defined based on the threat and concerns. This process was selected to capture all affected habitat on a comparative basis relative to the level or magnitude of the threat to help inform the decision making process specific to the forest. Table 10 is a breakdown of the spatial products used to define each of these program emphasis areas.

Table 10 Spatial Data Used to Define Program Emphasis Areas

		Program Emphasis Areas				
		Fire Operations	**Fuels Management**	**Invasive Annual Grasses**	**Conifer Encroachment**	**Restoration and BAER**
Threat	Fire Threat	X	X			
	Invasive Annual Grass Species	X		X		
	Conifer Encroachment				X	
Concern	Sagebrush Focal Areas (SFAs)	X	X	X	X	X
	Priority Habitat Management Areas	X	X	X	X	X
	General Habitat Management Areas	X	X	X	X	X
	Other Habitat Management Areas	X	X	X	X	X
	Local - Breeding and Brood Rearing Habitat	X	X	X	X	X
Resistance and Resilience		X	X	X	X	X

The attributes of each data layer were numerically ranked in order of importance with the highest value being the most critical area to protect or target for treatment (Appendix T). Fire threat index received a numerical ranking value of 1 (very low) thru 5 (very high). Resistance and resilience data was numerically ranked for each emphasis area based on the overall objective. Fire operations and fuels management were scored the same while invasives, restoration and conifer encroachment had different scoring because they each have different objectives. Conifer encroachment was numerically ranked based on the stage encroachment is in (Phase I, II or III), targeting the easiest acres to achieve with Phase I being the highest priority value with a numerical ranking of 6 and Phase II scored as 4 and Phase III scored as 2. Sage-grouse habitat types (priority, general, and other habitat) were numerically ranked with a score of 6, 4, and 2 respectively. Areas within SFAs were numerically scored as a 2. Local habitat was also used and consisted of breeding/nesting and brood-rearing/summer habitat both scored as 6, connectivity habitat which also includes non-habitat scored as 4 and specific areas identified by Humboldt-Toiyabe biologists scored as 2. The GRSG total score for habitat equaled all habitat source data scores (HMA, SFA, seasonal habitats, and/or local) added together and that total multiplied by the density of the 3 layer types (1, 2 or 3 based on whether there was a score in one, two or three of the data sources). Areas of invasive annual grasses were treated as light, moderate or heavy infestation potential and were assigned a numeric value of 2, 4, or 6, respectively. The rationale behind the numerical ranking system was to create a data layer with the sum of the highest values being the most critical areas to protect or target for treatments. Once the

data layers were combined into a single representation and the numerical scoring fields were populated, a total score was calculated for each emphasis area based on the objective of each. The GRSG total score and resistance and resilience values were included as part of the equation for each emphasis area. Resistance and resilience scores were added to further emphasize the relative importance of highest quality habitat, and least risk for invasive establishment or expansion, as strategies were developed based on Chambers et al (2014) for wildfire, conifer encroachment, and invasive annual grasses that would address these three threats. The final score was separated in five percentile breakpoints to assign a rating of very low to very high. Appendix T outlines the process and parameters for all data used in this prioritization process by each emphasis area.

Findings

Fire Operations Program Emphasis Area

- There is a need to protect existing habitat from large scale fire. Approximately 38% of the categorized habitat has a moderate, high or very high fire threat index and approximately 16% of the habitat is in moderate, high or very high fire occurrence areas.

Based on the need identified above and review of existing conditions the following actions will provide enhanced protection and conservation of GRSG habitat specific to Fire Operations Program Emphasis Areas.

- Conduct road maintenance such as brush/blade (476 mi) of identified road to improve response times (Appendix I).
- Consider a more robust long-term road maintenance program in an effort to retain access to critical habitat.
- Consider using severity funding to increase capacity at lower NFDRS thresholds.
- Deploy remote cameras in GRSG habitat, high fire frequency areas, and ongoing incidents to improve situational awareness and detection of fire starts.
- Develop mobile applications and provide devices for fireline leadership to improve situational awareness.
- Install mobile hotspot technology in fire vehicles in order to utilize mobile applications.
- Improve mission capability of existing radio/repeater infrastructure.
- Consider adding facilities or improving existing facilities for the addition of resources (for example, at Gold Creek).
- Formalize weed washing program and invest in wash stations where other options are not available.
- Consider increasing employee tours as a retention tool.
- Reference the Humboldt-Toiyabe Fire Management Resource Enhancement Proposal. Specifically:
- Augment current organizational chart and positions to include:
    - Add 3 additional Type VI Fire Engines to the Forest's existing engine complement: 1 on the Santa Rosa RD, 1 on Mountain City/Ruby Mountain/Jarbidge RDs, and 1 on Austin-Tonopah/Ely RDs
    - 1 GS-09 PFT Assistant Fire Management Officer (Santa Rosa RD)
    - 1 GS-08 PFT Fire Operations Specialist (Austin-Tonopah/Ely RD)

- 3 GS-07 18/8 Fire Prevention Technicians (Santa Rosa RD, the Mountain City/Ruby Mountains/Jarbidge RDs and the Austin-Tonopah RDs)

- Identify critical GRSG habitat on adjoining jurisdictions and/or other administrative boundaries.
- Utilize the FOA maps to determine logical areas to implement fire prevention strategies.
- Identify fire priority areas, digitize, and input into the Wildland Fire Decision Support System (WFDSS).
- In an effort to increase capacity and availability of Resource Advisors, formalize training.
- Consider developing water resources such as heli-wells and other drafting sites for resources to shorten "turn" times on incidents.
- When Forest and Zone Duty Officers identify that forest resources are spread thin, or short due to multiple starts and fire activity, the appropriate resources orders will be placed through Elko Interagency Dispatch Center.
- Re-classify the standard engine modules for a moderate level complexity to a high complexity rating and adding an additional two firefighters to each module to increase available suppression resources from 5 day to 7 day staffing.

Based on the need identified above, but not analyzed in the existing conditions, the following actions have been identified by resource specialists to provide enhanced protection and conservation of GRSG habitat that are applicable to the Humboldt-Toiyabe National Forest.

- Coordinate with BLM concerning the interagency response zones and ensure run-cards have been modified to incorporate additional response to pre-identified GRSG habitat.
- Review Statewide protocol for backfilling resources

Considerations/Recommendations

- ✓ Consider developing a timeline to address the actions identified above that are a result of this assessment.
- ✓ Consider the use of the Fire Operations Program Emphasis Area map to inform the decision making process for fire suppression, and pre-planning suppression activities (Appendix B).
- ✓ Determine NFDRS thresholds for staffing needs that account for increased risk to GRSG habitat to determine severity request funding thresholds to increase capacity for the critical fire season.
- ✓ Any additions to the existing staffing, infrastructure, or pre-attack planning should be well coordinated with interagency partners so as to achieve maximum efficiency across jurisdictional protection areas, including rural fire protection districts having responsibility for rangeland fire protection, and other local partners.

Fuels Management/Conifer Encroachment Program Emphasis Areas

- ❖ There is a need to manage the landscape through a variety of management activities in order to conserve, maintain and enhance GRSG habitat into the future. There are approximately 1,390,247 acres of conifer encroachment, and approximately 476 miles of fuel breaks that utilize the existing road network, as identified through this assessment, that could provide beneficial actions to maintain, conserve and enhance GRSG habitat.

Table 11 is a list of current and planned activities for either fuels management or conifer encroachment in GRSG habitat for the HTNF.

Table 11 List of Current and Planned Fuels and Conifer Encroachment Activities

District	Project Name	Project Phase	Acres
Austin/Tonopah	Antelope Peak Unit N Monitors	Implementation	3,250
Austin/Tonopah	Antelope Peak Willow Creek Subunit	Implementation	300
Austin/Tonopah	Kingston	Implementation	400
Austin/Tonopah	Horse Heaven Unit N Monitors	Planning	
Austin/Tonopah	Big Ten Mustang Meadow Unit	Implementation	500
Austin/Tonopah	Cloverdale	Implementation	300
Austin/Tonopah	Austin WUI	Planning	
Austin/Tonopah	McGinness Hills P/J	Implementation	1,000
Austin/Tonopah	Little Fish Valley-Monitor Valley	Implementation	1,000
Austin/Tonopah	Craver Bench Phase 1 P/J Cutting	Implementation	500
Austin/Tonopah	Pasco Canyon Phase 1 P/J cutting	Implementation	500
Austin/Tonopah	Big Ten/Hat Creek Steves Unit	Implementation	200
Ely	Mt Moriah	Planning	
Ely	North Schell	Implementation	3,000
Ely	Ward Mt.	Implementation	2,500
Ely	Currant/Ellison	Implementation	1,850
Ely	Adaven	Implementation	1,000
Ely	Ward Mountain	Implementation	1,750
Ely	Worthington	Implementation	200
Ely	Central White Pine	Implementation	750
Ely	Duck Creek Basin PJ cutting	Implementation	300
Ruby Mountains	Jiggs / Smith Creek WUI	Implementation	750
Ruby Mountains	Ruby Guard / East Rubies	Implementation	1,000
Ruby Mountains	Spring Creek WUI	Implementation	3,000
Ruby Mountains	Overland	Implementation	5,000
Ruby Mountains	Harrison Watershed	Implementation	1,500
Ruby Mountains	Lamoille Canyon WUI	Implementation	150
Jarbidge	T Creek	Implementation	1,000
Jarbidge	Bear Creek Watershed	Implementation	3,000
Santa Rosa	Green Strip Maintenance	Implementation	280
Santa Rosa	Bitterbrush Sage Brush Planting	Implementation	200

Based on the need identified above and review of existing conditions, the following actions could provide enhanced protection and conservation of GRSG habitat specific to Fuels Management and Conifer Encroachment Program Emphasis Areas.

- Develop a funded program of work to accomplish fuels treatment of 13,350-20,200 acres of Phase I conifer encroachment per year.

- Develop a funded program of work to analyze and, if determined feasible, conduct prescribed burning across 14,250 acres of Phase II and III conifer encroachment per year.
- Blade (416 miles) of identified road ROW, widening and improving, to provide fuels breaks and taking proactive measures to inhibit the establishment of cheat grass/invasive species. (Appendix J)
- Brush (457 miles) of identified road ROW, widening and improving, to provide fuels breaks and taking proactive measures to inhibit the establishment of cheat grass/invasive species. (Appendix J)
- Brush/blade (476 miles) of identified road ROW, widening and improving, to provide fuel breaks and take proactive measures to inhibit the establishment of cheat grass/invasive species in these ROWs. (Appendix J)
- Develop mosaics on the sagebrush landscape to break up continuous fuels to interrupt the spread and intensity of wildfires.
- Continue to analyze mechanical treatments as identified by forest resource specialists in an effort to create multi-aged mosaic, thus creating a landscape that is less conducive to large fire growth.

Based on the need identified above, but not analyzed in the existing conditions, the following actions have been identified by resource specialists to provide enhanced protection and conservation of GRSG habitat that are applicable to the Humboldt –Toiyabe National Forest.

- Increase planning (GIS, interdisciplinary (ID) team personnel) capacity to meet and exceed 5 year plan and ROD GRSG Plan Amendment objectives
- Add Human Resources, grants and agreements, and contract staff on the HTNF to specifically address existing and projected needs as they pertain to GRSG
- Add 20-person fuels crew possibly in Ely, Elko or Gold Creek
- Add a fuels and a suppression AFMO for the northeast zone/Santa Rosa
- Add a GS-11 and GS-09 fuels personnel for the northeast zone
- Add two GS-11 vegetation specialists or foresters for the northeast zone and one for the central zone
- Consider purchasing a masticator and/or chipper for the Forest
- Continue to work with other agencies and partners on agreements for vegetation/fuels treatments working across boundaries to tie in treatment areas and utilize resources
- Implement and fund recommendations of the Nevada Cohesive Strategy Resilient Landscapes sub-group
- Complete programmatic agreement(s) with State Historic Preservation Office (SHPO) in order to streamline project analysis and review

Methods to consider applicable to the Humboldt-Toiyabe National Forest

- Lop and scatter treatment of Phase I conifer encroachment that will not result in excessive fuel loading, or the expansion of cheatgrass or other invasive species.
- Employ mastication treatments of the Phase II conifer encroachment that will not result in excessive fuel loading followed by an evaluation for restoration needs.
- Lop/scatter or lop/scatter/pile (mechanical, handcut/pile) treatment in areas of Phase II conifer encroachment followed by an evaluation for restoration needs.

- According to the ROD guidelines, Phase III treatments should only be authorized to create movement corridors, connect habitats, or reduce the potential for catastrophic wildfire.
- Cut/haul/burn on site Phase III conifer encroachment followed by establishment and restoration of native species.
- Mechanical pile and burn Phase III conifer encroachment followed by establishment and restoration of native species.
- Cut/haul/biomass treatment of Phase III conifer encroachment followed by restoration of native species.
- Use prescribed fire where conditions allow. According to ROD guidelines, "do not use prescribed fire in 12-inch or less precipitation zones unless necessary to facilitate restoration of greater sage-grouse habitat consistent with desired conditions… or for pile burning".

Considerations/Recommendations

- ✓ Consider developing a timeline to address the actions identified above, resulting from this assessment.
- ✓ Consider the use of the Conifer Encroachment Program Emphasis Area map to inform the decision making process when designing and implementing conifer encroachment treatments (Appendix D)
- ✓ Consider integrating areas of Phase II and Phase III conifer encroachment into the "Red Yellow Green" maps the Forest uses to aid in the decision to use a managed fire approach to meet LMP objectives.
- ✓ Consider a strategy of developing fuel breaks that are in timber adjacent to habitat, to supplement fire suppression actions before fire arrives in habitat.
- ✓ Planning project areas, NEPA analyses, scheduling, and implementation should be well coordinated with interagency partners so as to have maximum efficiency across administrative boundaries, including private landowners and other local partners. Opportunities for collaboration are highly encouraged.
- ✓ To foster collaboration with adjoining agencies, cooperators, community leaders and to improve communication of fire threat and risk to GRSG habitats, consider using the West Wide Risk Assessment data that is provided. A description of available data layers are contained in Appendix U.
- ✓ Consider the use of the Fuels Management Program Emphasis Area map to inform the decision making process when designing and implementing fuels management treatments. (Appendix C)
- ✓ Consider implementing fuel treatments in areas that exhibit elevated Fire Occurrence (FOA) and are adjacent to GRSG habitat. (Appendix H)
- ✓ Consider implementing fuel treatments in areas that exhibit an elevated Fire Threat Index and are adjacent to GRSG habitat. (Appendix G)
- ✓ Hazardous fuels treatments in GRSG habitat in the wildland urban interface should focus on fine fuels treatments to reduce invasive annuals, and disrupt the repetitive burning cycle, followed by the establishment of native perennial vegetation thereby reducing spread rates, minimizing fire size, protecting private values at risk within and adjacent to GRSG habitat.
- ✓ Focus on conifer encroachment in the wildland urban interface using mechanical treatments to reduce the potential for undesirable fire behavior and effects, followed by the restoration of native vegetation thereby reducing spread rates, minimizing potential fire size, reducing the risk to private property values within and adjacent to GRSG habitat.

Invasive Plants/Restoration/BAER Program Emphasis Areas

- There is a need to manage the landscape through a variety of management activities in order to conserve, maintain and enhance GRSG habitat into the future. Through this assessment it was determined that there is modeled potential of invasive annual grass infestations on 2,018,019 acres within GRSG habitat on the forest that would benefit from invasive annual grass treatment.
- The Humboldt-Toiyabe NF did not identify any specific areas for restoration opportunities at this time.

Based on the need identified above and review of existing conditions the following actions will provide enhanced protection and conservation of GRSG habitat specific to Invasive Plants, Restoration/BAER Program Emphasis Areas

- Develop a funded program of work to spray and reseed a range of 43,000 – 201,800 acres of non-native, invasive species per year.
- Develop and use weed-washing stations at locations on each Ranger District.
- Conduct EIS for aerial application of herbicides.
- Improve the functionality of wetlands and riparian areas, including the restoration of water tables that have dropped due to incision, to promote competition against invasives by native species.
- Coordinate and collaborate with external partners for invasive control.

Methods to consider applicable to the Humboldt-Toiyabe National Forest

- Seek opportunities to develop target grazing of cheatgrass within the estimated potential invasive annual grass infestations (2,018,019 acres).
- Use biological agents to help efforts to control the potential 2,018,019 acres that have a potential of invasive annual grasses on the forest, GRSG habitat in addition to the current program already in place.
- Use bio-control on invasive species followed by reseeding natives.
- Develop grazing systems that are designed to promote healthy sagebrush ecosystems.

Considerations/Recommendations

- ✓ Consider developing a timeline to address the actions identified above resulting from this assessment.
- ✓ Consider using the Annual Invasive Program Emphasis Area map to inform the decision making process when prioritizing, designing and implementing invasive annual treatments (Appendix E).
- ✓ Consider using the Restoration/BAER Program Emphasis Area map to inform the decision making process when prioritizing, designing and implementing restoration treatments and post fire restoration (Appendix F).
- ✓ Consider developing a funding mechanism for post-fire restoration that is aligned with natural succession (e.g. BLM's Emergency Stabilization and Rehabilitation). As it currently stands, budget distribution for this kind of work is limited in its application over time.

- ✓ Planning project areas, NEPA, scheduling, and implementation should be well coordinated with interagency partners so as to have maximum efficiency across administrative boundaries, including private landowners and other local partners. Opportunities for collaboration are highly encouraged.
- ✓ Develop a comprehensive monitoring program that can be implemented over many decades.
- ✓ Consider increasing invasive species invasion, spread, and control education, beyond what already exists.
- ✓ Consider the identification and rehabilitation of non-system routes. This should be well coordinated with fire management staff to ensure the rehabilitation of non-system routes do not conflict with potential access points and fuel breaks.
- ✓ Consider creating weed-washing stations at each Forest office for the local fleet.
- ✓ Continue an aggressive weed-washing requirement for vehicles from off-forest as they are mobilized and demobilized, even on the smallest fires.
- ✓ Consider developing a native plant seedbank, including sagebrush seed, for response to post-fire and other disturbance restoration that is commensurate with the modeled potential for 2,018,019 acres of invasive annuals.

Conclusion

This assessment team's findings are that sagebrush ecosystems on the HTNF are threatened, to varying extents, by wildland fire, conifer encroachment, and non-native, invasive annual grasses; primarily cheatgrass and medusahead. The team considered the GRSG Conservation Team (COT) report (USFWS 2013), recent scientific research on resistance and resilience of Great Basin ecosystems (Chambers et al. 2014), and implemented an analysis that incorporated the best available science, current research, computer modeling, geospatial information and local intelligence provided by Humboldt-Toiyabe National Forest employees.

The three primary threats were identified on the landscape and solutions were brought forward by the Forest staff. The assessment team then further quantified and authored this document providing a summary of quantitative findings, potential treatment methods, recommendations and considerations. These findings will aid the Forest in developing a framework for future programs of work to address these identified major threats to sagebrush ecosystems on the Humboldt-Toiyabe National Forest.

To further enhance communications with personnel, forest staff, and other federal, state, and local resources a comprehensive set of spatial products was produced for this assessment and is listed in the appendixes. All spatial products are geo-referenced for ease of data transfer and sharing with field going personnel.

The findings and recommendations in this report will support the USFWS goal to promote the long-term conservation of the GRSG as indicated in Appendix S. It additionally will aid the Humboldt-Toiyabe National Forest in its stewardship of healthy sagebrush, shrub, and native perennial grass and forb communities by maintaining viable, connected, and well-distributed populations and habitats across the Forest in partnership with adjoining federal, state, and private lands.

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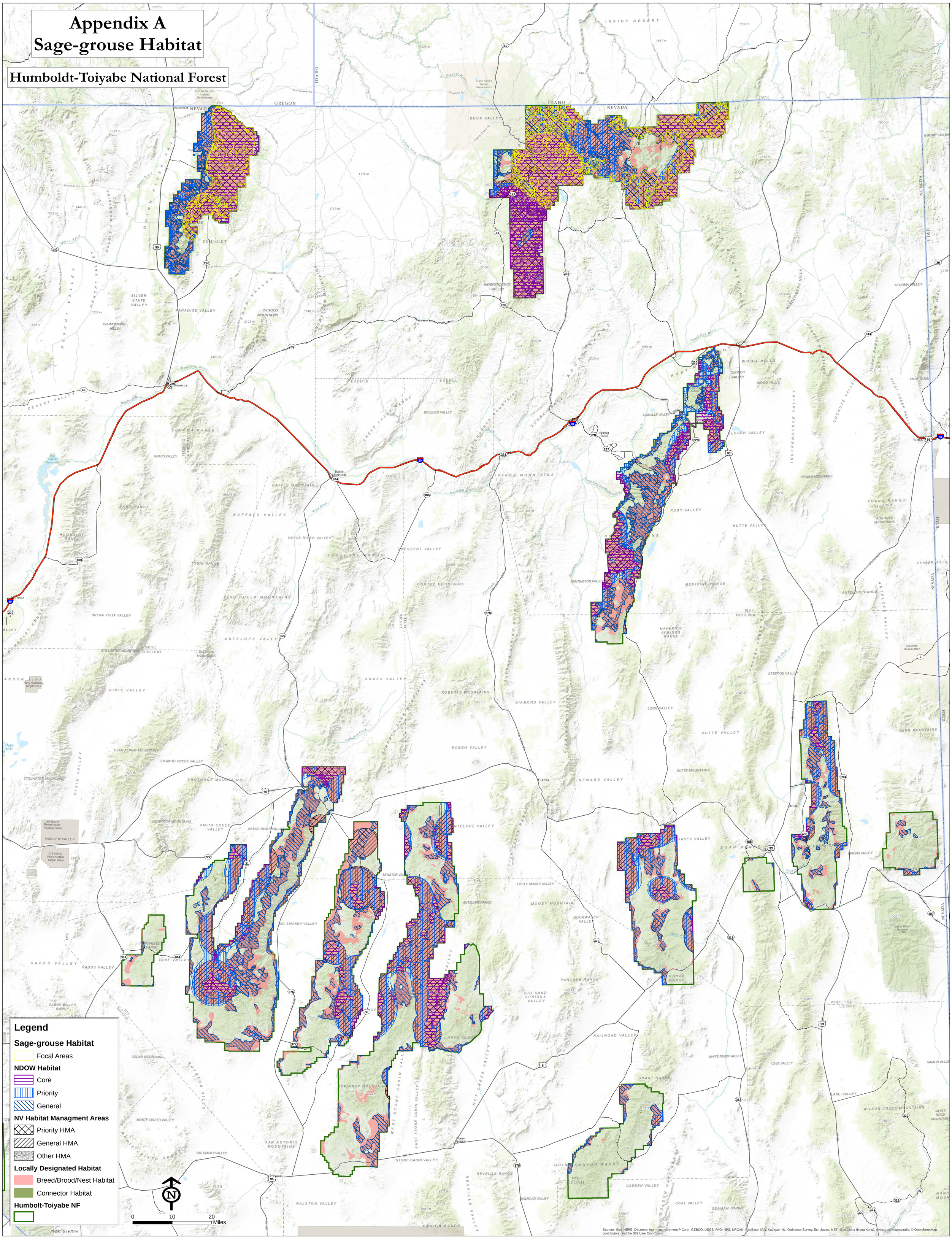
Appendices

Appendix A Sage-grouse Habitats

Appendix A
Sage-grouse Habitat

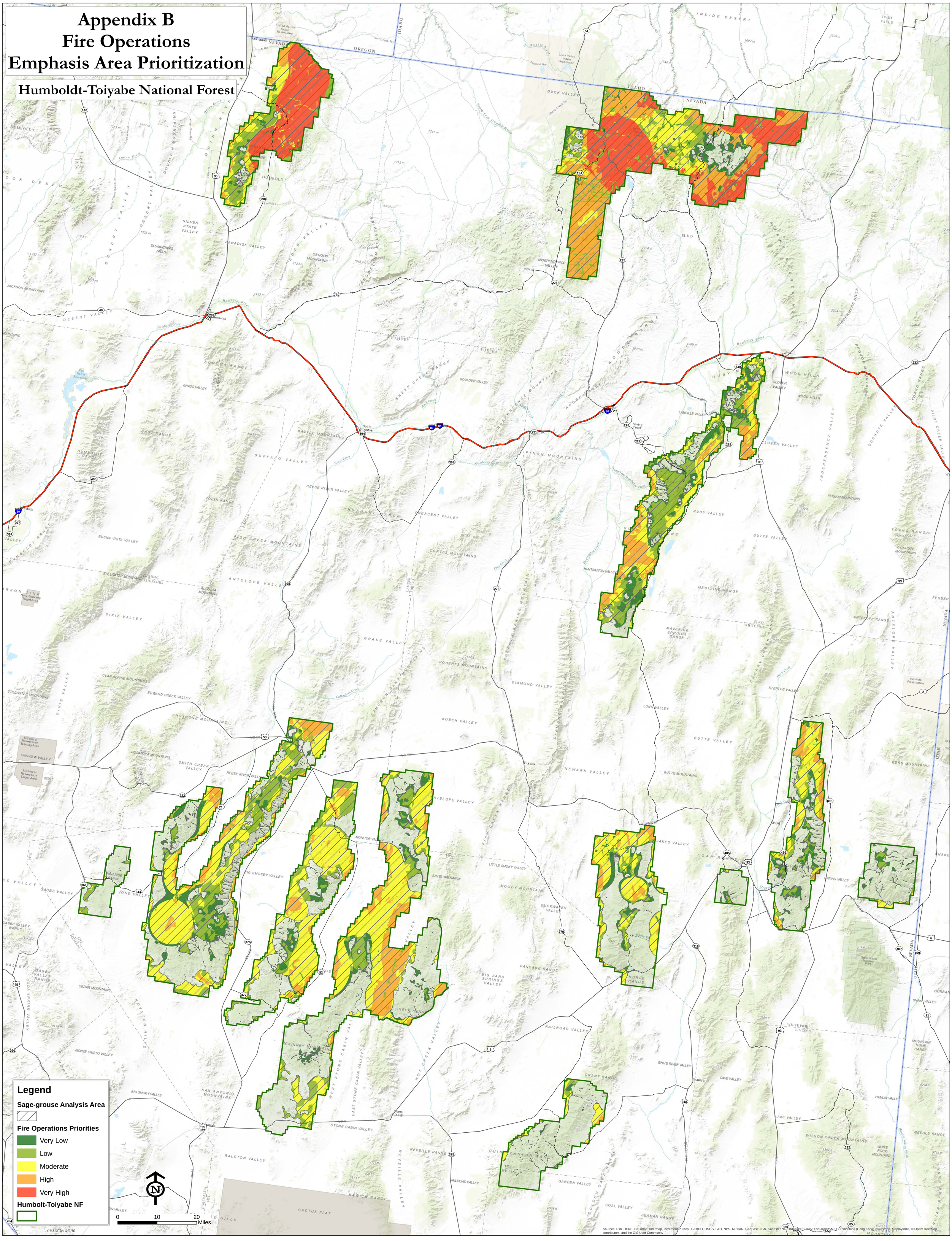
Humboldt-Toiyabe National Forest



Appendix B Fire Operations Program Emphasis Area Prioritization

Appendix B
Fire Operations
Emphasis Area Prioritization

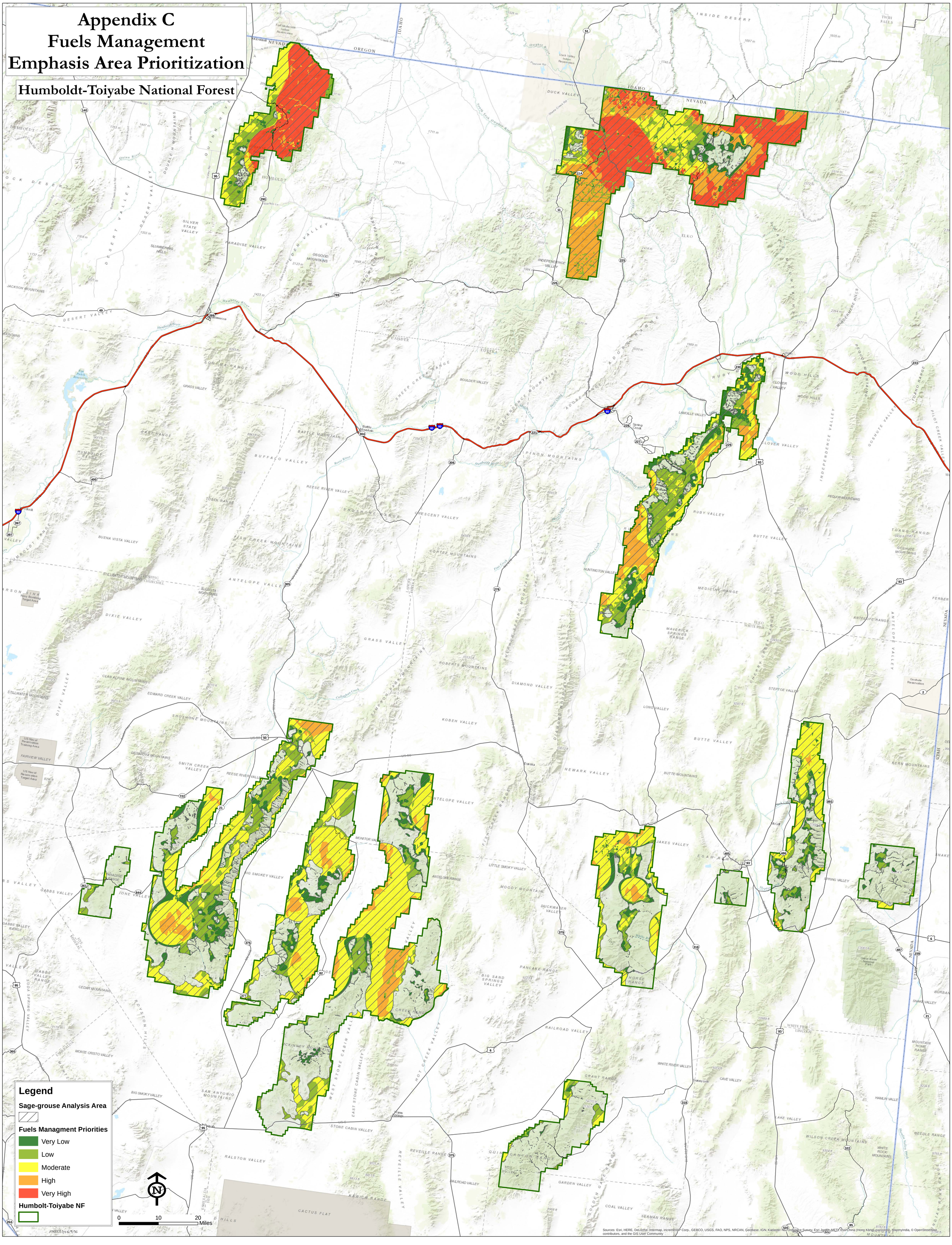
Humboldt-Toiyabe National Forest



Appendix C Fuels Management Program Emphasis Area Prioritization

Appendix C
Fuels Management
Emphasis Area Prioritization

Humboldt-Toiyabe National Forest



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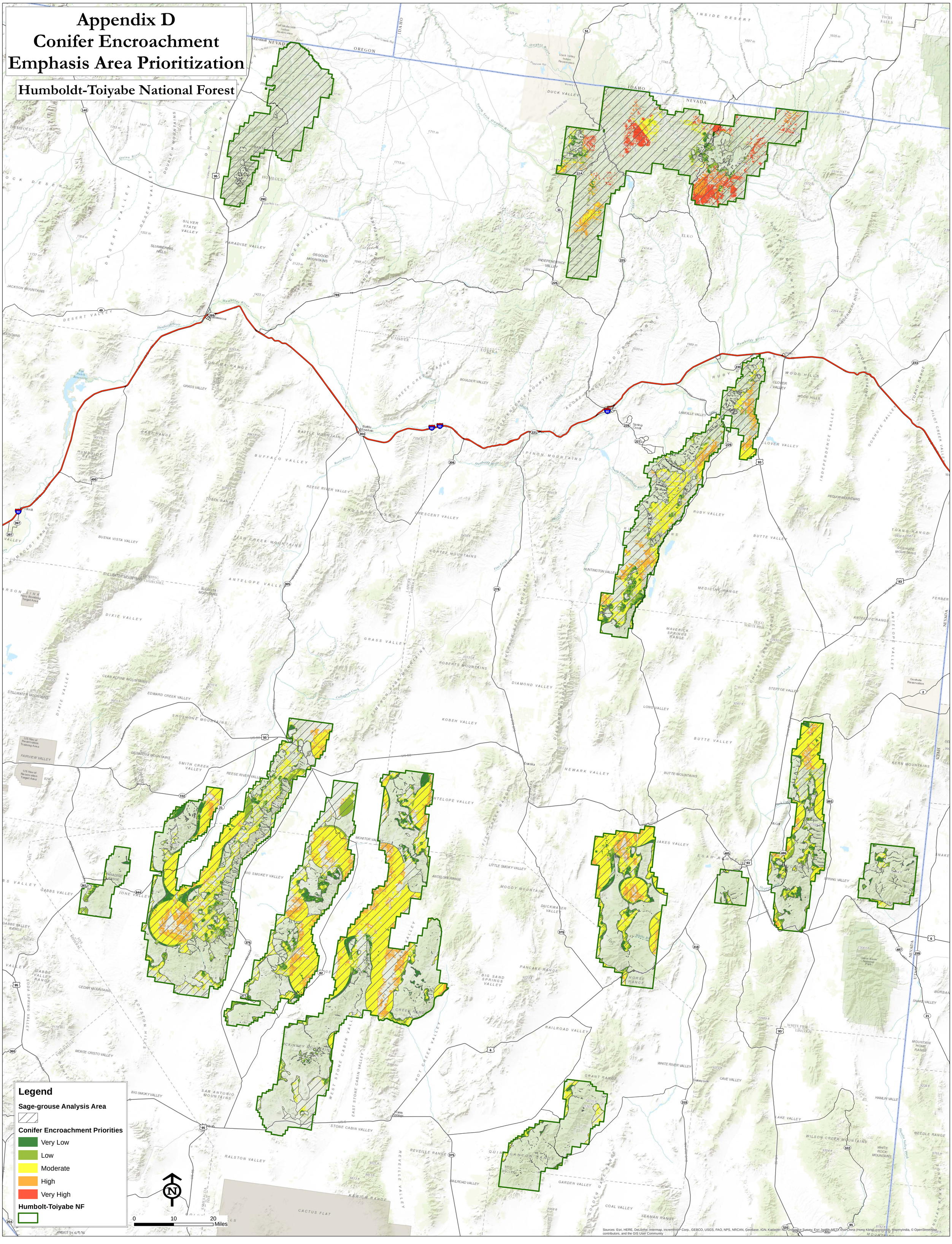
Appendix D Conifer Encroachment Program Emphasis Area Prioritization

Appendix D
Conifer Encroachment Emphasis Area Prioritization

Humboldt-Toiyabe National Forest



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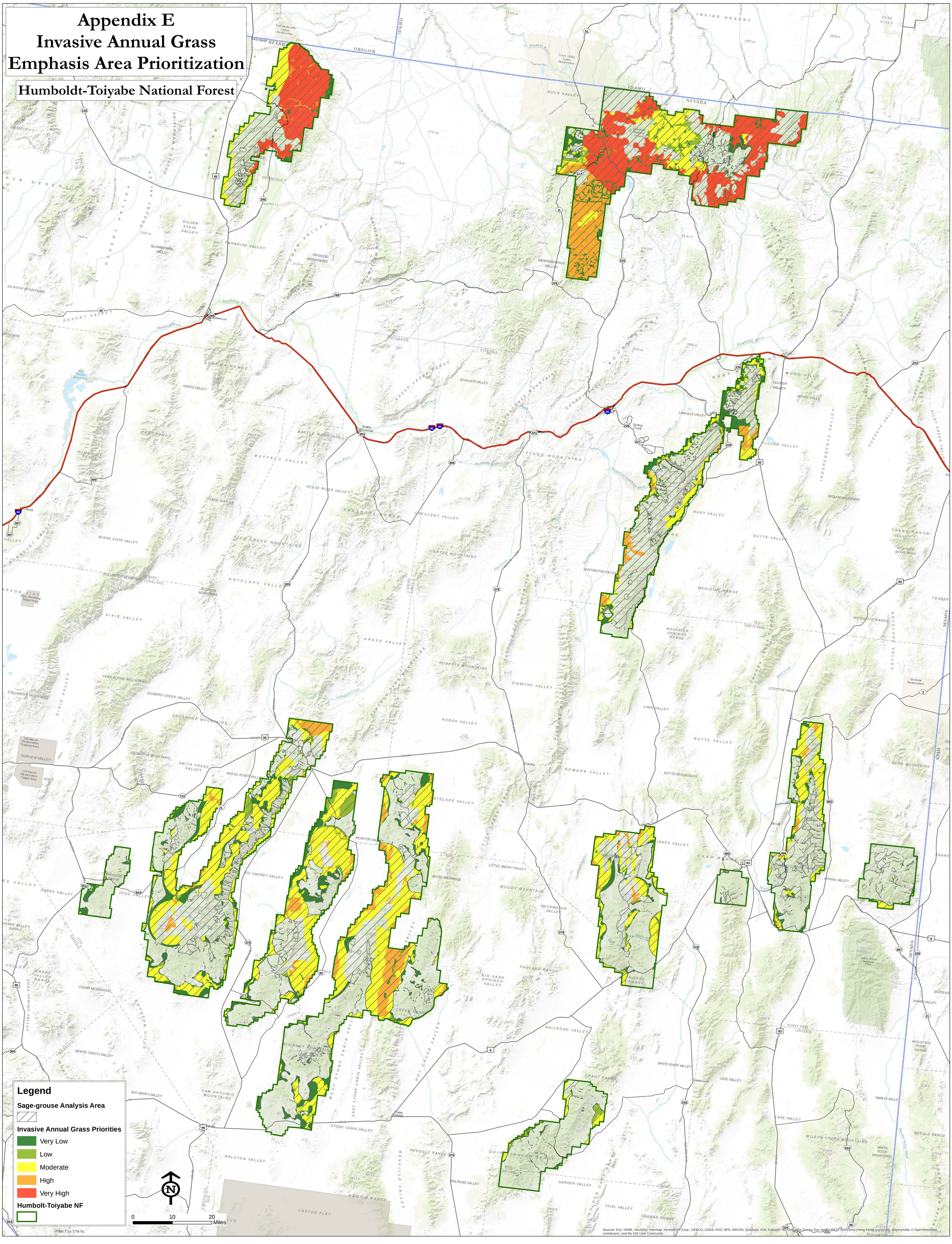
Appendix E Invasive Annual Grass Species Program Emphasis Area Prioritization

Appendix E
Invasive Annual Grass Emphasis Area Prioritization

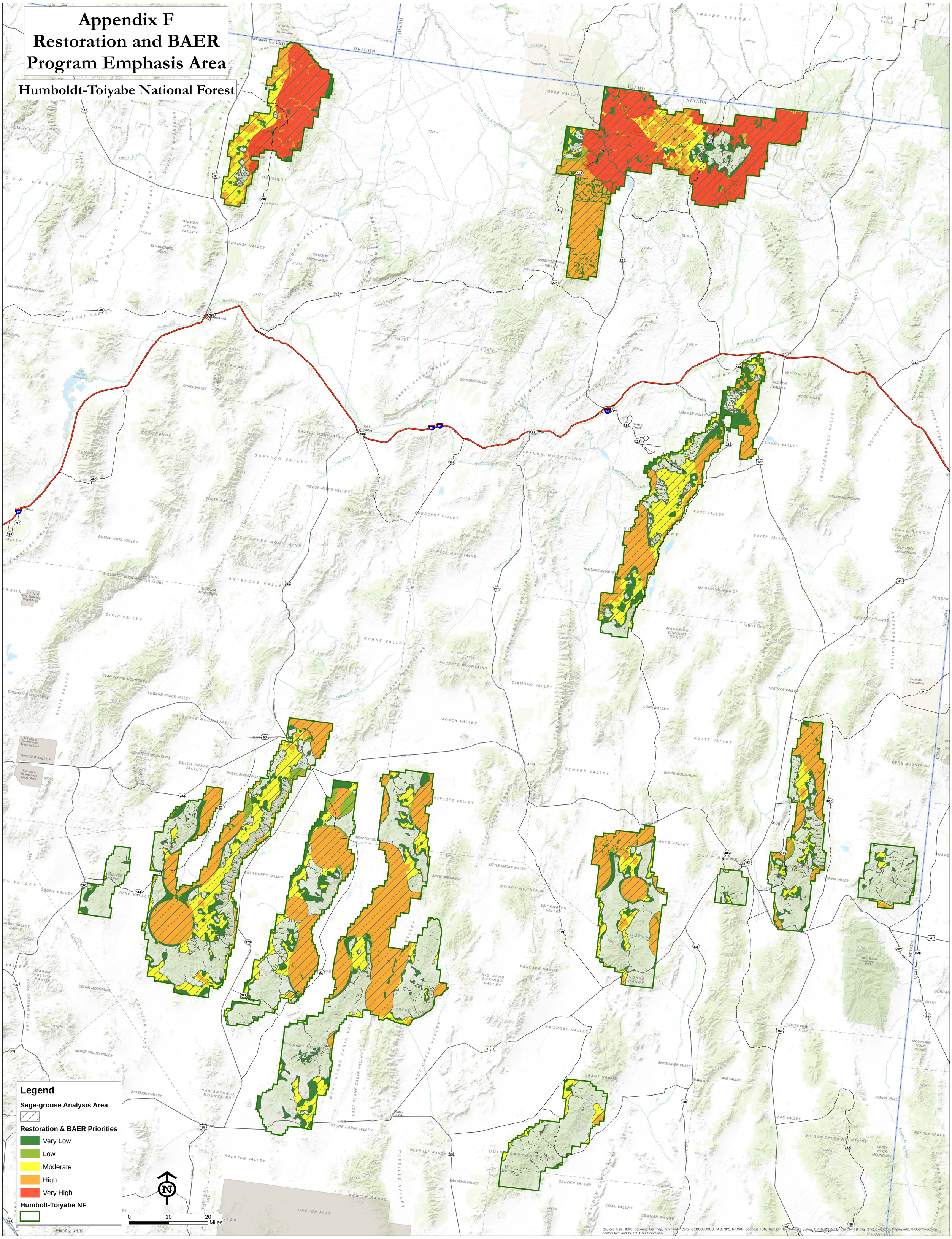
Humboldt-Toiyabe National Forest



Appendix F Restoration/BAER Program Emphasis Area Prioritization

Appendix F
Restoration and BAER Program Emphasis Area

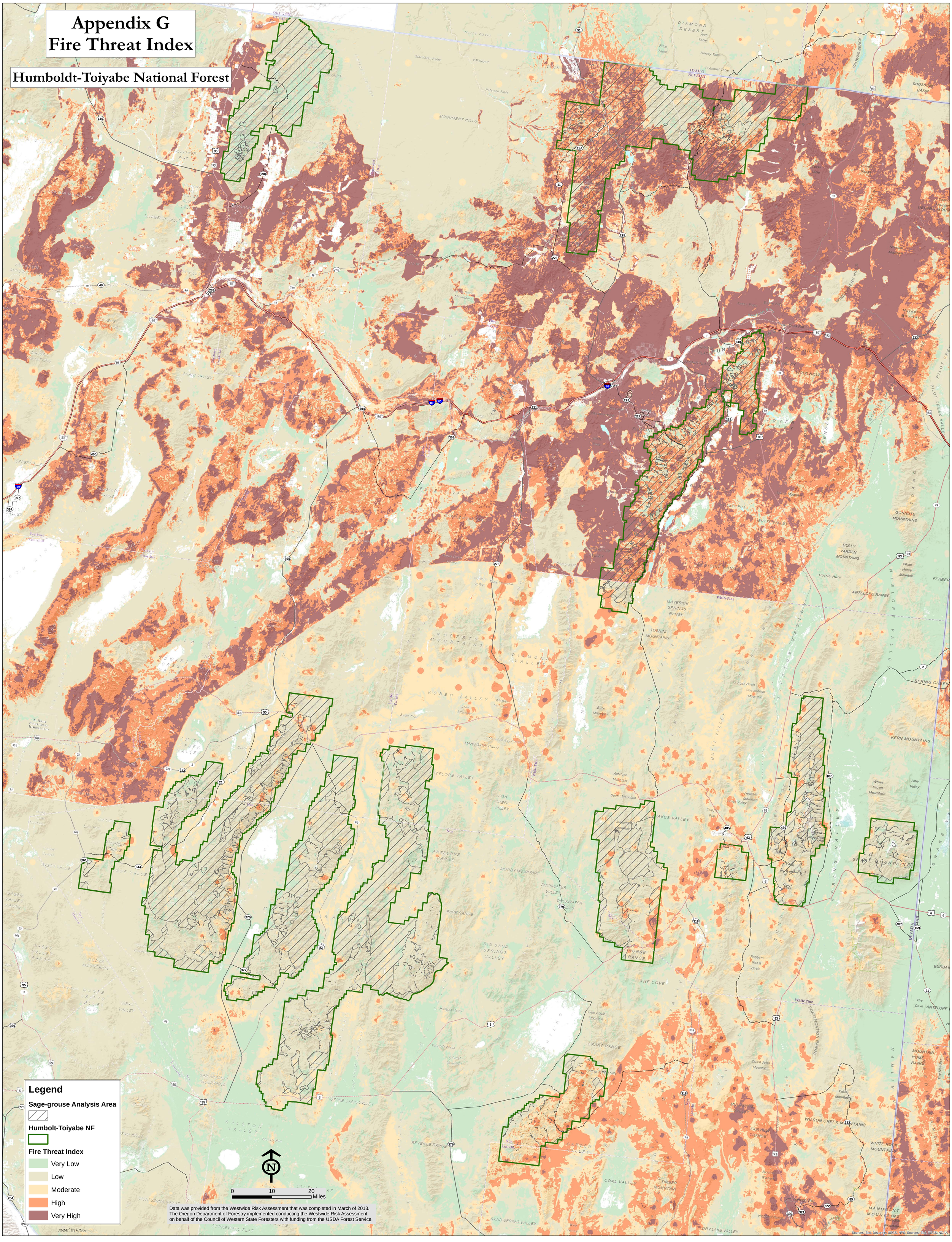
Humboldt-Toiyabe National Forest



Appendix G Fire Threat Index

Appendix G
Fire Threat Index

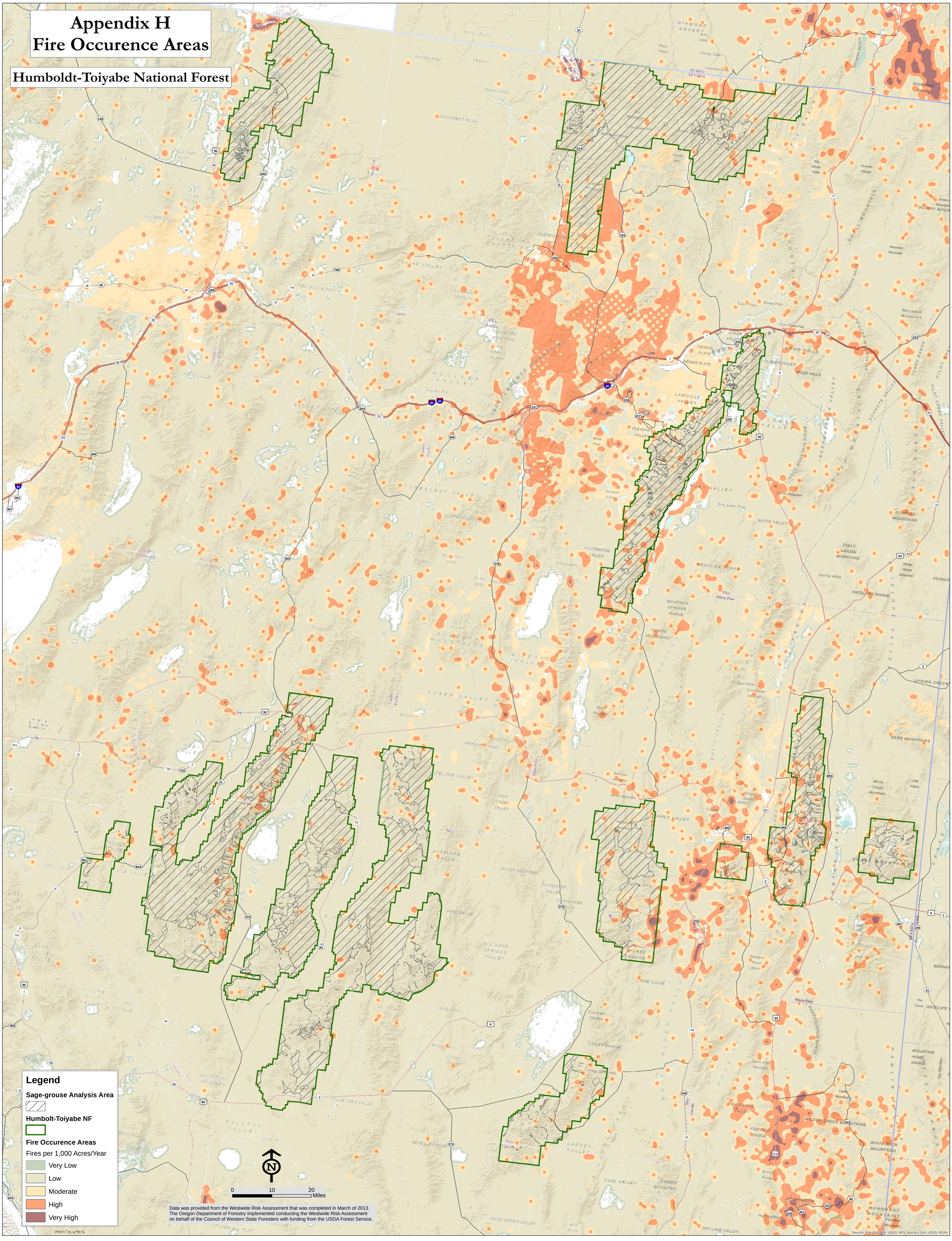
Humboldt-Toiyabe National Forest



Appendix H Fire Occurrence Area

Appendix H
Fire Occurence Areas

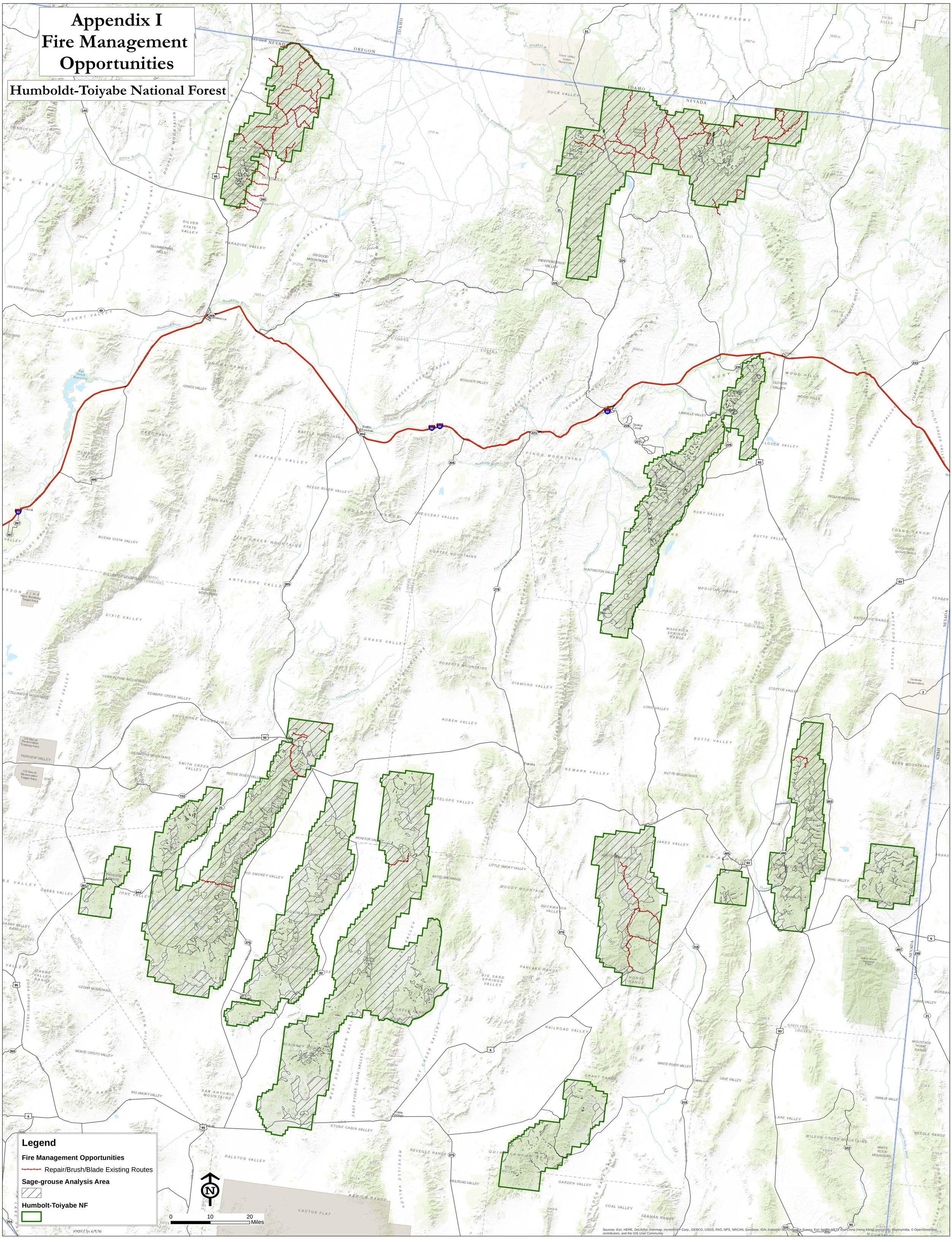
Humboldt-Toiyabe National Forest



Appendix I Fire Management Opportunities

Appendix I
Fire Management Opportunities

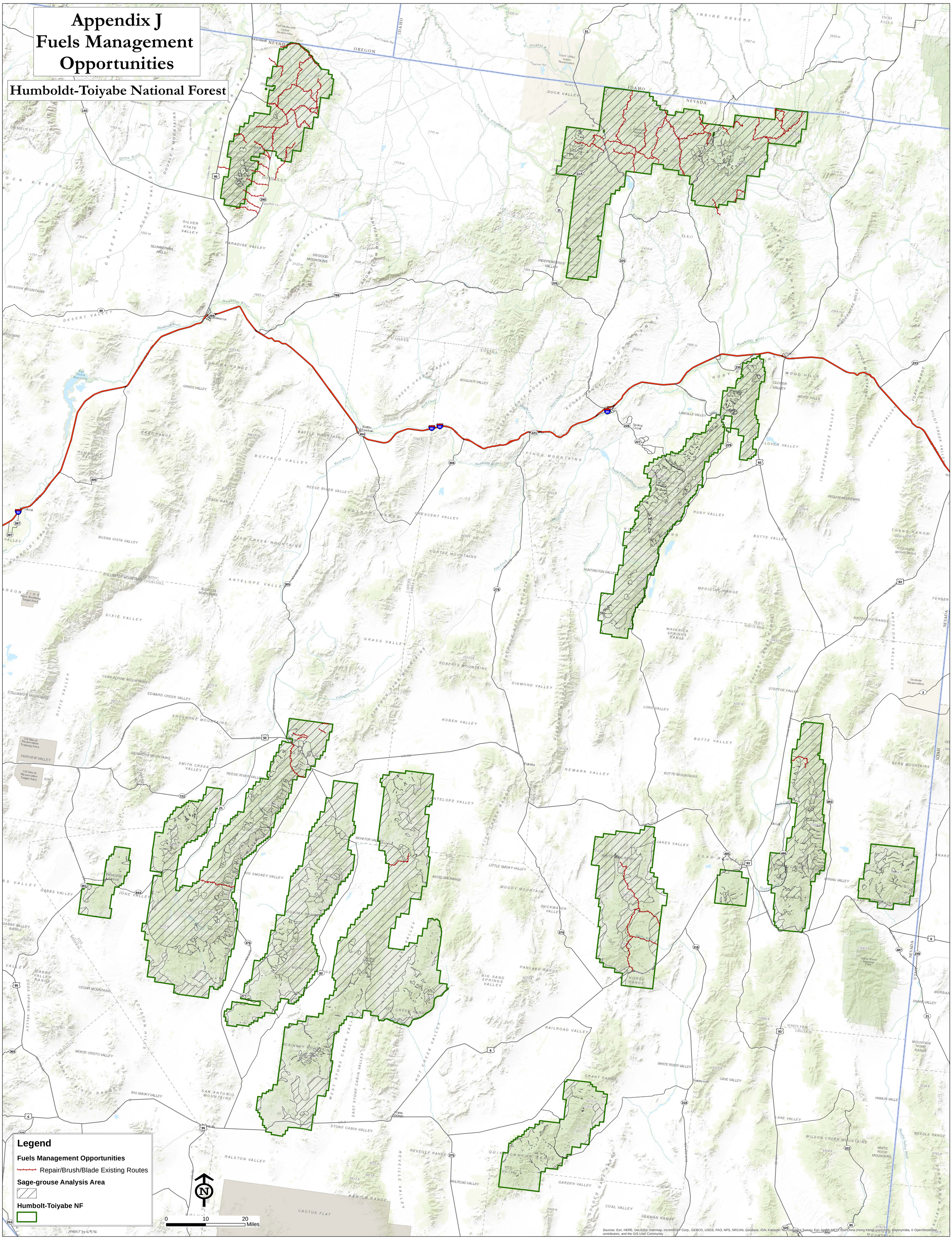
Humboldt-Toiyabe National Forest



Appendix J Fuels Management Opportunities

Appendix J
Fuels Management Opportunities

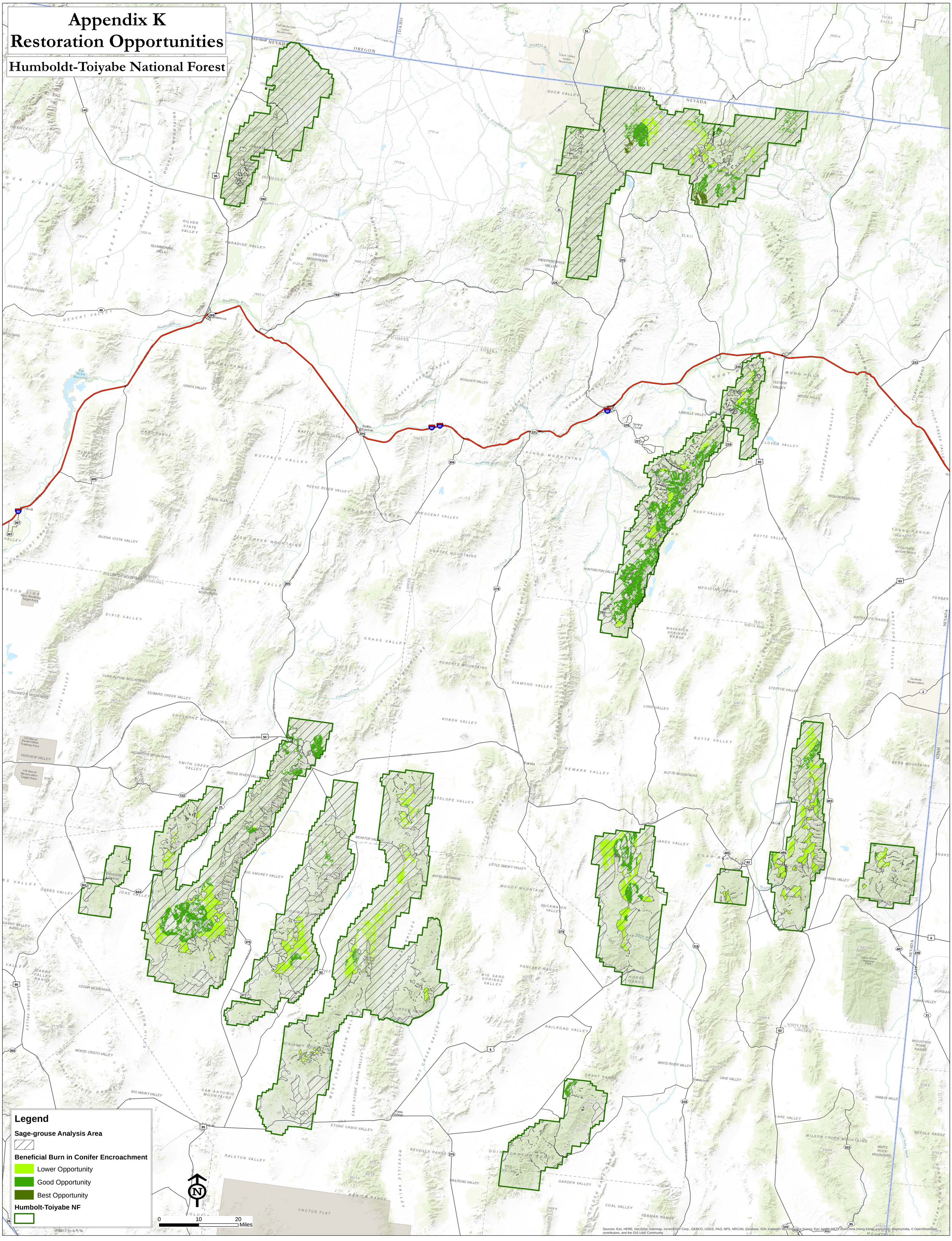
Humboldt-Toiyabe National Forest



Appendix K Restoration Opportunities

Appendix K
Restoration Opportunities

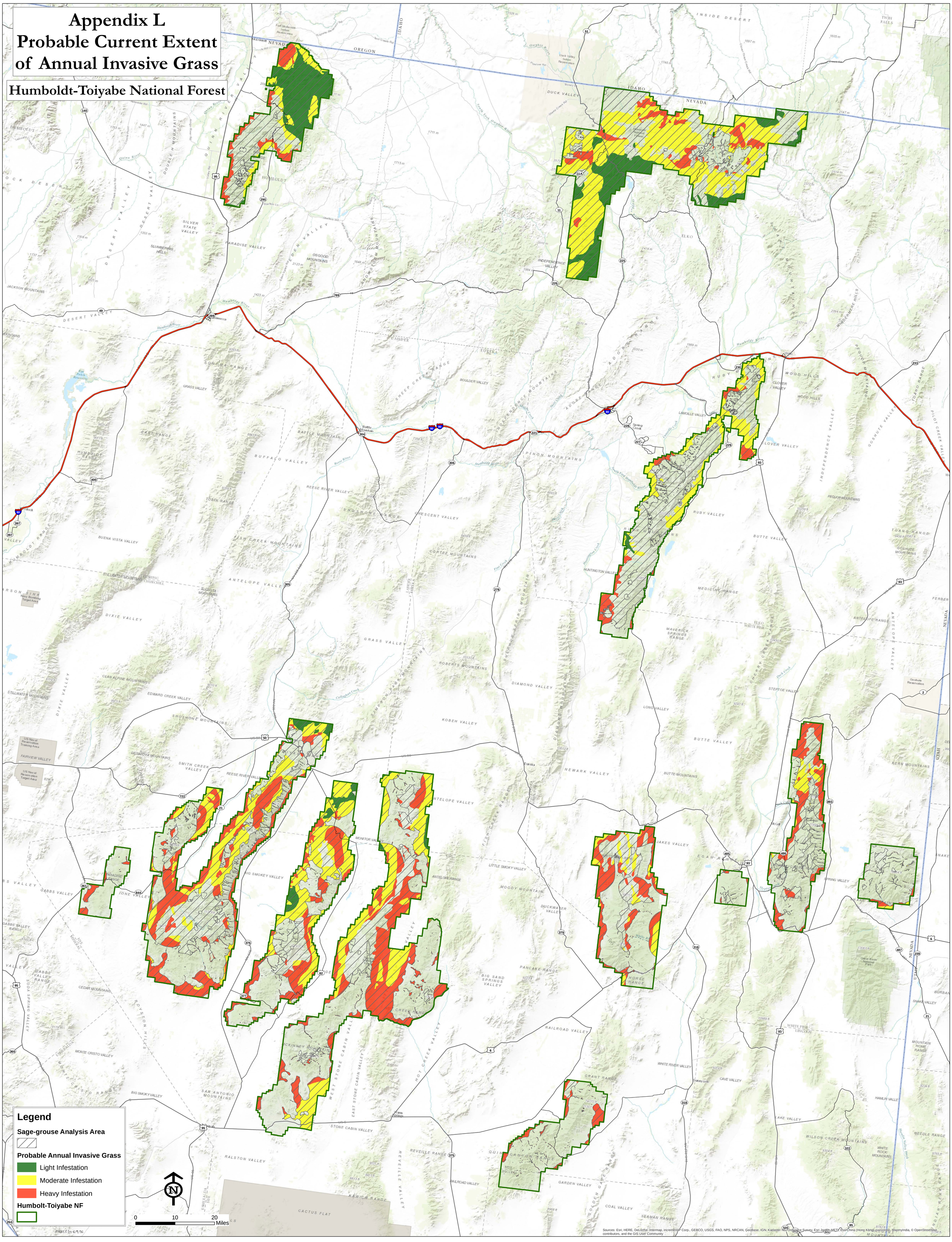
Humboldt-Toiyabe National Forest



Appendix L Current Extent of Invasive Annual Grasses

Appendix L
Probable Current Extent of Annual Invasive Grass

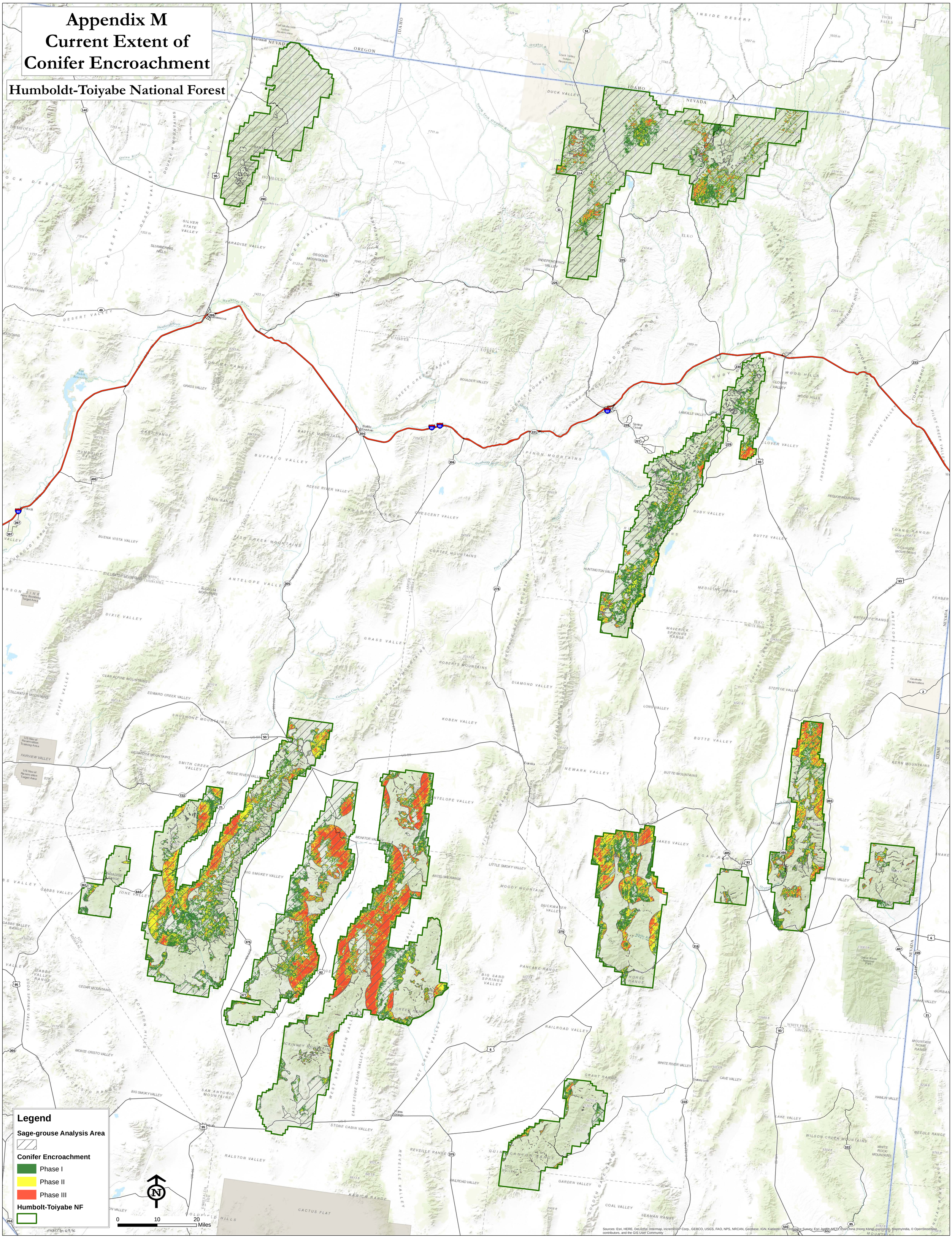
Humboldt-Toiyabe National Forest



Appendix M Current Extent of Conifer Encroachment

Appendix M
Current Extent of Conifer Encroachment

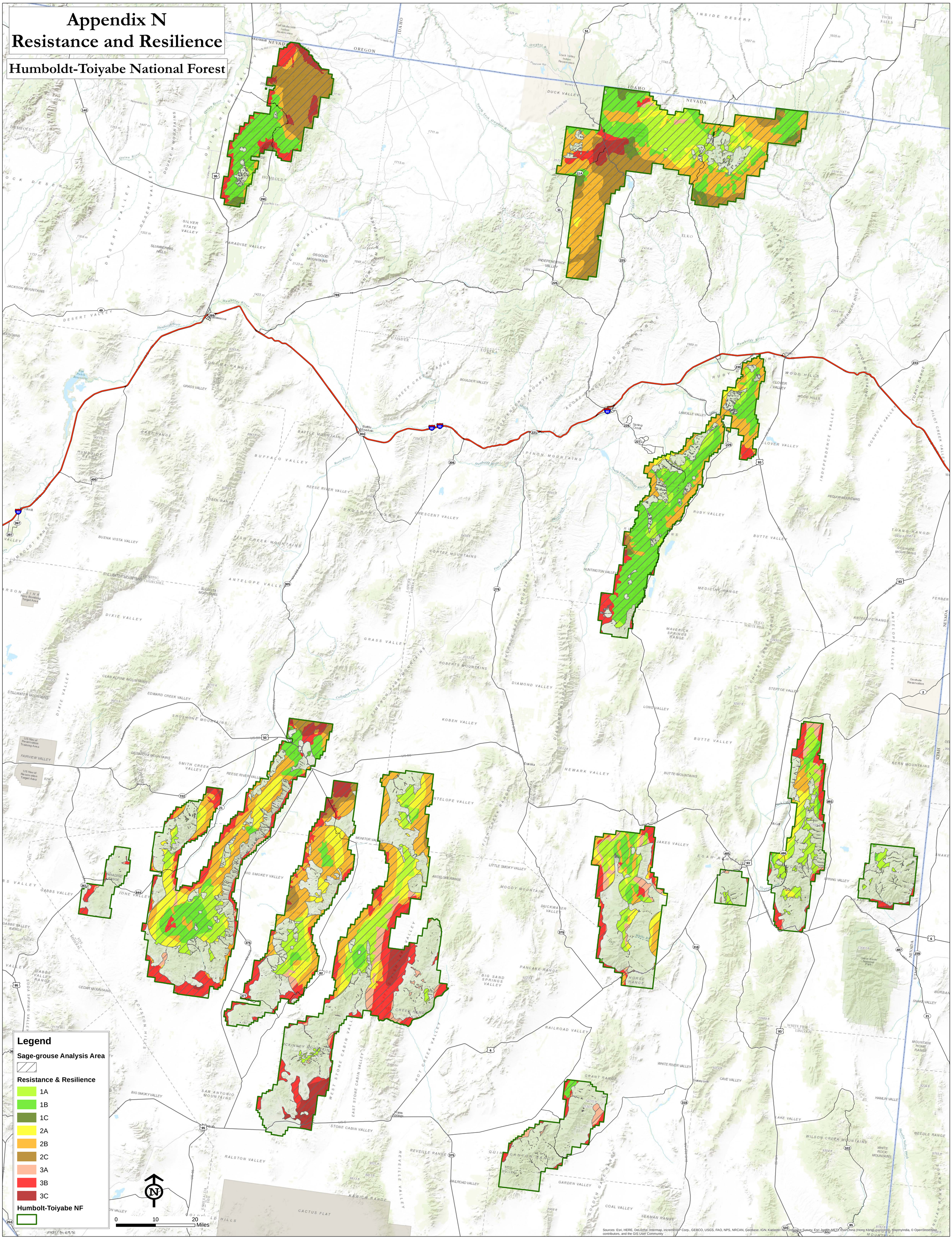
Humboldt-Toiyabe National Forest



Appendix N Resistance and Resilience (Soil Temperature and Moisture Regime)

Appendix N
Resistance and Resilience

Humboldt-Toiyabe National Forest



Appendix O Table of Potential Actions from the BLM-led FIAT Effort

Potential Treatment Area	Invasive Annual Grass	Conifer Encroachment	Habitat Restoration Recovery	Fuels Management	Post-Fire Rehabilitation	Fire Operations	Grand Total
Antelope Flat-Big Lost Conifer 1st Priority		10,763					0
Antelope Flat-Big Lost Conifer 2nd Priority		7,662					0
Antelope Flat-Big Lost ESR 2nd Priority					3,512		3,512
Antelope Flat-Big Lost ESR 3rd Priority					27,403		27,403
Antelope Flat-Big Lost Fire 2nd Priority					21,127	3,512	24,639
Antelope Flat-Big Lost Fire 3rd Priority						27,403	27,403
Big Lost ESR 3rd Priority							0
Big Lost Fire 3rd Priority						21,127	21,127
Hat Creek Conifers 1st Priority		18,062					18,062
Hat Creek Conifers 2nd Priority		1,208					0
Hat Creek ESR 2nd Priority					13,218		13,218
Hat Creek ESR 3rd Priority					6,970		6,970
Hat Creek Fire 2nd Priority						12,220	12,220
Hat Creek Fire 3rd Priority						6,970	6,970
Hat Creek Morgan Creek Fuels 3rd Priority				4			0
Lemhi Birch Conifer 1st Priority		8,934					8,934
Lemhi Birch Conifer 2nd Priority		285					285
Lemhi Birch ESR 2nd Priority					604		604
Lemhi Birch ESR 3rd Priority					8,843		8,843
Lemhi Birch Fire 2nd Priority						604	604
Lemhi Birch Fire 3rd Priority						8,843	8,843
Little Lost ESR 2nd Priority					1,003		1,003
Little Lost ESR 3rd Priority					439		439
Little Lost Fire 2nd Priority						1,003	1,003
Little Lost Fire 3rd Priority						484	484
Pahsimeroi Restoration 2nd Priority			163				0
Pahsimeroi Conifer 1st Priority		20,337					0
Pahsimeroi ESR 2nd Priority					5,614		5,614
Pahsimeroi ESR 3rd Priority					11,400		11,400

Potential Treatment Area	Invasive Annual Grass	Conifer Encroachment	Habitat Restoration Recovery	Fuels Management	Post-Fire Rehabilitation	Fire Operations	Grand Total
Pahsimeroi Fire 2nd Priority						5,614	5,614
Pahsimeroi Fire 3rd Priority						11,400	11,400
Twin Buttes Conifer 1st Priority		385					0
Twin Buttes ESR 1st Priority					3		3
Twin Buttes ESR 2nd Priority					0		0
Twin Buttes ESR 3rd Priority					382		0
Twin Buttes Fire 2nd Priority						628	628
Grand Total	0	27,281	163	4	100,136	99,808	227,225

Appendix P BLM led FIAT Effort Fire Suppression /Fuels Management Priorities

Appendix P
BLM Led FIAT Effort Fire Suppression/ Fuels Management Priorities

Humbolt-Toiyabe National Forest

Bowden Hills
Owyhee South
Rogerson
Jim Sage
Oakley
Nevada
Owyhee Desert
Greater Owyhee
West Box Elder
Oneil
Tuscarora
North Fork
Sonomas
Ruby
South Fork
Cooks Creek
Cortez
Cherry Creek
North Spring
Long Valley
Egan
Bates Callaghan
Western White Pine
Antelope Valley
Reese R. Yomba Desatoya
Steptoe Cave
Punchbowl
Table Mtn Hamlin Valley

Legend

Humbolt-Toiyabe NF Sage-grouse
- FIAT Analysis Area

Humbolt-Toiyabe NF
- Humbolt-Toiyabe NF

BLM - FIAT Data
- Project Planning Area

BLM Potential Treatment Areas
- Fuels

Fire Operations Priority Areas
- Priority 1
- Priority 2
- Priority 3

BLM Northern Great Basin Fire Operations
- Priority Areas

N

0 25 50 Miles

AMSET lys 7/23/15

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

AMSET lys 4/20/15

Appendix Q-BLM led FIAT Effort Restoration Priority Areas

Appendix Q
BLM Led FIAT Effort
Restoration Priority Areas

Humbolt-Toiyabe National Forest

Bowden Hills
Owyhee South
Rogerson
Oakley
Jim Sage
Nevada
Greater Owyhee
Owyhee Desert
West Box Elder
Oneil
Tuscarora
North Fork
Sonomas
Ruby
South Fork
Cooks Creek
Cortez
Cherry Creek
Long Valley
North Spring
Bates Callaghan
Egan
Western White Pine
Antelope Valley
Reese R. Yomba Desatoya
Steptoe Cave
Punchbowl
Table Mtn Hamlin Valley

Legend

Humbolt-Toiyabe NF Sage-grouse

FIAT Analysis Area

Humbolt-Toiyabe NF

Administrative Boundary

BLM - FIAT Data

Project Planning Area

BLM Potential Treatment Areas

Restoration

N

0 25 50 Miles

AMSET h/s 6/5/16

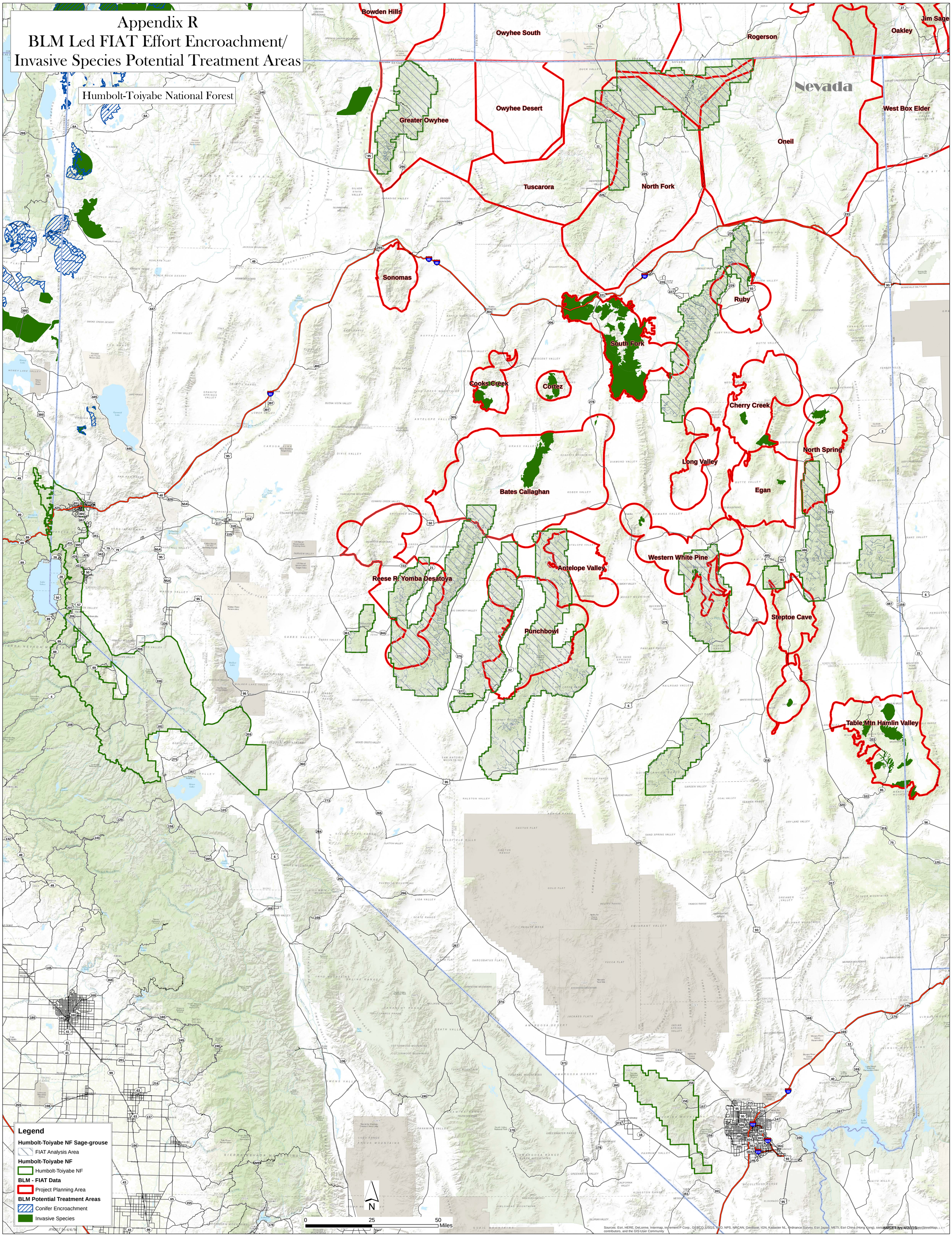
AMSET h/s 4/22/15

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community, Sources: Esri, DeLorme, USGS, NPS

Appendix R BLM led FIAT Effort Conifer Encroachment/Invasive Species Priority Areas

Appendix R
BLM Led FIAT Effort Encroachment/ Invasive Species Potential Treatment Areas

Humbolt-Toiyabe National Forest



Appendix S Comparison of COT Report Conservation Objectives and Measures to Assessment Findings

Fire Operations

Conservation Measures					
FIRE OPERATIONS	Restrict or contain fire within the normal range of fire activity (assuming a healthy native perennial sagebrush community), including size and frequency, as defined by the best available science.	Use caution when planning use of prescribed fire in high elevation mountain big sage sites to prevent fire escape and any subsequent establishment of invasive annual grasses or other weeds	Design and implement restoration of burned sagebrush habitats to allow for natural succession to healthy native sagebrush plant communities.	Implement monitoring programs for restoration activities.	Immediately suppress fire in all sagebrush habitats. Where resources are limited, these actions should first focus on PACs (SFAs and HMAs) and any identified connectivity corridors between PACs (SFAs and HMAs).
High Complexity Engines (1)	X	X			X
Asst. Fire Management Officer	X	X			X
Fire Operations Specialist	X				
(3) Fire Prevention Techs	X				

Fuels Management

Conservation Measures				
FUELS MANAGEMENT	Restrict or contain fire within the normal range of fire activity (assuming a healthy native perennial sagebrush community), including size and frequency, as defined by the best available science.	Retain all remaining large intact sagebrush patches, particularly at low elevations.	Reduce or eliminate disturbances that promote the spread of these invasive species, such as reducing fires to a "normal range" of fire activity for the local ecosystem…..	Reduce conifer ecroachment in sage-grouse habitats to less than 5%, but preferably eliminate entirely.
Blade 416 miles of road	X	X	X	X
Blade 457 mi road	X	X	X	X
Brush/Blade 476 miles of road	X	X	X	X
Develop a funded program of work to accomplish mechanical treatment of 13,350-20,200 acres of Phase I conifer encroachment per year.	X	X	X	
Develop a funded program of work to accomplish mechanical treatment of 14,250 acres of Phase II and III conifer encroachment per year.	X	X	X	
Develop mosaics across sagebrush landscapes	X	X	X	

Pre-Attack Planning

Conservation Measures					
Pre-Attack Planning	Restrict or contain fire within the normal range of fire activity (assuming a healthy native perennial sagebrush community), including size and frequency, as defined by the best available science.	Retain all remaining large intact sagebrush patches, particularly at low elevations.	Use caution when planning use of prescribed fire in high elevation mountain big sage sites to prevent fire escape and any subsequent establishment of invasive annual grasses or other weeds.	Reduce or eliminate disturbances that promote the spread of these invasive species, such as reducing fires to a "normal range" of fire activity for the local ecosystem….	Immediately suppress fire in all sagebrush habitats. Where resources are limited, these actions should first focus on PACs (SFAs and HMAs) and any identified connectivity corridors between PACs (SFAs and HMAs).
Determine NDFRS thresholds for daily staffing with consideration to GRSG	X	X			X
Identify fire priority areas, digitize and input into WFDSS	X	X			X
Utilize Fire Occurrence Maps to determine logical areas to implement fire prevention strategies	X	X			

Infrastructure, Development and Improvement

Conservation Measures					
Infrastructure Development and Improvement	Restrict or contain fire within the normal range of fire activity (assuming a healthy native perennial sagebrush community), including size and frequency, as defined by the best available science.	Retain all remaining large intact sagebrush patches, particularly at low elevations.	Reduce or eliminate disturbances that promote the spread of these invasive species, such as reducing fires to a "normal range" of fire activity for the local ecosystem, employing grazing management that maintains the perennial native grass and shrub community appropriate to the local site, reducing impacts from any source that allows for the invasion by these species into undisturbed sagebrush habitats.	Use caution when planning use of prescribed fire in high elevation mountain big sage sites to prevent fire escape and any subsequent establishment of invasive annual grasses or other weeds.	Immediately suppress fire in all sagebrush habitats. Where resources are limited, these actions should first focus on PACs (SFAs and HMAs) and any identified connectivity corridors between PACs (SFAs and HMAs).
Improve Response Time					
Brush/Blade 476 miles of road	X	X	X		X
Improved Situational Awareness					
Mobile apps	X		X		X
Remote Cameras	X		X		X
Improve radio/repeater Infrastructure	X	X			X
Install mobile hotspot technology in fire vehicles in order to utilize mobile applications	X		X		X

Conifer Encroachment

Conservation Measures						
CONIFER ENCROACHMENT	Restrict or contain fire within the normal range of fire activity (assuming a healthy native perennial sagebrush community), including size and frequency, as defined by the best available science.	Retain all remaining large intact sagebrush patches, particularly at low elevations.	Reduce or eliminate disturbances that promote the spread of these invasive species, such as reducing fires to a "normal range" of fire activity for the local ecosystem….	Prioritize the use of mechanical treatments for removing conifer encroachment. These techniques allow for more selective removal of invading plants, and more importantly allows understory habitats to remain intact.	Reduce conifer encroachment cover in sage-grouse habitats to less than 5%, but preferably eliminate entirely.	Employ all necessary management actions to maintain the benefit of conifer encroachment removal for sage-grouse habitats….
Phase I Treatment Options						
Lop and scatter	X	X	X	X	X	X
Phase II Treatment Options						
Mastication	X	X	X	X	X	X
Lop/scatter or lop/scatter/pile (mechanical, handcut/pile)	X	X	X	X	X	X
Phase III Treatment Options						
Cut/haul/burn	X	X	X	X	X	X
Mechanical pile/burn	X	X	X	X	X	X
Cut/haul/biomass treatment	X	X	X	X	X	X

Restoration Opportunities

Conservation Measures				
RESTORATION OPPORTUNITIES	Restrict or contain fire within the normal range of fire activity (assuming a healthy native perennial sagebrush community), including size and frequency, as defined by the best available science.	Design and implement restoration of burned sagebrush habitats to allow for natural succession to healthy native sagebrush plant communities.	Reduce or eliminate disturbances that promote the spread of these invasive species, such as reducing fires to a "normal range" of fire activity for the local ecosystem…..	Immediately suppress fire in all sagebrush habitats. Where resources are limited, these actions should first focus on PACs (SFAs and HMAs) and any identified connectivity corridors between PACs (SFAs and HMAs).
Develop a native seedbank including sagebrush seed		X		X
Bio-control, followed by re-seeding	X	X		X
Treat up to 2,100 acres of non-native, invasive species per year		X	X	
Develop grazing systems to promote sagebrush growth	X	X	X	
Non-system road rehabilitation				X
Grazing to target cheatgrass infestations.	X	X	X	

Appendix T Program Emphasis Area Calculations

R= Resistance and Resilience, FTI=Fire Threat Index, H=Habitat Management Areas, F=Focal Habitat, S=Seasonal Habitat, C=Cheatgrass, E=Conifer encroachment, D=Density of overlapping habitat values and concerns

Fire Operations Program Emphasis Areas (Appendix B)

[[((HMA)+(SFA)+(Local)) *(D)] + [CG + FTI]] + (RR *2) = Fire Operation Program Emphasis Areas

Resistance and Resilience Scoring for Fire Operations Based on Matrix

Resistance & Resilience	Low Sagebrush Cover 1-25%	Moderate Sagebrush Cover 26-65%	High Sagebrush Cover >65%
High	1	4	5
Moderate	2	6	7
Low	3	8	9

Fire Operations Final Score Categories:

Very Low = 1-16
Low = 17-32
Moderate = 33-48
High = 49-64
Very High = 65-80

Fuels Management Program Emphasis Areas (Appendix C)

[[((HMA)+(SFA)+(Local)) *(D)] + FTI] + (RR *2) = Fire Management Program Emphasis Areas

Resistance and Resilience Scoring for Fuels Management Based on Matrix

Resistance & Resilience	Low Sagebrush Cover 1-25%	Moderate Sagebrush Cover 26-65%	High Sagebrush Cover >65%
High	1	4	5
Moderate	2	6	7
Low	3	8	9

Fuels Management Final Score Categories

Very Low = 1-15
Low = 16-30
Moderate = 31-45
High = 46-60
Very High = 61-74

Invasive Species Program Emphasis Areas (Appendix E)

[[((HMA)+(SFA)+(Local)) *(D)] + CG] + (RR) = Invasive Species Program Emphasis Areas

Translation into Modeled Potential of Invasive Annual Grasses:

Resistance & Resilience	Low Sagebrush Cover 1-25%	Moderate Sagebrush Cover 26-65%	High Sagebrush Cover >65%
High	-	-	-
Moderate	6	4	2
Low	6	6	4

Where:

6= Potential heavy invasive annual grass infestation

4 = Potential moderate invasive annual grass infestation

2 = Potential low invasive annual grass infestation

Resistance and Resilience Scoring for Invasive Annual Grasses Based on Matrix

Resistance & Resilience	Low Sagebrush Cover 1-25%	Moderate Sagebrush Cover 26-65%	High Sagebrush Cover >65%
High	3	4	5
Moderate	2	8	9
Low	1	6	7

Invasive Annual Grass Final Score Categories

Very Low = 4-16
Low = 17-29
Moderate = 30-42
High = 43-55
Very High = 56-66

Conifer Encroachment Program Emphasis Areas (Appendix D)

[[((HMA)+(SFA)+(Local)) *(D)] + CE] + (RR*4) = Conifer Encroachment Program Emphasis Areas

Resistance and Resilience Scoring for Invasive Annual Grasses Based on Matrix

Resistance & Resilience	Low Sagebrush Cover 1-25%	Moderate Sagebrush Cover 26-65%	High Sagebrush Cover >65%
High	9	8	5
Moderate	7	6	4
Low	3	2	1

Conifer Encroachment Final Score Categories:

Very Low = 4-16
Low = 17-29
Moderate = 30-42
High = 43-55
Very High = 56-66

Restoration and BAER Program Emphasis Areas (Appendix F)

(((HMA)+(SFA)+(Local)) * (D)) + (RR) = Restoration and BAER Program Emphasis Area

Resistance and Resilience Scoring for Restoration Based on Matrix

Resistance & Resilience	Low Sagebrush Cover 1-25%	Moderate Sagebrush Cover 26-65%	High Sagebrush Cover >65%
High	9	8	5
Moderate	7	6	4
Low	3	2	1

Final Restoration Score Categories:

Very Low: 2-14
Low: 15 - 25
Moderate: 26 – 37
High: 38 – 48
Very High: 49 - 60

Appendix U West Wide Risk Assessment Data Layers

Dataset	Description	Feature Type
Fire Risk Index (FRI)	Measure of overall wildfire risk.	Raster
Fire Effects Index (FEI)	Identifies areas with important values affected by wildland fire and/or that are costly to suppress. FEI is a weighted combination of the Values Impacted Rating (VIR) and Suppression Difficulty Rating (SDR) layers described below.	Raster
Fire Threat Index (FTI)	Wildfire threat is an index related to the likelihood of an acre burning. The FTI integrates the probability of an acre igniting and the expected final fire size, based on the rate of spread in four weather percentile categories, into a single measure of wildfire threat.	Raster
Ratings		
Values Impacted Rating (VIR)	Reflects areas that have important values affected by wildland fire. This combines all Values Impacted being assessed based on a composite of weights provided by the states. Fire Threat Index is not a component of VIR, so values are conditional, assuming that the probability of being impacted by fire is equal	Raster
Suppression Difficulty Rating (SDR)	Reflects areas with increased difficulty for fire suppression. It is based on fireline production rates and slope and a composite of the scores and weights provided by the states.	Raster
Scores		
Response Function Scores (RFS)	For each individual Value dataset, identifies areas for those values impacted that are at risk to wildland fire. This is based on the scores and weights provided by the states.	Raster
Key Inputs		
Wildland Development Areas (WDA)	"Describes where people are living in wildland areas (i.e. urban areas masked out). This dataset is derived from the LandScan population count data and represents the number of housing units per acre."	Raster
Forest Assets (FA)	Forested lands categorized by height, cover and susceptibility (response to wildland fire). The LANDFIRE vegetation datasets (existing vegetation type, cover, and height) were the primary inputs to this dataset along with a crosswalk of the existing Vegetation Type dataset to a susceptibility class.	Raster
Drinking Water Importance Areas (DWIA)	An index that identifies areas that are most crucial to sustaining the quality of drinking water by incorporating data on water supply, surface drinking water consumers at the point of intake, and the flow patterns to the surface water intakes. The U.S. Forest Service's Forests to Faucets (F2F) project is the primary source of this dataset, however, F2F does not exist for Alaska and Hawaii so alternative datasets were used for these two states.	Raster
Dataset	**Description**	**Feature Type**
Riparian Assets (RA)	Riparian areas that are important as a suite of ecosystem services, including both terrestrial and aquatic habitat, water quality and quantity, and other ecological functions. The National Hydrography Dataset (NHD), the National Wetlands Inventory (NWI) and LANDFIRE's Existing Vegetation Dataset (EVT) were the primary inputs to this dataset.	Raster
Infrastructure Assets (IA)	"Key infrastructure assets that are susceptible to adverse effects from wildfires. Includes Roads (Levels 1-3), Railroads, Airports, Schools and Hospitals (roads and railroads are buffered by 300m and airports, schools and hospitals are buffered by 500m)."	Raster
Fire Occurrence Areas (FOA)	Areas within which the probability of each acre igniting is the same. (Based on historical fire occurrence data).	Raster
Fire Behavior Outputs	"Rate of Spread, Flame Length, Fire Type (canopy fire potential) by Low, Moderate, High and Extreme percentile weather. Also provided is the Expected Rate of Spread and Flame Length which is the weighted average of using probability of a fire occurring by percentile weather times the output at that percentile weather. The probability of a surface or canopy fire type occurring is also provided.	Raster

Dataset	Description	Feature Type
Weather Influence Zones (WIZ)	Areas where, for analysis purposes, the weather on any given day is uniform.	Polygon
Where People Live (WPL)	Describes where people are living and includes both urban and rural areas. This dataset is derived from the LandScan population count data and is based on the number of housing units per acre. The WDA dataset (above) is a subset of the WPL dataset.	Raster
Other Input Datasets		
Vegetation Type*	Existing Vegetation Type (from LANDFIRE)	Raster
Vegetation Height*	Existing Vegetation Height (from LANDFIRE)	Raster
Percent Canopy Cover*	Tree Canopy Cover (from LANDFIRE)	Raster
Canopy Base Height* (CBH)	Canopy fuels variable (from LANDFIRE)	Raster
Canopy Bulk Density* (CBD)	Canopy fuels variable (from LANDFIRE)	Raster
Canopy Ceiling Height* (CCH)	Canopy fuels variable (from LANDFIRE Canopy Height)	Raster
Surface Fuels	Derived from the LANDFIRE FBFM40 dataset which uses the 2005 Fire Behavior Prediction System Fuel Model Set	Raster
Historical Fire Ignition Data	Historical fire ignition locations (federal and state sources)	Points and Polygons
Topography*	Slope, Aspect and Elevation (from LANDFIRE)	Raster
Roads*	Roads from the ESRI Data v10	Lines
Airports*	Location of airports from the ESRI Data v10	Points
Schools*	Location of schools from the ESRI Data v10	Points
Hospitals*	Location of hospitals from the ESRI Data v10	Points
Railroads*	Railroads from the ESRI Data v10	Lines
Counties	County boundaries from the ESRI Data v10 except in Alaska where boundaries were compiled from other data sources.	Polygons
Vegetation Type*	Existing Vegetation Type (from LANDFIRE)	Raster
Vegetation Height*	Existing Vegetation Height (from LANDFIRE)	Raster
Dataset	**Description**	**Feature Type**
Land Ownership*	Land ownership – based on the Conservation Biology Institute (CBI) data	Polygons
Congressional Districts*	Congressional District Boundaries (from ESRI and U.S. Census Bureau)	Polygons
Cell Towers*	Location of cell towers. Source is FCC data.	Points

*These datasets were taken directly from their data source. No adjustments or additional modeling of the data was done.

Appendix V Inventory of all Invasive Plant Species

Inventoried Invasive Plants on the Humboldt-Toiyabe National Forest

Humboldt-Toiyabe National Forest Invasive Species Inventoried	Acres
Austin Ranger District	**2,805**
CADR- whitetop	613
CANU4- nodding plumeless thistle	2,105
CIAR4- Canada thistle	8
CIVU- bull thistle	35
LELA2 – broadleaf pepperweed	18
RUCR- curly dock	24
Ely Ranger District	**8,615**
2FA	55
ACRE3 – hardheads	5
BRTE- cheatgrass	336
CADR- whitetop	429
CANU4- nodding plumeless thistle	1,024
CEBI2- spotted knapweed	33
CEMA4 – spotted knapweed	33
CERE6- hardheads	30
CETR8 – squarrose knapweed	27
CIAR4- Canada thistle	901
CINE – New Mexico thistle	269
CIOC2- yellowspine thistle	3,990
CIUN- wavyleaf thistle	241
CIVU- bull thistle	994
HAGL- saltlover	121
HYNI – black henbane	2
LELA2- broadleaved pepperweed	13
ONAC- Scotch cottonthistle	100
TAAF – African tamarisk	10
Jarbidge Ranger District	**5,215**
BRTE- cheatgrass	233
CADR- whitetop	9
CANU4- nodding plumeless thistle	6
CIAR4- Canada thistle	1,285
CIOC2- yellowspine thistle	3,607
CIVU- bull thistle	75
Mountain City Ranger District	**7,776**

Humboldt-Toiyabe National Forest Invasive Species Inventoried	**Acres**
BRTE- cheatgrass	212
CADR- whitetop	34
CANU4- nodding plumeless thistle	1,408
CEBI2- spotted knapweed	18
CEDI3 – diffuse knapweed	3
CESO3 – yellow star-thistle	1
CIAR4- Canada thistle	2,332
CIOC2- yellowspine thistle	2,113
CIVU- bull thistle	1,150
CYOF - gypsyflower	29
EUESE – leafy spurge	302
HYNI – black henbane	4
LELA2- broadleaved pepperweed	2
ONAC- Scotch cottonthistle	47
RUCR- curly dock	103
TACA8- medusahead	18
Ruby Mountains Ranger District	**7,945**
2FA	14
ARMI2 – lesser burdock	1
BRTE- cheatgrass	84
CANU4- nodding plumeless thistle	110
CEBI2- spotted knapweed	3
CEDI3 – diffuse knapweed	2
CIAR4- Canada thistle	2,305
CIFO – elk thistle	3
CIOC2- yellowspine thistle	13
CIVU- bull thistle	694
COMA2 – poison hemlock	1
CYOF - gypsyflower	73
EUESE – leafy spurge	478
ISTI – Dyer's woad	3
LIVU2 – butter and eggs	15
ONAC- Scotch cottonthistle	3,842
RUCR- curly dock	76
TACA8- medusahead	229
Santa Rosa Ranger District	**3,513**
2FA	8
ACRE3 - hardheads	1
BRTE- cheatgrass	96
CADR- whitetop	166

Humboldt-Toiyabe National Forest Invasive Species Inventoried	**Acres**
CANU4- nodding plumeless thistle	4
CERE6- hardheads	6
CESO3 – yellow star-thistle	5
CIAR4- Canada thistle	876
CIFO – elk thistle	9
CIVU- bull thistle	772
COAR4 – field bindweed	1
EUESE - leafy spurge	27
LIVU2 – butter and eggs	1
ONAC- Scotch cottonthistle	1,339
RUCR- curly dock	19
TACA8- medusahead	181
TRTE – puncturevine	4
Tonopah Ranger District	**84**
CADR- whitetop	5
CANU4- nodding plumeless thistle	2
CERE6- hardheads	64
CIAR4- Canada thistle	6
CIVU- bull thistle	2
LELA2- broadleaved pepperweed	5
RUCR- curly dock	1
Grand Total	**35,953**

Treated Invasive Plants on the Humboldt-Toiyabe National Forest

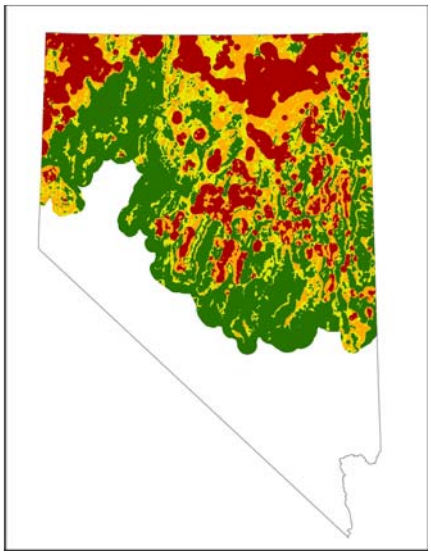
Humboldt-Toiyabe National Forest Invasive Species Treated	**Acres**
Austin Ranger District	**712**
CANU4 - nodding plumeless thistle	663
CIAR4 - Canada thistle	6
CIVU - bull thistle	9
LELA2 - broadleaved pepperweed	14
RUCR - curly dock	20
Ely Ranger District	**2,901**
BRTE - cheatgrass	221
CADR - whitetop	8
CADR - whitetop ; CIAR4 - Canada thistle	118

Humboldt-Toiyabe National Forest Invasive Species Treated	**Acres**
CADR - whitetop ; CIOC2 - yellowspine thistle	72
CANU4 - nodding plumeless thistle	173
CANU4 - nodding plumeless thistle ; CIOC2 - yellowspine thistle	166
CANU4 - nodding plumeless thistle ; CIOC2 - yellowspine thistle ; CIVU - bull thistle	292
CEBI2 - spotted knapweed	1
CIAR4 - Canada thistle ; CIOC2 - yellowspine thistle	145
CIOC2 - yellowspine thistle	1,006
CIOC2 - yellowspine thistle ; CIVU - bull thistle	454
CIUN - wavyleaf thistle	1
CIVU - bull thistle	72
HAGL - saltlover	121
ONAC - Scotch cottonthistle	52
Mountain City Ranger District	**352**
CEBI2 - spotted knapweed	18
CIAR4 - Canada thistle	292
ONAC - Scotch cottonthistle	42
Ruby Mountains Ranger District	**595**
ONAC - Scotch cottonthistle	387
TACA8 - medusahead	208
Santa Rosa Ranger District	**991**
CIAR4 - Canada thistle	127
CIVU - bull thistle	400
ONAC - Scotch cottonthistle	454
TACA8 - medusahead	9
Tonopah Ranger District	**18**
CERE6 - hardheads	17
CIVU - bull thistle	1
Grand Total	**5,569**

Appendix W Metadata for Select GIS Layers

Management Categories for Greater Sage-grouse in Nevada: Updated with 2014 Lek Status and Abundance (March 2015)

Shapefile



Tags

Sage-Grouse, Habitat, Nevada, Sagebrush Ecosystem Council

Summary

These data provide the Nevada Sagebrush Ecosystem Council, and other wildlife managers, with an additional resource to aid in planning and management of greater sage-grouse populations. THIS MAP HAS BEEN UPDATED USING LEK COUNT DATA AND LEK ACTIVITY CLASSIFIED FROM THE 2014 BRREDING SEASON.

Description

Sage-Grouse habitat areas divided into proposed management categories within Nevada project study boundaries.

MANAGEMENT CATEGORY DETERMINATION-(*remains unchanged from prior drafts, including resource selection function modeling)*

The process for category determination was directed by the Nevada Sagebrush Ecosystem Technical team. Sage-grouse habitat was determined from a statewide resource selection function model and first categorized into 4 classes: high, moderate, low, and non-habitat. The standard deviations (SD) from a normal distribution of RSF values created from a set of validation points (10% of the entire telemetry dataset) were used to categorize habitat 'quality' classes. High quality habitat comprised pixels with RSF values < 0.5 SD, Moderate > 0.5 and < 1.0 SD, Low < 1.0 and > 1.5, Non-Habitat > 1.5 SD. Proposed Habitat Management Categories were then defined and calculated as follows.

1) Core habitat: Defined as the intersection between all suitable habitat (high, moderate, and low) and the 85% Space Use Index (SUI).

2) Priority habitat: Defined as all high quality falling outside the 85% SUI and all non-habitat falling within the 85% SUI. This was a 2-part process. High quality falling outside the 85% SUI was erased by the 85% SUI, and non-habitat was clipped by the SUI.

3) General habitat: Defined as moderate and low quality habitat falling outside the 85% SUI.

4) Non habitat. Defined as non-habitat falling outside the 85% SUI.

SPACE USE INDEX CALCULATION-(*Updated with 2014 lek counts*)

Lek coordinates and associated trend count data were obtained from the 2014 Nevada Sage-grouse Lek Database compiled by the Nevada Department of Wildlife (NDOW, S. Espinosa, 9/22/2014). Leks count data from the California side of the Buffalo-Skeddadle and Modoc PMU's that contrbuted to the overall space-use model were obtained from Callifornia Dept of Fish & Wildlife (S. Gardner). We queried the database for leks with a 'LEKSTATUS' field classified as 'Active' or 'Pending'. Active leks comprised leks with breeding males observed within the last 5 years (through the 2014 breeding season). Pending leks comprised leks without consistent breeding activity during the prior 3 – 5 surveys or had not been surveyed during the past 5 years; these leks typically trended towards 'inactive'. A sage-grouse management area (SGMA) was calculated by buffering Population Management Units developed by NDOW by 10km. This included leks from the Buffalo-Skedaddle and Modoc PMUs that straddles the northeastern California – Nevada border, but excluded leks for the Bi-State Distinct Population Segment. The 5-year average (2010 – 2015) for the number of males grouse (or unknown gender if males were not identified) attending each lek was calculated. The final 2014 dataset for space-use estimation comprised 878 total leks, which represented a reduction of 29 total leks in comparison to the the number of leks (n=907) used in the previous analysis using lek count data up to 2013. In Nevada only, the number of active and pending leks dropped from 883 in 2013 to 846 in 2014.

Utilization distributions describing the probability of lek occurrence were calculated using fixed kernel density estimators (Silverman 1986) with bandwidths estimated from likelihood based cross-validation (CVh) (Horne and Garton 2006). UDs were weighted by the 5-year average (2009 – 2013) for the number of males grouse (or unknown gender if males were not identified) attending leks. UDs and bandwidths were calculated using Geospatial Modelling Environment (Beyer 2012) and the 'ks' package (Duong 2012) in Program R. Grid cell size was 30m. The resulting raster was clipped by the SGMA polygon, and values were re-scaled between zero and one by dividing by the maximum pixel value.

The non-linear effect of distance to lek on the probability of grouse spatial use was estimated using the inverse of the utilization distribution curves described by Coates et al. (2013), where essentially the highest probability of grouse spatial use occurs near leks and then declines precipitously as a non-linear function. Euclidean distance was first calculated in ArcGIS, reclassified into 30-m distance bins (ranging from 0 – 30,000m), and bins reclassified according to the non-linear curve in Coates et al. (2013). The resulting raster was clipped by the SGMA polygon, and re-scaled between zero and one by dividing by the maximum pixel value.

A Spatial Use Index (SUI) was calculated taking the average of the lek utilization distribution and non-linear distance to lek rasters in ArcGIS, and re-scaled between zero and 1 by dividing by the maximum pixel value.

The volume of the SUI at cumulative 5% increments (isopleths) was extracted in Geospatial Modelling Environment (Beyer 2012) with the command 'isopleth'. Interior polygons (i.e., donuts' > 1.2 km2) representing no probability of use within a larger polygon of use were erased from each isopleth. The relationship between percent land area within each isopleth and isopleth volume (VanderWal and Rodgers 2012) indicated statistically concentrated use at the 70% isopleth. The 85% isopleth, which provided greater spatial connectivity and consistency with previously used agency standards (e.g., Doherty et al. 2010), was ultimately recommended by the Sagebrush Ecosystem Technical Team. The 85% SUI isopleth was clipped by the SGMA clipped by the Nevada state boundary, which only included habitat within the state of Nevada.

Please see the following USGS open file report for detailed information regariding methods and

rationale used to create this map. Coates, P.S., Casazza, M.L., Brussee, B.E., Ricca, M.A., Gustafson, K.B., Overton, C.T., Sanchez-Chopitea, E., Kroger, T., Mauch, K., Niell, L., Howe, K., Gardner, S., Espinosa, S., and Delehanty, D.J. 2014, Spatially explicit modeling of greater sage-grouse (Centrocercus urophasianus) habitat in Nevada and northeastern California—A decision-support tool for management: U.S. Geological Survey Open-File Report 2014-1163, 83 p., http://dx.doi.org/10.3133/ofr20141163. ISSN 2331-1258 (online)

REFERENCES

Beyer HL. 2012. Geospatial Modelling Environment (Version 0.7.2.0). http://www.spatialecology.com/gme

Coates PS, Casazza ML, Blomberg EJ, Gardner SC, Espinosa SP, Yee JL, Wiechman L, Halstead BJ. 2013. "Evaluating greater sage-grouse seasonal space use relative to leks: Implications for surface use designations in sagebrush ecosystems." The Journal of Wildlife Management 77: 1598-1609.

Doherty KE, Tack JD, Evans JS, Naugle DE. 2010. *Mapping breeding densities of greater sage-grouse: A tool for range-wide conservation planning. Bureau of Land Management.* Report Number: L10PG00911. Accessed at: http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/Pages/sagegrouse.aspx#

Duong T. 2012. ks: Kernel smoothing. R package version 1.8.10. http://CRAN.R-project.org/package=ks

Horne JS, Garton EO. 2006. "Likelihood cross-validation versus least squares cross-validation for choosing the smoothing parameter in kernel home-range analysis." Journal of Wildlife Management 70: 641-648.

Silverman BW. 1986. *Density estimation for statistics and data analysis*. Chapman & Hall, London, United Kingdom.

Vander Wal E, Rodgers AR. 2012. "An individual-based quantitative approach for delineating core areas of animal space use." Ecological Modelling 224: 48-53.

NOTE: This file does not include habitat areas for the Bi-State management area.

Credits

U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station, Dixon. CA.

Nevada Sagebrush Ecosystem Program, Carson City, NV.

Use limitations

These data are released on condition that the U.S. Geological Survey, or United States Government may not be held liable for any damages resulting from authorized or unauthorized use.

Extent

West	-120.111843	**East**	-113.863208
North	42.031850	**South**	37.530607

Scale Range

Maximum (zoomed in) 1:50,000

Minimum (zoomed out) 1:5,000,000

You are currently using the Item Description metadata style. Change your metadata style in the Options dialog box to see additional metadata content.

SageGrouse_Habitat

File Geodatabase Feature Class

Tags

Greater Sage-Grouse, PPH, PGH, NV, CA

Summary

The dataset was developed to support the National Sage-Grouse Planning Strategy Nevada and northeastern California planning region. This dataset supports the alternatives. Official NVCA SG alternatives dataset for PPH and PGH, clipped to BLM USFS land in the decision area. As per BLM JTg and AK, PPH+PGH=occupied habitat 2013 04.

Description

3-27-14 Changes made by Leisa Wesch - BLM NVSO to make the boundries to match with the landstatus and the state borders. the NV and CA border was also fixed - over 3000 acres was not accounted for because of the gap - along with sliver and small polygon data less than 5 acres were deleted- - Some PPH have been changed to PGH and PGH changed to PPH where appropriate to make connectiviity and to reduce island areas.This data set should be used for the FEIS

Changes made per GSG Habitat Delineation Meeting 7/18/13 per Joe Tague - this coverage is the result of WSA_WA_PMU_MINE_ALT_D unioned with NVCA_SG_PPHPGH - law 8-8-13

Changes were made to all PGH habitat within Wilderness areas changed to PPH, All PGH habitat within Wilderness Study areas changed to PPH. PMU areas Majuba 3, Trinity 1 and Kawich All PPH within these PMU's were changed to PGH. Mining blocks of PPH within immediate adjacent grid cells changed to PGH - law 8-8-13

Clipped to BLM- and USFS- administered land in the NVCA planning area: \\blm\dfs\loc\EGIS\NV\GIS_Work\Multi-District_Project\RMP\GSG_RMP_Amend\Alternatives\NVCA_SG_alts_base_V02.gdb\NVCA_SG_landstat_PAwith query "NAME" = 'Bureau of Land Management' OR "NAME" = 'Forest Service' (no change between land stat version 01 and land stat version 02) EMPSi MR 2013 05 09.

20130509 EMPSi MR QAQC for overlap as per suggestion from USFS Lara Oles. Intersect with the NV PPH with the NV PGH and found the 257 acres of slivers errors. EMPSi MR checked them against the original NDOW data, assigned them to be only in the correct habitat type. EMPSi MR did a second intersect of PPH vs. PGH and got an empty feature class (the version 02 alternatives NVCA PPH and PGH have zero overlap with each other=good). Dissolved by habitat type and surface administration.

In Nevada, this dataset is across all land ownerships (suface administrations). In California, private lands have been removed as per Arlene Kosic, 2013 04.

Merge the BER PPHPGH data that had the old CA data erased with the

revised "PPH_PGH_FINAL_20130227.shp" file. Made fields consistent. Calculated acres. EMPSi MR 2013 05 07. Does not include "NV analysis ongoing" areas from the BER data and does not include CA non-habitat areas.

Erase "PPH_PGH_FINAL_20130227.shp" , the revised CA PPHPGH file, from BER_SG_PPHPGH_base_PA) by EMPSi MR 2013 05 07.

Clipped BER (BER_SG_PPHPGH) to NVCA_SG_PA by EMPSi MR 2013 05 07.

Exported from T:\OC\BLMGIS\GRSG\rangewide\Data\1_Baseline_CEA_Analysis\GRSG\Consolidated_PPH_PGH_for_CEA.gdb\GRSG_PPH_PGH_06262012 on 2013 02 20 by EMPSi JPT as "BER_SG_PPH_PGH_base".

BER (Manier et. al 2013 metadata: A conglomerate of State submitted greater sage-grouse preliminary priority and preliminary general habitat. This data is a snapshot of state defined PPH/PGH polygons as of June 26th, 2012. States may continue to refine the PPH/PGH designations beyond this date; however this dataset will be used in the current state for CEA calculations. Individual state data, including original metadata submitted with each data set is available here:
T:\OC\BLMGIS\GRSG\rangewide\Data\wildlife\GRSG_PPH_PGH\Individual_State_Layers

California –PPH and PGH: FINAL DRAFT; Developed cooperatively by California BLM and California Department of Fish and Game.

Nevada –PPH and PGH: SEMIFINAL DRAFT; Developed by Nevada Department of Wildlife in cooperation with Nevada BLM (90% Completed).

Credits

BLM National Operations Center (NOC) Baseline Ecological Report (BER) GIS base data, most datasets made static in June 2012.
BLM Dan Kozar, (775)861-6519 dkozar@blm.gov, Michael Schade, (775)861-6772 mschade@blm.gov Nevada State office, Nevada, Bureau of Land Management, Megan Oyarzun, California BLM, (503)233-7922 moyarzun@blm.gov
Support from:
EMPSi Jordan Tucker
EMPSi Marcia Rickey
EMPSi Jenna Jonker

Use limitations

Reference and acknowledge the Bureau of Land Management in products derived from this map. No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data. Original data were compiled from various sources. This information may not meet National Map Accuracy Standards. This project was developed through digital means and may be updated without notice. Map produced by Nevada State Office, Bureau of Land Management, Nevada. Data are at the statewide scale. User assumes responsibility when using these data at scales larger (more zoomed in, for example the country scale) than a statewide scale.

Extent

West	670424.288839	**East**	755437.199051
North	4653531.03507	**South**	4460634.5

Scale Range

Maximum (zoomed in) 1:5,000

Minimum (zoomed out) 1:5,000,000

You are currently using the Item Description metadata style. Change your metadata style in the Options dialog box to see additional metadata content.

NVCA_BreedingNesting_02192015_FINAL

File Geodatabase Feature Class

Thumbnail Not Available

Tags

Greater sage-grouse, leks, Centrocercus urophasianus, sage-grouse, Nevada, breeding habitat, nesting habitat

Summary

This dataset represents Greater Sage-Grouse nesting/breeding seasonal habitat modelled using a primarily lek-centric approach. This dataset was used in the Grazing Effects Analysis completed March 2015.

Description

This dataset was created by buffering active leks within Nevada and Oregon either on or within 4 miles of the NVCA FS GRSG EIS boundary by 4 miles, and buffering active leks within Idaho either on or within 6.2 miles of the NVCA FS GRSG EIS boundary by 6.2 miles. Then those areas were isolated to within the NVCA FS GRSG EIS boundaries and further clipped to what was defined as occupied habitat at the time. This dataset was used in the Grazing Effects Analysis completed March 2015.

Credits

USDA Forest Service

Use limitations

The USDA Forest Service makes no warranty, expressed or implied, including the warranties of merchantability and fitness for a particular purpose, nor assumes any legal liability or responsibility for the accuracy, reliability, completeness or utility of these geospatial data, or for the improper or incorrect use of these geospatial data. These geospatial data and related maps or graphics are not legal documents and are not intended to be used as such. The data and maps may not be used to determine title, ownership, legal descriptions or boundaries, legal jurisdiction, or restrictions that may be in place on either public or private land. Natural hazards may or may not be depicted on the data and maps, and land users should exercise due caution. The data are dynamic and may change over time. The user is responsible to verify the limitations of the geospatial data and to use the data accordingly.

Extent

West	-118.527393	**East**	-114.134649
North	42.383369	**South**	38.203267

Scale Range

Maximum (zoomed in)	1:5,000
Minimum (zoomed out)	1:5,000,000

You are currently using the Item Description metadata style. Change your metadata style in the Options dialog box to see additional metadata content.

NVCA_BroodingSummer_02192015_FINAL

File Geodatabase Feature Class

Thumbnail Not Available

Tags

Greater sage-grouse, leks, Centrocercus urophasianus, sage-grouse, Nevada, brood-rearing habitat, summer habitat

Summary

This dataset represents Greater Sage-Grouse brood-rearing/summer seasonal habitat modelled in conjunction with nesting/breeding seasonal habitat that was generated using a primarily lek-centric approach. This dataset was used in the Grazing Effects Analysis completed March 2015.

Description

This dataset was created by erasing modelled breeding/nesting habitat from occupied habitat areas. The breeding/nesting areas were created by buffering active leks within Nevada and Oregon either on or within 4 miles of the NVCA FS GRSG EIS boundary by 4 miles, and buffering active leks within Idaho either on or within 6.2 miles of the NVCA FS GRSG EIS boundary by 6.2 miles. Then those areas were isolated to within the NVCA FS GRSG EIS boundaries and further clipped to what was defined as occupied habitat at the time.

This dataset was used in the Grazing Effects Analysis completed March 2015.

Credits

USDA Forest Service

Use limitations

The USDA Forest Service makes no warranty, expressed or implied, including the warranties of merchantability and fitness for a particular purpose, nor assumes any legal liability or responsibility for the accuracy, reliability, completeness or utility of these geospatial data, or for the improper or incorrect use of these geospatial data. These geospatial data and related maps or graphics are not legal documents and are not intended to be used as such. The data and maps may not be used to determine title, ownership, legal descriptions or boundaries, legal jurisdiction, or restrictions that may be in place on either public or private land. Natural hazards may or may not be depicted on the data and maps, and land users should exercise due caution. The data are dynamic and may change over

time. The user is responsible to verify the limitations of the geospatial data and to use the data accordingly.

Extent

West	-118.874541	**East**	-113.827382
North	42.394768	**South**	37.718213

Scale Range

Maximum (zoomed in)	1:50,000
Minimum (zoomed out)	1:5,000,000

You are currently using the Item Description metadata style. Change your metadata style in the Options dialog box to see additional metadata content.