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

Dixie National Forest

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Table of Contents

Introduction 4

Purpose 5

Location 6

Threats 6

Issue #1, Fire 6

Issue #2, Non-native, Invasive Annual Plant Species 6

Issue #3, Conifer Encroachment 7

BLM-Led FIAT Process 7

Existing Conditions 8

Analysis Area 8

Vegetation 9

Current Conditions 9

Historical Range of Variation 9

Vegetation Dynamics Development Tool (VDDT) 9

Conifer Encroachment 10

Invasive Plant Species 11

Fire Operations 13

Fuels Management 16

Methodology 17

General Process 17

Landscape Prioritization (Putting it all Together) 18

Data Layers Used in Determining Landscape Priorities 18

Habitat Data 18

Resistance and Resilience Layer 18

West Wide Risk Assessment 21

Fire Occurrence Areas 21

Fire Threat Index 22

Invasive Plant Species 23

Conifer Encroachment 23

Process 24

Findings 25

Fire Operations Program Emphasis Area 25
Fuels Management/Conifer Encroachment Program Emphasis Areas 27
Invasive Plants/Restoration/BAER Program Emphasis Areas 29
Conclusion 32
Acknowledgements 34
List of Preparers 34
References 35
Appendices 37
Appendix A Sage-grouse Habitats 38
Appendix B Fire Operations Program Emphasis Area Prioritization 40
Appendix C Fuels Management Program Emphasis Area Prioritization 42
Appendix D Conifer Encroachment Program Emphasis Area Prioritization 44
Appendix E Invasive Annual Grass Species Program Emphasis Area Prioritization 46
Appendix F Restoration/BAER Program Emphasis Area Prioritization 48
Appendix G Fire Threat Index 50
Appendix H Fire Occurrence Area 52
Appendix I Fire Management Opportunities 54
Appendix J Fuels Management Opportunities 56
Appendix K Restoration Opportunities 58
Appendix L Current Extent of Invasive Annual Grasses 59
Appendix M Current Extent of Conifer Encroachment 61
Appendix N Resistance and Resilience (Soil Temperature and Moisture Regime) 63
Appendix O Table of from the BLM led FIAT Effort 65
Appendix P BLM led FIAT Effort Fire Suppression /Fuels Management Priorities 66
Appendix Q-BLM led FIAT Effort Restoration Priority Areas 68
Appendix R BLM led FIAT Effort Conifer Encroachment/Invasive Species Priority Areas 70
Appendix S Comparison of COT Report Conservation Objectives and Measures to Assessment Findings 72
Appendix T Program Emphasis Area Calculations 86
Appendix U West Wide Risk Assessment Data Layers 91
Appendix V Inventory of all Invasive Plant Species 93

Introduction

The Greater Sage-grouse (GRSG) (*Centrocercus urophasianus)* is the largest grouse species in North America and is 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 and exhibit strong site fidelity to areas even when habitat conditions are degraded and no longer valuable to the species (USFWS 2013).

In 2010, the United States Fish and Wildlife Service (USFWS) determined that GRSG would be designated as a candidate species for listing under the Endangered Species Act. As an alternative to listing GRSG as a threatened or endangered species, it was decided that a multi-state and multi-agency effort to ensure the long-term viability of the species by addressing threats which impact GRSG habitat would be pursued.

As part of the United States Fish and Wildlife Service's (USFWS) decision to not list GRSG as a threatened or endangered species, the United States Forest Service (Forest Service) and the Bureau of Land Management (BLM) amended Land and Resource Management (Land Use) Plans for areas where GRSG currently exist. These amended Land Use plans require some Forest Service units to develop and implement new or revised standards and guidelines in order to conserve and restore GRSG habitat on their managed lands (BLM 2015). To address the threats to GRSG habitat, the BLM and the Forest Service have committed to completing wildfire, invasive annual grasses, and conifer encroachment assessments in GRSG habitat. 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.

Wildfires in sagebrush-dominated ecosystems result in the temporary and sometimes permanent loss of habitat for GRSG. Fire is an important and dynamic environmental factor in the Great Basin. However, increases in wildfire frequency in sagebrush ecosystems—fueled in part by annual invasive grasses—is one of the greatest threats to GRSG habitat in the Great Basin.

Invasive annual 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 re-establishment of invasive plant species resulting in a positive feedback loop with fire that can greatly hinder the re-establishment of sagebrush.

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.

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 strategic prioritization of the landscape for management activities to conserve GRSG habitat, as well as options for the actions to be used. While it is understood that other threats to GRSG habitat exist, this report follows the Forest Service intent to address the three primary threats

identified in the Greater Sage-grouse Conservation Objectives Team (COT) report (USFWS 2013a): fire, invasive annual grasses, and conifer encroachment.

Purpose

The purpose of the Dixie 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 Dixie National Forest (also, the Dixie, 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 Dixie.

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 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 Dixie 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 Dixie National Forest is comprised of four Ranger Districts: Cedar City, Escalante, Pine Valley, and Powell. There is no GRSG habitat on the Pine Valley Ranger District, therefore it will not be included as part of the analysis. Portions of the remaining three Ranger Districts do have GRSG habitat and are included in this analysis.

GRSG habitat based on local geospatial data including habitat management areas (HMA) which are further segmented into priority, important and general; Utah Division of Wildlife Resources data; and sagebrush focal areas, as determined by the LRMP amendment process (BLM 2015) and as described in the Greater Sage-grouse Record of Decision for Utah (USFS 2015). Local habitat data is also used and is based on habitat and GRSG use across the Dixie as collected by local biologists. See Existing Conditions section for a detailed description of habitat data and 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 and also affects the type of forage available to GRSG.

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 and other tree species, such as chokecherry, 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 Dixie 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 Appendices P, Q, and 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 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 Dixie NF, GRSG habitat in shrubland areas consists largely of mountain big sagebrush (*Artemisia tridentata* spp. *vaseyana*) and dwarf sagebrush (*Artemisia arbuscular*) with smaller amounts of silver sagebrush (*Artemisia cana*) and fringed sagebrush (*Artemisia frigida*).

The analysis area was defined using several habitat datasets developed by various agencies including US Fish and Wildlife Service (USFWS), BLM, Utah Division of Wildlife Resources (UDWR) and the Dixie NF. USFWS data consists of areas known as Priority Areas for Conservation (PACs). PACs are key GRSG habitat areas that are considered to be the most important in maintaining sage grouse representation, redundancy and resilience across the landscape. Within PACs are areas identified as Sagebrush Focal Areas (SFA). SFAs are based on PACs and 75% Breeding Bird Density (BBD) maps and include breeding and nesting habitats that are considered critical for GRSG survival and are necessary for recovery of the species (BLM, 2014). 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). There are no SFAs identified for the Dixie NF. BLM and UDWR worked together to create GRSG Habitat Management Areas (HMA) and are categorized as priority, important and general habitat. These areas were delineated based on population and breeding bird data collected by both agencies. UDWR also delineated areas known to be occupied by GRSG based on data collected by the state. Local data or Dixie NF data includes areas identified as breeding/nesting, brooding/summer, and winter habitat based on lek and telemetry data. There is a total of 224,155 acres of GRSG habitat on the Dixie NF. Table 1 is a summary of GRSG habitat in the analysis area. A map of GRSG habitat can be found in Appendix A.

Table 1 GRSG Habitat Acres by District

Ranger Districts	Habitat Management Areas[1]			Utah State Data	Dixie NF Local Data		
	Priority Habitat	Important Habitat	General Habitat	Occupied	Nesting Habitat	Summer Habitat	Summer Outside of Priority
Cedar City	52,421	0	0	51,189	0	2,003	1,782
Escalante	54,971	0	0	54,971	0	0	8,240
Powell	85,576	0	0	86,556	7,541	0	10,641
Grand Total*	**192,968**	**0**	**0**	**192,716**	**7,541**	**2,003**	**20,663**

[1] HMA dataset used: ID_SWMT GRSG Habitat Full dated: 5/7/2015

Vegetation

Current Conditions

Vegetation types identified in the Dixie NF analysis area is composed primarily of shrubland vegetation which covers approximately 41% of the analysis area. Shrubland vegetation is the primary vegetation type for GRSG habitat and consists mainly of mountain big sagebrush, dwarf sagebrush, and smaller amounts of silver sagebrush and fringed sagebrush. Other major components of the analysis area include vegetation types that are not used as frequently by GRSG or occur less frequently in GRSG habitat. These types include grasslands, and riparian/herbaceous which make up about 16% of the analysis area; coniferous forest types including Douglas-fir, and ponderosa pine accounts for 26%; pinyon juniper covers 9%; and aspen makes up 6% of known vegetation types. There are vegetation types not identified in the analysis area which is likely due to the scale at which the analysis is conducted making it difficult to get an accurate percent and description of vegetation in the area.

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 Sensing Applications Center (RSAC) in 2008 imagery. This dataset 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 13,000 ac/10yrs mechanical conifer removal, 1,000 ac/10yrs conifer removal by prescribed fire, and 7,000 ac/10yrs of native grass restoration. Table 2 displays treatment acres within the forest over ten years. More information concerning the VDDT analysis can be found in the Utah Sub-region GRSG Environmental Impact Statement/Land Use Plan Amendment.

Table 2 VDDT Modeling Specific to the Dixie National Forest

Treatment	Mechanical[1]	Prescribed Fire[2]	Native Grass Restoration[3]
Treatment Rate (acres/10 years)	13,000	1,000	7,000

Conifer Encroachment

Conifer encroachment is another key threat to sage grouse habitat at higher elevations in the analysis area. In this context, conifer encroachment refers to the fact that pinyon pine (hereafter, simply "pinyon") and juniper species are aggressively expanding beyond their historical range as a result of several factors including historic livestock overgrazing, climate change, and effective fire suppression. Across all areas identified with conifer encroachment on the Dixie NF, 23% is comprised of pinyon-juniper with 64% comprised of other conifer species including ponderosa pine (35%), and spruce-fir (29%). Aspen is also present and comprises 12% of these areas while the remaining 1% are other species. As conifer 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 conifer expansion even when the understory vegetation state would otherwise be considered desirable habitat (Casazza et al. 2010, 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 158,965 acres of active encroachment, found mostly within the Powell Ranger District with 44% of the total; followed by the Escalante and Cedar City Ranger Districts with 30% and 26% of the total, respectively. A map is included in Appendix M. Table 3, below shows the breakdown of encroachment acres by ranger district and totals.

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[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

Table 3 Acres of Encroachment Phase Class According to Relative Density of Tree Cover

Ranger District	Phase I	Phase II	Phase III	Total
Cedar City	16,077	11,526	13,931	41,534
Escalante	16,330	15,702	15,544	47,576
Powell	29,494	19,784	20,576	69,854
Grand Total	**61,901**	**47,012**	**50,051**	**158,965**

In general terms, if the Forest was to develop a 10 year plan to restore these landscapes to their natural condition, approximately 15,900 acres of conifer thinning would need to be scheduled each year based on the sum total of acres across the Forest where conifer encroachment has occurred.

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 1,300 acres of mechanical treatment of conifer encroachment should be implemented annually (13,000 acres per decade).

The overlay of currently known Phase I conifer encroachment (61,901 acres, Table 3) coupled with VDDT analysis encroachment (Table 2) indicates that a range of 1,200 to 1,300 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 (47,012 acres, Table 3) coupled with VDDT analysis encroachment (Table 2) indicates that a range of 100 to 900 acres of prescribed burning treatments of Phase II encroachment per year for the next 50 years would help to improve and maintain habitat objectives.

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.

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 (WAFWA 2015).

Invasive Annual Grasses

A breakdown of the modeled potential of annual invasive grass-infested acres on the Dixie NF within GRSG habitat analysis area is displayed in Table 4.

Table 4 Modeled Potential Invasive Annual Grass Infestation Acres by District

Ranger District	Light Infestation	Moderate Infestation	Heavy Infestation	Grand Total
Cedar City	0	1,022	3,916	4,938
Escalante	0	2,417	15,051	17,467
Powell	0	6,503	9,489	15,992
Grand Total	**0**	**9,942**	**28,456**	**38,398**

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.

Invasive and Noxious Weeds

Based on Dixie NF spatial data, the Forest has inventoried approximately 5,867 acres of invasive and noxious weeds. Approximately 287 of these acres are within the GRSG analysis area. Treatment of 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 Dixie NF, inventoried and treated invasive plant species are primarily along road ways and riparian areas where there is a high rate of spread A complete table of inventoried invasive species on the Dixie within the GRSG habitat is located in Appendix V. The inventoried invasive species data may not include all areas where invasives are established. There are known cheatgrass, medusahead, and bulbous bluegrass 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 Dixie NF within the GRSG habitat analysis area. Estimated acres of infestations derived from the model total approximately 38,398 acres.

Through the modeling effort for this FIAT, we have estimated the Forest to currently have approximately 38,398 acres of GRSG habitat that is likely infested to some degree with invasive annual grass (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 3,839 acres and potential seeding with native perennial plants annually. Biological control could potentially compliment herbicide treatments.

As with conifer encroachment above, the modeled potential of annual invasive grass infestations (38,398 acres) coupled with VDDT modeling of annual invasive species (Table 3) was completed. The model suggests that a total of approximately 7,000 acres or 700 acres annually over ten years of invasive grass treatments are needed to improve and maintain habitat objectives. Note that the VDDT analysis provides general guidance for treatment rates at the landscape scale. It is appropriate for actual treatment rates to be adjusted for variations in conditions obtained by more refined or more current data, or by local knowledge.

Fire Operations

The Dixie National Forest has a fire season that can be characterized as being typical of the Great Basin, starting in late June, peaking in early 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. In addition, the area typically experiences monsoonal weather late July to early August, resulting in a bi-modal fire season across much of the forest. 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 60,635 acres of wildland fire on the Forest. Fire of up to 18,044 acres is further evidenced in the record.

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 will 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 364 miles of road network that could be beneficial for fire suppression operations.

There are various assets stationed across the Forest (Table 5) and cooperative agreements with other federal, state, and local resources to respond to wildland fire incidents. The program consists of 56 dedicated, preparedness funded firefighters in 2016. Assets such as a helicopters, hand crews, and fire engines are available on the unit.

The Forest is also host to a variety of National Shared Resources (NSRs) in Cedar City. There is one Interagency Hotshot Crews and a Type 1 helicopter. While these are resources are not part of the initial attack compliment of the Forest, they are at times, based upon availability, in close proximity and can be ordered quickly for initial attack.

The Dixie NF and other cooperative resources are dispatched to new incidents under a "closest forces" concept from the Color Country Interagency Dispatch Center with suppression responsibilities on the Dixie NF, and other public lands. The Color Country Interagency Fire (CCIF) organization is used to coordinate fire management planning. CCIF leads a cooperative effort to assist with all phases of fire

management of Color Country public lands. The group's mission is to promote safe, effective fire management through interagency cooperation.

Because many wildland fires are of a multi-jurisdictional nature, interagency cooperation provides an ideal background for cohesive ecological, social, political, and economical considerations for land management. CCIF is comprised of five local land agencies: the U.S. Forest Service (USFS), Bureau of Land Management (BLM), National Park Service (NPS), Bureau of Indian Affairs (BIA), and Utah Division of Forestry, Fire, and State Lands (FF&SL). CCIF continually assesses opportunities for collaboration on fire management planning.

Furthermore, CCIFC is responsible for dispatching and coordination of wildfires (avg. 400 fires per/yr) and incidents for approximately 16.5 million acres located in the following Utah and Arizona Counties: UT; Beaver, Garfield, Iron, Kane, and Washington. AZ; Coconino and Mohave. CCIFC has South Zone Logistics located in St. George, UT covering the logistics for Washington Country, UT and the Arizona Strip BLM. Local and rural fire departments also assist in the protection of public lands and are in turn assisted by federal and state cooperators.

Table 5 Forest Duty Stations and Resources by Ranger District

Location	Resource	Type	Number	Staffing
Pine Valley Ranger District, St George	Engine	4	1	5 person, 5 days
	Helicopter	3	1	11 people, 7 days (shared with Arizona Strip BLM)
	ICT 3		2	
Cedar City Ranger District, Cedar City	Engine	4	2	5 person, 5 days
	Initial Attack Squad	IA	1	5 people, 5 days
	Helicopter (managed by SO)	1 NSR	1	1 person, 7 days
	Hotshot Crew	1 NSR	1	20 person, 7 days
	ICT3		3	
Powell Ranger District, Panguitch	Engine	6	1	5 person, 5 days
	Initial Attack Squad	IA	1	5 people, 5 days
	Fuels Squad (not staffed in 2016)	IA	1	5 person, 5 days
	ICT3		1	
Escalante Ranger District	Engine	4	1	5 person, 5 days
	Initial Attack Squad	IA	1	5 people, 5 days
	Fuels Squad (not staffed in 2016)	IA	1	5 person, 5 days
	ICT3	Trainee	1	

The Forest has identified a variety of improvements to existing facilities, infrastructure and additional resources that could improve fire preparedness in an effort to better detect, respond and manage new fire starts. There is opportunity to improve helipad facilities in at least one location, as well as improving facilities at a variety of stations across the Forest

Additional resources could be added to the existing compliment of preparedness funded resources to better achieve response and readiness on initial attack and emerging incidents including an Operations AFMO, additional engines, prevention technicians and fully funding tours with allocated dollars. These resources would be available for initial and extended attack fires to improve response times across the Forest.

In some areas, available water is in short supply and "turn times" are long. Improvements such as heliwells, guzzlers, and stock tanks could be strategically placed on the landscape where this resource is in short supply, thusly shortening turn times for engines and helicopters during initial attack.

The Forest has a comprehensive Interagency Fire Danger Operating Plan (FDOP). It includes the use of the National Fire Danger Rating System (NFDRS) 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.

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 Dixie 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 and Park Service, 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 23 RAWS stations across the dispatch areas of responsibility.

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.

For fire planning purposes, the Forest is further broken down into Fire Danger Rating Areas (FDRAs). These are defined as being large geographic areas that are relatively homogeneous with respect to climate, vegetation and topography. Thus, it can be assumed that fire danger within the FDRA is uniform.

Looking at fire records and indices, it is reasonable to make a determination that the Burning Index (BI) breakpoints correlate well with multiple fire days and large fire days.

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. 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 certain 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.

The Region is in the process of updating the WUI layer and at this time the amount of GRSG habitat that is contained within this WUI area is unknown. The Forest has an established WUI layer that was sent to the Regional Office for its use. 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.

There are 158,965 acres of conifer encroachment within GRSG habitat. This includes meadows that would be used for habitat connectivity that are currently in need of treatment. These areas could be treated with a variety of methods, restoring them to vital habitat for GRSG.

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 could be 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. The potential road improvements could include a brushing, blading, repairing, Dixie harrowing, or any combination of these actions. 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 meeting was 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)

The process of delineating priority areas across the landscape consists of using a multi-step approach. The analysis area is defined by the greatest extent of all identified GRSG habitat based on various datasets including local data. Once this is defined and agreed upon, the application of the resistance and resilience concept (Chambers et. al. 2014) is overlain and scored specifically as it relates to the general objectives of the five emphasis areas as described above. Specific scoring detail can be found in Appendix T. Other layers overlaid for various emphasis areas include fire risk as calculated by the West Wide Risk Assessment dataset (2014), annual invasive grass and conifer encroachment layers. A detailed discussion of each of these datasets including how they are derived is described below. A table (table 10) outlining the combination of these various elements used in the prioritization of the landscape for each of the five emphasis areas can also be found in the "Process" section below. From this, appropriate management strategies and treatments can be further fleshed out.

Data Layers Used in Determining Landscape Priorities

Habitat Data

Habitat Management Areas

- **Priority Habitat Management Area (PHMA)** - lands identified as having the highest value to maintaining sustainable GRSG populations. Areas of PHMA largely coincide with areas identified as Priority Areas for Conservation in the COT report.
- **Important Habitat Management Areas (IHMA)** – lands that encompass high value habitat and populations that provide a management buffer for the priority and sagebrush focal management areas and connect patches of priority and sagebrush focal management areas. They generally include areas of high conservation value habitat and/or populations and, in some conservation areas, include areas beyond those identified by USFWS as necessary to maintain redundant, representative, and resilient populations.
- **General Habitat Management Area (GHMA**) - lands where some special management would apply to sustain GRSG populations. They include areas outside of priority and sagebrush focal management areas and occupied by GRSG seasonally or year-round.

Sagebrush Focal Areas (SFAs) – Are a subset of the priority habitat management areas and represent "strongholds" for the species. SFAs are based on PACs and 75% Breeding Bird Density (BBD) maps and include breeding and nesting habitats that are considered critical for GRSG survival. They have the highest densities of the species and are necessary for recovery of the species (BLM, 2014). No SFAs were found to occur on the Dixie NF.

Occupied Habitat – Habitat known to be by GRSG based on data collected by the Utah Division of Wildlife Resources.

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

- Nesting habitat
- Summer habitat
- Summer habitat outside of Priority Habitat

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). Resilience refers to a landscape's ability to recover the ecosystem's structure, function, and processes after a disturbance such as fire as opposed to slipping toward a different ecosystem dominated by invasive species. Resistance refers to the landscape's ability to resist invasive annual grass establishment or expansion. Chambers et al (2014) uses soil temperature and moisture regimes as the key predictors in defining resilience and resistance. Each soil type is rated based on its relative R&R (high, moderate, or low) to help facilitate rapid risk assessments and prioritize resources in fighting both wildfires and weeds (Chambers et al 2014). Sagebrush is then overlaid with R&R to delineate Sage-grouse habitat. Sage-grouse habitat is evaluated based on the landscape cover of sagebrush (Wisdom et al.; Aldridge et al.; Knick et al. 2013). See Figure 2 for more detail.

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 6 is a representation of acres per district of the resilience and resistance categories, coupled with the sagebrush cover categories as adopted from Chambers et al. A map of the Resilience and Resistance is in Appendix N.

Figure 1. Resistance and Resilience Classification Matrix for Sagebrush (from Chambers et al 2014)

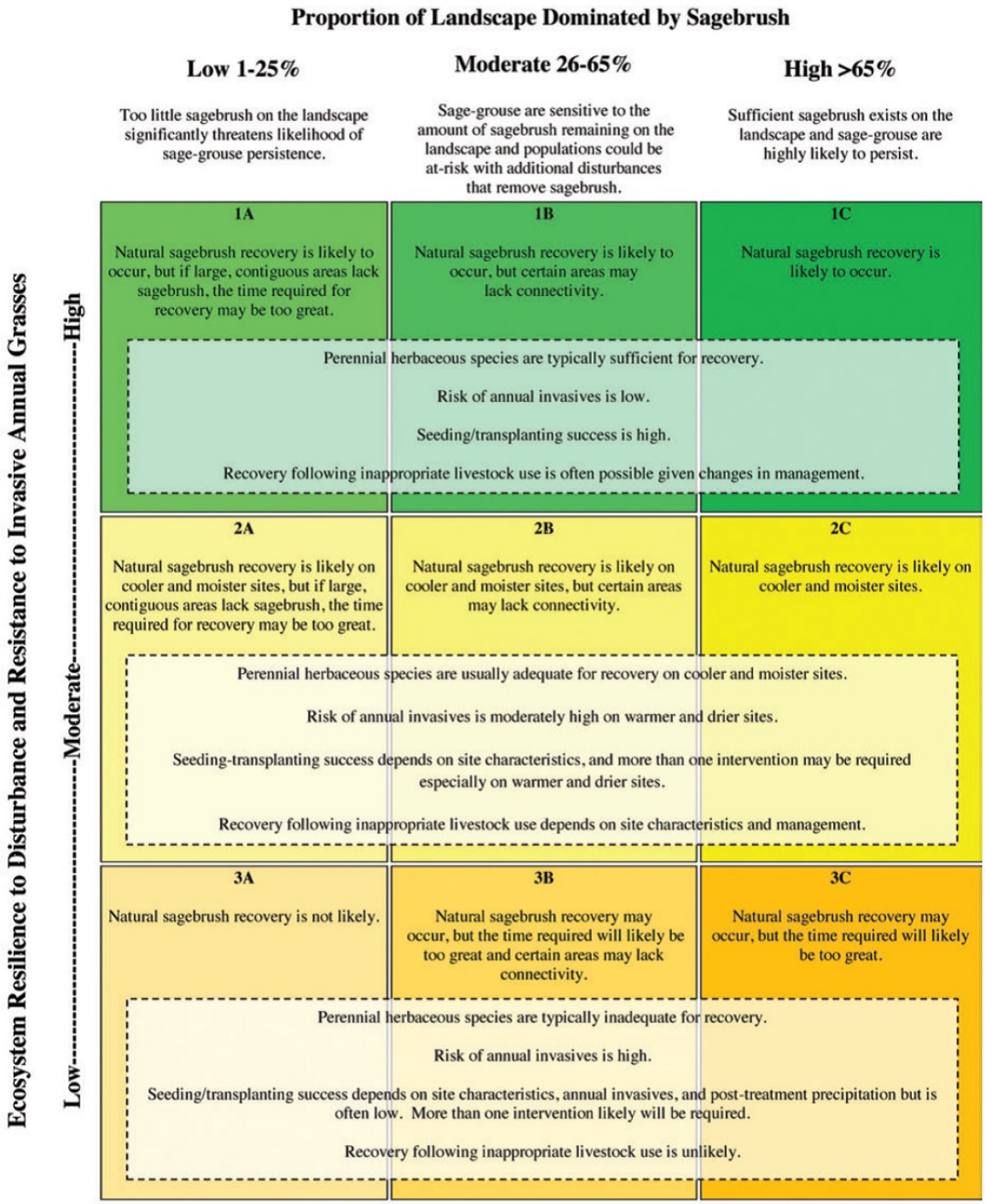

Table 6 Acres of Resistance and Resilience Rating by District within the GRSG Analysis Area[5]

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	Total
Cedar City	44,229	3,957	0	5,600	1,288	0	3	55,0770
Escalante	30,856	5,891	299	15,741	6,882	980	3	60,653
Powell	50,921	20,055	0	10,260	6,507	0	0	87,743
Grand Total	**126,006**	**29,903**	**299**	**31,601**	**14,677**	**980**	**6**	**203,473**

In order to prioritize the landscape based on its resistance and resilience, the R&R matrix overlain with sagebrush cover percent, was given numeric values (1 through 9). This numeric ranking of the R&R matrix provided an avenue to give higher weight to areas that are currently good GRSG habitat with low resiliency, and need protection from disturbance. It also allowed for the converse, allowing prioritization of areas in greater need of human intervention such as areas of conifer encroachment or areas with invasive annual grass infestations. Appendix T is a guide to the landscape prioritization process.

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

[5]These areas do not include wetland/riparian nor areas where the R&R score is zero. Thus, acres do not equal the total number of acres for the analysis area.

per 1,000 acres. Table 7 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 7 Acres of GRSG Habitat within Fire Occurrence Areas[6]

Ranger Districts	Fire Occurrence Area Rating					Grand Total
	Very Low	Low	Moderate	High	Very High	
Cedar City	0	20,227	7,936	10,318	170	55,359
Escalante	67	21,884	9,272	9,417	681	62,291
Powell	76	56,085	10,759	9,589	85	103,930
Grand Total	**143**	**98,196**	**27,967**	**29,325**	**935**	**221,580**

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. Table 8 shows a summary of the FTI to GRSG habitats associated with this assessment. Appendix G displays a map of the FTI.

[6] There is no FOA data for areas that cover waterbodies. Thus, acres do not equal the total number of acres for the analysis area.

Table 8 Acres of GRSG Habitat by Fire Threat Index[7]

Ranger District	Very Low	Low	Moderate	High	Very High	Grand Total
Cedar City	17,018	24,648	9,897	3,074	301	54,939
Escalante	26,885	14,320	12,461	7,983	361	62,009
Powell	46,240	39,776	13,900	3,424	0	103,339
Grand Total	**90,144**	**78,744**	**36,258**	**14,480**	**662**	**220,288**

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

Invasive Plant Species

Because there was limited invasive annual grass spatial data for the Dixie NF, 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 Dixie NF were modeled using the following methodology: from the resistance and resilience spatial data: 2A, 2B, 2C, 3A, 3B, and 3C polygons were selected. From here, elevation below 8500 feet were selected. This spatial layer provides a forest landscape scale representation of modeled potential annual invasive grass infestations within the GRSG analysis area within the Dixie NF.

The Forest has inventoried invasive plant species infestation GIS data. From this spatial layer, inventoried invasive plant infestation acres within the analysis area were determined.

Conifer Encroachment

Conifer encroachment status within GRSG habitat was based on tree canopy cover spatial data obtained from the Sage Grouse Initiate (SGI) website (Falkowski et al, In Press 2016). This layer presents tree canopy cover on a per acre basis according to the following classes:

- 1: <1%
- 2: 1-4%
- 3: 4-10%
- 4: 10-20%
- 5: 20-50%
- 6: >50%

Conifer encroachment phases I, II, and III were classified according to the SGI sourced canopy cover classifications as follows:

- Phase I: Classes 2, 3, and 4 (1 to 10%)
- Phase II: Class 4 (10 to 20%)
- Phase III: Classes 5 and 6 (>20%)

[7] There is no FTI data for waterbodies which is why the total number of FTI acres do not equal the total number of acres for the analysis area.

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 9 is a breakdown of the spatial products used to define each of these program emphasis areas.

Table 9 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 8 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 Dixie NF biologists scored as 2. The GRSG total score for habitat equaled all habitat source data scores (HMA, Utah State data, 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

A summary of fire operations priority acres based on level of priority and land ownership is displayed in Table 10. It is a result of the processes described above in prioritizing the landscape for fire operations. A map displaying the priority areas can be found in Appendix B.

Table 10 Fire Operation Priority Acres by Land Ownership

Ranger District	Very Low	Low	Moderate	High	Grand Total
Cedar City	4,902	46,649	4,828	0	56,379
Escalante	7,283	34,515	21,413	0	63,211
Powell	18,857	70,598	15,283	1	104,739
Grand Total	**31,041**	**151,762**	**41,524**	**1**	**224,329**

Based on the results of the analysis:

- There is a need to protect existing habitat from large scale fire. Approximately 23% 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.

- Brush/blade/repair (366 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 GRSG habitat and across adjacent land ownerships (i.e. BLM, private).
- Consider monitoring increased public access/use and fire starts associated with road maintenance program.
- Develop mobile applications and provide devices for fireline leadership to improve situational awareness.
- Improve mission capability of existing radio/repeater infrastructure.
- Utilize the Fire Occurrence Area (FOA) maps to determine logical areas to implement fire prevention strategies.
- Utilize the Fire Ops prioritization map to determine logical areas to implement fire prevention strategies.
- Identify fire priority areas, digitize and input into WFDSS.
- Consider improving Dave's Hollow Helipad facilities (power, water and utilization of space) for the addition of resources.
- Consider improving existing stations by expanding and building new structures (i.e. engine bays, cache facilities).
- Formalize and or invest in weed wash stations with containment system. Also consider CWN contracts for weed wash stations for non-large fire incidents.
- Consider adding a heliwell for the Forest to support aerial firefighting resources.
- Identify GRSG habitat on adjoining Forests and/or other administrative boundaries.
- In an effort to increase capacity and availability of Resource Advisors, formalize recruitment and training efforts.
- Augment current organizational chart with additional staff positions.
    - GS-09 Operations AFMO on Cedar City RD.
- Additional equipment needs.
    - Two additional engines and associated staffing.
- Consider fully funding employee tours with allocated dollars, as opposed to underfunding them and having them rely on P-code funding taken from other resource areas (fire borrowing).
- Consider adding more Prevention Techs (seasonal) assigned to districts.

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 Dixie National Forest.

- Modify run-cards to incorporate additional response to pre-identified GRSG habitat. Where conflicting priorities may exist, ensure Line Officers are engaged in setting suppression priorities, particularity in pre-season planning.

- Coordinate with BLM concerning the interagency response zones and insure run-cards have been modified to incorporate additional response to pre-identified GRSG habitat.
- Identify, in advance, strategic locations for incident command posts (ICPs) that would not impact GRSG habitat (Appendix I).

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

A summary of the amount of acres of each priority classification for fuels management based on land ownership is displayed in Table 11. It is a result of the processes described above in prioritizing the landscape for fuels management and for conifer encroachment. A map of the results can be found in Appendices C.

Table 11 Fuels Management Priority Acres by Land Ownership

Ranger District	Very Low	Low	Moderate	High	Grand Total
Cedar City	5,020	45,781	5,578	0	56,379
Escalante	8,240	36,170	18,801	0	63,211
Powell	18,970	59,400	26,366	1	104,737
Grand Total	**32,230**	**141,351**	**50,746**	**1**	**224,327**

A summary of the amount of acres of each priority classification for conifer encroachment based on land ownership is displayed in Table 12. 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 using this table. 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. A map of the results can be found in Appendices D.

Table 12 Acres of Conifer Encroachment by Phase and Treatment Priority Class

Encroachment Phase	Very Low	Low	Moderate	High	Grand Total
Phase I -Light	0	10,924	50,977	0	61,901
Phase II - Moderate	3,430	43,582	0	0	47,012
Phase III - Heavy	8,406	41,646	0	0	50,051
Grand Total	**11,835**	**96,152**	**50,977**	**0**	**158,965**

Based on the results of the analysis:

- 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 158,965 acres of conifer encroachment, approximately 75 miles of fuel breaks utilizing the existing road network that have been identified through this assessment that could provide beneficial actions to maintain, conserve and enhance GRSG habitat..

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.

- Maintain the ability to develop, plan and implement a program of work to accomplish mechanical treatment of 1,200 to 1,300 acres of conifer encroachment per year.
- Maintain the ability to develop, plan and implement a program of work to accomplish prescribed burning, or other treatment options across 100 to 900 acres conifer encroachment per year.
- Maintain a funded program of work to develop meadow restoration treatments.
- Blade, brush, repair, and general road improvement (75 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)
- Develop mosaics on the sagebrush landscape that are < 100 acres in the < 12 inch precipitation zones, to break up continuous fuels to interrupt the spread and intensity of wildfires.
- 13,000 acres of mechanical treatment have been 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.
- Enhance areas of connectivity habitat for improved movement between populations and habitat areas.

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 Dixie National Forest.

- Develop a five year program of work that prioritizes, NFMA, NEPA and implementation to create a list for out-year planning.
- Promote landscape level tools for planning and increase Forest capacity to accomplish national landscape planning objectives.

- Increase funding for the Forest fuels and vegetation crew for data collection, implementation and monitoring.
- Consider adding a Forest Range Technician to support GRSG work.
- Increase funding to fully fund employees to accomplish GRSG work load associated with implementing ROD direction.
- Maintain or ensure a programmatic agreement(s) with state SHPO is complete in order to streamline project analysis and review.
- 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.
- Develop and implement monitoring protocols for effectiveness of treatments.

Methods to consider applicable to the Dixie National Forest

- Employ mastication treatments of the conifer encroachment that will not result in excessive fuel loading followed by an evaluation for restoration needs.
- Dixie harrow treatments of Phase I and Phase II conifer encroachment.
- Lop/scatter and/or lop/scatter/pile (mechanical, handcut/pile) treatment in areas of conifer encroachment followed by an evaluation for restoration needs.
- Pile burn and where applicable, broadcast burn in conifer encroachment followed by an evaluation for restoration needs.
- Cut/haul/biomass treatment of Phase III conifer encroachment followed by restoration of native species.
- Retain biomass option for future utilization.
- Apply herbicides, use prescribed fire and mechanical treatments to diversify and create a mosaic of age classes stimulating growth of understory forbs and grasses.

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 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 integrating areas of conifer encroachment into the "Red / Green" maps the Forest uses to aid in the decision to use a managed fire approach to meet LMP objectives.
- ✓ 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 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 adjacent to private land inholdings or in urban interface should focus on conifer encroachment and 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, reducing the risk to private property values within and adjacent to GRSG habitat.

Invasive Plants/Restoration/BAER Program Emphasis Areas

A summary of invasive plant priority acres based on level of priority and land ownership is displayed in Table 13. It is a result of the processes described above in prioritizing the landscape for invasive annual grasses. A map displaying the priority areas can be found in Appendix E.

Table 13. Invasive Annual Grass Priority Acres by Ranger District

Ranger District	Low	Moderate	High	Grand Total
Cedar City	564	4,374	0	4,938
Escalante	1,676	15,791	0	17,467
Powell	2,855	13,138	0	15,992
Grand Total	**5,095**	**33,303**	**0**	**38,398**

A summary of restoration priority acres based on level of priority and land ownership is displayed in Table 14. It is a result of the processes described above in prioritizing the landscape for restoration opportunities. A map displaying the priority areas can be found in Appendix F.

Table 14. Restoration Priority Acres by Land Ownership

Ranger District	Very Low	Low	Moderate	High	Grand Total
Cedar City	754	5,554	50,071	0	56,379
Escalante	1,800	8,983	52,428	0	63,211
Powell	5,546	29,729	69,462	1	104,737
Grand Total	**8,100**	**44,266**	**171,960**	**1**	**224,327**

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 Dixie NF 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 include, but may not be limited to:

- Developing a comprehensive monitoring program.
- Increasing educational efforts surrounding the impacts of invasives along with spread and control.
- Coordinating and collaborating with external partners for invasive control.
- Developing a funding mechanism for post-fire restoration that is aligned with natural succession.
- Improving 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.

Based on the results of the analysis:

- ❖ 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 some probability of invasive annual grass infestations on 38,398 acres within GRSG habitat on the forest that would benefit from invasive annual grass treatment.
- ❖ Restoration opportunities have been identified in the Sanford Fire area for both noxious weed treatments and GRSG habitat treatments.
- ❖ Treat white top, Scotch thistle, rabbit brush on Sandy Creek (D2).
- ❖ Treat musk thistle along Three Mile, Five Mile, and Three Creeks 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 Invasive Plants, Restoration/BAER Program Emphasis Areas

- Expand existing program of work to spray and reseed approximately 3,898 acres of non-native, invasive species per year.
- Use Dixie harrow and/or mow sagebrush to create multi-aged mosaics, creating a landscape that is less conducive to large fire growth.

Methods to consider applicable to the Dixie National Forest

- o Seek opportunities for grazing management of annual invasive grass infestations.
- o Use biological agents to gain control of invasive annual grasses that have a modeled potential of invasive annual grasses on the forest in GRSG habitat followed by reseeding if necessary, in addition to the current program already in place.
- o Develop adaptive management grazing systems that are designed to promote sagebrush growth.
- o Utilize goats/sheep that are trained to consume invasive annual grasses in conjunction with herbicide and/or biological agents to slow the spread of these unwanted species across identified acres.
- o Apply herbicide treatment on rabbit brush, white top, Scotch thistle, musk thistle patches and reseed with native species.

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. BLMs ESR). As it currently stands, budget distribution for this kind of work is limited in its application over time.
- ✓ The agency needs to recognize and establish a post-fire restoration program beyond what BAER currently provides to meet long term restoration needs.
- ✓ 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/improve existing partnership with Cooperative Weed Management Areas (ie. counties, private landowners, etc)
- ✓ Develop and/or continue to implement 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 creating weed-washing stations at each Forest office for the local fleet.
- ✓ Invest in weed wash stations with containment system. Also consider CWN contracts for weed wash stations for non-large fire incidents.
- ✓ Consider expanding, improving and funding a native plant seedbank, including sagebrush seed, for response to post-fire and other disturbance restoration that is commensurate with the presence of invasive annuals.

Conclusion

This assessment team's findings are that sagebrush ecosystems on the Dixie NF are threatened, to varying extents, by wildland fire, conifer encroachment, and non-native, invasive annual grasses. 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 Dixie 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 Dixie 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 Dixie 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.

Acknowledgements

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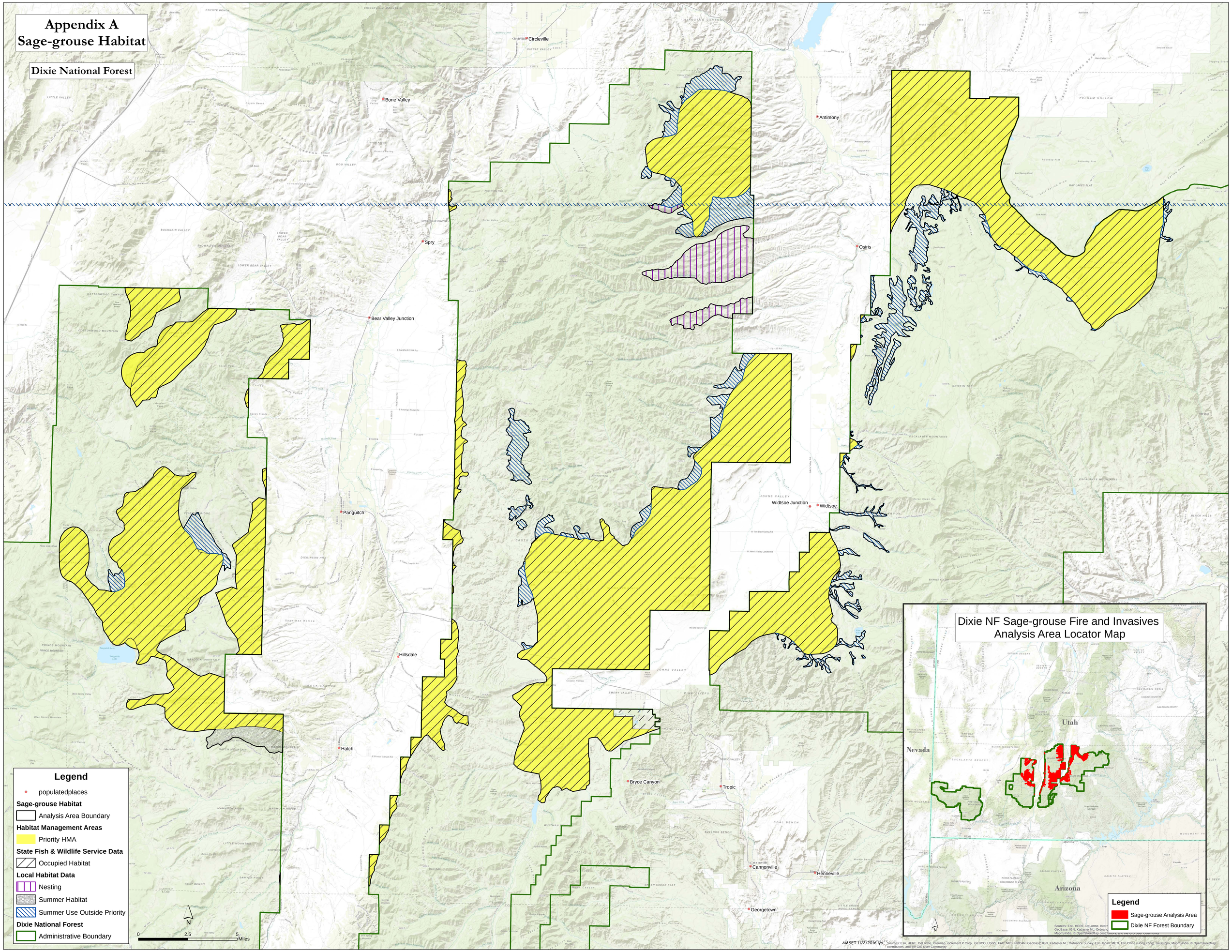
Appendices

Appendix A Sage-grouse Habitats

Appendix A
Sage-grouse Habitat

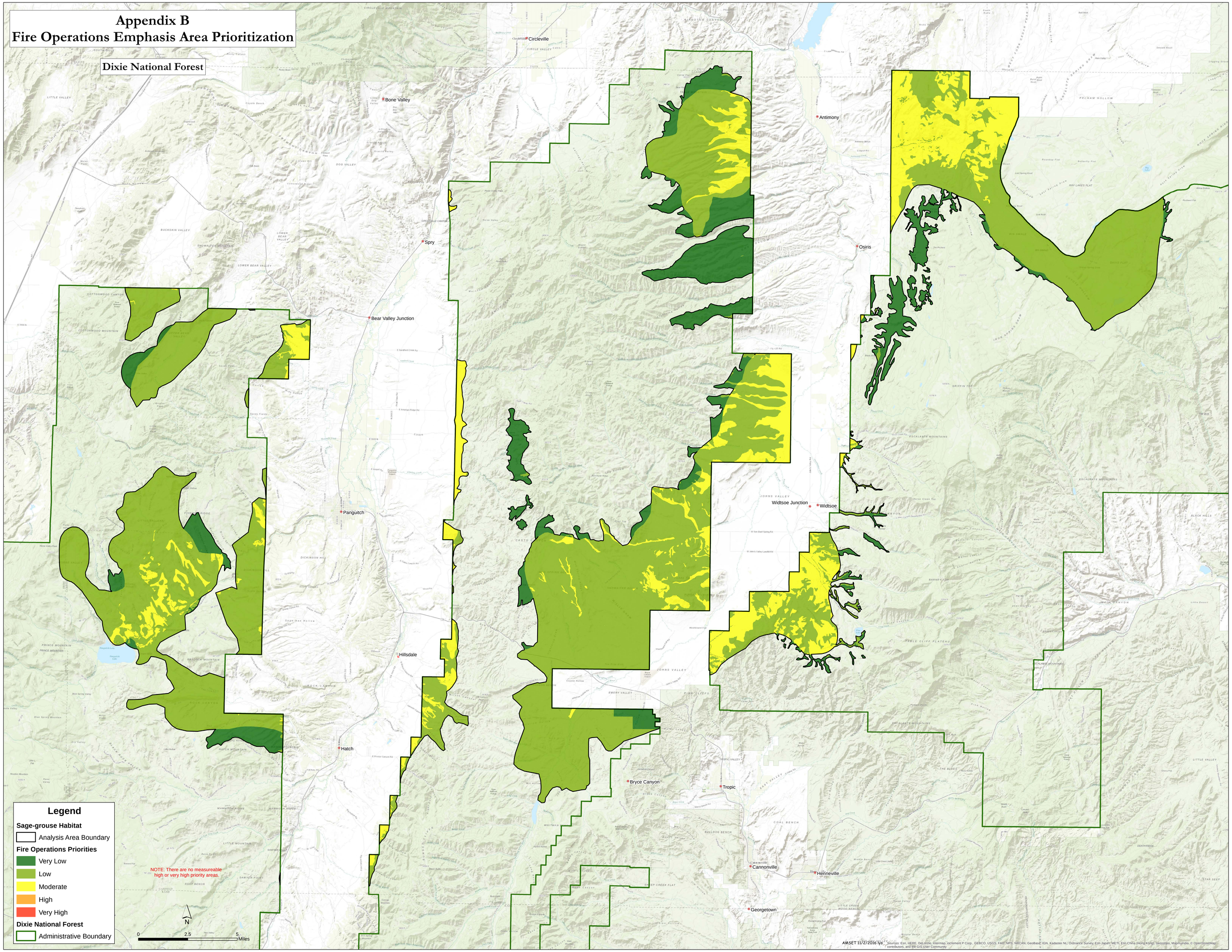
Dixie National Forest



Appendix B Fire Operations Program Emphasis Area Prioritization

Appendix B
Fire Operations Emphasis Area Prioritization

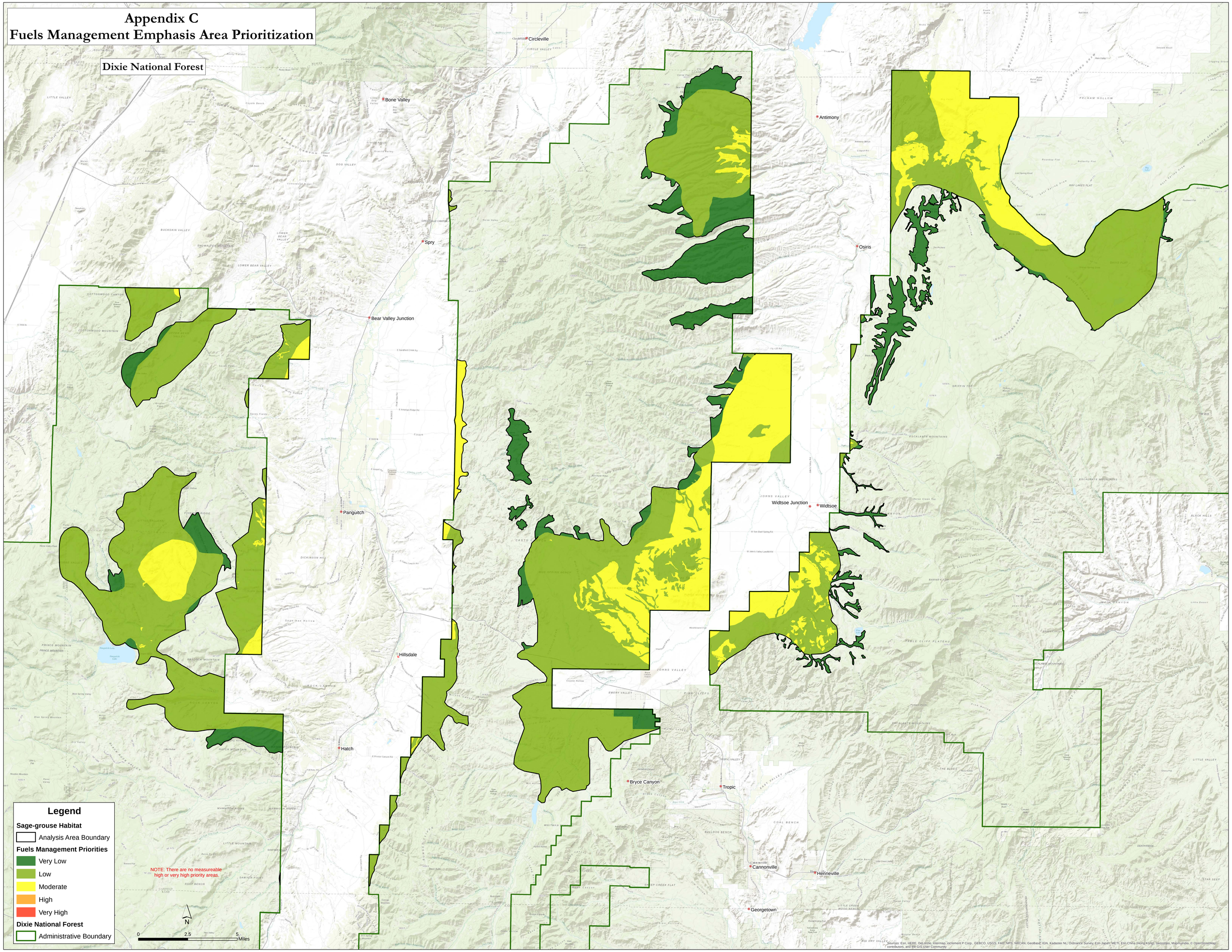
Dixie National Forest



Appendix C Fuels Management Program Emphasis Area Prioritization

Appendix C
Fuels Management Emphasis Area Prioritization

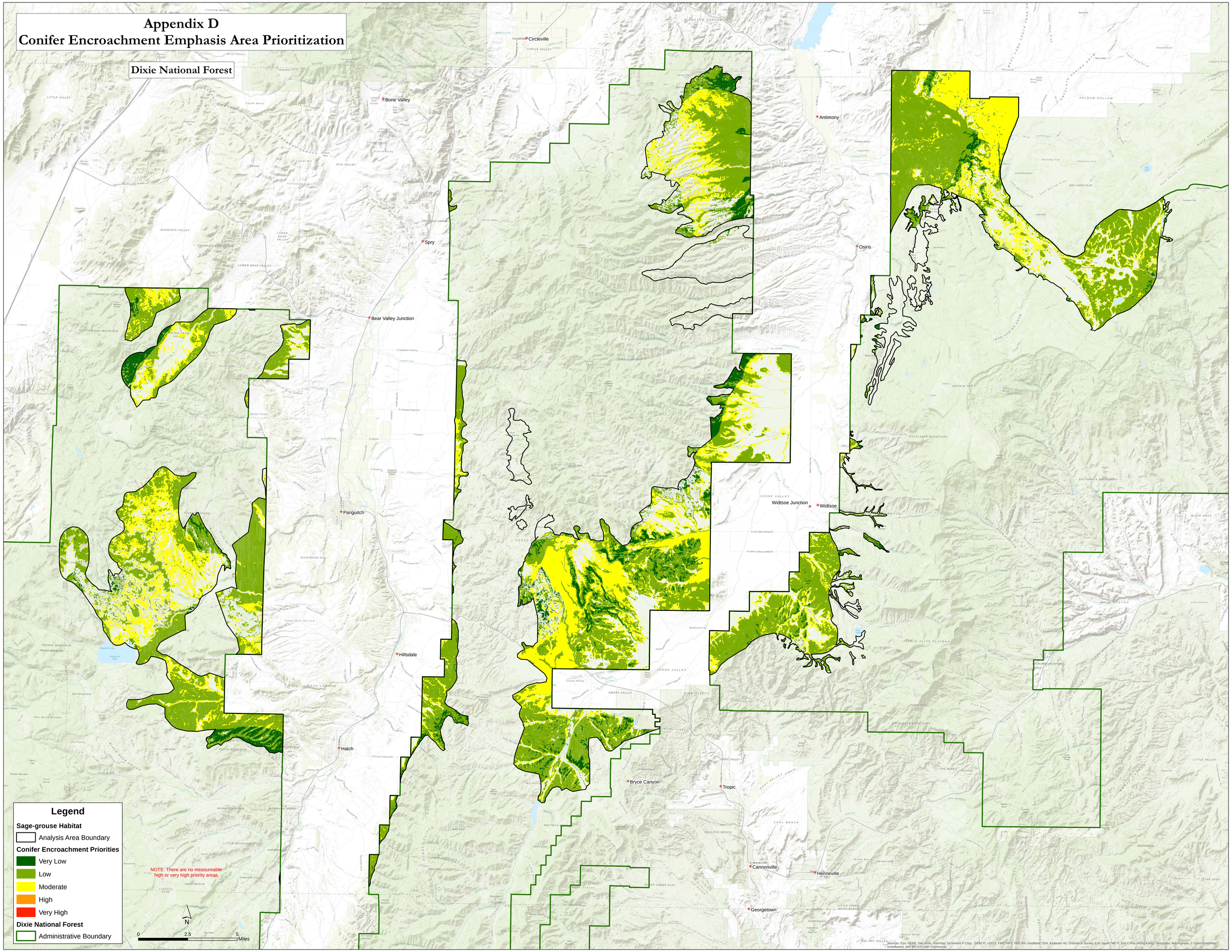
Dixie National Forest



Appendix D Conifer Encroachment Program Emphasis Area Prioritization

Appendix D
Conifer Encroachment Emphasis Area Prioritization

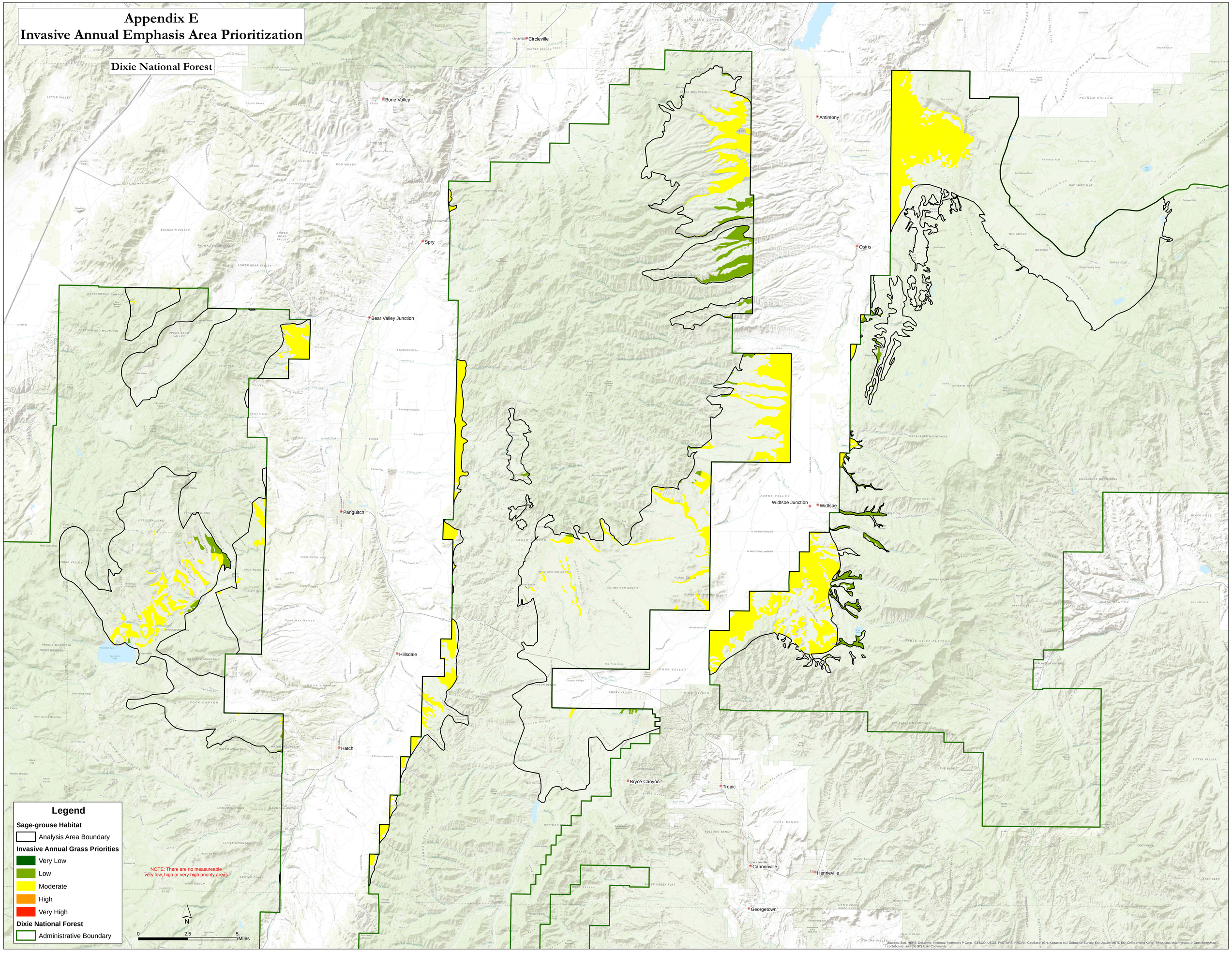
Dixie National Forest



Appendix E Invasive Annual Grass Species Program Emphasis Area Prioritization

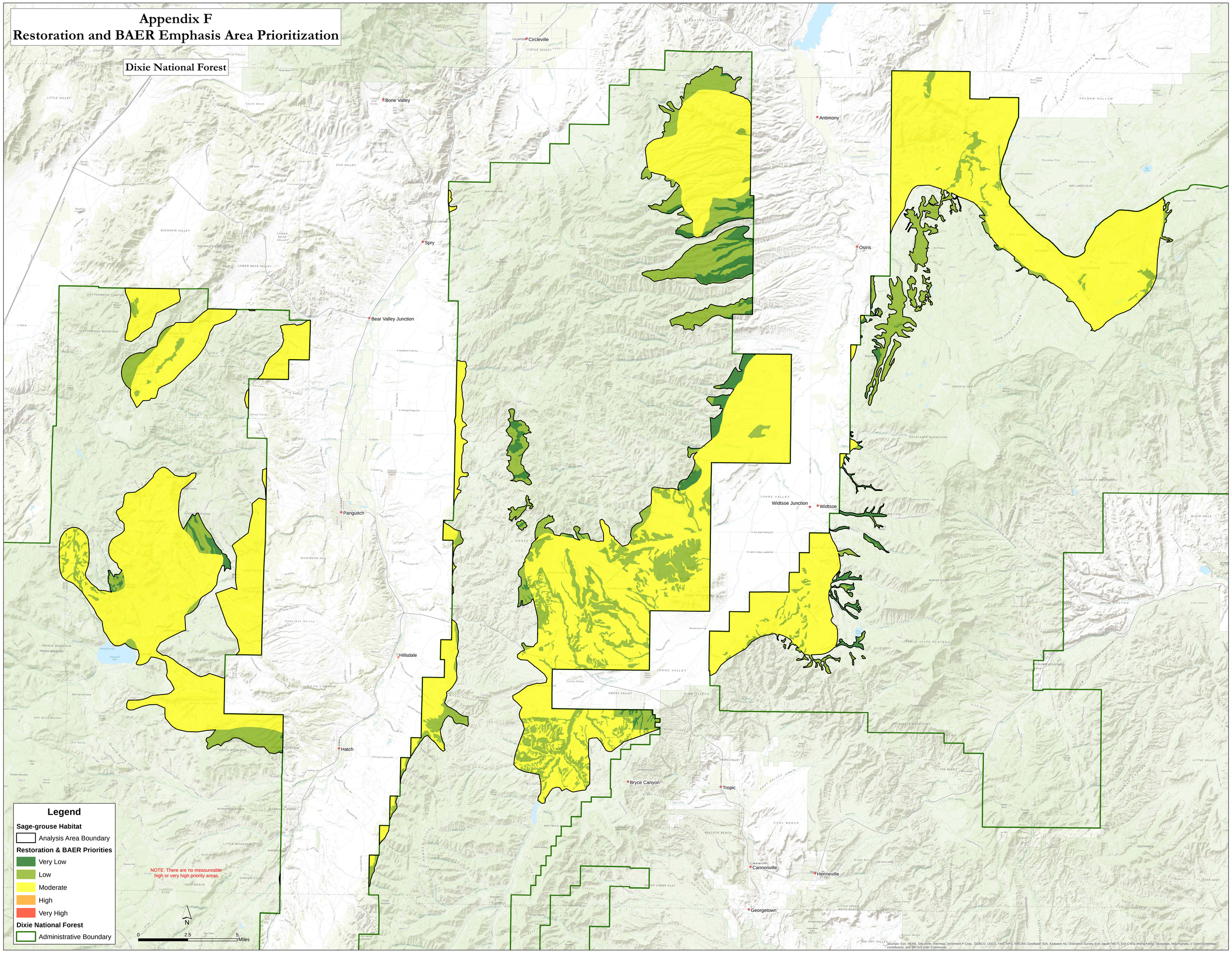
Appendix E
Invasive Annual Emphasis Area Prioritization

Dixie National Forest

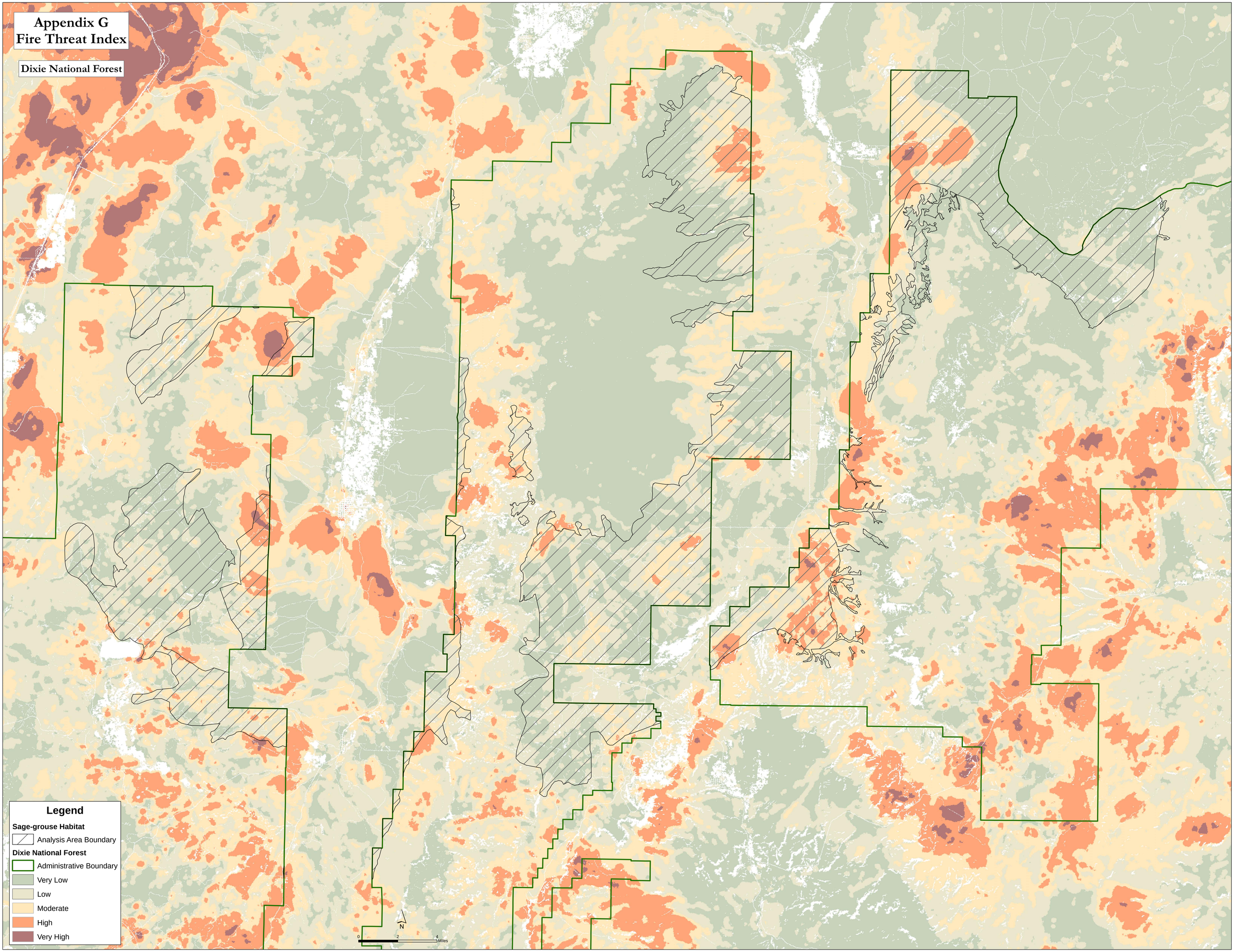


Appendix F Restoration/BAER Program Emphasis Area Prioritization

Appendix F
Restoration and BAER Emphasis Area Prioritization



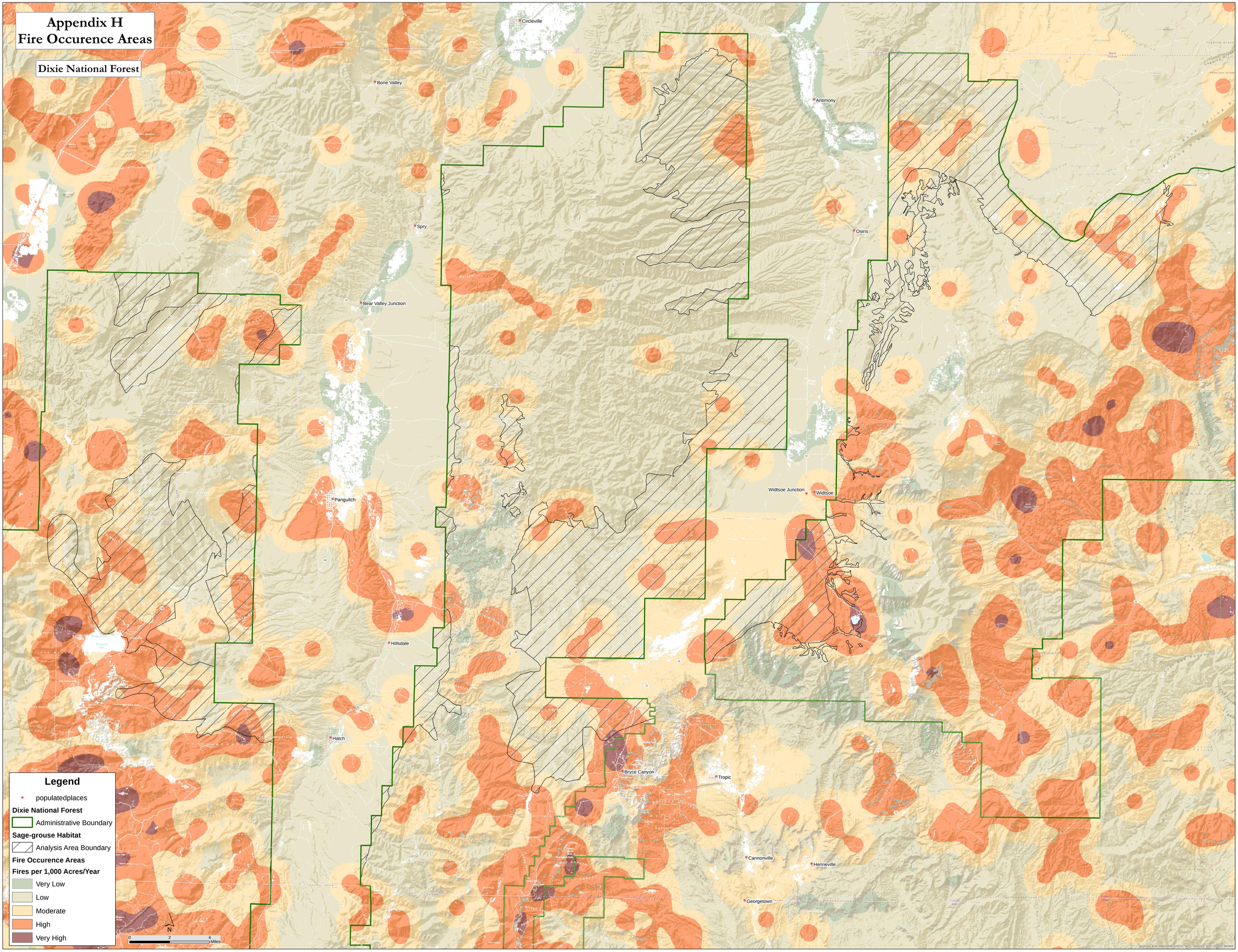
Appendix G Fire Threat Index


Appendix G
Fire Threat Index
Dixie National Forest
Legend
Sage-grouse Habitat
Analysis Area Boundary
Dixie National Forest
Administrative Boundary
Very Low
Low
Moderate
High
Very High
N
0
2
4
Miles

Appendix H Fire Occurrence Area

Appendix H
Fire Occurence Areas

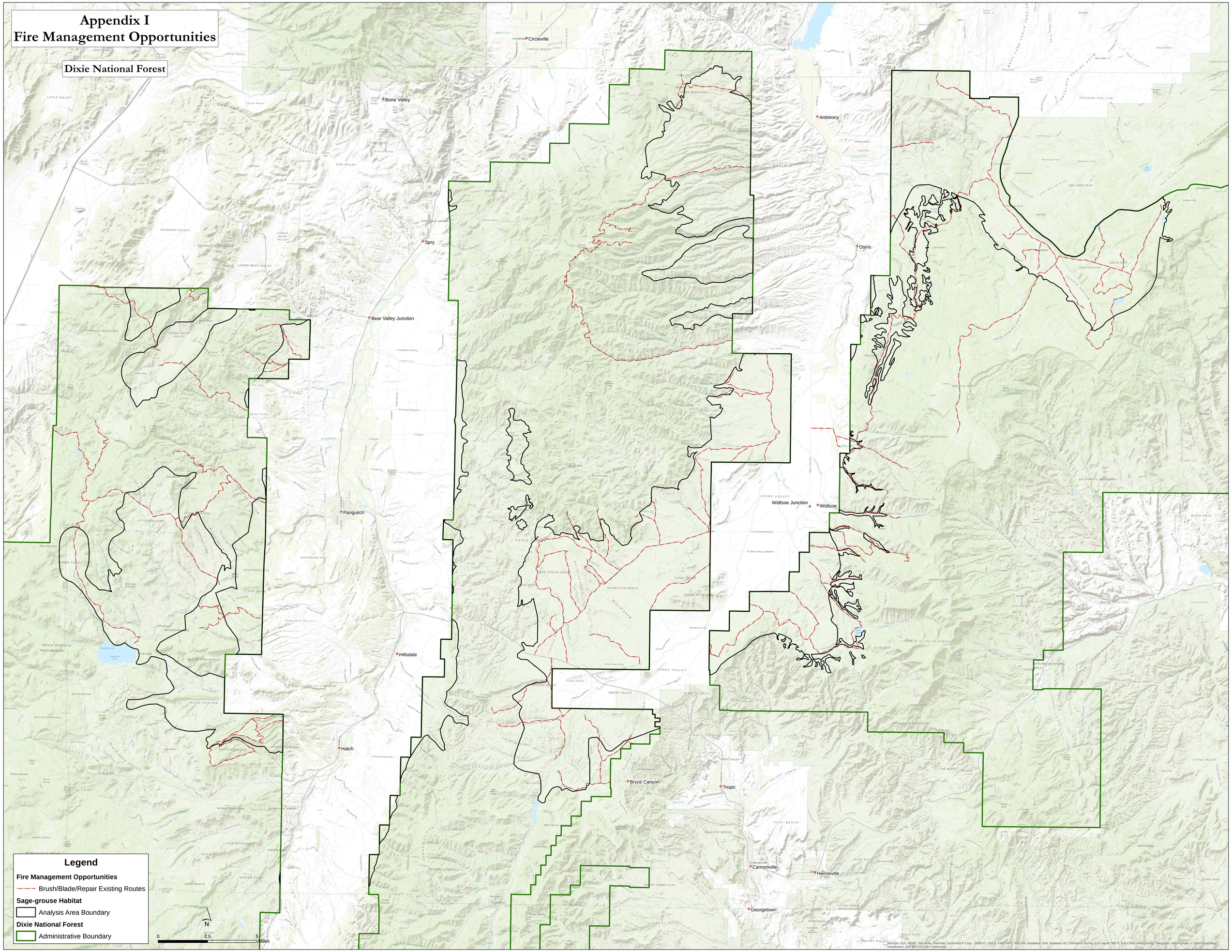
Dixie National Forest



Appendix I Fire Management Opportunities

Appendix I
Fire Management Opportunities

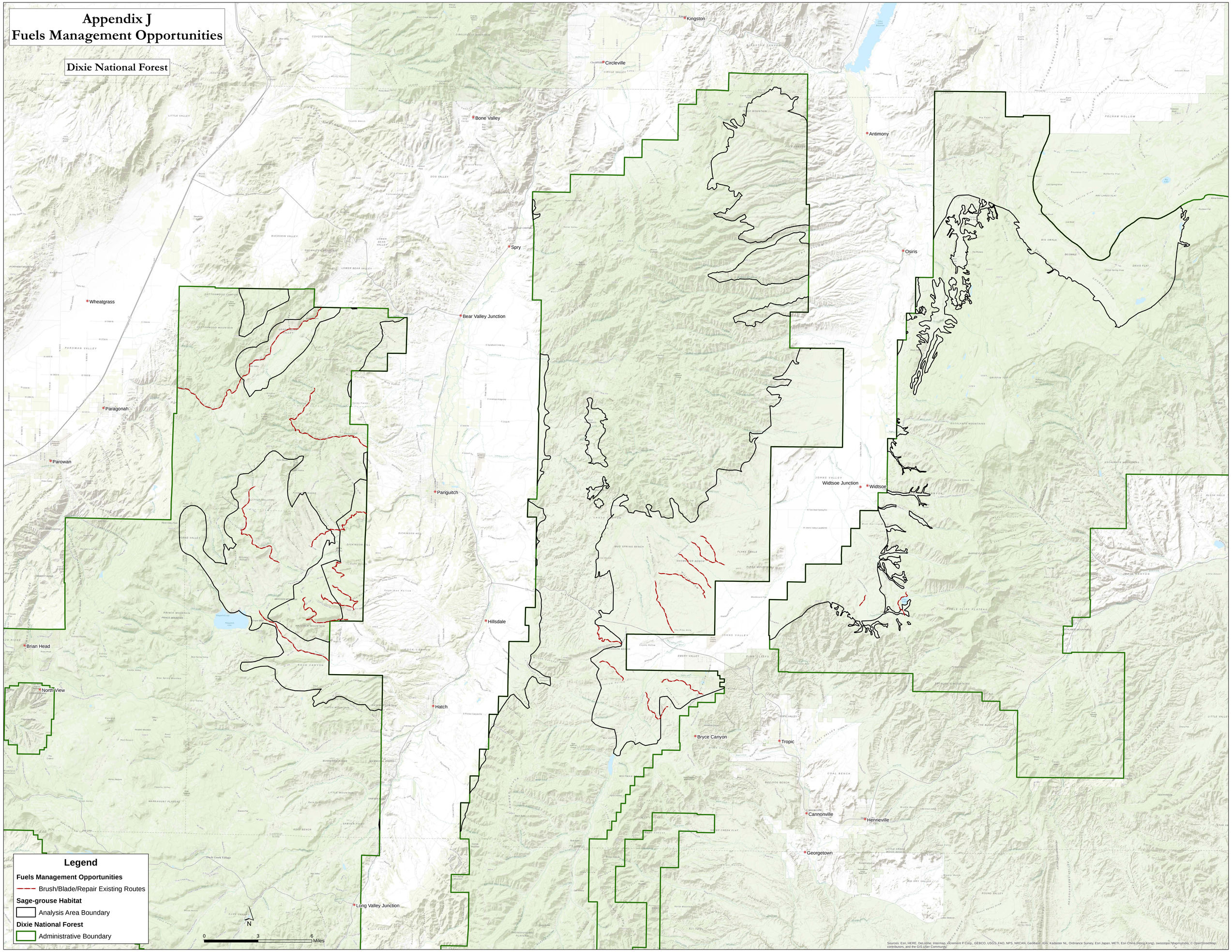
Dixie National Forest



Appendix J Fuels Management Opportunities

Appendix J
Fuels Management Opportunities

Dixie National Forest

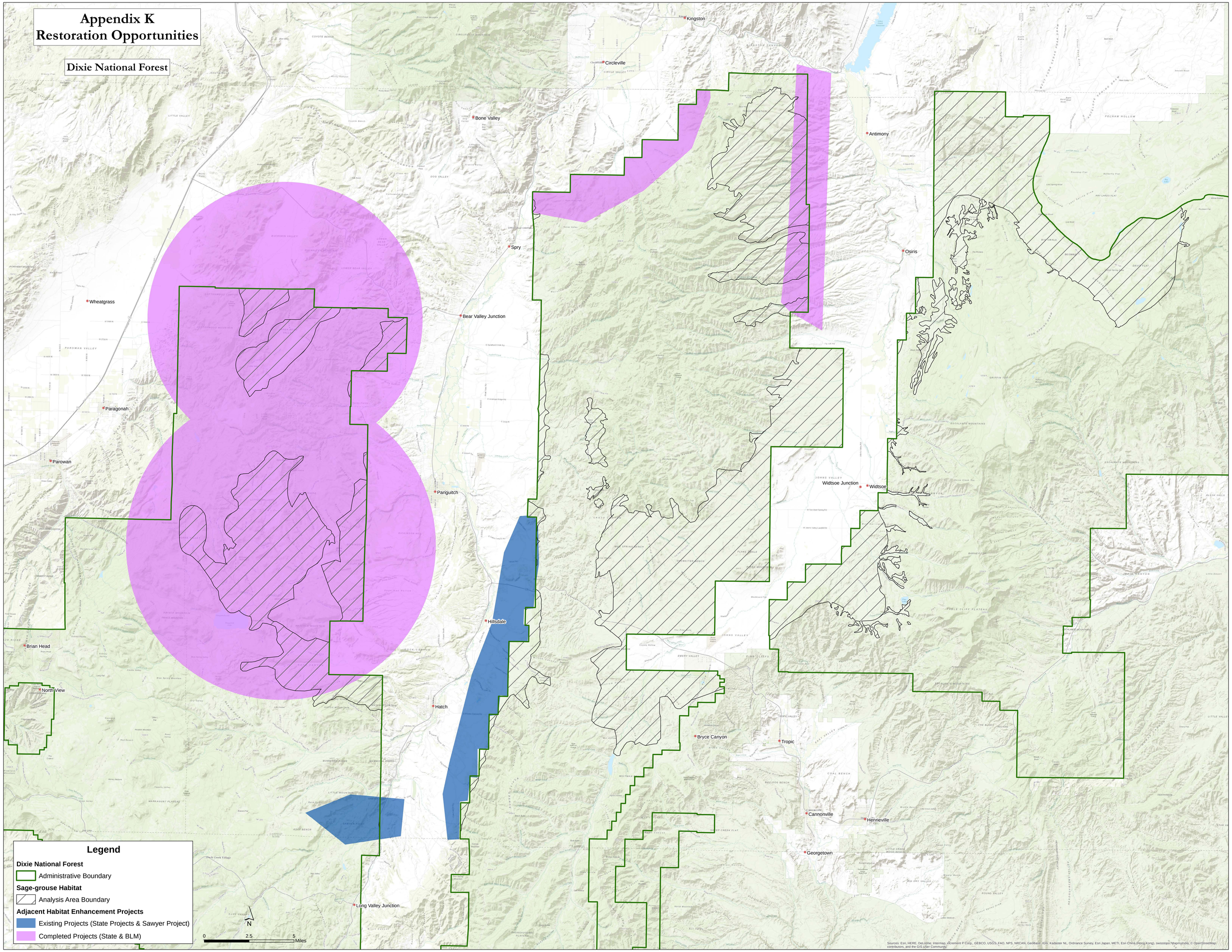


Appendix K Restoration Opportunities

The Dixie National Forest has not identified any specific areas for restoration opportunities.

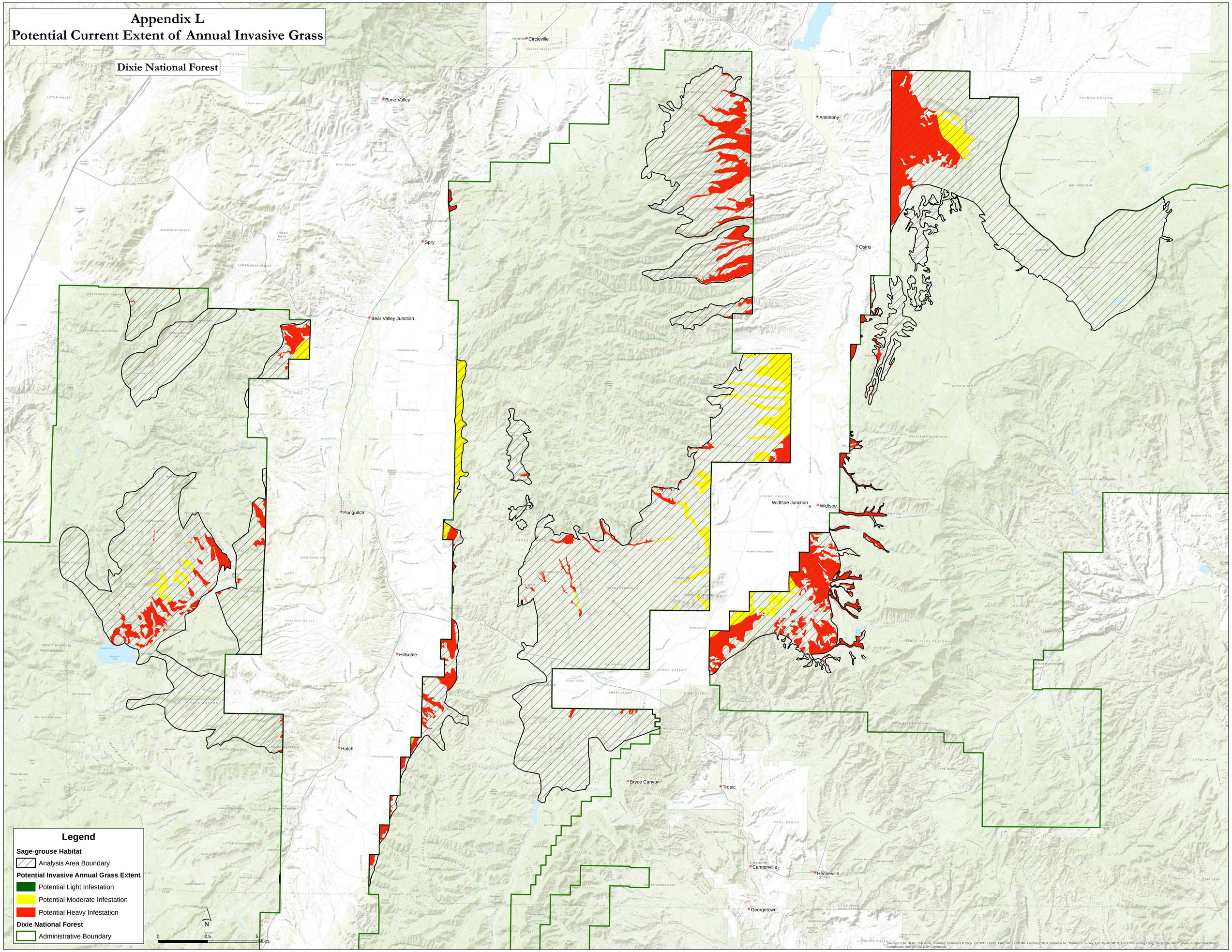
Appendix K
Restoration Opportunities

Dixie National Forest



Appendix L Current Extent of Invasive Annual Grasses

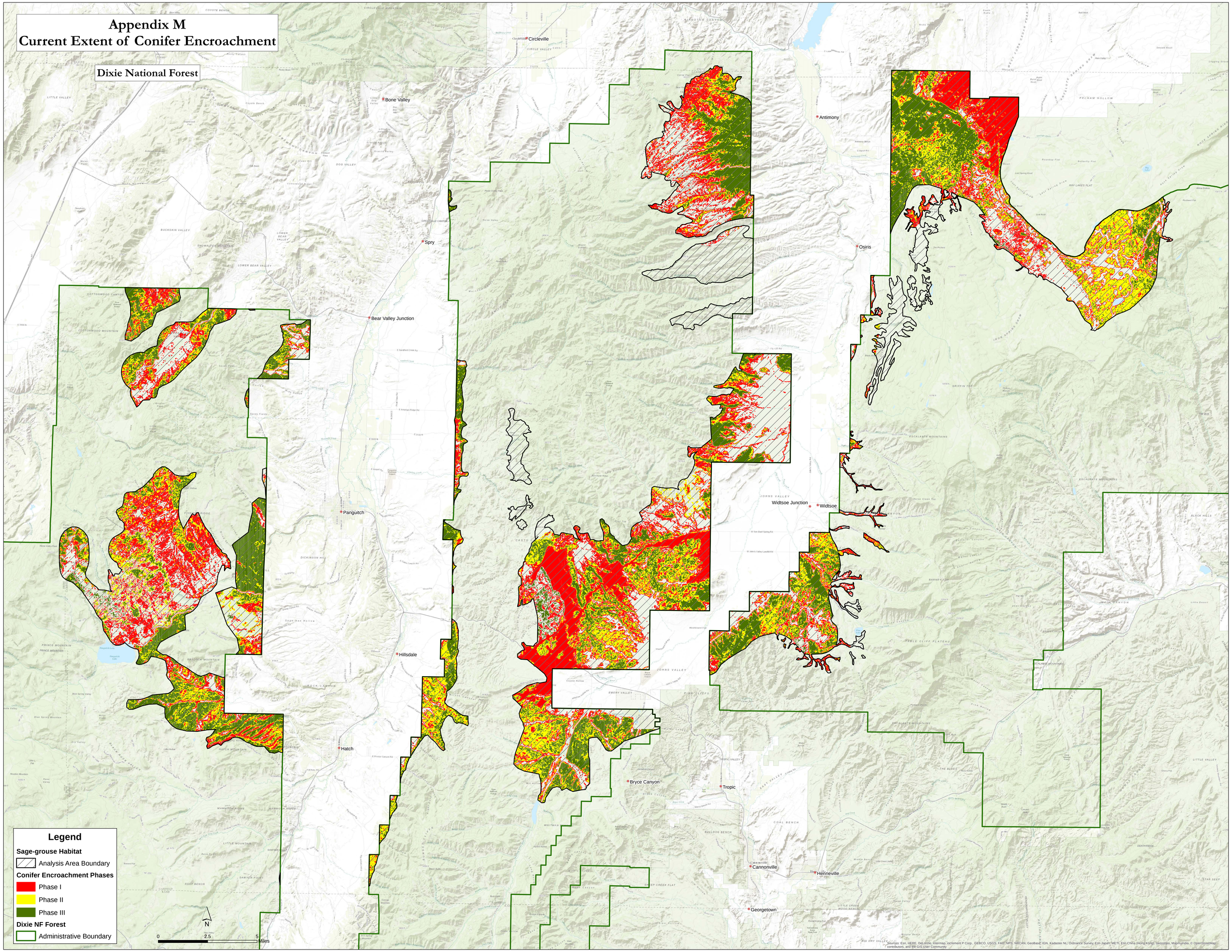
Appendix L
Potential Current Extent of Annual Invasive Grass



Appendix M Current Extent of Conifer Encroachment

Appendix M
Current Extent of Conifer Encroachment

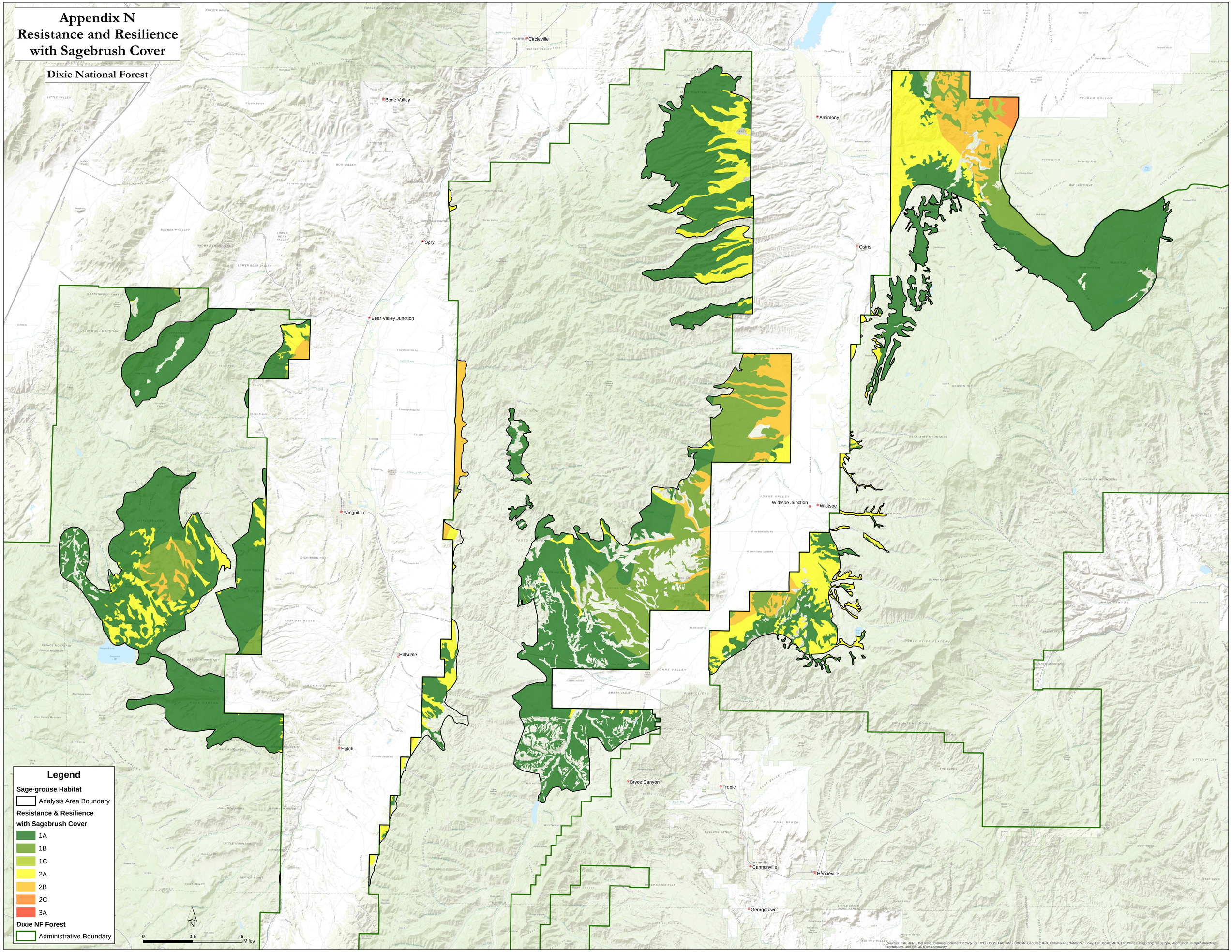
Dixie National Forest



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

Appendix N
Resistance and Resilience with Sagebrush Cover

Dixie National Forest



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

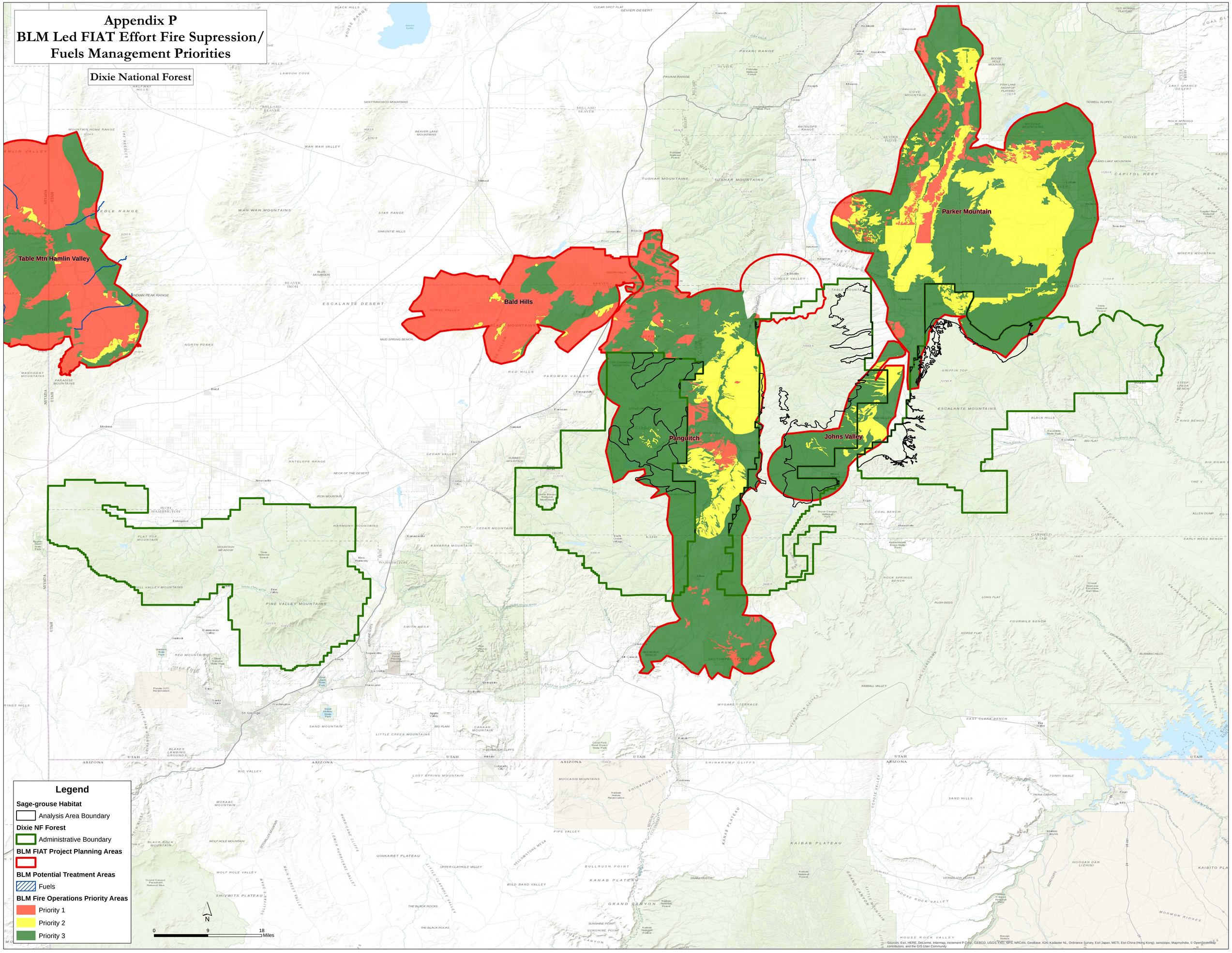
Appendix O Table of Potential Treatments by Treatment Area From the BLM led FIAT Effort

Potential Treatment Area	Conifer Encroachment			Invasive Annual Grass			Habitat Restoration Recovery			Grand Total
	High	Mod	Low	High	Mod	Low	High	Mod	Low	
Antelope Valley	11,661	10,224	13,046	0	0	0	215	364	0	35,510
Bald Hills	56,806	48,934	0	0	0	0	0	0	21,186	126,926
Bates Callahan	98,829	1,391	0	0	59,117	802	16,869	49,717	0	226,725
Cherry Creek	65,948	8,646	0	5,802	11,837	0	12,138	83	0	104,454
Cooks Creek	12,841	0	0	0	0	28,176	445	0	0	41,462
Cortez	0	0	0	0	14,253	2,383	352	0	0	16,988
Egan	42,779	13,971	0	2,712	0	0	5,808	2,596	0	67,866
Johns Valley	36,986	40,487	0	0	0	0	0	0	1,615	79,088
Long Valley	37,530	10,958	0	0	0	0	740	0	0	49,228
North Spring	32,267	15,917	0	0	1,283	0	519	133	0	50,119
Panguitch	278,812	173,533	0	0	0	2,199	0	0	5,524	460,068
Parker Mountain	103,950	293,129	0	0	3,038	0	0	0	0	400,117
Punchbowl	136,121	82,212	0	0	0	0	861	0	0	219,194
Reese R. Yomba Desatoya	54,573	36,922	0	0	0	0	67,452	0	0	158,947
Ruby	39,641	0	0	0	2,202	0	15,966	27	20	57,856
Sonomas	0	0	0	0	0	0	319	300	0	619
South Fork	831	17,033	0	7,133	143,981	145,767	2,269	372	0	317,386
Steptoe Cave	40,165	50,308	420	2,970	0	0	26,169	1,438	0	121,470
Table Mountain Hamlin Valley	106,561	110,521	0	23,531	0	55,845	678	0	527	297,663
Western White Pine	94,039	51,314	0	0	3,458	3,702	6,380	0	210	159,103
Grand Total	1,250,340	965,500	13,466	42,148	239,169	238,874	157,180	55,030	29,082	2,990,789

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

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

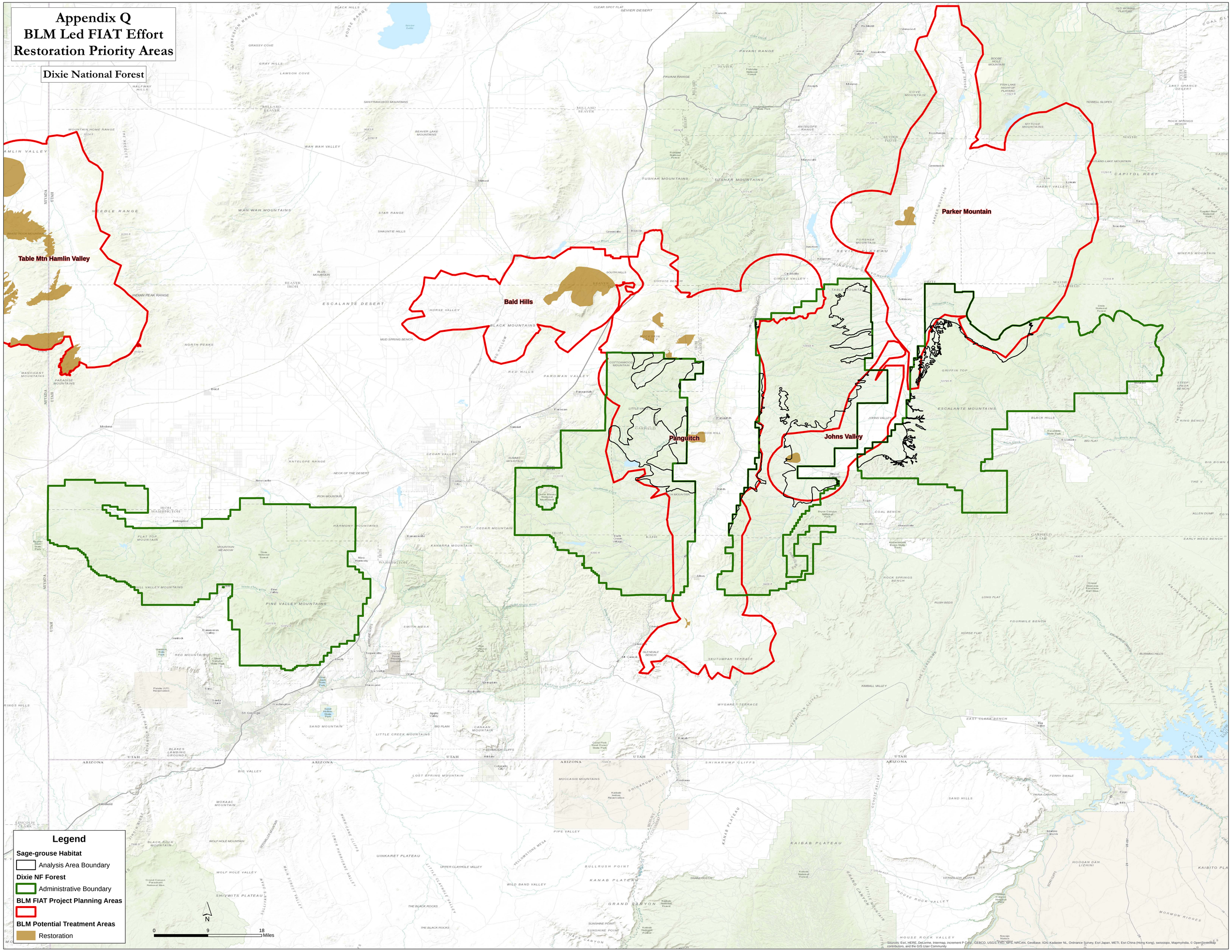
Dixie National Forest



Appendix Q-BLM led FIAT Effort Restoration Priority Areas

Appendix Q
BLM Led FIAT Effort
Restoration Priority Areas

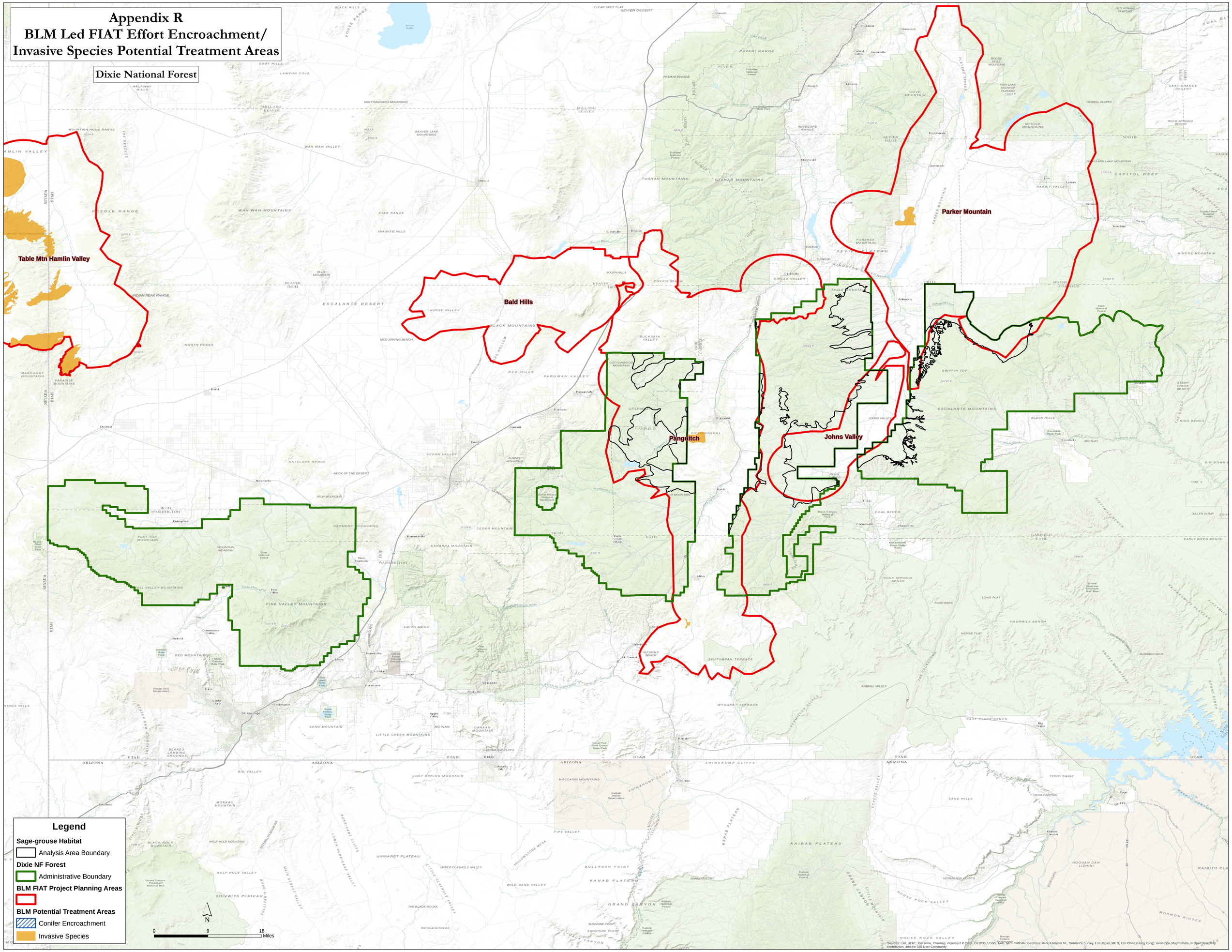
Dixie National Forest



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

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

Dixie 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 and any identified connectivity corridors between PACs.	Reduce juniper cover in sage-grouse habitats to less than 5% (Freese 2009, Cassaza et al. 2011), but preferably eliminate entirely.
Resources						
Two additional engines, and associated staff	X	X			X	
Develop mobile applications and provide additional devices	X	X			X	
Personnel						
Formalize recruitment of Resource Advisors (READs)			X	X	X	
Consider adding Prevention Techs (seasonal)	X	X			X	
Augment staff – GS-9 Ops AFMO on Cedar City RD	X	X	X	X	X	X

Consider fully funding employee tours with allocated dollars	X	X	X	X	X	X
Associated Infrastructure						
Consider adding heliwell	X	X			X	
Consider improving Dave's Hollow Helipad facilities	X	X			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…..	Immediately suppress fire in all sagebrush habitats. Where resources are limited, these actions should first focus on PACs and any identified connectivity corridors between PACs.
Widen/Improve existing road ROW				
Blade/brush/repair/greenstrip 366 mi road	X	X	X	X
Prescribed burning				
Mosaic burning (< 100 ac., < 12" ppt zone)	X	X	X	X
Personnel				
Align planning staff capacity to meet GRSG objectives	X	X	X	X
Increase funding for fuels and veg crew for data collection, implementation, monitoring	X	X	X	
Consider adding forest range tech		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 and any identified connectivity corridors between PACs.
Consider using severity funding to increase capacity at lower NFRDS levels	X	X			X
Modify run-cards for additional response to GRSG habitat.	X	X		X	X
Input fire suppression priority areas to WFDSS	X	X		X	X
Coordinate with BLM to ensure access/response to critical habitat.	X	X	X	X	X
Coordinate any additions to staffing/infrastructure/planning with interagency partners	X	X	X	X	X
Identify GRSG habitat on adjoining property	X	X	X	X	X
Identify in advance ICP locations that do not impact GRSG habitat				X	

Consider integrating areas of conifer encroachment into “Red-Yellow-Green” maps	X	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 and any identified connectivity corridors between PACs.
Improve Response Time					
Consider improving and/or adding capacity at existing stations, and cache facilities	X	X	X		X
Blade/brush/repair 366 miles of road	X	X	X		X
Consider more robust long-term road maint. program	X	X	X		X
Improve Situational Awareness					
Develop mobile apps	X	X	X		X

Acquire mobile devices	X	X	X		X
Improve radio/repeater infrastructure	X	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 pinyon and/or juniper. These techniques allow for more selective removal of invading plants, and more importantly allows understory habitats to remain intact.	Reduce juniper cover in sage-grouse habitats to less than 5% (Freese 2009, Cassaza et al. 2010), but preferably eliminate entirely	Employ all necessary management actions to maintain the benefit of pinyon and/or juniper removal for sage-grouse habitats….
Phase I Treatment Options						
Lop and scatter	X	X	X	X	X	X
Mastication	X	X	X	X	X	X
Lop/scatter/pile (mechanical, handcut/pile)	X	X	X	X	X	X
Lop/scatter/leave	X	X	X	X	X	X
Maintain funded program of work for meadow restoration						X
Enhance areas of connectivity for improved movement between habitat areas		X		X		X
Develop/implement monitoring for treatment effectiveness			X		X	X
Dixie harrow treatments of Phase I and II		X		X	X	X

Phase II Treatment Options						
Pile, and underburn (where appropriate)	X	X	X		X	X
Phase III Treatment Options						
Pile, and underburn (where appropriate)	X	X	X		X	X
Cut/haul/biomass, followed by eval for restoration needs				X	X	X

Non-Native Plant Species

Conservation Measures							
NON NATIVE PLANT SPECIES	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.	Implement monitoring programs for restoration activities….	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….	Require best management practices for construction projects in and adjacent to sagebrush habitats to prevent invasion.	Restore altered ecosystems such that non-native invasive plants are reduced to levels that do not put the area at risk of conversion if a catastrophic event were to occur.
Prevention							
Consider investing in weed wash stations, and formalize expectations for use		X		X		X	
Education		X		X		X	
Mindful grazing		X		X			
Response							
Spraying	X	X		X		X	X
Seeding/Re-seed		X		X		X	X
Biological agents	X	X		X		X	X
Utilize goats/sheep to consume invasive annual grasses							
Include effectiveness monitoring		X	X				
Help agency recognize need to support long term		X					X

post-fire restoration effort beyond current BAER levels.							
Develop/continue long term monitoring program (decades)			X				
Preparation							
Funding aligned with succession (e.g.ESR)		X		X			X
Improve/maintain existing collaboration with agency partners	X	X		X	X	X	X
Expand/improve native plant material program		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 and any identified connectivity corridors between PACs.
Spraying	x			
Seeding/Re-seed		x		
Biological agents				
Include effectiveness monitoring		x		
Help agency recognize need to support long term post-fire restoration effort beyond current BAER levels.		x	x	
Restoration opportunities exist in Sanford Fire area for noxious weeds, GRSG habitat improvement		x		
Treat invasives on Sandy Creek		x		

Treat invasives along Three Mile, Five Mile, and Three Creeks areas		x		

Appendix T Program Emphasis Area Calculations

Abbreviation Descriptions

SFA=Focal Habitat
HMA=Habitat Management Areas
P=Priority, I=Important, G=General
UT State = UT State Habitat Data
Local=Local Seasonal Habitat
D=Density of overlapping habitat values and concerns

FTI=Fire Threat Index
IAG=Invasive Annual Grass
CE=Conifer Encroachment
RR= Resistance and Resilience

GRSG Habitat

GRSG habitat delineates the analysis area and is the base for all emphasis areas. The calculation for habitat is detailed here, and carried forth as "GRSG Habitat" into each emphasis area calculation.

[(HMA) + (UT State) + (Local)] * (D) = GRSG Habitat

HMA (PHMA = 6, IHMA = 4, GHMA = 2) … max = 6, min =0
UT State (Occupied = 4) … max = 4, min = 0
Local (Nesting, Summer Habitat, Summer Use Outside Priority: = 4)… Max = 4, min = 0
Density: max = 3, min =1
GRSG total … max = 42, min = 2

Fire Operations Program Emphasis Areas (Appendix B)

[(GRSG Habitat) + (IAG + FTI)] + (RR *2) = Fire Operation Program Emphasis Areas

GRSG Habitat: max = 42, min = 2
FTI: max =5, min = 0
IAG: max = 6, min =0
R&R: max = 18, min =0

Total: Max = 71, Min =2

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

The R&R/Sage Cover matrix was numerically prioritized for Fire Operations to emphasize areas with high quality GRSG habitat, and where resistance and resilience is low. This prioritizes the protection of high quality habitat that is at greatest risk of being lost due to disturbances such as wildland fire. The weighting (scores) for R&R/Sagebrush Cover is displayed in matrix above.

Fire Operations Final Score Categories:

Very Low = 2-16
Low = 17-30
Moderate = 31-43
High = 44-57
Very High = 58-71

Fuels Management Program Emphasis Areas (Appendix C)

[(GRSG Habitat) + FTI] + (RR *2) = Fire Management Program Emphasis Areas

GRSG Habitat: max = 42, min = 2
FTI: max =5, min = 0
R&R: max = 18, min =0

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

The R&R/Sage Cover matrix was numerically prioritized for Fuels Management to emphasize areas with high quality GRSG habitat, and where resistance and resilience is low. This prioritizes the protection of high quality habitat that is at greatest risk of being lost due to disturbances such as wildland fire. The weighting (scores) for R&R/Sagebrush Cover is displayed in matrix above.

Fuels Management Final Score Categories

Very Low = 2-15
Low = 16-27
Moderate = 28-40
High = 41-52
Very High = 53-65

Invasive Annual Grass Program Emphasis Areas (Appendix E)

[(GRSG Habitat) + (IAG*4)] + (RR) = Invasive Species Program Emphasis Areas

Translation into Probability 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= Heavy invasive annual grass infestation probable

4 = Moderate invasive annual grass infestation probable

2 = Low invasive annual grass infestation probable

GRSG Habitat: max = 42, min = 2
IAG: max = 6, min = 2 (Multiplied by 4: max = 24, min 8)
R&R: max = 9, min = 0

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

The R&R/Sage Cover matrix was numerically prioritized for Invasive Annual Grasses to emphasize areas with high quality GRSG habitat, and where resistance and resilience is low. This prioritizes the improvement of high quality habitat that has moderate potential for recovery following any disturbances caused by treatment activities. The weighting (scores) for R&R/Sagebrush Cover is displayed in matrix above.

Invasive Annual Grass Final Score Categories

Very Low = 10-23
Low = 24-36
Moderate = 37-49
High = 50-62
Very High = 63-75

Conifer Encroachment Program Emphasis Areas (Appendix D)

[(GRSG Habitat) + (CE*4)] + (RR) = Conifer Encroachment Program Emphasis Areas

Conifer Encroachment Scoring Phase I = 8, Phase II = 4, Phase III = 2

Conifer Encroachment: max = 8, min = 2 (multiplied by 4: max 64, min = 8)

GRSG Habitat: max = 42, min = 2
R&R: max = 9, min = 0

Resistance and Resilience Scoring for Conifer Encroachment- 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

The R&R/Sage Cover matrix was numerically prioritized for Conifer Encroachment to emphasize areas with low quality GRSG habitat, and where resistance and resilience is high. This prioritizes the improvement of low quality habitat that has the greatest potential for recovery following any disturbances caused by treatment activities. The weighting (scores) for R&R/Sagebrush Cover is displayed in matrix above.

Conifer Encroachment Final Score Categories:

Very Low = 10-31
Low = 32-52
Moderate = 53-73
High = 74-94
Very High = 95-115

Restoration and BAER Program Emphasis Areas (Appendix F)

[(GRSG Habitat) + (RR) = Restoration and BAER Program Emphasis Area

GRSG Habitat: max = 42, min = 2
R&R: max = 9, min = 0

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

The R&R/Sage Cover matrix was numerically prioritized for Restoration to emphasize areas with high quality GRSG habitat, and where resistance and resilience is high. This prioritizes restoration of areas with the greatest potential for recovery following treatment activities. The weighting (scores) for R&R/Sagebrush Cover is displayed in matrix above.

Final Restoration Score Categories:

Very Low: 2-12

Low: 13 - 22

Moderate: 23 – 31

High: 32 – 41

Very High: 42 - 51

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
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	Raster

Dataset	Description	Feature Type
	on the number of housing units per acre. The WDA dataset (above) is a subset of the WPL dataset.	
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 Dixie National Forest

Common Name	Acres
Bermudagrass	24
Broadleaved pepperweed	56
Bull thistle	1,051
Canada thistle	5
Dalmatian toadflax	38
Field bindweed	158
Gypsyflower	4
Hardheads	2
Nodding plumeless thistle	366
Russian olive	52
Saltcedar	1
Scotch cottonthistle	3,864
Spotted knapweed	2
Whitetop	210
Yellow star-thistle	0
Undetermined Sp.	32
Grand Total	**5,866**

Inventoried Invasive Plant Species in the GRSG Analysis Area

Common Name	Acres
Bermudagrass	24.2
bull thistle	81.8
Canada thistle	2.4
Dalmatian toadflax	0.3
hardheads	1.1
nodding plumeless thistle	91.2
whitetop	84.7
Undetermined Sp.	1.1
Grand Total	**286.8**