# Ecoregional Assessment Report

## Northern Great Basin
## Rapid Ecoregional Assessment

Contract L10PC00483

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# ECOREGIONAL ASSESSMENT PROGRAM

# NORTHERN GREAT BASIN ECOREGION
# Rapid Ecoregional Assessment

FINAL REPORT
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# Executive Summary

The Rapid Ecoregional Assessment (REA) is the U.S. Bureau of Land Management's (BLM's) first step toward a broader initiative to systematically develop and incorporate landscape-scale information into the evaluation and eventual management of public land resources. In response, the BLM launched several REAs to improve the understanding of the existing condition of these landscapes, and how the current conditions may be altered by ongoing environmental changes and land use demands (BLM 2012). These scientific assessments were conducted to increase the understanding of the existing landscapes, how they may be affected, and to provide information for future management actions.

## REA Process

The purpose of the REA is to identify, assemble, synthesize, and integrate existing information about natural resources and environmental change agents to provide information that will help BLM land managers in the ecoregion understand resource status and the potential for change from a broad landscape viewpoint. The BLM defines landscapes as large, connected geographical regions that have similar environmental characteristics. These landscapes span administrative boundaries and can encompass all or portions of several BLM field offices. REAs provide a tool to identify and analyze the key "management questions" regarding the resources, values, and processes that are fundamental to the conservation of BLM lands. The landscape-scale approach recognizes landscapes are being affected by complex influences that reach beyond traditional management boundaries and across watersheds and jurisdictions.

To complete this REA, an Assessment Management Team was established, which was comprised of resource specialists from BLM and other state and federal agencies, and stakeholder scientists and planners. The U.S. Geologic Survey (USGS) provided scientific peer review for the REA process. The team was tasked with identifying the "conservation elements", "change agents", and management questions specific to the ecoregion, and met at each project milestone to coordinate progress, data, and path forward. The conservation elements below represent the core ecological values at the ecoregional level (fine-filter), and all of the predominant ecosystem types and functions that occur within the ecoregion (coarse-filters) (Table ES-1).

Table ES-1. Coarse-filter and Fine-filter Conservation Elements and Change Agents for the NGB Ecoregion

| Coarse-filter Conservation Elements | |
|---|---|
| Groundwater | Wetlands |
| Springs and Seeps | Salt Desert Shrub |
| Perennial Streams and Rivers | Sagebrush |
| Open Water | Juniper |
| Vulnerable Soils | Aspen |
| Riparian | Other Conifers |
| Wild Horse and Burros | Specially Designated Areas |
| **Fine-filter Conservation Elements** | |
| Greater Sage-grouse | Columbia Spotted Frog |
| Bighorn Sheep | Pygmy Rabbit |
| Mule Deer | Bats |
| Pronghorn | Bull Trout |
| Golden Eagle | Coldwater Fish Assemblage |
| Bald Eagle | White Sturgeon |
| **Change Agents** | |
| Climate Change | Development (Major Hydrologic Alterations, Urban and Exurban Development , Energy Development, Agriculture, Recreation and Military Expansion) |
| Invasive Species and Disease | |
| Wildfire | |
| Grazing | |

## Overview of the Northern Great Basin Ecoregion

The study area for this REA is comprised of two ecoregions, the Northern Basin and Range and the Snake River Plains, identified going forward as the Northern Great Basin (NGB). The NGB encompasses southeastern Oregon, portions of southern Idaho, northern Nevada, and a small extension into northeastern California and northwestern Utah. It is the northern extent of the larger Basin and Range physiographic province and also includes the important upper Snake River drainage system. Most of the ecoregion is dominated by sagebrush steppe ecosystems on the desert floor, but distinct vegetation zones related to relief and elevation also exist including juniper, mountain mahogany, aspen and riparian habitats. In the upper elevations Douglas-fir and aspen stands occur up the sub-alpine zone, which supports primarily low-growing shrubs, grasses, and forbs. Wildlife species of importance to the region include bighorn sheep (*Ovis canadensis*), mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), pronghorn (*Antilocapra americana*), pygmy rabbit (*Brachylagus idahoensis*), golden eagle (*Aquila chrysaetos*), and greater sage-grouse (*Centrocercus urophasianus*). Important habitats in the ecoregion include migration corridors and areas for overwintering pronghorn, as well as key habitat for greater sage-grouse. Federal agencies manage the majority of land in this ecoregion but large areas of tribal and private agricultural lands are present as well. Historical and current land use includes mining, livestock grazing, agriculture, and recreation. Current management priorities include energy development, wild horse and burro management, and invasive plant species (particularly cheatgrass).

Human populations in the ecoregion are concentrated along the Snake River corridor and land development remains an important change agent. Much of the Snake River Plains ecoregion is used as cropland and federally managed rangeland, in which the distribution and extent of native vegetation communities have been significantly altered. Land use issues focus on the impacts of farming and livestock grazing, residential and commercial development, invasive annual grasses, dispersed recreation, surface water and groundwater withdrawal for irrigation, and soil erosion.

## Results Summary

The core work products developed from the REA are the data packages, presented in Appendix B of the Final Report. Each package includes a detailed overview of the methods and analysis conducted, data collected/available, and geospatial outputs presenting the results. The data packages also present all management questions with responses to help guide the reader. Results are typically presented on map products with a graded high-low scale. Because many of the results are difficult to qualitatively summarize in an Executive Summary, only key results and discussions are presented below. Additional brief summaries of each of the change agents and conservation elements are presented in Chapter 6 and full presentations are included in Appendix B of the Final Report.

The greater sage-grouse is iconic to the NGB ecoregion and the subject of several conservation and regulatory planning efforts.The greater sage-grouse is considered an umbrella species for sagebrush-associated vertebrates (Rowland *et al.* 2006, Hanser and Knick 2011); however, most portions of the identified Preliminary Priority Habitat in the ecoregion are degraded or in a low-quality condition. The analysis has identified greater sage-grouse strongholds in Northwestern Nevada, Southeastern Oregon and the tri-state region where Idaho, Nevada and Oregon meet. Focusing conservation and management efforts into these regions may be necessary to prevent further deterioration of habitat. Greater sage-grouse drives major planning and conservation efforts throughout the ecoregion. On a separate parallel track to this REA, the BLM is developing a national strategy to preserve and conserve sagebrush communities and throughout the range of the greater sage-grouse, which includes the development of an Environmental Impact Statement (drafts expected in 2013). The U.S. Fish and Wildlife Service published its listing decision for the species as “warranted but precluded” in 2010.

Sagebrush communities are now of great conservation concern and are currently receiving management and restoration efforts in recognition of the many species that depend on sagebrush, notably the greater sage-grouse. As part of this REA, intact sagebrush communities (minimally impacted by human activities) were classified using cumulative indicator scores, which are derived by combining: Distance to Development and Burn Probability. Frequency, intensity, and areal extent of wildfires were noted to be of greatest importance to this ecosystem and are in turn affected by characteristics of the vegetation (fuel characteristics) and livestock grazing (which affects vegetation and soils).

Because of the habitat value associated with native plant communities. wildfire is a key ecological process in western ecosystems that influences virtually all other ecosystem processes. The NGB ecoregion has been affected by several landscape level fires in recent years and fire will continue to be a key management concern for years to come. Under conditions of higher fire frequency, the sagebrush communities are vulnerable to being replaced by cheatgrass, resulting a in a flashy annual grassland community maintained by fire. Thus, the presence of invasive species such as cheatgrass in arid lands has made fire more problematic in vegetation that historically experienced only occasional to periodic burning. Climate models predict increasing temperatures, increasing convective precipitation (lightning potential) and decreasing overall precipitation during the fire season that could increase the frequency and intensity of fires. Increasing population growth and conversion of agricultural land to exurban uses may increase the possibility of ignition sources through more people using the ecoregion’s recreation amenities. Grazing has the dual role of both managing fuel loads while altering the landscape and vegetation communities. Improperly timed and repeated grazing on rangelands heightens the rate of dispersal and greatly enhances the post-dispersal dominance of cheatgrass.

## Change Agent and Conservation Elements Packages

Section 6 of the Final Report provides summaries for each of the change agents and conservation elements. These summaries are meant to be fairly brief but give the reader the base information needed. The appendices for the change agent, fine filter elements, and coarse filter elements (Appendix B1, B2, and B3) contain the conceptual model and a more detailed discussion on the analysis and findings.

## Lessons Learned

Section 7 of this document contains information on lessons learned and recommendations made for future REAs. Skipping to this section before continuing with the main report will be useful to help give the reader some context as to data limitations encountered, conservation elements that were discussed but not included and the reasons for that decision.

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# Table of Contents

1. Summary of Possible Effects........1-1
1.1 Change Agents........1-1
1.1.1 Development........1-1
1.1.2 Wildfire........1-1
1.1.3 Invasive Species and Disease........1-1
1.1.4 Grazing........1-2
1.1.5 Climate Change........1-2
1.2 Fine Filter Conservation Elements........1-2
1.2.1 Coldwater Fish........1-2
1.2.2 Bull Trout........1-3
1.2.3 White Sturgeon........1-3
1.2.4 Columbia Spotted Frog........1-3
1.2.5 Greater Sage Grouse........1-3
1.2.6 Golden Eagle........1-3
1.2.7 Bald Eagle........1-4
1.2.8 Pygmy Rabbit........1-4
1.2.9 Pronghorn........1-4
1.2.10 Bighorn Sheep........1-4
1.2.11 Mule Deer........1-4
1.3 Coarse-filters Conservation Elements........1-5
1.3.1 Groundwater........1-5
1.3.2 Springs and Seeps........1-5
1.3.3 Perennial Streams and Rivers........1-5
1.3.4 Open Water........1-5
1.3.5 Vulnerable Soils........1-6
1.3.6 Riparian........1-6
1.3.7 Wetland........1-6
1.3.8 Salt Desert Shrub........1-6
1.3.9 Sagebrush........1-6
1.3.10 Combined Juniper........1-7
1.3.11 Aspen........1-7
1.3.12 Other Conifer........1-7
1.3.13 Wild Horse and Burro........1-7
1.3.14 Specially Designated Areas........1-7
2. Introduction........2-1
2.1 Purpose of the Rapid Ecoregional Assessment........2-1
2.2 The Rapid Ecoregional Assessment Process........2-1
2.2.1 Scope and Scale........2-2
2.2.2 Time Horizon........2-2
2.2.3 Uncertainty........2-4
2.3 Rapid Ecoregional Assessment Team........2-4
3. Ecoregion Description........3-1
3.1 Ecosystem Characteristics........3-1
3.2 Management Questions........3-2
3.3 Conservation Elements........3-8
3.3.1 Coarse-filter Selection........3-8
3.3.2 Fine Filter Selection........3-8
3.4 Change Agents........3-9

4. Ecological Models and Indicators ........ 4-1
4.1 Conceptual Ecological Models ........ 4-1
4.1.1 Example Conceptual Ecological Model: Greater Sage-grouse ........ 4-1
4.2 Ecological Attributes and Indicators and Metrics ........ 4-3
4.3 Data Classification ........ 4-4
4.4 Geospatial Data Sources ........ 4-4
5. Geospatial Modeling Methods and Tools ........ 5-1
5.1 ArcGIS ........ 5-1
5.2 Decision Support Tools ........ 5-1
5.3 Geospatial Process Models ........ 5-1
5.4 Conservation Element Specific Modeling Tools ........ 5-2
5.4.1 Maxent Distribution Modeling ........ 5-2
5.4.2 Non-Maxent Distribution Modeling ........ 5-2
5.5 Change Agent Specific Modeling Tools ........ 5-2
5.5.1 Development ........ 5-2
5.5.2 Wildfire ........ 5-4
5.5.3 Invasive Species Model ........ 5-4
5.5.4 Insect Outbreak and Disease ........ 5-4
5.5.5 Climate Change Model ........ 5-4
6. Ecoregional Findings ........ 6-1
6.1 Change Agents ........ 6-1
6.1.1 Development ........ 6-1
Change Agent ........ 6-1
6.1.2 Wildfire ........ 6-4
6.1.3 Invasive Species and Disease ........ 6-6
6.1.4 Grazing ........ 6-10
6.1.5 Climate Change ........ 6-12
6.2 Fine-Filter Conservation Elements ........ 6-16
6.2.1 Coldwater Fish ........ 6-16
6.2.2 Bull Trout ........ 6-18
6.2.3 White Sturgeon ........ 6-20
6.2.4 Columbia Spotted Frog ........ 6-22
6.2.5 Greater sage-grouse ........ 6-24
6.2.6 Golden Eagle ........ 6-26
6.2.7 Bald Eagle ........ 6-28
6.2.8 Pygmy Rabbit ........ 6-31
6.2.9 Pronghorn ........ 6-33
6.2.10 Bighorn Sheep ........ 6-35
6.2.11 Mule deer ........ 6-37
6.3 Coarse-Filter Conservation Elements ........ 6-39
6.3.1 Groundwater ........ 6-39
6.3.2 Springs and Seeps ........ 6-41
6.3.3 Perennial Streams and Rivers ........ 6-43
6.3.4 Open Water ........ 6-45
6.3.5 Vulnerable Soils ........ 6-47
6.3.6 Riparian ........ 6-49
6.3.7 Wetland ........ 6-51
6.3.8 Salt Desert Shrub ........ 6-53
6.3.9 Sagebrush ........ 6-55
6.3.10 Combined Juniper ........ 6-57

6.3.11 Aspen ....... 6-59
6.3.12 Other Conifer ....... 6-61
6.3.13 Wild Horse and Burro ....... 6-63
6.3.14 Specially Designated Areas ....... 6-65
6.4 Ecological Integrity ....... 6-67
6.4 Ecological Integrity ....... 6-67
7. Lessons Learned ....... 7-1
7.1 Summary of Analysis and Reporting ....... 7-1
7.2 Data Limitations ....... 7-1
7.3 Significant Data Gaps ....... 7-3
7.3.1 Cheatgrass ....... 7-3
7.3.2 Grazing ....... 7-3
7.3.3 Bats ....... 7-3
7.3.4 Cottonwood Galleries ....... 7-3
7.3.5 Off-highway Vehicle Areas ....... 7-3
7.3.6 Pipelines ....... 7-4
7.3.7 Pronghorn Distribution Data ....... 7-4
7.3.8 Aquatic Ecological Integrity ....... 7-4
7.3.9 Other Important Conservation Elements ....... 7-4
7.4 Recommendations for Future REAs ....... 7-5
8. References ....... 8-1

## List of Appendices

Appendix A Rolling Review Team ....... A-1
Appendix B1 Change Agents Data Package ....... 1
Appendix B2 Fine Filters Conservation Element Package ....... 1
Appendix B3 Coarse Filters Conservation Element Package ....... 1

## List of Figures

2.2-1. Northern Great Basin Ecoregion with Other Adjoining REA Boundaries ....... 2-3
2.2-2. Land Ownership by Jurisdiction in Northern Great Basin Ecoregion ....... 2-3
4.1-1. Greater Sage-grouse System Model ....... 4-2
5.3-1. Example GIS Process Model for Merging State Greater Sage-grouse Preliminary Priority Habitat Layers ....... 5-3
5.4-1. Example Process Flow for Running MaxENT Model ....... 5-4
6.1-1. Agricultural and Urban/Developed Areas within the Northern Great Basin. Combined Agricultural and Urban Development within the Ecoregion Represents 10 Percent of the Total Area ....... 6-1
6.1-2. Land Treatments from the Land Treatment Digital Library (USGS) ....... 6-2
6.1-3. Renewable Energy: Current Locations of Operating Solar, Wind, and Geothermal Facilities in the NGB ....... 6-2
6.1-4. Predicted Change in Housing Density by 2060. Key Changes in Housing Density are Centered Around Boise, Idaho Falls, and Logan. The Primary Change Type is from Rural to Exurban. ....... 6-3
6.1-5. Fire Frequency 1990 – 2012 in the Northern Great Basin (GeoMAC [2000-2012], Sagemaps Western Fires) ....... 6-4
6.1-6. Burn Probability in the Northern Great Basin ....... 6-5
6.1-7. Existing Cheatgrass Cover from 2010 (EROS USGS 2012) ....... 6-6

6.1-9. Invasive Species Occurrences in NGB Ecoregion from NISIMS, NNHP and BLM Oregon ....... 6-7
6.1-8. Invasive Species Occurrences in NGB Ecoregion within NISIMS (min. 100 occurrences) ....... 6-7
6.1-10. Invasive Aquatic Detections ....... 6-8
6.1-11. Location of Grazing Allotments in the Northern Great Basin ....... 6-10
6.1-12. Land Health Standards for Grazing Allotments in the NGB (USGS) ....... 6-11
6.1-13. March to May Temperature and Forecasted Change in Selected Ranges ....... 6-13
6.1-14. July and August Temperature and Forecasted Change in Selected Ranges ....... 6-13
6.1-15. Annual Precipitation and Forecasted Change in Selected Ranges ....... 6-14
6.1-16. September and October Precipitation and Forecasted Change in Selected Ranges ....... 6-14
6.2-1. Coldwater Fish Assemblages Distribution ....... 6-16
6.2-2. Coldwater Fish Cumulative Indicator Score ....... 6-17
6.2-3. Bull Trout Critical Habitat and Distribution in the Northern Great Basin ....... 6-18
6.2-4. Bull Trout Cumulative Indicator Score ....... 6-19
6.2-5. White Sturgeon Habitat within the Northern Great Basin ....... 6-20
6.2-6. Cumulative Indicator Score for White Sturgeon by HUC 12 ....... 6-21
6.2-7. Columbia Spotted Frog Modeled Suitable Habitat ....... 6-22
6.2-8. Columbia Spotted Frog Cumulative Indicator Score ....... 6-23
6.2-9. Preliminary Priority Habitat for Greater Sage-Grouse from Each State ....... 6-24
6.2-10. Cumulative Indicator Score for Greater Sage-grouse Preliminary Priority Habitat ....... 6-25
6.2-11. Golden Eagle Modeled Distribution ....... 6-26
6.2-12. Cumulative Indicator Score for Golden Eagle Habitat ....... 6-27
6.2-13. Bald Eagle Modeled Distribution ....... 6-28
6.2-14. Cumulative Indicator Score for Bald Eagle Summer Habitat ....... 6-29
6.2-15. Cumulative Indicator Score for Bald Eagle Winter Habitat ....... 6-29
6.2-16. Pygmy Rabbit Suitable Habitat ....... 6-31
6.2-17. Cumulative Indicator Score for Pygmy Rabbit Habitat ....... 6-32
6.2-18. Comparison of State Agency Pronghorn Range Data with Modeled Pronghorn Habitat ....... 6-33
6.2-19. Cumulative Indicator Score for Modeled Pronghorn Habitat ....... 6-34
6.2-20. Bighorn Sheep WAFWA Range Habitat (WAFWA 2011) ....... 6-35
6.2-21. Cumulative Indicator Score for Bighorn Sheep Habitat ....... 6-36
6.2-22. Comparison of WAFWA Summer Range and Year-Long Range with Modeled Summer Habitat for Mule Deer ....... 6-37
6.2-23. Cumulative Indicator Score for Modeled Mule Deer Winter Habitat ....... 6-38
6.3-2. Current Groundwater Levels – Percentile Class ....... 6-39
6.3-1. Groundwater Use ....... 6-39
6.3-3. Current Groundwater Conditions ....... 6-40
6.3-5. Springs, Seeps, and Spring Snails ....... 6-41
6.3-4. Spring Discharge Snake River ....... 6-41
6.3-6. Springs, Spring Snails, and Areas with Declining Groundwater Tables ....... 6-42
6.3-8. Perennial Streams and Rivers with Monthly Flow Statistics ....... 6-43
6.3-7. Surface Water Use ....... 6-43
6.3-9. Streams and Rivers Cumulative Indicator Score ....... 6-44
6.3-10. Open Water Features ....... 6-45
6.3-11. Open Water Cumulative Indicator Score ....... 6-46
6.3-12. Water Erosion Potential ....... 6-47
6.3-13. Rangeland Wind Erosion Potential ....... 6-48
6.3-14. Estimated Riparian Corridor in the Ecoregion ....... 6-49
6.3-15. Fraction of Natural or Undeveloped Land Cover in the Riparian Corridor ....... 6-50
6.3-16. Wetland Distribution in the REA ....... 6-51

6.3-17. Wetland Cumulative Indicator Score........................................................................ 6-52
6.3-18. Salt Desert Shrub in the Northern Great Basin................................................................ 6-53
6.3-19. Intact Salt Desert Shrub within the Northern Great Basin.............**Error! Bookmark not defined.**
6.3-20. Sagebrush in the Northern Great Basin......................................................................... 6-55
6.3-21. Intact Sagebrush within the Northern Great Basin ........................................................ 6-56
6.3-22. Combined Juniper (Utah and Western) in the Northern Great Basin ............................. 6-57
6.3-23. Intact Juniper within the Northern Great Basin ............................................................. 6-58
6.3-24. Aspen in the Northern Great Basin................................................................................ 6-59
6.3-25. Intact Aspen within the Northern Great Basin...............................**Error! Bookmark not defined.**
6.3-26. Other Conifer in the Northern Great Basin.................................................................... 6-61
6.3-28. Intact Other Conifer within the Northern Great Basin.................................................... 6-62
6-3.28. Percent of AML for Wild Horse and Burro within Herd Management Areas.................. 6-63
6.3-29. Rangeland Health Standard by Herd Management Area ............................................... 6-64
6.3-30. Specially Designated Areas in the Northern Great Basin ............................................... 6-65
6.3-31. Travel Time from Urban Centers (> 20,000 in Population) to SDAs............................. 6-66
6.4-1. Western Governor's Association Landscape Integrity Score from the Landscape Condition Model ............................................................................................................. 6-68
6.4-2. Large Intact Blocks from the Western Governors Association Landscape Integrity Dataset.................................................................................................................. 6-69
6.4-3. Important Connectivity Zones Linking Cool Desert Large Intact Blocks ....................... 6-69
6.4-4. Important Connectivity Zones Linking Forest Large Intact Blocks ............................... 6-70
6.4-5. Northeastern Part of the Ecoregion's Connectivity Zones for Cool Desert Biome Large Intact Blocks........................................................................................................ 6-70
6.4-6. Northeastern Part of the Ecoregion's Connectivity Zones for Forest Biome Large Intact Blocks ................................................................................................................. 6-71

## List of Tables

ES-1. Coarse-filter and Fine-filter Conservation Elements and Change Agents for the NGB Ecoregion.............................................................................................................. ES-1
2.3-1. Assessment Management Team and Peer Review Team.................................................. 2-4
2.3-2. Rolling Review Team Membership................................................................................. 2-6
3.2-1. Management Questions for the NGB.............................................................................. 3-3

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# 1. Summary of Possible Effects

## 1.1 Change Agents

### 1.1.1 Development

Development for this ecoregion was defined by the Assessment Management Team as containing these broad categories: (1) Energy Development and Mining; (2) Urban, Exurban and Rural Development and Recreation; (3) Agriculture; (4) Hydrologic Uses; (5) Military and other Federal Land Management; and, (6) Rangeland Treatments. The majority of existing and proposed renewable energy facilities are wind energy and within the Idaho Snake River Plain corridor. Increasing development brings competition for both land and access to water. Increasing population growth and conversion of agricultural land to exurban may reduce unburnable areas as well as increase the possibility of ignition sources through more people using the ecoregion's recreation opportunities.

### 1.1.2 Wildfire

Wildfire is a key ecological process in western ecosystems that influences virtually all other ecosystem processes. Under conditions of higher fire frequency coupled with presence of cheatgrass, the sagebrush communities are vulnerable to being replaced by cheatgrass, resulting a in a flashy annual grassland community maintained by fire. Thus, the presence of invasive species such as cheatgrass in arid lands has made fire more problematic in vegetation that historically experienced only occasional to periodic burning. Climate models predict increasing temperatures, increasing convective precipitation (lightning potential) and decreasing overall precipitation during the fire season that could increase the frequency and intensity of fires. Increasing population growth and conversion of agricultural land to exurban uses may reduce unburnable areas and increase the possibility of ignition sources through more people using the ecoregion's recreation amenities. Grazing as well as mowing, prescribed fire, chemical applications and perennial seedings have the dual role of both managing fuel loads while altering the landscape and vegetation communities. Improper timing and/or intensity of grazing can reduce the success rate of post-fire rehabilitation and treatment efforts, and may promote cheatgrass dominance in vulnerable ecosystems.

### 1.1.3 Invasive Species and Disease

Invasive species include non-native species that have been introduced to a region often through human actions, or have expanded their range. The most important characteristic of invasive species is that they have the ability to proliferate in their new environment and affect the condition of native vegetation communities and wildlife assemblages. The Assessment Management Team specified that cheatgrass (*Bromus tectorum*), medusahead (*Taeniatherum caput-medusae*), ventenata (*Ventenata dubia*), and other annual invasive grasses should be covered in this analysis, as well as saltcedar or tamarisk (*Tamarix* spp.) and Russian-olive (*Elaeagnus angustifolia*). Tamarisk and Russian olive are woody species that are spreading through riparian areas in the ecoregion. Cheatgrass invades open areas created by fire and other disturbance in sagebrush ecosystems (National Invasive Species Council 2006), displacing native shrubsteppe communities. Disturbance from development often provides bare ground habitat that invasives can colonize and then outcompete native plants. The replacement of native vegetation with invasives such as cheatgrass and other annual grasses will also increase the fire frequency. Invasive animal species and pathogens also occur in the ecoregion. For example, West Nile virus is a source of mortality in greater sage-grouse in some parts of the country since its introduction in 1999, and has the greatest potential for population-level effects among all parasites and infectious diseases identified in greater sage-grouse (Christiansen and Tate 2011).

### 1.1.4 Grazing

Livestock grazing can affect the vegetation community structure and composition, woody plant regeneration, riparian area health, nutrient cycling, fire fuel availability, wildlife forage amounts, soil stability and compaction, invasive species spread, and many other ecosystems aspects. In much of the Northern Great Basin, the principal effect of grazing may be reduction or removal of preferred herbaceous species, modifying the competition dynamics and possibly creating a vector and niche for establishment of invasive species. In shrub-dominated communities, fall and winter grazing could result in modifications to the shrub component of the system at the site level. The BLM has a long history of authorizing grazing and continues to monitor and collect data on the health of individual grazing allotments. In addition, the U.S. Geologic Survey (USGS) has conducted a review of BLM's range health assessments covering grazing allotments in the west (USGS 2011). Since there were data gaps with regards to livestock grazing (see Grazing CA package in Appendix B1) there wasn't a more detailed analysis done for grazing as a change agent. Large wildfires such as those that occurred in 2012 could close grazing allotments to allow for reseeding of vegetation and condense the number of grazing allotments available. Development plays a role in adding possible vectors for spreading invasives through recreation such as off-highway vehicle.

### 1.1.5 Climate Change

Climate exerts a top-down control over the natural distribution of species, as well as range expansions and contractions: therefore it is expected that future climate change will have a significant impact on the distribution of species. For this Rapid Ecoregional Assessment (REA), the analysis of future impacts due to climate change relied on 15 kilometers (km) pixel regional climate change model data by Hostetler *et al.* (2011) (RegCM3 data). The results compare the 1980 to 1999 baseline period with model predictions for the period of 2050 to 2069. On average climate change is modeled to increase the annual average precipitation in the ecoregion and not result in an average annual change in temperature. However, there are important seasonal shifts in temperature and precipitation that could impact conservation elements within the ecoregion. Most notably, the Hostetler *et al.* (2011) model forecasts increasing precipitation in the winter over portions of the ecoregion, which could result in greater early season plant growth. With increasing temperatures and decreasing precipitation during peak fire season (July and August), this may increase the frequency and severity of wildfires. In fuel-limited rangeland ecosystems, warmer and drier conditions may lead to less fuel production, thereby reducing fire potential. Readers are advised that the data precluded an analysis of extreme temperatures (maximum and minimum temperature changes over time).

## 1.2 Fine Filter Conservation Elements

### 1.2.1 Coldwater Fish

The species in this assemblage require well–oxygenated water; clean, well–sorted gravels with minimal fine sediments for successful spawning; temperatures <21 C (<70 F), and complex instream habitat structure such as large woody debris and overhanging banks for cover. Five of the metrics from the Perennial Streams conservation element (water quality, aquatic invasives, flow regulation, groundwater condition, and riparian condition) were combined with two additional metrics for fish, barriers and burn probability. The highest scoring coldwater fish habitat areas were the Owyhee and Bruneau rivers. The lowest scoring areas were near development and included much of the Snake and Boise rivers. The numerous dams and diversion structures have fragmented the native coldwater fish in the region. Hybridization, increased stream temperatures due to climate change, management impacts on habitat, and large, severe wildfires also threaten the native coldwater fish in the ecoregion.

### 1.2.2 Bull Trout

Bull trout require colder water temperature than most salmonids, very clean stream substrates for spawning and rearing, complex and connected habitats, including streams with riffles and deep pools, undercut banks and lots of large logs, for rearing and annual spawning and feeding migrations. Numerous dams and diversion structures have fragmented the native bull trout habitat with migration barriers. Hybridization, increased stream temperatures due to climate change, management impacts on habitat, and large, severe wildfires also threaten the bull trout in the ecoregion.

### 1.2.3 White Sturgeon

Since this species upstream movement is blocked by dams and downstream movement is only available over spillways, populations can become locked into defined ranges. Due to poor recruitment of naturally-spawned white sturgeon in the Northern Great Basin (NGB), the species is dependent on hatchery production for their continued presence. The metrics for water quality, aquatic invasives, burn probability and fish barriers were used to estimate the cumulative indicator score for white sturgeon. Dams and withdrawals of surface water and ground water are the greatest threats to white sturgeon in the Snake River. Invasives species and increased stream temperatures due to climate change are also important future threats in the ecoregion.

### 1.2.4 Columbia Spotted Frog

The Columbia spotted frog (*Rana luteiventris*) was selected as a conservation element due to losses of historically known occupied sites, reduced numbers of individuals within local populations, and declines in the reproduction of those individuals (USFWS 2011b). Within the ecoregion, this species' distribution associates with low population areas such as the Owyhee Mountain region and Boise National Forest. Human footprint elements are the most important agents in assessing habitat suitability for this species. Large, severe wildfire, invasive predatory fish, and poorly managed grazing in springs and riparian zones also currently threaten the spotted frog in the ecoregion. Future expansion of the American bullfrog into habitats occupied by the Columbia spotted frog may result in increased predation and competition as well as transmission of the fungal infection chytridiomycosis to spotted frog populations (Lu and Sopory 2010; McKercher and Gregoire 2013).

### 1.2.5 Greater Sage Grouse

The greater sage-grouse was approved by the Assessment Management Team as a conservation element because of the bird's ecoregional importance. The greater sage-grouse is considered an umbrella species for sagebrush-associated vertebrates (Rowland *et al.* 2006; Hanser and Knick 2011). Most portions of the ecoregion and the identified Preliminary Priority Habitat is degraded or in a low-quality condition, based on the identified Key Ecological Attributes. The analysis has identified greater sage grouse stronghold in Northwestern Nevada, Southeastern Oregon and the tri-state region where Idaho, Nevada and Oregon meet.

### 1.2.6 Golden Eagle

The golden eagle (*Aquila chrysaetos*) is one of only two species of eagle indigenous to North America and occupies sagebrush-steppe communities within the Great Basin and adjacent Intermountain West. In general the risks to golden eagle across the NGB appear low. Species adaptability and prey abundance indicate an overall relative stable ecoregional ecosystem for the golden eagle. Throughout the majority of the ecoregion, lack of human activity remains an important factor with regard to risk. Development in the form of urban growth is the most likely factor to have a broad effect on the species. Localized mortality risks increase in areas where wind turbine activity and high-traffic roadways exist within specific ranges of golden eagle habitat. Development along major urban corridors in Idaho is most likely to affect the population of golden eagles.

### 1.2.7 Bald Eagle

The distribution of the bald eagle (*Haliaeetus leucocephalus*) is limited in the Great Basin to water bodies located intermittently across Oregon, Idaho, California, Nevada, and Utah. The overall threat is moderate to high for the summer range of the bald eagle. However, the areas that are most closely associated with the lower ratings are also those areas in which bald eagles may appear only rarely during the summer period. Foraging and nesting activities will most likely remain in close proximity to areas of ideal habitat. The threats to wintering bald eagles appear low overall. The cumulative indicator scores for bald eagle priority summer habitat under current conditions should be useful in identifying the areas most in need of preservation or the best restoration opportunities.

### 1.2.8 Pygmy Rabbit

The pygmy rabbit (*Brachylagus idahoensis*) is the smallest rabbit species in North America and occupies sagebrush-steppe communities within the Great Basin and adjacent Intermountain West. Pygmy rabbit habitat was modeled using the following variables: presence of sagebrush, soil depth to bedrock, not in a recent burned area, percent clay of soil and suitable slope to prioritize habitat. The Key Ecological Attributes of sagebrush cover, vegetation height, wildfire burn probability, agriculture within 5 km and human footprint were used to create a cumulative indicator score of pygmy rabbit habitat quality. The cumulative indicator scores for pygmy rabbit priority habitat under current conditions should be useful in identifying the areas most in need of preservation or the best restoration opportunities.

### 1.2.9 Pronghorn

Characteristics of good pronghorn (*Antilocapra americana*) habitat include large areas of unbroken rangeland, relatively flat or undulating terrain with high visibility, and sufficient rainfall (12-25 inches). Pronghorn browse on shrubs, forbs, and grasses. Big sagebrush, rabbitbrush, and bitterbrush are particularly important pronghorn forage in this ecoregion. Most of the pronghorn range throughout the ecoregion is already fragmented and affected by roads, agriculture and development. Increasing development, and possibly energy exploration and development will cause further habitat decline. The cumulative threats to pronghorn could result in increasing habitat fragmentation, which may affect migrations and seasonal range use. An elevated risk of increasing fire frequency and severity promotes irreversible ecological state transitions away from preferred shrub-steppe habitats and towards grass-dominated systems at lower elevations (as compared to temporary transition to native perennial grassland in a healthy post fire ecosystem).

### 1.2.10 Bighorn Sheep

Two subspecies of bighorn sheep, the California (*Ovis canadensis californiana*) and Rocky Mountain (*O.c. canadensis*) inhabit portions of the NGB. Key attributes for bighorn sheep habitat included habitat size, escape terrain, horizontal visibility, distance to barriers, distance to human disturbance/presence and risk of disease transmission. Currently, many bighorn sheep populations within the ecoregion appear highly vulnerable. The cumulative threats to bighorn sheep within the NGB ecoregion and its habitat include an elevated risk of increasing fires, which may promote irreversible ecological state transitions away from preferred native grassland and shrub-steppe habitats. Human development, tree encroachment and diseases transmitted from domestic sheep are considerable stressors that may interact and reduced habitat suitability.

### 1.2.11 Mule Deer

Mule deer (*Odocoileus hemionus*) in the Northern Great Basin ecoregion inhabit areas primarily classified as sagebrush and other shrub-steppe habitats. The primary result of this analysis identified prime habitat

conditions over much of the mule deer range in the ecoregion. The increasing fragmentation of habitat in agricultural areas of the ecoregion, as evidenced by higher road density and smaller patches of habitat, and coupled with invasion of cheatgrass into shrubsteppe ecosystems provides for a high stress environment for mule deer. The cumulative threats to mule deer and its habitat include an elevated risk of increasing fires, which may promote irreversible ecological state transitions (as compared to temporary transition to native perennial grassland in a healthy post fire ecosystem). The transitions do not favor mule deer and accelerated habitat loss may occur as a result of the cumulative threats in the future.

## 1.3 Coarse-filters Conservation Elements

### 1.3.1 Groundwater

Over 90 percent of the groundwater withdrawals in the REA are used for agriculture. Portions of the ecoregion, especially in the Snake River Plain and developed basins in the Northern Great Basin, have water levels below or much below normal and show declines in groundwater elevations over time, indicating groundwater use in excess of recharge. The greatest threat to the groundwater resource in the ecoregion is continued unsustainable and increasing groundwater extraction for agriculture and urban development. Areas in the ecoregion with significant declining water levels or groundwater extractions in excess of groundwater recharge are more likely to experience reductions in surface water flows in springs and streams, degrading the habitat for resources that depend on those flows such as spring snails and coldwater fish.

### 1.3.2 Springs and Seeps

Springs and seeps are known as biological hotspots, associated with unique aquatic ecosystems. There are currently 47,222 springs and seeps mapped by the USGS in the ecoregion however; it is likely that many springs remain unmapped. The primary threat to springs and seeps in the ecoregion is from agricultural groundwater withdrawals. Groundwater withdrawals have increased by 20 percent from 2000 to 2005 and there is evidence of declining groundwater levels in agriculturally developed areas. The spread of invasive aquatic species can also locally impact endemic spring species. Livestock grazing often requires the development of springs for livestock watering and can also impact water quality. Wildfire and climate change could affect vegetation composition and precipitation patterns which could alter the recharge to springs and seeps in the ecoregion.

### 1.3.3 Perennial Streams and Rivers

Perennial streams and rivers provided habitat for coldwater fish, bull trout, and white sturgeon, as well as important riparian habitat for birds and other wildlife species along their banks. Five metrics were used to cumulatively assess the health and function of perennial streams and rivers: water quality based on 303(d) criteria, detection of aquatic invasives, flow regulation by dams, groundwater condition based on water level data, and riparian condition based on development in the riparian corridor. Future threats of concern include continued spread of invasive aquatics species and increasingly large, severe wildfires that can result in the sedimentation of entire stream systems. Increasing fire frequency and intensity are also more likely to result in the removal stabilizing riparian vegetation and increasing intensity of runoff events into destabilized channels.

### 1.3.4 Open Water

There are over 1.5 million acres of open water in ecoregion represented by 75,000 individual water bodies, with the majority of acreage associated with large water bodies of 10,000 acres or more of surface area. Four metrics were used to cumulatively assess the health and function of open water features: water quality based on 303(d) criteria, detection of aquatic invasives species, distance from anthropogenic sources, and the fraction of undeveloped land in the watershed. Future threats of concern include

continued spread of aquatic invasives and increasingly frequent and larger wildfires that can result in the sedimentation of open water features.

### 1.3.5 Vulnerable Soils

Vegetation cover is the best frontline defense against accelerated soil erosion. As vegetation cover is reduced, soil erosion exponentially increases. To evaluate soils that are vulnerable to water erosion on an ecoregional scale, the Revised Universal Soil Loss Equation (RUSLE) equation was applied using the Rainfall Erosivity (R), Soil Erodibility (K), and Steepness (S) factors. Generally, the areas most vulnerable to water erosion are silt-textured and on steeper slopes. The greatest threat to soils vulnerable to wind erosion is increasing wildfire frequency and severity in the ecoregion. The exposure of soils following recent wildfires have resulted in wind erosion events in the ecoregion that are as great (or greater) in magnitude than many previously studied environments in Africa, Australia, and the United States (Sankey *et al*. 2009). Poorly managed grazing can also result in significant soil erosion and land degradation. Continued inventory, management, and focus on rangeland health would reduce impacts of grazing.

### 1.3.6 Riparian

Riparian vegetation in the NGB ecoregion is dominated by deciduous trees and shrubs, such as willows, mountain alder, aspen, cottonwood, and red-osier dogwood. Well protected riparian habitats reduce the amount of sediment, organic nutrient and other pollutants in surface water runoff, create shade for lower water temperatures improving habitat for fish, provide source of detritus and large woody debris for fish and other organism, and provide room for water courses to establish geomorphic stability. The estimate of the riparian condition was based on how much development has occurred in the riparian corridor. Ecoregion-wide, 16 percent of the riparian corridor has been developed with urban or agricultural land and 84 percent is undeveloped or natural land cover. Future threats of concern include continued spread of invasive species (tamarisk and Russian olive) and poorly-managed livestock grazing in riparian areas.

### 1.3.7 Wetland

Based on available National Wetlands Inventory and state wetlands data, wetlands occupy two percent of the NGB with a mapped acreage of just over 1.5 million acres. Four metrics were used to cumulatively assess the health and function of wetlands at the ecoregion scale: water quality based on 303(d) criteria, detection of aquatic invasives, groundwater condition, and the fraction of undeveloped land in the watershed. Historically, agricultural development and draining of wetlands has been the primary change agent to wetlands. Future threats include impacts of groundwater withdrawals and continued spread of invasive species into wetland habitats.

### 1.3.8 Salt Desert Shrub

The dominant shrubs in salt desert shrub may vary considerably from site to site and many sites are strongly dominated by a single shrub species. Salt Desert Shrub systems are primarily used for livestock grazing. Intact salt desert shrub stands (minimally impacted by human activities) were classified using cumulative indicator scores. The greatest threat to salt desert shrub is invasives and wildfire. Poorly managed grazing can also result in cheatgrass invasion and land degradation that will affect the recovery of salt desert shrub.

### 1.3.9 Sagebrush

There are numerous species of sagebrush in the ecoregion that dominate different sites, generally occurring along soil temperature and moisture gradients. Sagebrush communities are now of great conservation concern due to threats from conversion to agriculture, urban growth and supporting infrastructure and are

currently receiving management and restoration efforts in recognition of the many species that depend on sagebrush, notably the greater sage-grouse. Intact sagebrush communities (minimally impacted by human activities) were classified using cumulative indicator scores, which were derived by combining: Distance to Development and Burn Probability. Frequency, intensity, and areal extent of wildfires are of greatest importance to this ecosystem and are in turn affected by characteristics of the vegetation (fuel characteristics) and livestock grazing (which affects vegetation and soils).

### 1.3.10 Combined Juniper

The junipers were selected as a conservation element due to their expanding distribution and because of their aesthetic and wildlife habitat values. Pre-settlement juniper stands are of considerable conservation concern but cannot be addressed at the ecoregional scale because identification requires on the ground field investigation. Intact juniper stands (minimally impacted by human activities) were classified using cumulative indicator score. The greatest threat to junipers is climate change and its role in increasing wildfire frequency which would most affect areas where juniper has expanded out of its normal historic range and into areas with higher fire frequency.

### 1.3.11 Aspen

Aspen was selected as a conservation element due to concerns over recent declines of aspen stands and the need for increased aspen management and restoration efforts. Two vegetation types, mixed conifer aspen and Rocky Mountain aspen, were combined to make up one class for aspen. Intact aspen stands (minimally impacted by human activities) where classified using cumulative indicator scores. The greatest threat to aspen is climate change and Sudden Aspen Decline. Continued inventory, management of aspen stands and studies to better understanding Sudden Alpine Decline could help reduce aspen decline.

### 1.3.12 Other Conifer

Conifers are an integral component of forest communities at higher elevations in the NGB. Intact Other Conifer stands (minimally impacted by human activities) where classified using cumulative indicator scores, which was derived by combining: Distance to Development, Burn Probability and Distance to Disease Stands. Climate change, in particular toward hotter and drier conditions in the summer, may alter the current distribution of coniferous forests and periodic drought weakens the trees making them more vulnerable to insect or disease attack.

### 1.3.13 Wild Horse and Burro

Wild horse and burro herds, which have virtually no natural predators, grow at a rate of about 20 percent a year. Because these populations grow at such a fast pace, there are many potential adverse impacts to public lands as a result of the overpopulated herds. In response to herd growth, the BLM must remove thousands of wild horses and burros from the range each year to protect public rangelands from the environmental impacts of herd overgrazing. The greatest threat to the wild horse and burros are increasing population growth and limited forage and resources. Due to the absence of predators to keep growing populations in check, BLM will need to continue to actively manage herd populations through herd gathers, contraception and adoption programs.

### 1.3.14 Specially Designated Areas

Since the Northern Great Basin is made up predominantly of BLM and USFS land, there are a large number of specially designated areas within the ecoregion. Wilderness Areas are the most protected from development of all the specially designated areas as they are designated by Congress to restrict wheeled

vehicles, development of structures and most types of development. Other specially designated areas prevalent within the ecoregion would include Wilderness Study Areas, Areas of Critical Environmental Concern, National Conservation Areas, and Wild and Scenic Rivers. The greatest threat to specially designated areas is increasing population growth and their proximity to urban centers. Another important threat would be the altering of vegetation and habitats within the specially designated areas by aquatic and terrestrial invasives.

# 2. Introduction

The BLM is currently evaluating a wide variety of environmental challenges to western ecosystems while maintaining their mission of resource management, and authorizing multiple uses of the public lands under the jurisdiction of each field office. These challenges transcend land ownership and administrative jurisdictions, and necessitate a landscape-scale approach to evaluate of potential changes and threats to these ecosystems. An REA is the BLM's first step toward a broader initiative to systematically develop and incorporate landscape-scale information into the evaluation and eventual application to management of public land resources. An REA is one of a suite of tools available to resource managers and field personnel for assessing natural resource values.

## 2.1 Purpose of the Rapid Ecoregional Assessment

The purpose of the REA process is to document important regional resource values and patterns of environmental change that may not be evident when managing smaller, local land areas separately. The REA process maintains a focus at the scale of the ecoregion to understand more fully the ecological conditions and trends; encompass the extent of natural and human influences; and identify opportunities for resource conservation, restoration, and sustainable development. REAs define the core ecological elements of the ecoregion, conservation elements, define the relevant parameters, and describe and map areas of high ecological value. REAs then gauge the potential of these values to be affected by environmental change agents. Analysis results and maps are presented in Chapter 6 of this document. REAs are called "rapid" assessments because they synthesize existing information, rather than conduct research or collect new data, and are generally completed within 18 months. As part of this synthesis, a better understanding of critical data gaps also emerges.

Because it is not feasible to create an assessment of all of the individual ecological resources that are present in the ecoregion, such as species or ecosystems, conducting the REA involves selecting important, specific resource values throughout the ecoregion and carrying them through the assessment of change agent effects.

## 2.2 The Rapid Ecoregional Assessment Process

Each ecoregion may require unique methods or utilize different types of data to achieve their goals. By its definition, an REA ideally will take place in the shortest timeframe possible to produce reliable and applicable results for its defined purpose and may be particularly relevant for evaluating resource values that are distributed across large spatial scales, ecosystems, and administrative jurisdictions (BLM 2010). Spatial-based assessments using geographic information systems (GIS) can assist in documenting issues such as a change in distribution for an important species or expanding extent of a land use type such as solar energy development. Models can also be used to qualitatively analyze or quantitatively measure impacts from change agents considered to be hazards or threats. The approach has provided managers with maximum return for minimal investment in new data collection by identifying priority areas where management intervention may yield the greatest positive result for the resource values of concern (BLM 2010). The following key elements represent the REA process:

- Identification of "conservation elements" of greatest interest within the ecoregion.
- Identification of the environmental "change agents" most likely to have the potential to alter the conservation elements over time.
- Development of "management questions" to guide the analysis and provide clear direction concerning the information needed and the answers sought. An example management question is "Where will vulnerable soil types overlap with change agents?"

- Development or identification of conceptual models to guide the selection of appropriate ecological attributes that could be quantified, ranked or scored to determine the relative status of key resources within the ecoregion. Where possible, conceptual models that currently exist in literature were used as part of the REA process. When necessary, subject matter experts developed specific conceptual models as part of this REA.
- Identification of the key ecological attributes of the systems that can be measured or categorized and spatially represented. “A key ecological attribute of a focal ecological resource is a characteristic of the resource’s biology, ecology, or physical environment that is so critical to the resource’s persistence, in the face of both natural and human-caused disturbance, that its alteration beyond some critical range of variation will lead to the degradation or loss of the resource…” (Unnasch *et al.* 2009).
- Identification of geospatial data that represents the distribution, key ecological attributes, and/or major components of the element being evaluated.
- Analysis of acquired data in a manner that best answers the management questions.
- Understanding of the limitations of the data available.
- Presentation of results (this report).

### 2.2.1 Scope and Scale

The study area for this REA is composed of two ecoregions, the Northern Basin and Range and the Snake River Plains, which is referred as the NGB. (Figure 2.2-1). There are two other REAs that have been completed which adjoin this ecoregion, Central Basin and Range and Middle Rockies. BLM is the largest landowner in the ecoregion with ownership of over 50 percent of the land (Figure 2.2-2). Throughout this REA process, a wide variety of data has been collected and evaluated, and, depending on source, varies in size and scale within the region. Uniform landscape reporting units provide common assessment reporting throughout the process. Landscape reporting units are predefined areas that are specific enough to provide useful information about species and communities, but general enough to provide appropriate context and avoid mapping at an inappropriately small scale. Although collected datasets were maintained at their native resolution, the primary landscape unit for this REA is a 4 km grid for terrestrial species and both a 4 km grid and the 6$^{th}$ level hydrological unit (HUC) of the National Watershed Boundary Dataset for aquatic species (USGS 2009). In addition, ecological integrity is assessed at the 5$^{th}$ level HUC. Thirty meter pixel raster data is utilized in the geospatial analysis and modeling in support of answering the management questions. For raster data, 30 meter pixel resolution refers to the resolution of the satellite or aerial imagery. In addition to the landscape reporting units listed above, the downscaled regional climate model data was only available at the 15 km resolution level.

### 2.2.2 Time Horizon

Current status was defined as the existing state or cumulative conditions that have resulted from all past changes upon the prior historical condition (BLM 2010). Current status was defined as 2010 but available data generally included data gathered up to 10 years prior. The REA process includes an understanding of the current status of the landscapes within the ecoregion, as well as a predictive modeling of future scenarios based on change agents. For this REA, the analysis of future impacts due to climate change relied on 15 km pixel regional climate change model data by Hostetler *et al.* (2011) (RegCM3 data). The results compare the 1980 to 1999 baseline period with model predictions from the 2050 to 2069. The Integrated Climate and Land Use Scenarios model was used for the predicted housing density change by 2060. The locations of renewable energy development include projects that are currently in permitting, approved or under construction that would be online by 2025.

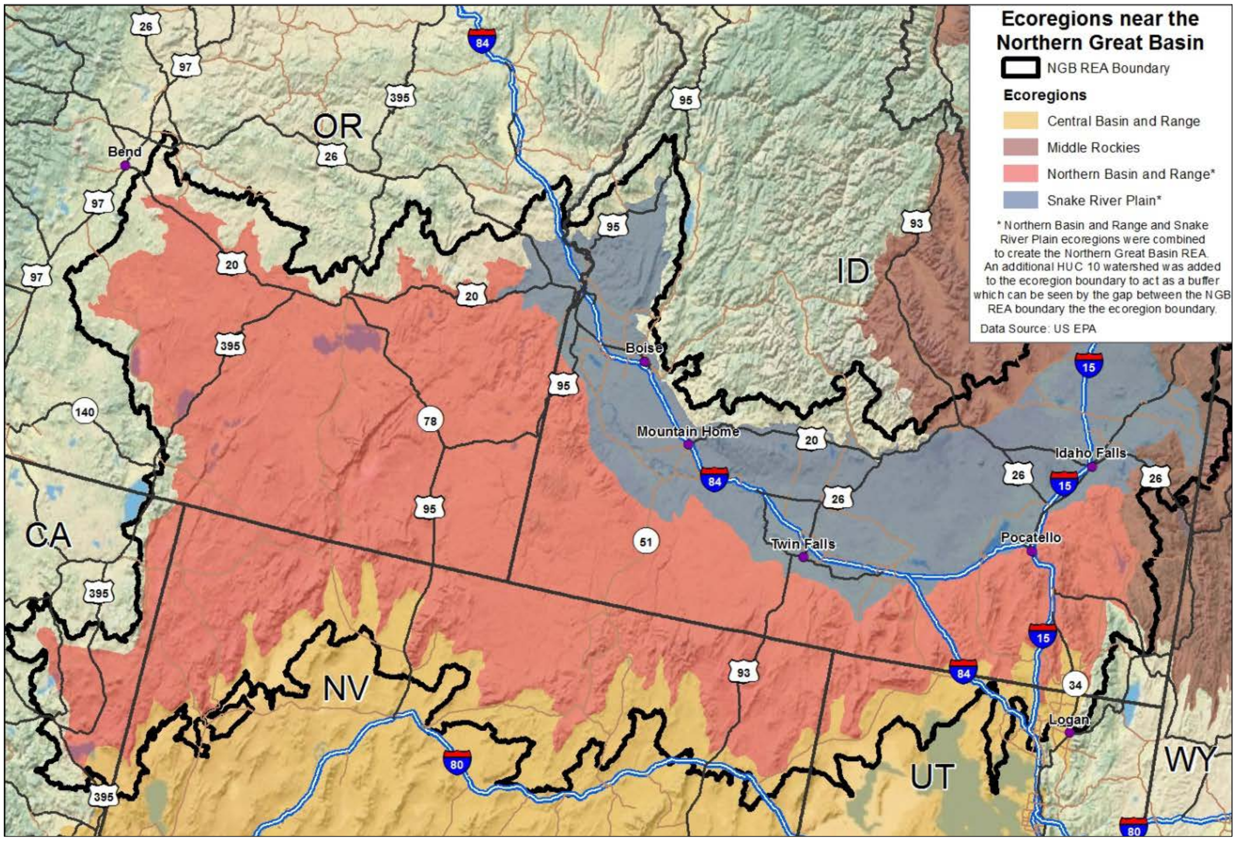


Figure 2.2-1. Northern Great Basin Ecoregion with Other Adjoining REA Boundaries

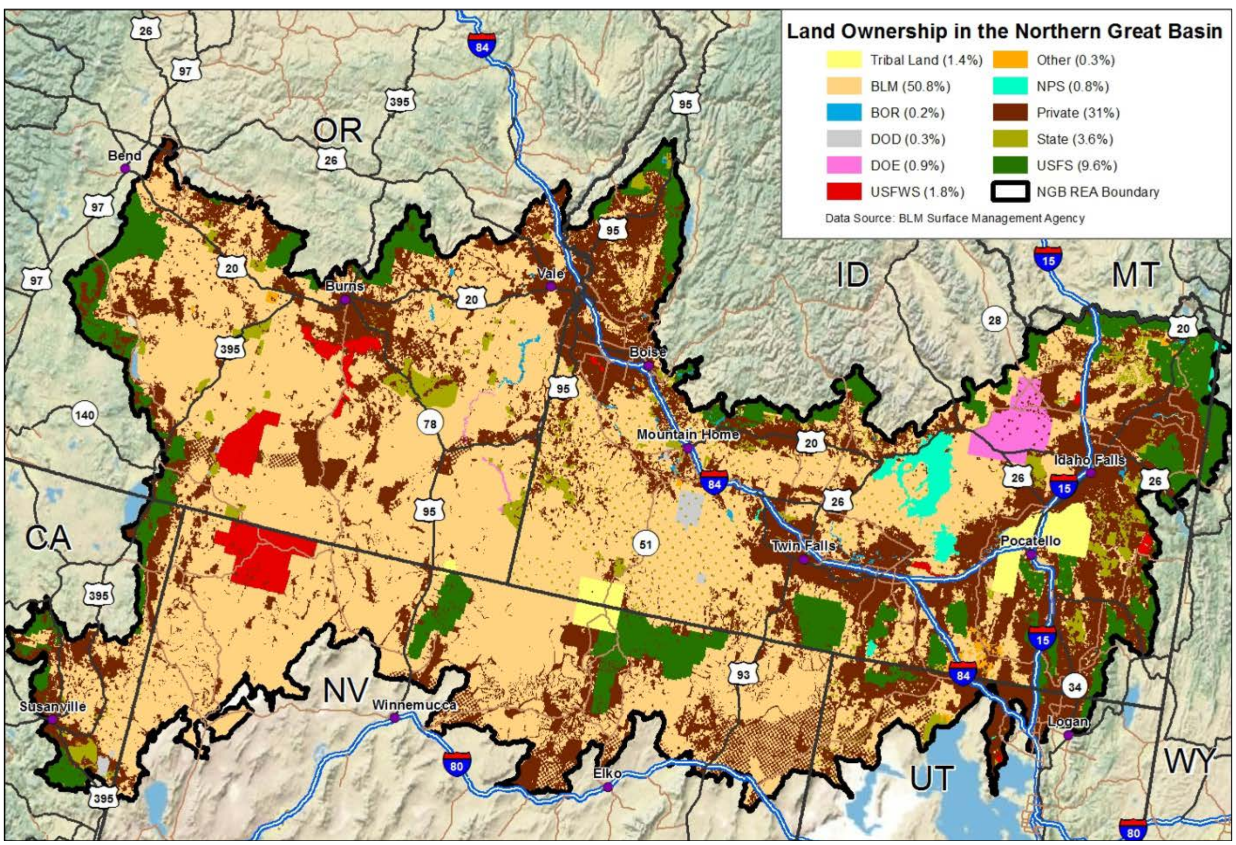


Figure 2.2-2. Land Ownership by Jurisdiction in Northern Great Basin Ecoregion

### 2.2.3 Uncertainty

The uncertainty inherent in an analysis of this magnitude can take a variety of different forms. For example, there can be variation in the accuracy, precision and completeness of datasets and model inputs which compounds the amounts of uncertainty when multiple datasets are used to complete an analysis. There is also the uncertainty associated with our current understanding of all of the interactions of the conservation elements and change agents and the natural processes that occur. The climate change analysis for example is one where a high level of uncertainty was recognized because our understanding is based on historical data and modeling efforts that may or may not be consistent with what happens in the future.

Communicating the uncertainty is one of the most important aspects of this document and the authors made every effort to present uncertainty at key decision points; however, determining the confidence level associated with every dataset would be difficult if not impossible in the rapid timeframe available for this analysis. Because we recognize the potential for uncertainty associated with all of the analysis, we have attempted to make this REA as transparent and repeatable as possible. In addition, a series of checks and balances were incorporated throughout the process to manage uncertainty. Uncertainty is most explicitly presented in the data packages in Appendix B, which comprehensively walk through each change agent, fine filter and coarse filter conservation element. In general, uncertainly is associated with the predictive modeling completed for climate change, human development, and other modeling. Further, any analysis based on data is subject to the assumptions and methods prescribed to in collecting the data, and as the analysis becomes more sophisticated, it is common for the assumptions to be defined and uncertainties to be minimized.

Where necessary, the Assessment Management Team made the decision not to carry forward an analysis where it was determined that the uncertainty of the data or the potential misuse of the results outweighed the benefits of the information. One example of this was the bat assemblage conservation element. There were very limited data available and GAP modeling was inconsistent by species within the ecoregion. As a result, the Assessment Management Team determined that the data were not sufficiently qualified to communicate an analysis to the general public.

## 2.3 Rapid Ecoregional Assessment Team

The Assessment Management Team responsible for each REA was comprised of resource specialists from BLM and other state and federal agencies, and stakeholder scientists and planners. The USGS provides scientific peer review for the REA process (Table 2.3-1). The assessment management team and peer reviewers developed the management questions and directed the work products throughout the REA. The assessment management team met at each project milestone to coordinate progress, data, and the path forward.

Table 2.3-1. Assessment Management Team and Peer Review Team

| Agency | AMT Members |
|---|---|
| BLM | Tim Bottomley, Nika Lepak, Elias Flores, Sandra Brewer, Don Major, Bruce Sillitoe, Mike Pellant, Joe Tague, Kurt Wiedenmann, Bob Hopper, Rolando Mendez, Verlin Smith |
| State Agencies | Steve Siegel |
| USGS (Peer Review) | Sue Phillips, Matt Germino, Steve Knick, Jason Dunham |
| Western Governors Association | Gregg Servheen |

During the assessment phase, the BLM recognized that conservation element subject matter experts would be the best resources to evaluate individual conservation element analyses results. To accommodate this approach, rolling review teams for each conservation element were established. Each Rolling Review Team was comprised of Science Applications International Corporation (SAIC) scientists, SAIC GIS personnel, Assessment Management Team member(s) and other subject matter experts from Department of Interior or state agencies. To ensure consistency amongst the different Rolling Review Teams, the number of lead SAIC scientist was restricted to only a few individuals. This ensured that there was a common approach or framework used amongst the different Rolling Review Teams and that one Rolling Review Team did not to stray too far from the rest. USGS scientists also supported the Rolling Review Team process. These rolling review teams met several times to establish evaluation metrics and review data packages and results for each of the conservation elements (Table 2.3-2).

Table 2.3-2. Rolling Review Team Membership

| Fine Filter Conservation Element's | | | | | | |
|---|---|---|---|---|---|---|
| Conservation Element/Group | SAIC Lead | SAIC 2nd | SAIC GIS | BLM Lead | State | Other |
| Big Game (mule deer, bighorn sheep, pronghorn) | B. Tannenbaum | | C. McColl | E. Flores (BLM-CA) | S. Siegel (NDOW) | T. Allen (BLM-UT) |
| Eagles (Bald Eagle, Golden Eagle) | B. Tannenbaum | J. Leiendecker | J. Leiendecker | S. Brewer (BLM-NV) | S. Siegel (NDOW) | C. Moulton (IDFG) |
| Fisheries (CWF Assemblage, Bull Trout, White Sturgeon) | B. Tannenbaum | C. Hunt | C. Woods | Scott Hoefer (BLM-ID) | Paul Thompson (UT DWR) | Cynthia Tait (USFS) |
| Greater Sage-Grouse | B. Tannenbaum | | C. Woods | Tom Rinkes (BLM-ID) | Mike McDonald (IDFG) | Erik Blomberg (USGS) |
| Spotted Frog, Pygmy Rabbit, Bats | B. Tannenbaum | D. Barringer | C. Woods | Don Major (BLM-ID) | Bill Bosworth (IDFG) | |

| Coarse Filter Conservation Element's | | | | | | |
|---|---|---|---|---|---|---|
| Conservation Element/Group | SAIC Lead | SAIC 2nd | SAIC GIS | BLM Lead | State | Other |
| Sagebrush, Salt Desert Shrub | T. Mulroy | T. Schoenwetter | C. Woods | Mike Pellant (GBRI) | Steve Siegel (NDOW) | Mark Coca (BLM-NV) |
| Aspen and Other Conifer Woodland | T. Mulroy | T. Schoenwetter | T. Caselton | Tim Bottomley (BLM-NOC) | | Joe Adamski (BLM-ID) |
| Riparian, Cottonwood Galleries, Perennial Streams, Springs and Seeps, Open Water and Wetlands | T. Mulroy | T. Schoenwetter | J. Degner | Bryce Bohn (BLM-ID) | Rick Ward (IDFG) | |
| Vulnerable Soils and Groundwater | T. Mulroy | T. Schoenwetter | J. Degner | Bryce Bohn (BLM-ID) | | Matt Germino (USGS) |
| Specially Designated Areas and Wild Horse and Burro HMAs | T. Mulroy | D. Barringer | C. Woods | Nika Lepak (BLM-ID) | | |

| Change Agents | | | | | | |
|---|---|---|---|---|---|---|
| Change Agent | SAIC Lead | SAIC 2nd | SAIC GIS | BLM Lead | State | Other |
| Development | T. Caselton | | C. Woods | R. Hopper (BLM-OR) | Jim Mende (IDFG) | Mike McDonald (IDFG) |
| Invasives and Disease | J. Gerlach | | C. McColl | M. Pellant (GBRI) | S. Siegel (NDOW) | T. Allen (BLM-UT) |
| Climate Change | J. Gerlach | | J. Leiendecker | M. Pellant (GBRI) | | S. Phillips (USGS) |
| Wildfire | T. Caselton | | C. Woods | Craig Goodell (BLM-OR) | | D. Havelina (NIFC) |
| Grazing | T. Pattison | D. Barringer | C. Woods | N. Lepak (BLM-ID) | G. Servheen (IDFG) | |

| Ecological Integrity | | | | | | |
|---|---|---|---|---|---|---|
| Ecological Integrity | SAIC Lead | SAIC 2nd | SAIC GIS | BLM Lead | State | Other |
| Terrestrial / Aquatic | B. Tannenbaum | | C. Woods | T. Bottomley (BLM-NOC) | G. Servheen (IDFG) | |

# 3. Ecoregion Description

## 3.1 Ecosystem Characteristics

The study area for this REA is comprised of two ecoregions, the Northern Basin and Range and the Snake River Plains, identified going forward as the Northern Great Basin (NGB; Figure 2.2-1).

The Northern Basin and Range ecoregion (Commission for Environmental Cooperation [2006]; Level III Ecoregions) encompasses 54,903 square miles (142,200 $km^2$) of southeastern Oregon, portions of southern Idaho, northern Nevada, and a small extension into northeastern California. It is the northern extent of the larger Basin and Range physiographic province. Most of the ecoregion is dominated by sagebrush steppe ecosystems on the desert floor, but distinct vegetation zones related to relief and elevation also exist including juniper, mountain mahogany, aspen and riparian habitats. In the upper elevations Douglas-fir and aspen stands occur up the sub-alpine zone, which supports primarily low-growing shrubs, grasses, and forbs.

Wildlife species of importance to the region include bighorn sheep (*Ovis canadensis*), mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), pronghorn (*Antilocapra americana*), pygmy rabbit (*Brachylagus idahoensis*), golden eagle (*Aquila chrysaetos*), and greater sage-grouse (*Centrocercus urophasianus*). Important habitats in the ecoregion include migration corridors and areas for overwintering pronghorn, as well as key habitat for greater sage-grouse. The Northern Basin and Range ecoregion also supports thousands of migratory waterfowl in the Malheur Lake area, and populations of the Endangered Species Act-listed threatened Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*). Other important species within this ecoregion include redband trout (*Oncorhynchus mykiss*), warm water fish, bat species, and spotted frog (*Rana luteiventris*).

Federal agencies manage the majority of land in this ecoregion. Historical and current land use includes mining, livestock grazing, and recreation. Current management priorities include energy development (geothermal, solar and wind development), wild horse and burro management, and invasive species control. Potential wind development sites under consideration by land management agencies must resolve concerns involving disturbance and other threats to sagebrush ecosystems and sagebrush obligates (e.g. greater sage-grouse, , pygmy rabbit) mule deer winter range, golden eagle (including nest locations), other raptors, and bats.

The Snake River Plain ecoregion (Commission for Environmental Cooperation [2006]; Level III Ecoregions) occupies 20,705 square miles (53,626 $km^2$) of southern Idaho dissected by the Snake River drainage system along with part of eastern Oregon, resulting in well-developed terraces along the river. Native upland vegetation cover is dominated by sagebrush-bunchgrass communities. Important wildlife species of concern in this ecoregion are mule deer, pronghorn, sage-grouse, bald eagle (*Haliaeetus leucocephalus*), and golden eagle. The Snake River is an important habitat and migration route for fish species including white sturgeon (*Acipenser transmontanus*) and redband trout.

The largest human populations of the ecoregion are concentrated along the Snake River corridor and land development remains an important change agent. Much of the Snake River Plains ecoregion is used as cropland and federally managed rangeland, in which the distribution and extent of native vegetation communities have been significantly altered. Land use issues focus on the impacts of farming and livestock grazing, residential and commercial development, invasive annual grasses, dispersed recreation, surface water and groundwater withdrawal for irrigation, and soil erosion.

Greater sage-grouse drives major planning and conservation efforts throughout the ecoregion. The BLM is developing a national strategy to preserve and conserve sagebrush communities and throughout the range of the greater sage-grouse, which includes the development of an Environmental Impact Statement (drafts expected in 2013). The U.S. Fish and Wildlife Service published its listing decision for the species as “warranted but precluded” in 2010.

Land ownership in the ecoregion is dominated by BLM with over 50 percent of the land (32 million acres) with Private (18 million acres) and USFS (6 million acres) having the second and third largest ownership (Figure 2.2-2). The majority of the Private land ownership is agricultural areas mostly in Idaho but all states within the ecoregion have some level of agriculture. The USFS land ownership is consists of National Forest along the edge of the east, north and west sides of the ecoregion.

## 3.2 Management Questions

The SAIC team presented the screened list of 55 management questions from the Scope of Work to the Assessment Management Team in the pre-workshop memo (1-a) prior to Assessment Management Team Workshop 1. However, it was determined at Assessment Management Team Workshop 1 that the management questions developed for the adjacent and similar ecoregion, Central Basin and Range, would better serve as a starting point for the Northern Great Basin, as well as provide desirable consistency between the adjacent ecoregional assessments. The management questions from the Central Basin and Range were refined (i.e., rewording, removals, and additions) throughout that REA process. This set of management questions was discussed and further refined during the Assessment Management Team Workshop and conference calls. In addition to Central Basin and Range management questions, the NGB Assessment Management Team determined that it was appropriate and necessary to include management questions related to grazing both as a change agent and conservation element. As a result, eight additional grazing-focused management questions were developed and included, for a total of 78 draft management questions (Table 3.2-1). Throughout the REA process, the Assessment Management Team also deleted some management questions because it became clear that there was no meaningful way to answer the question in a geospatial manner based on existing information these are identified with “strike-through” text in Table 3.2-1. These important questions were considered through the analysis process and where possible a qualitative discussion was incorporated. Future REA efforts should reconsider these questions when newer data are available for the ecoregion.

The Assessment Management Team also developed a classification system for management questions comprised of three tiers that correspond to the level of data inputs, GIS processing, and management implications associated with the question. These are:

- Tier 1 management questions include the lowest level of questions that involve presentation of basic data describing where conservation elements or change agents are located. These management questions are posed for all of the conservation elements and change agents in the assessment in order to depict their distribution or location. An example of a Tier 1 question is management question 42: Where are current locations of development change agents? This would be resolved by mapping each of the development change agents (e.g., mining, urban development, etc.) that exist in the NGB.
- Tier 2 management questions focus on identifying where conflicts occur between a conservation element and the change agents. This is the intersections of conservation element distributions and change agent effects. An example of a Tier 2 question is management question 45: Where do current locations of conservation elements overlap with development change agents (e.g., where wind development proposals may affect golden eagle nesting habitat)?
- Tier 3 management questions are the highest-level questions in which we ask about the significance of the change agent risks identified by the Tier 2 analyses or management implications of the Tier 2 management questions. An example of a Tier 3 question is management question 44: Where do development change agents cause significant loss of ecological integrity? As discussed in Workshop 4, other Tier 3 management questions are more explicit in asking for a measure of the effect of change agents, e.g. a gradient of intensity of effects.

Table 3.2-1. Management Questions for the NGB

| Management Question Number | Management Question Group | Revised Management Question | Tier |
|---|---|---|---|
| Questions Related to Conservation Elements | | | |
| 1 | Species | What is the currently occupied habitat or modeled suitable habitat for each species conservation element? | 1 |
| 2 | Species | Where are the areas of greatest and least collective impact of existing change agents on occupied habitat or modeled suitable habitats of species conservation elements? | 3 |
| 3 | Species | Where are the connectivity corridors identified by the Western Governors Association landscape integrity dataset? | 1 |
| 4 | Species | Where are the areas of greatest and least collective impact of existing change agents on connectivity corridors identified in management question 3? | 3 |
| 5 | Species | Where are species conservation elements whose current locations or suitable habitats overlap with the potential future distribution of change agents (other than climate change)? | 2 |
| 6 | Species | Given current and anticipated future locations of change agents, which habitat areas remain as opportunities for habitat enhancement/ restoration? | 3 |
| 7 | Species | Where are potential areas to restore connectivity for landscape species and species assemblage conservation elements, based on current locations of change agents? | 3 |
| 8 | Species | Where will landscape species and species assemblage conservation elements (not including white sturgeon and cave bat species, and limited to winter and/or summer range for mule deer, pronghorn winter range) experience climate outside their current climate envelope? | 2 |
| 9 | Native Plant Communities | Where are coarse filter conservation element vegetative communities located? | 1 |
| 10 | Native Plant Communities | Where are intact (i.e., minimally disturbed by human activities) coarse filter conservation element vegetative communities located? | 2 |
| 11 | Native Plant Communities | Where will existing and potential future change agents (aside from climate change) affect current communities? | 2 |
| 12 | Native Plant Communities | Where will current locations of these communities experience significant deviations from normal climate variation? | 2 |
| ~~13~~ | ~~Terrestrial Sites of High Biodiversity~~ | ~~Where are sites identified as having high biodiversity characteristics? Which designated sites are protected?~~ | |
| ~~14~~ | ~~Terrestrial Sites of High Biodiversity~~ | ~~Where will change agents (aside from climate change) potentially affect sites of high biodiversity?~~ | |
| ~~15~~ | ~~Terrestrial Sites of High Biodiversity~~ | ~~Where will locations of these high biodiversity sites experience significant deviations from normal climate variation?~~ | |
| 16 | Aquatic High Biodiversity Sites | Where do spring snails occur? | 1 |
| ~~17~~ | ~~Aquatic High Biodiversity Sites~~ | ~~Where are areas representing unique aquatic lineages or assemblages or other areas of high aquatic biodiversity (considering both local [alpha] and regional [beta or gamma] diversity)?~~ | ~~2~~ |
| ~~18~~ | ~~Aquatic High Biodiversity Sites~~ | ~~Where will these aquatic high biodiversity sites (as defined in MANAGEMENT QUESTION 17) be potentially affected by change agents (aside from climate change)?~~ | ~~2~~ |

Table 3.2-1. Management Questions for the NGB

| Management Question Number | Management Question Group | Revised Management Question | Tier |
|---|---|---|---|
| ~~19~~ | ~~Aquatic High Biodiversity Sites~~ | ~~Where will current locations of these aquatic high biodiversity sites (as defined in MANAGEMENT QUESTION 17) experience significant deviations from normal climate variation?~~ | ~~2~~ |
| 20 | SPECIALLY DESIGNATED AREASs | Where are specially designated areas of ecological and/or cultural value? | 1 |
| 21 | Wild Horse and Burro Management Areas | Where are the current wild horse and burro Herd Management Areas (HMAs)? | 1 |
| 22 | Wild Horse and Burro Management Areas | Where will change agents (excluding climate change) overlap HMAs, under each time scenario? | 2 |
| Questions Related to Change Agents | | | |
| 23 | Wild Horse and Burro Management Areas | Where will HMAs experience significant deviations from normal climate variation? | 2 |
| 24 | Grazing (livestock) conservation element | Where are the current livestock grazing allotments? | 1 |
| 25 | Grazing (livestock) conservation element | Where will change agents (excluding climate change) overlap grazing allotments under each time scenario? | 2 |
| 26 | Grazing (livestock) conservation element | Where will grazing allotments experience significant deviations from normal climate variation? | 2 |
| 27 | Vulnerable Soils | Where are vulnerable (e.g., erodible, slickspot) soil types within the ecoregion? | 1 |
| 28 | Vulnerable Soils | Where will vulnerable soil types overlap with change agents (aside from climate change) under each time scenario? | 2 |
| 29 | Vulnerable Soils | Where will current vulnerable soil types experience significant deviations from normal climate variation? | 2 |
| 30 | Surface/Subsurface Water | Where are current natural and man-made surface water resources, and which are perennial, seasonal, ephemeral, spatially intermittent, etc.? | 1 |
| 31 | Surface/Subsurface Water | What is the natural variation of monthly discharge and monthly base flow for streams and rivers? | 1 |
| ~~32~~ | ~~Surface/Subsurface Water~~ | ~~Where are the likely recharge areas within a HUC?~~ | ~~1~~ |
| ~~33~~ | ~~Surface/Subsurface Water~~ | ~~Where will the recharge areas (relating to aquatic conservation elements) identified in MANAGEMENT QUESTION 32 potentially be affected by CAs?~~ | ~~2~~ |

Table 3.2-1. Management Questions for the NGB

| Management Question Number | Management Question Group | Revised Management Question | Tier |
|---|---|---|---|
| Questions Related to change agents (continued) | | | |
| 34 | Aquatic Ecological Function and Structure | What is the condition (ecological integrity) of aquatic conservation elements? | 2 |
| 35 | Fire | What are the frequency, size, and distribution of wildfire on the landscape? | 1 |
| 36 | Fire | What areas now have (high, medium, low) potential for fire based on fuels composition (e.g., invasive plants, uncharacteristically dense sagebrush)? | 2 |
| 37 | Fire | Where are areas that in the future will have high potential for fire? | 2 |
| 38 | Invasive Species | What is the current distribution of invasive species included as change agents? | 1 |
| 39 | Invasive Species | What is the relative abundance or intensity of effect of invasive species included as change agents (dominant/non-dominant, presence/absence, or not detected)? | 3 |
| 40 | Invasive Species | Focusing on the distributions of terrestrial and aquatic conservation elements that are significantly affected by invasive species, which areas have restoration potential? | 3 |
| 41 | Invasive Species | Given current patterns of occurrence and expansion of the invasive species included as change agents, what is the potential future distribution of these invasive species? | |
| 42 | Development | Where are current locations of development change agents? | 1 |
| 43 | Development | Where are areas of planned or potential development change agents? | 1 |
| 44 | Development | Where do development change agents cause significant loss of ecological integrity? | 3 |
| 45 | Development | Where do current locations of conservation elements overlap with development change agents? | 2 |
| 46 | Recreation | Where are areas with significant recreational use? | 1 |
| 47 | Recreation | Where have designated recreation areas, such as for off-highway vehicle use, affected conservation elements and invasive species? | 2 |
| 48 | Recreation | Where are other areas of likely high off-highway vehicle use [as determined by modeling] that may affect conservation elements and invasive species? | 2 |
| 49 | Oil, Gas, and Mining Development | Where are the current locations of oil, gas, and mineral extraction? | 1 |
| 50 | Oil, Gas, and Mining Development | Where will locations of oil, gas, and mineral extraction potentially exist by 2025? | 1 |
| 51 | Oil, Gas, and Mining Development | Where are the areas of potential future locations of Oil, Gas, and Mining (including gypsum) development (locatable, salable, and fluid and solid leasable minerals)? | 2 |

Table 3.2-1. Management Questions for the NGB

| Management Question Number | Management Question Group | Revised Management Question | Tier |
|---|---|---|---|
| | | Questions Related to change agents (continued) | |
| 52 | Oil, Gas, and Mining Development | Where do locations of current conservation elements overlap with areas of potential future locations of non-renewable energy development? | 3 |
| 53 | Renewable Energy Development | Where are the current locations of renewable energy development (solar, wind, geothermal, transmission)? | 1 |
| 54 | Renewable Energy Development | Where are the areas identified by the National Renewable Energy Laboratory (NREL) as potential locations for renewable energy development? | 1 |
| 55 | Renewable Energy Development | Where are the areas of low renewable and non-renewable energy development that could potentially mitigate impacts to conservation elements from potential energy development? | 3 |
| 56 | Renewable Energy Development | Where do current locations of conservation elements overlap with areas of potential future locations of renewable energy development? | 3 |
| 57 | Renewable Energy Development | Where will locations of renewable energy [development] potentially exist by 2025? | 2 |
| 58a | Groundwater Extraction and Transportation | Where are areas with current groundwater extraction? | 1 |
| 58b | Groundwater Extraction and Transportation | Where are the areas of potential future change in groundwater extraction? | 2 |
| ~~59~~ | ~~Groundwater Extraction and Transportation~~ | ~~What is the present distribution of municipal and agricultural water use of groundwater resources in relation to the distribution of aquatic conservation elements?~~ | |
| 60 | Groundwater Extraction and Transportation | Where are the aquatic conservation elements showing degraded ecological integrity from existing groundwater extraction? | 3 |
| ~~61~~ | ~~Surface Water Consumption and Diversion~~ | ~~Where are current surface water diversions?~~ | ~~1~~ |
| 62 | Surface Water Consumption and Diversion | Where are the areas of potential future change in surface water diversion? | 2 |
| 63 | Surface Water Consumption and Diversion | Where are the conservation elements showing degraded ecological integrity from existing surface water diversion? | 3 |

Table 3.2-1. Management Questions for the NGB

| Management Question Number | Management Question Group | Revised Management Question | Tier |
|---|---|---|---|
| | | Questions Related to change agents (continued) | |
| 64 | Climate Change: Terrestrial Resource Issues | Where will changes in climate be greatest relative to normal climate variability? | 2 |
| 65 | Climate Change: Terrestrial Resource Issues | Given anticipated climate shifts and the direction shifts in climate envelopes for conservation elements, where are potential areas of significant change in extent such as ecotones? | 3 |
| 66 | Climate Change: Terrestrial Resource Issues | Where are vegetation conservation elements that will experience significant deviations from normal climate variation? | 2 |
| 67 | Climate Change: Terrestrial Resource Issues | Where are wildlife conservation element habitats that will experience significant deviations from normal climate variation? | 2 |
| 68 | Climate Change: Aquatic Resource Issues | Where will aquatic conservation elements experience significant deviations from historic climate variation that potentially could affect the hydrologic and temperature regimes of these aquatic conservation elements? | 2 |
| 69 | Military Constrained Areas | Where are areas of Department of Defense and Department of Energy use? | 1 |
| 70 | Atmospheric Deposition | Where are areas affected by atmospheric deposition of pollutants, as represented specifically by nitrogen deposition, acid deposition, and mercury deposition? | 1 |
| 71 | Livestock Grazing | Where is structure of vegetation conservation elements affected by livestock grazing? | 2 |
| 72 | Livestock Grazing | Where can livestock grazing be used to reduce wildfire risk in areas with herbaceous fuel loads and proximity to high-probability ignition locations (roads, train tracks, lightning etc.)? | 3 |
| 73 | Livestock Grazing | Where will livestock grazing have the potential to increase fire frequency as a result of increased cover of annual grasses (high, medium, low)? | 3 |
| 74 | Livestock Grazing | Where are areas in the landscape with various (low, medium, high) levels of resilience to livestock grazing (based upon ecological site and existing vegetation)? | 3 |
| 75 | Livestock Grazing | Where has the landscape been modified for purposes of livestock grazing and management (sagebrush elimination, fences, plantings, water sources, etc.)? | 2 |
| ~~76~~ | ~~Livestock Grazing~~ | ~~What areas of the landscape are low density vs. high density livestock grazed (streams, water developments, corrals, steep slopes, etc.)?~~ | ~~2~~ |
| ~~77~~ | ~~Livestock Grazing~~ | ~~Where are areas best suited to potential livestock cattle and sheep grazing based on environmental factors (such as slope, aspect, water availability, wild ungulate grazing)?~~ | ~~3~~ |
| ~~78~~ | ~~Livestock Grazing~~ | ~~Where do grazing areas have the highest potential to increase invasive and/or noxious species occurrences?~~ | ~~3~~ |

*Note:* Strikethrough indicates that the management question was removed from consideration by the AMT because they could not be geospatially answered or because there was a data gap. In many cases, these MQs were addressed qualitatively. Each MQ answer is included in Appendix B, data packages.

## 3.3 Conservation Elements

Because it is not feasible to create an assessment of all of the individual ecological resources present within the ecoregion, conducting the REA involves selecting important, specific resource values and carrying them through the assessment of change agent effects. These selected resources are referred to as conservation elements and are the objects of assessment that represent current condition and future status and trends. Conservation elements are the 'what' that are to be conserved and/or restored. Classes of conservation elements include species, ecosystems and landscapes, and scenery/special values recognized as warranting conservation/protection.

The conservation elements included consideration of the following core ecological values identified by BLM and discussed with the Assessment Management Team include:

1. Native fish, wildlife, or plants of regional conservation concern (e.g., populations, species, or communities identified in state wildlife action plans; species listed under the Endangered Species Act; species and communities identified through other agency/non-governmental organization assessments; etc.).
2. Regionally-important, terrestrial ecological features, functions, and services (e.g., large areas of native vegetation providing important cover, fiber, and forage; habitat strongholds and corridors; upland areas important for water quality or water supply; areas capable of significant carbon sequestration; etc.).
3. Regionally-important, aquatic ecological features, functions, and services (e.g., habitat strongholds and corridors; wetland, riparian, and other aquatic areas important for water quality, water supply, stream bank stability, flood control, and similar purposes).

### 3.3.1 Coarse-filter Selection

Coarse-filter conservation elements include all of the major ecosystem types that occur within the ecoregion, and should represent the predominant natural ecosystem functions and services in the ecoregion. Other factors included focusing on species for which management by one BLM field office may affect management concerns of other BLM field offices (i.e., these species have trans-boundary management issues). The desired outcome of coarse-filter selection is to provide coverage for the vast majority of species that occur in the ecoregion. Specially designated areas and wild horse and burros are also included as coarse filters even though they are not an ecosystem type as described previously. The Assessment Management Team provided a list of coarse-filter conservation elements to be used for the NGB in the Scope of Work.

| Coarse-filter Conservation Elements | |
|---|---|
| Groundwater | Wetlands |
| Springs and Seeps | Salt Desert Shrub |
| Perennial Streams and Rivers | Sagebrush |
| Open Water | Combined Juniper |
| Vulnerable Soils | Aspen |
| Riparian | Other Conifers |
| Wild Horse and Burros | Specially Designated Areas |

### 3.3.2 Fine Filter Selection

The primary criterion for selecting fine-filter conservation elements is that they should be native species of regional management concern. Other guidance included focusing on species for which management by one BLM field office may affect management concerns of other BLM field offices (i.e., these species have trans-

boundary management issues). Conservation element species are not only surrogates for other species of concern, they should be of concern themselves. The following additional criteria reflect Assessment Management Team workshop guidance and were used to refine the list of candidate fine-filter conservation elements:

- Appropriateness of the conservation element for answering management questions (e.g., vulnerability to change agents that can be readily measured or categorized in the REA);
- Strong association with one or more coarse-filter conservation elements (e.g., species that require sagebrush habitat);
- Association with a species group or assemblage being carried forward as a conservation element (e.g., fish species included in the cold water fish species assemblage); and
- Lack of consensus among the Assessment Management Team to carry the species forward as a fine-filter conservation element also affected fine-filter conservation element selections. Reasons for not carrying a species forward included:
  - Insufficient ecological knowledge;
  - Not a landscape species;
  - Not particularly susceptible to change agents covered in this REA; and/or
  - Not of regional significance or strong agency concern throughout the ecoregion.

These criteria were used to refine the candidate list of fine-filter conservation elements in the Scope of Work that are carried forward in subsequent tasks of this REA. In some cases, for example, cold water fish species, individual species were combined into assemblages following discussion with Assessment Management Team fisheries experts. The Assessment Management Team also provided guidance on emphasizing life cycle stages for certain conservation elements based on their vulnerability to change agents at those stages (e.g., migratory corridors for the golden eagle).

| Fine-filter Conservation Elements | |
|---|---|
| Greater Sage-grouse | Columbia Spotted Frog |
| Bighorn Sheep | Pygmy Rabbit |
| Mule Deer | Bats |
| Pronghorn | Bull Trout |
| Golden Eagle | Coldwater Fish Assemblage |
| Bald Eagle | White Sturgeon |

## 3.4 Change Agents

Change agents are natural or anthropogenic disturbances that influence the current and future status of conservation elements. The initial change agents for this ecoregion were outlined by the Assessment Management Team (AMT) in the Scope of Work. The REA process focuses on regionally significant change agents that operate and impact on large scales and not on a site-by-site basis. The following is the list of change agents that are included in the REA:

| Change Agents | |
|---|---|
| Development (Major Hydrologic Alterations, Urban and Exurban Development , Energy Development, Agriculture, Recreation and Military Expansion) | Climate Change |
| | Invasive Species and Disease |
| | Wildfire |
| | Grazing |

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# 4. Ecological Models and Indicators

Conceptual models represent the current understanding of the underlying natural processes controlling a system or conservation element. The purpose of the conceptual models was to guide the selection of appropriate ecological attributes (that could be quantified, ranked or scored to determine the relative status of key resources within the ecoregion). This section includes a high-level summary of the process, tools, and applications employed during the REA process. All specific information is included in Appendix B relative to each conservation element or change agent.

## 4.1 Conceptual Ecological Models

Natural systems are complex and many factors influence ecological processes. Conceptual models are useful for describing functional relationships among structural components of ecological systems (biotic, abiotic, and local- and landscape-level), and for depicting the effects of natural and human-influenced change agents (Miller *et al.* 2005). Well-constructed conceptual models provide a scientific framework and justification for the choice of key indicators intended for use in assessing ecological integrity in landscape reporting units. Several types of conceptual models were considered for use in this REA, including control models and stressor models. Control models depict, in a mechanistic way, the actual controls, feedback, and interactions responsible for system dynamics (Gross 2003). Control models sometimes consist of sets of models that illustrate functional subsystems such as soils, fire, or nutrient flow. Stressor models depict relationships between stressors and ecosystem components, and often include indicators of the responses to stressors. Stressor models do not depict feedbacks and usually illustrate only a subset of system components (e.g., selected conservation elements). Since the purpose of these models is to illustrate sources of stress or disturbance in a system and the responses of system components of interest, they generally do not present relationships in a mechanistic manner. Stressor models are an appropriate choice for the evaluation of conservation elements in this REA because they are better suited to illustrating the linkages between change agents and system components relied upon by the particular conservation element. For each conservation element, a system-level conceptual model depicts the conservation element and the actions of change agents upon it. Models are further discussed and presented in Appendix B.

### 4.1.1 Example Conceptual Ecological Model: Greater Sage-grouse

The model for greater sage-grouse incorporates a life cycle model that indicates the major components of sagebrush ecosystems that are used during the course of the year (Connelly *et al.* 2011a) (Figure 4.1-1). There is considerable variation among populations with respect to migration distances, but some migratory populations move relatively large distances (often >20 km) between different seasonal habitats, and occupy large home ranges (>600 square kilometers). Life cycle components related to habitat (Connelly *et al.* 2011b) include: (1) Lek sites, which are typically located in sparse to short grassland or man-made openings within sagebrush communities. Sagebrush immediately surrounding lek sites is used for feeding, resting and cover from weather and security from predators when the birds are not on leks; (2) Nesting habitat, which requires a sagebrush canopy that provides cover from predation during the growing season; (3) Early brood-rearing habitat, which is characterized by the chicks' requirements for escape cover (sagebrush canopy) and food resources (primarily arthropods and forbs); (4) Summer and late brood-rearing, during which greater sage-grouse may shift to areas that support green vegetation, such as riparian habitats, springs and seeps, and agricultural croplands, irrigated hayfields and high elevation meadows; (5) Winter habitat, in which the primary requirement is sagebrush exposed above the snow. Exposed sagebrush is used for feed and cover; greater sage-grouse feed almost exclusively on sagebrush in the winter.

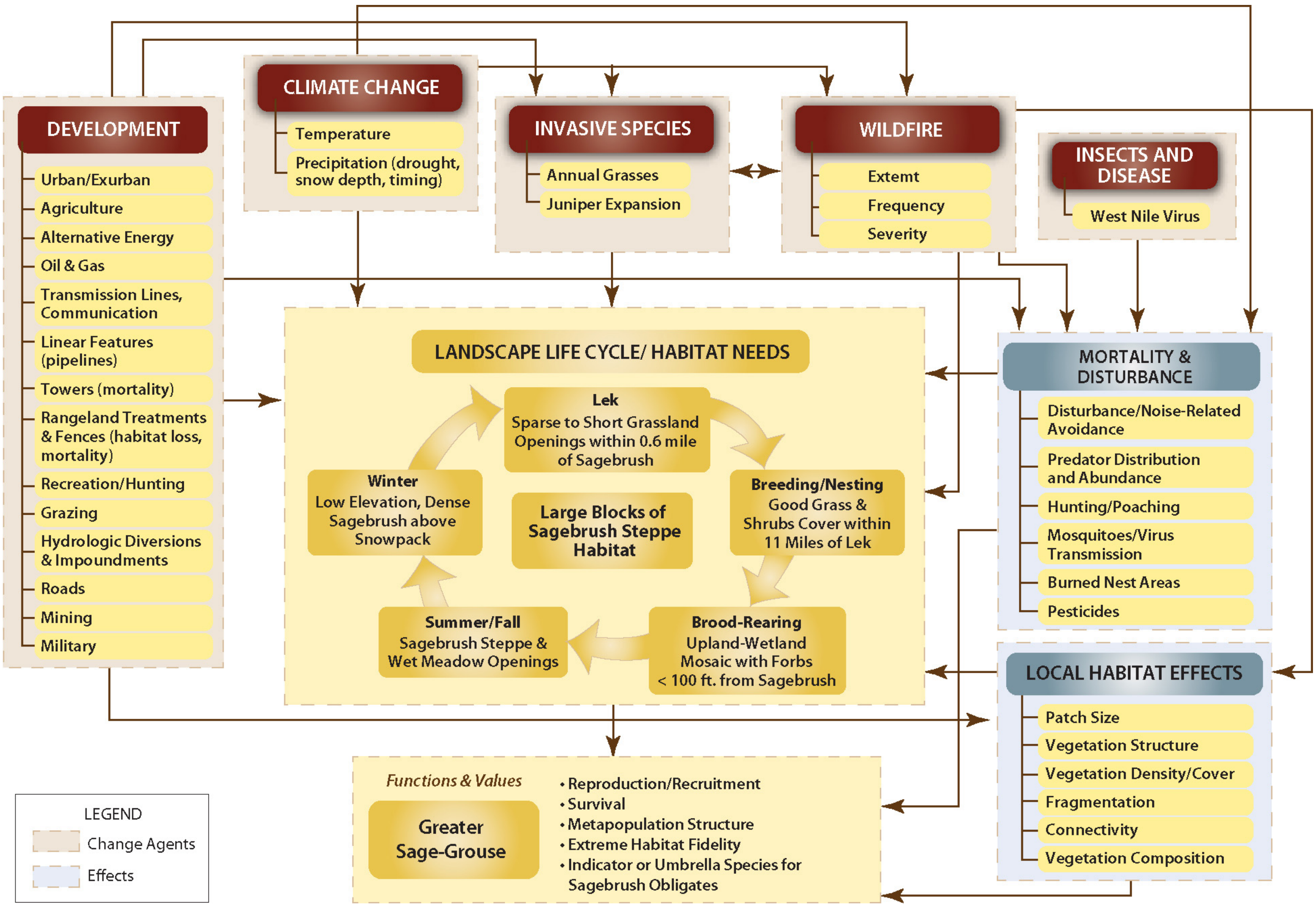



Figure 4.1-1. Greater Sage-grouse System Model

At the landscape scale, greater sage-grouse require large, interconnected expanses of sagebrush ecosystems, with varying density and height of sagebrush cover, age, and moisture regimes (Doherty *et al.* 2008). Sagebrush steppe vegetation types vary in resilience to disturbance depending on the species or subspecies and site characteristics but sagebrush systems as a whole are generally not considered resilient to frequent and large-scale disturbance (Davies *et al.* 2009). Resprouting species of sagebrush have the ability to recover rapidly from disturbance if root crowns remain intact and certain types on productive sites (e.g., mountain big sagebrush) have greater ability to recover from disturbance than species or subspecies growing on less productive sites (e.g., Wyoming big sagebrush). Many semiarid systems are characterized by alternate stable states (vegetation conditions) resulting from different disturbance events, as described in greater detail in the coarse filter vegetation models. Altering a native disturbance regime (e.g., fire frequency or grazing intensity) may drive a sagebrush community across a threshold to an alternate stable state (e.g., woodland). Because these details of transitions between sagebrush vegetation states are presented in a later section, they are not repeated in the greater sage-grouse model. However, the greater sage-grouse system model does indicate the relationships between the change agents that act upon the species' habitat needs.

## 4.2 Ecological Attributes and Indicators and Metrics

The next step in the process of modeling threats to the conservation elements was to extract the key ecological attributes of the systems that can be measured or categorized and spatially represented. A detailed explanation of specific key ecological attributes for each of the conservation elements is included in the data packages (Appendix B). "A key ecological attribute of a focal ecological resource is a characteristic of the resource's biology, ecology, or physical environment that is so critical to the resource's persistence, in the face of both natural and human-caused disturbance, that its alteration beyond some critical range of variation will lead to the degradation or loss of the resource…." (Unnasch *et al.* 2009). For some species, the key ecological attributes are well known from historical and recent research. For others, key ecological attributes may depend on the geographic location of the conservation elements. In general, however, key ecological attributes of a resource include "critical biological and ecological processes and characteristics of the environment that : (a) limit the regional or local spatial distribution of the resource; (b) exert pivotal causal influence on other characteristics; (c) drive temporal variation in the resource's structure, composition, and distribution; (d) contribute significantly to the ability of the resource to resist change in the face of environmental disturbances or to recover following a disturbance; or (e) determine the sensitivity of the resource to human impacts" (Unnasch 2009).

In this section, we describe their use in formulating data inputs into GIS process models. Unnasch *et al.* (2009) recommended that three factors be considered when selecting attributes:

- "**Size** refers to attributes related to the numerical size and/or geographic extent of the focal ecological resource" (conservation element in this REA). An example would be the area within which a particular ecological system occurs."
- "**Condition** refers to attributes related to biological composition, reproduction and health, and succession; critical ecological processes affecting biological structure, composition and interactions; and physical environmental features within the geographic scope of the focal ecological resource". Examples include species composition and variation, patch and succession dynamics in ecological systems, and disturbance regimes."
- "**Landscape Context** refers to both the spatial structure (spatial patterning and connectivity) of the landscape…and to critical processes and environmental features that affect the focal ecological resource from beyond its immediate geographic scope. Examples of the former include attributes of fragmentation, patchiness, and proximity or connectivity among habitats. Examples of the latter include…regional or larger-scale disturbances."

## 4.3 Data Classification

The purpose of the data quality evaluation was to ensure that the acquired data met or exceeded the criteria outlined in the 2008 U.S. Department of the Interior Data Quality Management Guide (DOI 2008) and that it was appropriate to use in the modeling that was completed for this REA. Each dataset and its associated metadata was evaluated and verified for quality and usability against the 11 BLM criteria identified from the 2008 data management guide. The data quality evaluation was provided to the BLM National Operations Center with the final data transmittal of spatial data, metadata, GIS process models, MXDs, map data tracking forms, and delivered data tracking forms.

## 4.4 Geospatial Data Sources

Geospatial data were acquired from various federal agencies, state agencies and universities. A detailed list of data used for each change agent and conservation element analysis can be viewed within data package.

# 5. Geospatial Modeling Methods and Tools

GIS and decision support modeling provide important analytical tools for land-use planning and decision making. The method adopted for this REA as the decision support model analysis is called multi-criteria evaluation. The use of GIS and multi-criteria evaluation applications allows the integration of a variety of geographic datasets to produce an output map for a specific purpose. Multi-criteria evaluation analysis and GIS have been successfully applied in various ecological resource planning and management efforts. While the resulting maps are site specific, the approach and procedures are applicable throughout the ecoregion. The overall goal of the multi-criteria evaluation approach was to provide a product that can be easily used by BLM staff without a steep learning curve to provide a methodology that is easy to duplicate without having to learn new software with overall low cost, and with the flexibility needed to incorporate other analysis tools if needed.

## 5.1 ArcGIS

The geospatial analysis was completed using Environmental Systems Research Inst. Inc. (ESRI) ArcGIS Version 10.0 as the primary tool for spatial analysis. ArcGIS is a GIS that integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. The ArcGIS Spatial Analyst extension provides a range of tools and capabilities for performing spatial modeling and analysis of rasters intended for the MCE modeling approach needed to perform this REA.

## 5.2 Decision Support Tools

A GIS-based multi-criteria evaluation model incorporated within the Decision Support System module of ArcGIS was selected because this approach has been well documented in land use planning, landscape ecosystem analysis, and regional and urban planning. Multi-criteria evaluation is a method that utilizes decision-making rules to combine the information from several criteria in the form of GIS layers. Multiple geospatial layers are aggregated to produce a single index or map that shows the appropriateness of the land for a particular purpose or activity (Voogd 1983; Carver 1991; López-Marrero, *et al.* 2011). The multi-criteria evaluation approach was easily implemented with the ArcGIS platform using ModelBuilder. Each criterion can be controlled using a weighted sum analysis in order to arrive at a final analysis map. Input from knowledgeable BLM biologists and managers in selecting and prioritizing the criteria to be used in the analysis helps to ensure that key concerns are addressed in the REA. The final procedure to generate the map is to run the multi-criteria evaluation module in the ArcGIS software.

## 5.3 Geospatial Process Models

The purpose of the GIS process model is to detail the approach being recommended to take existing data and alter it to match the needs to the REA. The modeled process can be as simple as clipping an existing spatial layer to an ecoregion or as complex as using an inductive model such as Maxent (Phillips *et al.* 2006) which defines the extent of suitable habitat based on species occurrence data. Certain species that may not have region-wide datasets benefit from modeling approaches such as Maxent to create a modeled suitable habitat across the ecoregion. Maxent is a presence-only data model using species observation and a series of environmental layers to try to predict the species suitable habitat. Occurrence data was provided from state's Natural Heritage Programs or Fish and Wildlife agencies to populate the models. Since many of the conservation elements are modeled using existing established datasets such as Western Association of Fish and Wildlife Agencies for bighorn sheep or mule deer, simple GIS process models are used to document the altering of the spatial layers for the REA.

Every conservation element has a GIS process model to document how each spatial layer was created. This serves two purposes: first, it is a transparent way to show all of the processes that were used to derive the final layer; and secondly, it provides a way to quickly repeat the process if a data layer is updated or the process needs to be altered. GIS process models are created and delivered using ESRI's

ModelBuilder. This module of ArcGIS allows users to graphically depict the workflow of their analysis and save the workflow in individual models within toolboxes that are sharable with other users. This information was used by the BLM National Operation Center's GIS team to quality assurance/quality control (QA/QC) the data layers being used in the REA.

An example of the GIS process model for greater sage-grouse can be viewed in Figure 5.3-1. Oregon, California, Idaho and Utah all provided their Preliminary Priority Habitat data in shapefile format. The Preliminary Priority Habitat data was then extracted from the shapefiles (some states included other habitats such as Preliminary General Habitat in the same layer) based on the attributes and the data was projected to the REA common project (Albers NAD 1983) and clipped (limited in spatial extent) to the ecoregion. Nevada's Preliminary Priority Habitat data was provided as a raster (grid of cells) therefore it was converted to polygons and Preliminary Priority Habitat was extracted by attributes. Once the data was clipped and projected, it was merged to form one dataset, dissolved (to remove coincident boundaries such as state lines) and converted back to a raster for use in modeling key ecological attributes and change agents threat analysis.

## 5.4 Conservation Element Specific Modeling Tools

### 5.4.1 Maxent Distribution Modeling

Maxent modeling consists of using presence-only species occurrence data and a series of environmental raster layers (Soil, Temperature, Elevation, etc) to try to determine suitable habitat. During a model run, the species occurrence data is compared to the individual values within the environmental raster layers to evaluate the commonality among observations (training the model). Once these commonalities are established it can expand beyond locations of occurrences to find suitable locations based on the commonalities between data. The Maxent output is a value between 0-1; with the higher the number the higher, the habitat suitability. Maxent also allows for testing the model to validate the accuracy of the predictions based on occurrence data and also provides various validation measures. Figure 5.4-1 shows an example of the process of creating a modeled suitable habitat using Maxent for Columbia spotted frog. Since Maxent is a standalone tool, GIS process models were used to extract, project and format the data into required formats for the model inputs. Maxent was used to create potential suitable habitat for golden eagle and Columbia spotted frog.

### 5.4.2 Non-Maxent Distribution Modeling

An example of a non-Maxent distribution model would be the model developed for pygmy rabbit. The modeling for pygmy rabbit was based on a model created by Rachlow and Svancara (2003). Their model focused on key requirements they identified for pygmy rabbit such as depth of soil, presence of sagebrush, recent fire activity, etc. These factors were combined and overlaid to isolate suitable habitat where all these factors overlap which was considered potentially suitable habitat for pygmy rabbit.

## 5.5 Change Agent Specific Modeling Tools

### 5.5.1 Development

Most development datasets required limited manipulation. One area where modeling occurred was in the determination of locations of possible off-highway vehicle use close to urban areas. For this model, urban areas and roads within 100 miles of the ecoregion were extracted. The 100 miles was an estimate on the length of time it would take to travel into the ecoregion from outside the ecoregion. Studies by the Idaho State Lands found that two hours was a suitable one way travel threshold for a 'day trip.' Using urban areas over 20,000 in population and the road network speed limit as an attribute, areas that were within two hours were calculate using a cost distance spatial operation. The results of this analysis can be viewed in the development change agent package.

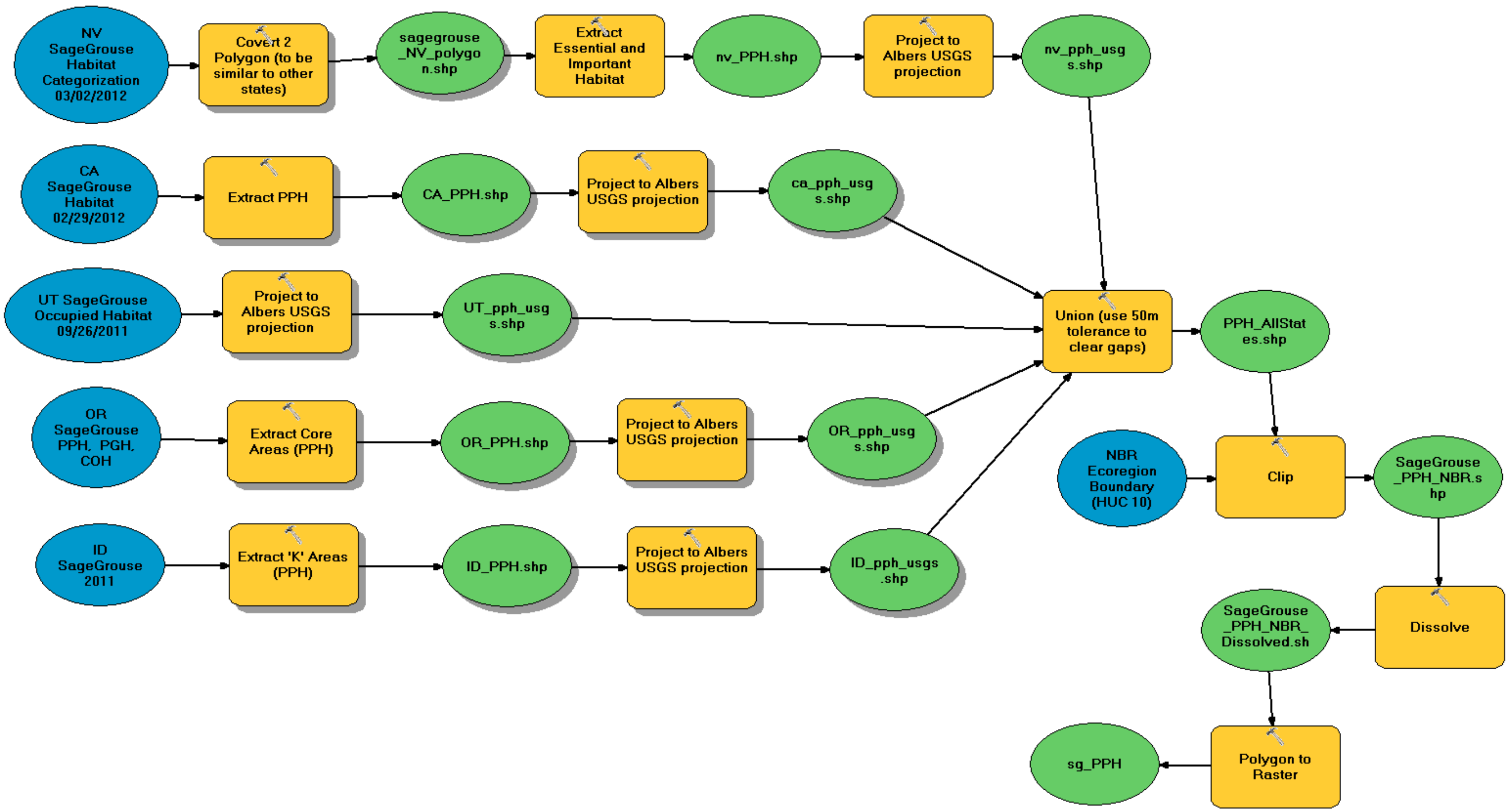



Figure 5.3-1. Example GIS Process Model for Merging State Greater Sage-grouse Preliminary Priority Habitat Layers

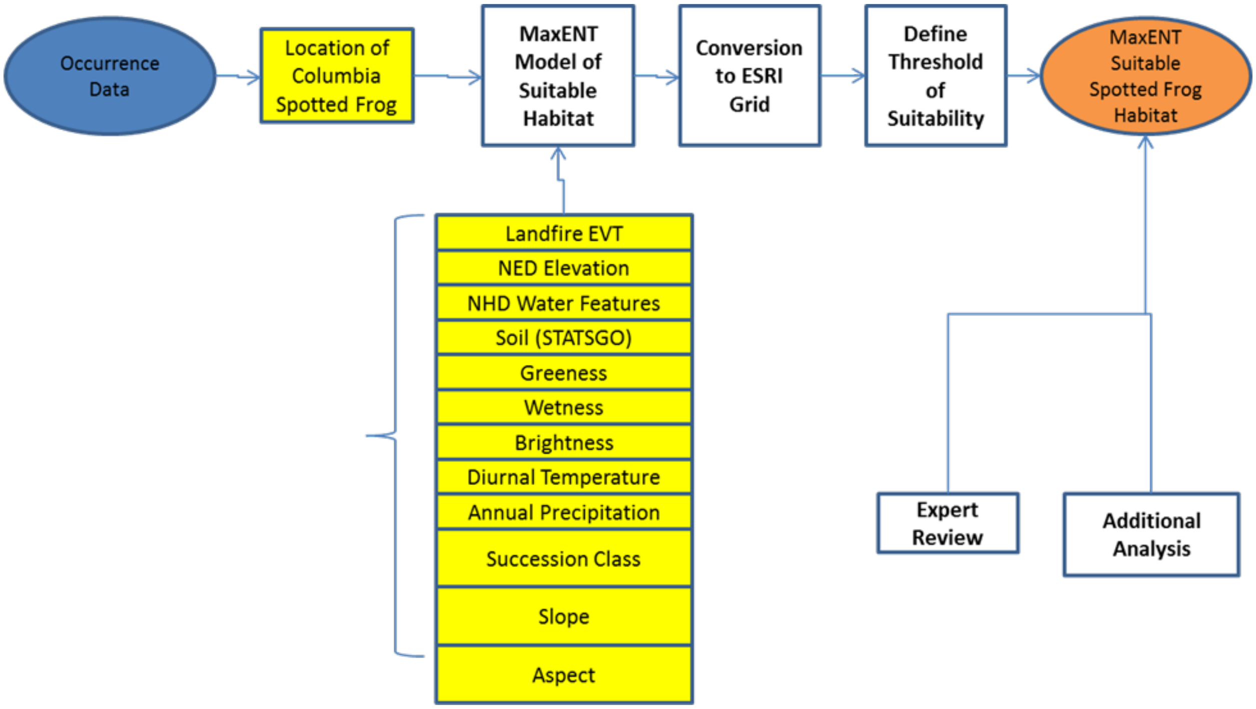



Figure 5.4-1. Example Process Flow for Running MaxENT Model

### 5.5.2 Wildfire

One of the management questions for wildfire dealt with the size and frequency of wildfires. The question was answered by using geospatial process to take fire perimeters from 1990 – 2012 and determining the frequency of overlapping perimeters. The resulting figures (in the wildfire change agent package) depicted where wildfires have occurred and how often areas have burned during that timeframe.

### 5.5.3 Invasive Species Model

Cheatgrass was the main invasive modeled within this REA. The analysis consisted mostly of a review of available data and coverage of the ecoregion for various cheatgrass mapping exercises. A detailed listing of data sources and coverage of the ecoregion can be found in the invasive change agent package.

### 5.5.4 Insect Outbreak and Disease

The main data source for insect outbreak and disease was the USFS aerial disease surveys. These datasets were used to extract locations of sudden aspen decline and various conifer pests and diseases (pine bark beetle). The data was extracted and used in spatial operations to determine the distance from healthy stands to infected stands.

### 5.5.5 Climate Change Model

Climate was modeled using the USGS (Hostetler RegCM3) datasets. Four variables were selected for their importance for understanding climate in the ecoregion: temperature, precipitation, convective precipitation and snow water equivalent. These four variables were analyzed using seasonal bins to allow focus on key seasons and months within the ecoregion. The monthly bins for temperature and precipitation were: November – February, March – May, June, July – August and September – October. Convective precipitation was only examined for July and August and snow water equivalent was only measure for the months of March and April. A more detailed description of the methods and findings can be found in the climate change agent package.

# 6. Ecoregional Findings

## 6.1 Change Agents

This section provides brief summaries for each of the change agents and conservation elements based on the data packages developed as part of the REA process. These summaries are meant to be brief but give the reader the basic information. Key aspects of the analysis are highlighted in the section. **The full data packages and analysis are included in Appendix B.** Appendix B includes conceptual models, data utilized for this effort, all map outputs, presentation of findings, and management questions.

### 6.1.1 Development
Change Agent

Human development affects conservation elements by changing the total habitat area (habitat loss) and the suitability of available habitat (habitat degradation) for the conservation elements. Effects to individuals and populations (behavioral disturbance and direct mortality) may also result. Development for this ecoregion is divided into these broad categories: (1) Energy Development and Mining; (2) Urban, Exurban and Rural Development and Recreation; (3) Agriculture; (4) Hydrologic Uses; (5) Military and other Federal Land Management; and, (6) Rangeland Treatments.

#### Current Status

Agricultural development covers nine percent of the region and dominates the landscape in the Snake River Plain in Idaho and in the basins between the ranges extending down into Utah. Urban development only covers one percent of the ecoregion and is mainly focused within the Snake River Plain (Figure 6.1-1). The remaining portion of the ecoregion is mostly BLM and the USFWS-administered rangeland and specially designated areas. Within the grazing allotments various land treatments have occurred ranging from erosion control to treatments following wildfires (Figure 6.1-2).

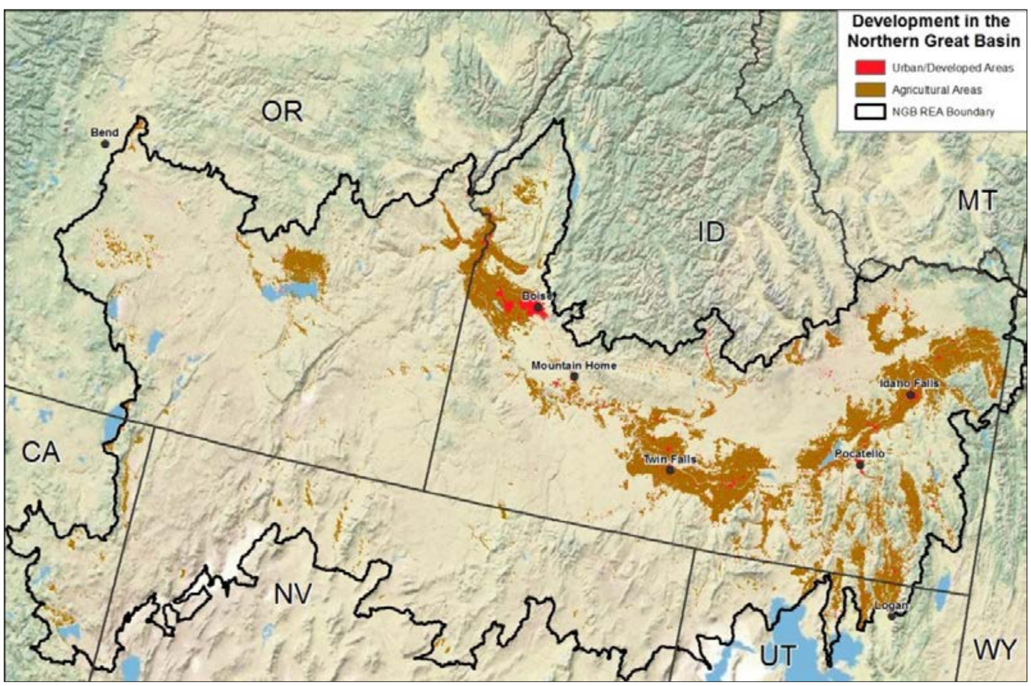



Figure 6.1-1. Agricultural and Urban/Developed Areas within the Northern Great Basin. Combined Agricultural and Urban Development within the Ecoregion Represents 10 Percent of the Total Area

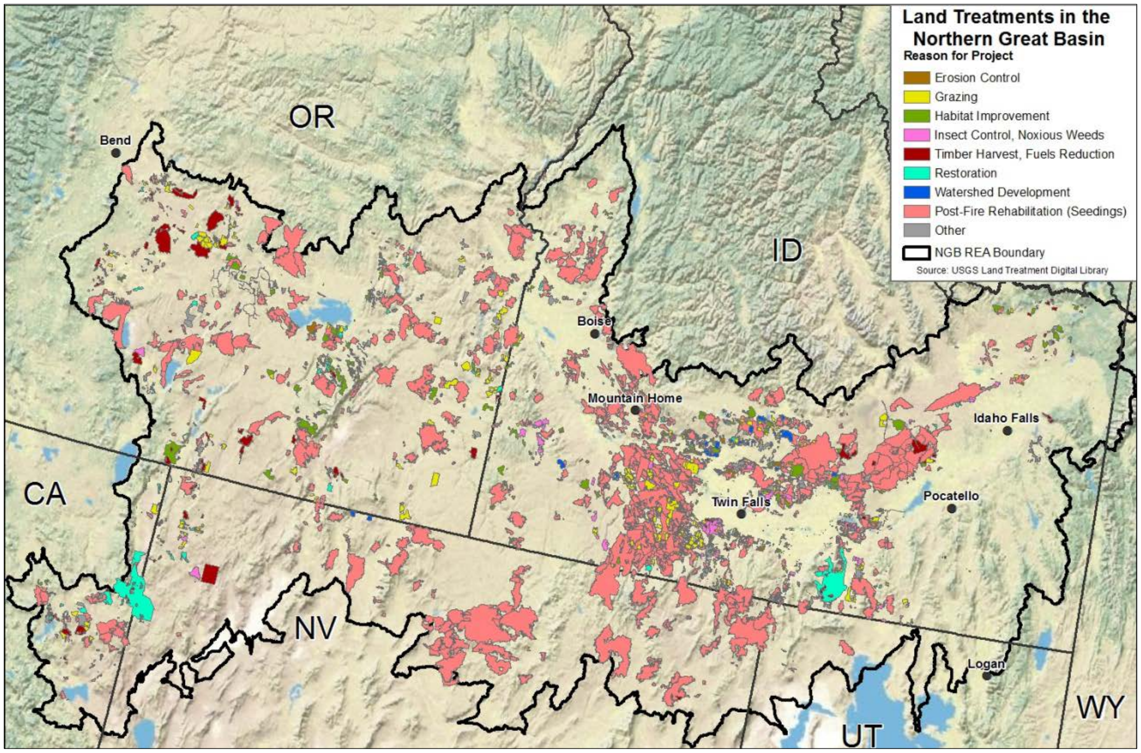



Figure 6.1-2. Land Treatments from the Land Treatment Digital Library (USGS)

Industry interest in developing renewable energy projects on federal lands is expected to increase as wind development on private land is completed and demand for land with good wind potential grows. Figure 6.1-3 shows locations of renewable energy within the ecoregion. The majority of existing and proposed renewable energy facilities are wind energy.

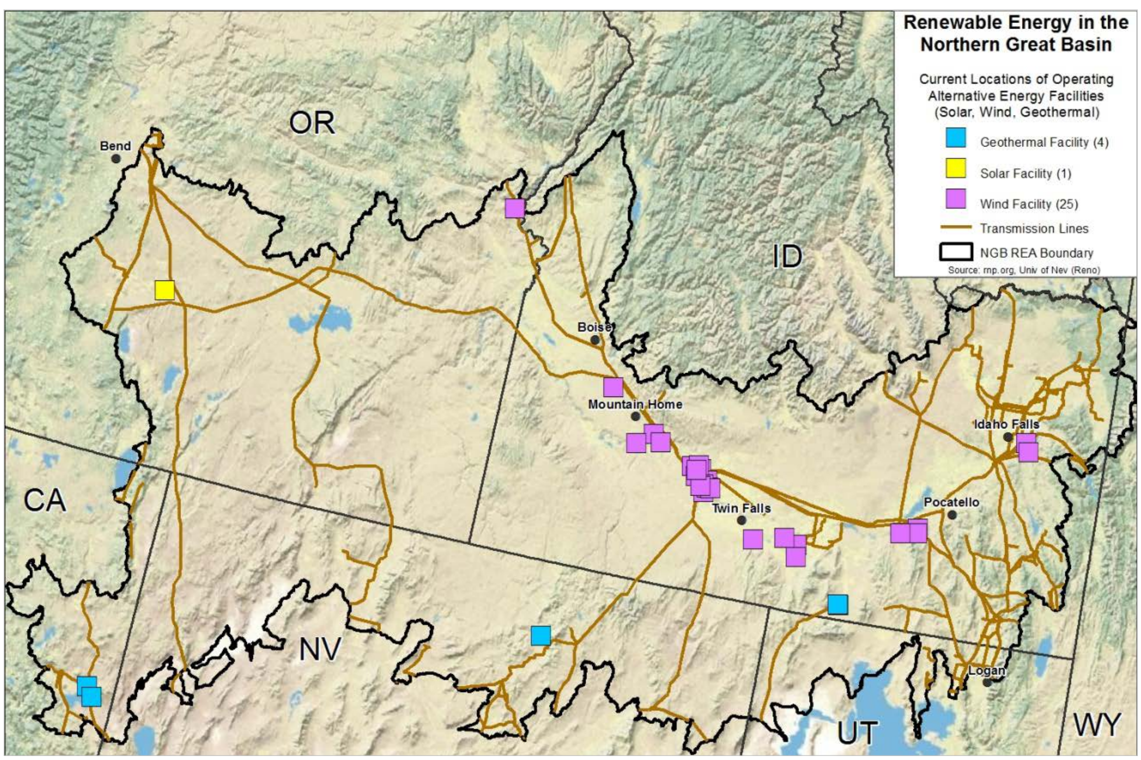



Figure 6.1-3. Renewable Energy: Current Locations of Operating Solar, Wind, and Geothermal Facilities in the NGB

Identifying planned or potential development is difficult for an entire ecoregion as most planning is conducted at a municipal or county level. Figure 6.1-4 shows the predicted housing density change by 2060 using the Integrated Climate and Land Use Scenarios baseline scenario. The majority of the change in housing density will be the conversion of rural to exurban (parcels of land greater than 40 acres converted into parcels 2.5 – 40 acres). Boise, ID and its surrounding cities (Caldwell, Meridian, and Nampa) will be the most affected part of the ecoregion for this housing density change and population growth. Two other areas identified would be the area around Idaho Falls along with the area north of Logan, UT. Many of the counties of the ecoregion are predicted to have negative population growth while large urban centers like Boise, ID will increase in population.

For the purposes of this summary, four examples of the management question are presented above. Over 20 different map products were developed in response to management questions. The data available and additional analyses are provided in Appendix B.

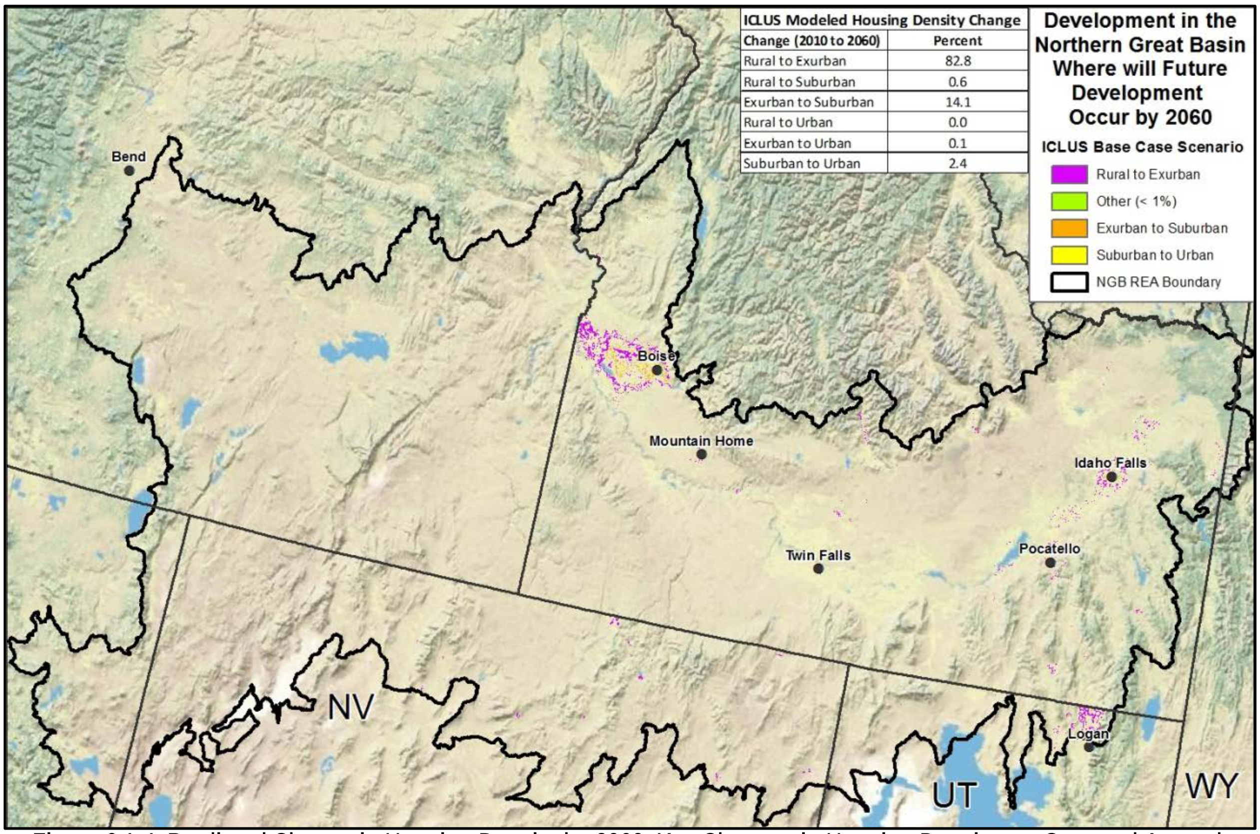



Figure 6.1-4. Predicted Change in Housing Density by 2060. Key Changes in Housing Density are Centered Around Boise, Idaho Falls, and Logan. The Primary Change Type is from Rural to Exurban.

### Interactions with other Change Agents

Increasing population growth in the ecoregion will likely lead to more recreational use on BLM lands in the NGB. This may increase the possibility of ignition sources for wildfires and facilitate the spread of invasive species by transport on clothing and vehicles. In addition, grazing allotments may compete for use between livestock and wild horse and burro, rangeland treatments and recreation access. Increasing population will also increase the water use within the ecoregion. More information on ground and surface water use can be found in the coarse filter section.

## 6.1.2 Wildfire
Change Agent

Wildfire is a key ecological process in western ecosystems that influences virtually all other ecosystem processes, such as landscape patterns and species diversity, nutrient cycling, hydrology and erosion, air quality, plant ecology, and the maintenance of wildlife habitats and biodiversity.

Human-influences in the NGB ecoregion have affected fire frequency, severity, and seasonality, including new ignition sources associated with development, rangeland management, fire suppression, and introduction of invasive plant species. Fire is also strongly influenced by weather and climate. Climate change/fire interactions include increased area burned, variability and frequency of extreme fire weather, and length of fire seasons (Wotton and Flannigan 1993; Flannigan and Wotton 2001; Flannigan *et al.* 2005).

Sagebrush communities are vulnerable to being replaced by cheatgrass, especially under conditions of higher fire frequency (Figure 6.1-5), ultimately resulting in a flashy annual grassland community maintained by fire. The presence of invasive species such as cheatgrass in arid lands has made fire more problematic in vegetation that historically experienced only occasional to periodic burning and whose dominant species lack adequate regeneration mechanisms such as resprouting, having fire-resistant seeds with fire stimulated germination, and/or having seed dispersal mechanisms consistent with rapidly recolonizing large burned areas.

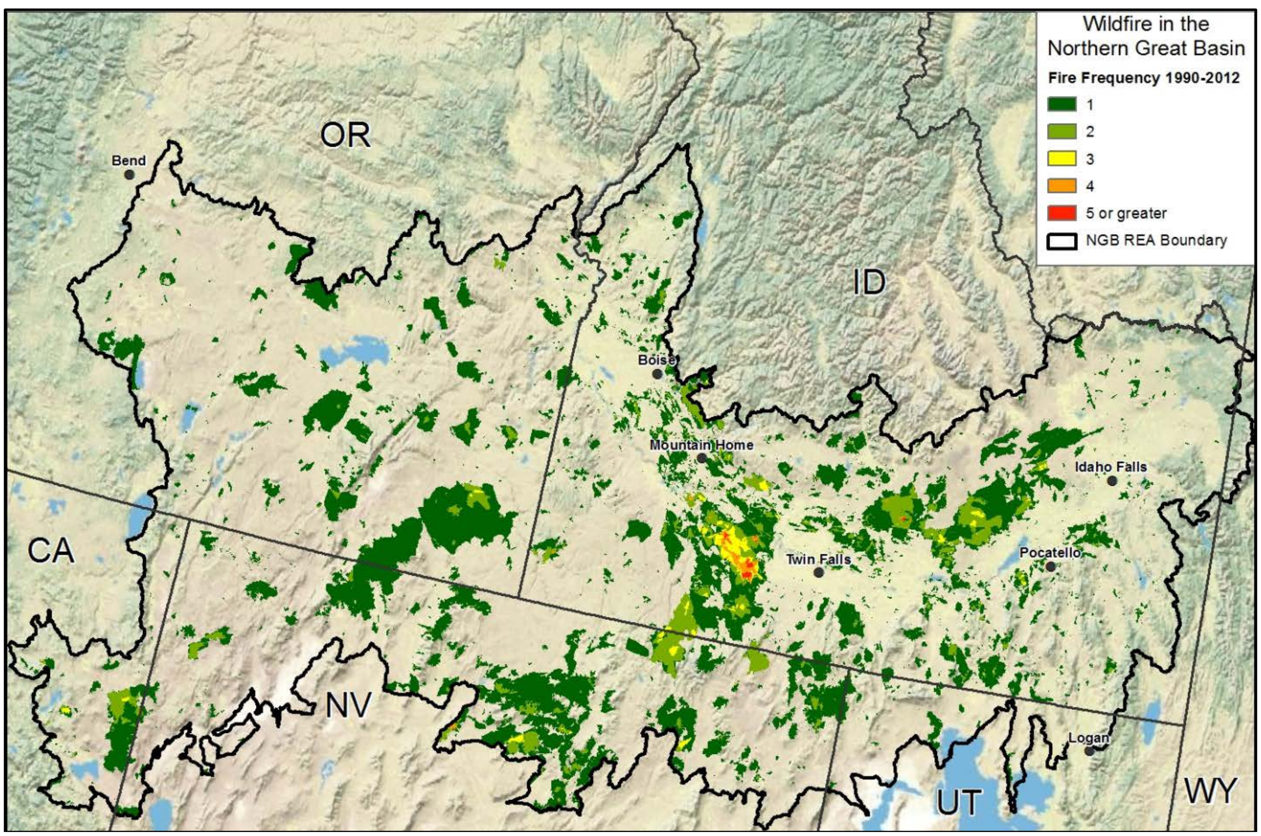



Figure 6.1-5. Fire Frequency 1990 – 2012 in the Northern Great Basin (GeoMAC [2000-2012], Sagemaps Western Fires)

Burn Probability was modeled by the USGS and USFS using their FSIM model (Figure 6.1-6). The results of the nation-wide FSIM burn probability were rebalanced so that there were three equal classes (low, moderate, and high) for the Northern Great Basin. This rebalancing was done to highlight burn probabilities within the ecoregion rather than compare the burn probability to surrounding ecoregions that may have generally lower burn probabilities. Unburnable areas are usually playa lakes, salt desert shrub basins (unless cheatgrass or annual grasses are present) or agricultural areas.

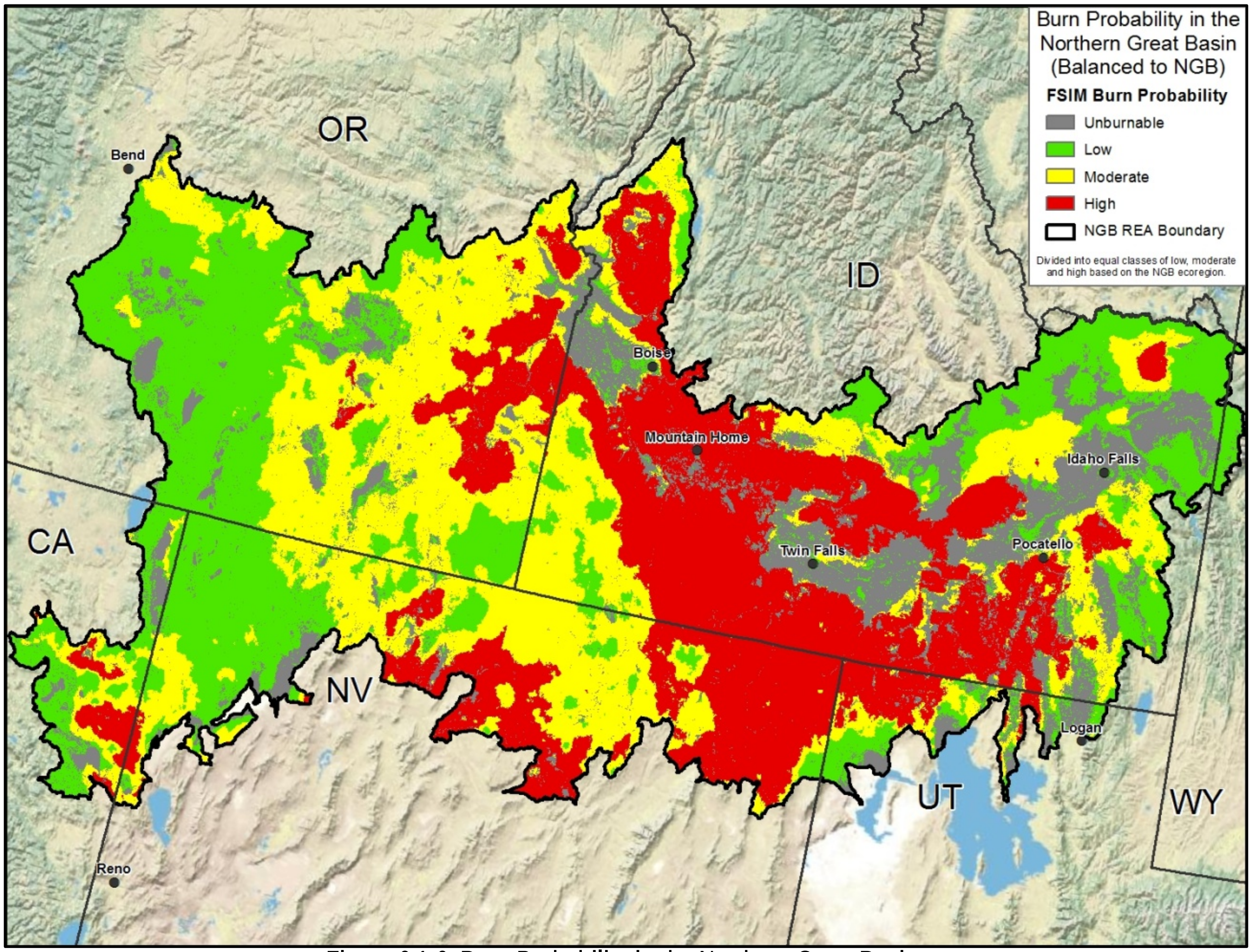



Figure 6.1-6. Burn Probability in the Northern Great Basin

## Interactions with Other Change Agents

Climate change and invasive species may affect the frequency and severity of wildfires in the ecoregion. Climate models predict increasing temperatures, increasing convective precipitation (lightning potential) and decreasing overall precipitation during the fire season that could increase the frequency and intensity of fires. In more or less intact sagebrush steppe communities, warmer, drier conditions are likely to lead to less fuel as a consequence of reduced productivity, thus reducing fire occurrence. Where there has been replacement of native vegetation by invasive annual grasses, such as cheatgrass, fire frequency can increase even under low fuel loadings because the annual grasses provide a more or less continuous fuelbed between shrubs. Invasives such as cheatgrass can increase the burn probability and decrease the fire return interval by rapidly recolonizing recently burned areas.

Increasing population growth and conversion of agricultural land to exurban uses may reduce unburnable areas and increase the possibility of ignition sources through more people using the ecoregion's recreation amenities. Grazing has the dual role of both managing fuel loads while also altering the landscape and vegetation communities.

## 6.1.3 Invasive Species and Disease
Change Agent

Cheatgrass (*Bromus tectorum*) Invasion. Photo from USDA.

An invasive species is defined by the BLM as "Plants that are not part of (if exotic), or are a minor component of (if native), the original plant community or communities that have the potential to become a dominant or co-dominant species on the site if their future establishment and growth is not actively controlled by management interventions, or are classified as exotic or noxious plants under state or federal law. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants" (BLM 2008).

### Cheatgrass, Medusahead, and Other Invasive Grasses

Cheatgrass (*Bromus tectorum*), medusahead (*Taeniatherum caput-medusae*), ventenata (*Ventenata dubia*), and other annual invasive grasses are of particular concern in the NGB ecoregion due to the widespread changes that have occurred through invasion of these species into open areas created by fire and other disturbance in sagebrush ecosystems (National Invasive Species Council 2006). Cheatgrass outcompetes native perennial grasses under disturbance and profoundly influences fire regimes. Cheatgrass increases the continuity of fine-textured fuel which promotes larger and more frequent fires. Because the fire return interval is shortened, perennial vegetation is unable to completely recover before the next fire. Perennial vegetation is eventually reduced, resulting in dominance by cheatgrass or medusahead. Medusahead infestations, although less widespread than cheatgrass in this ecoregion, similarly outcompete native plant species, increase the risk of large, severe wildfire, and form monocultures. Figure 6.1-7 provides the 2010 cheatgrass mapping by the EROS/USGS study on cheatgrass mortality.

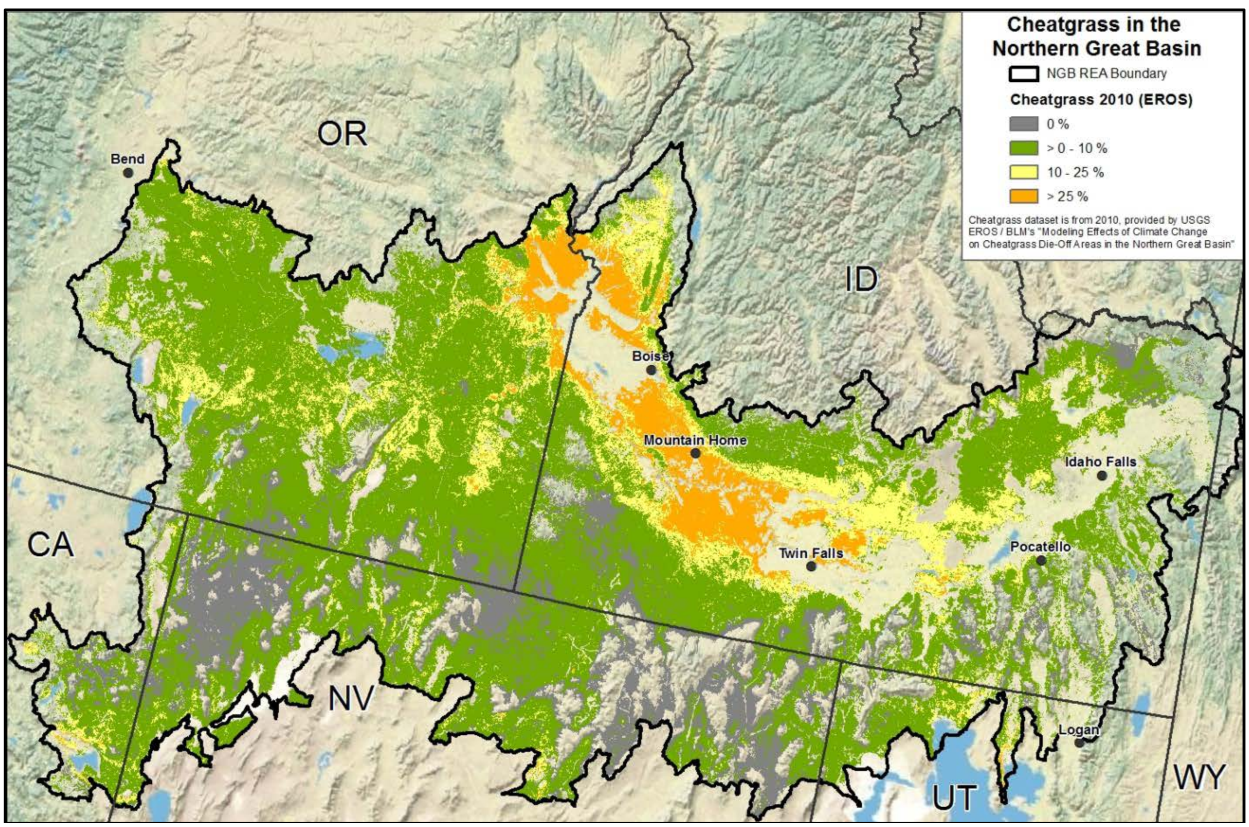



Figure 6.1-7. Existing Cheatgrass Cover from 2010 (EROS USGS 2012)

The cheatgrass habitat model results of Meinke *et al.* (2009) found that essentially all of the moderate to high vulnerable areas to cheatgrass invasion in Idaho are already dominated by cheatgrass[1]. However, there are substantial areas in northwestern Utah, Owyhee Upland, northwestern Nevada, and northeastern California, where the habitat is suitable for cheatgrass but was not yet dominated by cheatgrass at the time of the distribution mapping. Medusahead and ventenata are less widespread than cheatgrass but are also expanding their ranges

### Invasive Forbs

In general, exotic forbs establish in disturbed habitats and outcompete native plants, forming monocultures. Many are noxious to wildlife. Exotic forbs such as skeletonweed, knapweeds, and whitetop are common in the ecoregion. Biological controls have been introduced for some invasive forb species with varying success. Figure 6.1-8 provides a chart of the occurrences of exotic forbs in the ecoregion in the NISIMS (National Invasive Species Information Management System) database and Figure 6.1-9 shows a distribution map occurrences.

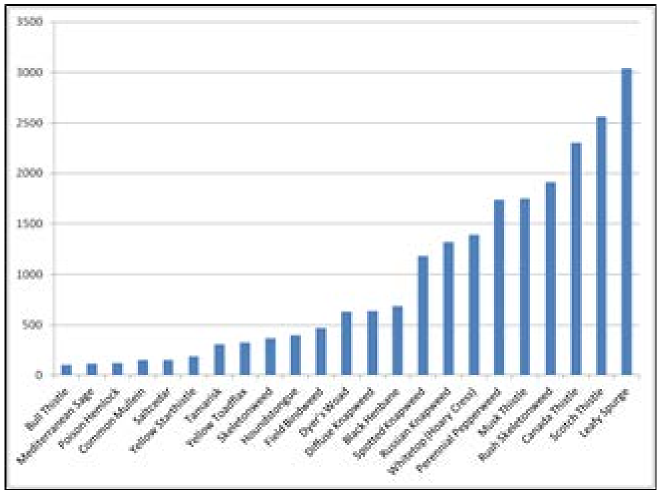



Figure 6.1-8. Invasive Species Occurrences in NGB Ecoregion within NISIMS (min. 100 occurrences)

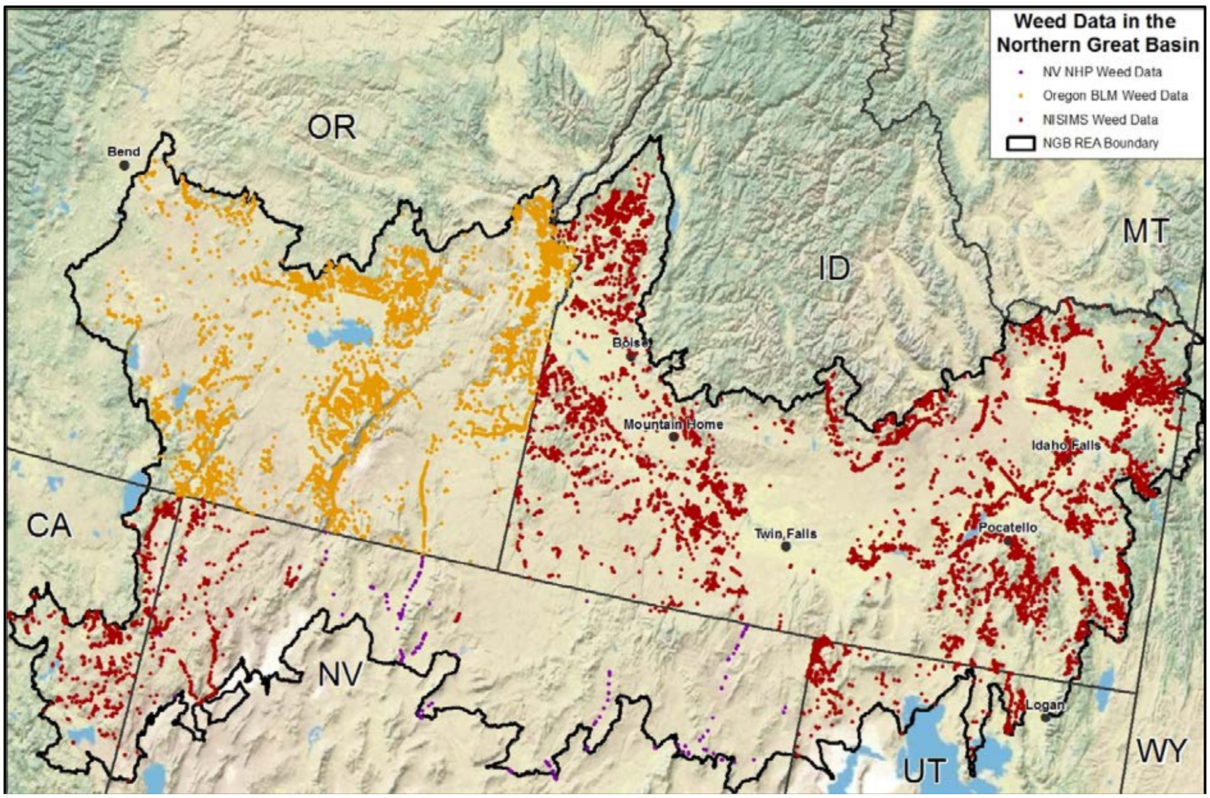



Figure 6.1-9. Invasive Species Occurrences in NGB Ecoregion from NISIMS, NNHP and BLM Oregon

1 The studies that generated the data ran habitat suitability models for cheatgrass over the landscape and that language was retained for consistency with their approaches. The terminology refers to the modeled ability of a habitat to accommodate the establishment of cheatgrass, independent of whether cheatgrass was already established.

### Invasive Woody Plants (Russian-olive, Tamarisk)

Saltcedar or tamarisk (*Tamarix* spp.) and Russian-olive (*Eleagnus angustifolia*) are invasive woody plants that establish in riparian habitats, often outcompeting native plants (Shafroth *et al.* 1995). Both species are present in the Great Basin, and Kerns *et al.* (2009) predicted that the range of tamarisk will expand within the NGB ecoregion in response to climate change.

### Aquatic Invasive Species

Many nonnative species have been introduced into North American waters which have changed the structures of native communities and caused extinction through hybridization, predation, and competition (Sada and Vinyard 2002). In the Great Basin region, introductions of non-native species and habitat modification have caused the extinction of 16 endemic species, subspecies, or other distinctive populations since the late 1800s (Sada and Vinyard 2002). High value native fish species and the spotted frog are threatened by introduced species (often game fish such as rainbow and brook trout) that compete with the native species for habitat and food sources, hybridize with native fish species, or become predators on native aquatic species. Other invasive species such as New Zealand mudsnails (*Potamopyrgus antipodarum*), quagga/zebra mussels (*Dreissena spp*), and Asian clams (*Corbicula fluminea*) adversely affect aquatic systems in various ways, encrusting substrates including the shells of native mussels, altering algae communities, producing waste, and dominating food webs (USGS 2012). A map of aquatic invasive species detections is shown in Figure 6.1-10.

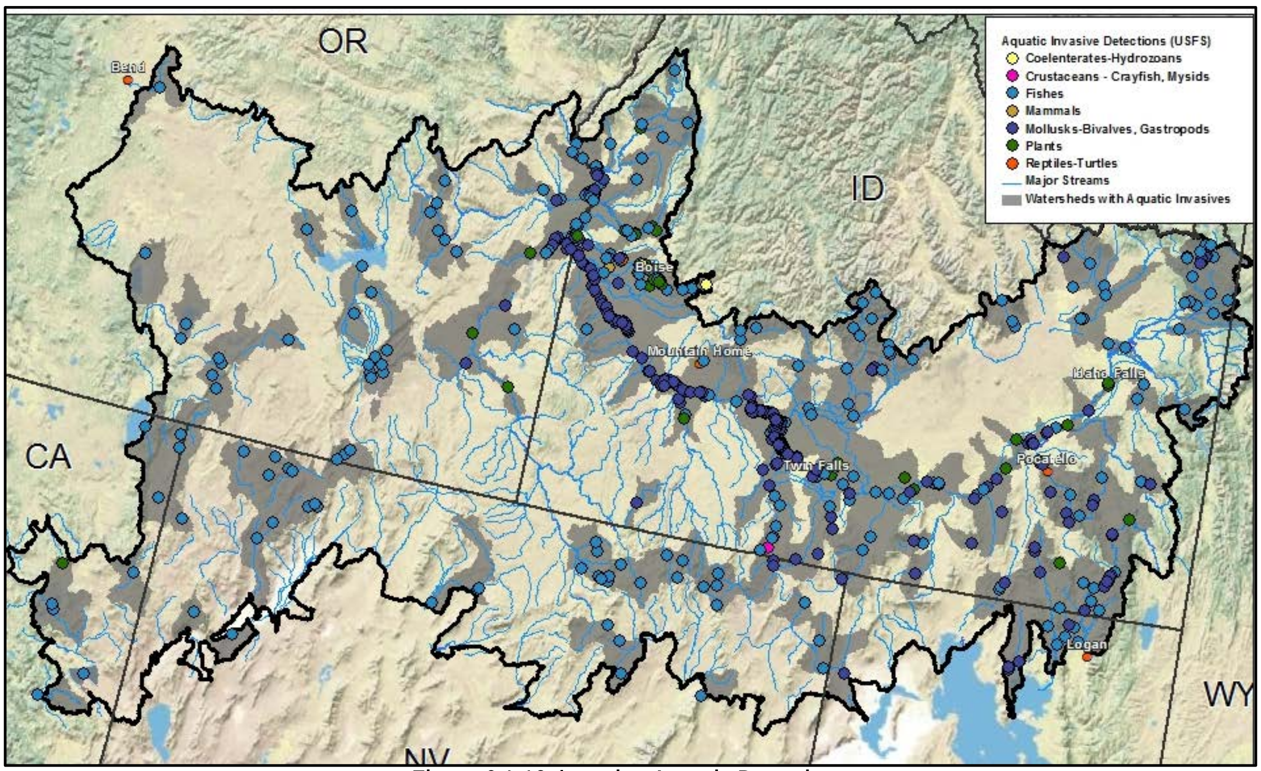



Figure 6.1-10. Invasive Aquatic Detections

### Insect Outbreaks

Concerns over insect outbreaks in the western states have focused on forested habitats, which may be of greater concern in adjacent ecoregions such as the Middle Rockies. However, higher elevations in the NGB have forest stands that are dominated by Douglas-fir and other conifers, and thus are vulnerable to outbreaks of bark beetles (*Dendroctonus* spp.), western spruce budworm (*Choristoneura occidentalis*) and other insects. Aroga moth, which defoliates sagebrush, had a multi-state outbreak in 2012 following more localized outbreaks since the mid-2000s. Periodic outbreaks of locusts and Mormon crickets affect

salt desert shrub communities. The frequency, scale, and effects of rangeland insect outbreaks are not well-known and have received comparatively little study compared to outbreaks in forested systems.

### Diseases

Diseases of plants and animals have become more prominent in recent years and are a threat to several conservation elements chosen for the ecoregion. West Nile virus is a source of mortality in greater sage-grouse in some parts of the country since its introduction in 1999, and has the greatest potential for population-level effects among all parasites and infectious diseases identified in greater sage-grouse (Christiansen and Tate 2011). Chytrid fungus and ranavirus are serious diseases affecting amphibians such as the Columbian spotted frog. White-nose syndrome, a fungal disease that is killing hibernating bats in eastern North America, may potentially spread into western states. Bacterial pneumonia causes severe respiratory disease and/or acute pneumonia in wild bighorn sheep populations and is a rising concern in Idaho, Nevada, Oregon and Utah because of the potential for transmission from domestic sheep. Not yet of serious concern in the ecoregion is chronic wasting disease, which affects mule deer and so far is concentrated in mid-western and northern Rockies states. Whirling disease is now present in Idaho and the significance of this and other diseases as change agents for native coldwater fishes is unknown at present but can be a serious problem in hatcheries.

Plant community conservation elements also have been affected by disease issues. In recent years, many aspen stands in other ecoregions have exhibited declines resulting from the effects of several change agents including climate change and mortality from biotic vectors. Pathogens primarily infect clones already stressed by factors such as drought, insects, wind damage, heavy livestock and wildlife use.

### Interactions with Other Change Agents

Climate change effects such as hotter and drier conditions may weaken trees making them more vulnerable to insect attack and disease. With respect to invasive weeds, climate envelope modeling indicates that cheatgrass habitat suitability would be reduced in the ecoregion if climate changes results in increased precipitation during the summer (June-September) (Bradley 2009). Based on the RegCM3 climate modeling predictions, June is projected to have a slight increase in precipitation and July and August is projected to have minimal change. It is not clear how changes in summer precipitation will impact cheat grass habitat suitability in the ecoregion.

The replacement of native vegetation with invasives such as cheatgrass and other annual grasses will also affect fire frequency. Invasives such as cheatgrass increase the burn probability and can be the first to recolonize recently burned areas. Disturbance from development often provides bare ground habitat that invasives can colonize and then outcompete native plants. Improperly managed grazing on rangelands heighten the rate of dispersal and greatly enhance the post-dispersal dominance of cheatgrass. Increasing atmospheric $CO_2$ can accelerate the growth of opportunistic plant species and may be a factor in expansion of invasive annual grasses and juniper in recent decades. Similarly, deposition of atmospheric nitrogen may promote the growth of weedy species that are able to respond to its availability more rapidly than slower growing native species.

## 6.1.4 Grazing
Change Agent

The AMT made the decision to include an analysis of livestock grazing in the NGB REA to recognize the historic and future importance of grazing as a Change Agent and land management tool in the western United States. The management of grazing is also a major responsibility of the BLM in the western U.S.

### Current Status

Livestock grazing can affect the vegetation community structure and composition, woody plant regeneration, riparian area health, nutrient cycling, fire fuel availability, wildlife forage amounts, soil stability and compaction, invasive species spread, and many other ecosystems aspects that relate to other change agents and conservation elements (Freilich *et al.* 2003; Holechek *et al.* 1982; Yeo 2005). Figure 6.1-11 shows the location of grazing allotments used for livestock for both BLM and the USFS.

The BLM has a long history of authorizing grazing and continues to monitor and collect data on the health of individual grazing allotments that each field office manages by tracking whether allotments meet standards and guidelines. Pursuant to BLM grazing regulations, livestock management on BLM allotments must be compatible with meeting the Fundamentals of Rangeland Health (FRH) and the Standards and Guidelines for Livestock Grazing Management (S&Gs), which provide for ecosystem functionality and wildlife habitat, and have been adopted by each BLM state within the ecoregion. BLM continues to monitor and assess rangeland health conditions, and is required to modify grazing management practices that are not in conformance with the FRH and/or S&Gs.

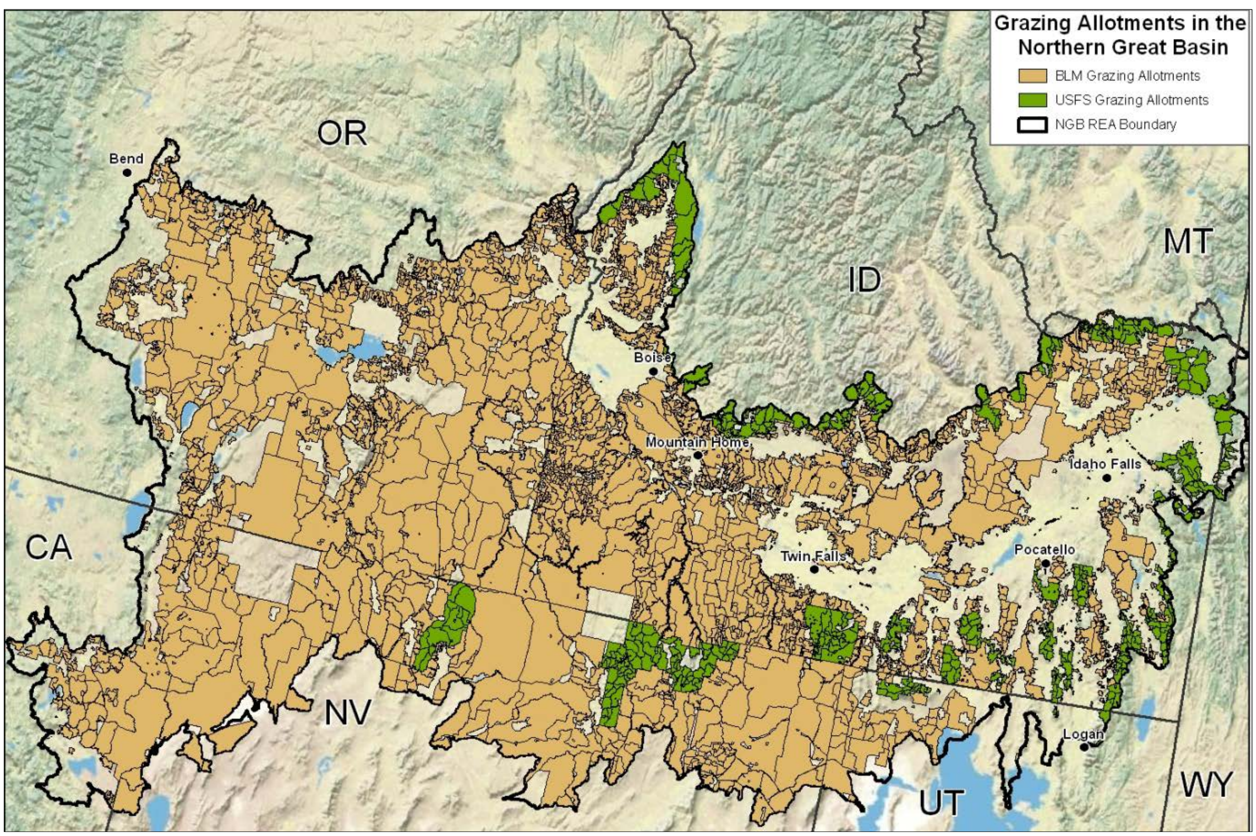



Figure 6.1-11. Location of Grazing Allotments in the Northern Great Basin

In addition, the USGS analyzed BLM range health assessments for grazing allotments to review the land health (Figure 6.1-12) of these allotments (USGS 2011). In addition, the USGS analyzed BLM range health assessments for grazing allotments (Figure 6.1-12) to review the land health of these allotments (USGS 2011). There was not a complete coverage of range health assessments across the NGB ecoregion and there also were differences between how states conduct or assess rangeland health. In addition, if one part of a grazing allotment did not meet the standard, the entire allotment was coded as not meeting standards, which over-estimates the amount of grazing land not meeting the standards. Once areas are identified that are not meeting standards or progressing towards meeting standards, BLM must make changes in livestock grazing management within one year.

These data can also be combined with mapping of sensitive/vulnerable habitat areas or future development projects to find areas of concern and in need of additional management actions (however, the USGS report would not be used at the local level to determine where livestock management changes need to occur). Areas more vulnerable to erosion and trampling by livestock, such as slopes, thin soils, wetland and riparian areas, and concentration areas (feedlots, loading areas) can also be identified geospatially. In a similar manner, areas identified as needing additional grass fuel removal can be pinpointed and scheduled for additional grazing intensities or longer seasons during the appropriate season to reduce the risk of carrying wildfire.

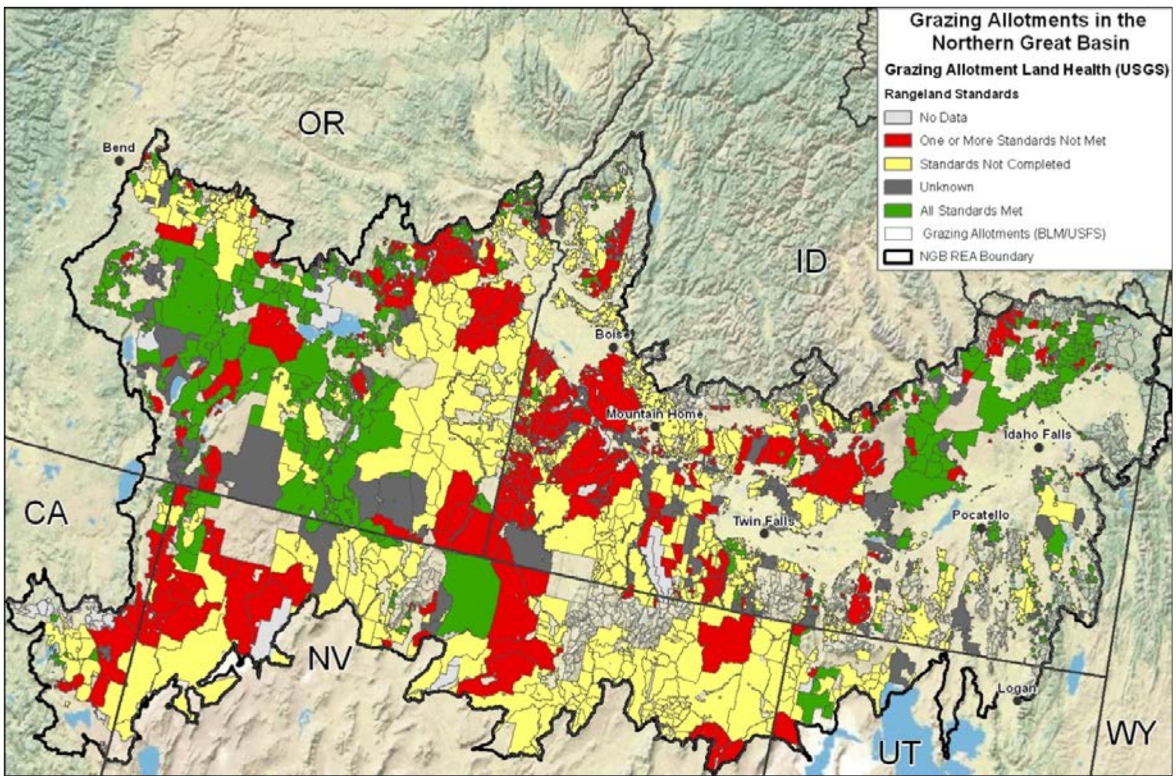
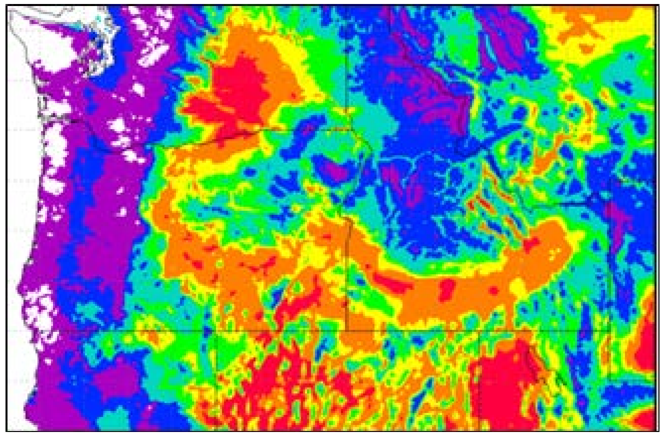



Figure 6.1-12. Land Health Standards for Grazing Allotments in the NGB (USGS)

## Interactions with Other Change Agents

Climate models predict an increase in winter and spring precipitation which could benefit cheatgrass dominated areas and a competitive advantage over cool season perennials. Available water for the grazing allotments near irrigated agricultural lands could be reduced as agriculture in the ecoregion relies more on groundwater pumping. Large wildfires such as those that occurred in 2012 could close grazing allotments to allow for vegetation recovery and/or reseeding of vegetation and temporarily reduce the number of grazing allotments available. Development plays a role in adding possible vectors for spreading invasives through recreation such as off-highway vehicle use along with the chance of ignition sources for wildfire which could result in closure for post fire rehabilitation.

## 6.1.5 Climate Change
Change Agent



Annual Precipitation from PRISM

Climate exerts a dominant control over the natural distribution of species, as well as range expansions and contractions: therefore it is expected that future climate change will have a significant impact on the distribution of species. Climate change may include changes in temperature averages and extremes, precipitation amounts, distribution, and seasonality, and frequency and duration of drought periods. Climate change is also likely to affect species and communities by affecting the frequency and distribution of fire and occurrences of invasive species, disease, and insect outbreaks. Although there is a view that climate change toward warmer-drier conditions would cause communities to move northward or to higher elevations, in actuality species will respond individually to climate change and new species associations may result. Human-caused barriers to movement may affect the ability of species or communities to move in response to changing conditions or lead some species to become genetically isolated.

### Current Climate

Most precipitation in the ecoregion occurs in winter and spring with orographic enhancements in the mountains. June is a transition to generally dry summer months. In July and August, the North American monsoon can locally enhance summer precipitation but those effects are most pronounced to the south of the ecoregion. Average temperatures are generally around freezing or below freezing in the winter, slightly above freezing in the valleys and slightly below freezing in the uplands in the spring, hot in the valleys and warm in the uplands in the summer, and cool in the fall.

### Future Climate

The analysis of future impacts due to climate change relied on 15 km pixel regional climate change model data by Hostetler *et al.* (2011) (RegCM3 data). The results compare the 1980 to 1999 baseline period with model predictions from the 2050 to 2069. The figures presented here are for the predicted change (predicted future climate value minus baseline climate value). Predictions for current and future climate were analyzed across five periods within a year: (1) March through May (transition period and spring); (2) June (important late spring precipitation); (3) July and August (hot season with convective storms); (4) September and October (transition period to winter, and; (5) November through February (winter snow precipitation season).

#### *Forecasted Temperature Changes*

The Hostetler model forecast predicts no overall change in annual temperature across the NGB ecoregion. However the model predicts some important seasonal changes in temperature. The areas from the Owyhee Uplands westward as well as the toe of the Boise Mountains are predicted to warm by about 1 degree C from November to February. The model forecast predicts a cooling of about -0.5 degree C during March to May period (Figure 6.1-13) while the average temperature in late summer (July and August) in basin and range topography across the ecoregion is modeled to warm by about 0.8 degree C. However, the average temperature in late summer in the middle and lower Snake River Plains and Owyhee Uplands is predicted to remain the same (Figure 6.1-14). Long-term (1962-2006) snow, climate, and streamflow measurements at the Reynolds Creek in the Owyhee Mountains, have documented increasing temperatures at all elevations with decreasing proportions of snow to rain at all elevations. As a result, streamflow has seasonally shifted to larger winter and early spring flows and reduced late spring and summer flows (Nayak *et al.* 2010).

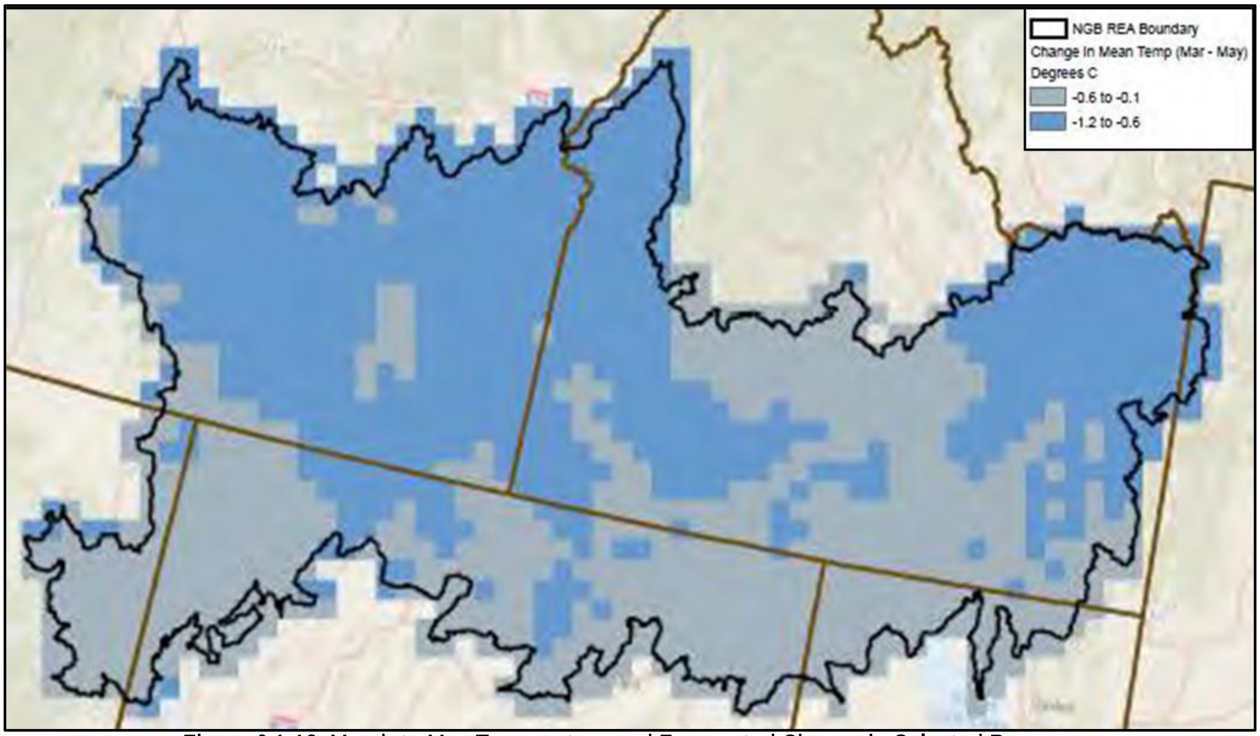


Figure 6.1-13. March to May Temperature and Forecasted Change in Selected Ranges

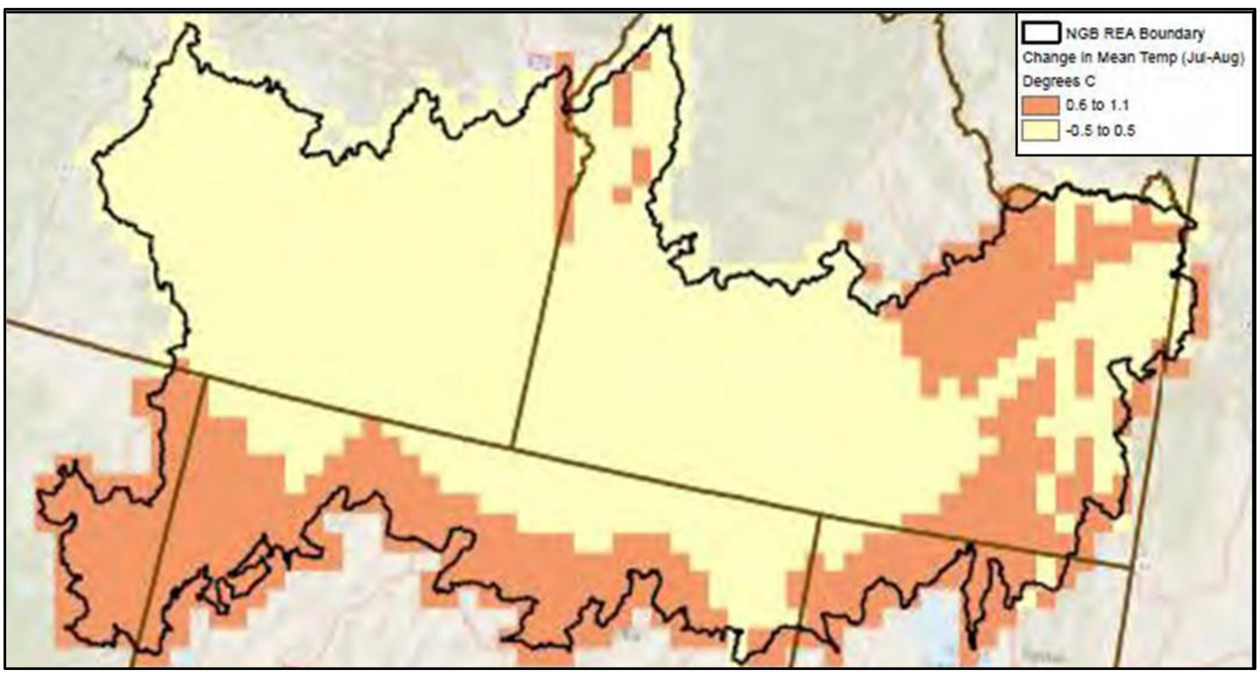


Figure 6.1-14. July and August Temperature and Forecasted Change in Selected Ranges

### *Forecasted Precipitation Changes*

Overall, the model predicts a slight increase in the average annual precipitation in the basins, valleys, and uplands and large increases in the mountains (Figure 6.1-15). However, the entire NGB ecoregion is expected to experience reduced precipitation in early fall (September and October) with isolated mountain ranges showing larger decreases (Figure 6.1-16). It should be noted that regional models used for the Northern Great Basin generally do not account for monsoonal circulation and it is possible that there would be an increase in summer precipitation.

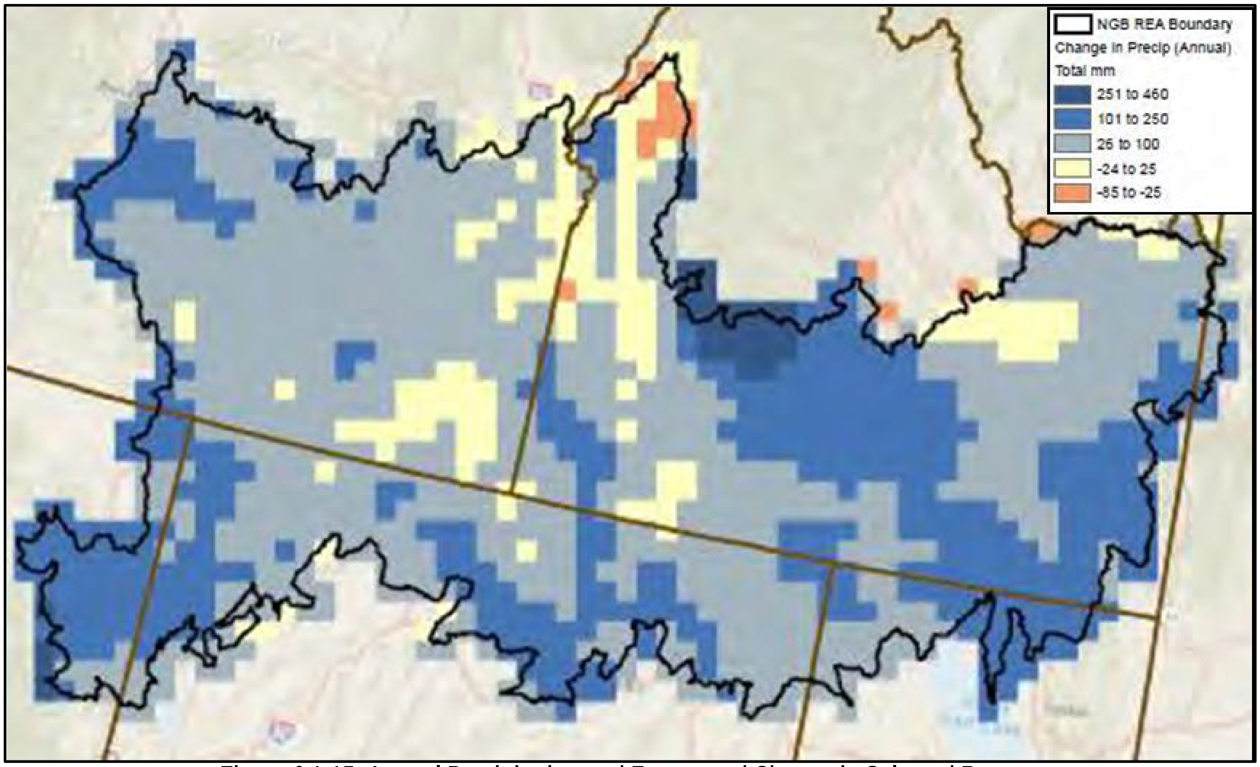



Figure 6.1-15. Annual Precipitation and Forecasted Change in Selected Ranges

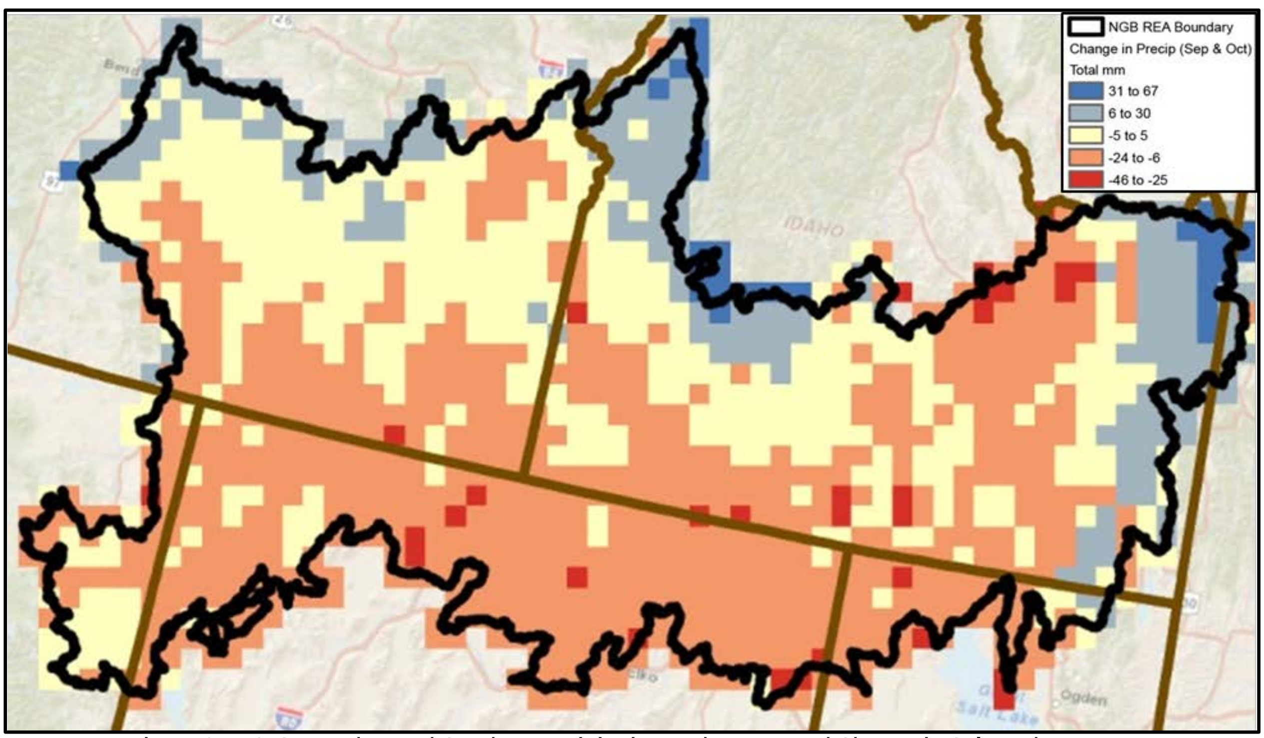



Figure 6.1-16. September and October Precipitation and Forecasted Change in Selected Ranges

### *Forecasted Changes in Convective Precipitation*

An area extending from the Blue Mountains to the middle Snake River Plains and another at the toe of the Middle Rockies are predicted to experience a slight increase in convective precipitation while the remainder of the NGB ecoregion will not change or experience a slight decrease. Interpreting this result in terms of its impact on fire ignitions is difficult without further modeling because of the complex topography in the NGB ecoregion and the coarse resolution of RegCM3.

### *Forecasted Changes in Snow Water Equivalent*

Temperature, precipitation, snow, and streamflow data have been carefully measured for forty-five water years (1962 to 2006) in the Reynolds Creek Experimental Watershed in the Owyhee Mountains. The analysis of the data has found increasing temperatures at all elevations. The proportion of snow to rain and maximum snow water equivalent has decreased at all elevations with the most significant decreases at the mid elevations and low elevations. Streamflow has shown a seasonal shift to larger winter and early spring flows and reduced late spring and summer flows (Nayak *et al.* 2010). Based on the modeled increase in temperature in November to February, the proportion of snow to rain could continue to decrease in the future from the Owyhee Uplands westward reducing the snow water equivalent accumulation during November to February. However, model forecasts for temperature from March to May predict a cooling of about -0.5 degree C. Therefore the modeling would suggest a potential for a slight to moderate increase in Snow Water Equivalent accumulation from March to May.

### *Cheatgrass Fire Dust Effects on Snow Pack Duration*

While climate change projections indicate a significant increase in mean Snow Water Equivalent during March and April, the deposition of dust from post cheatgrass-fire dust storms within the NGB ecoregion on snow in downwind mountain ranges (Germino *et al.* 2012) could increase snowmelt.

### *Summer Precipitation Sources Outside of Modeling Domain*

Existing model predictions of drying in the southwest US are generated by the reduction of winter season precipitation and not by changes in the North American Monsoon (Segar and Vecchi 2010). However, the current models do a poor job of simulating the changes to the North American Monsoon (Segar and Vecchi 2010). In contrast to much of the past literature, very recent results have found that the maximum sea level of Lake Lahontan and Lake Bonneville were due to the transport of moisture northwards from the tropics during a summer monsoon and not a southerly shift in the winter Westerlies (Lyle *et al.* 2012).

## Interactions with other Change Agents

On average climate change is forecasted to increase the annual average precipitation in the ecoregion and not result in an average annual change in temperature. However, there are important seasonal shifts in temperature and precipitation that could impact conservation elements within the ecoregion. Most notably, the increasing precipitation in the winter could result in more early season plant growth and increasing temperatures in summer during peak fire season (July and August) and decreasing precipitation in early fall (September and October) may increase the frequency and severity of wildfires and the length of the fire season.

Agricultural and urban development depends on stable water supplies. Overall, precipitation is modeled to increase, however, temperature increases from November to February could reduce the proportion of snow to rain and result in a seasonal shift of increased winter streamflow and reduced summer flows in portions of the ecoregion. In addition, increasing temperatures in July and August could increase irrigation demands at the height of summer. Reduced flows in the summer combined with increased irrigation demands, could reduce the water available in the streams and rivers in the late summer months.

## 6.2 Fine-Filter Conservation Elements

### 6.2.1 Coldwater Fish
Fine-Filter Conservation Element

Redband trout. Photo from Montana Fish, Wildlife & Parks.

The coldwater fish assemblage conservation element (mountain whitefish, Yellowstone cutthroat trout, Lahontan cutthroat trout, and redband trout) occurs throughout drainages in the NGB. For species such as redband trout, hybridization with other salmonids has contributed to its decline (Thurow *et al.* 2007). In addition, a number of these species consist of genetically isolated populations due to impoundments and other barriers to movement that limit connectivity between populations within a given drainage. The species in this assemblage require well–oxygenated water; clean, well–sorted gravels with minimal fine sediments for successful spawning; temperatures <21 C (<70 F), and complex instream habitat structure such as large woody debris and overhanging banks for cover.

#### Current Status

The current distribution of the coldwater species assemblage is depicted in Figure 6.2-1. Five of the metrics from the Perennial Streams conservation element (water quality, aquatic invasives, flow regulation, groundwater condition, and riparian condition) were combined with two the additional metrics for fish barriers and burn probability. Figure 6.2-2 shows the high and low scoring areas of coldwater fish habitat. . The highest scoring coldwater fish habitat areas were the Owyhee and Bruneau rivers. The lowest scoring areas were near development and included much of the Snake and Boise rivers.

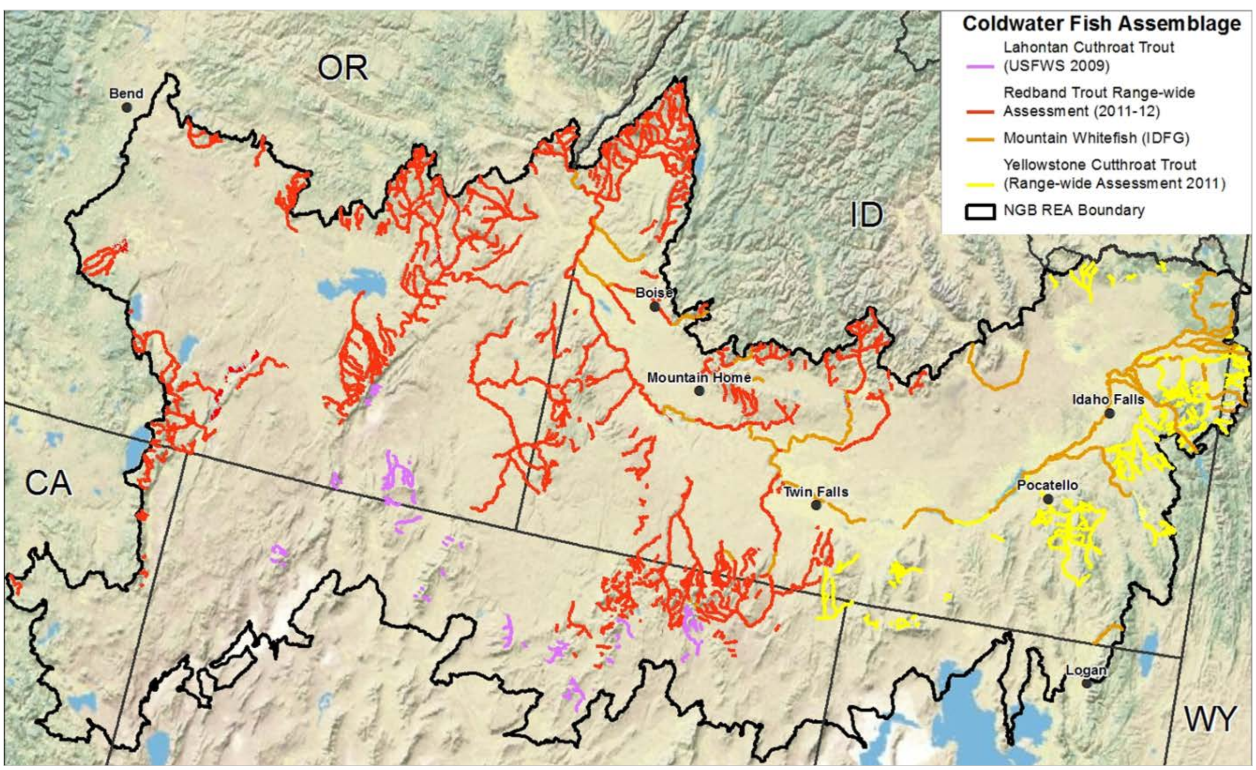



Figure 6.2-1. Coldwater Fish Assemblages Distribution

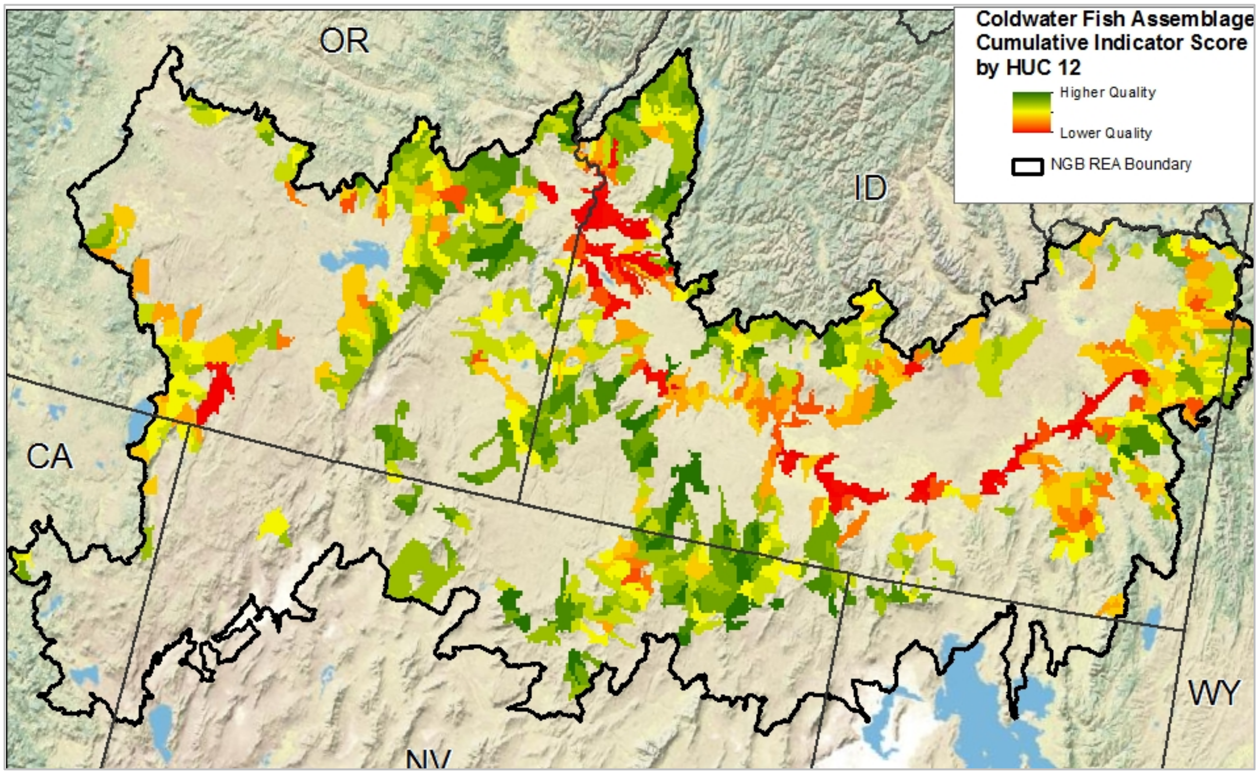



Figure 6.2-2. Coldwater Fish Cumulative Indicator Score

## Future Threats

Historically, development has been and continues to be the greatest threat to the coldwater fish species. Agricultural development in the ecoregion has resulted in widespread construction of dams or diversion structures for surface water withdrawals that have reduced stream flows. Dams, improperly placed culverts, irrigation diversions, and other migration barriers have negatively affected individuals and habitat and likely have interfered with metapopulation dynamics. In addition, coldwater fish species are under the threat of hybridization by introduced trout, competition with aquatic invasives species, and vulnerable to spreading parasites and diseases. Redband trout frequently hybridize with introduced trout and monitoring is required to determine genetic purity within systems. Trout species may become infected with the parasite responsible for whirling disease (*Myxobolus cerebralis*). Presence of the parasite does not always cause dramatic population losses, but has had severe impacts on some wild trout populations.

The increased occurrence of large and severe fires threatens entire coldwater fish populations in a watershed. Though wildfire can contribute to small increases in stream temperature attributable to riparian vegetation loss, the greatest impact to coldwater fish from wildfire comes from the influx of sediment from upland sources. In sufficient quantities, the additional sediment can degrade water quality conditions and smother spawning habitats and eggs. In most aquatic systems, fish populations can recolonize quickly after a fire (Gresswell 1999). However, native fish populations in the fire area that exist as isolated populations in fragmented habitats are at greater risk of localized extirpation.

Water temperature changes due to climate change could potentially make habitat unsuitable in the low elevation areas of the ecoregion. Increasing temperatures in July and August, could increase irrigation demands at the height of summer reducing the water available in the streams and rivers in the late summer months. Based on the analysis of winter flooding risk, most of the ecoregion will mostly continue as rain-dominated or be in a low winter precipitation area. The areas at risk are located in the northwestern parts of the ecoregion in Idaho and Wyoming (Greater Yellowstone Ecosystem). Finally, poorly managed grazing in riparian zones can impact the water quality and habitat condition of streams and rivers that coldwater fish depend on.

## 6.2.2 Bull Trout
Fine-Filter Conservation Element

Bull trout. Photo from USFWS.

Bull trout, a threatened species, currently occurs in less than half of their historic range. Bull trout are considered excellent indicators of water quality. Habitat alteration/loss, habitat fragmentation, riparian condition, climate change, environmental effects of mining and hybridization with introduced trout species are also factors affecting bull trout status and distribution over its range (Rieman and McIntyre 1993; USFWS 2002; Andonaegui 2003; Dunham *et al.* 2003a). Bull trout require colder water temperature than most salmonids, very clean stream substrates for spawning and rearing, complex and connected habitats, including streams with riffles and deep pools, undercut banks and lots of large logs, for rearing and annual spawning and feeding migrations.

### Current Status

The current distribution of the bull trout can be viewed in Figure 6.2-3. The two main data sources used are StreamNet and USFWS critical habitat layers (last updated in 2010). Key rivers in the ecoregion with Bull Trout critical habitat include the Malheur and Jarbidge Rivers.

Five of the metrics from the Perennial Streams conservation element (water quality, aquatic invasives, flow regulation, groundwater condition, and riparian condition) were combined with two additional metrics applicable to bull trout, fish barriers and burn probability. The seven metrics were added together to derive a cumulative score. Figure 6.2-4 shows the resulting high and low scoring areas by HUC12.

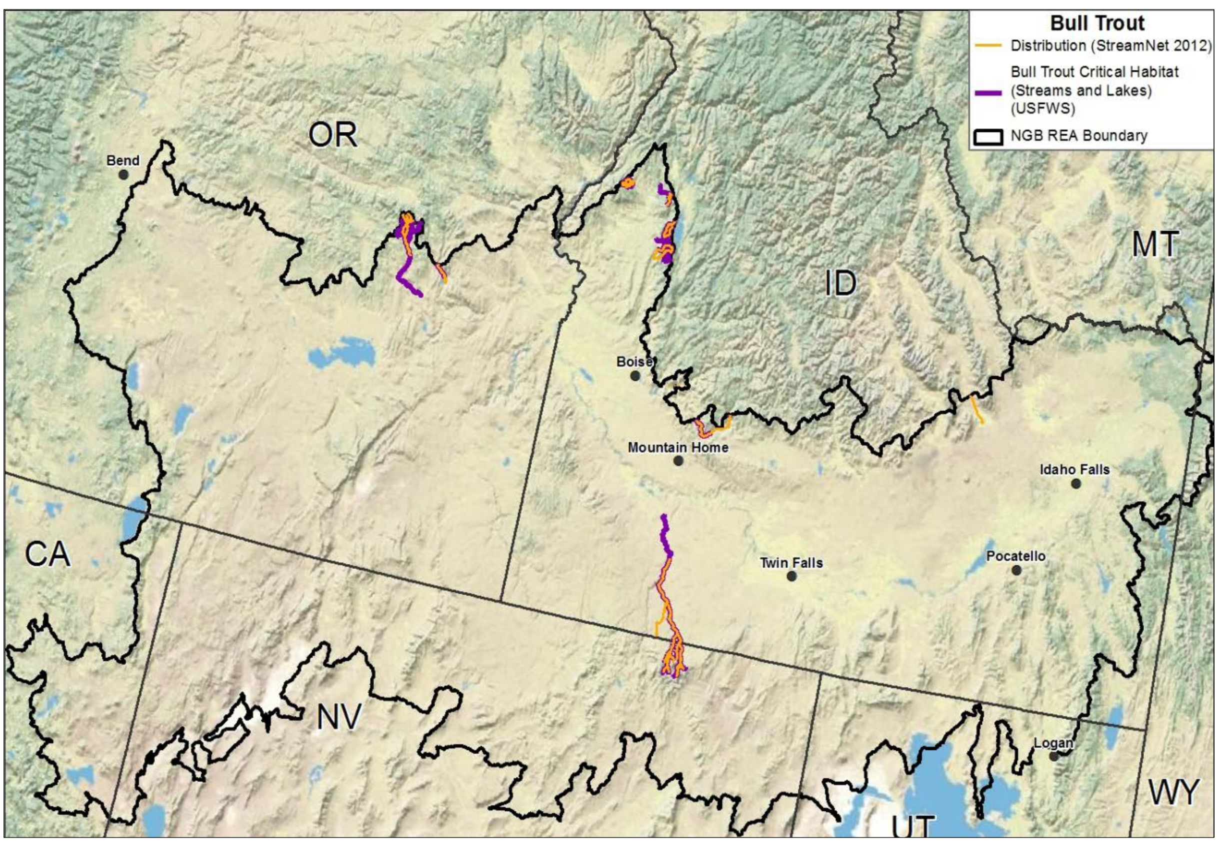



Figure 6.2-3. Bull Trout Critical Habitat and Distribution in the Northern Great Basin

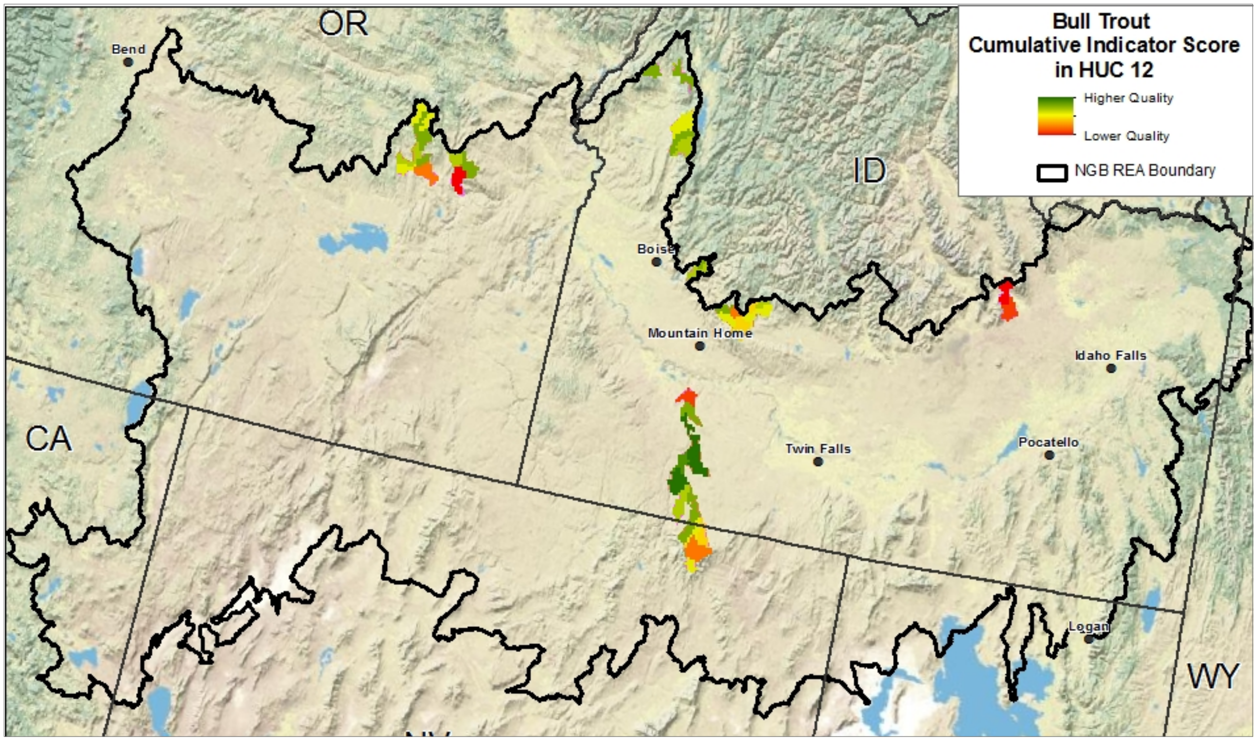



Figure 6.2-4. Bull Trout Cumulative Indicator Score

### Future Threats

Development activities (dams, agricultural practices, transportation networks, mining, and urbanization) have resulted in the isolation and fragmentation of bull trout habitat to such an extent that it has been federally-listed as threatened. For example, dams and diversion structures on the Snake and Bruneau Rivers have eliminated connectivity and isolated the bull trout populations in the Jarbidge River for over 100 years (USFWS 2012). Historically, mining has contributed to degraded water quality conditions, especially in the Jarbidge watershed. Hybridization with introduced brook trout may lead to sterile offspring (Leary *et al.* 1993). Introduced non-native fish species such as brook trout, lake trout, brown trout, northern pike, and walleye, can be competitors or predators of bull trout and threaten bull trout in areas that are otherwise secure habitat. Nonnative fish (cutthroat, rainbow, and brook trout) were stocked in the Jarbidge River watershed for approximately 40 years (USFWS 2012). Species of trout and salmon may become infected with the parasite responsible for whirling disease (*Myxobolus cerebralis*). However, Bull trout appear to be somewhat resistant of the whirling disease (*Myxobolus cerebralis*) (Lorz *et al.* 2002).

Currently, warm water temperatures in portions of the Jarbidge River watershed seasonally restrict bull trout movements (USFWS 2012). Water temperature changes due to climate change could further restrict seasonal movements and potentially make habitat unsuitable in the low elevation areas of the ecoregion. Based on the analysis of winter flooding risk, most of the precipitation in the bull trout habitat will mostly continue as rain-dominated or be in a low winter precipitation area. Large, severe fires can threaten entire fish populations in a watershed due to the influx of sediment from upland sources that can degrade water quality conditions and smother spawning habitats and eggs. In most aquatic systems, fish populations can recolonize quickly after a fire (Gresswell 1999). However, native fish populations in the fire area that exist as isolated populations in fragmented habitats are at greater risk of localized extirpation. Poorly managed livestock grazing also contributes sediment to bull trout streams and impacts riparian areas.

## 6.2.3 White Sturgeon
Fine-Filter Conservation Element

White Sturgeon.
Photo from USGS.

The white sturgeon are dependent on cold, clean waters of suitable depth and flow to allow reproductive-sized adult fish access to suitable spawning habitats (IDFG 2008, Israel *et al.* 2009). Eggs and larvae require clean substrates, and cool waters to ensure healthy egg survival and larval development (Israel *et al.* 2009). Introduced species have been shown to limit white sturgeon survival through alteration of foodwebs, and direct predation on larval and juvenile white sturgeon. Other factors that have limited white sturgeon abundance in the NGB ecoregions and prompted its inclusion as a conservation element are harvest, regional population isolation, loss of habitat connectivity, and loss of flowing water habitats due to dams.

### Current Status

The current distribution data can be viewed in Figure 6.2-5. Since this species upstream movement is blocked by dams and downstream movement is only available over spillways, populations can become locked into defined ranges. Due to poor recruitment of naturally-spawned white sturgeon in the NGB, the species is dependent on hatchery production for their continued presence.

The metrics for water quality, aquatic invasives, burn probability and fish barriers were used to estimate the cumulative indicator score for white sturgeon. Figure 6.2-6 shows the resulting high and low scoring areas by HUC12.

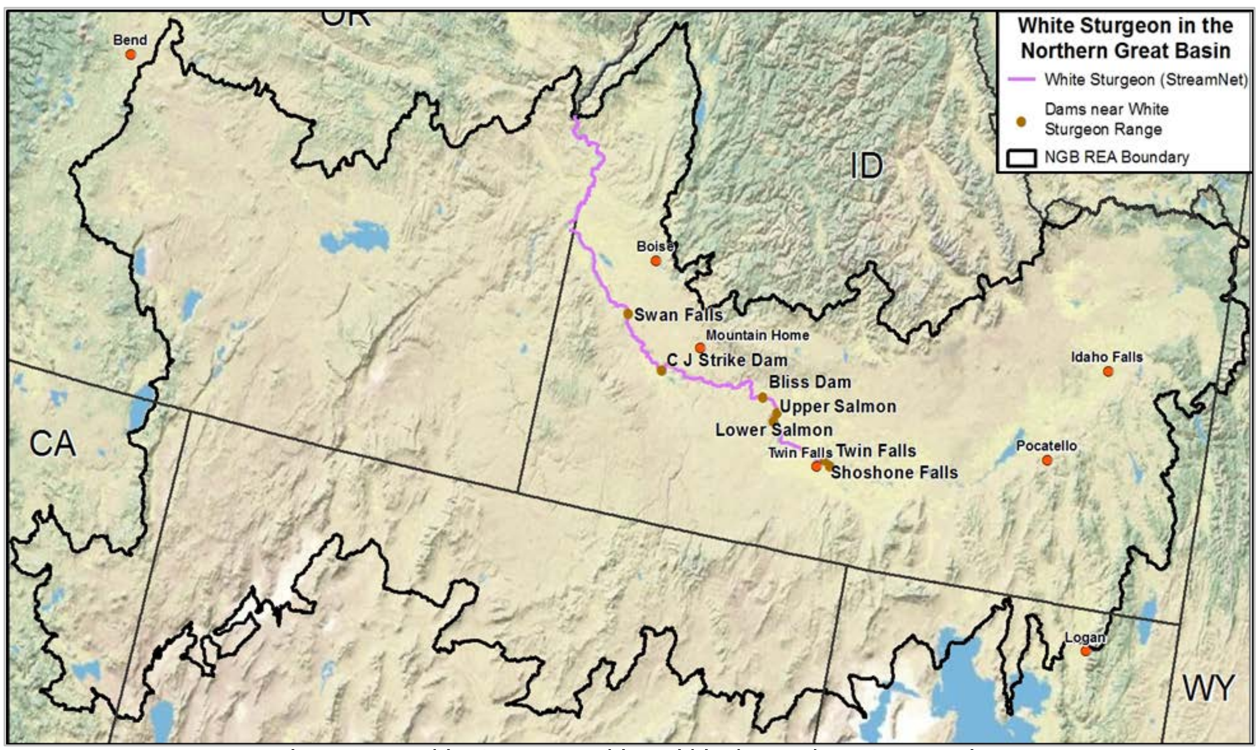



Figure 6.2-5. White Sturgeon Habitat within the Northern Great Basin

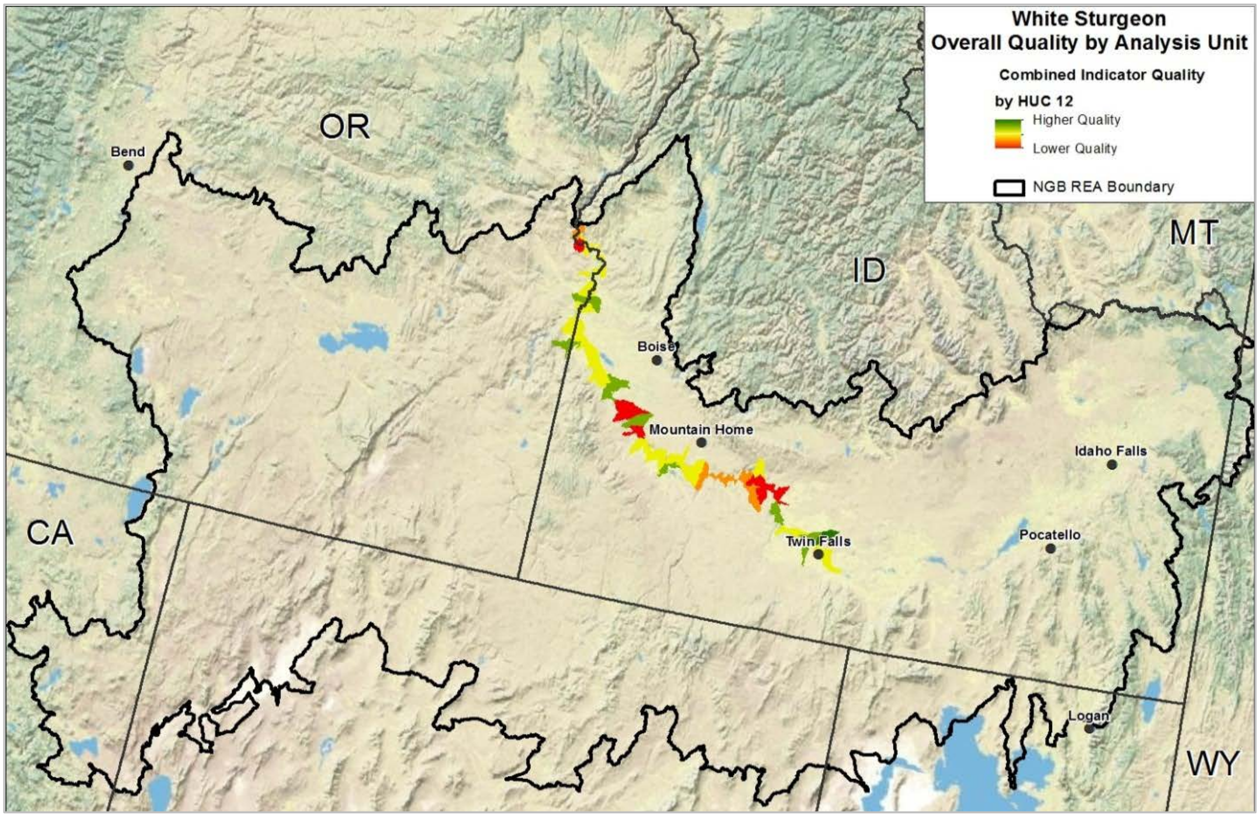



Figure 6.2-6. Cumulative Indicator Score for White Sturgeon by HUC 12

### Future Threats

Impoundments and diversions along the Snake River from Hell's Canyon Dam upstream, have reduced flow, altered and fragmented riverine habitats, and limited fish movements between upstream and downstream reaches (Lepla *et al.* 2003). Continued agricultural withdrawals of surface and groundwater may affect white sturgeon habitats. Seasonal adjustment of reservoir levels and associated flows is required to facilitate fish access to and use of habitats, and maintain suitable instream temperatures. In addition, introduced non-native species generally prey on eggs, larvae and younger juveniles (< year 2-3) before juvenile sturgeon growth is sufficient to provide them a size refuge from fish predation pressures (Israel *et al.* 2009). White sturgeon are also at risk due to white sturgeon iridovirus disease. Wild populations may be susceptible to infection from hatchery transplants because white sturgeon iridovirus disease is more prevalent in dense populations, and can spread rampantly in hatcheries (LaPatra *et al.* 1996).

Potential threats to white sturgeon attributable to climate change include the decrease of flows due to changing summer irrigation demands and the potential increase of riverine and reservoir water temperatures. Based on the Hostetler predictive models of climate change, temperatures are expected to increase by one degree in July and August. Intense fire can result in the temporary loss of riparian vegetation, sedimentation, loss of shading and water temperature increases. However, since the white sturgeon habitat is limited to the Snake River, fire and grazing impacts will be muted by the large watershed contribution area and dams.

## 6.2.4 Columbia Spotted Frog
### Fine-Filter Conservation Element

The Columbia spotted frog (*Rana luteiventris*) was selected as a conservation element due to losses of historically known occupied sites, reduced numbers of individuals within local populations, and declines in the reproduction of those individuals (USFWS 2011b). The Great Basin distinct population segment of Columbia spotted frog is a candidate species for ESA listing. Sites at which frogs become locally extinct have a small probability of reoccupation due to overall low levels of migration.

Columbia Spotted Frog (*Rana luteiventris*). Photo from USFWS.

### Current Status

The Columbia spotted frog is strongly associated with clear, slow-moving or ponded surface waters with little shade, and relatively constant water temperatures. In more arid portions of the ecoregion breeding sites are predominantly associated with springs or other permanent water features. Within the ecoregion, this species' distribution associates with low population areas such as the Owyhee Mountain region and Boise National Forest (Figure 6.2-7).

Human footprint elements are the most important agents in assessing habitat suitability for this species, and as result, much of the modeled habitat in the ecoregion outside of the Owyhee Mountain region, portions of northeastern and northwestern Nevada, and scattered smaller portions of southeastern Oregon, received low scores (Figure 6.2-8).

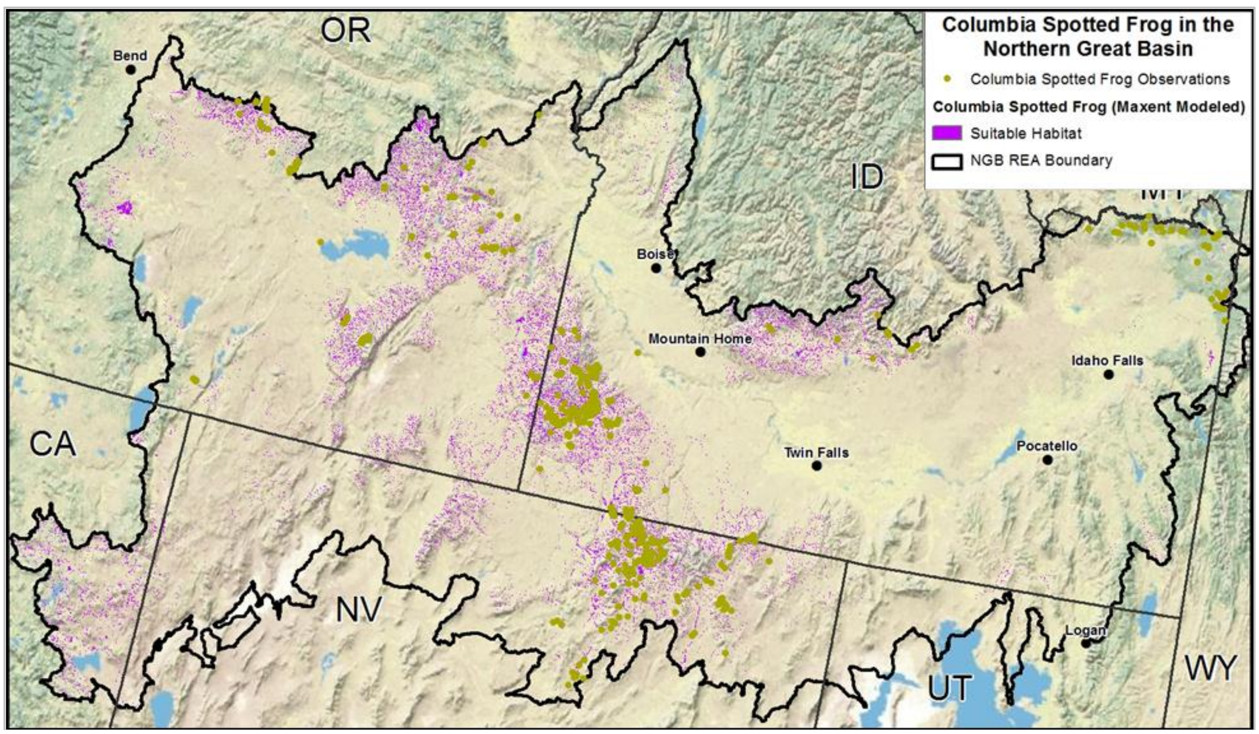



Figure 6.2-7. Columbia Spotted Frog Modeled Suitable Habitat

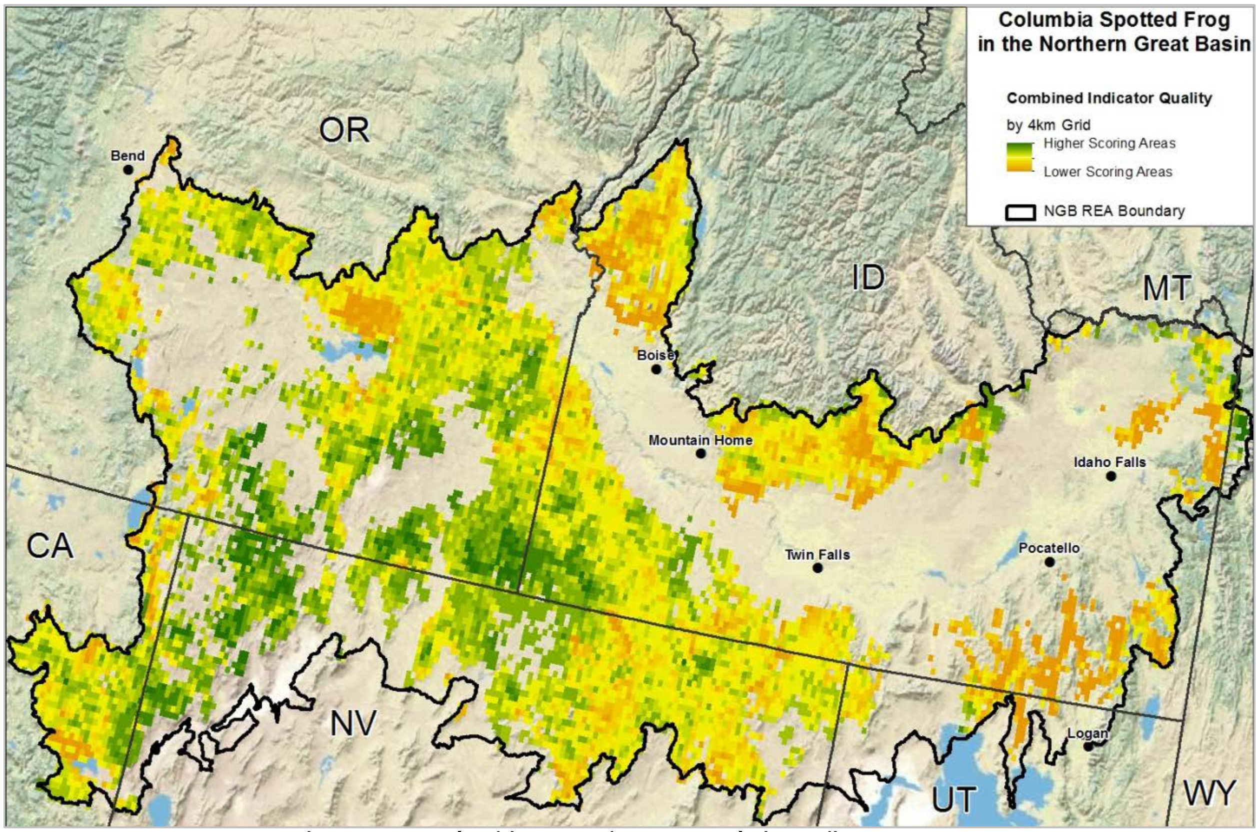



Figure 6.2-8. Columbia Spotted Frog Cumulative Indicator Score

## Future Threats

The greatest threat to spotted frogs is habitat alteration and loss, specifically loss of wetlands used for feeding, breeding, hibernating, and migrating (USFWS 2013a). Development activities, especially spring development, wetland destruction, water diversions, dam construction and road construction, have resulted in loss of habitat in the region. As a result, populations have become increasingly fragmented.

Invasive predatory fish (salmonids and bass) will likely remain as important mortality agents for spotted frogs. Disease agents (chytrids, trematodes and parasitic snails) have also been identified in the ecoregion, and monitoring will be required to identify whether expansion of these disease agents will pose a significant threat in the future. Climate change is predicted to produce a slight precipitation increase in the basins, valleys, and uplands and large increases in the mountains. However, climate change may result in seasonal shifts in streamflow, with greater winter flows and reduced summer flows. Reduced summer streamflows combined with predicted increases in temperature in July and August, could result in impacts to spotted frog habitat in the late summer.

Current and future impacts of poorly managed grazing in unfenced riparian zones, springs, ponds, and streams within spotted frog habitat include water quality degradation, introduction of disease agents, and trampling of riparian vegetation and spotted frog egg masses. The magnitude of these effects is related to livestock density and rangeland improvements such as developing water sources for livestock. Large, severe fires can threaten spotted frogs. If the local populations are lost their former habitat will likely not be quickly recolonized.

## 6.2.5 Greater sage-grouse
Fine-Filter Conservation Element

Greater sage-grouse (*Centrocercus urophasianus*) Photo: BLM

The greater sage-grouse was approved by the Assessment Management Team as a conservation element because of the bird's ecoregional importance. The greater sage-grouse is considered an umbrella species for sagebrush-associated vertebrates (Rowland *et al.* 2006; Hanser and Knick 2011). Indirect effects of sagebrush habitat loss, fragmentation, and degradation are thought to have caused the extirpation of the greater sage-grouse from approximately 50 percent of its original range (Connelly and Braun 1997; Connelly *et al.* 2004; Schroeder *et al.* 2004), leading to a finding by the USFWS in 2010 that greater sage-grouse warranted listing the Endangered Species Act, but listing was precluded and greater sage-grouse remains a candidate for listing.

### Current Status

The AMT decided that the state Preliminary Priority Habitat (Figure 6.2-9) data was the best source of greater sage-grouse suitable habitat. Each state provided their Preliminary Priority Habitat data which was merged together to form one dataset.

Key Ecological Attributes were used to create a cumulative indicator score for greater sage-grouse Preliminary Priority Habitat (Preliminary Priority Habitat in protected areas, distance to highways, distance to towers, distance to transmission lines, percentage of Preliminary Priority Habitat in agriculture and human population density within Preliminary Priority Habitat). The individual metrics for the Key Ecological Attributes were scored with a 1, 2 or 3 with 1 given to lowest quality indicator and 3 given to the highest quality indicator. The six Key Ecological Attributes were then added together using raster calculator to derive a range of cumulative scores from six (lowest possible score) to eighteen (highest possible score). Figure 6.2-10 shows the resulting high and low scoring areas with a stretched raster based on the 4 km grid analysis unit.

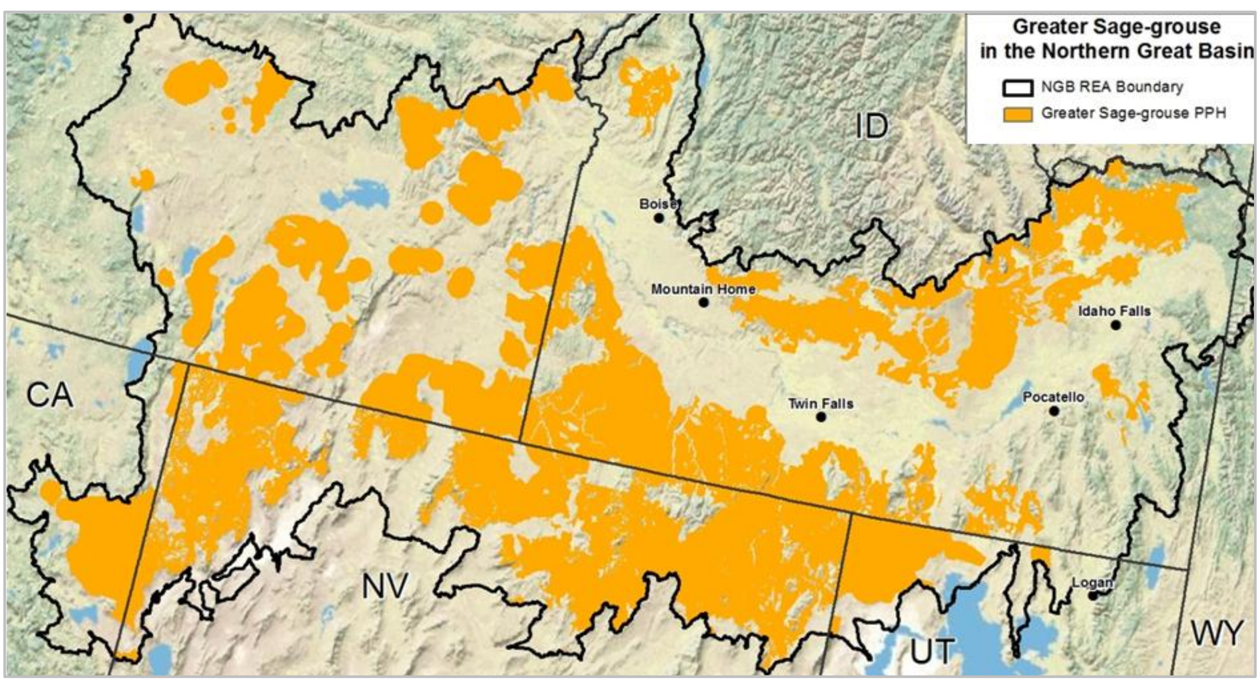



Figure 6.2-9. Preliminary Priority Habitat for Greater Sage-Grouse from Each State

Most portions of the ecoregion and the identified Preliminary Priority Habitat is degraded or low-quality habitat condition, based on the identified Key Ecological Attributes. The analysis has identified greater sage-grouse stronghold in Northwestern Nevada, Southeastern Oregon and the tri-state region where Idaho, Nevada and Oregon meet.

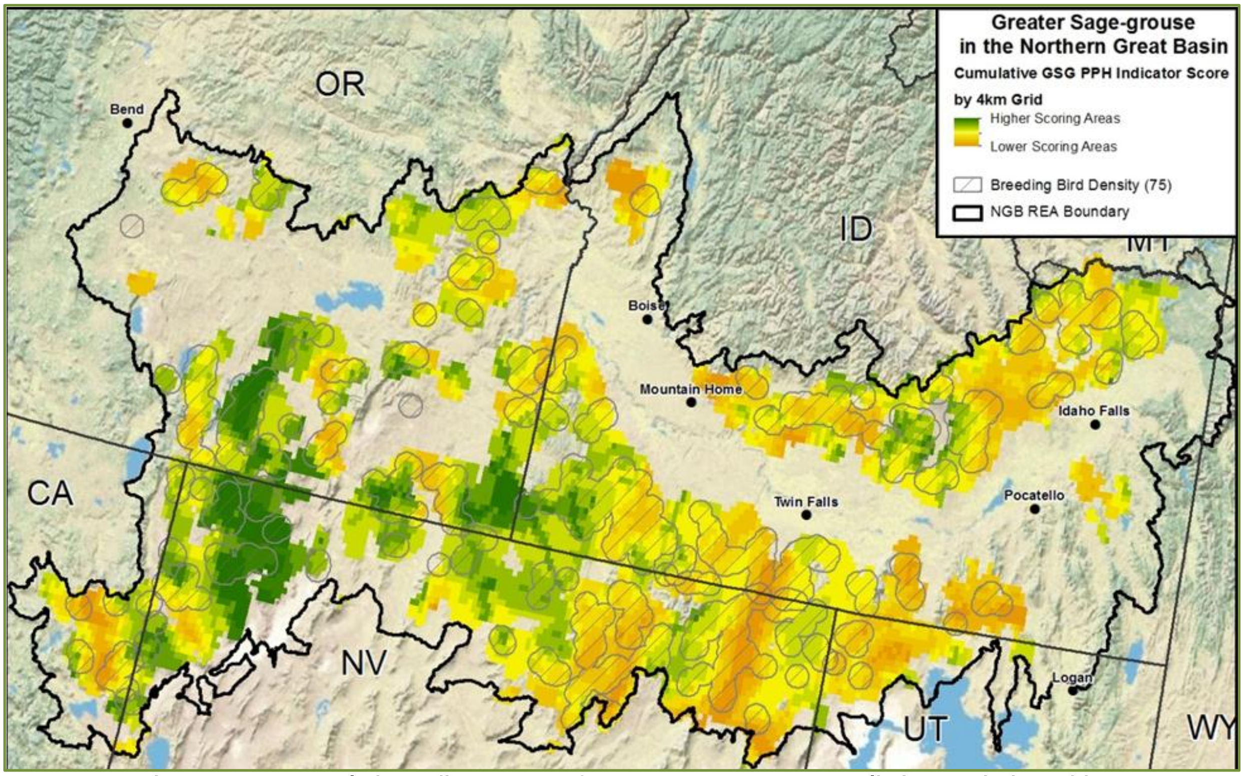



Figure 6.2-10. Cumulative Indicator Score for Greater Sage-grouse Preliminary Priority Habitat

## Future Threats

Increasing cheatgrass cover is predicted for northwestern Nevada with significant risk of invasion into some of the least-fragmented greater sage-grouse habitat that is remaining in the ecoregion. Under natural conditions, moderate fire return intervals and low intensity fires (that did not completely consume shrub cover) promoted the mixed composition of sagebrush communities. Wildfires are becoming larger and occur more frequently, reducing habitat quality and quantity of sagebrush communities. With an increasing number of fires exceeding 100,000 acres in 2012, fire is currently the major contributing factor in the conversion of shrub-steppes to grasslands.

As roads, development, transmission lines and other infrastructure continues to fragment sage grouse habitat in the ecoregion, the species can be expected to suffer from additional habitat loss and reduced landscape integrity. Leks are increasingly affected by increasing traffic and other disturbances on existing and new roads.

West Nile Virus is the predominant disease threat to greater sage-grouse. Mosquito and bird infections have been detected throughout the ecoregion. The risk of WNV is expected to increase as temperatures increase with predicted climate change. Historically, uncontrolled livestock grazing affected sage-grouse habitat quality at the site level, primarily through unsustainable utilization levels of forbs and grasses needed by sage-grouse for food and nesting cover. Grazing management on BLM lands has steadily improved in recent decades, and currently must conform to Standards and Guidelines, which include wildlife habitat requirements. However, recovery times can be protracted, especially in more arid environments. The 2013 USFWS Conservation Objectives report stresses sound grazing management, which continues to be a focus of the BLM range management program.

## 6.2.6 Golden Eagle
Fine-Filter Conservation Element

The golden eagle (*Aquila chrysaetos*) is one of only two species of eagle indigenous to North America and occupies sagebrush-steppe communities within the Great Basin and adjacent Intermountain West. The distribution of the species is widespread across the Great Basin with a large geographic range that roughly stretches from southeastern Oregon, through central Nevada, to northwestern Utah, into southern Idaho. The golden eagle is highly dependent upon the availability of prey species (jackrabbit, rabbit, and ground squirrel) throughout the region.

Golden Eagle (*Aquila chrysaetos*).
Photo: NPS – Kent Miller.

### Current Status

The distribution of the golden eagle was modeled using the Maxent (Maximum Entropy model) modeling program and nest site locations. Figure 6.2-11 shows areas that were classified as suitable habitat for golden eagles, which was used in further analyses.

The Key Ecological Attributes of extent of suitable habitat, vegetation condition class, proximity to urban development, proximity to agriculture, road density, and proximity to wind turbines were used to create a cumulative indicator score of golden eagle habitat quality. Figure 6.2-12 shows the resulting high and low scoring areas with a stretched raster.

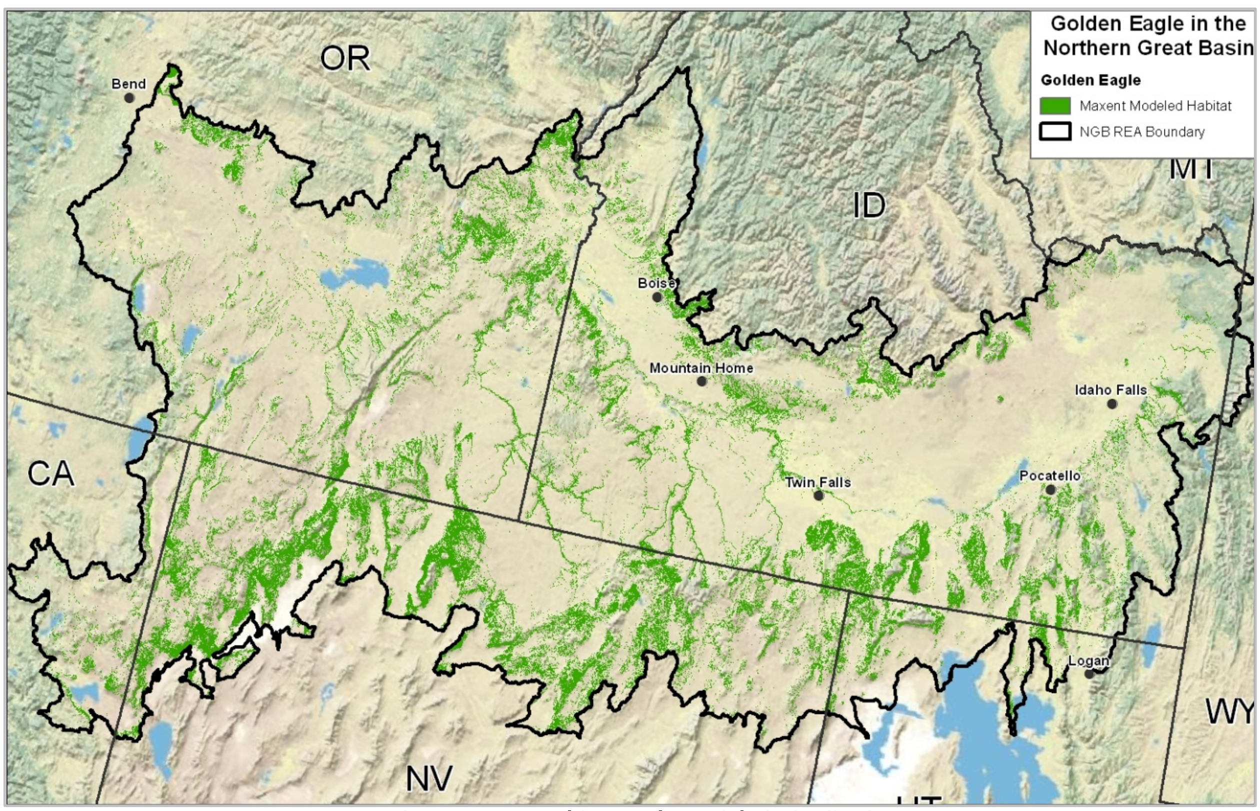



Figure 6.2-11. Golden Eagle Modeled Distribution

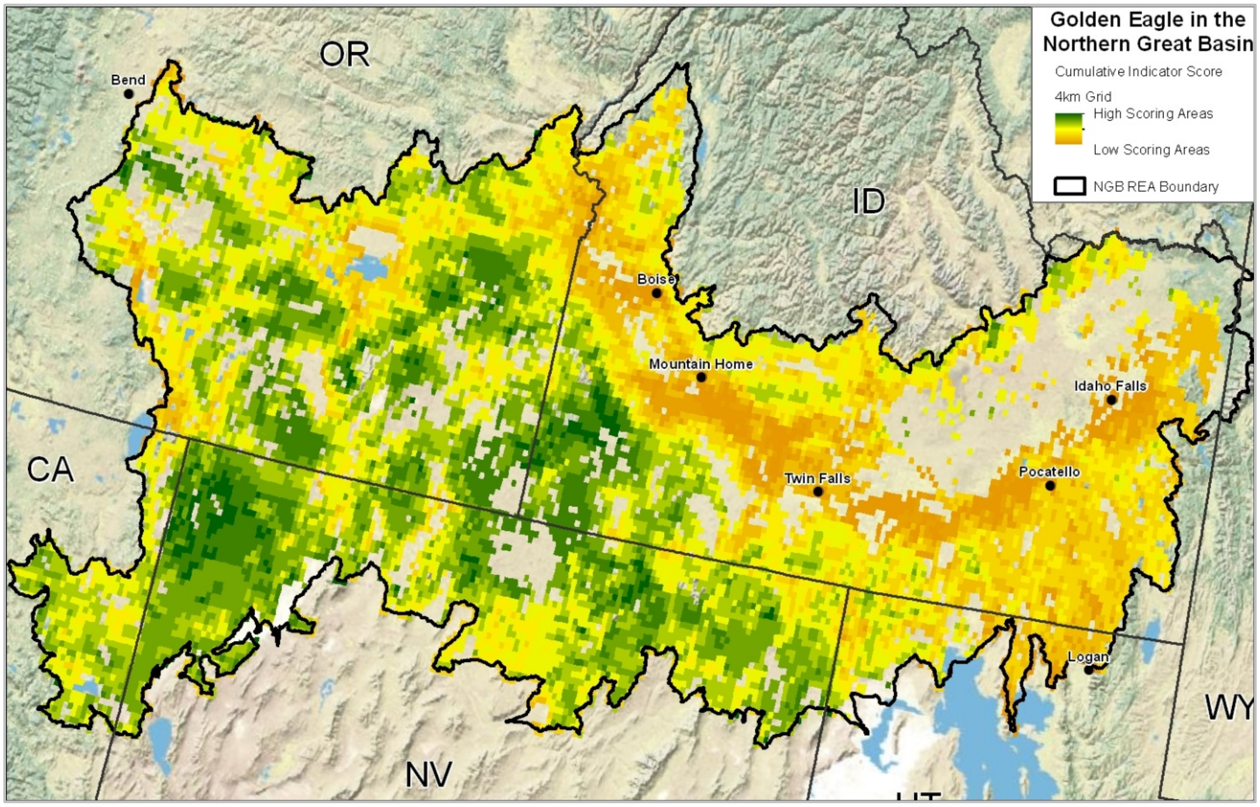



Figure 6.2-12. Cumulative Indicator Score for Golden Eagle Habitat

## Future Threats

In general the risks to golden eagle across the NGB appear low. Species adaptability and prey abundance indicate an overall relative stable ecoregional ecosystem for the golden eagle. Throughout the majority of the ecoregion, lack of human activity remains an important factor with regard to risk. Development in the form of urban growth is the most likely factor to have a broad effect on the species. Localized mortality risks increase in areas where wind turbine activity and high-traffic roadways exist within specific ranges of golden eagle habitat. Development along major urban corridors in Idaho is most likely to affect the population of golden eagles.

The increase in fire frequency in the West within this century poses potential short-term threats to golden eagles. Habitat destruction through wildfire may result in temporary extirpation (<10 years) of breeding adults. More frequent fires than occurred historically reduces the time between burns required for sagebrush to fully mature limiting the availability of prey species habitat. The increase in cheatgrass cover reduces prey species occupancy. In addition, increasing dominance of invasive annuals produces fuel for wildfire and facilitates short fire return intervals. Golden eagle foraging habitat is affected by livestock grazing when grazing intensity is severe enough to alter sagebrush cover or the nutritional quality of forage for prey species. However, golden eagles are highly adaptable and may alter foraging locations or switch to alternative prey species. The role of climate change in golden eagle distribution and abundance is unclear and is likely associated with vegetation and temperature changes affecting prey populations.

## 6.2.7 Bald Eagle
Fine-Filter Conservation Element

Bald Eagle (*Haliaeetus leucocephalus*)
Photo: NPS – Dan Mohr

The bald eagle (*Haliaeetus leucocephalus*) is the other of only two species of eagle indigenous to North America and occupies areas surrounding water bodies and large tributaries within the Great Basin and adjacent Intermountain West. The distribution of the species is limited in the Great Basin to water bodies located irregularly across Oregon, Idaho, California, Nevada, and Utah. The bald eagle is highly dependent upon the availability of fish species in the summer months and open water and carrion in the winter.

### Current Status

The distribution of the bald eagle was modeled by the USGS GAP Analysis Program. Figure 6.2-13 shows areas that were classified as suitable summer, winter, and year-round habitat, which were used in further analyses.

The Key Ecological Attributes of availability of suitable habitat, proximity of nest site locations to foraging habitat, prey base condition, proximity to urban development, proximity to agriculture, and road density were used to create a cumulative indicator score of bald eagle summer habitat quality. Figure 6.2-14 shows the resulting high and low scoring summer areas with a stretched raster. Figure 6.2-15 shows the winter analyses results.

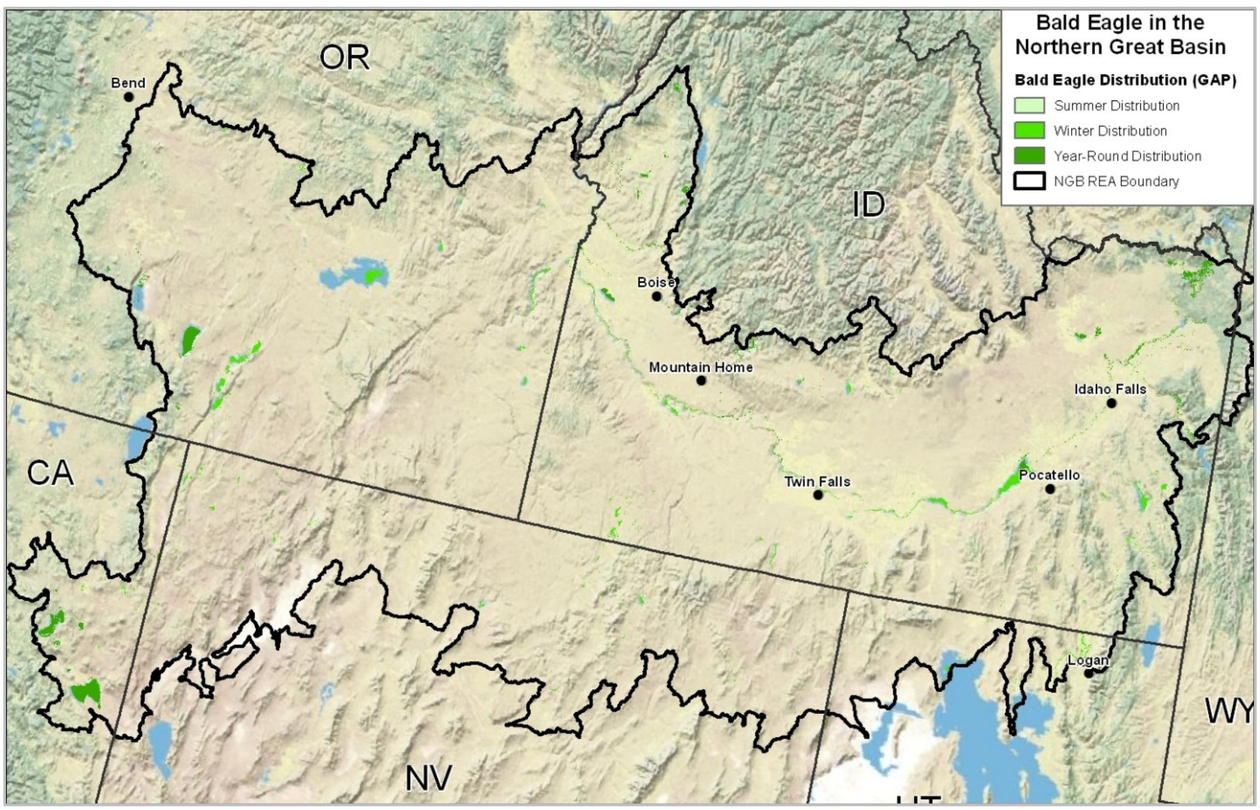



Figure 6.2-13. Bald Eagle Modeled Distribution

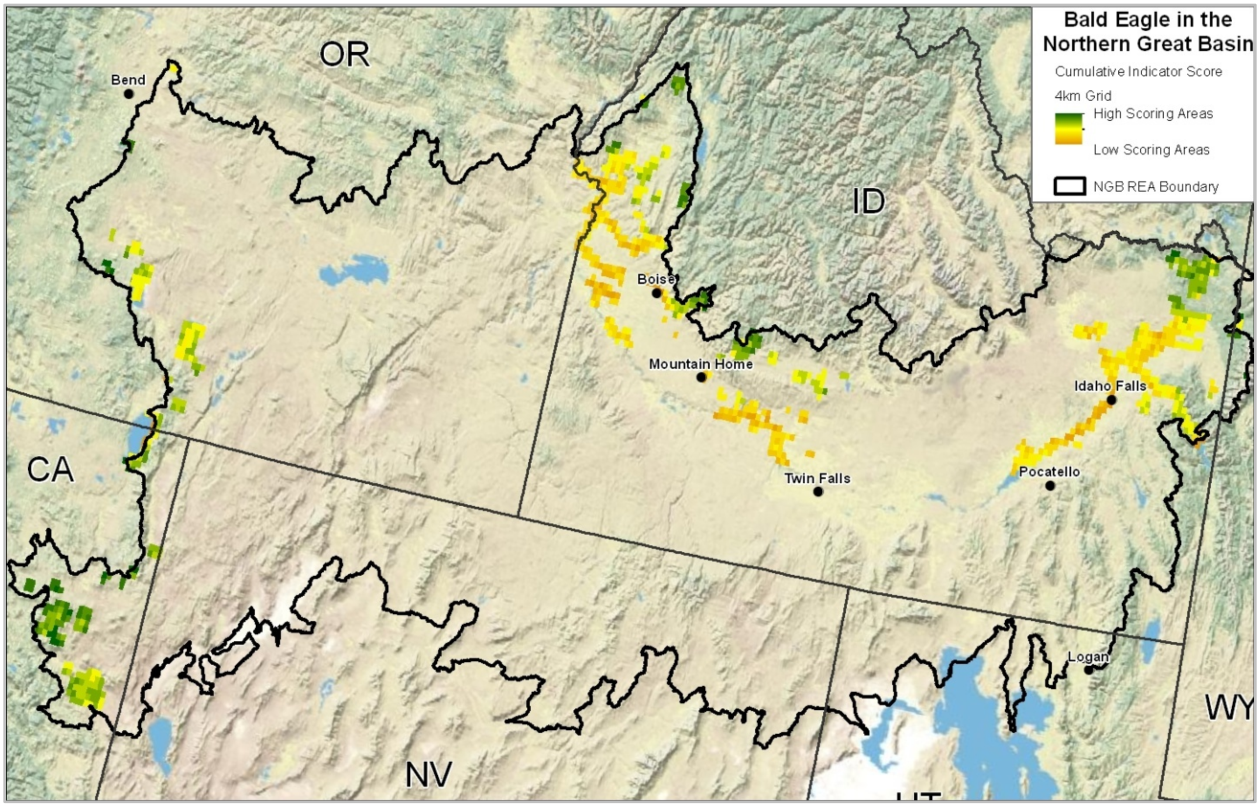



Figure 6.2-14. Cumulative Indicator Score for Bald Eagle Summer Habitat

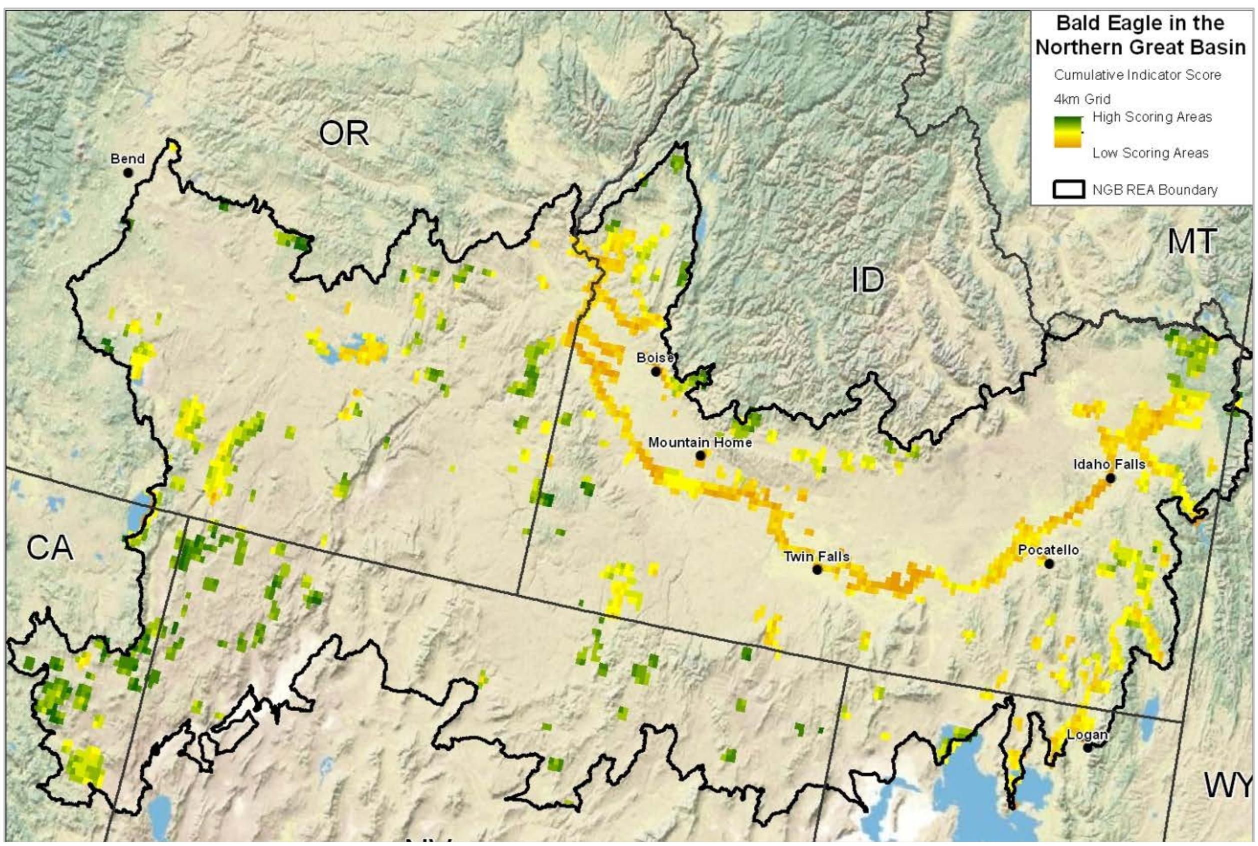



Figure 6.2-15. Cumulative Indicator Score for Bald Eagle Winter Habitat

### Future Threats

The overall threat is moderate to high for the summer range of the bald eagle. However, the areas that are most closely associated with the lower ratings are also those areas in which bald eagles may appear only rarely during the summer period. Foraging and nesting activities will most likely remain in close proximity to areas of ideal habitat. The threats to wintering bald eagles appear low overall. The cumulative indicator scores for bald eagle priority summer habitat under current conditions should be useful in identifying the areas most in need of preservation or the best restoration opportunities.

Development along major urban corridors in Idaho affects the population of bald eagles. Nesting habitat and foraging and roosting sites are threatened by future urban/exurban expansion and agriculture development (especially when land conversion occurs). Large, healthy bodies of water in rural/remote areas will continue to provide preferred habitat for the species. The increase in fire frequency in the West poses potential short-term threats to bald eagles. As noted above, nesting habitat destruction through wildfire results in temporary extirpation (<10 years) of breeding golden eagles, and could similarly affect bald eagles through the direct loss of suitable nest sites and foraging and roosting habitat.

Invasive species were not directly analyzed in relation to the bald eagle. However, potential aquatic invasive species that could affect bald eagles are species that could harm native fish populations (e.g., zebra mussels, snakehead fish, etc.). Grazing could affect the bald eagle population through the degradation of aquatic habitats in grazing allotments where riparian zones are unfenced and forest and woodland perch sites are removed. The net effect of climate change (increasing in precipitation and increase in summer temperatures) on prey populations for bald eagles is currently difficult to predict.

## 6.2.8 Pygmy Rabbit
Fine-Filter Conservation Element

Pygmy Rabbit (*Brachylagus idahoensis*)
Photo: Idaho National Laboratory.

The pygmy rabbit (*Brachylagus idahoensis*) is the smallest rabbit species in North America and occupies sagebrush-steppe communities within the Great Basin and adjacent Intermountain West. The distribution of the species is widespread but populations are disjunct within a large geographic range that roughly stretches from southwestern Oregon, through central Nevada, to western Utah, into southern Idaho. The pygmy rabbit is a sagebrush obligate and relies year-round on big sagebrush (*Artemisia tridentata* spp.) for food and cover from thermal extremes and predators. A combination of natural factors and effects from anthropogenic causes have generated concern for the status and conservation of pygmy rabbit populations.

### Current Status

Pygmy rabbit habitat was modeled using the following variables: presence of sagebrush, soil depth to bedrock, not in a recent burned area, percent clay of soil and suitable slope to prioritize habitat. Figure 6.2-16 shows areas that were classified as suitable habitat for pygmy rabbit and used in further analyses. Areas that have been recently burned were left out and would be considered as possible restoration or rehabilitation sites.

The Key Ecological Attributes of sagebrush cover, vegetation height, wildfire burn probability, agriculture within 5 km, and human footprint, were used to create a cumulative indicator score of pygmy rabbit habitat quality. Figure 6.2-17 shows the resulting high and low scoring areas with a stretched raster.

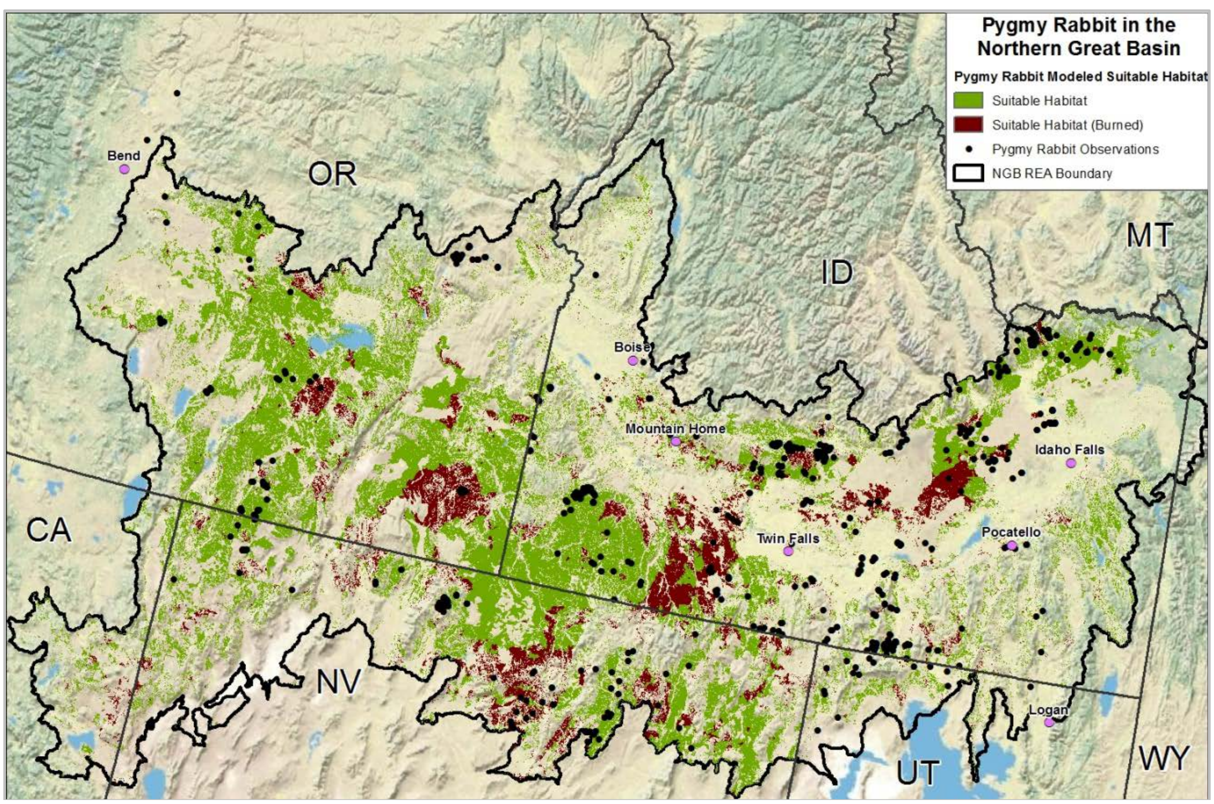



Figure 6.2-16. Pygmy Rabbit Suitable Habitat

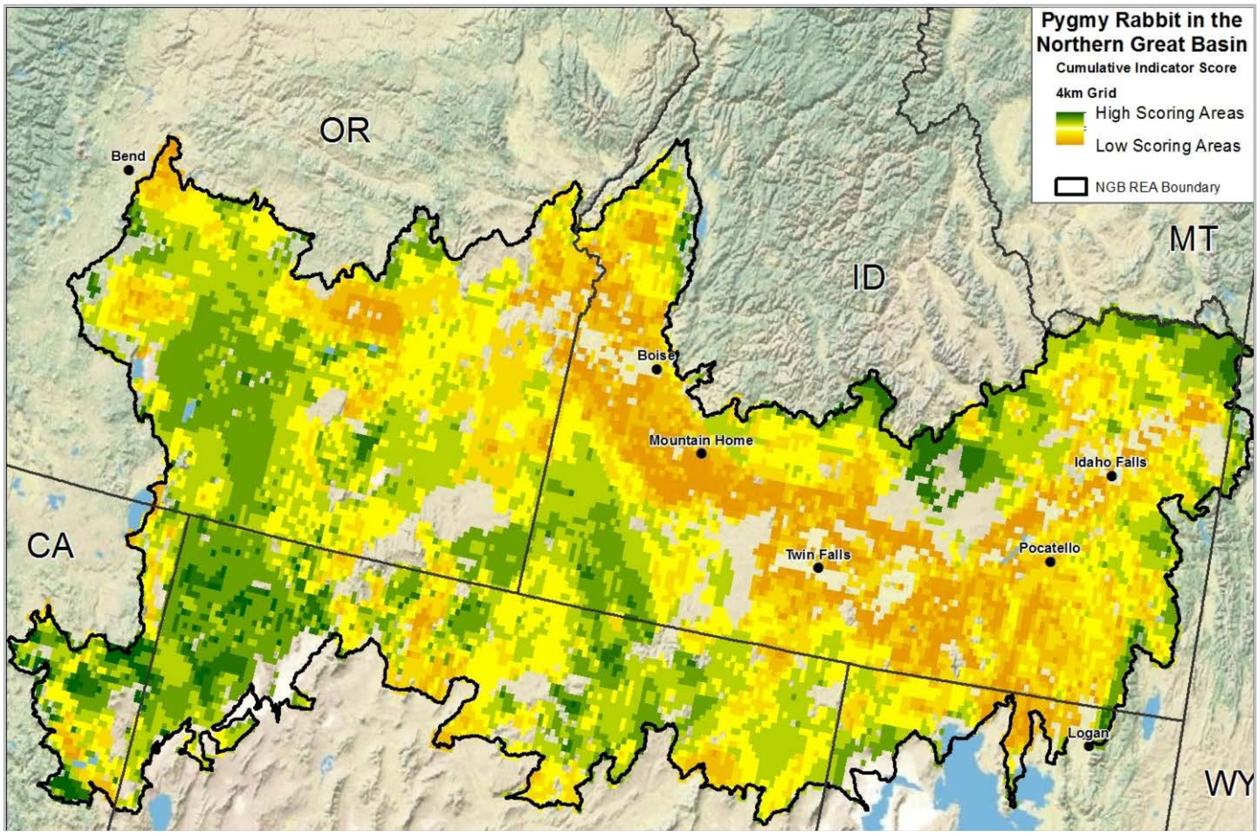



Figure 6.2-17. Cumulative Indicator Score for Pygmy Rabbit Habitat

### Future Threats

Wildfire and cheatgrass invasion are the greatest threats to pygmy rabbit habitat. The increase in fire frequency in the West within this century poses serious threats to pygmy rabbit persistence. More frequent fires than occurred historically reduces the time between burns required for sagebrush to fully mature into the canopy cover pygmy rabbits occupy. The increase in cheatgrass cover reduces pygmy rabbit occupancy. In addition, increasing dominance of invasive annuals produces fuel for wildfire and facilitates short fire return intervals. Pygmy rabbit habit overlaps areas with high burn probability in much of Idaho and northwestern Nevada. Sagebrush in high burn probability areas may be vulnerable to type conversion to cheatgrass-dominated grasslands. Modeled priority habitat areas that have burned in recent years deserve closer evaluation as potential habitat restoration sites.

Large-scale habitat fragmentation through agricultural development over the last 200 years has reduced what once was probably a single pygmy rabbit population by at least 20 percent. Habitat is threatened by future urban/exurban expansion, agriculture, alternative and traditional energy exploration and development, and linear features (especially pipelines that disrupt vegetation and soil structure). Pygmy rabbit habitat is affected by livestock grazing when it is severe enough to alter sagebrush cover or the nutritional quality of forage. Pygmy rabbit occupied sites may increase in elevation with the effects of climate change.

## 6.2.9 Pronghorn
Fine-Filter Conservation Element

Characteristics of good pronghorn habitat include large areas of unbroken rangeland, relatively flat or undulating terrain with high visibility, and sufficient rainfall (12-25 inches). Pronghorn prefer forbs and rarely consume grasses. Big sagebrush, rabbitbrush, and bitterbrush are particularly important pronghorn forage in this ecoregion. Reduced vegetation height during parturition has been linked to high predation rates on fawns. Good pronghorn habitat is free of encroaching trees, fragmenting infrastructure (roads, fences, and oil and gas development) and other anthropogenic disturbances. Snow depth above 15 inches appears to limit pronghorn use of winter range.

### Current Status

The Analysis of this conservation element was based on a habitat model based on known pronghorn-habitat relationships. Vegetation suitability, slope, road density and elevation were combined to develop a habitat suitability layer and compared with existing agency range maps (Figure 6.2-18).

Key Ecological Attributes included size of contiguous habitat fragments, proportion of native sagebrush and grassland habitats, snow depth, slope, distance to roads, and road density. The primary result of this analysis identified prime habitat conditions over the existing pronghorn range in the ecoregion. The increasing fragmentation of native sagebrush shrub-steppe, as evidenced by increasing road density and smaller patches of habitat, provides for a high stress environment for pronghorn (Figure 6.2-19).

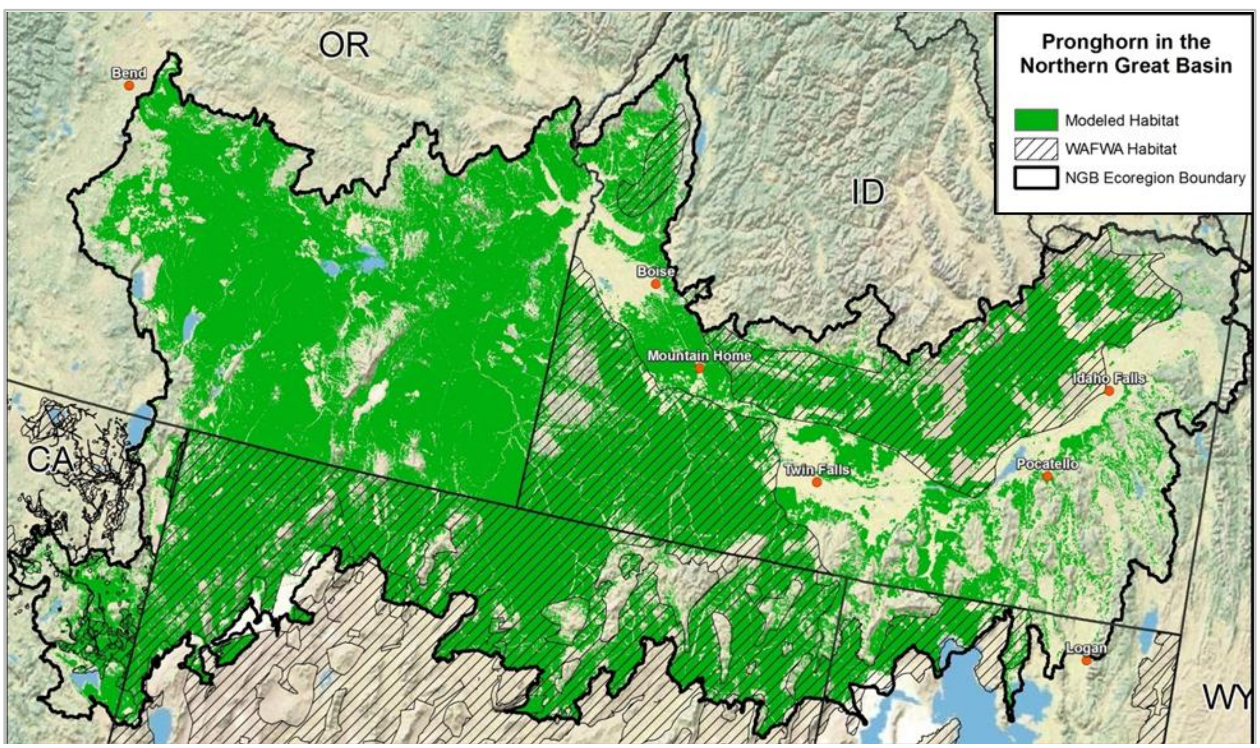



Figure 6.2-18. Comparison of State Agency Pronghorn Range Data with Modeled Pronghorn Habitat

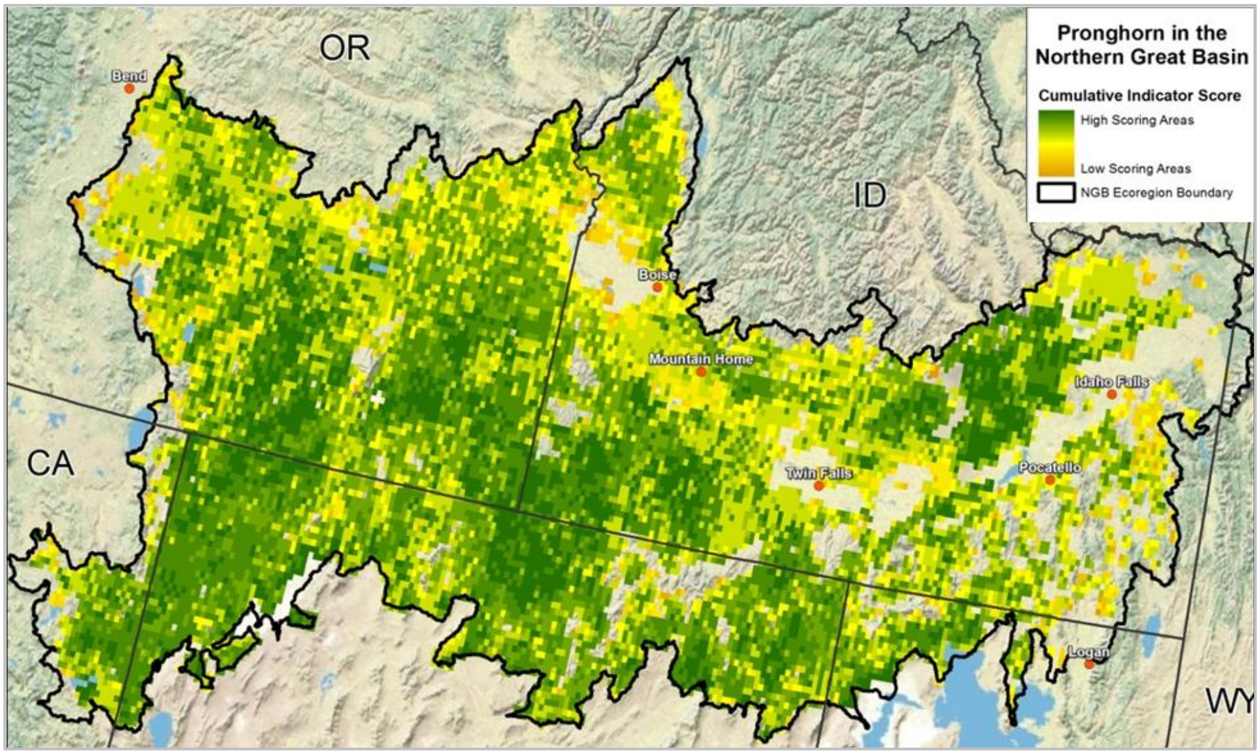


Figure 6.2-19. Cumulative Indicator Score for Modeled Pronghorn Habitat

### Future Threats

The cumulative threats to pronghorn could result in increasing habitat fragmentation, which may affect migrations and seasonal range use. Pronghorn are a shrubsteppe obligate species, and as sagebrush communities are converted, degraded or fragmented, pronghorn populations are expected to decline. Pronghorn are adapted to a mosaic of age classes of sagebrush and other shrubs as maintained by natural fire frequencies. Increasing cheatgrass cover is predicted for northwestern Nevada with significant risk of invasion into some of the best and least-fragmented pronghorn habitat in the ecoregion. Due to cheat grass invasion, poor historic grazing management and increasing frequency of droughts, wildfires now are larger and occur more frequently, reducing habitat quality and quantity of sagebrush communities. With an increasing number of fires exceeding 100,000 acres during the last decade, fire is currently the major contributing factor to the transition from shrubsteppe to grassland habitat which do not support productive pronghorn populations. Although cattle and pronghorn tend not to compete for forage directly, effects of poor grazing management and fence construction have led to the deterioration of pronghorn habitat throughout the west. Management of pronghorn habitat thus should emphasize the reduction of additional stressors due to fragmentation and wildfire. Sound grazing management is a key factor in maintaining productive pronghorn ranges.

Climate change effects on big game species are primarily related to changes in vegetation communities, fire regimes, plant productivity, water availability (in arid environments), and the amount and persistence of snow pack affecting winter range. The predicted changes associated with climate change for the NGB pronghorn ranges include increasing winter and spring precipitation. Increased early season precipitation may favor the spread of cheatgrass in pronghorn habitats, which may displace native shrubsteppe communities and exacerbate fire frequency and extent by providing more abundant continuous fuel sources during the dry summer months. Most of the pronghorn range throughout the ecoregion is already fragmented and affected by roads, agriculture and development. Increasing development, and possibly energy exploitation will cause further habitat decline.

## 6.2.10 Bighorn Sheep
Fine-Filter Conservation Element

Bighorn sheep (*Ovis canadensis*)
Photo: Tim Keating, USGS

Two subspecies of bighorn sheep, the California (*Ovis canadensis californiana*) and Rocky Mountain (*O.c. canadensis*) inhabit portions of the NGB. Bighorn sheep prefer rugged, open habitats with high visibility of their surroundings. Survival is positively correlated with amount of cliff faces, rimrock, and rocky outcroppings, particularly important for lambing and escape from predators. The most common habitats include include alpine and sub-alpine, open grasslands, shrub-steppes. In lower elevation canyons, this species will utilize steep bunchgrass slopes interspersed with rock rims. Seasonal migrations occur in most populations, and open grasslands and shrublands typically provide winter ranges. Diets are diverse and can include grasses and sedges, browse, or forbs. Bighorn sheep typically remain close to escape terrain and avoid open valley bottoms, stream coridors, roads, and forested areas. Disease transmission from domestic sheep grazing within bighorn ranges has been the cause of numerous die-offs of bighorns and is a major management issue (Larkins 2010).

### Current Status

The AMT decided the main dataset to be used for the distribution of bighorn sheep within the ecoregion was the WAFWA 2011 dataset (Figure 6.2-20). This dataset is a combination of state data available with no additional information on ranges or habitats.

Key Ecological Attributes used to create a cumulative indicator score for bighorn sheep habitat included habitat size, escape terrain, horizontal visibility, distance to barriers, distance to human disturbance/presence and risk of disease transmission (Figure 6.2-21). Bighorn habitat in western Nevada and in Oregon appears to have the highest quality, while populations occupying habitat in eastern Nevada and Idaho appear to experience significant threats, primarily from fragmentation, but domestic sheep disease threats are locally important in large portions of southeastern Idaho and northern Nevada.

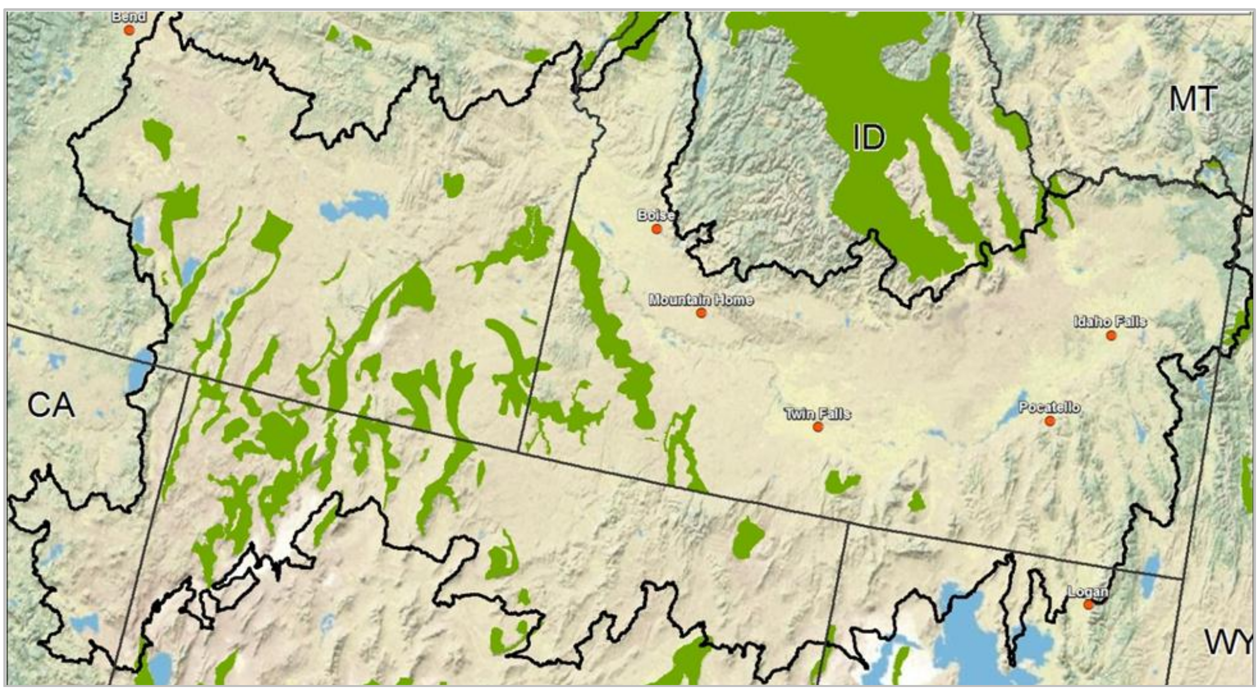



Figure 6.2-20. Bighorn Sheep WAFWA Range Habitat (WAFWA 2011)

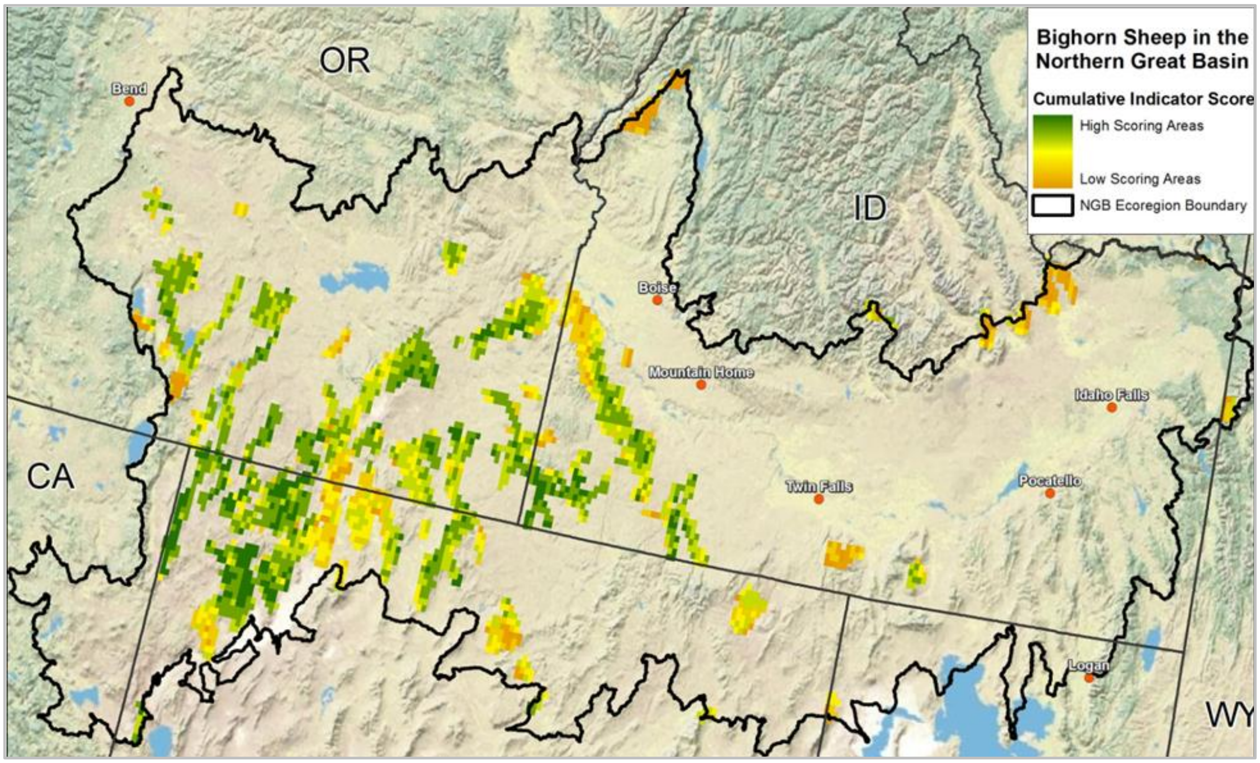



Figure 6.2-21. Cumulative Indicator Score for Bighorn Sheep Habitat

### Future Threats

Currently, many bighorn sheep populations within the ecoregion appear highly vulnerable. The cumulative threats to bighorn sheep within the NGB ecoregion and its habitat include an elevated risk of increasing fires, which may promote irreversible ecological state transitions away from preferred native grassland and shrub-steppe habitats. Human development, tree encroachment and diseases transmitted from domestic sheep are considerable stressors. Bighorn sheep are relatively intolerant to poor range condition, interspecific competition, and habitat alteration.

Cheatgrass is the primary invasive species affecting bighorn sheep by reducing the cover of forage species and sustaining detrimental fire regimes. Wildfire in fragmented habitat or when fires are extremely large (as can be expected under future climate and invasive weed scenarios) may reduce the available habitat. Low-elevation herds are especially vulnerable to habitat changes associated with short fire intervals. Bighorns are susceptible to the bacterial pneumonia pathogens, especially *Pasteurella haemolytica* (Kraabel and Miller 1997). The current close proximity of several domestic sheep allotments in Northern Nevada and southern Idaho are a risk factor to bighorns. Bighorns and domestic livestock (primarily cattle) generally are spatially separated due to different diets and habitat preferences; however bighorn sheep have been observed to vacate areas grazed by cattle, possibly associated with social intolerance and avoidance (King and Workman 1984).

The predicted climate changes throughout the NGB include increases in winter and spring precipitation which may increase forage quality, but may also support further tree encroachment into grasslands. Decreased precipitation in early fall months may detrimentally affect forage availability during these months. As developments increase, higher elevations are likely to receive disproportionate pressure due to the availability of water, scenery and recreational opportunities. Expansion of outdoor recreation, such as off-highway vehicle traffic, hiking and skiing are expected to increasingly affect bighorn sheep.

## 6.2.11 Mule deer
### Fine-Filter Conservation Element

Mule deer in the Northern Great Basin ecoregion inhabit areas primarily classified as sagebrush (*Artemisia* spp.) and other shrub-steppe habitats. Riparian and woodlands are often interspersed within the shrub-steppe habitats, providing a mosaic of habitat types used by mule deer. Agricultural areas are also used throughout the year. Mule deer are habitat generalists, but are highly selective foragers (browsers) that rely on specific components of these diverse habitats (palatable shrubs and forbs). Vegetation disturbance and subsequent renewal is a key element to maintaining high quality deer habitat; however, many natural disturbance regimes have been altered over the last decades and significant habitat loss has occurred for mule deer.

Mule deer (*Odocoileus hemionus*)
Photo: Nevada Department of Wildlife.

### Current Status

Mule deer habitat was modeled as a combination of existing range maps developed by the Western Association of Fish and Wildlife Agencies and the Habitat Core Area toolset developed by the Washington Wildlife Habitat Connectivity Working Group (WHCWG 2010) (Figure 6.2-22).

Key Ecological Attributes included size of Core Habitat Fragments, snow depth, patch fragmentation, distance to roads, and road density. The result of this analysis identified the higher and lower scoring areas across of the mule deer range in the ecoregion (Figure 6.2-23). The increasing fragmentation of habitat in agricultural areas of the ecoregion, as evidenced by higher road density and smaller patches of habitat, and coupled with invasion of cheatgrass into shrubsteppe ecosystems provides for a high stress environment for mule deer.

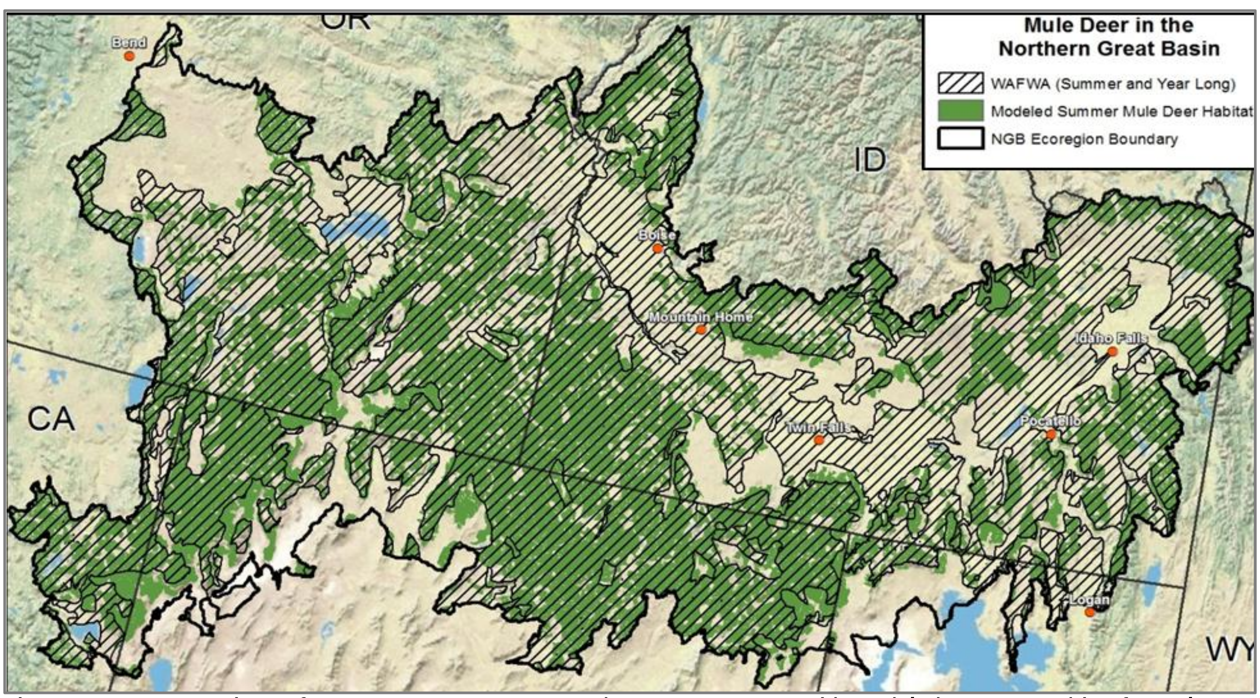



Figure 6.2-22. Comparison of WAFWA Summer Range and Year-Long Range with Modeled Summer Habitat for Mule Deer

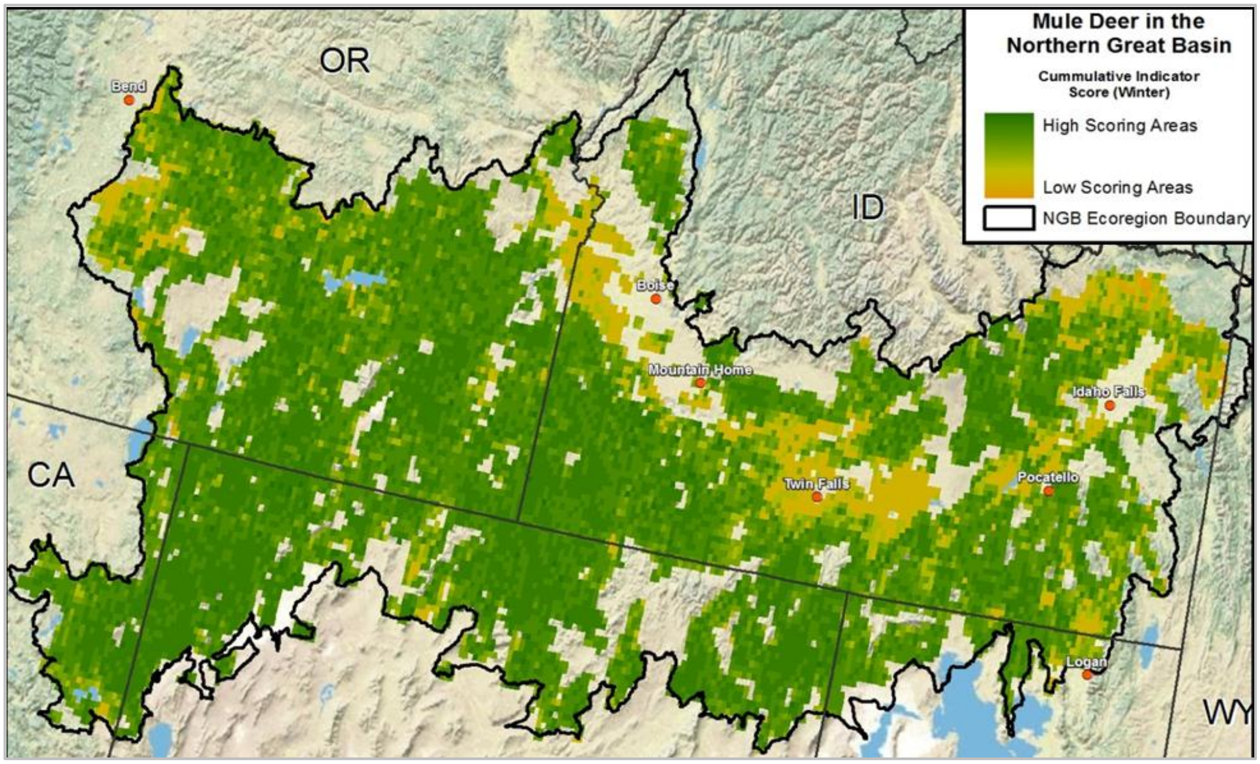



Figure 6.2-23. Cumulative Indicator Score for Modeled Mule Deer Winter Habitat

### Future Threats

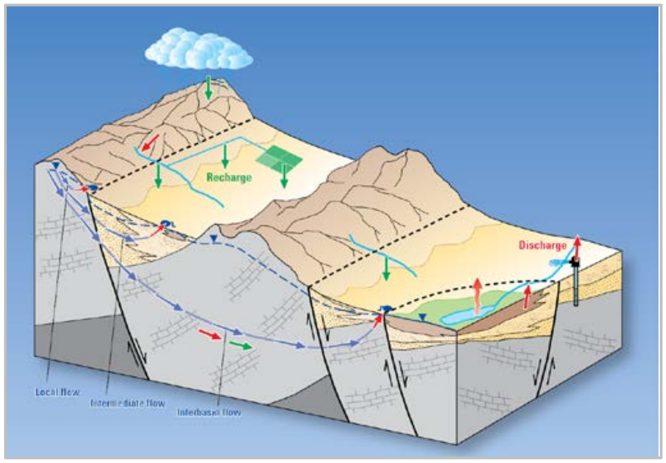
The cumulative threats to mule deer and its habitat include an elevated risk of increasing fires, which may promote irreversible ecological state transitions away from preferred shrub-steppe habitats and towards grass-dominated systems at lower elevations, and possible denser woodlands at higher elevations, Both transitions do not favor mule deer and accelerated habitat loss may occur as a result of the cumulative threats in the future.

Large-scale habitat fragmentation resulting from agricultural development, roads and urban development over the last 150 years has greatly affected the quality of the most productive mule deer winter habitat in the region. Summer habitat is also threatened by future urban/exurban expansion, agriculture, alternative and traditional energy development, and linear features (especially roads). Wildfire now covers larger areas and occurs more frequently, reducing habitat quality and quantity of preferred vegetation communities used by mule deer. Furthermore, increased fire frequency has shortened the interval between fires, and thus reduced the time window for sagebrush and other browse species to recover. Increasing cheatgrass cover is predicted for much of the ecoregion with significant risk of invasion into some of the best and least-fragmented mule deer habitat that is remaining in the ecoregion. As cheatgrass invades areas, increasing fire frequencies may affect not only the availability of quality browse, but also generate increasing development of fire roads and fire suppression activities.

Most rangeland improvement for livestock grazing aims to increase grass cover and develop water sources for domestic livestock; habitat improvement for mule deer is generally not the focus of management actions. These management actions have variable effects on mule deer. Climate models predict added moisture during spring which is expected to increase the amount of cover and browse, both factors that may reduce fawn mortality and bolster the nutritional status of parturient and lactating does. On the other hand, higher biomass and vegetation growth may exacerbate the risk of frequent wildfires later in the summer, which may eliminate or reduce important browse species. Added moisture in higher elevations may also increase growth of coniferous forests that in return may out-compete and out-shade browse species.

## 6.3 Coarse-Filter Conservation Elements

### 6.3.1 Groundwater
Coarse-Filter Conservation Element




Increasing groundwater withdrawals and changes likely to occur to the available groundwater supply are of key interest to resource managers. Groundwater withdrawals eventually result in a reduction in the discharge of an aquifer, reducing the flow of springs, streams, and the extent of groundwater dependent wetlands and riparian systems (Bredehoft and Durbin 2009).

### Current Status

Over 90 percent of the groundwater withdrawals in the ecoregion are used for agriculture. Groundwater withdrawals have also increased in the ecoregion by over 50 percent from 1995 to 2005 (Figure 6.3-1) as agricultural lands have shifted from surface water to groundwater to supply irrigation (Slaughter 2003; Kenney *et al*. 2009).

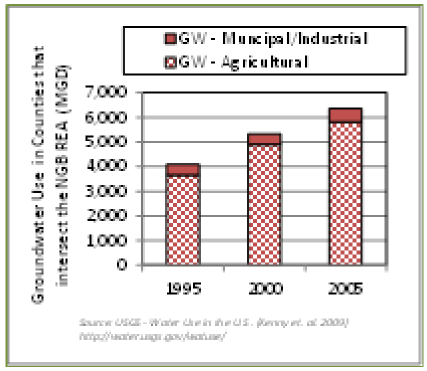



Figure 6.3-1. Groundwater Use

Portions of the ecoregion, especially in the Snake River Plain and developed basins in the Northern Great Basin, have water levels below or much below normal and show declines in groundwater elevations over time, indicating groundwater use in excess of recharge (Figure 6.3-2). On average, groundwater levels are declining by -0.58 feet per year across the ecoregion.

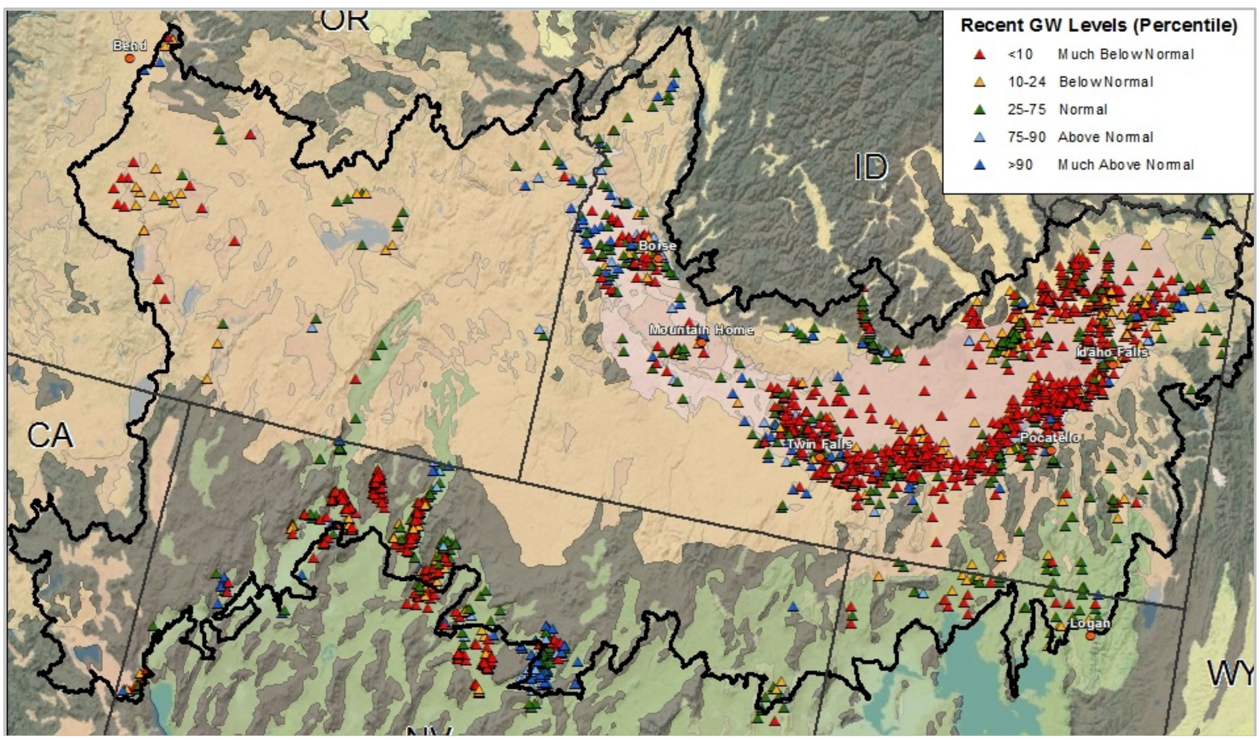



Figure 6.3-2 .Current Groundwater Levels – Percentile Class

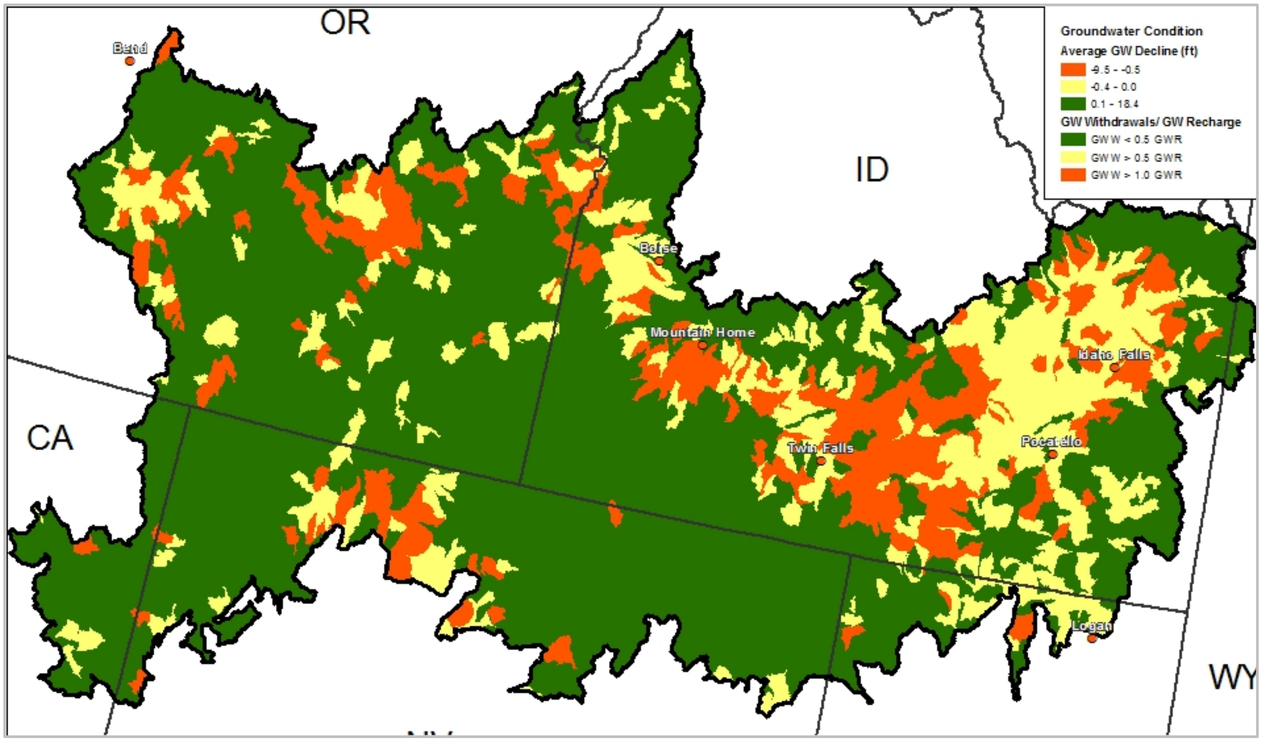



Figure 6.3-3. Current Groundwater Conditions

### Future Threats

The greatest threat to the groundwater resource in the REA is increasing groundwater extraction for agriculture and urban development. Areas in the ecoregion with significant declining water levels or groundwater extractions in excess of groundwater recharge are more likely to experience reductions in surface water flows in springs, seeps, and streams, degrading the habitat for resources that depend on those flows such as spring snails and coldwater fish.

While the overall water use will likely be relatively stable in the near future, the continuation of the shift from surface water to groundwater use for irritation in the ecoregion will likely put more pressure on the groundwater resources (Figure 6.3-3). With 90 percent of the groundwater extractions used in agriculture, changes in agricultural practices that result in more efficient use of water would have the greatest impact on reducing extraction rates.

Climate models predict a slight increase in total precipitation in the basins, valleys, and uplands and large increases in total precipitation the mountains by 2060. Observed climate trends in the Owyhee Uplands on Reynolds Creek have measured seasonal shifts in streamflow due to increased temperatures, with larger streamflows in winter and early spring and reduced streamflow in summer (Nayak *et al.* 2010). While increased precipitation generally would result in corresponding increases in groundwater recharge, seasonal shifts in runoff patterns can affect recharge patterns, making climate change impacts to groundwater recharge difficult to predict. The models also predict no change in annual temperature across the entire ecoregion. However, temperatures are expected to increase by one degree in July and August which could result in an increase evapotranspiration and a resulting increase in agriculture water use in those months.

## 6.3.2 Springs and Seeps
Coarse-Filter Conservation Element

Thousand Springs. Photo from www.idahobyways.gov.

Springs in arid regions are isolated and have experienced endemism and other processes that can make each spring a unique feature (Miller *et al.* 2007). They often support rare plants that are restricted to habitats with wet or marshy soils, as well as springsnails, pillbugs, amphipods and arthropods particular to isolated individual or small groups of springs. Springs can also be important stopover or nesting sites for summer resident or migratory neotropical bird species. The springsnail of the genus *Pyrgulopsis*, is of special interest in the ecoregion, and the increased investigation of the species that has occurred has resulted in rapidly expanding the number of species being described (approximately four per year since 1994).

### Current Status

Surface water irrigation in the Snake River Plain in the first half of the 20th century increased spring discharge near the Snake River; however, a decrease in surface water irrigation and an increase in groundwater withdrawals have led to declining spring flows since the 1950s (Figure 6.3-4). There are currently 47,222 springs and seeps mapped by the USGS in the ecoregion, but this may underrepresent the springs in the region. Based on Smithsonian collection records, spring snails (*Pyrgulopsis sp.*) are distributed throughout the ecoregion although these records should not be assumed to be comprehensive (Figure 6.3-5).

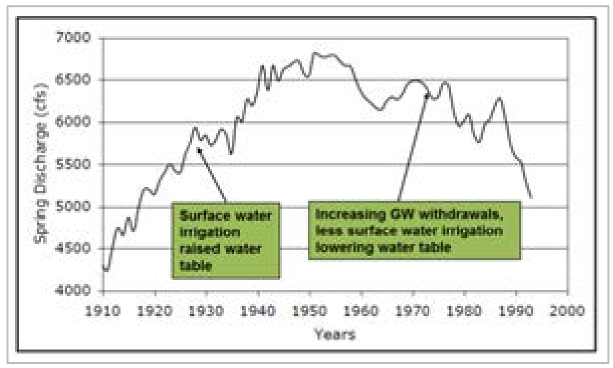



Figure 6.3-4.Spring Discharge Snake River

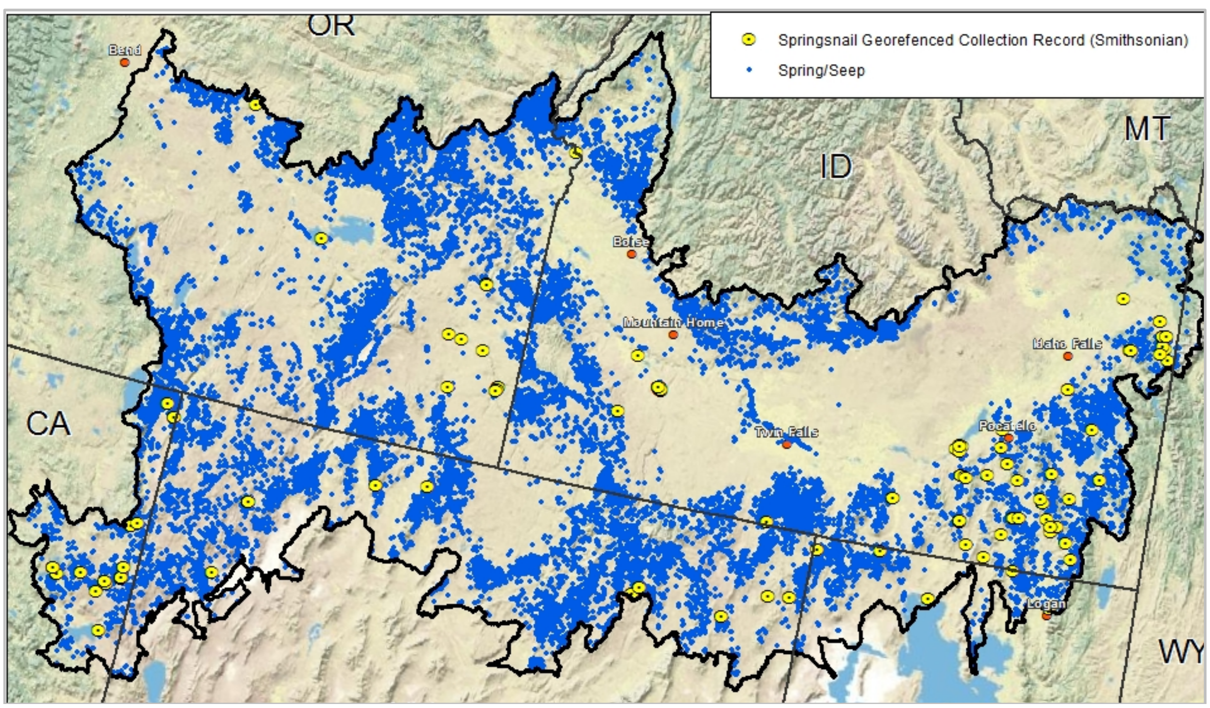



Figure 6.3-5. Springs, Seeps, and Spring Snails

Groundwater condition and the effects from groundwater withdrawals are most important in evaluating the status of springs and seeps ecosystems. Springs are dependent upon groundwater sources for water recharge and sensitive to changes in water supply. Figure 6.3-6 overlays the estimated areas that have declining groundwater conditions (see Groundwater Conservation Element Package, Appendix B) with the springs, seeps and spring snail records.

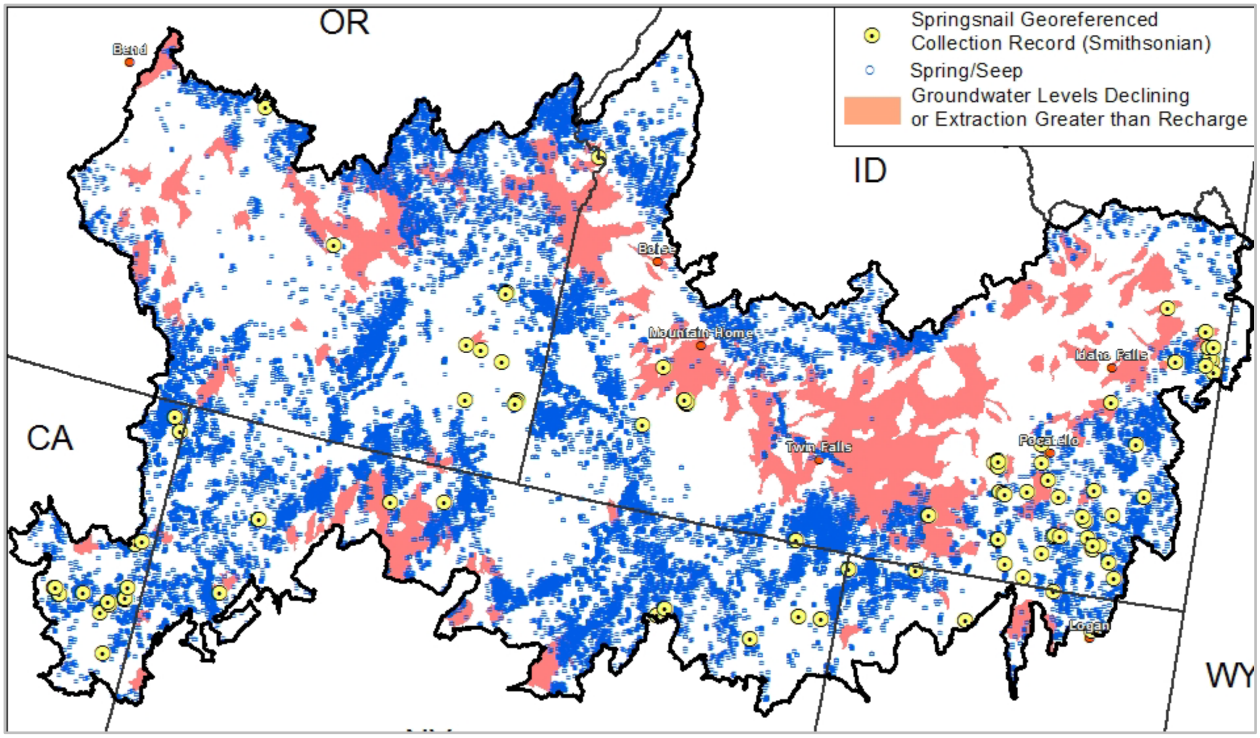



Figure 6.3-6. Springs, Spring Snails, and Areas with Declining Groundwater Tables

### Future Threats

The primary threat to springs and seeps in the ecoregion results from agricultural groundwater withdrawals. Groundwater withdrawals have increased by 20 percent from 2000 to 2005 and there is evidence of declining groundwater levels in agriculturally developed areas. If the trend of increasing groundwater use to replace surface water use continues in the ecoregion, groundwater levels are likely to continue to decline in portions of the ecoregion and impact spring and seep flows. Many nonnative species have been introduced into North American waters, which have changed the structures of native communities and caused extinction through hybridization, predation, and competition (Sada and Vinyard 2002). Introductions of the red-rimmed thiara may have led to reductions in spring snail populations in southern Nevada, just outside of the ecoregion (Sada and Vinyard 2002). The spread of invasive aquatic species can also locally impact endemic spring species. Livestock grazing often involves the development of springs and can also impact water quality.

Livestock can trample and disturb riparian vegetation surrounding springs, impact water quality by increasing nutrient and bacteria concentrations. Grazing activities may also result in the development (piping) of springs for water sources which could reduce habitat quality for native plants and animals. Climate modeling for the ecoregion predicts a slight increase precipitation in the basins, valleys, and uplands and large increases in precipitation the mountains by 2060 (RegCM3; Hostetler *et al.* 2011). However, climate change may result in seasonal shifts in streamflow. As a result, climate change impacts on spring flow are difficult to predict. Wildfire could change vegetation composition and slightly impact recharge to springs and seeps.

## 6.3.3 Perennial Streams and Rivers
Coarse-Filter Conservation Element

Bruneau River. Photo from Idaho BLM.

Perennial streams and rivers are dynamic physical and biological systems that are the focus of management and restoration efforts in the ecoregion. Perennial streams and rivers provided habitat for coldwater fish, bull trout, and white sturgeon, as well as important riparian habitat for birds and other wildlife species along their banks. The habitat conditions of streams and rivers are largely dependent on the types and condition of plants and other land cover in the contributing watershed (Horne and Goldman 1994).

### Current Status

Perennial rivers have been substantially altered near areas of agricultural development. The Snake River Plain supports over 3 million acres of agricultural land with over 99 percent of the surface water diversions in the ecoregion for agricultural irrigation (Figure 6.3-7). Peak flows in mountainous areas generally occur in May, with the lowest flows occurring in winter. However, in the heavily-regulated and spring-fed Snake River flows are steadier throughout the year, with significant declines in summer during the peak irrigation months (Figure 6.3-8).

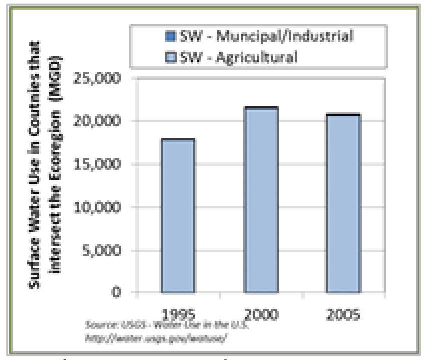



Figure 6.3-7. Surface Water Use

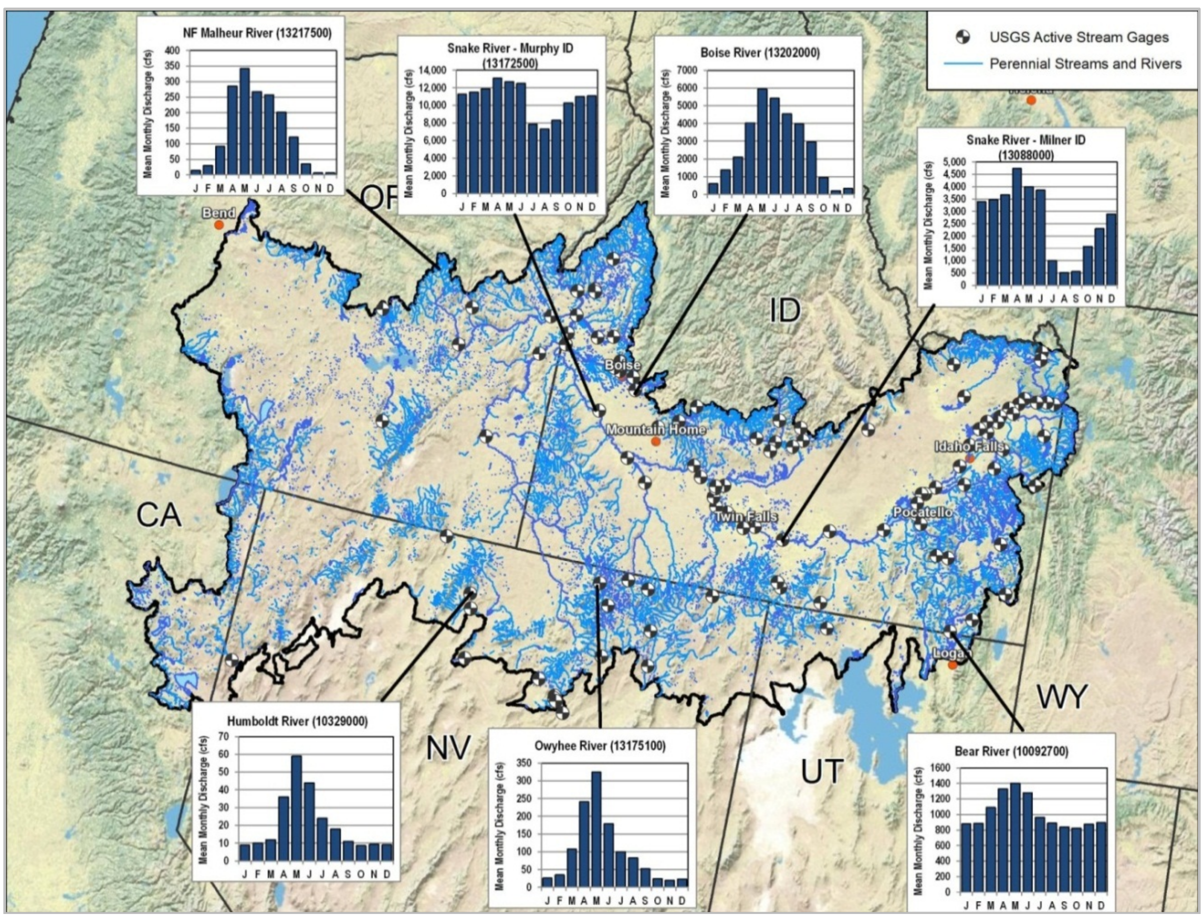



Figure 6.3-8. Perennial Streams and Rivers with Monthly Flow Statistics

Five metrics were used to cumulatively assess the health and function of perennial streams and rivers: water quality based on 303(d) criteria, detection of aquatic invasives, flow regulation by dams, groundwater condition based on water level data, and riparian condition based on development in the riparian corridor (Figure 6.3-9).

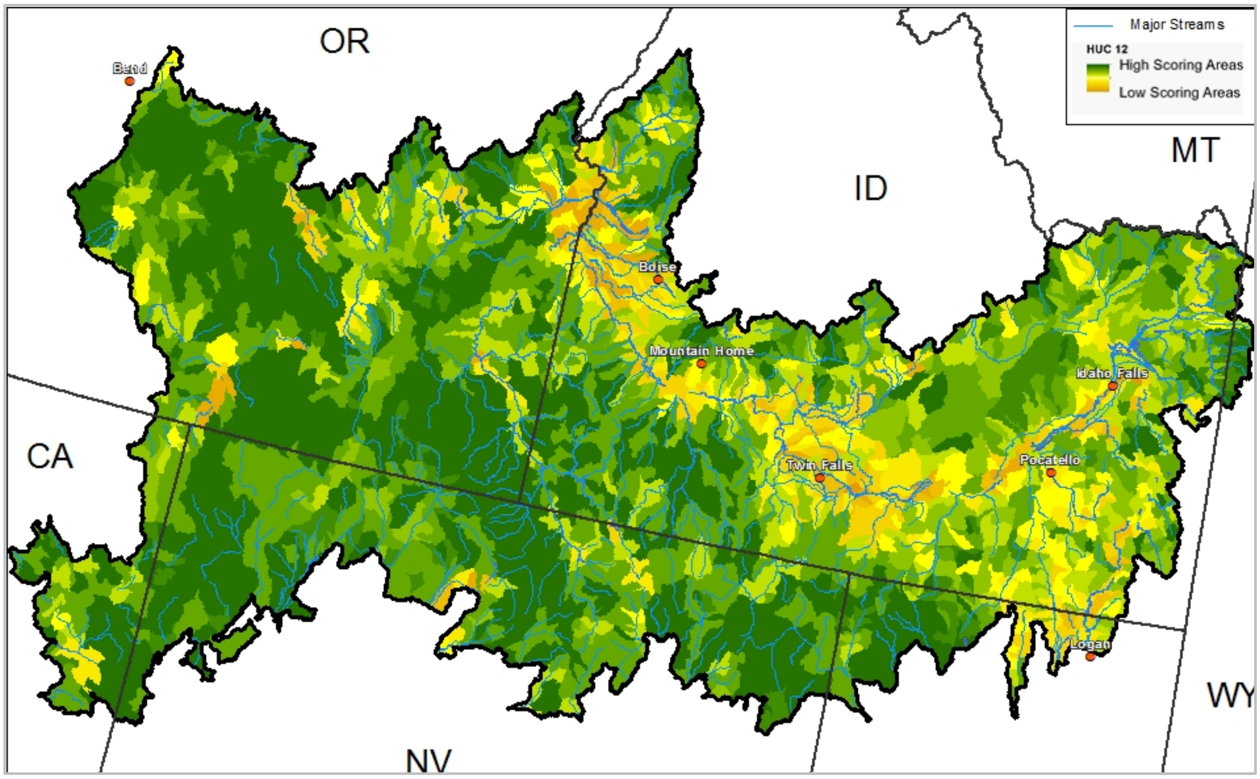



Figure 6.3-9. Streams and Rivers Cumulative Indicator Score

### Future Threats

Historically, agricultural development has been the primary change agent to perennial streams and rivers. However, agricultural surface water use has been stable the last decade. Agricultural development in the ecoregion has resulted in widespread construction of dams or diversion structures for surface water withdrawals that have reduced flows. Tailwater from agricultural irrigation can also have elevated concentrations of nutrients and pesticides, impairing water quality. Increasing groundwater withdrawals also reduce flows in spring-fed sections of streams. Most Great Basin fish assemblages are dominated by non-native taxa, with 50 species of non-native fish taxa introduced. This has changed the structures of native communities and caused extinction through hybridization, predation, and competition (Sada and Vinyard 2002) and continues to threaten narrowly distributed, vulnerable, endemic fish populations.

Long-term snow, climate, and streamflow trends at the Reynolds Creek in the Owyhee Mountains, have measured increasing temperatures at all elevations with decreasing proportions of snow to rain at all elevations. As a result, streamflow has seasonally shifted to larger winter and early spring flows and reduced late spring and summer flows (Nayak *et al.* 2010). RegCM3 (Hostetler *et al.* 2011) climate modeling predicts a increases in temperature from November to February from the Owyhee uplands westward. Therefore, observed trends of larger winter and early spring flows and reduced late spring and summer flows could potentially continue. Fire can have temporary impacts on water quality due to sedimentation from erosion following fires. Larger, more severe fires, such as those in 2012, can threaten fish populations by temporarily removing riparian vegetation and result in increased stream temperatures. Poorly managed grazing can increase erosion, result in the trampling of riparian vegetation surrounding streams, and impact water quality by increasing nutrient and bacteria concentrations.

## 6.3.4 Open Water
### Coarse-Filter Conservation Element

Open water habitat areas include lakes, reservoirs, other large water bodies, and seasonally ponded habitats (playas). Water bodies in the West are extremely important and support diverse ecological communities with concentrated wildlife seasonal and migration use. The unique and diverse assemblage of terrestrial, emergent, and aquatic plant and animal species supported by open water habitats on a relatively small proportion of lands has increased the need for focused open water habitat management and restoration efforts.

Lava Lake

### Current Status

There are over 1.5 million acres of open water in ecoregion represented by 75,000 individual water bodies, with the majority of acreage associated with large water bodies of 10,000 acres or more of surface area (Figure 6.3-10). Sixty percent of the bodies are playa or intermittent lakes and 40 percent are perennial ponds/ lakes/reservoirs.

Four metrics were used to cumulatively assess the health and function of open water features: water quality based on 303(d) criteria, detection of aquatic invasives, distance from anthropogenic sources, and the fraction of undeveloped land in the watershed (Figure 6.3-11).

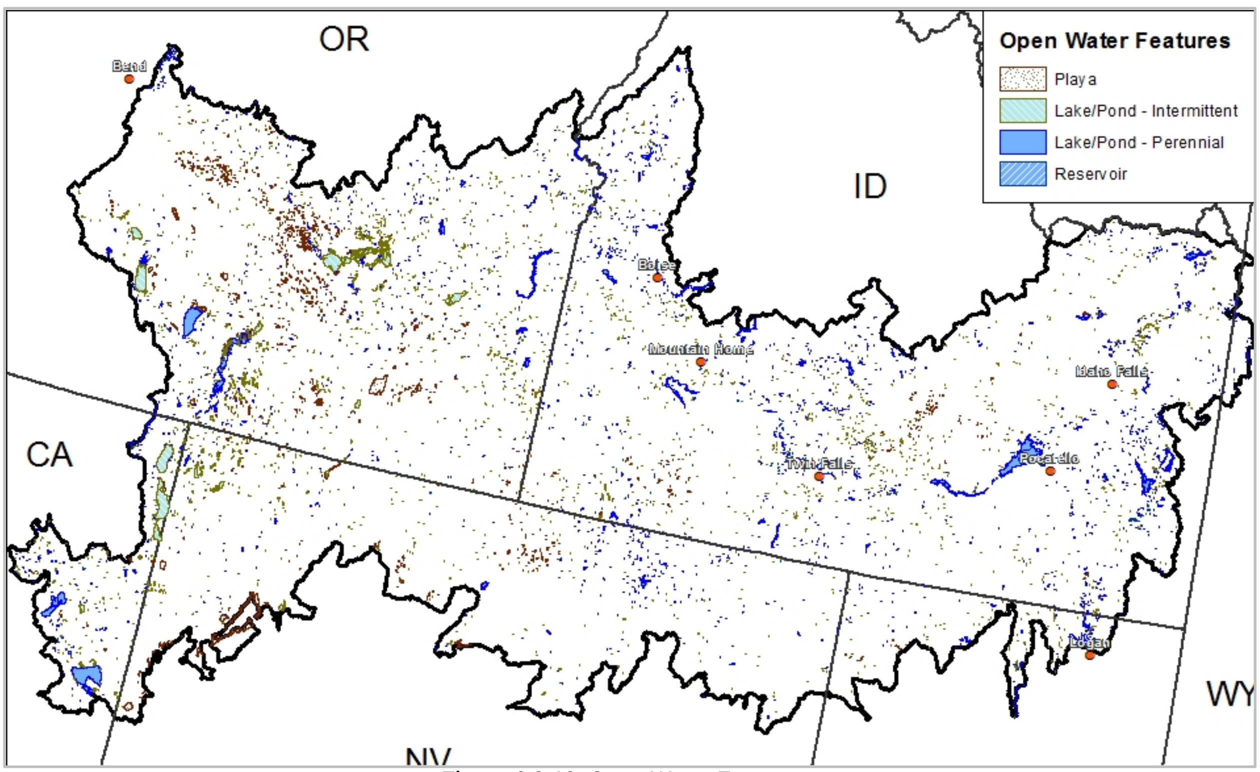



Figure 6.3-10. Open Water Features

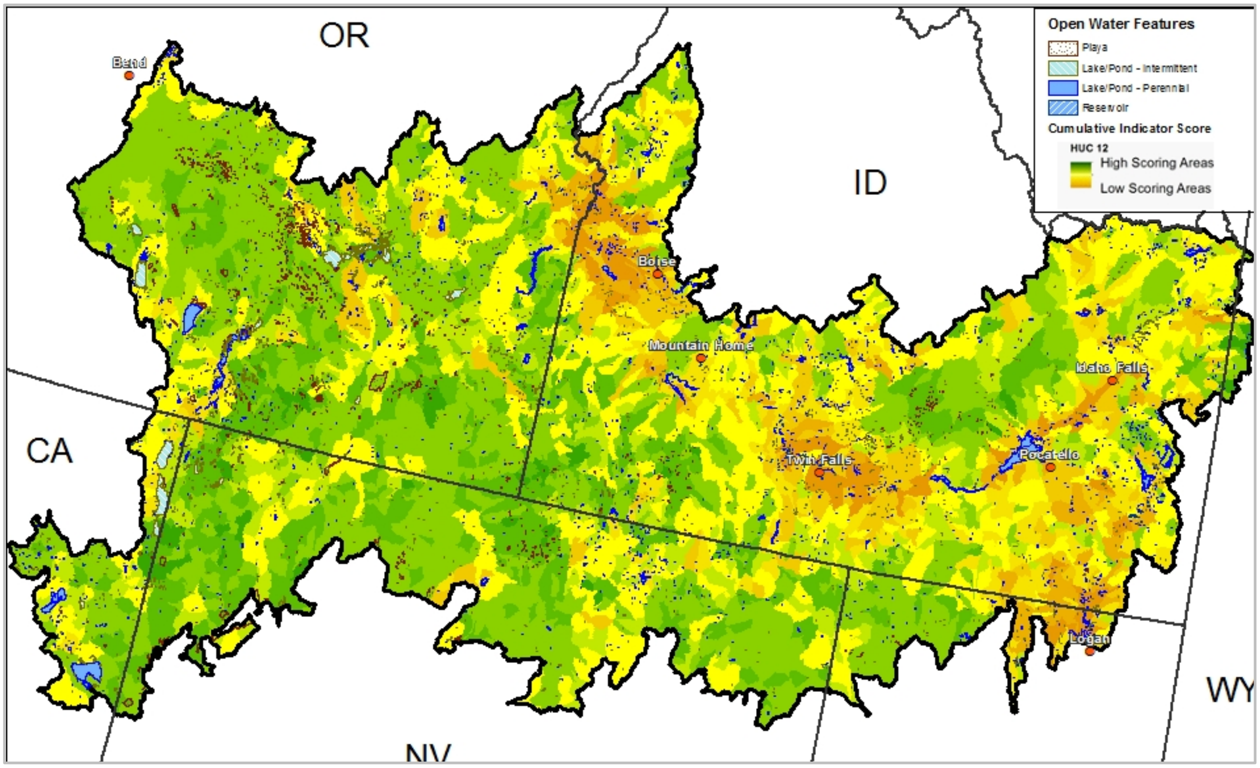



Figure 6.3-11. Open Water Cumulative Indicator Score

## Future Threats

Historically, agricultural development has been the primary change agent to open water bodies as 84 major dams have been constructed, greatly increasing the amount of open water in the ecoregion. However, agricultural water use has been stable the last decade and major dam construction peaked in the 1950s to 1970s. Future threats of concern include continued spread of aquatic invasives and increasingly frequent and larger wildfires that can result in the sedimentation of open water features.

Most Great Basin fish assemblages are dominated by non-native taxa with fifty non-native fish taxa and several invertebrate taxa introduced in the Great Basin. The most common introduced fish in open water bodies include channel catfish, largemouth bass, common carp, and brown trout. Forest fires accelerate sediment transport from mountain drainage basins. The erosion events following fires can result in reservoir sedimentation and shorten the lifespan of reservoirs within the ecoregion. Reservoirs filled with sediment often no longer function for their intended purposes and restrict fish migration in streams and rivers.

Overall, RegCM3 (Hostetler *et al.* 2011) climate modeling predicts increased precipitation, however, temperature increases from November to February could reduce the proportion of snow to rain and result in a seasonal shift of increased winter flows and reduced summer flows. In addition, increasing temperatures and decreasing precipitation in July and August, could increase irrigation demands at the height of summer. Grazing animals and pasture production can also negatively affect water quality in open water bodies through erosion and nutrients dropped by the animals and pathogens from the wastes (Hubbard 2004). In addition, tailwater from agricultural irrigation can also have elevated concentrations of nutrients which can lead to the eutrophication of open water bodies, and result in unpleasant odors or fish die-offs.

## 6.3.5 Vulnerable Soils
### Coarse-Filter Conservation Element


Dust Storm following Clover Creek Burn 2007. Photo from Idaho State University.

Soil erosion caused by water and wind is a natural phenomenon; however, human activities have accelerated the natural erosion process in some areas, which can cause widespread soil loss or degradation with ecosystem-level impacts. Vulnerable soils typically have fine texture (e.g., loess) and may be on sloping terrain or exposed to a long fetch in the direction of prevailing high winds. Lack of protective cover by vegetation can expose vulnerable soils to significant erosion. Vegetation cover is the best frontline defense against soil erosion. As vegetation cover is reduced, soil erosion exponentially increases (USACE 2004).

### Current Status

The vulnerable soils distribution was estimated based on inherent geophysical characteristics of the soils and topography in the ecoregion. Water erosion can occur by sheet, rill, or gully erosion. To evaluate soils that are vulnerable to water erosion on an ecoregional scale, the RUSLE equation was applied using the Rainfall Erosivity (R), Soil Erodibility (K), and Steepness(S) factors. Generally, the areas most vulnerable to water erosion are silt-textured and on steeper slopes in the ecoregion (Figure 6.3-12).

In the semiarid cold desert climates in the NGB ecoregion, wind erosion is most evident when vegetation is temporarily eliminated by wildfire (Sankey *et al.* 2009). Wind erosion following burning in the semiarid cold desert of the ecoregion might be of shorter duration, but is as great (or greater) in magnitude than many previously studied environments in Africa, Australia, and the U.S. (Sankey *et al.* 2009). Little to no erosion has been detected in unburned sites with vegetative cover in the ecoregion (Sankey *et al.* 2009). Figure 6.3-13 provides the rangeland wind erosion potential for the NGB ecoregion.

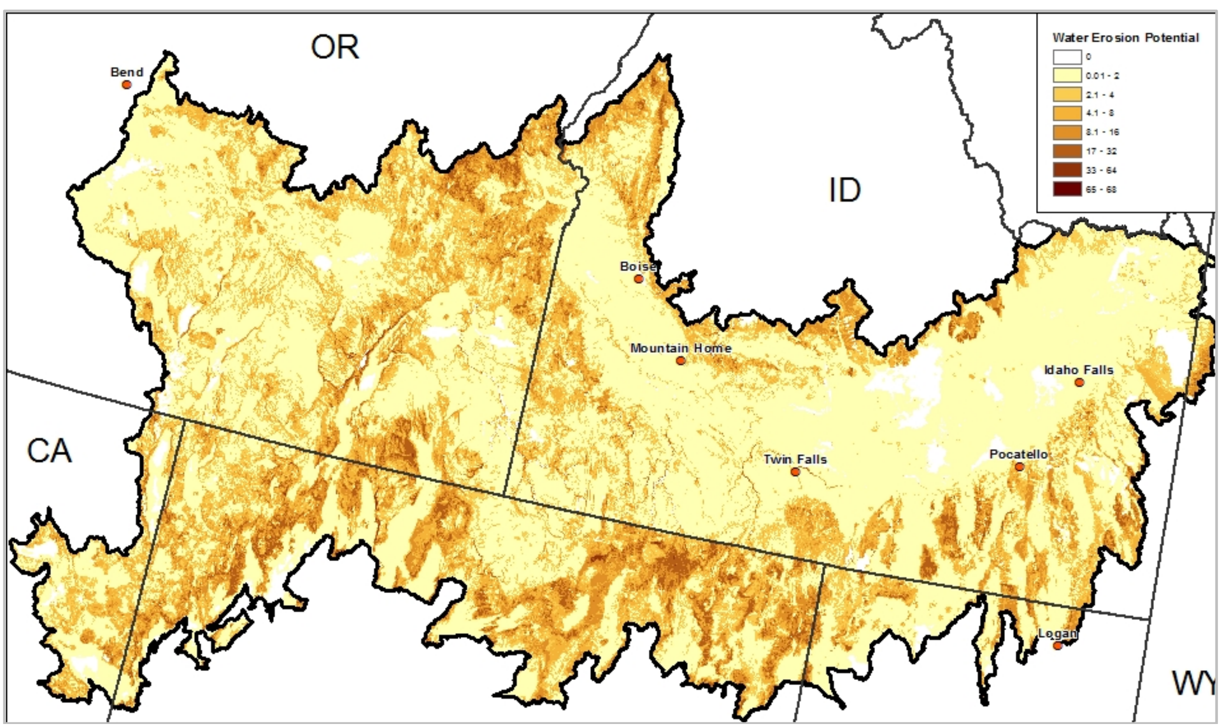


Figure 6.3-12. Water Erosion Potential

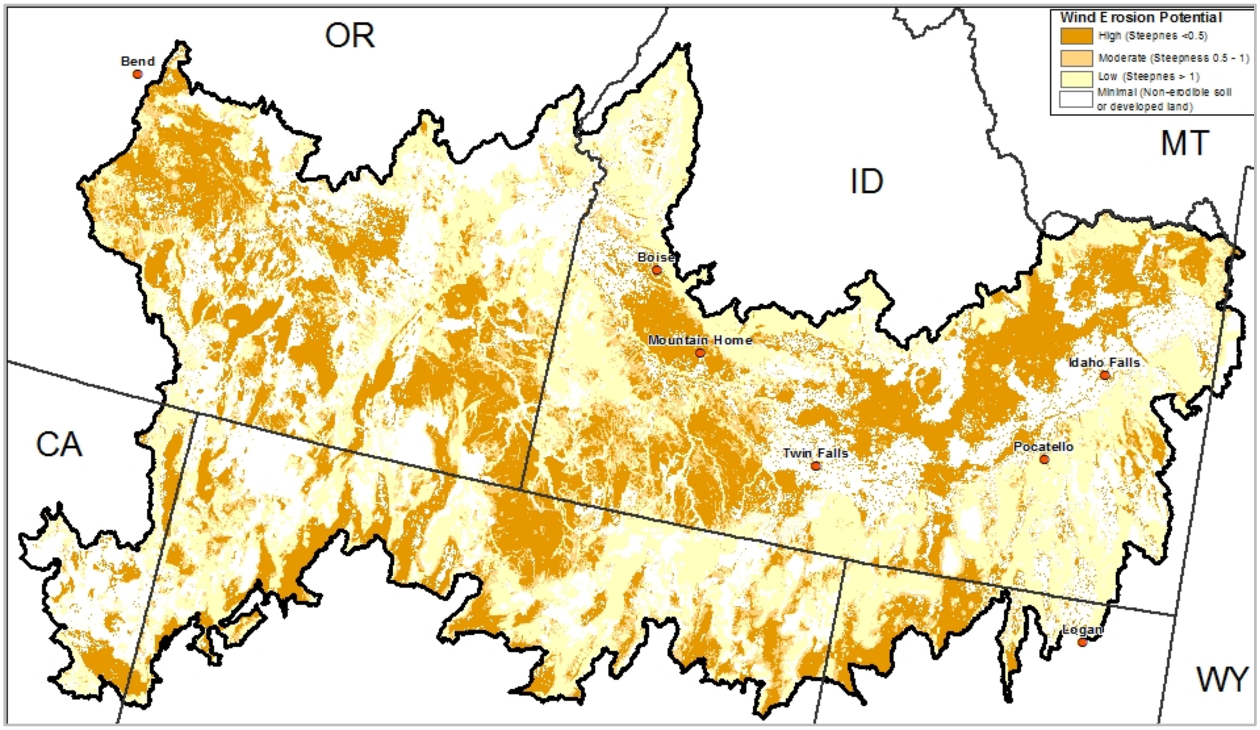



Figure 6.3-13. Rangeland Wind Erosion Potential

## Future Threats

The greatest threat to vulnerable soils is increasing wildfire frequency and severity in the ecoregion. Poorly managed grazing can also result in significant soil erosion and land degradation. Continued inventory, management, and focus on rangeland health would reduce impacts of grazing. Large, severe wildfires in the ecoregion (2012) have recently exposed large areas of bare soil to wind erosion. These post-fire large wind erosion episodes are of concern to the scientists and land managers in the ecoregion.

Poorly managed grazing that increases bare soil or modifies vegetation structure, can accelerate soil erosion. Based on the Fiscal Year 2012 Inventory of Grazing allotments in Idaho, over 80 percent of the inventoried allotments are meeting all standards or making significant progress toward meeting the standards and 20 percent of the allotments are failing to meet the standards (BLM 2012). Lands not meeting standards may have inadequate vegetation cover or structure to allow for soil protection. A change in climatic patterns of precipitation and temperatures can influence many factors indirectly affecting soil health, including insects and diseases. Vegetation damage and mortality reduces cover and can potentially create exposed soils.

Invasive species, particularly cheatgrass and medusahead, alter the fire regime and reduce persistent vegetation cover. Increasing dominance of invasive annuals produces fuel for wildfire and facilitates short fire return intervals, which exacerbates the potential for vulnerable soils. Annual grass monocultures do not have a diversity of aboveground vegetation to reduce ground-level wind speeds, and do not have a diversity of belowground rooting structures to stabilize soils, and are often lacking stabilizing biotic soil crusts. Off-road vehicle recreation near development areas can accelerate soil erosion in vulnerable soils.

## 6.3.6 Riparian
Coarse-Filter Conservation Element

Riparian habitats are dynamic systems that are important to a diverse assemblage of wildlife, aquatic and plant species, especially in the western U.S. where water can be available only seasonally or intermittently. Riparian vegetation in the NGB ecoregion is dominated by deciduous trees and shrubs, such as willows, mountain alder, aspen, cottonwood, and red-osier dogwood. Well protected riparian habitats reduce the amount of sediment, organic nutrient other pollutants in surface water runoff, create shade for lower water temperatures improving habitat for fish, provide a source of detritus and large woody debris for fish and other organisms, and provide room for water courses to establish geomorphic stability.

### Current Status

Based on riparian vegetation classes, there are 877,368 acres of riparian vegetation in the ecoregion. Healthy riparian corridors support biodiversity, water quality, flow regime, physical habitat and provides sources of food energy. The riparian corridor was estimated using the NRCS riparian forest buffer guidelines based on the width of the stream. Stream width was estimated using a regional curve based on the Salmon River, which correlates contributing area to stream width (Figure 6.3-14).

The estimate of the riparian condition was based on how much development has occurred in the riparian corridor. Figure 6.3-15 shows the fraction of natural land cover (undeveloped) in the riparian corridor by HUC 12 watershed. Ecoregion-wide, 16 percent of the riparian corridor has been developed with urban or agricultural land and 84 percent is undeveloped or natural land cover.

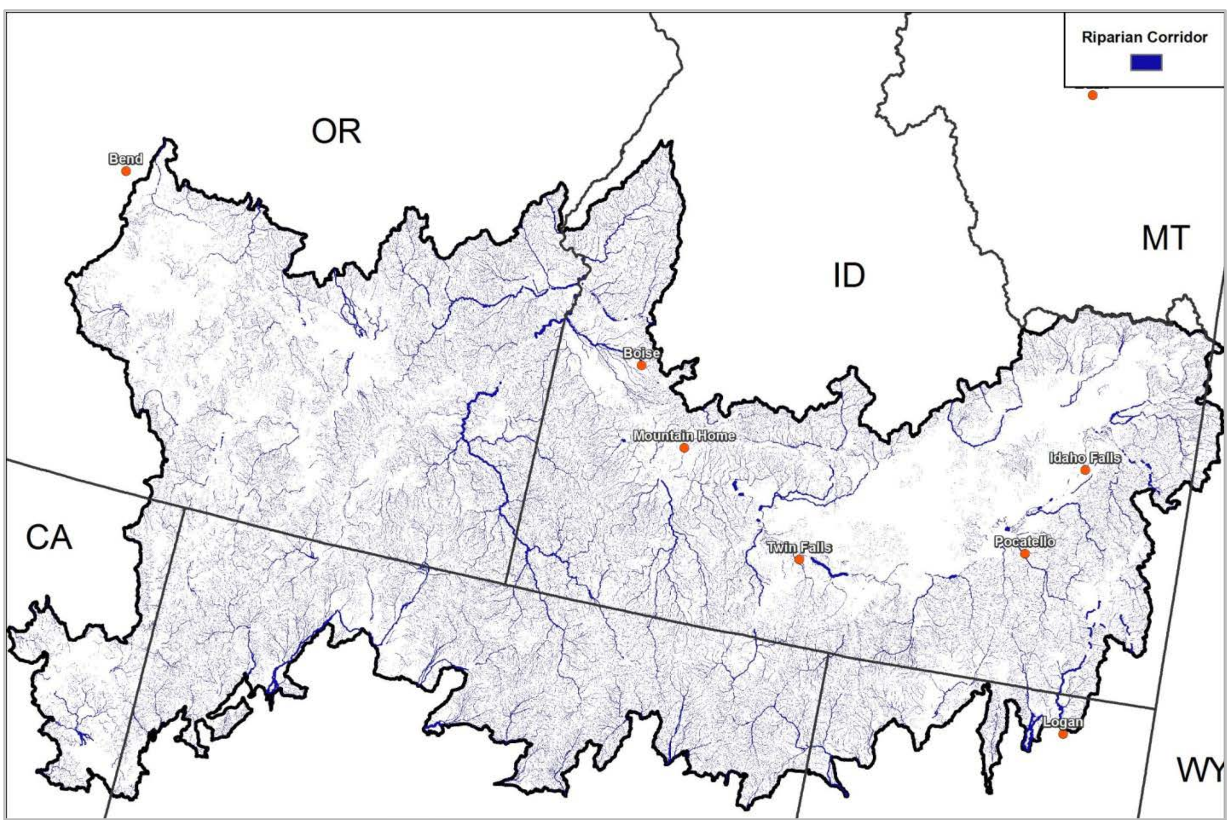



Figure 6.3-14. Estimated Riparian Corridor in the Ecoregion

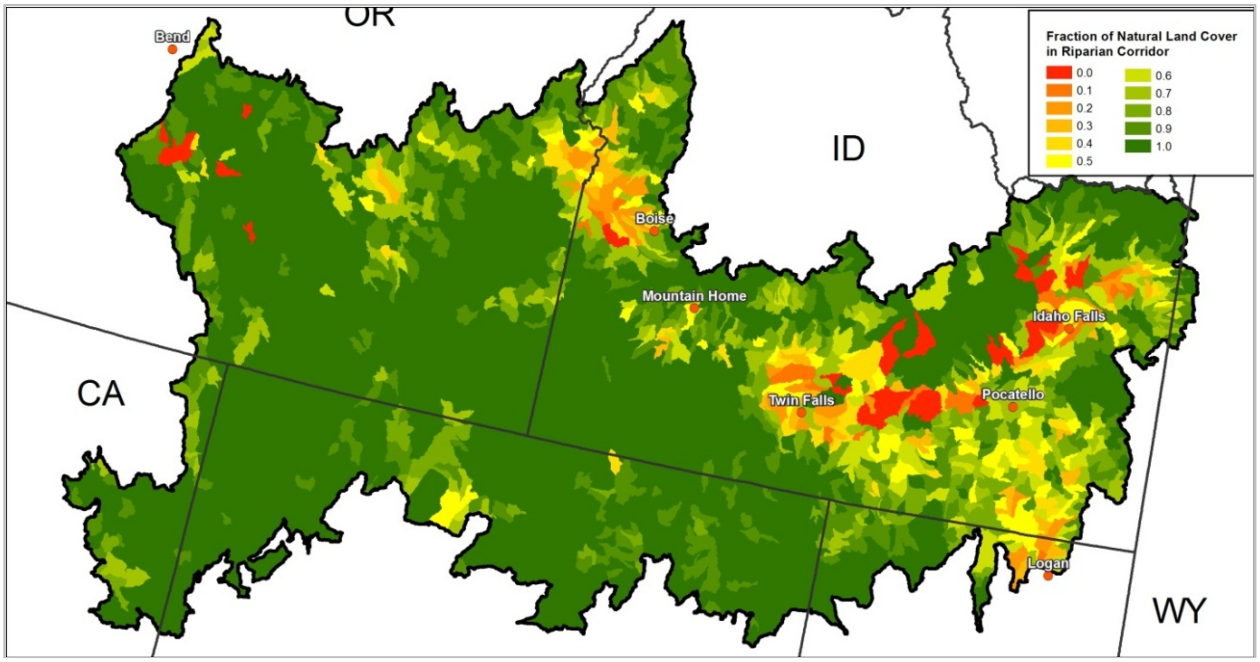



Figure 6.3-15. Fraction of Natural or Undeveloped Land Cover in the Riparian Corridor

### Future Threats

Historically, agricultural development has been the primary change agent to riparian habitats. However, agricultural surface water use has been stable the last decade. Future threats of concern include continued spread of invasive species (tamarisk and Russian olive) and poorly-managed livestock grazing in riparian areas. Riparian corridors have been most severely impacted by agricultural and urban development in the Snake River Plain. Development reduces riparian vegetation, which has the potential to result in greater temperature fluctuations, increased sedimentation, less woody debris, higher stream velocities, and increased pollution. In addition, groundwater extractions can lower the water table and reduce the growth of phreatophytic plants (plants that send deep roots to groundwater).

Saltcedar or tamarisk and Russian-olive are invasive woody plants that establish in riparian habitats, often outcompeting and displacing native plants (Shafroth *et al.* 1994). Both species are present in the Northern Great Basin, and Kerns *et al.* (2009) predicted that the range of tamarisk will expand within the NGB ecoregion in response to climate change.

While the RegCM3 (Hostetler *et al.* 2011) climate modeling predicts a slight increase in total precipitation in the basins, valleys, and uplands, and large increases in total precipitation in the mountains by 2060, climate modeling also predicts increased temperatures from November to February. These increases in winter temperatures could continue the observed trends of larger winter flows and reduced summer flows (Nayak *et al.* 2010). Fire can have temporary impacts on water quality due to sedimentation from erosion following fires. However, low to moderate intensity fires are important to land and stream form development.

## 6.3.7 Wetland
Coarse-Filter Conservation Element

Due to a number of practices including draining wetlands for agriculture, urban and rural development, Idaho has less than half its original wetlands and most remaining have some degree of degradation (IDFG 2004). Wetlands were selected as conservation element because there is concern for the loss of area and/or quality, and remaining wetlands require careful consideration and management by resource managers.

Wetlands are areas inundated or saturated by surface or groundwater and generally include swamps, marshes and bogs. This conservation element supports unique, biologically diverse communities and provides multiple functions to ecosystems such as preventing flooding; holding water; regulating flows; providing habitat; and filtering sediment, nutrients and toxins from water. Wetlands are used by terrestrial and aquatic species year-round, seasonally, and during migration.

### Current Status

Based on available National Wetlands Inventory and state wetlands data, wetlands occupy two percent of the NGB with a mapped acreage of just over 1.5 million acres. The majority of the wetlands are classified as fresh water emergent (75 percent) with the rest as Freshwater/Forested/Shrub Wetlands (18 percent), and Riverine (6 percent) (Figure 6.3-16).

Metrics utilized to cumulatively assess the health and function of wetlands at the ecoregion scale include: water quality based on 303(d) criteria, detection of aquatic invasives, groundwater condition, and the fraction of undeveloped land in the watershed (Figure 6.3-17).

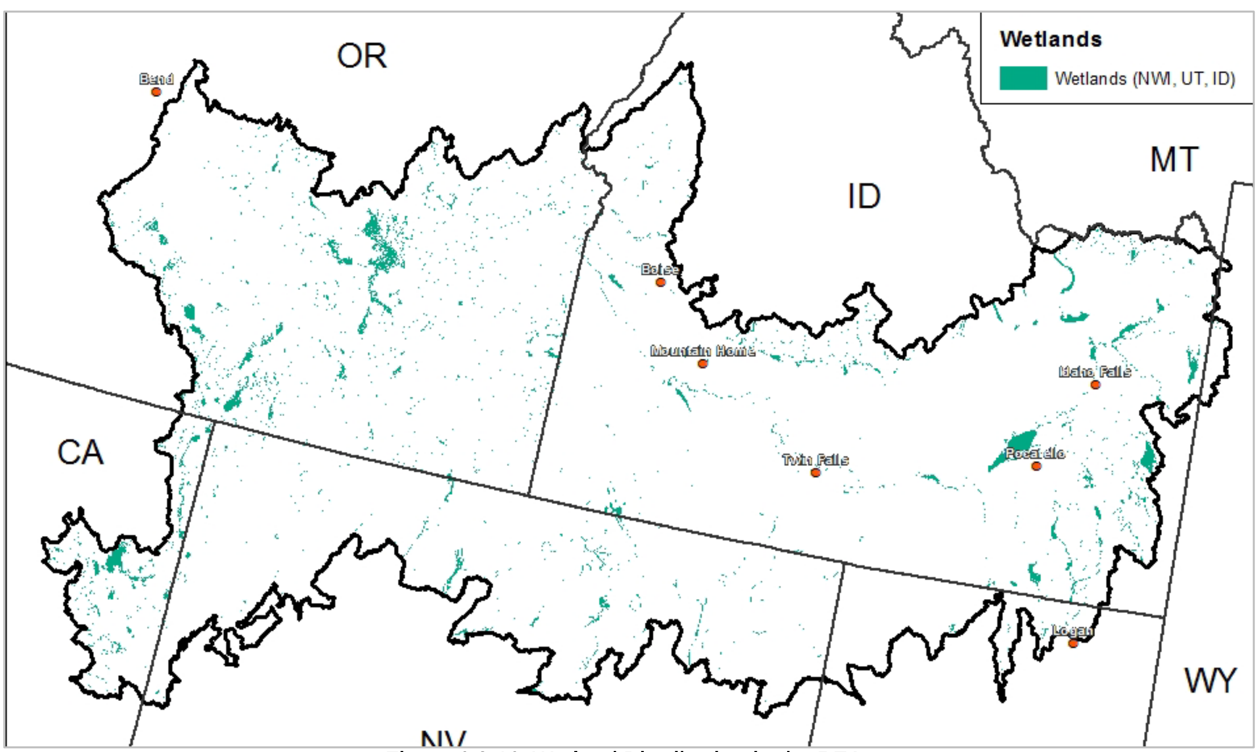



Figure 6.3-16. Wetland Distribution in the REA

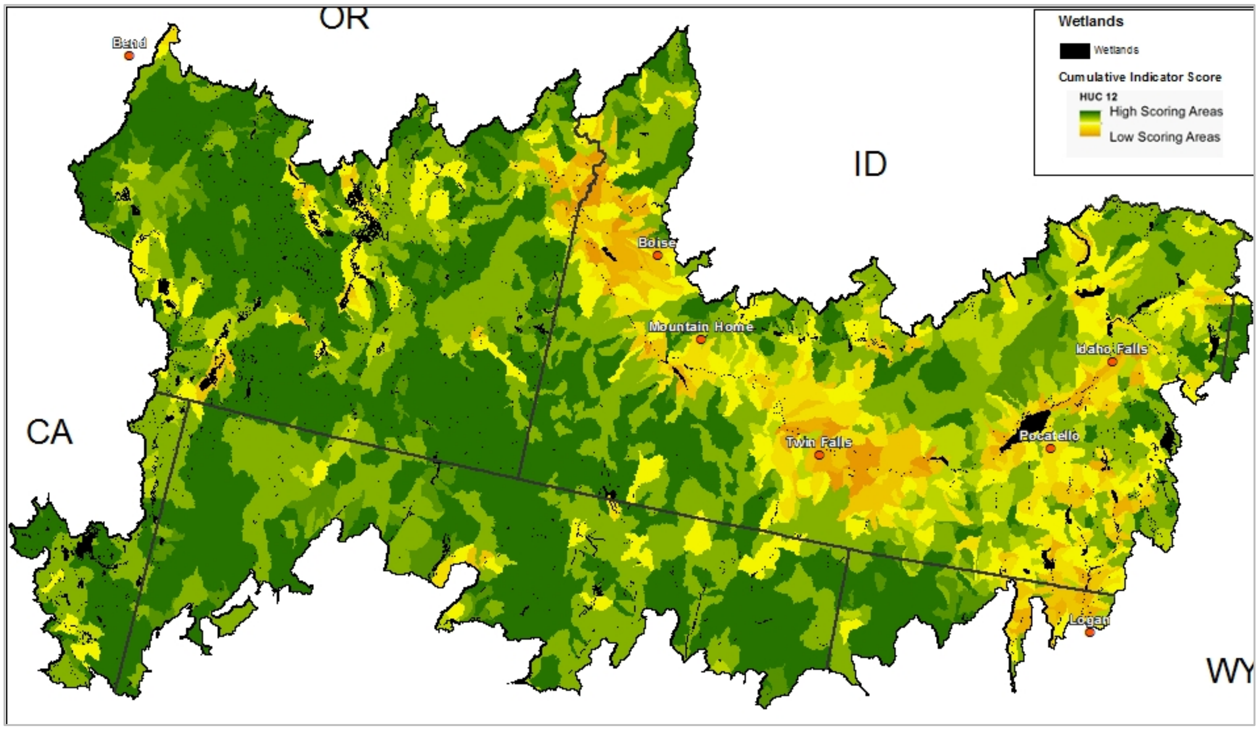



Figure 6.3-17. Wetland Cumulative Indicator Score

### Future Threats

Historically, development has been the primary threat to wetlands through the draining and filling of wetlands for agriculture, urban and rural development. Groundwater dependent wetlands can also be impacted by groundwater withdrawals. Groundwater withdrawals have increased by fifty percent from 1995 to 2005.

Wetlands are susceptible to invasion from both aquatic invertebrates and plant species. Many nonnative species have been introduced into North American waters, which have changed the structures of native communities and caused extinction through hybridization, predation, and competition (Sada and Vinyard 2002).

Long-term snow, climate, and streamflow trends at the Reynolds Creek in the Owyhee Mountains, have measured increasing temperatures at all elevations with decreasing proportions of snow to rain at all elevations. As a result, streamflow has seasonally shifted to larger winter and early spring flows and reduced late spring and summer flows (Nayak *et al.* 2010). RegCM3 (Hostetler *et al.* 2011) climate modeling predicts a slight increase precipitation in the basins, valleys, and uplands, and large increases in precipitation in the mountains by 2060. Therefore, water supply to wetlands may be greater in the winter and early spring and reduced in the summer. Wildfire is expected to have a minimal impact on wetlands although type conversion in adjacent uplands and reduced cover can decrease water quality through increased sedimentation. Livestock can trample and disturb riparian vegetation surrounding springs and wetlands which can reduce habitat quality for native plants and animals and alter hydrologic function.

## 6.3.8 Salt Desert Shrub
Coarse-Filter Conservation Element

Salt Desert Shrub.
Photo from U. of Idaho

Salt Desert Shrub is a term that refers to shrub-dominated systems occupying extremely arid sites toward the bottom of basins where soils may be salt-affected and where heat and aridity are locally the greatest. With increasing elevation and decreasing soil salinity salt desert shrub systems give way to sagebrush dominated systems. The dominant shrubs in salt desert shrub may vary considerably from site to site and many sites are strongly dominated by a single shrub species. Salt Desert Shrub systems are primarily used for livestock grazing.

### Current Status

In general, salt desert shrub occurs in large patches mostly in the western and southern portions of the ecoregion. Some of the densest locations of salt desert shrub are near the Great Salt Lake in Utah, the Black Rock Desert Wilderness in Nevada and Honey Lake Valley on the border between California and Nevada (Figure 6.3-18).

Intact salt desert shrub stands (minimally impacted by human activities) were classified using cumulative indicator scores, derived by combining: Distance to Development and Burn Probability (Figure 6.3-19). In the southern and western parts of the ecoregion there are relatively extensive areas of undisturbed salt desert shrub. The area between the Owyhee Mountains and Snake River Plain seem to be one of the least intact areas for salt desert shrub in the ecoregion due to the high burn probability.

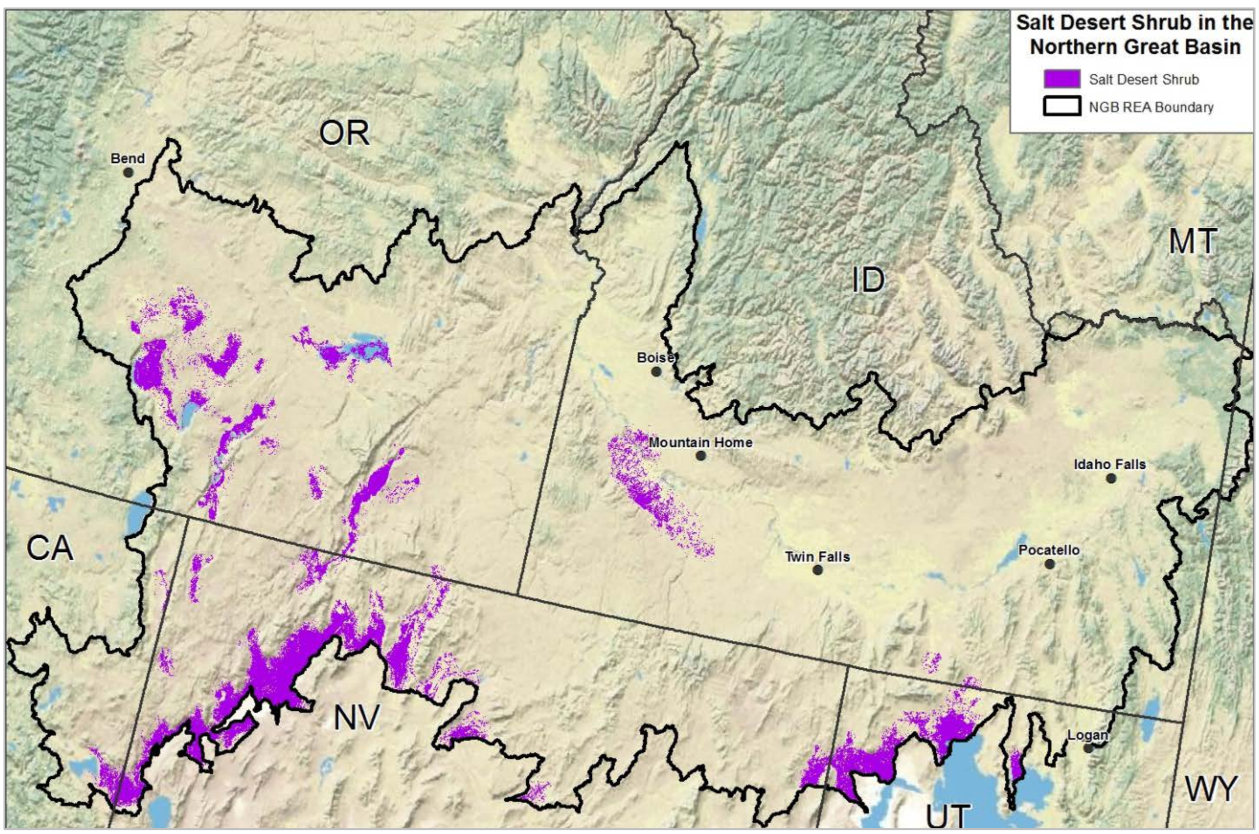



Figure 6.3-18. Salt Desert Shrub in the Northern Great Basin

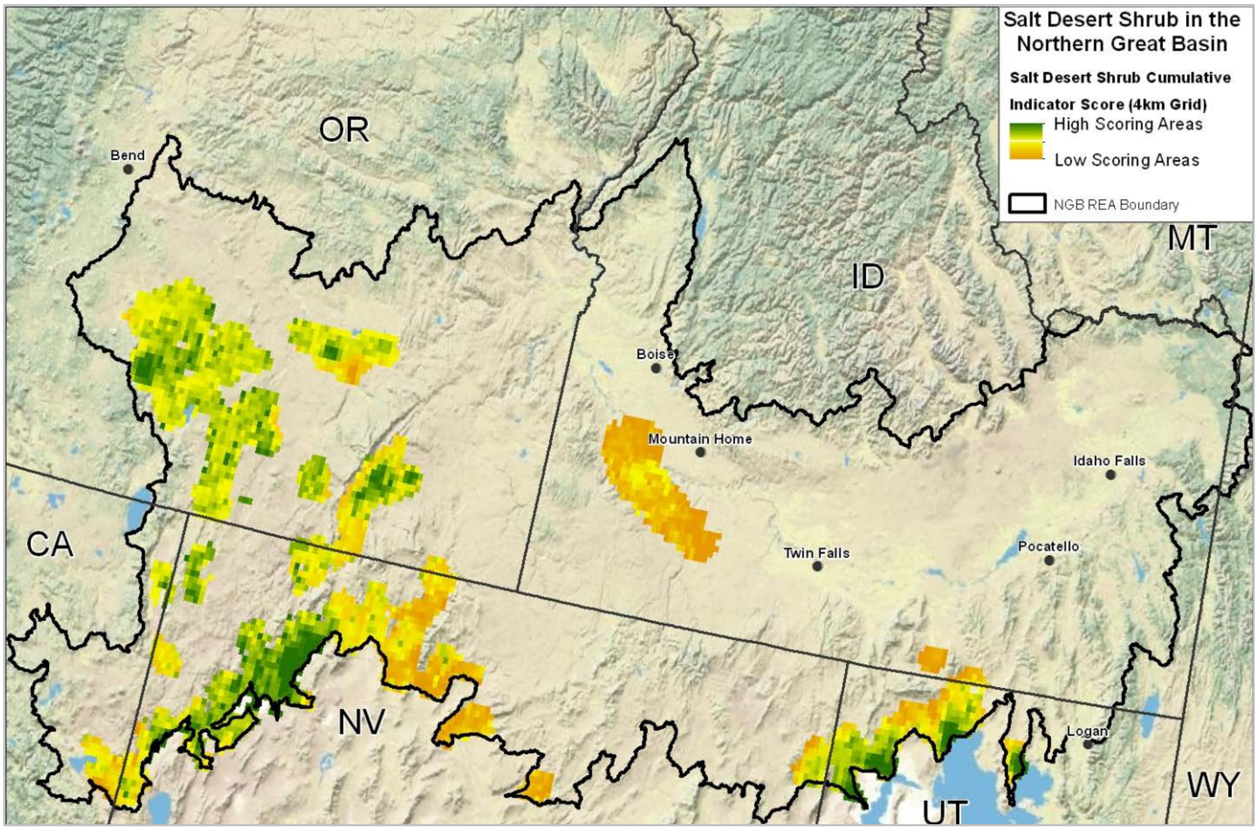



Figure 6.3-19. Intact Salt Desert Shrub within the Northern Great Basin

## Future Threats

The greatest threats to salt desert shrub are from invasives and wildfire. Invasive species including cheatgrass, halogeton, and Russian-thistle are interrelated and affect salt desert shrub. The areas with the highest encroachment of cheatgrass would be within the Snake River Plain. The lowest lying areas near Black Rock Desert Wilderness, Great Salt Lake and playas have little to no cheatgrass. The highest burn probability in salt desert shrub areas is within the southwestern Idaho (Snake River Plain near the Owyhee Mountains) and the north central Nevada portions of the ecoregion. Much of the salt desert shrub in the ecoregion is classified as low burn probability or 'unburnable' due to being a playa or having low amounts of fuel.

The relationship between livestock grazing and salt desert shrub ecosystems is complex and livestock grazing is relatively widespread within this ecosystem. The effects of past practices may persist today, complicating the evaluation of current management practices. The principal effect of grazing is removal of preferred herbaceous species, modifying the competition dynamics and possibly creating a niche for cheatgrass establishment. Fall and winter grazing could result in modifications to the shrub component of the system at the site level.

The most prominent type of development interacting with salt desert shrub is roads. Throughout most of the ecoregion, roads are found within 1,000 m of salt desert shrub, and often at much smaller distances. Few salt desert shrub areas, scattered around the ecoregion, have roads greater than 1 km away. The low basins where salt desert shrub occurs also is popular for off-highway vehicle use.

The uncertainties involved in predicting climate change coupled with the complexity and heterogeneity of conditions and species in salt desert shrub make predictions a complex and very uncertain undertaking. Undoubtedly there will be local range expansions and contractions of individual species responding to changes in climatic variables according to their individual tolerances but it is likely that there will be unanticipated effects resulting from complex and unforeseeable interactions.

## 6.3.9 Sagebrush
### Coarse-Filter Conservation Element

Sagebrush, Photo from USFS

Sagebrush communities are emblematic as the most characteristic and widespread native plant communities in the northern Great Basin and Intermountain West. Sagebrush-steppe ecosystems are dominated by species of sagebrush (*Artemisia* spp.) and perennial grasses. They are the focus of broad-based ecosystem conservation efforts (e.g., Davies *et al.* 2011; Great Basin Restoration Initiative 2012). There are numerous species of sagebrush in the ecoregion that dominate different sites, generally occurring along soil temperature and moisture gradients.

Once taken for granted, sagebrush communities have undergone ecological changes and have gained considerable attention since the middle of the twentieth century. Sagebrush communities are now of great conservation concern and are currently receiving management and restoration efforts in recognition of the many species that depend on sagebrush, notably the greater sage-grouse.

### Current Status

Sagebrush communities were separated into, low sagebrush, Wyoming/basin big sagebrush and mountain big sagebrush. Low sagebrush tend to occupy a variety of sites over a considerable elevational range and cover about 13 percent of the total area occupied by sagebrush in the ecoregion (Figure 6.3-20). Low sagebrush is more prevalent in the western and southern portions of the ecoregion. Wyoming/basin big sagebrush is the most widespread category of sagebrush cover and is distributed nearly throughout the ecoregion. Mountain big sagebrush tends to occupy higher elevation sites than its close relatives basin big sagebrush and Wyoming big sagebrush and has a more limited distribution within the ecoregion.

Intact sagebrush communities (minimally impacted by human activities) were classified using cumulative indicator scores, which were derived by combining: Distance to Development and Burn Probability (Figure 6.3-21). Extensive areas of relatively undisturbed sagebrush and large blocks of sagebrush occur in the southern and western parts of the ecoregion and to a lesser degree to the north of the Snake River Plain. Habitat within and adjacent to the Snake River Plain tends to be the most fragmented.

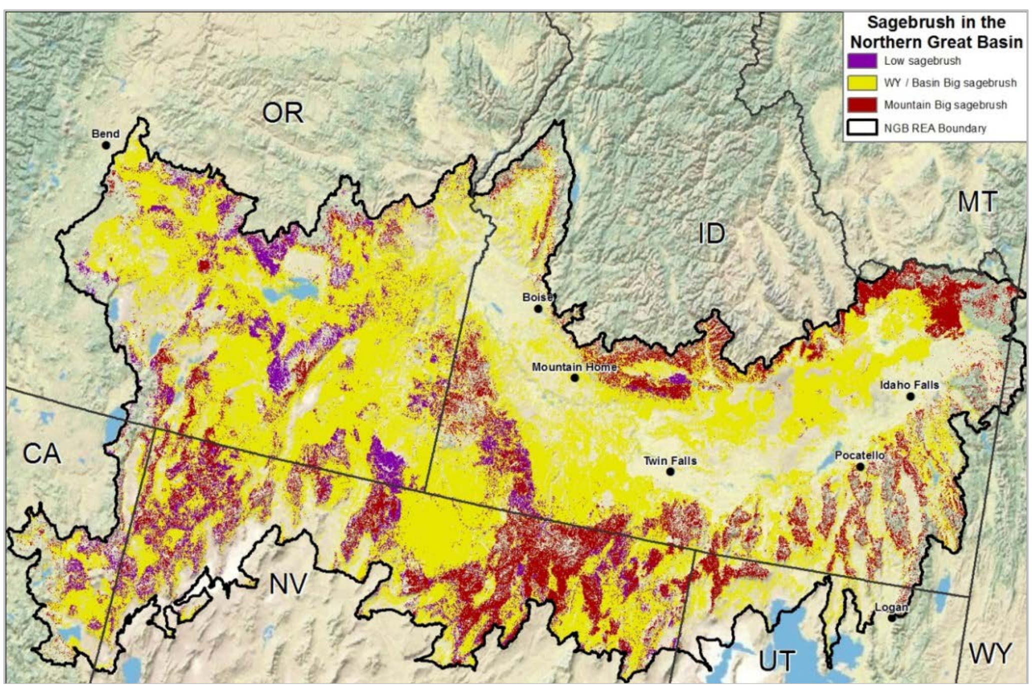



Figure 6.3-20. Sagebrush in the Northern Great Basin

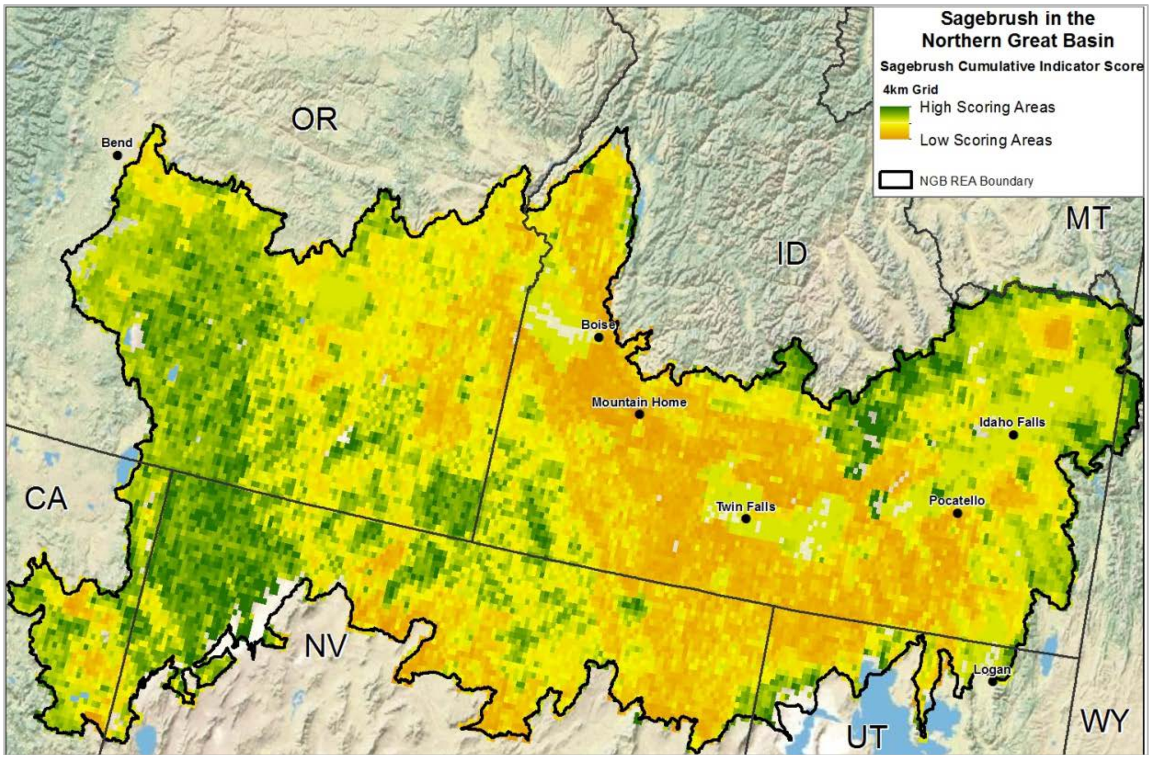



Figure 6.3-21. Intact Sagebrush within the Northern Great Basin

### Future Threats

Frequency, intensity, and areal extent of wildfires are of greatest importance to this ecosystem and are in turn affected by characteristics of the vegetation (fuel characteristics) and livestock grazing (which affects vegetation and soils). Wyoming big sagebrush is especially vulnerable to type conversion to cheatgrass monocultures after fire whereas mountain big sagebrush is less vulnerable to cheatgrass invasion but is susceptible to juniper expansion under conditions of infrequent wildfire. Juniper and other conifers have been the focus of additional attention because of their ability to rapidly colonize and establish in sagebrush communities. Periodic outbreaks of Aroga moths have been linked to defoliation of sagebrush but the causes and ecological significance of these disturbances are not well understood.

The relationship between livestock grazing and sagebrush ecosystems is complex and livestock grazing is widespread within sagebrush ecosystems. The effects of past practices remain today complicating the evaluation of current management practices. Livestock grazing, wildfire, cheatgrass, and expansion of junipers into sagebrush systems are interrelated and affect sagebrush ecosystems.

The broad ecological amplitude of the various species of sagebrush present in the ecoregion and the uncertainties involved in predicting climate change make predictions a complex and uncertain undertaking. It is likely that there will be greater year to year fluctuations and more frequent incidence of periods of drought or elevated temperatures than experienced in the past half century. The rapidity of climate change coupled with prevalence of cheatgrass, the expansion of junipers, and the apparent recent trend toward larger and more frequent wildfires are interrelated factors that need to be taken into account. Post-fire recovery of sagebrush, if it does burn, would be likely be hindered by rapid reestablishment of invasive species in lower elevation Wyoming big sagebrush sites.

## 6.3.10 Combined Juniper
Coarse-Filter Conservation Element

Utah juniper *(Juniperus osteosperma)*
Photo from BLM

Western juniper (*Juniperus occidentalis*) and Utah juniper (*J. osteosperma*) dominate large areas across the ecoregion. Western juniper is prevalent in Oregon, northeastern California, northwestern Nevada and southwestern Idaho. It is geographically replaced by Utah juniper to the south and east. Since the mid-1800s and especially in the early 1900s, both junipers have expanded their distributions into sagebrush steppes, which is a concern because of loss of grass-forb and shrub cover. Junipers were selected as a conservation element because of their aesthetic and wildlife habitat values. However, due to their expanding distribution, juniper may also be viewed as a change agent. Finer-scaled mapping is required to differentiate between pre-settlement juniper and juniper expansion areas, and to determine whether these communities meet land management objectives.

### Current Status

Utah juniper is mostly concentrated in the southeastern part of the ecoregion along the Grouse Creek Mountains whereas Western juniper is along the northwestern and western periphery with isolated patches in the Owyhee and Steens Mountains (Figure 6.3-22). Juniper is also scattered along the southern portion of the ecoregion. Three areas stand out as large and dense locations of juniper in the Northern Great Basin: Steens Mountains, Owyhee Mountains and the area around the border of northeastern Nevada / northwestern Utah (Grouse Mountains).

Intact juniper stands (minimally impacted by human activities) were classified using cumulative indicator scores, which was derived by combining the distance to development and burn probability (Figure 6.3-23). The southeastern portion of the ecoregion is less intact due to the high density of roads and high burn probability whereas the western portion of the ecoregion is more intact due to fewer roads and lower burn probability.

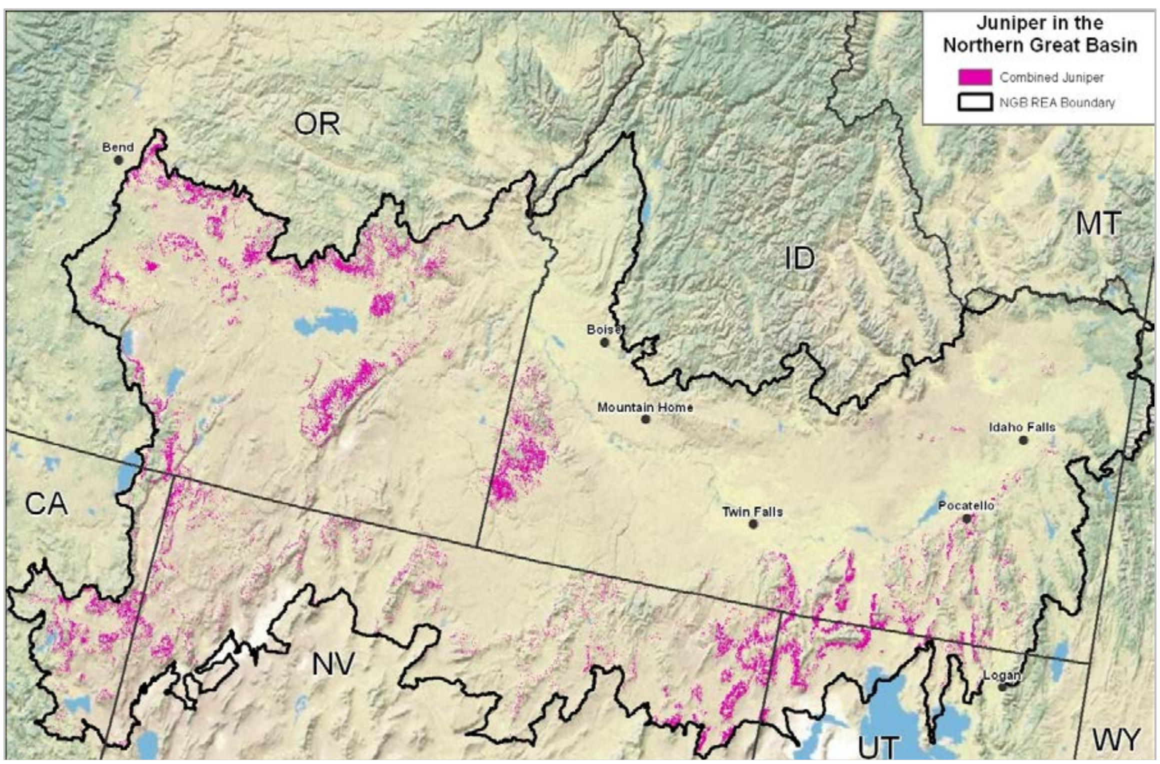



Figure 6.3-22. Combined Juniper (Utah and Western) in the Northern Great Basin

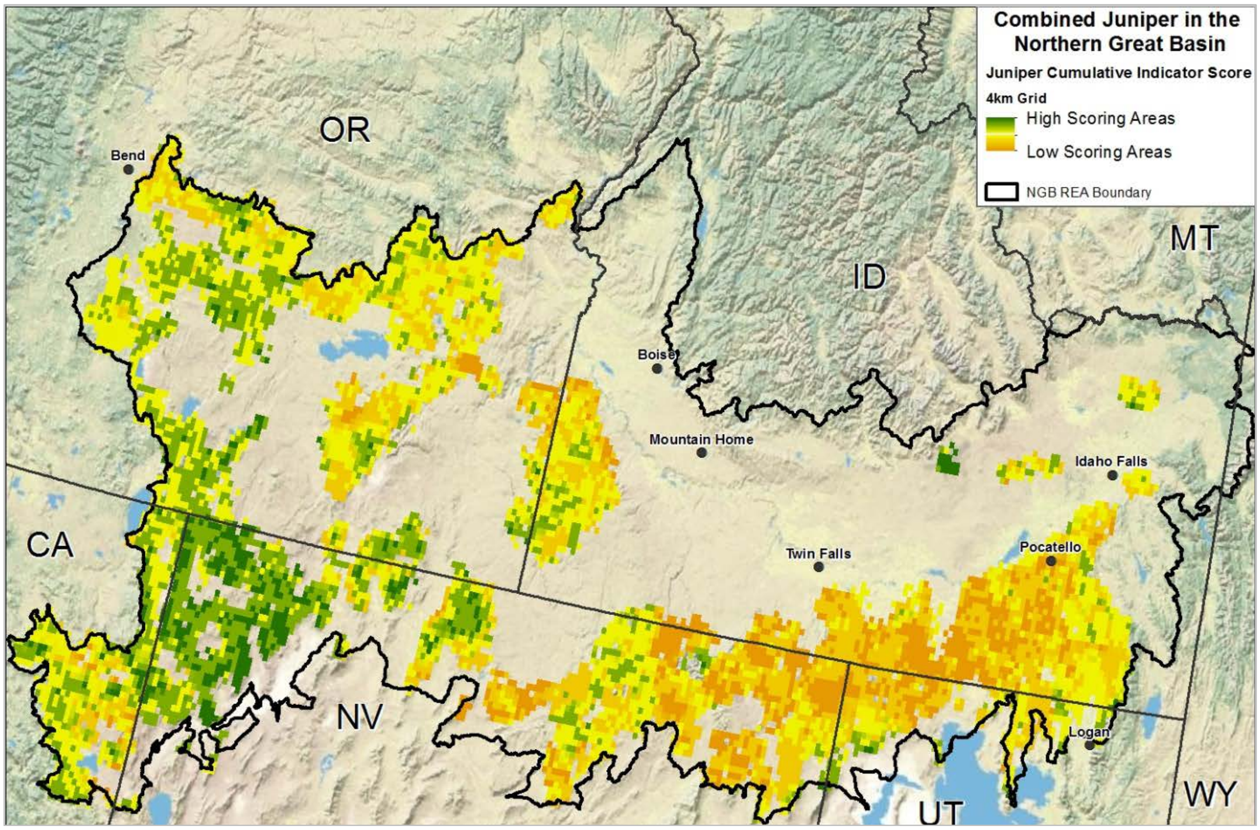



Figure 6.3-23. Intact Juniper within the Northern Great Basin

### Future Threats

The greatest threat to junipers is increased wildfire intensity and frequency from projected climate change. Except for large individuals in relatively fire safe sites, both Utah and western junipers are killed outright by fire and do not resprout. The highest burn probability juniper areas are within southeastern Idaho, northeastern Nevada and Utah. The areas with the lowest burn probability are in the western portions of the ecoregion including Oregon, California, and western Nevada.

Livestock grazing is thought to be a potential causal mechanism for juniper expansion. Intensive livestock grazing can reduce the cover of competing perennial grasses and shrubs and reduce fine fuel loads leading to decreased fire intensity and spread of wildfires. In addition, livestock grazing historically made wildfires less frequent and contributed to development of higher juniper land cover type (e.g. Miller *et al.* 2008).

Although there is considerable uncertainty, the results from the individual climate change projections suggest a continued viability of juniper in the ecoregion. However, the areas where viability is highest will shift around and, in many cases, away from areas where junipers are abundant into areas where junipers are currently sparse or absent. A shift in juniper distribution would be expected to gradually follow, at least in areas where barriers such as large areas of inhospitable habitat (e.g., low saline areas, extensive agricultural areas) do not inhibit dispersal.

In addition, low elevation sites into which junipers have expanded are vulnerable to cheatgrass invasion which can ultimately lead to a type conversion and soil loss. Other ecological factors evaluated include disease and development. Disease does not appear to be a significant change agent in juniper stands of either species. The distance to development was determined by merging many types of development (e.g. ski resorts, roads, agricultural, development, transmission lines). The most prominent type of development interacting with junipers is roads. Roads allow access for disturbance, introduction of invasives and possible sources of ignition for wildfire.

## 6.3.11 Aspen
Coarse-Filter Conservation Element

Quaking aspen (*Populus tremuloides)* is one of the most widely distributed tree species in North America. Across the intermountain region of western North America, aspen forests rank among the most biologically diverse plant communities (Strand *et al.* 2009). Aspen stands are one of the few broad-leaved trees capable of growing at high elevations and can also occur on a variety of terrain, from gentle to moderate slopes, in swales, or on level sites. Aspen occurrences are primarily limited by adequate soil moisture that is required to meet high evapotranspiration demand, length of growing season, and temperatures. Aspen was selected as a Conservation Element due to concerns over recent declines of aspen stands, high value wildlife habitat, and the need for increased aspen management and restoration efforts.

### Current Status

The distribution of two vegetation types, mixed conifer aspen and Rocky Mountain aspen, were combined to make up one class for aspen. Aspen within the ecoregion are most concentrated in the southeastern part of Idaho and northeastern Nevada and along the periphery of the ecoregion, see Figure 6.3-24. Some of the densest aspen stands can be found in the Sawtooth National Forest south of Twin Falls and the Portneuf Range east of Pocatello.

Intact aspen stands (minimally impacted by human activities) were classified using cumulative indicator scores, which were derived by combining: Distance to Development, Burn Probability and Distance to Disease Stands. Figure 6.3-25 shows the cumulative indicator scores for aspen. Aspen stands tend to be smaller and further apart in western Nevada, southern Oregon, and southwestern Idaho portions of the ecoregion. Aspen is more prevalent in the lower scoring areas or less intact areas, which occur in the mountain ranges in southwestern Idaho, northeastern Nevada and along the western and northern ecoregion boundaries.

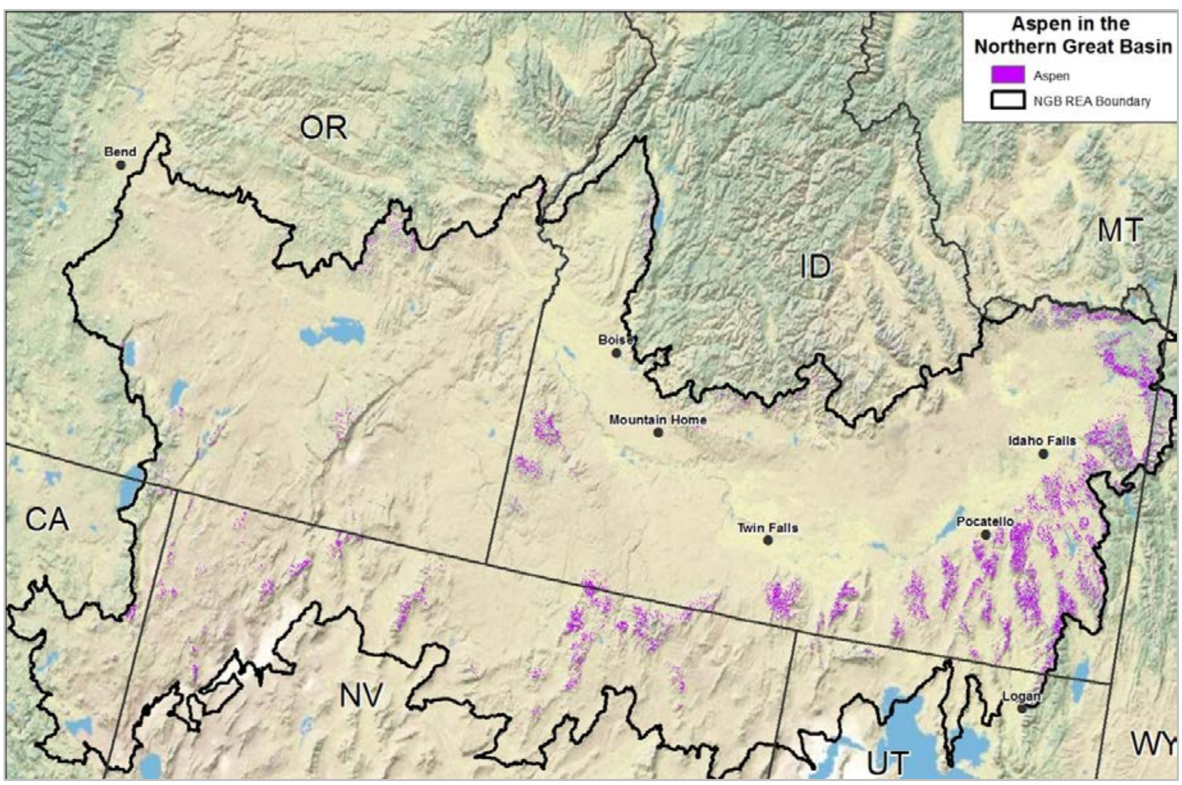



Figure 6.3-24. Aspen in the Northern Great Basin

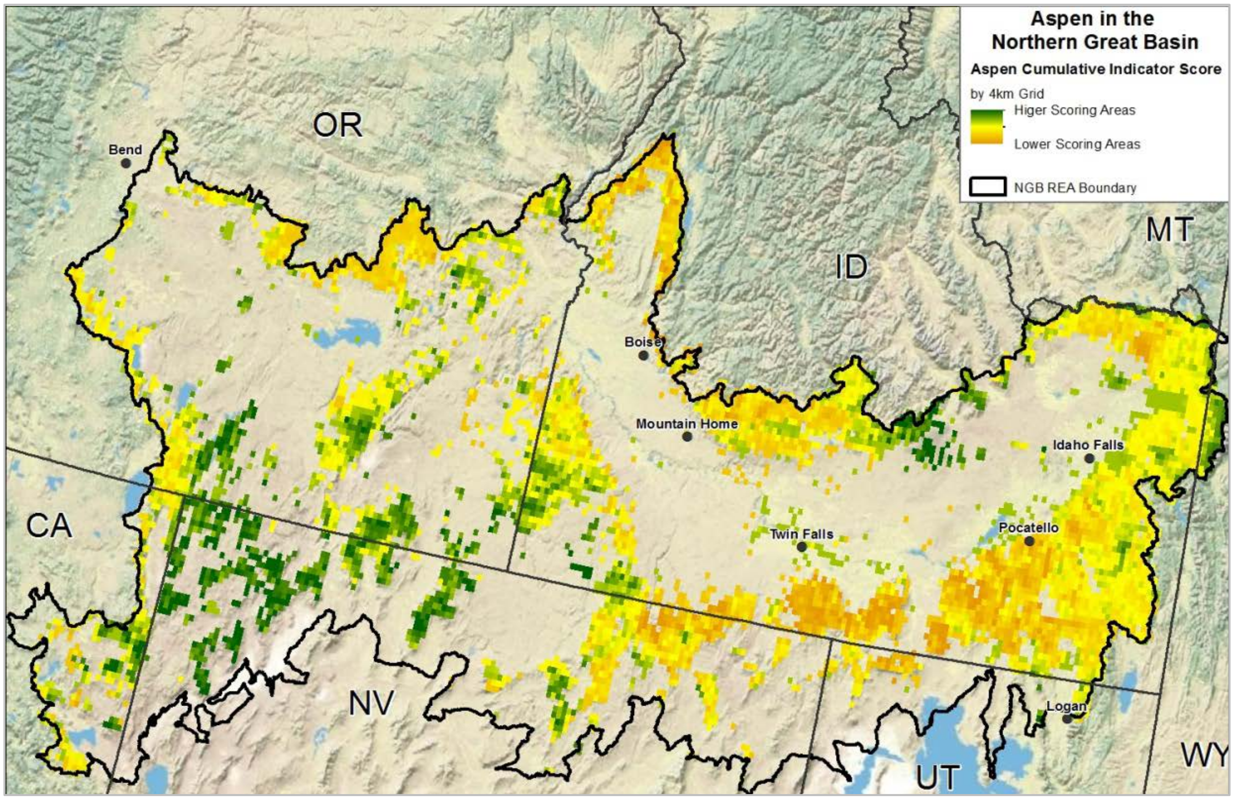



Figure 6.3-25. Intact Aspen within the Northern Great Basin

Mixed conifer aspen stands could be considered less intact than Rocky Mountain aspen because without fire the shade tolerant conifers will eventually outcompete the aspen. However the mixed conifer aspen wasn't scored differently than Rocky Mountain aspen.

## Future Threats

The greatest threat to aspen is climate change and Sudden Aspen Decline (SAD). Aspen are vulnerable to changing climatic patterns, particularly hot and dry conditions. Continued inventory, management of aspen stands and studies on better understanding SAD could help reduce aspen decline.

The areas that are closest to SAD areas are mostly in the periphery of the northern part of the ecoregion. The part of the ecoregion that has the greatest distance from aspen to SAD stands is the southern part of Oregon and the western part of Nevada. Climate change, in particular hot and dry conditions, is expected to weaken the trees, making them more vulnerable to insect attack and disease and at risk for SAD. Modeled climate change shows the potential for dramatic reduction in aspen viability by 2030 and further reduction throughout the ecoregion by 2060. The critical factor for aspen persistence is adequate summer soil moisture.

Livestock grazing is common in the ecoregion and approximately 70 percent of the ecoregion is under grazing allotments. Livestock grazing can affect aspen health and cover. Livestock browsing on resprouts may retard aspen regeneration and cause stress that may lead to SAD. Trampling by cattle can cause soil compaction, reduce bank stability, widen channels, and increase groundwater depth that can directly and indirectly affect aspen. Managed livestock grazing is generally compatible with aspen persistence.

Wildfire can have a renewing effect on aspen stands by killing competing shade-tolerant conifers and removing senescent aspen top growth. Without wildfires, aspen tend to decline under conifer encroachment. The highest burn probability aspen areas are within southeastern Idaho, northeastern Nevada and Utah. The areas with the lowest burn probability are on the periphery of the ecoregion and in southern Oregon and western Nevada.

## 6.3.12 Other Conifer
Coarse-Filter Conservation Element

Conifers are an integral component of forest communities at higher elevations in the NGB. “Other Conifer” is a collection of conifers within the ecoregion such as Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), ponderosa pine (*Pinus ponderosa*) and Engelmann spruce (*Picea engelmannii*). Conifer establishment is increasingly common and leads to new management decisions on existing stands and conifer expansion into sagebrush and aspen communities.

Ponderosa pine (*Pinus ponderosa*)
Photo from BLM

### Current Status

Other Conifers are located along the periphery of the ecoregion generally above 6,000 feet within National Forests such as Targhee, Payette, Boise, Sawtooth, Deschutes, Malheur, Freemont, Modoc, Lassen, and Plumas (Figure 6.3-26). Isolated conifer patches occur at lower elevations such as along the east fork of the Bruneau River. The densest locations of other conifers are within the Deschutes, Fremont and Malheur National Forests within Oregon and Payette and Targhee forests within Idaho and Wyoming.

Intact Other Conifer stands (minimally impacted by human activities) were classified using cumulative indicator scores, which were derived by combining: Distance to Development, Burn Probability and Distance to Disease Stands (Figure 6.3-27). In general, the highest scoring areas are the less dense interior sections of the ecoregion such as the Owyhee Mountains and Craters of the Moon National Monument. Certain national forests along the periphery of the ecoregion such as Challis and Targhee also had some areas with high scores. The less intact areas are the Payette, Boise and Malheur National Forest.

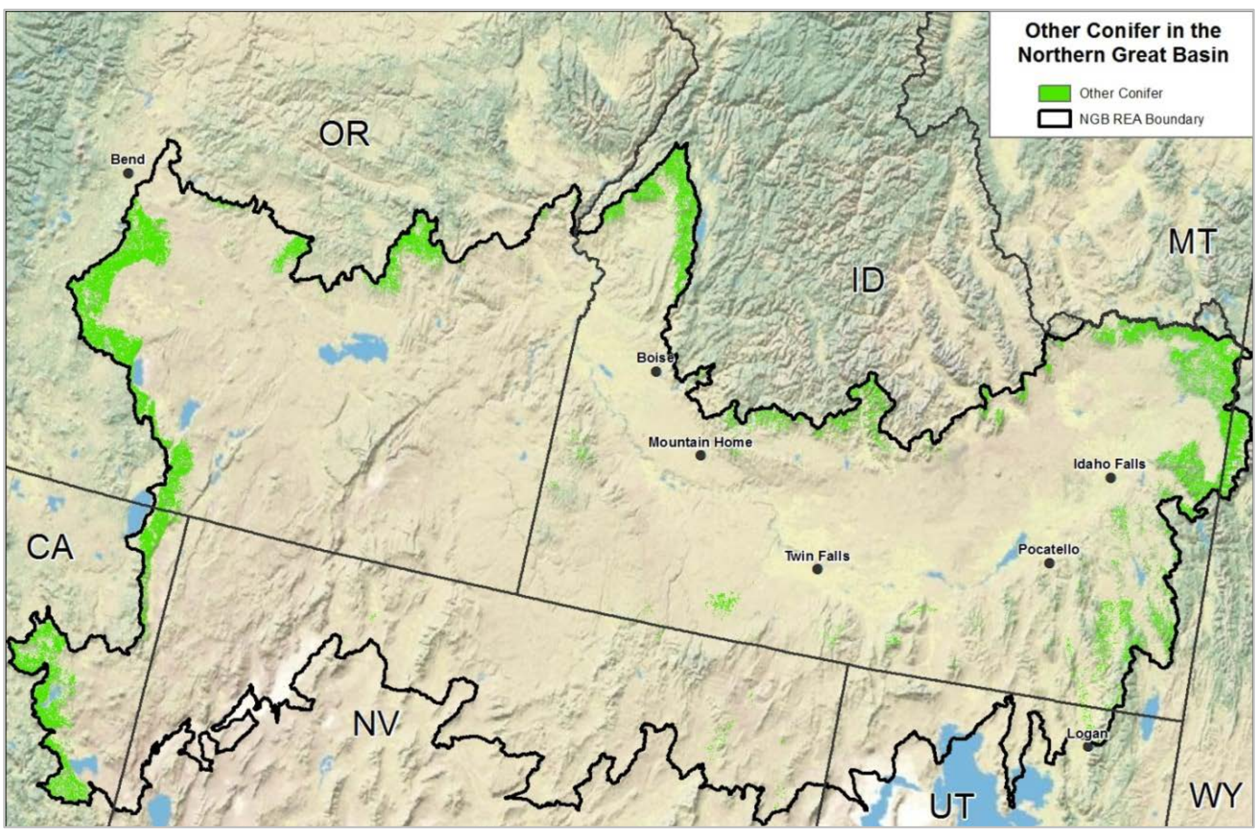



Figure 6.3-26. Other Conifer in the Northern Great Basin

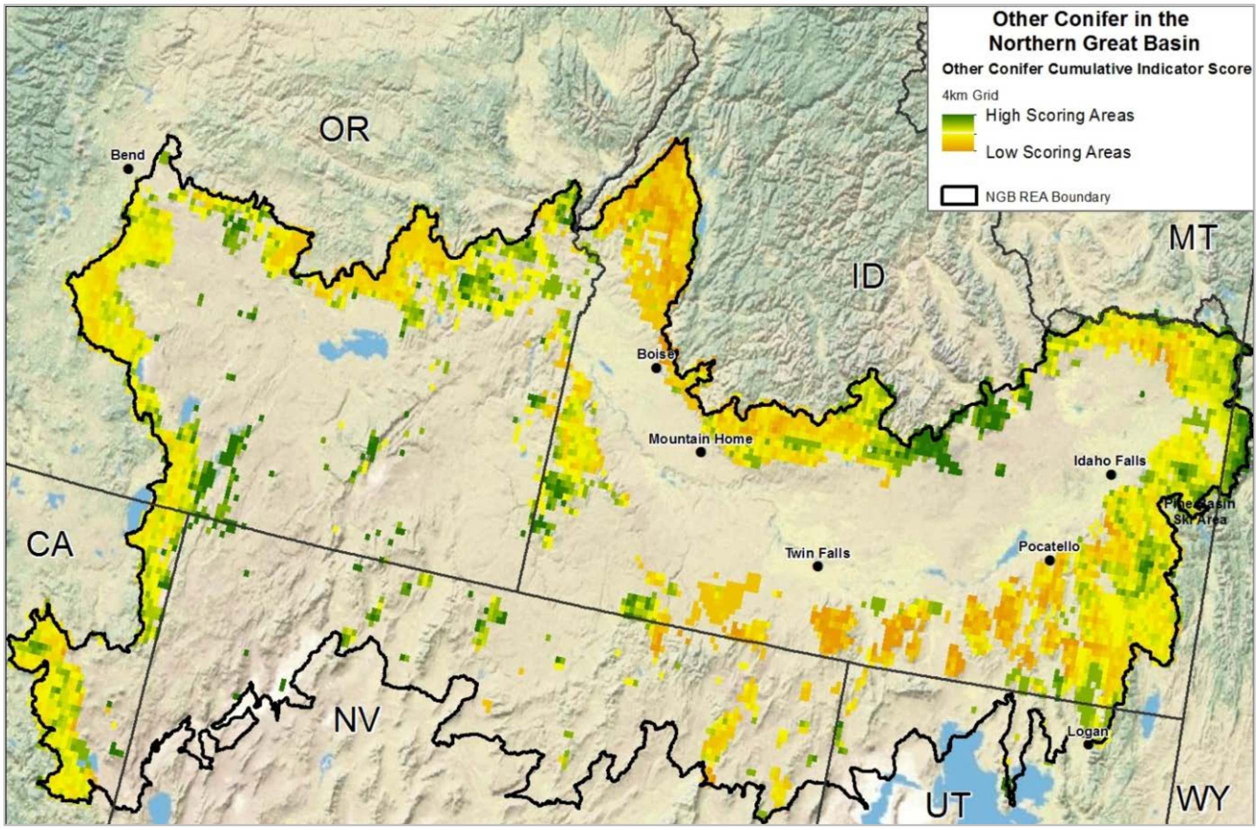



Figure 6.3-27. Intact Other Conifer within the Northern Great Basin

### Future Threats

Climate change, in particular toward hotter and drier conditions in the summer, may alter the current distribution of coniferous forests and is thought to weaken the trees making them more vulnerable to insect attack. Conifers can vary in their tolerance for wildfire. Douglas-fir can survive low intensity surface fires but are killed by moderate to high intensity fires whereas lodgepole pine and Engelmann spruce require open habitat for regeneration and regenerate from seed after a wildfire. The highest burn probability is in Other Conifer areas within southern and northern Idaho from the southern edges of the Payette National Forest to the Boise National Forest northeast of Mountain Home. The areas with the lowest burn probability are on the periphery of the ecoregion within the National Forests except for Payette and Boise as previously mentioned.

Livestock grazing is common in the ecoregion, with approximately 70 percent of the total area under grazing allotments. Livestock browsing on buds, needles and cambium may retard growth and regeneration and consumption of preferred herbaceous species may affect the establishment dynamics of conifers. USFS models show the Other Conifers to be negatively impacted by climate change especially in the 2060 timeframe. One outlier is ponderosa pine that causes some uncertainty in the modeling as it is forecasted to become more viable in locations (lower elevation) where it currently doesn't exist.

When openings exists, invasive plant species particularly knapweed (*Centaurea virgata*) and smooth brome (*Bromus inermis*) invade conifer communities. The main disease or insect affecting conifers is the pine bark beetle. The Malheur National Forest, western and eastern edges of the ecoregion appear to have the lowest distance between infected Other Conifer stands. The Other Conifer stands further from the edges of the ecoregion tend to have higher distances to diseased stands probably due to lower density of Other Conifers. The most prominent type of development interacting with Other Conifers is roads. Roads allow access for disturbance, introduction of invasives and possible sources of ignition for wildfire.

## 6.3.13 Wild Horse and Burro
Coarse-Filter Conservation Element

Wild Horses, Photo from BLM

The BLM's goal is to maintain sustainable wild horse populations on healthy public lands. To do this, the BLM works to achieve what is known as the Appropriate Management Level (AML) – the point at which wild horse and burro herd populations are consistent with the land's capacity to support them. In the context of its multiple-use mission, AML is the level at which wild horses and burros can thrive in balance with other public land uses and resources, including livestock grazing, vegetation, and wildlife (BLM 2011b).

### Current Status

Wild horse and burro herds grow at a rate on average of 20 percent a year, which means herds can double in size every four years. Because these populations grow at such a fast pace, there are many potential adverse impacts to public lands as a result of the overpopulated herds. In response to herd growth, the BLM must remove thousands of wild horses and burros from the range each year to protect public rangelands from the environmental impacts of overgrazing and prevent horse deaths from starvation and dehydration. Wild horse and burro populations are managed within Herd Management Areas (HMAs) predominantly within Oregon and Nevada within the ecoregion. The populations within the HMAs (based on the 2012 census), show that most are at or over the Appropriate Management Level (AML) (Figure 6.3-28).

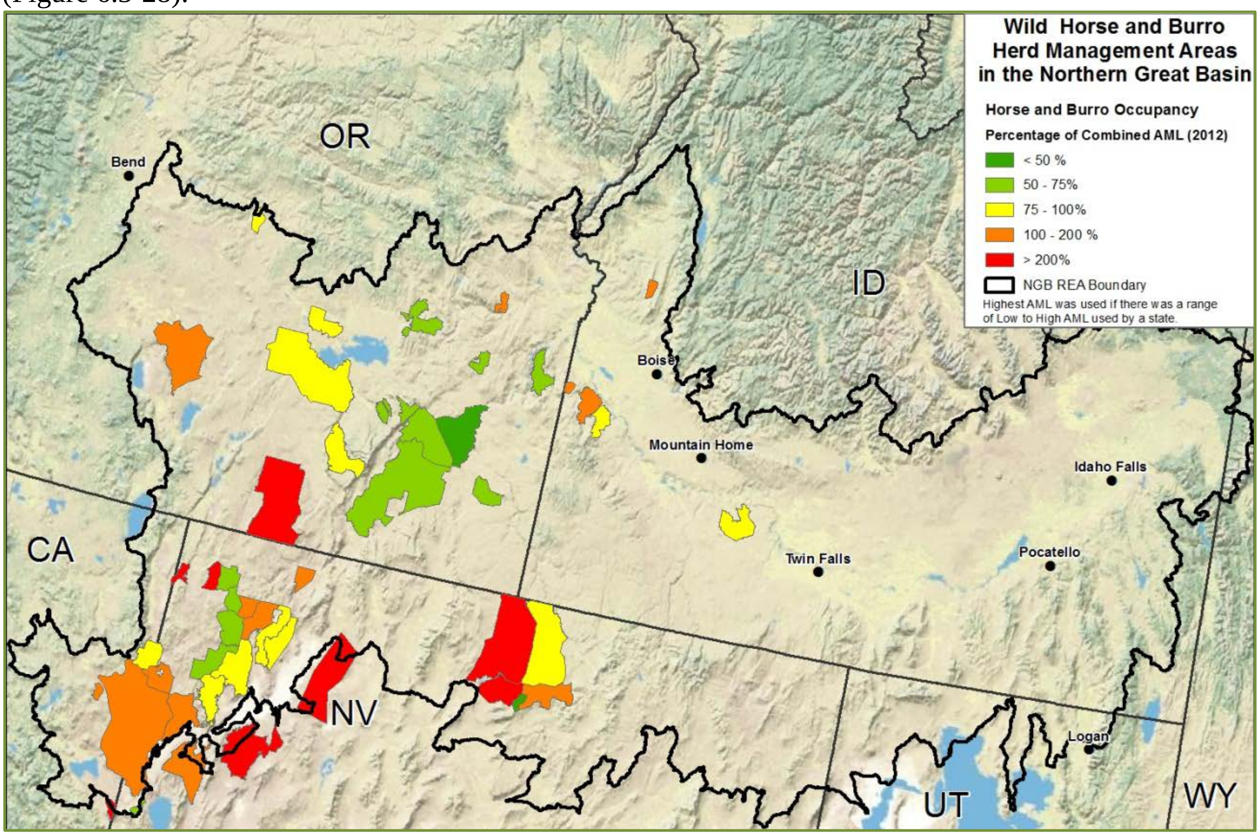



Figure 6-3.28. Percent of AML for Wild Horse and Burro within Herd Management Areas

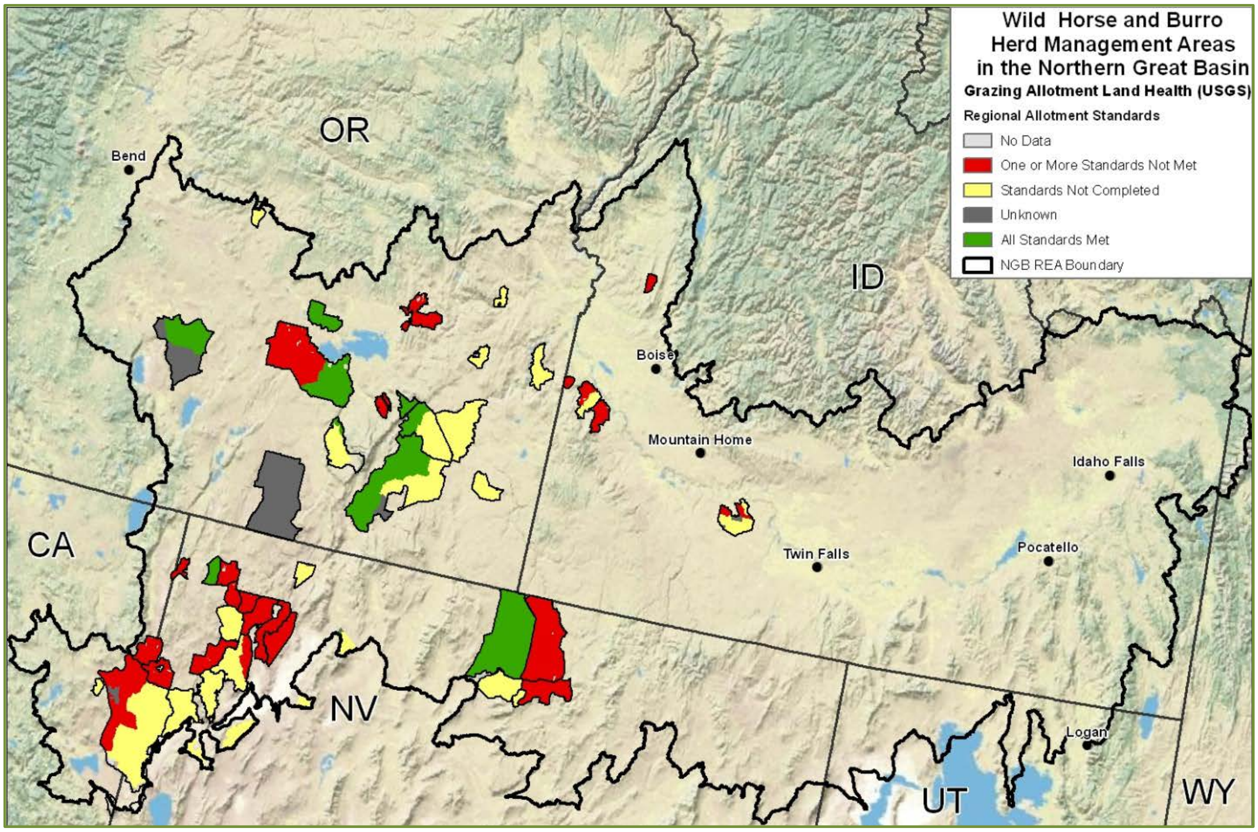



Figure 6.3-29. Rangeland Health Standard by Herd Management Area

Rangeland Health was studied by the USGS and documented in an Open File Report 2011-1263 examining whether the grazing allotment was meeting rangeland standards. Figure 6.3-29 shows the results of this study for the wild horse and burro HMAs.

## Future Threats

Due to the absence of predators to keep growing populations in check BLM will need to continue to actively manage herd populations through herd gathers, contraception, and adoption programs. Climate change, wildfire and invasives only add to the problems of maintaining healthy rangeland for the wild horse and burros and populations below the AML.

Climate models predict an increase in winter and spring precipitation but a decrease in precipitation during July and August. Drought is one of the biggest climate change challenges for wild horse and burros since many of the HMAs are at capacity or over capacity.

The expansion of cheatgrass and other invasives increasing the fuels in Herd Management Areas is a risk to Wild Horse and Burros. Since they are contained within Herd Management Areas, fires or change in forage reduce the carrying capacity for that area resulting in changes in the AML. Large fires may remove most of the vegetation leaving the Herd Management Area unusable until it has been reseeded and regeneration has occurred.

## 6.3.14 Specially Designated Areas
Coarse-Filter Conservation Element

St. Anthony Dunes, Photo from BLM

Specially Designated Areas (SDAs) are areas of natural and historic importance in the United States that have been, or have been proposed to be, designated by Congress to become federally protected entities, identified through land use planning, Presidential proclamation (National Monuments) or by states (for State Parks). SDAs require special management attention to protect and prevent irreparable damage to areas with historic, cultural, and scenic values as well as areas supporting fish, wildlife, or other natural resources or processes (BLM 2011).

### Current Status

Since the Northern Great Basin is made up predominantly of BLM and USFS land, there is a large number of SDAs within the ecoregion (Figure 6.3-30). Wilderness Areas are the most protected from development of all the SDAs as they are designated by Congress to restrict motorized vehicles, development of structures and most types of development. There are currently 27 wilderness areas and 54 wilderness study areas that are classified as suitable to become wilderness areas in the future. The northwest corner of Nevada contains a large concentration of SDAs making it the most protected part of the ecoregion with ten wilderness areas, the large Charles Sheldon National Wildlife Refuge, eleven Wilderness Study Areas and nine Areas of Critical Environmental Concern. Steens Mountain in Oregon is another location within the ecoregion containing a concentration of SDAs. Wild and Scenic Rivers are prevalent in Oregon and Idaho with 21 stretches of river designated as wild and scenic.

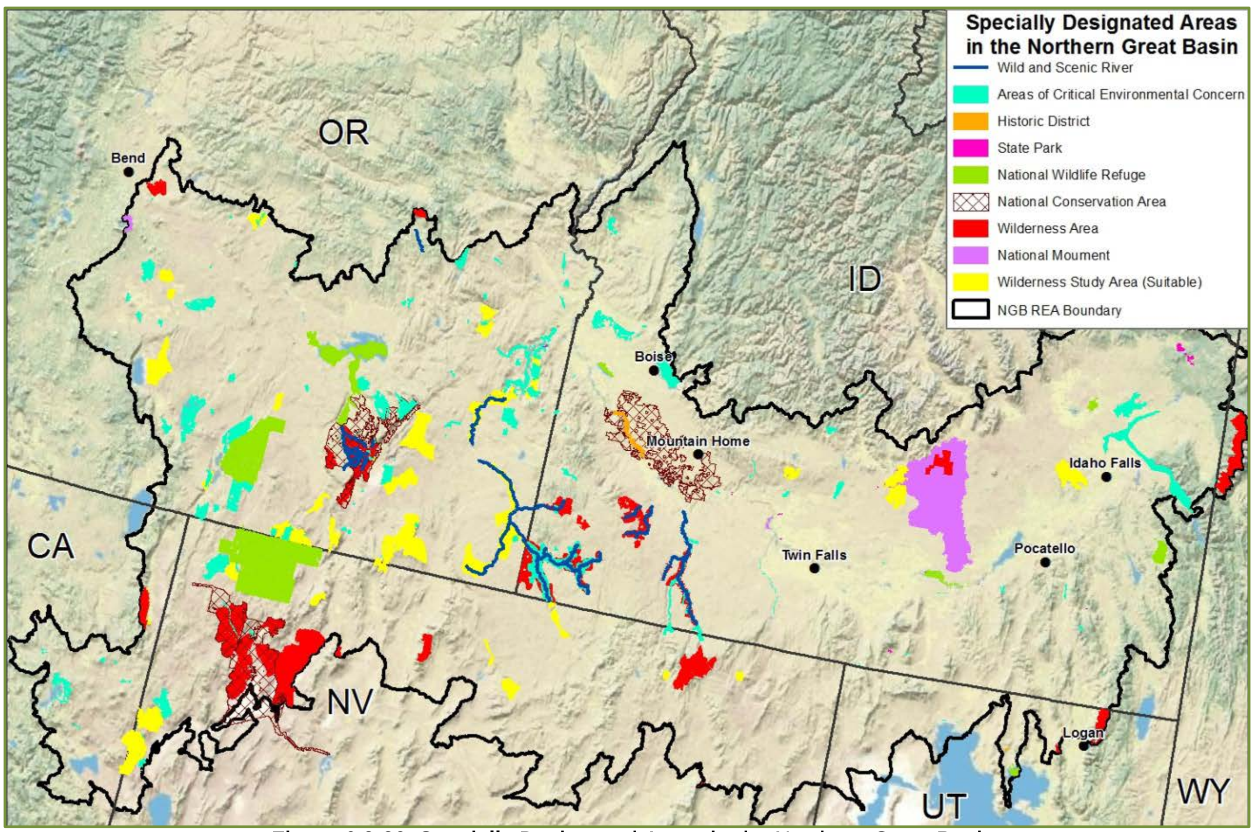



Figure 6.3-30. Specially Designated Areas in the Northern Great Basin

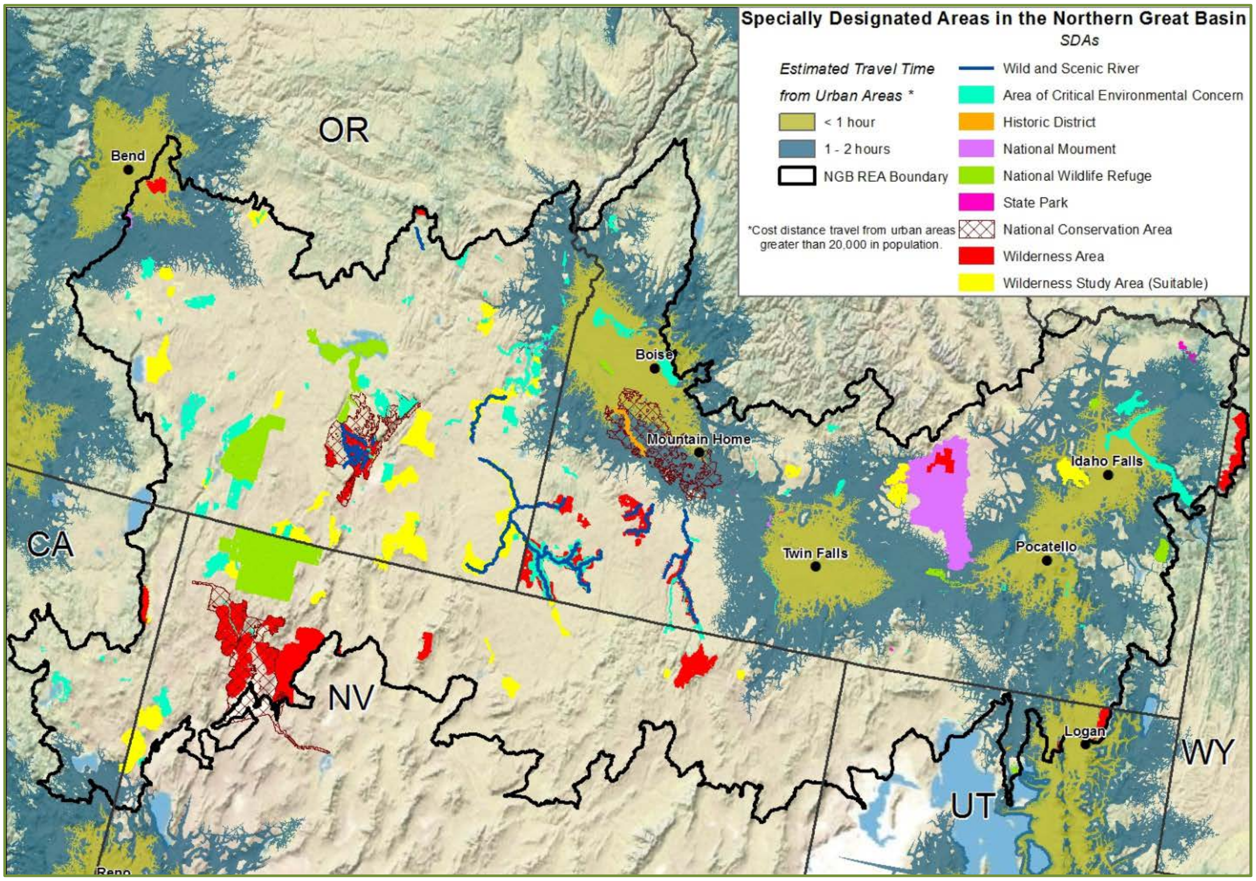



Figure 6.3-31. Travel Time from Urban Centers (> 20,000 in Population) to SDAs

## Future Threats

The greatest threat to SDAs is increasing population growth and their proximity to urban centers. Most SDA's serve a dual role of protecting the SDA but also allow access for recreation and development (based on restrictions and management goals of the SDA). Increasing populations in close proximity to an SDA can put additional pressures such as risk of wildfires and introduction of invasives. Figure 6.3-31 shows predicted population growth by 2060 for counties in the ecoregion. Major centers such as Boise, ID and Reno, NV are predicted to have the highest growth by 2060.

Since wilderness areas restrict vehicles and heavy equipment, fires in these areas can be difficult to contain from the ground if fire breaks out. Wildfires have become more frequent and larger. Large, intense wildfires in wilderness areas can drastically alter forest and sagebrush communities. Aquatic and terrestrial invasives are easily transmitted by people visiting SDAs. Some SDAs allow grazing as each SDA is managed to protect its resource. Climate change will affect the SDAs very little as a geographic entity but could alter the environment and resources it was designated to protect.

## 6.4 Ecological Integrity

**6.4 Ecological Integrity**

For the purposes of the REA, "ecological integrity" is defined as the ability of an ecological system to support and maintain a community of organisms that have the species composition, diversity, and functional organization comparable to those of natural habitats within the ecoregion. The Western Governor's Association developed a system to map west-wide landscape integrity using a landscape condition model developed by Natureserve, which the AMT determined was an appropriate inclusion in the Northern Great Basin REA.

### Ecological Integrity vs. Landscape Integrity

Ecological integrity is difficult to evaluate across large areas such as the Northern Great Basin ecoregion using a species diversity approach. Stated species composition and diversity can vary greatly amongst states based on the level of surveying and collection of data as well as how many species it lists as sensitive. Remote areas with low levels of species mapping could be interpreted as being impaired because they may not have a recorded abundance of species or diversity. Ecological integrity also relies on a benchmark or reference sites to compare the naturalness or impairment of one location to another (Schroeder *et al.* 2011). Landscape integrity moves away from a species diversity approach and focuses on finding out where is the best of what is left. This is conducted by starting with a natural land cover and stripping away anthropogenic features (urban, agriculture, roads, etc). Once areas are classified by their intactness they can be assessed further to classify them by the size of blocks and the connectivity amongst these blocks. The Western Governors Association chose to use a landscape integrity approach for a west-wide mapping effort. Based on the scale, timing of efforts and continuity between agencies the AMT felt that it was a better approach for this ecoregion.

### Western Governors Association Landscape Integrity

The Western Governors Association approach to Landscape Integrity uses twenty datasets containing transportation, urban and industrial development and land cover to derive a landscape integrity score. The intent of this model is to use regionally available spatial data to visualize the effects of land uses on natural ecosystems and habitats (Comer *et al.* 2012). Figure 6.4-1 shows the resulting landscape conidition model score for the Northern Great Basin. Agricultural areas of the Snake River Plain are the most easily identifiable features displaying an impacted landscape. Road corridors such as interstate 15 (heading into Montana), 84 (Idaho to Utah) and US 93 (Nevada to Idaho) are visible as well but scored less impacted than agricultural areas. Areas that scored as very intact were areas in dark blue such as Craters of the Moon National Monument and Preserve and Black Rock Desert Wilderness.

### Western Governor's Association Large Intact Blocks

Based on the results of the landscape condition model, Large Intact Blocks were extracted to define what is the best of what is left. Large Intact Blocks were defined by the Western Governor's Association as having a minimum size of 1,000 hectares and achieving a minimum threshold of a landscape condition score. The Large Intact Blocks were divided into three classes, Level 1, 2 and 3 with Level 1 Large Intact Blocks being the top 1/3 of all the Large Intact Blocks, Level 2 the middle 1/3 of Large Intact Blocks and Level 3 the lowest 1/3 of the Large Intact Blocks. Figure 6.4-2 shows the resulting Large Intact Blocks for the Northern Great Basin. The darkest green represents the top 1/3 of all the Large Intact Blocks for the ecoregion. Comparing Figure 6.4-1 and 6.4-2, areas with the darkest blue (highest intactness) in Figure 6.4-1 translates fairly well to Level 1 or Level 2 Large Intact Blocks. Agricultural areas are not included within the Large Intact Blocks along with some road corridors such as the I-84 leaving Idaho into Montana. Craters of the Moon and Black Rock Desert Wilderness show up predominantly as some of the largest of the Large Intact Blocks. Nevada appears to have the highest amount of Level 1 and Level 2 Blocks while Oregon and California have the fewest. Most of the ecoregion besides the previously identified agricultural belt of the Snake River Plain is at least a Level 3 Large Intact Block.

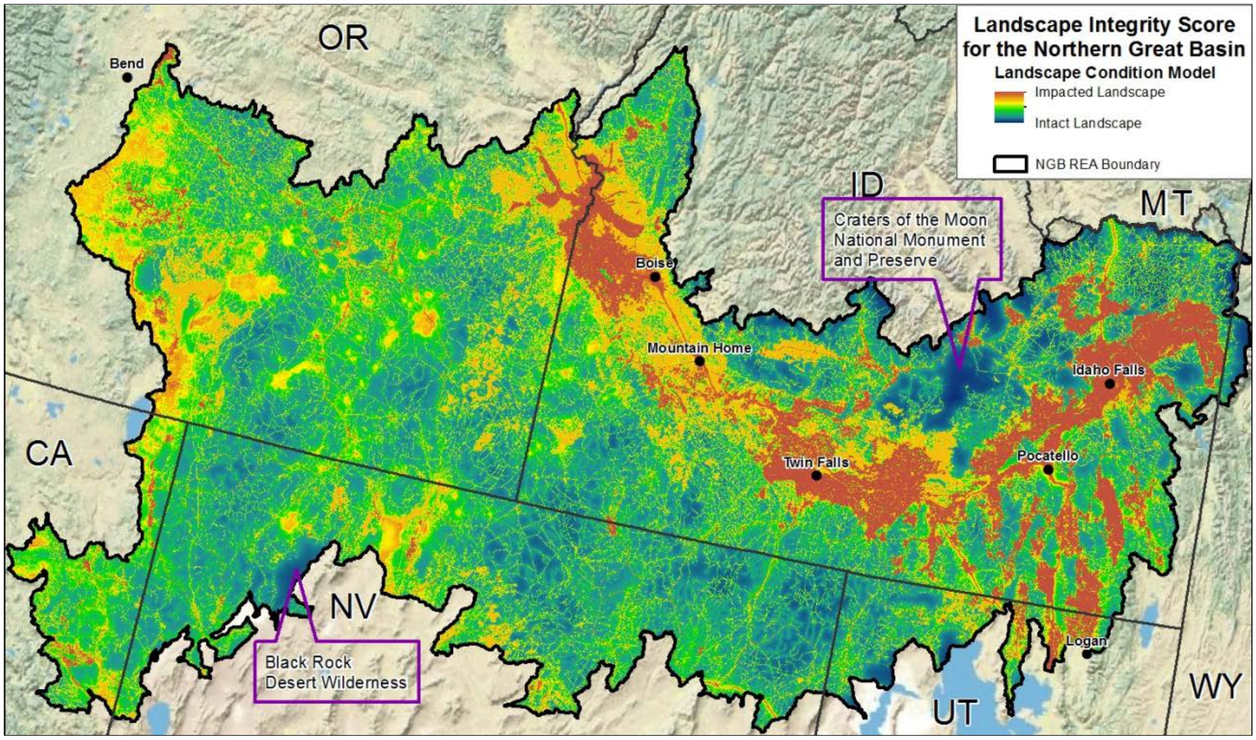



Figure 6.4-1. Western Governor's Association Landscape Integrity Score from the Landscape Condition Model

## Western Governor's Association Important Connectivity Zones

Important Connectivity Zones were ranked based on four factors, the landscape integrity score, mean centrality score (how networkable or interconnected), the length or area and whether the Important Connectivity Zones interconnected two Large Intact Blocks or if it was a feeder from a non-Large Intact Block area into a Large Intact Block. The shorter in length of the Important Connectivity Zones, the higher score it achieved while long Important Connectivity Zones connecting distant Large Intact Blocks or feeder Important Connectivity Zones were scored lower.

Important Connectivity Zones were broken up into three biomes, Grassland, Desert and Forest. Figure 6.4-3 shows an example of the Cool Desert Biome Important Connectivity Zones and Figure 6.4-4 shows the Forest Biome. The Grasslands Biome wasn't shown as there were minimal Important Connectivity Zones in the ecoregion. These two figures both show connectivity zones extending outside of the ecoregion (mostly in Oregon) and connecting with other Large Intact Blocks outside the ecoregion.

Figure 6.4-5 shows a zoomed in view of the Cool Desert Biome on the eastern side of the ecoregion to view the connectivity zones more easily. The Craters of the Moon National Monument and Preserve Large Intact Block has many Important Connectivity Zones connecting it to areas like Mount Bennet to west, Challis National Forest to the north and Deep Creek Mountains to the south.

Figure 6.4-6 shows the same zoomed in view for the forest biome connectivity zones. The forest biome corridors show the modeled interconnections between the ranges in southeastern Idaho such as the Aspen, Bannock, Portneuf, Deep Creek and Wasatch.

## Summary of Landscape Integrity

The AMT decided to use the Western Governor's Association's Landscape Integrity analysis for this REA since its timeline matched the REA and it was being developed west-wide and would cover the entire ecoregion. The landscape condition score from the Landscape Condition Model clearly shows that agricultural areas are the largest anthropogenic impact on the landscape within the Northern Great Basin. Removing the anthropogenic impacted areas still yields many Large Intact Blocks of intact landscape of varying levels of importance. The Important Connectivity Zones shows key corridors between these Large Intact Blocks that are key for movement of species between these intact areas.

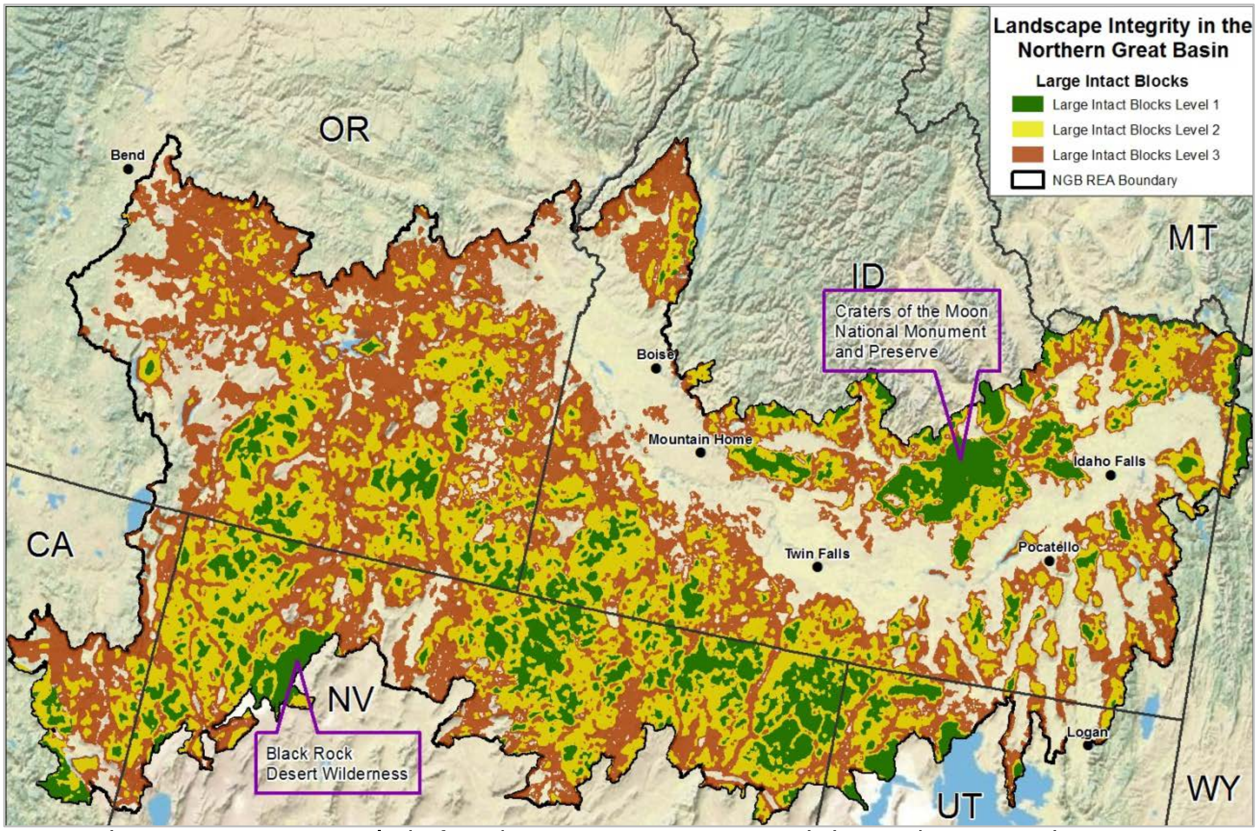



Figure 6.4-2. Large Intact Blocks from the Western Governors Association Landscape Integrity Dataset

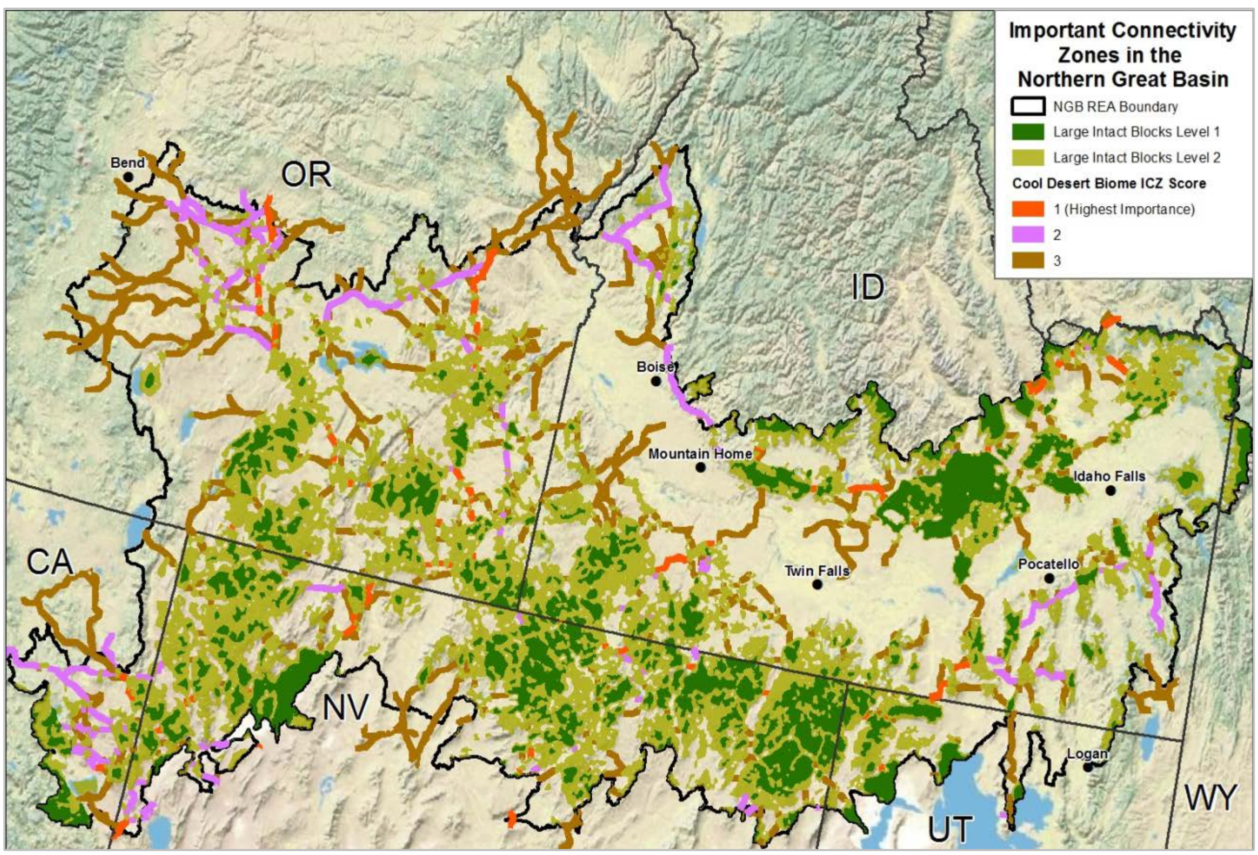



Figure 6.4-3. Important Connectivity Zones Linking Cool Desert Large Intact Blocks

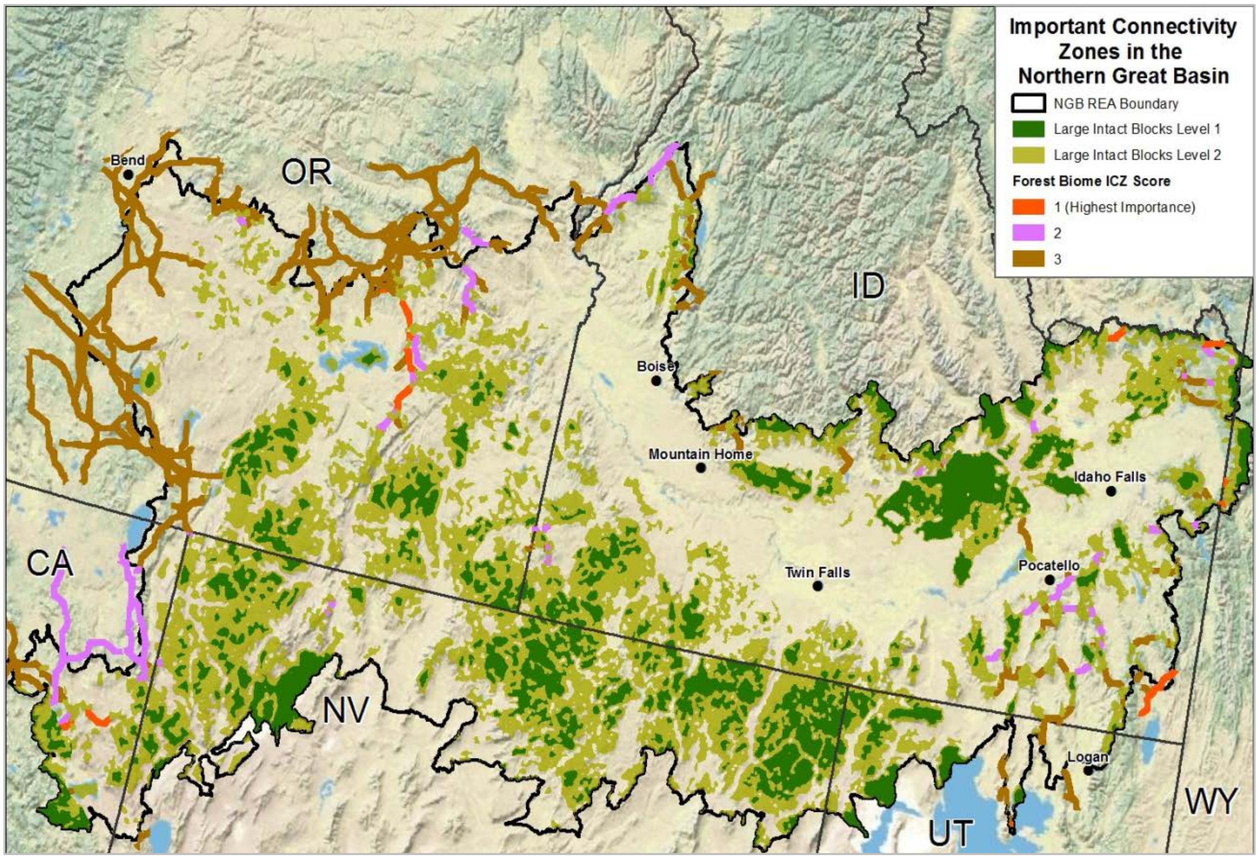



Figure 6.4-4. Important Connectivity Zones Linking Forest Large Intact Blocks

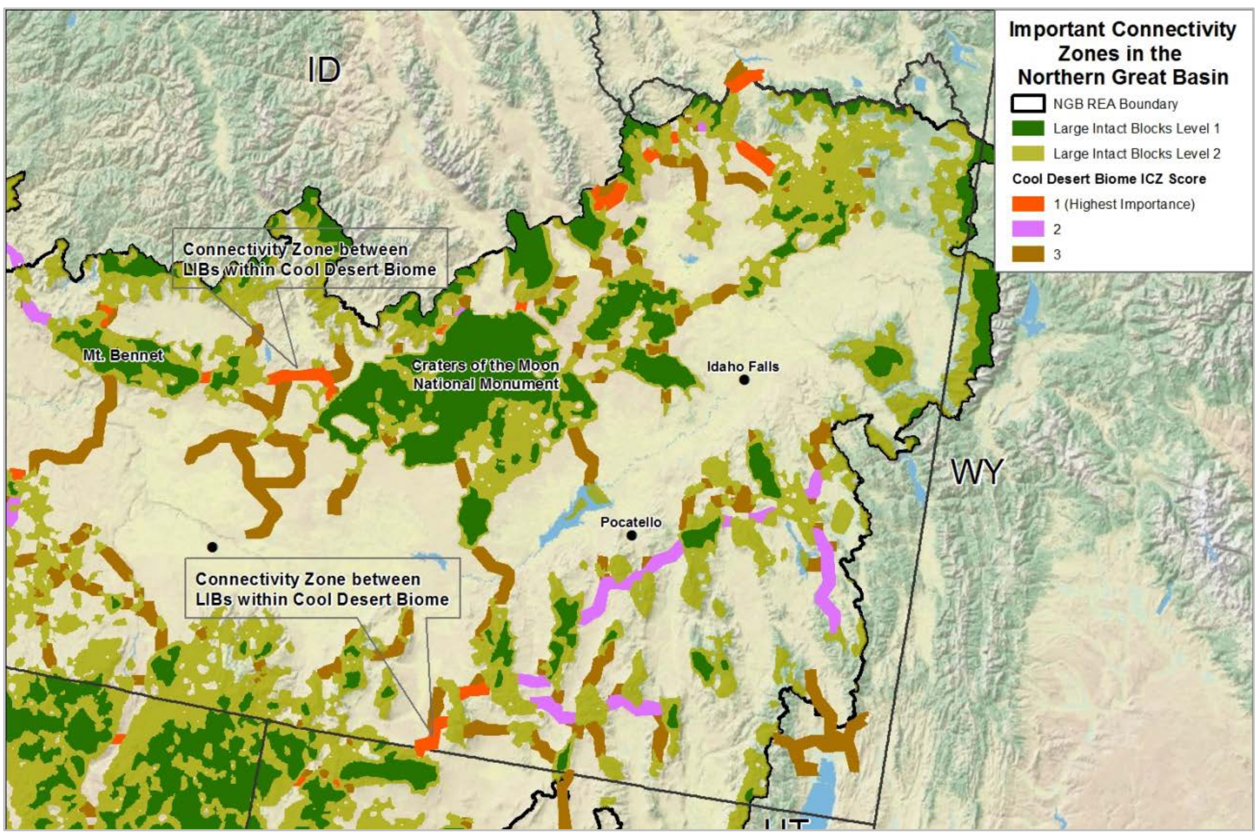



Figure 6.4-5. Northeastern Part of the Ecoregion's Connectivity Zones for Cool Desert Biome Large Intact Blocks

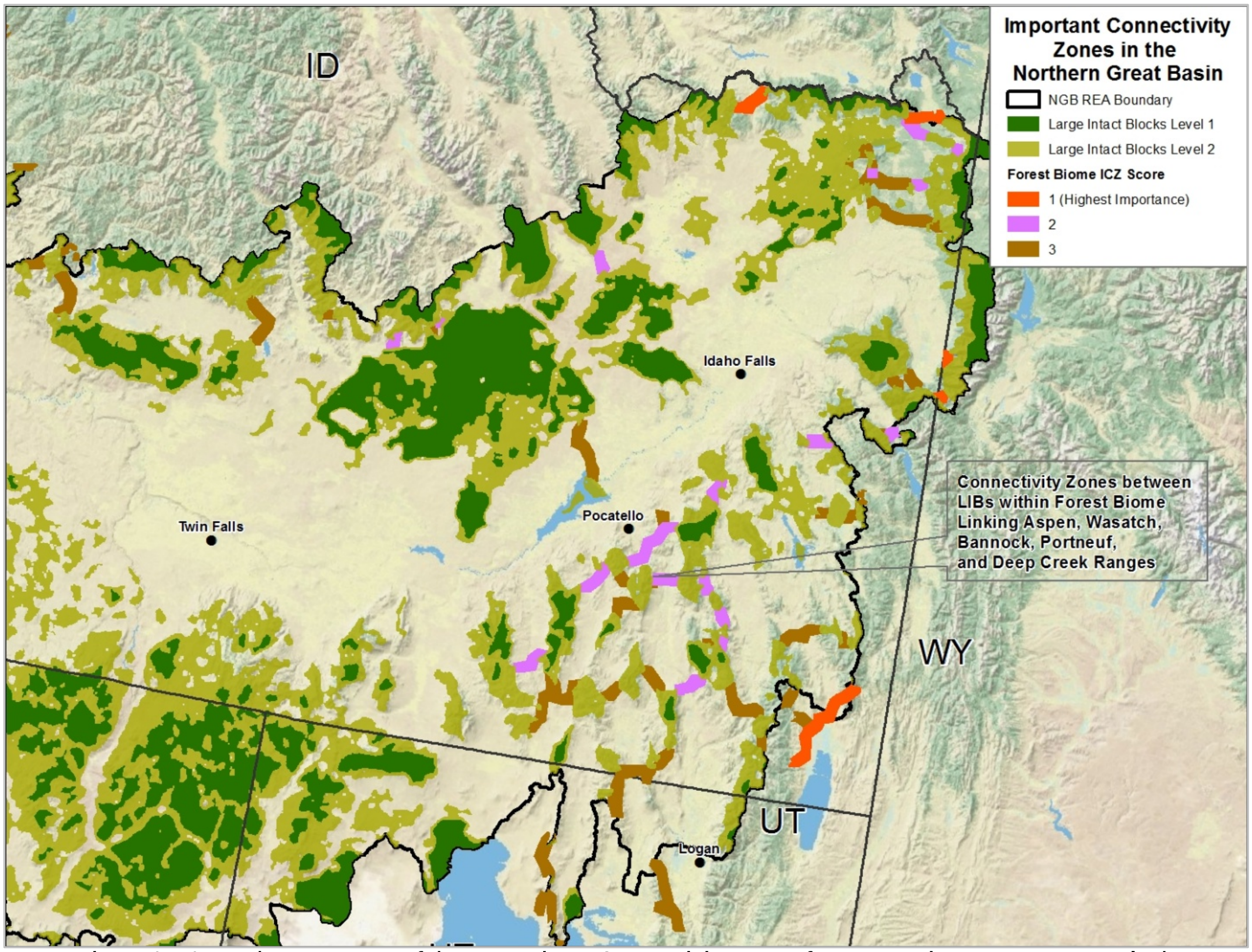



Figure 6.4-6. Northeastern Part of the Ecoregion's Connectivity Zones for Forest Biome Large Intact Blocks

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# 7. Lessons Learned

This assessment benefited greatly from the previous REA efforts completed. Primary benefits included experience by both scientific contractors and assessment management team members, which resulted in better defined expectations and understanding of limitations in the process. The development of management questions emphasized the importance of being able to provide a geospatial answer and the assessment management team worked together to agree on tough decisions whether or not to include resources as conservation elements. There was also a valuable assessment on whether or not resources should be or could be evaluated at the ecoregional scale. Finally, additional improvements include better cooperation and data collection support by the assessment management team members and colleagues. Nonetheless, landscape scale assessments are challenging because of the wide variety of resources that are being evaluated, the relative (and variable) importance of those resources across various boundaries such as state lines, and most importantly the availability of uniformly collected consistent geospatial datasets that cross state lines. This chapter provides an overall summary of the analyses that were completed and provides lessons learned on how to make the REA process better in the future.

Many of the lessons relate to the acquisition and manipulation of geospatial data. Unfortunately, most of the multi-state datasets that were required for this REA were not previously assembled and available for use for this ecoregion.

## 7.1 Summary of Analysis and Reporting

This assessment, produced in collaboration with a number of key BLM staff and partners, provides a tool to address key management questions yet lays the groundwork to significantly expand future geospatial studies to support short and long-term management of public land resources.

The scope of this REA and the evaluation of conservation elements (coarse and fine filters) relative to their interactions with the change agents required the identification and evaluation of more than 500 datasets and a massive effort to develop maps of not only where these resources are located within a multi-state area but also what is happening to these resources in each of those states. Substantial resources were dedicated to the development and creation of the geospatial output products contained in the appendices of this document. Where data were available, the geospatial output of all the fine-filter, coarse-filter, and change agent analyses provides answers to the management questions. Although the REA products will be useful to resource managers in the future, it is important to understand the limitations associated with this type of analysis. The Maxent outputs will be particularly useful to managers to understand the potential for species or assemblage habitats throughout the ecoregion. However, the current status analyses were heavily dependent upon the Key Ecological Attributes that were developed and the quality of the data employed.

Further, the development of management questions required several meetings and time to understand whether or not they could be answered. The number of management questions continued to increase as additional questions were posed by the management team. These questions were important in setting the stage but the authors noted that throughout the process, the objective to answer every single question became more difficult. The analysis scope focused on maximizing the understanding of the interactions between conservation elements and change agents, which commonly corresponded to management questions, but not always.

## 7.2 Data Limitations

Because this analysis substantially relied on large scale multi-state datasets, it is subject to all the limitations in accuracy and precision associated with the original data. The data were not assessed for

accuracy; however, a data quality evaluation was completed as part of the initial phase. Because misclassification of data could significantly alter the results of the analyses, it is advisable that this limitation be considered for future analyses.

It is important to note that the results of the bioclimatic analysis are heavily biased/influenced by the resolution of the predictor data (bioclimatic factors) as well as the values assigned as thresholds from the literature. The inherent bias in this type of approach starts with the 30×30 m Landsat pixel that likely includes (reflects) native vegetation, invasive vegetation, bare ground, litter, etc. There is high variability within the cell, even though a single value (attribute) is assigned to that cell. In other words, just because a pixel returns a positive result for whatever the attribute is that it supposedly reflects doesn't mean that every square meter within that pixel contains that attribute.

In addition, attempting to apply quantitative values for elevation, temperature and precipitation across a particular species distribution in an area with a semi-arid climate might not be completely accurate. Sometimes, physiological details of species abilities are known and can be related to environmental data and therefore reasonably modeled. Upon review of all of the figures in this REA, it must be recognized that there is a mixture of data quality, generalization and similar specifications on the target species. There are clear limitations with this approach and the results that are based on these biases must be used with all of this in mind.

Although the best available data were used at the time of this assessment, there are several limitations to the data and the methods used to complete the REA. Most of these were beyond the control of the study team. Some of these included:

- Lack of ecoregion-wide datasets. Some states in the ecoregion actively collect and store geospatial resource data and other states did not.
- Some states provided very fine scale data that were not appropriate for use at the landscape scale or would not match data from other states.
- Although some ecoregion-wide datasets were obtained (e.g., WAFWA), the way the states collected or categorized the information varied from state to state which is evident when state data is combined by groups like WAFWA.
- Point occurrence records are initially biased due to the fact that researchers are actively seeking out the species.
- Point occurrence data may be historic in nature and represent areas where the species no longer occurs.
- Records typically only indicated species that were present in an area and not absences data. Absence of the species from other areas may only indicate that those areas were not surveyed.
- Development of some of the species assemblages was not conducive to an assemblage type analysis because of the different habitat requirements of the species. For example, the various fish species could not be modeled as an assemblage because of the different habitat requirements of each of the species.
- Using a stretched raster to show a gradient of high to low scoring areas rather than breaking up the results into arbitrary bins of good fair and poor was done at the recommendation of the AMT. This type of display of results will have its limitations such as defining what percentage of the ecoregion scored ‘high’. It was felt that the determination of what is classified high or low should be done in a step down approach by regional experts using the data for a focused task.
- Rolling the analysis up to the watershed level or 4km grid also dilutes the original data.

## 7.3 Significant Data Gaps

### 7.3.1 Cheatgrass

There were many cheatgrass datasets presented in the invasives change agent package from a variety of studies over the last decade, Most of these studies only covered a portion of the ecoregion. This REA ended up using a cheatgrass distribution layer from Peterson (2005) that covered half the ecoregion but the Rolling Review Team felt that it was the best of what was available. The USGS has been conducting a study on cheatgrass mortality that did cover the ecoregion with current and historic data (2000-2010). This dataset became available during the production of this document and was included in some of the figures replacing the older dataset with limited coverage.

### 7.3.2 Grazing

There were several data gaps that prevented a more detailed analysis of grazing as a change agent. Some of the data gaps identified are listed below.

Fences are one of the main alterations to the landscape to allow grazing. Pasture boundaries were used as a surrogate for fences in lieu of actual fence data. There are fences and other alterations that won't be represented in the analysis. Pasture boundaries were only available for BLM land and weren't provided for USFS grazing allotments.

Other livestock management infrastructure such as troughs, corrals, pipelines were not available throughout the ecoregion.

The spatial data gathered on grazing was limited to BLM and USFS land. Private or state managed grazing or range improvements were not mapped or considered.

The actual use of grazing allotments broken down by pastures used along with numbers of animals and time frame the pasture was used.

### 7.3.3 Bats

Bats were considered an important resource for the ecoregion especially with the large amount of wind energy development. Datasets for bats were limited in the ecoregion so an assemblage of bats was created; however, with the variety of habitats and roosts for the various bat groups (riparian vs. cave), the uncertainty resulting from any analysis was determined to be high. GAP data models for some bats species in the ecoregion also exist, but they varied greatly from covering the whole ecoregion to being barely present and thus were not carried forward.

### 7.3.4 Cottonwood Galleries

Cottonwood galleries was selected as a coarse filter but there was no spatial data available. ReGAP and Landfire do not include cottonwood galleries as a vegetation type and there was no state mapping available.

### 7.3.5 Off-highway Vehicle Areas

Off-highway vehicle areas were a partial data gap for the ecoregion. Idaho state office provided an off-highway vehicle area layer showing the areas and status (open, closed, limited use). There was little data on off-highway vehicle roads beyond what is included in the TIGER roads layer. California also had an off-highway vehicle layer for the one off-highway vehicle area on the edge of the ecoregion. Oregon only

had backcountry byways and some small areas around Bend, OR that were classified as off-highway vehicle recreation areas.

### 7.3.6 Pipelines

The Ruby pipeline was one of the main pipelines cutting through the ecoregion from Oregon to Nevada and through to Utah. Only the Nevada section was able to be retrieved through data requests with the Oregon and Utah sections being a data gap.

### 7.3.7 Pronghorn Distribution Data

The largest data gap for pronghorn was WAFWA data for Oregon.

### 7.3.8 Aquatic Ecological Integrity

The Western Governor's Association was providing the data for ecological integrity for this REA. Landscape integrity data was received for terrestrial resources but aquatic ecological integrity was still in a working group. It was mentioned that the Western Governor's Association is focused on creating a product for Oregon and Washington State current which would only cover part of the ecoregion.

### 7.3.9 Other Important Conservation Elements

During the course of the REA process, some recommendations were made for consideration of species groups not listed as potential conservation elements in the Statement of Work. These groups include:

- Freshwater Mussels. A recent status review of several freshwater mussels (*Margaritifera falcata*, *Gonidea angulata*, and *Anodonta californiensis/Anodonta nuttalliana*) that inhabit the U.S. west of the Rocky Mountains indicates that severe declines have occurred in parts of the ranges of each of the species or species groups, and all three are of conservation concern (Xerces Society 2012). These are widely distributed species in western states, but have declined or have been extirpated from historically occupied sites in NGB. The Xerces Society reports state that there is a paucity of information on the biology and status of western freshwater mussels. These species are sedentary as adults and long-lived, and are sensitive to water quality changes, flow regime changes, water impoundments and diversion, loss of host fish, and introduction of non-native fish and invertebrates.
- Isolated endemic fish species. This group would include Endangered Species Act-listed species such as Borax Lake Tui Chub (*Gila boraxobius*), Foskett Springs Speckled Dace (*Rhinichthys osculus ssp.),* Hutton Tui Chub (*Gila bicolor ssp.*), and Warner Sucker (*Catostomus warnerensis*), and possibly other endemic species that have very limited distribution. These species are vulnerable to local land and water use impacts, drought, and predation by introduced species.
- Hydrobiid springsnails. This group includes species that occur in persistent aquatic habitats that are scattered throughout the Great Basin. Forty-two species of Great Basin springsnails have been petitioned for listing under the Endangered Species Act. Threats include groundwater withdrawal, spring development, water quality, and non-native invasive species.

There is considerable uncertainty about aquatic species in this ecoregion including (1) uncertainty about the taxonomic status of many species; (2) incomplete surveys and unknown sampling biases; and, (3) inconsistent documentation among states or other institutions. Their distribution probably reflects hydrological connections that no longer exist, and cannot be easily modeled. At present, compiling data, some of which will likely not be geospatial or recent, from a number of potential sources would at best,

result in an incomplete distribution layer with many significant data gaps. However, we recognize that aquatic taxa are among the most vulnerable groups in the ecoregion because water is a scarce resource, it is sensitive to human influences and exploited for development, and aquatic species have limited ability to move or adapt to these impacts. Therefore, this Work Plan calls attention to these groups as important subjects for future REAs.

With respect to the freshwater mussels, there are important data gaps for these species, including their taxonomy, distribution, host fish species, and change agent effects that would limit our ability to conduct a threat analysis at present. There are likely comparable data issues for isolated endemic fishes and springsnails.

Possible conservation element species with limited distribution or isolated habitats were discussed at AMT Workshop 1 and follow-up discussions. The AMT initially listed a non-specific warm-water fish assemblage conservation element in the Statement of Work, and SAIC suggested several species, but the AMT decided in Workshop 1 not to carry them forward as conservation elements because distribution mapping would be inadequate. The northern leatherside chub was also dropped as a conservation element because its range is limited. In general, the AMT selected widespread conservation elements for this assessment. Some occupy a broad range of habitats and they became species conservation elements because their requirements would not be adequately covered by the “umbrella” of a coarse filter conservation element. Other species that occur as isolated populations may be better suited to assessment using a habitat-focused surrogate conservation element, such as wetlands, seeps and springs. In addition, the threat analysis at the ecoregional scale would likely miss many localized impacts on these small populations, and would be more appropriate in a drill-down field office-level effort. However, we do have a management question (revised to ask “Where do spring snails occur?”) that was discussed at Workshop 4, and provide some spring snail occurrence data in the Springs/Seeps data package. As a result, the authors suggest that freshwater mussels, isolated endemic fish and mollusk species be carried forward in the REA as species with limited data availability and other uncertainties at present that deserve consideration in future REAs.

USGS review of the conservation elements also focused on anadromous fishes, noting that the NGB historically supported runs of Chinook salmon, steelhead, and Pacific lamprey, and they have the potential to be restored if barriers to passage are removed. However, the AMT considered and eliminated Chinook, sockeye, summer steelhead, and Pacific lamprey as potential conservation elements in AMT Workshop 1 because they do not currently occur in the ecoregion and the timeframe for removing barriers and recolonization is unknown and would likely be outside the timeframe of the REA.

## 7.4 Recommendations for Future REAs

- Reduce the number of management questions. Management questions are the most important driver of decisions points within the REA process. They dictate what data are gathered and are an important factor in the level of analysis required. However, the authors believe that too many management questions require a change of focus from the interactions between the conservation elements and change agents to answer direct questions. A reduced number of management question drivers would provide comparable direction and understanding of the key questions and save time and energy trying to answer those management questions that may become less important over the REA process.
- Formally incorporate an “Uncertainty Analysis.” Although uncertainty and a presentation of data gaps are included in the REA process, a formalized uncertainty workshop and analysis would improve the usability of the work products. USGS proposed a system for capturing uncertainty, which could be included as the first page of each data package. This would help set the stage for the information that follows.

- Use 4-km for Terrestrial Conservation Elements and HUC 12 for watershed-based Conservation Elements. A decision was made to transition to 4-kilometer pixels for all terrestrial conservation elements. This was appropriate because the assessment management team provided guidance to not artificially bin results or utilize natural data breaks when presenting information. If a graded scale is utilized, there is no reason to limit the scale of the results unless it extends beyond the ability of the data. If a graded scale is incorporated, reporting the results is more of a challenge because there is not a clear estimation of “red=low quality” or “green=high quality.”
- Maximize the use of Existing Conceptual Models. Conceptual models are the most important mechanism for identifying and validating key ecological attributes for a conservation element. However, the development of new conceptual models is time consuming and has the potential to create conflicts with other models available. We recommend that a search for conceptual models be explicitly incorporated into the literature review task and identified models be carried forward. If multiple conceptual models are available, the emphasis should be placed on the models that best identify the key ecological attributes for the resource.
- Formalize the Rolling Review Team Process. The rolling review teams were immensely valuable to this REA and the authors recognize that earlier establishment of the teams would have improved and streamlined Phase I tasks. We recommend that rolling review teams be established immediately after the development of the conservation elements, change agents, and management questions. Small group input on conceptual models, data, and analysis emphasis would streamline and improve the outputs.
- Approach to Data Requirements. There was disagreement within the assessment management team on what datasets were more valuable to the state managers/end user of the assessment. The REA was faced with several decision points where the recommended datasets (based on some characteristics such as ecoregion coverage, robustness, or quality) would not provide value to the state-level because they would conflict with existing built-up data. Consistency with existing state programs is an important factor in developing an analysis for regional managers; however, utilization of the best available information is also an important aspect. This challenge emphasizes the intersection between a planning documentation program and a research initiative. The authors recommend that as part of the Phase I tasking, a detailed assessment of state programs and data be incorporated. This would allow the assessment management team understand the risk and rewards associated with future data decisions.

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# Appendix A

Rolling Review Teams

# Appendix A

## 1.1 Subject Matter Expert Review

Subject Matter Experts (SMEs) played a key role in ensuring that the Rapid Ecological Assessments (REA) reflects the best available data and modeling processes suitable for each conservation element (CE) and change agent (CA). SMEs were added to Rolling Review Teams (RRTs) comprised of Science Applications International Corporation (SAIC) scientists, SAIC geographic information systems (GIS) personnel, Assessment Management Team (AMT) member(s) and other subject matter experts from the Department of Interior or state agencies. Membership of the RRTs is listed in Table A-1. To ensure consistency amongst the different RRTs, the number of lead SAIC scientists was limited to only a few individuals. This ensured that there is a common approach, or framework, used among the different RRTs and that one RRT did not stray too far from the rest. The U.S. Geologic Survey (USGS), as peer reviewers, were invited to participate in RRTs.

RRTs consisted of 2-3 one hour conference calls to give recommendations on the appropriateness and feasibility of specific CAs within each Development category, data sources, modeling techniques, preliminary analysis results, and a path forward for finalizing the analysis for each CE or CA and determining if the Management Questions (MQs) were answered by the analysis. An outline of the review process and schedule is presented in Table A-2.

The main function of the RRT was to:

- review datasets being used for analysis,
- comment on the use of change agents as surrogate indicators in Key Ecological Attribute (KEA) tables for coarse- and fine-filter CEs
- give input on how to score the results (bins for poor, fair, good),
- give recommendations on suitable future time frame for analyzing CAs effects on CEs, and
- determine if the approaches are consistent with other similar efforts such as the Western Governor's Association (WGA's) Crucial Habitats, neighboring REAs or other state initiatives.

## 1.2 Membership

Each Rolling Review Team (RRT) will be comprised of SAIC scientists, SAIC GIS personnel, Assessment Management Team member(s) and other subject matter experts from Department of Interior or state agencies. To ensure consistency amongst the different RRTs, the number of lead SAIC scientist will be maintained to only a few individuals. This ensured that there is a common approach or framework used amongst the different RRTs and that one RRT doesn't to stray too far from the rest. The U.S. Geologic Survey (USGS), as peer reviewers, were invited to participate in RRTs.

Table A-1. Membership of the Rolling Review Teams

| Conservation Element/Group | SAIC Lead | SAIC 2nd | SAIC GIS | BLM Lead | State | Other |
|---|---|---|---|---|---|---|
| **Fine Filter CE's** | | | | | | |
| Conservation Element/Group | SAIC Lead | SAIC 2nd | SAIC GIS | BLM Lead | State | Other |
| Big Game (mule deer, bighorn sheep, pronghorn) | B. Tannenbaum | | C. McColl | E. Flores (BLM-CA) | S. Siegel (NDOW) | T. Allen (BLM-UT) |
| Eagles (Bald Eagle, Golden Eagle) | B. Tannenbaum | J. Leiendecker | J. Leiendecker | S. Brewer (BLM-NV) | S. Siegel (NDOW) | C. Moulton (IDFG) |
| Fisheries (CWF Assemblage, Bull Trout, White Sturgeon) | B. Tannenbaum | C. Hunt | C. Woods | Scott Hoefer (BLM-ID) | Paul Thompson (UT DWR) | Cynthia Tait (USFS) |
| Greater Sage-Grouse | B. Tannenbaum | | C. Woods | Tom Rinkes (BLM-ID) | Mike McDonald (IDFG) | Erik Blomberg (USGS) |
| Spotted Frog, Pygmy Rabbit, Bats | B. Tannenbaum | D. Barringer | C. Woods | Don Major (BLM-ID) | Bill Bosworth (IDFG) | |
| **Coarse Filter CE's** | | | | | | |
| Conservation Element/Group | SAIC Lead | SAIC 2nd | SAIC GIS | BLM Lead | State | Other |
| Sagebrush, Salt Desert Shrub | T. Mulroy | T. Schoenwetter | C. Woods | Mike Pellant (GBRI) | Steve Siegel (NDOW) | Mark Coca (BLM-NV) |
| Aspen and Other Conifer Woodland | T. Mulroy | T. Schoenwetter | T. Caselton | Tim Bottomley (BLM-NOC) | | Joe Adamski (BLM-ID) |
| Riparian, Cottonwood Galleries, Perennial Streams, Springs and Seeps, Open Water and Wetlands | T. Mulroy | T. Schoenwetter | J. Degner | Bryce Bohn (BLM-ID) | Rick Ward (IDFG) | |
| Vulnerable Soils and Groundwater | T. Mulroy | T. Schoenwetter | J. Degner | Bryce Bohn (BLM-ID) | | Matt Germino (USGS) |
| Specially Designated Areas and Wild Horse and Burro HMAs | T. Mulroy | D. Barringer | C. Woods | Nika Lepak (BLM-ID) | | |
| **Change Agent** | | | | | | |
| Change Agent | SAIC Lead | SAIC 2nd | SAIC GIS | BLM Lead | State | Other |
| Development | T. Caselton | | C.Woods | R. Hopper (BLM-OR) | Jim Mende (IDFG) | Mike McDonald (IDFG) |
| Invasives and Disease | J. Gerlach | | C. McColl | M. Pellant (GBRI) | S. Siegel (NDOW) | T. Allen (BLM-UT) |
| Climate Change | J. Gerlach | | J. Leiendecker | M. Pellant (GBRI) | | S. Phillips (USGS) |
| Wildland Fire | T. Caselton | | C. Woods | Craig Goodell (BLM-OR) | | D. Havelina (NIFC) |
| Grazing | T. Pattison | D. Barringer | C. Woods | N. Lepak (BLM-ID) | G. Servheen (IDFG) | |
| **Ecological Integrity** | | | | | | |
| Ecological Integrity | SAIC Lead | SAIC 2nd | SAIC GIS | BLM Lead | State | Other |
| Terrestrial / Aquatic | B. Tannenbaum | | C. Woods | T. Bottomley (BLM-NOC) | G. Servheen (IDFG) | |

Table A-2. CE/CA Package Review Process and Schedule

| CA Package Review Steps | CA Package Content | Tasks | RRT Review Focus | Timeframe for Completion |
|---|---|---|---|---|
| CA Package ver. 1 | • Rationale for selection of CA<br>• Narrative describing CA<br>• Preliminary data needs<br>• GIS process model(s), if available<br>• Relevant MQs | • SAIC submit CA package ver. 1 and meeting #1 agenda to RRT members<br>• RRT members review CA Package 1 & attend Meeting #1 | • Relationship between MQs and the CA: appropriateness and feasibility<br>• Value of specific data types to answer MQs<br>• Discuss data sources and data capture plan<br>• Preliminary discussion on CA indicators and metrics, | • SAIC submit CA package 1 within 2-3 weeks of RRT member selection.<br>• RRT Meeting 1 with 1 week of CA package submittal |
| CA Package ver. 2 | • Rationale for selection of CA<br>• Narrative describing CA<br>• Data sources<br>• Preliminary CA Indicators and Metrics table including supporting data sources<br>• GIS process model(s), if available<br>• Relevant MQs<br>• Preliminary analysis output | • SAIC submit CA package ver. 2 and meeting #2 agenda to RRT members<br>• RRT members review CA Package 2 & attend Meeting #2 | • Indicators and Metrics table and supporting data sets<br>• Data source coordination<br>• Review preliminary output | • SAIC submit CA Package 2 to RRT members.<br>• RRT Meeting 2 within 2-3 weeks of RRT meeting 1. |
| CA Package ver. 3 | • Rationale for selection of CA<br>• Narrative describing CA<br>• Refined data sources<br>• Refined CA Indicators and Metrics table including supporting data sources<br>• GIS process model(s)<br>• Relevant MQs<br>• Preliminary analysis output | • SAIC submit CA package ver. 3 and meeting #3 agenda to RRT members<br>• RRT members review CA Package 3 & attend Meeting #3 | • Concluding discussion of CA Indicators and Metrics tables, approach to GIS processing.<br>• Discussion of analysis approach and feasibility of answering MQs | • SAIC submit CA Package 3 to RRT members.<br>• RRT Meeting 3 within 2-3 weeks of RRT meeting 2. |