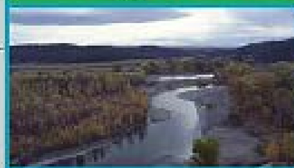
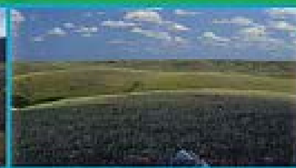
Northwestern Plains
Rapid Ecoregional Assessment


FINAL MEMORANDUM II-3-C NORTHWESTERN PLAINS RAPID ECOREGIONAL ASSESSMENT

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Department of Interior
Bureau of Land Management
Rapid Ecological Assessments

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
ADS	Aerial Detection Surveys
AET	actual evapotranspiration
AIM	Assessment, Inventory, and Monitoring
AMT	Assessment Management Team
AUC	area under the curve
BBD	breeding bird density
BFF	black-footed ferret
BLM	Bureau of Land Management
BpS	biophysical setting
BTPD	black-tailed prairie dog
CA	change agent
CAPS	Crucial Areas Planning System
CBM	coalbed methane
CE	conservation element
CHAT	Crucial Habitat Assessment Tool
CIG	Climate Impacts Group
cm	centimeter(s)
CO_2	carbon dioxide
DEM	Digital Elevation Model
DMG	Data Quality Management Guide
DQE	data quality evaluation
DSS	Decision Support System
E&P	exploration and production
EA	ecological attribute
EI	ecological intactness
EIA	Ecological Integrity Assessment
EIAF	Ecological Integrity Assessment Framework
EPCA	Energy Policy and Conservation Act
ESA	Endangered Species Act
ESRI	Environmental Systems Research Inst. Inc.
EVT	existing vegetation
FCC	Federal Communications Commission
FMAR	forest mortality assessment report
FRCC	fire regime condition class
FRI	fire return interval
GAP	Gap Analysis Program
GCC	global climate change
GCM	Global Climate Model
GFDL	Geophysical Fluid Dynamic Laboratory
GIS	geographic information system
GRSG	greater sage-grouse
ha	hectare
HCA	Habitat Core Area
HUC	Hydrologic Unit Code
ICLUS	Integrated Climate and Land-Use Scenarios
IVC	International Vegetation Classification
KEA	key ecological attributes
km	kilometer
km^2	square kilometers
kV	kiloVolt

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

LANDFIRE	Landscape Fire and Resource Management Planning Tools Project
LCC	Landscape Conservation Cooperative
LCCS	Land Cover Classification System
m	meter(s)
mm	millimeter(s)
MCE	Multi-Criteria Evaluation
MFish	Montana Fisheries Information System
MPB	mountain pine beetle
MQ	management question
MRDS	Mineral Resources Data System
NAVD 88	North American Vertical Datum of 1988
NED	National Elevation Dataset
NGO	nongovernmental organization
NHD	National Hydrography Dataset
NHP	Natural Heritage Program
NLCD	National Land Cover Data
NOC	National Operations Center
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRM	Northern Rocky Mountains
NSCCVI	NatureServe Climate Change Vulnerability Index
NVCS	National Vegetation Classification System
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
OHV	off-highway vehicle
P/E	predicted over expected frequency
PAD-US	Protected Areas Database of the United States
PDF	portable document format
PET	potential evapotranspiration
PRISM	Parameter-elevation Regressions on Independent Slopes Model
PSTG	plains sharp-tailed grouse
REA	Rapid Ecoregional Assessment
ReGAP	Regional Gap Analysis Program
RegCM3	USGS Regional Climate Model Version 3
RMEF	Rocky Mountain Elk Foundation
RRT	Rolling Review Team
SAD	Sudden Aspen Decline
SAIC	Science Applications International Corporation
SME	subject matter expert
SRM	Southern Rocky Mountains
SSURGO	Soil Survey Geographic
STATSGO	State Soil Geographic
SWAP	state wildlife action plan
SWE	snow water equivalent
TIGER	Topologically Integrated Geographic Encoding and Referencing
TRI	toxic release inventory
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

USGS	U.S. Geological Survey
VCC	Vegetation Condition Class
WCS	World Conservation Society
WGA	Western Governors' Association
WNV	West Nile Virus
WPBR	white pine blister rust
WUI	Wildland Urban Interface
WYNDD	Wyoming Natural Diversity Database

LIST OF SCIENTIFIC NAMES

Common Name	Scientific Name
alfalfa	*Medicago spp.*
American crow	*Corvus brachyrhynchos*
Baird's sparrow	*Ammodramus bairdii*
big sagebrush	*Artemesia tridentata*
bison	*Bison bison*
bitterbrush	*Purshia tridentata*
black cottonwood	*Populus balsamifera ssp. trichocarpa*
black-footed ferret	*Mustela nigripes*
blacknose dace	*Rhinichthyes atratulus*
blacknose shiner	*Notropis heterolepis*
black-tailed prairie dog	*Cynomys ludovicianus*
bluebunch wheatgrass	*Pseudoroegneria spicata*
blue grama grass	*Bouteloua gracilis*
bluegrass	*Poa spp.*
brassy minnow	*Hybognathus hankinsoni*
brome grass	*Bromus spp.*
broom snakeweed	*Gutierrezia sarothrae*
buffalograss	*Buchloe dactyloides*
bur oak	*Quercus macrocarpa*
burrowing owl	*Athene cunicularia*
cactus	*Opuntia spp.*
Canada thistle	*Cirsium arvense*
Canby blue grass	*Poa canbyi*
cheatgrass	*Bromus tectorum*
chestnut-collared longspur	*Calcarius ornatus*
club moss	*Selaginella densa*
common raven	*Corvus corax*
creek chub	*Semotilus atromaculatus*
crested wheatgrass	*Agropyron cristatum*
curl-leaf mountain mahogany	*Cercocarpus ledifolius*
Dalmatian toadflax	*Linaria dalmatica*
didymo	*Didymosphenia geminata*
diffuse knapweed	*Centaurea diffusa*
Douglas-fir	*Pseudotsuga menziesii*
Douglas-fir beetle	*Dendroctonus pseudotsugae*
eastern red cedar	*Juniperus virginiana*
ferruginous hawk	*Buteo regalis*
finescale dace	*Phoxinus neogaeus*
fir engraver beetle	*Scolylus ventralis*
golden eagle	*Aquila chrysaetos*
greater sage-grouse	*Centrocercus urophasianus*
green needle grass	*Stipa viridula*
hoary cress	*Cardaria draba*
horizontal juniper	*Juniperus horizontalis*
houndstounge	*Cynoglossum officinale*
June grass	*Koeleria pyramidata*
leafy spurge	*Euphorbia esula*
limber pine	*Pinus flexilis*
McCown's longspur	*Rhynchophanes mccownii*
mosquito	*Culex tarsalis*
mountain pine beetle	*Dendroctonus ponderosae*
mountain plover	*Charadrius montanus*
mule deer	*Odocoileus hemionus*

LIST OF SCIENTIFIC NAMES (Continued)

Common Name	Scientific Name
mustard	*Sisymbrium spp.* and *Descurainia spp.*
needle-and-thread grass	*Stipa comata*
New Zealand mudsnail	*Potamopyrgus antipodarum*
northern redbelly dace	*Phoxinus eos*
northern redbelly dace x finescale dace hybrid	*Phoxinus eos x P. neogaeus*
northern wheatgrass	*Agropyron dasystachyum*
paddlefish	*Polyodon spathula*
pallid sturgeon	*Scaphirhynchus albus*
pasture sage	*Artemisia frigida*
pearl dace	*Margariscus margarita*
pine engraver beetle	*Ips pini*
plains muhly	*Muhlenbergia cuspidata*
plains sharp-tailed grouse	*Tympanuchus phasianellus jamesii*
plains topminnow	*Fundulus sciadicus*
ponderosa pine	*Pinus ponderosa*
porcupine grass	*Stipa spartea*
pronghorn	*Antilocapra americana*
quaking aspen	*Populus tremuloides*
red three-awn	*Aristida longiseta*
rough fescue	*Festuca scabrella*
rubber rabbitbrush	*Chrysothamnus nauseosus*
Russian knapweed	*Acroptilon repens*
Russian olive	*Eleagnus angustifolia*
Russian thistle	*Salsola iberica*
sagebrush	*Artemisia spp.*
saltcedar (Tamarisk)	*Tamarix aphylla, T. chinensis, T. gallica, T. parviflora, T. ramosissima*
sauger	*Sander canadensis*
sedge	*Carex obtusata*
sicklefin chub	*Macrhybopsis meeki*
skunkrush	*Rhus trilobata*
slender wheatgrass	*Agropyron trachycaulum*
smooth brome	*Bromus inermis*
smooth softshell turtle	*Apalone mutica*
spike oat	*Helictotrichon hookeri*
spiny softshell turtle	*Apalone spinifera*
spotted knapweed	*Centaurea stoebe*
Sprague's pipit	*Anthus spragueii*
spruce beetle	*Dendroctonus rufipenni*
sturgeon chub	*Macrhybopsis gelida*
sweet clover	*Melilotus spp.*
swift fox	*Vulpes velox*
sylvatic plague	*Yersinia pestis*
threadleaf sedge	*Carex filifolia*
western larch	*Larix occidentalis*
western spruce budworm	*Choristoneura occidentalis*
western wheatgrass	*Pascopyrum smithii*
white snowberry	*Symphoricarpos albus*
Wyoming big sagebrush	*Artemisia tridentata wyomingensis*
yellow toadflax	*Linaria vulgaris*
zebra mussel	*Dreissena polymorpha*

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EXECUTIVE SUMMARY

The Bureau of Land Management (BLM), being part of the Department of Interior (DOI) is responsible for implementing the landscape approach. The Landscape Approach for Managing the Public Lands, looks for ecological conditions, patterns, and management opportunities that may not be evident when managing smaller land areas. The approach will help the BLM respond to an increasing demand for the use of the public lands for recreation and energy development. Recreation and energy development often support local economies in the West. The landscape approach builds upon, connects, and supports these ongoing field efforts. This approach also complements and supports the Landscape Conservation Cooperatives the Department of the Interior is helping establish throughout the country. Information collected under the initiative will be used for long-term conservation, restoration, and development efforts, including partnerships.

The Rapid Ecoregional Assessment (REA) is the 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 (BLM 2012). In response, the BLM launched seven REAs in 2010 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.

ES.1 PURPOSE AND SCOPE

The purpose of the REA is to identify, assemble, synthesize, and integrate existing information about natural resources and environmental change agents (CAs) 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, such as the Sonoran Desert and the Northwestern Plains (BLM 2012). For this REA, the term landscape-scale approach refers to a large-scale (i.e., 30,000 foot aerial) view when evaluating natural resources. 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 (MQs) 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.

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. The key purpose of this REA is to identify and understand the ecoregional influences of substantial, widespread CAs on a limited number of focal ecological resources or conservation elements (CEs). CAs are features or phenomena (e.g., wildfire, development) that have the potential to affect the size, condition, and landscape context of CEs. The REA is intended to provide information that estimates the current status and potential future threats to natural resources in the ecoregion by examining the relationships between the CEs and CAs.

The scope of this REA is the Northwestern Plains ecoregion which includes the area within the boundaries of the Northwestern Glaciated Plains (9.3.1) and the Northwestern Great Plains (9.3.3) Level 3 Ecoregions (Commission for Environmental Cooperation 2006) plus a buffer area consisting of those 5th level hydrologic units (HUCs) watershed that overlap the ecoregion boundary. The extent of the assessment area, including the buffer area for this REA, is 236,249 square miles (611,885 square kilometers [km^2]). Canada was not included in the extent for this REA because it was recognized that consistent, like scale data would be difficult to obtain and crosswalk with the U.S. data.

ES.2 RAPID ECOREGIONAL ASSESSMENT PROCESS

The Nature Conservancy (TNC) developed a framework for evaluating conservation impact (Poiani et al. 1998). This framework has since been improved upon and is now widely used by agencies and organizations throughout the United States. Parrish et al. (2003) described the various approaches that

TNC and federal agencies have used to measure conservation success. In 2009, the TNC partnered with the National Park Service to complete the Ecological Integrity Assessment Framework (EIAF) as a methodology to guide planning for the conservation of biological and ecological resources U.S. National Parks (Unnasch et al. 2009).

The EIAF is a method of evaluating natural resources based on their ecological integrity defined as “the ability of an ecological system to support and maintain a community of organisms that has a species composition, diversity, and functional organization comparable to those of natural habitats within a region” (Unnasch et al. 2009). An ecological system has integrity when its dominant ecological characteristics occur within their natural range of variation and can withstand and recover from most environmental or human disruptions (Parish et al. 2003). The EIAF provides a methodology to establish criteria to distinguish high integrity conditions from low integrity (i.e., impaired) conditions (Unnasch et al. 2009). In this REA, the term “ecological intactness” (EI) is used to define ecological condition at an ecoregional scale.

The REA process incorporates EIAF methods of Parrish et al. (2003) and Unnasch et al. (2009) by defining MQs, identifying stressors known, suspected, or anticipated to affect key resources of the ecoregion and defined as CAs, and selection of a core group of species or species assemblages (CEs) on which to further focus management attention (Unnasch et al. 2009). For each CE, key ecological attributes (KEAs) or surrogate indicators are identified based on available data and are used to measure or evaluate ecoregion conditions for the current status and future threat analyses.

Management Questions

The REA process was designed to answer MQs that relate to the CEs and CAs. The MQs were developed to identify management issues and concerns of regional importance that could not be resolved by individual agencies or offices. The process of developing the MQs was iterative, with the goal of developing a clear understanding of the resources in need of assessment and identification of specific impacts that are of particular concern for the region. Although numerous MQs were initially developed for this ecoregion, they can all be summarized into two main over-arching questions:

1. ***Where are the resources located throughout the ecoregion?***
2. ***What is happening to those resources?***

Change Agents

The identification of the CAs formed the starting point to evaluate the current status and future threats to the key resources of the ecoregion. The CAs included wildfire, agriculture, invasive species, insect outbreak and disease, climate change, and development (both energy development and urban and exurban growth).

Conservation Elements

The selection of coarse- and fine-filter CEs started with the identification of ecosystems, species assemblages, and individual species that adequately represent the key resources of the ecoregion and that might best represent the effects of CAs across the ecoregion. Coarse-filter CEs represent the dominant or regionally important aquatic and terrestrial vegetation communities or ecosystems and were intended to cover the suite of taxa, communities, and ecological characteristics. Coarse-filter CEs evaluated in this REA included evergreen forests, deciduous woodlands, grasslands, shrubland and savanna systems, sparse vegetation, and riparian forest woodlands.

Fine-filter CEs include protected, keystone, or wide ranging species or assemblages that are considered important ecoregional resources. Species or species assemblages were selected because they play critical ecological roles, have substantial spatial requirements, or are known to be rare, imperiled, or narrowly endemic. The fine-filter CEs selected for this ecoregion included mule deer, greater sage-grouse (GRSG), golden eagle, the grassland bird assemblage, the black-tailed prairie dog (BTPD) assemblage, the prairie pothole community, the prairie fish assemblage, the big river fish assemblage, plains sharp-tailed grouse (PSTG), and pronghorn.

Time Horizons

The purpose of the REA is to provide a current status of the landscapes within the ecoregion. Current status was defined as 2010, but available data generally included data gathered up to 10 years prior. For the climate change CA, the current condition was defined as 2010 (BLM 2010); however, data for the period between 2000 and 2010 were not available for the REA analysis. Current climate data were based on models for the period of 1980 to 1999.

Many of the MQs identified for this REA involve questions related to the potential for change over time. The BLM determined that future change should be evaluated to forecast for two future timeframes; near term and the long term. The near term horizon is a 15 year outlook through the year 2025 and the long term horizon is a 50 year outlook through the year 2060. However, for all of the CAs except climate change and development (population growth), data were not available to assess the long term horizon.

Conceptual Models

Conceptual models were developed to represent the current understanding of the underlying natural processes controlling or influencing a CE in order to identify the appropriate data needed to conduct the REA. Development of the conceptual models included an extensive review of current scientific literature of the ecological requirements for each CE as well as any information relative to the current or potential impacts of CAs. Where available, existing conceptual models were reviewed and evaluated before new models were developed.

Data Sources

A variety of geospatial data were identified, acquired, evaluated, developed, and/or adopted. Datasets were identified to define the distribution of CEs and to represent the KEAs selected for analysis of current status and future threats. The evaluation of CEs relative to their interactions with the CAs required the identification and evaluation of more than 500 datasets. The primary data sources used for this REA were BLM, U.S. Forest Service (USFS), state partners, Natural Heritage Programs (NHPs), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS), Regional Gap Analysis Program (ReGAP), Gap Analysis Program (GAP), and Landscape Fire and Resource Management Planning Tools Project (LANDFIRE). Several BLM datasets as well as publicly available spatial data were also evaluated to determine which data would provide the coverage required for the current status and future threat analyses. Some datasets contained multiple features and attributes that were important to more than one CE or CA (e.g., elevation, vegetation, water, etc.). The geospatial modeling that was completed was based solely on the availability and quality of geospatial data for the states included in the ecoregion.

Modeling Tools

The geospatial analysis was completed using Environmental Systems Research Inst. Inc. (ESRI) ArcGIS Version 10.0 as the primary tool for spatial analysis. Multi-criteria evaluation (MCE) was the method adopted for this REA as the decision support model analysis. The MCE approach was easily implemented with the ArcGIS platform using ModelBuilder. The use of a geographical information system (GIS) and MCE applications allows the integration of a variety of geospatial datasets to produce an output map for a specific purpose. While the resulting maps are site specific, the approach and procedures are applicable throughout the BLM management regions.

For some species, existing distribution models were adopted and used as the distribution layer for the CE-specific current status and future threat analyses. Data sources included existing data layers from USFS, Western Association of Fish and Wildlife Agencies (WAFWA), Rocky Mountain Elk Foundation (RMEF), or World Conservation Society (WCS). For several of the CEs (golden eagle, grassland bird assemblage, BTPD assemblage) where existing distribution models did not exist, point occurrence data from NHPs and state agencies were used to develop Maxent distribution models (Phillips et al. 2004). The Maxent model combines species occurrence data with input overlay layers to determine a probability of suitability. For the fish assemblages, potential distribution layers were created using a predictive distribution model with quantitative models of species-habitat associations to extrapolate species presence to unsampled areas (MoRAP 2012). For other CEs, uses of other data were necessary where adequate occurrence data were not available. For example, for the WAFWA mule deer the winter range data served as the distribution layer for this species.

Evaluation Method

In order to answer the MQs regarding the current status or ecological condition of the ecoregion and potential future threats to the CEs based on CAs, this REA incorporated concepts of an ecological scorecard based on Parrish et al. (2003) and Unnasch et al. (2009). Every species, biological community, or ecological system has distinct characteristics. The dominant and critical characteristics that contribute to the persistence of the resource are defined as the KEAs. KEAs were used to assess and “score” the relative status of habitat conditions based on the CE’s distribution within the ecoregion, and reported at the 6th level HUC.

Conceptual models were used to guide the selection of appropriate KEAs or surrogate indicators that could be quantified, ranked, or scored. Existing geospatial data were evaluated to determine its usability in measuring the KEAs. For each KEA or indicator, values or estimates of the ecologically acceptable range of variation were defined as well as thresholds of unacceptable change (Unnasch et al. 2009). An ecological acceptable range was considered indicative of a habitat with a good current status while those outside of the acceptable range were considered degraded or poor status habitats. The metrics were taken from available scientific publications, coupled with expert analysis and professional judgment of the Rolling Review Team (RRT) comprised of BLM resource managers, SAIC subject matter experts,, and federal and state agency experts. The RRT met periodically to contribute information and to analyze KEA, indicators, metrics, and GIS outputs that were derived from spatial analyses. In order to address the differences in magnitude of metric values, the values were standardized using an indicator rating of good, fair, or poor. The status of the KEA was considered good if the KEA or indicator fell within the natural (or acceptable) range of variation as defined by the metrics. If the KEA or indicator fell outside of the minimum desired range of variation, then the status was considered fair or poor (Gordon et al. 2005).

In order to provide information on the overall current status for each CE, each of the KEA indicator ratings were assigned a score (1 = good, 2 = fair, 3 = poor) and averaged. In some cases, KEAs were weighted before averaging based on RRT decisions. A final overall rating (good, fair, or poor) for each 6th level HUC was determined using the natural breaks method.

For future threat analysis for each CE, ecoregion-wide assessments for each CA were developed. For some coarse-filter CEs, future threat analysis was also conducted based on CE-specific KEAs and then a final overall rating for each 6th level HUC was determined based on methods conducted for the current status.

ES.3 RAPID ECOREGIONAL ASSESSMENT PRODUCTS AND RESULTS

The scope of this REA and the evaluation of CEs relative to their interactions with the CAs required the identification and evaluation of more than 500 datasets and an extensive effort to provide geospatial products that can be used as tools to address key management questions. Summaries of the results of the analysis are located in the main body of this report with the appendices containing the detailed information on the models, methods, tools and summaries for the CAs and CEs.

Change Agents

Development: Development was selected as a CA because the Northwestern Plains are experiencing an expansion of urban and exurban development, an increase in infrastructure, oil and gas exploration, and renewable energy development, along with modification of the landscape by agricultural and hydrological development. The impact of current development on natural resources of the ecoregion was assessed based on a CE-specific approach and also through an ecoregion-wide ecological intactness analysis for two land cover classes; terrestrial and aquatic. Future spatial data for development were limited to potential energy development, modeled urban growth, and potential agricultural development.

Some human activities including livestock grazing and logging are agents of change in native ecological systems in this ecoregion, but are not included in the REA. Data collection related to livestock grazing on BLM managed lands has been a locally driven process focused on vegetation response and is useful for analysis at the local scale but is not centralized. Additionally, grazing impacts cannot be accurately assessed and separated from other disturbances with available remotely sensed data. Because of these data limitations, grazing was not included as a specific CA in this landscape assessment.

Wildfire: The resources of this ecoregion are well adapted to periodic fire. However, as anthropogenic development has spread throughout the west, so has the suppression of wildfire. Wildfire suppression alters the historical fire regimes of fire-adapted vegetation systems which can lead to degraded habitats, invasive species and potential loss of other species such as the GRSG.

Invasives: As part of the pre-assessment for this CA, a wide variety of invasive species were originally evaluated for inclusion into the REA. It was determined that consistent ecoregion-wide invasive plant species data were not available to create an ecoregional distribution map. Data sources for other terrestrial and aquatic invasives (e.g., didymo, mudsnail) were also very limited in coverage and scale across the ecoregion. Because little or no data was available for any of the invasives, a surrogate analysis for terrestrial invasive plants was the only analysis on invasives completed as part of this REA.

The current status of invasive plants within the ecoregion was addressed by bioclimatic modeling. Five bioclimatic factors (vegetation, elevation, soil factors, precipitation, and temperature) were defined to graphically represent the affinities of the ten most common terrestrial invasive plant species throughout the ecoregion. Although the bioclimatic models are useful, a future threat assessment for invasive plants was not completed.

For many of the selected species (e.g., diffuse knapweed, Canada thistle), the range of values for the specific bioclimatic factored obtained from the literature was often not specific and therefore, encompassed most of the ecoregion. Additionally, applying quantitative values for elevation, temperature and precipitation across a particular species distribution in an area with a semi-arid climate may not be accurate. Lastly, the inclusion of a vegetation community as a bioclimatic factor was not effective in identifying high risk areas since many of the invasives were documented to occur in a variety of vegetation communities. However, based on the results of this analysis, it is apparent that much of the ecoregion is potentially at risk from invasive species, and many have the potential to be widespread.

Additional data on invasive species distribution is necessary to evaluate the potential, current, and future risks of this CA on the CEs of the ecoregion. Existing data collection efforts are probably biased based on weed control program priorities or the accessibility of an area which likely leaves a considerable portion of the ecoregion unsampled (Barnett et al. 2006; Barnett et al. 2007). It is recommended that future invasive species data collection efforts be designed to cover more of the landscape and include randomly distributed points to improve representativeness of habitats across the ecoregion. This effort may require that the scope and scale of an invasive species assessment be conducted in phases by focusing on a particular ecosystem and a few highly aggressive invasive species. Future studies that provide point occurrence data along with bioclimatic factors could be used with spatial models to estimate the actual and potential distribution of non-native species richness, cover, and the probability of occurrence. These models could also provide an indication of how environmental variables contribute to these distributions, and can also be useful for directing control and assessing impact to natural resource assets and management objectives (Barnett et al. 2006).

Insect Outbreak and Disease: Because of the lack of a consistent scale and comprehensive datasets for the disease component of this CA, insect outbreaks were the only component analyzed for this ecoregion. Insect infestation was analyzed using aerial detection survey (ADS) from by the U.S. Forest Service. Survey data on the health of affected forest areas is collected across State, Private and Federal Lands, assigned standardized forest damage codes, and recorded. ADS vector data from 1994 to 2010 was used. Three insects were identified for analysis; MPB, spruce budworm, and an "other beetles" category which included Douglas-fir beetle, Douglas-fir engraver beetle, pine engraver beetle, and spruce beetle. The current status analysis of the forests showed a low risk from insect outbreak across most of the ecoregion.

Climate Change: For this REA, data for present and future climate over western North America were provided by the USGS from dynamically downscaling global climate simulations using Regional Climate Model (Regional Climate Model Version 3 [RegCM3]). Current climate data were based on models for the period of 1980 to 1999. Data for the period between 2000 and 2010 were not available for the REA analysis. Future climate data were based on the models for the period of 2050 to 2069. The target date for this REA was 2060. Because the RegCM3 models were based on decadal periods, a date range encompassing this date was used in the analysis. For both the current and future time periods, climate change analysis was also evaluated for four bimonthly seasonal periods within a year as well as a four-month winter snow season and an annual period to supply a context for between seasonal changes.

NatureServe's Climate Change Vulnerability Index (NSCCVI) was used to assess the potential effects of climate change on the fine-filter CEs. The NSCCVI process uses a range of attributes for each species that, when assessed with the forecasted climatic change, determines a species' vulnerability. The NSCCVI results are provided in the CEs-specific discussions. Discussions regarding potential future conditions for each CEs based on climate change are limited to broad qualitative statements.

In general, the current precipitation pattern for the Northwestern Plains ecoregion is a trend of increasing precipitation from the northwest to the southeast. This trend is not present in the November to February period and is less apparent during the warm rainy season in May and June. The Powder River Basin southwest of the Black Hills is an exception as it is relatively drier than the southeastern area of the ecoregion. The mean annual temperature for existing climate pattern indicates that the southeastern corner of the Northwestern Plains could be generally warmer than the rest of the ecoregion. The model shows an exception as an area in south central Montana that is slightly warmer than the surrounding areas during the November to February season.

The RegCM3 model projects that future total annual precipitation will remain unchanged for the Power River Basin. A large annual precipitation increase in the southeastern area of the ecoregion is projected, and a moderate increase is projected across the rest of the ecoregion. Future temperature patterns from the RegCM3 model indicate that the Northwestern Plains could experience a temperature increase between 1.9 to 2.3 degrees Celsius (°C). The future temperature patterns for July indicate that most of the Northwestern Plains could increase between 1.1 to 2.3°C. Areas of the Powder River Basin and the southeastern corner of the ecoregion could increase between 3.1 to 4.2°C. As mentioned, these temperature increases could have a substantial effect on evapotranspiration rates in the Powder River Basin and reduce the water content of dead vegetation and litter. Both conditions will likely increase water stress in plants and provide more flammable materials for wildfires. For the November to February timeframe, the model indicates that temperatures across a broad diagonal band from northern Montana to South Dakota could increase between 3.1 to 5.4°C. This is a very significant change as the actual mean temperature for in the northern diagonal band could increase from below zero to zero degrees Celsius, likely resulting in more frequent freeze thaw cycles.

Conservation Elements

Six vegetation systems of the Northwestern Plains ecoregion represented the coarse-filter CEs, and five individual species and five species assemblages represented the fine-filter CEs. The KEA analysis provided the basis for the compilation of an overall map that defined the current status of the CE for each HUC across this ecoregion. Future spatial data for development were limited to potential energy development area, modeled urban growth, and potential agricultural development. Future risks due to wildfire and insect disease and outbreak CAs were evaluated for select vegetative communities. Due to the scale of the climate change CA analysis, discussions regarding potential future conditions for each CEs are limited to broad qualitative statements.

Coarse-Filter Conservation Elements

Evergreen Forest Woodland: The overall current status results indicate predominately good to fair scores across the range of evergreen forest woodlands within this ecoregion. Areas that appear most susceptible to current threats occur in the southern portion of the Black Hills and the areas near the Bitterroot

Mountains. The effects of Mountain Pine Beetle (MPB) and other beetle infestations on evergreen forests within the ecoregion are low with moderate threats in the Black Hills region. Western Spruce Budworm infestation appear limited to the Bitterroot Mountains and associated ranges with other small evergreen forest stands experiencing substantial levels of infestation in southwestern Montana. Much of the Bitterroot Mountains is located in the Middle Rockies ecoregion. Most of the evergreen forest woodlands in the ecoregion will likely remain unaffected by fossil fuels development and are at low risk with regard to future renewable energy development. Future insect outbreaks for the evergreen forest woodlands in middle portions of the Northwestern Great Plains and in the north central portion of the ecoregion indicate a high risk. However, areas north of the Black Hills and areas in the northwest of the ecoregion appear to be at low risk. The insect proximity analysis indicates that forests in the central and northwest portions of the ecoregion at higher risk for insect infestation. Potential future temperature increases due to climate change could result in increased outbreaks in the evergreen forest woodlands of the Northwestern Plains.

Deciduous Forest and Woodland: The results of the current status assessment indicate that approximately 44 percent of the 6th level HUC watersheds that intersect this forest distribution received an overall rating of fair. The deciduous forests located in Nebraska, around the Black Hills, and those along the western border of this ecoregion generally rated good for the overall current status analysis. The deciduous forests in North Dakota were rated as poor for the overall current status analysis. With the exception of areas in northeastern Wyoming, northwestern North Dakota, and northeastern Montana, the majority of the deciduous forests are at a moderate risk to the potential for fossil fuel development. The majority of the deciduous forests in the Northwestern Plains ecoregion are considered to be at low risk with regard to the threat of renewable energy production. Future temperature and precipitation changes appear to be minor in the deciduous forest areas of the Northwestern Plains. The onset of Sudden Aspen Decline has been linked to drought and therefore stands located at lower elevations and on south/southwest facing aspects with localized higher temperatures are the most susceptible (USFS 2009).

Grasslands: The current status analysis for grasslands resulted in good ratings for the largest patches of grasslands located in northwest and north central South Dakota around the areas of the Cheyenne and Standing Rock Indian Reservations and the Black Hills area. The remainder of the grassland areas in this ecoregion received fair to poor ratings. Most of the agricultural areas (current and future) are located throughout the grasslands distribution layer. Thus, agriculture conversion is a high risk to grasslands in the future. Future urban growth around Havre, Montana is expected however this does not appear to threaten grasslands on a landscape scale. Most of the grasslands in the ecoregion will likely remain unaffected by fossil fuels production, as the majority of potential fossil fuels production is limited to northeastern Wyoming. There is potential for future impacts from wind energy development within the eastern portion of the ecoregion. It does not appear that grasslands are at a high risk from temperature or precipitation changes in this ecoregion. However, the combined impacts of increased temperatures, invasive species, localized drought and conversion of lands to agricultural uses could negatively affect grasslands in the future.

Shrubland and Savanna: The current status analysis indicates that many small areas of shrub savanna in western North Dakota were rated as poor. In areas where shrubland savanna systems are concentrated from the patch size analysis, the overall score predominantly returned good results. Most of the agricultural areas (current and future) are located throughout the Missouri River Valley. Thus, the shrubland and savanna systems in this area are at risk to agriculture conversion in the future. Only minor portions of shrubland and savanna are currently in close proximity to urban/suburban populations and therefore urban growth is considered a low threat. Shrubland and savanna systems within northeastern Wyoming are at the highest risk to fossil fuel development while the majority shrubland and savanna systems in this ecoregion are not considered to be at risk from future renewable energy development. Modeled temperature and precipitation changes appear to be minor in the areas where shrublands occur in the Northwestern Plains. However, the combined risks of increased temperatures, localized drought and conversion of lands to agricultural uses could negatively affect shrubland and savanna systems in the future.

Sparse Vegetation: No KEAs were initially developed for this coarse filter CE. As a proxy to illustrate the potential impacts of off road vehicles, roads were used to complete a proximity analysis. The analysis indicates a low risk associated with roadways in the sparse vegetation habitats of this ecoregion. It does not appear that sparse vegetation habitats are at risk from future oil or gas development since the majority of potential gas production is limited to northeastern Wyoming and western North Dakota. Additionally, future renewable energy potential also appears to present a low risk to sparse vegetation habitats. Predicted future temperature increases of 1.9 to 2.3°C due to climate change may result in more extreme environmental conditions including temperature increases, which could accelerate erosion processes and restrict vegetation growth or recovery.

Riparian: The results of the current status assessment indicate that approximately 46 percent of the 6th level HUC watersheds that intersect the riparian forest distribution received an overall rating of good, while approximately 54 percent received an overall rating of fair or poor. Most of the riparian forest and woodlands found in the ecoregion are located in areas with greater than 60 percent of the riparian corridor in agricultural use and are some of the most fragmented areas in the ecoregion. Most of the land located throughout the Missouri River valley has been converted to agriculture, however, there are large areas of riparian forests located along the other major tributaries in this ecoregion that have the appropriate soil type for agricultural use and could be at a future risk of conversion to agriculture. With the exception of areas in northeastern Wyoming, northwestern North Dakota, and northeastern Montana most of the riparian areas in this ecoregion will likely remain unaffected by future fossil fuel development. The majority of riparian areas do not appear to be at risk of future wind energy development. Potential changes in temperatures across the ecoregion due to climate change, may threaten the vegetation of riparian areas. Riparian habitats may become stressed under the combined impacts of increased temperatures, localized drought and conversion of lands to agricultural uses in the future.

Fine-Filter Conservation Elements

Mule Deer: The results of the current status assessment for mule deer indicate that the majority (56 percent) of the 6th level HUC watersheds that intersect the mule deer distribution received an overall fair rating as compared to nearly 36 percent that had a good rating. The core habitat patch model indicates that the poorest density of mule deer habitat occurs throughout the northeastern boundary of the ecoregion as well as some smaller clusters of in the southeast and southwest. The overall current status analysis indicates that mule deer habitat is primarily at risk from roads in the northeast and southeast, and existing oil and gas wells in the southwest. Future agricultural development activities in the southwestern area may be a risk to mule deer through loss of habitat, especially in potential migration corridors. However, mule deer are very adaptable to agriculture. The southwestern portion of the ecoregion is also an important area for future oil and gas extraction, in addition to having the highest potential for solar energy. Changes in traditional summer/winter ranges as a result of climate change may lead to a short-term positive effect on the abundance and distribution of mule deer in this ecoregion. Increases in populations or ranges of mule deer within the region will depend on forage availability and quality, with a likely increase in competition for available resources. The NSCCVI tool indicated that available evidence suggests the abundance and/or range extent of this species within geographical area assessed is likely to increase by 2050.

Greater Sage-Grouse: The current status analysis indicates that the lek and range areas located in central Montana are at the lowest risk from all of the CAs. The patch size analysis indicates that, with the exception of some areas in central Montana and northeastern Wyoming, the majority of the distribution does not contain large contiguous patches of sagebrush. The anthropogenic features that contribute most to the ecoregion as a whole are the distances from highways and power infrastructure. The GRSG habitats in the southernmost portions of this ecoregion appear to be at risk from future agricultural conversion and energy development. These areas may become critical resources for GRSG because the current sagebrush cover and patch size are rated higher (good to fair) than other areas to the north. Future climate change modeling indicated that shifts in precipitation to earlier in the season (March and April) combined with increased temperatures during the May and June and July and August seasons suggests that the sagebrush habitat in areas such as the Powder River Basin may experience more frequent wildfires. Associated changes in fire regime which currently pose substantial threats to GRSG and the sagebrush ecosystem would increase. The NSCCVI tool indicated that available evidence suggests the abundance and/or range extent of this species within the geographical area assessed is likely to decrease by 2050.

Golden Eagle: The results of the current status assessment indicate that approximately 64 percent of the 6th level HUC watersheds that intersect the golden eagle distribution received an overall good rating. The majority of the ecoregion maintains suitable habitat for golden eagles with large areas in western North Dakota, southeastern South Dakota, west-central Montana and the Golden Triangle (Montana) indicating potential habitat loss. The effect of roads on golden eagles in the Northwestern Plains is minimal and generally localized around larger population centers and does not pose a current significant threat to Golden Eagle habitat across the ecoregion. Transmission lines do not cover broad areas relative to the overall size of the ecoregion, and only a small portion of the distribution exists in areas where proximity to transmission lines poses a threat.

The presence of wind turbines in this ecoregion is a concern for localized golden eagle habitat in western portions of this ecoregion, northeastern Wyoming, northern Nebraska, western North Dakota, central North Dakota, western South Dakota and central South Dakota. The majority of potential oil and gas development within the ecoregion is limited to northeastern Wyoming which represents a large part of the state that is characterized as golden eagle habitat. The overall South Dakota golden eagle population is limited to the western part of the state, and from a state perspective, is potentially at risk from oil development activities. Montana also has the potential for a more localized effect on golden eagles as a result of natural gas production activities. The overlap of the spatial distribution of golden eagle nesting areas and mid-level elevation for future potential wind energy development is apparent and therefore future wind energy development is considered a potential future risk. Potential climate change conditions could dramatically affect localized populations of golden eagles, especially at high elevations within the ecoregion. Potential future temperature increases could results in shifts in nesting periods and increased fire potential in vegetation systems which may decrease golden eagle prey availability. The NSCCVI tool indicated that available evidence suggests the abundance and/or range extent of this species within geographical area assessed is likely to increase by 2050.

Grassland Birds Assemblage: The focal species selected to represent this assemblage includes the Baird's sparrow, McCown's longspur, chestnut-collared longspur, and Sprague's pipit. The swift fox was included as part of this assemblage because of the species' strong association with short-structured grasslands. The results of the analysis for current status for the grassland bird assemblage indicate that the majority of the modeled grassland bird habitat is in the fair category. The assessment of fragmentation of habitat based on distance from anthropogenic features did show a risk from fragmentation. In contrast, the assessment of connectivity, based percentage of anthropogenic features within the HUC was good overall. Current and future agricultural development does pose a threat to this assemblage in northern Montana and northwestern North Dakota. Grassland bird assemblage habitat located in northeastern Wyoming and northeastern Montana/northwestern North Dakota appears to be at high risk from future potential oil and gas development. The majority of the habitat in the ecoregion does not appear to be at risk from renewable energy development. All of the species in the assemblage rely on intact grasslands as habitat. If vegetation communities substantially change as a result of increased temperatures and decreased precipitation, it is likely that fire regimes will change and invasive species will negatively affect this assemblage.

Black-Tailed Prairie Dog Assemblage: This assemblage is comprised of the following five species; BTPD, Ferruginous Hawk, Burrowing Owl, Mountain Plover and the Black-footed Ferret. The overall current status for this assemblage in South Dakota is good, however much of the assemblage in Wyoming and Montana is rated as fair. The proportion of protected lands and the proportion of prairie both scored poorly across most of the ecoregion. Good scores for protected lands were limited to central Montana and northeastern Wyoming with scattered areas throughout the rest of the ecoregion. Most of the agricultural areas (current and future) are located outside of the modeled distribution for this assemblage. The BTPD assemblage modeled habitat in northeastern Wyoming and southwestern North Dakota appears to be at high risk from future fossil fuel energy development. However, the large areas of modeled habitat in South Dakota appear to be at low risk from by fossil fuel development. Recent development of energy resources from the Bakken shale formations in eastern Montana and western North Dakota has substantially increased the rate of development in these areas. Although some small BTPD colonies exist in this area, the large concentrations of colonies primarily occur in northern South Dakota and Wyoming.

The majority of BTPD assemblage habitat throughout the Northwestern Plains appears to be at moderate risk from future renewable energy development. A constant overall increase in temperature is expected across the assemblage modeled habitat within the Northwestern Plains (1.9°C to 2.3°C). Increased fire potential is the most likely result of temperature increase that would directly affect assemblage habitat quality. All of the species in the assemblage rely on the BTPD to continue to provide habitat.

Prairie Potholes: The results of the current status assessment indicate that approximately 21 percent of the 6th level HUC watersheds that intersect the prairie pothole distribution received an overall rating of good. However, the majority of the watersheds (approximately 76.4 percent) received an overall rating of fair. The analysis indicates that the majority of the watersheds are at high or moderate (fair) risk of agricultural conversion both currently and in the future. Most of the potholes in the ecoregion will likely remain unaffected by fossil fuels development in the Northwestern Plains. The majority of potential fossil fuels development is limited to northeastern Wyoming. The majority of the potholes in the Northwestern Plains ecoregion are considered to be at low risk with regard to the threat of renewable energy development. The potholes of north central Montana do not appear to be at risk from future wind energy development; however, various areas of potholes in North and South Dakota appear to be at risk. Johnson et al. (2005) suggests that climate change could diminish the benefits of wetland conservation in the prairie potholes area of the Northwestern Plains. In addition, the combined impacts of increased temperatures, localized drought and conversion of lands to agricultural uses could negatively affect potholes in the future.

Prairie Fish Assemblage: The prairie fish assemblage is represented by two focal species; the pearl dace and the northern redbelly dace x finescale dace hybrid**.** The results of the current status assessment indicate that nearly 71 percent of the 6th level HUC watersheds that intersect the prairie fish assemblage distribution received an overall rating of fair or poor. The biggest factor in the overall status assessment seems to be the designation of GAP 3 (multiple use lands that may support extractive uses) and 4 (no known mandate for permanent protection) over most of the ecoregion (Figures E-7-6 and E-7-7). Lands that are not designated as 1 or 2 (permanent biodiversity protection) result in the rating of poor, which is indicated over most of the ecoregion. The only exception is the waters of Fort Peck Lake in Montana and a few smaller watersheds likely representing state or private natural areas. Other concerns regarding the overall habitat condition are the locations of 303d listed streams which are present throughout the range of occurrence of the focal species, and roadways and agricultural areas within close proximity to prairie fish streams. Species of this assemblage are at risk from future agricultural development in Montana and South Dakota. The portions of the species distributions in western North Dakota and Montana that appear to be at risk from future fossil fuel development do not appear to be at a high risk from future renewable energy development in these areas. Prairie fish species in the Northwestern Plains are particularly susceptible to the microhabitat changes caused by climate change. Some of these could include low base flows, high water temperatures in late summer and larger and more frequent winter flood events. Predicted future temperature increases may lead to increased instances of localized drought. This may have a dramatic effect on the prairie fish assemblage. Pools that serve as refuges for fish in small streams may also be lost and stream reaches may become fragmented. Reduced flow from cool-water springs may result in increases in water temperatures and lower dissolved-oxygen levels which may directly impact populations within these streams.

Big Fish Assemblage: The big river fish assemblage is represented by three focal species; the pallid sturgeon, paddlefish, and sauger. Additionally, four other species were also initially selected as part of this CE assemblage; the sturgeon chub, the sicklefin chub, and two sub-species of softshell turtles, smooth and spiny. However, species collection data and predictor variables were not adequate to produce distribution models for these species. Additionally, probability of occurrence model for the sauger was the only model that was able to be developed for this assemblage due to a lack of occurrence data. As a result of these data gaps, the big river fish assemblage was dropped from further analysis in this REA.

Plains Sharp-Tailed Grouse: Important data for this species would include occurrences, habitat and range, leks, nesting, brood-rearing, and winter habitat. Because of the lack of appropriate geospatial data for modeling, the current distribution and status of this species could not be mapped or modeled and therefore this CE was dropped from further analysis as part of the REA.

Pronghorn: Due to the lack of adequate geospatial data to define the distribution of the pronghorn, the current distribution and status of this species could not be mapped or modeled and therefore this CE was also dropped from further analysis as part of the REA.

ES.4 ECOLOGICAL INTACTNESS ANALYSIS

An ecological intactness analysis (EIA) was conducted to summarize the overall current conditions of terrestrial and aquatic ecosystems across the ecoregion and to compare the relative intactness of those systems at the 5th level HUC. Using a direct comparison of HUCs, the watersheds with the highest intactness within the ecoregion were identified.

A CE richness analysis was calculated based on the distribution of the fine-filter CEs throughout the region to identify specific areas of the ecoregion that are most widely used by these key resources. A species richness value was calculated for each 5th level HUC. A comparison between the areas of high intactness to the areas of high species richness provides information for on-going or future management efforts.

The geographical areas within the Northwestern Plains ecoregion that consistently received good EI ratings for terrestrial intactness and high species richness included the central grasslands of Montana along the Yellowstone River, the foothill grasslands of western Montana, the grasslands within the Powder River basin of eastern Wyoming, and sagebrush steppe habitats south of Casper, WY. The sagebrush steppe and prairie grasslands in northwest and north central South Dakota also received good intactness scores, predominantly due to the size of intact landscapes. Custer National Forest (MT), Lewis and Clark National Forest (MT), and Flathead National Forests (MT) were also rated as fair to good with regard to connectivity, development and size. The agricultural areas throughout the Missouri River Basin in eastern Montana and the Dakotas received predominantly poor terrestrial intactness scores as well as basins of the Marias and Milk Rivers in west-central Montana. Terrestrial EI was also evaluated for large tracts of BLM managed lands within the ecoregion. The BLM-managed lands east of Custer National Forest and extending up the Yellowstone River valley to the Little Missouri National Grassland are within a larger area of the ecoregion with a good terrestrial EI rating. Also, the BLM-managed lands north of Fort Peck Lake, MT resulted in terrestrial EI ratings from good to fair.

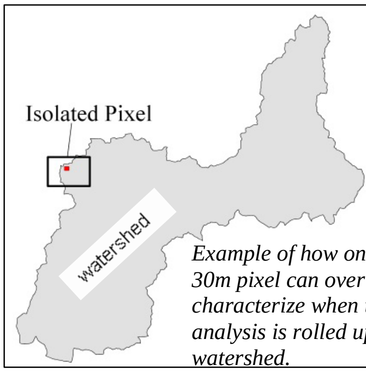
Aquatic EI results varied significantly across the ecoregion and generally resulted in poor ecological intactness for aquatic habitats as compared to the terrestrial habitats of the ecoregion. In Montana, the aquatic habitats of the Marias and of the Missouri River basin in eastern Montana near the confluence of the Missouri and Yellowstone Rivers, especially north of the confluence, are threatened by potential impacts associated with development and agriculture. With the exception of only a few Missouri River basin watersheds in North Dakota, the majority of watersheds in North Dakota were rated as poor. In Wyoming, the aquatic EI was strongly influenced by energy-related development; mines, oil and gas wells, and roadways. Aquatic habitats of the Cheyenne and White River watersheds within South Dakota resulted in good EI ratings. The aquatic habitats within BLM-managed lands north of Fort Peck Lake, MT and associated with the Milk River basin were rated as poor. These areas would benefit from more detailed step-down analysis to better understand and estimate risks to aquatic habitats.

ES.5 USE OF RESULTS

The results of all of the analysis developed by the REA should only be used at the landscape scale. All of the geospatial files will be delivered to the BLM and therefore the metrics of each analysis can be repeated in the future and adjusted to evaluate various scenarios across the landscape. 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 KEAs that were developed.

Although this REA defined that the analyses would be rolled up to the watershed level reporting unit, it was recognized that this has the potential to dilute the results of the analysis. In the future, the analysis should be completed at the 90 or 120 meter pixel and these intermediate layers should be used to answer the MQs. For example, as illustrated in the inset graphic, in an analysis for evergreen forests when the analysis is rolled up to the watershed level, if only one 30-m pixel of data in the entire watershed is labeled as evergreen forest, the entire watershed becomes characterized as evergreen forest.

This could be remedied by not including small patches in the analysis. In other words, if a patch of vegetation identified in GAP is less than five to ten acres, those areas should be excluded in the initial data clip.



Example of how one isolated 30m pixel can over characterize when the analysis is rolled up to the watershed.

In addition, in this ecoregion, watersheds have the tendency to span elevated areas into lower elevations which creates inaccurate results when attempting to rate a watershed that spans both areas. For example, if the majority of the pixels in the valley area are characterized as poor, the entire watershed including the elevated areas will be rated as poor.

Although the REA products will be useful for resource managers in the future, it is important that managers understand the limitations associated with this type of analysis. For example, the climate change analysis was developed on a foundation of data that should only be used at a very large scale. The original source data for climate change data was at a 160-km scale that was downscaled to 15 km. Comparing 15-km data at the 30-m pixel is not conducive to making detailed site-specific conclusions. In addition, the inclusion of the buffer around the Northwestern Plains includes the mountainous terrain of the Black Hills and the middle Rocky Mountains. This caused an artificial expansion of the ranges of temperature and precipitation. The expanded ranges in the buffer region made it difficult to graphically present the data using a single scale. To account for this, thresholds (temperature floors and precipitation ceilings) were determined empirically and then used to mask out the outliers in the buffer area. This masking of outlier pixels permitted the subtle differences on the plains of Northwestern Plains REA to be visually apparent but does cause some of the data to be excluded from the figures.

Because all of the analysis 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 substantially alter the results of the analyses, it is advisable that this limitation be considered for future analyses.

Limitations of Future Threat Analysis

Because of the inherent inaccuracies of the temporal scale of the future data, it is only possible to infer information pertaining to a subjective future period rather than a specific time period for some of these attributes. The results of these analyses are a crucial first step in prioritizing finer scale step-down analyses.

1.0 BLM'S APPROACH TO ECOREGIONAL DIRECTION AND ADAPTIVE MANAGEMENT

Assessments help managers address problems by providing information that can be integrated into future management actions. The success of this Rapid Ecoregional Assessment (REA) ultimately depends on how well it helps inform management decisions (Johnson and Herring 1999): 1) Was it contextual? Did it significantly improve understanding about the conditions of the resources being studied within the ecoregion and the consequences of particular actions? 2) Was it integrated? Was that understanding integrated into managers' thinking to guide future action? and 3) Was it pragmatic? Did the assessment lead to potential solutions for the management questions (MQs)?

The contract for this assessment clearly requests information designed to be integrated into specific future management approaches. However, the contract does not include integrating the findings into management actions. The Bureau of Land Management (BLM) chose to retain responsibility for all aspects of integrating the assessment into management actions and decisions. The process presented here is conceptual; no process has yet been established as a commitment or accepted as a responsibility by the BLM.

1.1 MANAGEMENT APPROACH

This proposed process helps address the environmental changes currently occurring in the western United States. To be effective in addressing these regional challenges, the process must address these challenges at multiple scales and across multiple jurisdictions. All BLM programs can contribute to this effort. The BLM is exploring innovative approaches to a process in landscape direction across programs and geographic scales. The following paragraphs briefly describe a systematic approach to these ecoregional challenges:

Managing resources at multiple scales: Traditionally, the BLM has undertaken resource management project by project, permit by permit, and land use plan by land use plan, without systematically assessing landscape scale effects. To effectively address the projected environmental changes in the West, resource managers will have to develop the capacity to evaluate effects at multiple geographic scales.

Managing resources across ownerships and jurisdictions: Traditionally, resource managers have focused on activities within their own administrative units. To effectively address the environmental changes the West is experiencing, resource managers will have to develop the institutional and technical capacity to work across ownerships and jurisdictions.

Managing resources across programs: Traditionally, resource management has been defined by programs (e.g., wildlife, range, minerals). To address the environmental changes the West is experiencing, resource managers will have to more effectively integrate activities across programs by inter-disciplinary management.

Standardizing and integrating data: The ability to collect, synthesize and share geospatial information about resource conditions, change agents (CAs) such as wildland fire, and on-the ground management activities is a critical part of this effort. Without the ability to compile and correlate such information within and outside the boundaries of BLM lands, it is extremely difficult to achieve conservation, restoration, and adaptation strategies across the landscape and to evaluate the effectiveness of such strategies once implemented.

Systematic integration requires some fundamental shifts in the BLM's traditional management practices. Although project-focused work and traditional practices will still be part of BLM's management strategy, the REAs will help the BLM to identify what processes are appropriate for the broader scale landscape approach (Table 1-1).

Table 1-1. Comparison of BLM's Traditional Management Practices and the Landscape Approach of the Rapid Ecoregional Assessment

Traditional Practice	Landscape Approach
Project Focus	Landscape Focus
Program/Functional Direction	Integrated Direction Across Programs
Unit Decision Making	Cross Jurisdictional Decision Making
Unit Priorities	Collaborative and Partnership Priorities
Program Accomplishments	Integrated Accomplishments Across Programs
Authorize Uses and Mitigate Ecological Values	Ecological Values and Use Authorizations Considered Equally
Ecological Component (Individual Species)	Ecological Function and Service
Agency Funding	Partnership Leveraged Funding

Many of the landscape approach activities listed in the table above have been part of BLM's approach at the land use planning scale. The BLM is undertaking the following activities at the regional scale to deal with environmental changes.

1.2 RAPID ECOREGIONAL ASSESSMENTS

Working with agency partners, the BLM is conducting REAs like this one, covering approximately 450 million acres of public and non-public lands in ten ecoregions in the American West to identify potential priority areas for conservation and development. Over time, the BLM anticipates collaboration with the Landscape Conservation Cooperatives (LCCs, which are public-private partnerships for adaptive management grounded in science) to periodically update ecoregional assessments and identify science needs.

1.2.1 Ecoregional Direction

The BLM is developing a standard ecoregion-scale process for identifying priority areas and incorporating REA results into land use planning, environmental impact assessments, use authorizations, conservation and restoration project planning, and acquisition of conservation easements.

Ecoregional direction uses information from the REAs, along with input from partner agencies, stakeholders, and tribal agencies to develop a broad scale management strategy for an ecoregion's BLM-managed lands. This broad scale management strategy will identify focal areas on BLM-managed lands for conservation and development, including areas for conserving wildlife habitats and migration corridors and for potential energy development and urban growth. Ecoregional direction will also provide a blueprint for coordinating and implementing these priorities at the BLM's state and field-office levels. Ecoregional direction links REAs and the BLM's Resource Management Planning and other on-the-ground decision making processes. It also helps integrate existing initiatives and facilitates coordination across programs, offices, and partnerships. Ecoregional direction establishes a regional roadmap for reviewing and updating Resource Management Plans, developing multi-year projects for identified priority conservation and development areas, establishing best management practices for authorized use, designing regional adaptation and mitigation strategies, and developing conservation land acquisitions.

Ecoregional direction development begins with conversations among regional partners about using the REA results to identify areas where more detailed (step down) analysis should be completed. Partners that guide the step-down process will likely include BLM State Directors (or their representatives) and equivalent peers from other federal, state, and tribal agencies and entities.

The partners will review the completed REA and other assessments to evaluate the proposed findings and recommendations and:

- Delineate a schedule, process and expected products;
- Gather more data to fill data gaps;

- Identify proposed and ongoing activities within the REA region. Such activities may include proposed or on-going assessments, planning efforts, or special area evaluations;
- Communicate with organizations knowledgeable about the REA or potentially affected by it; and
- Conduct partnership and stakeholder outreach.

Individual partners will develop their own respective direction to implement the agreements. In the case of the BLM, this will be in the form of ecoregional direction as described previously. In developing ecoregional direction, the proposed findings and recommendations will be discussed with:

- The affected BLM's State Management Teams;
- The leadership of local, state, federal, and tribal partners; and
- The Washington Office if there are potential national policy and coordination issues.

After reviewing the proposed findings and recommendations and discussing them with the leadership of potentially affected partners, the BLM State Director(s) may issue ecoregional direction outlining what the BLM will do over the next 3 to 5 years to incorporate the REAs into management activities. If desired, the partners may coordinate the implementation of ecoregional direction among the participating entities.

1.3 MONITORING AND ADAPTIVE MANAGEMEMT

Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices. Ecoregional assessments help to move adaptive management from a concept to an applied approach; if REAs reoccur every 5 to 10 years as planned, they will serve as a monitoring and evaluation process for the effectiveness of adaptive management. Working with partners, BLM employs a national Assessment, Inventory, and Monitoring (AIM) strategy that identifies core indicators of terrestrial and aquatic condition, performance indicators for fish and wildlife action plans, and scalable sampling designs to help integrate and focus BLM's monitoring activities and facilitate adaptive management.

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2.0 INTRODUCTION

Climate change and other widespread environmental influences are affecting western landscapes that are managed, in part, by the BLM. 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. Through the REA process, the BLM is taking a landscape-scale approach; a large-scale, 30,000 foot aerial view of the ecoregion, which recognizes natural resources are being affected by complex influences that cross traditional administrative boundaries and transcend ownership.

Ecoregions serve as a spatial framework for the REA which looks across an ecoregion to more fully understand ecological conditions and trends; natural and human influences; and opportunities for resource conservation, restoration, and development. An ecoregion is defined as a large, connected area with general similarity in ecosystems and in the type, quality, and quantity of environmental resources. Ecoregions typically encompass areas much larger than those managed by individual BLM field offices. The goal is to identify important resource values and patterns of environmental change that may not be evident when managing smaller, local land areas. But by doing so, the REAs provide regional information that will inform and benefit local management efforts. The seven ecoregions being assessed by the BLM are: the Central Basin and Range, Mojave Basin and Range, Sonoran Desert, Middle Rockies, Northwestern Plains, and Colorado Plateau in the continental United States, and the Seward Peninsula-Nulato Hills-Kotzebue Lowlands in Alaska. This report presents the assessment results for the Northwestern Plains ecoregion. The Northwestern Plains ecoregion encompasses lands in Montana, Wyoming, North Dakota, South Dakota, and Nebraska.

2.1 PURPOSE OF THE RAPID ECOREGIONAL ASSESSMENT

With a central purpose of sustaining the health, diversity, and productivity of America's public lands, the BLM must manage for a wide diversity of species, natural communities, and ecological changes. Effective conservation depends not just on persistence of the lands, waters, and physical landscape but also on the persistence of ecological processes that structure ecosystems and natural landscapes (Unnasch et al. 2009). The challenge of conservation management is assessing these ecological conditions and evaluating current and potential impacts to the ecoregion from human alterations to the landscapes ranging from invasive non-native species to climate change.

REAs provide a tool to identify and analyze the key MQs regarding the resources, values, and processes that are fundamental to the conservation of BLM lands and provide a focus for land management. REAs look across all lands in an ecoregion to identify regionally important habitats for fish, wildlife, and species of concern and evaluate potential impacts to those key conservation values as a basis for management planning. A vital component of the REA is that the method uses available data about the ecological values and then gauges the potential of these habitats to be affected by overarching environmental CAs: climate change, wildfires, invasive species, and development (both energy development and urban growth).

As part of BLMs efforts, all land ownerships were considered during the REA in order to understand how important wildlife habitats may be interconnected, and where the best opportunities may exist for conserving and restoring key ecological values. REAs do not allocate resource uses or make management decisions, instead the purpose of an REA is to provide science-based information and tools that any land manager and stakeholder can consider in managing their lands. The BLM will use the REAs to inform resource management at the ecoregional and local levels. At the ecoregional level, along with input from stakeholders, partner agencies, and tribes, the REAs will aid in developing broad-level management strategies for an ecoregion's public lands. This ecoregional direction will identify priority areas for conservation and development, including focal areas for conserving wildlife habitats and migration corridors, and focal areas for potential energy development and urban growth. Ecoregional direction will also provide a blueprint for coordinating and implementing these priorities through the BLM's state and field offices. At the local level, the REAs will enhance the quality of land-use planning and environmental analysis conducted by BLM field offices.

2.2 RAPID ECOREGIONAL ASSESSMENT PROCESS

The REAs will address priority management issues for BLM. This is accomplished by using MQs, which were developed by the Assessment Management Team (AMT), which included both state and federal partners for this ecoregion. The MQs largely address priority information needs for regionally important ecosystems but also focus on individual species as conservation elements (CEs). The REA process provides a method for converting management priorities into more specific goals based on a limited number of focal ecological resources or CEs. The evaluation of CEs centers on using quantifiable indicators for key ecological attributes (KEAs) to assess ecological conditions across the ecoregion. Indicators are also used to assess current or potential environmental impacts or stressors (i.e., development, wildfire) on a CE.

The REA process uses distribution data and models to show relationships between relative occurrence and the current and future potential impact of CAs such as development. The REA process used by BLM employs species distribution models to estimate the relationship between species occurrence records and the environmental factors and/or spatial characteristics that are relevant to habitat suitability (e.g., temperature, elevation, soil conditions, etc.). To depict these relationships, readily available data are aggregated and geospatially scored to show areas of the ecoregion that could require special management or focus. The products of the REA provide tools that can be used by BLM land managers to address management issues.

The REA process used by BLM incorporates concepts of the Ecological Integrity Assessment Framework (EIAF) method developed by Unnasch et al. (2009) which provides information on potential cumulative effects of stressors across jurisdictional boundaries (Tierney et al. 2009). Ecological integrity is defined as "the ability of ecological systems 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 range (or area)" (Parrish et al. 2003). The central tenet of the EIAF is that ecosystems with greater ecological integrity, will be more resistant (tolerate disturbances without exhibiting substantial change in structure and composition) and resilient (ability of a system to recover from disturbance) to the effects of changing patterns and types of disturbance (Parrish, Braun et al. 2003). In essence, ecological integrity can be viewed as the ecological condition or health of an ecosystem. For the purposes of this assessment, the term ecological intactness (EI) is used in place of ecological integrity. Because individual site field verification was not part of this assessment, the team did not deem it appropriate to classify watersheds of the ecoregion into varying levels of integrity based on geospatial data that have a varied amount of uncertainty. Ecological intactness is an evaluation of intact vegetation systems that are relatively non-impacted by anthropomorphic development. The approach to ecological intactness is explained in greater detail in Appendix G.

REAs are prepared in two phases, with specific tasks in each phase and memorandums that summarize each task (Table 2-1). The first phase is the *pre-assessment*, which defines MQ that examine ecological values (e.g., ecosystems, species), conditions, and trends within the ecoregion. MQs identify (implicitly or explicitly), the information needed to formulate management responses to regional or landscape-scale resource management issues or concerns. The MQs are intended to provide information that will estimate the current status and potential future risks to natural resources in the ecoregion by examining the relationships between a set of CE and disturbance factors or CA.

Table 2-1. Rapid Ecoregional Assessment Phases and Tasks

Phase	Task #	Product
I. Pre-assessment	1	Refine MQs, CEs, and CAs. Provide conceptual ecoregion models.
	2	Identify and recommend datasets for analysis.
	3	Identify and recommend analytical models and tools.
	4	Prepare REA work plan.
II. Assessment	1	Synthesize datasets.
	2	Conduct analyses and generate findings.
	3	Prepare REA report, maps, and supporting documents.

As part of the pre-assessment, CEs are evaluated based on their status relative to CAs, which addresses multiple levels of the system (ecosystems, communities, species), and includes "coarse-filter" and "fine-filter" components (Noss 1987). CEs are the key resource values of conservation concern; the species, assemblages, ecosystems and landscapes, and scenery/special values that are of interest or regional significance and recognized across the ecoregion as warranting conservation or protection. A CE is also commonly referred to as conservation target.

Because it is impossible to assess each component of the ecoregion individually, the selection of coarse-filter CEs is intended to best represent the biodiversity of an ecoregion, and to cover the suite of taxa, communities, and ecological characteristics in order to provide a comprehensive biodiversity assessment (Nature Conservancy 2006). The coarse-filter component emphasizes dynamic and intact communities and ecosystems (Poiani et al. 2000), and is based on the premise that intact and functioning systems are more resistant and resilient to stressors, thereby providing suitable habitat for most species (Noss 1987). Coarse-filter CEs represent the dominant or regionally important aquatic and terrestrial communities or ecosystems that collectively represent the general status of the ecosystem and are presumed to represent the habitat requirements of most plant and animal species of the ecoregion.

It is also recognized that some species may require greater specificity in habitat conditions than can be assessed by the coarse-filter component and these species or assemblages represent the "fine-filter" component. The fine-filter CEs consist of rare or specialized species (endangered, migratory, keystone) or types or categories of resources, such as ecological communities (e.g., five-needle pine) or larger ecological assemblages (e.g., stream fish assemblages) which would not adequately be protected by the coarse-filter component, and are selected to represent unique contributions to the integrity of a system (Poiani et al. 2000). Such species may require localized or limited habitats, or may already be at risk and require active management to prevent further population declines. Regionally significant species, communities, or assemblages were also evaluated as a fine-filter CE if the species was determined to have qualities that give the resource special worth, meaning, or value and have a range of distribution and affects management concerns across two or more BLM field office boundaries (BLM 2010).

The selected CEs also must be suitable gauges of the effects of CA impacts. CAs are those features or phenomena that have the potential to affect the size, condition and landscape context of CEs. CAs include wildfire, invasive species, insects and disease, climate change, and development, as well as impacts from agriculture, infrastructure, and energy development. A key purpose of this REA is to identify and understand the influences of significant, widespread CAs on the natural resources (represented by the CEs) of the ecoregion.

Phase I of the REA also includes the development of conceptual ecological models, the identification of indicators to be used and data gap analysis. In order to answer the MQs of this REA, conceptual models were developed for each of the fine-filter CEs. The main function of the conceptual ecological models in the REA process is as a tool to discern what attributes would be important to map, to provide meaningful metrics for assessing resources at the landscape-scale, and to guide and direct the analysis of management options and their ecological implications. The REA process synthesizes existing information and data rather than conducting research or collecting new data. Therefore, information in existing databases was evaluated to ensure that the current condition of the ecoregion could be characterized. More than 500 datasets were obtained, from more than 50 data sources to date. The primary data sources include federal, state, and non-profit agencies. Standard data evaluations were conducted to identify data gaps and to document the quality and usability of the individual datasets. Phase I culminated in a work plan that provided a roadmap for the completion of Phase II.

Phase II of the REA is the *assessment*, which includes analysis of the data relative to the identified CAs and CEs, documentation of the results, and culminates in the assessment report, maps, and supporting documents. This report is the product of Phase II

In summary, the goal of an REA is to provide information that will facilitate the decision-making process related to regional resource values and uses. The results of the REA can be used to:

- Identify and answer important MQs;

- Document key resource values with a focus on regionally significant terrestrial habitats, aquatic habitats, and species of concern;
- Describe influences from select environmental CAs;
- Assess the potential risks of projected CA trends;
- Identify and map key opportunities for resource conservation, restoration, and development;
- Identify science gaps and data needs; and
- Provide a baseline to evaluate and guide future management actions. (BLM 2012)

2.2.1 Scope and Scale

The scope of this REA is the Northwestern Plains ecoregion which includes the area within the boundaries of the Northwestern Glaciated Plains (9.3.1) and the Northwestern Great Plains (9.3.3) Level 3 Ecoregions (Commission for Environmental Cooperation 2006) plus a buffer area consisting of those 5th level hydrologic units (HUCs) watershed that overlap the ecoregion boundary (Figure 2-1). The purpose of the buffer is to help ensure seamless boundaries between mapped layers generated for REAs in neighboring regions and to avoid problems associated with "edge effects" during geographic information system (GIS) analyses. Canada was not included in the extent for this REA because it was recognized that consistent, like scale data would be difficult to obtain and crosswalk with the U.S. data.

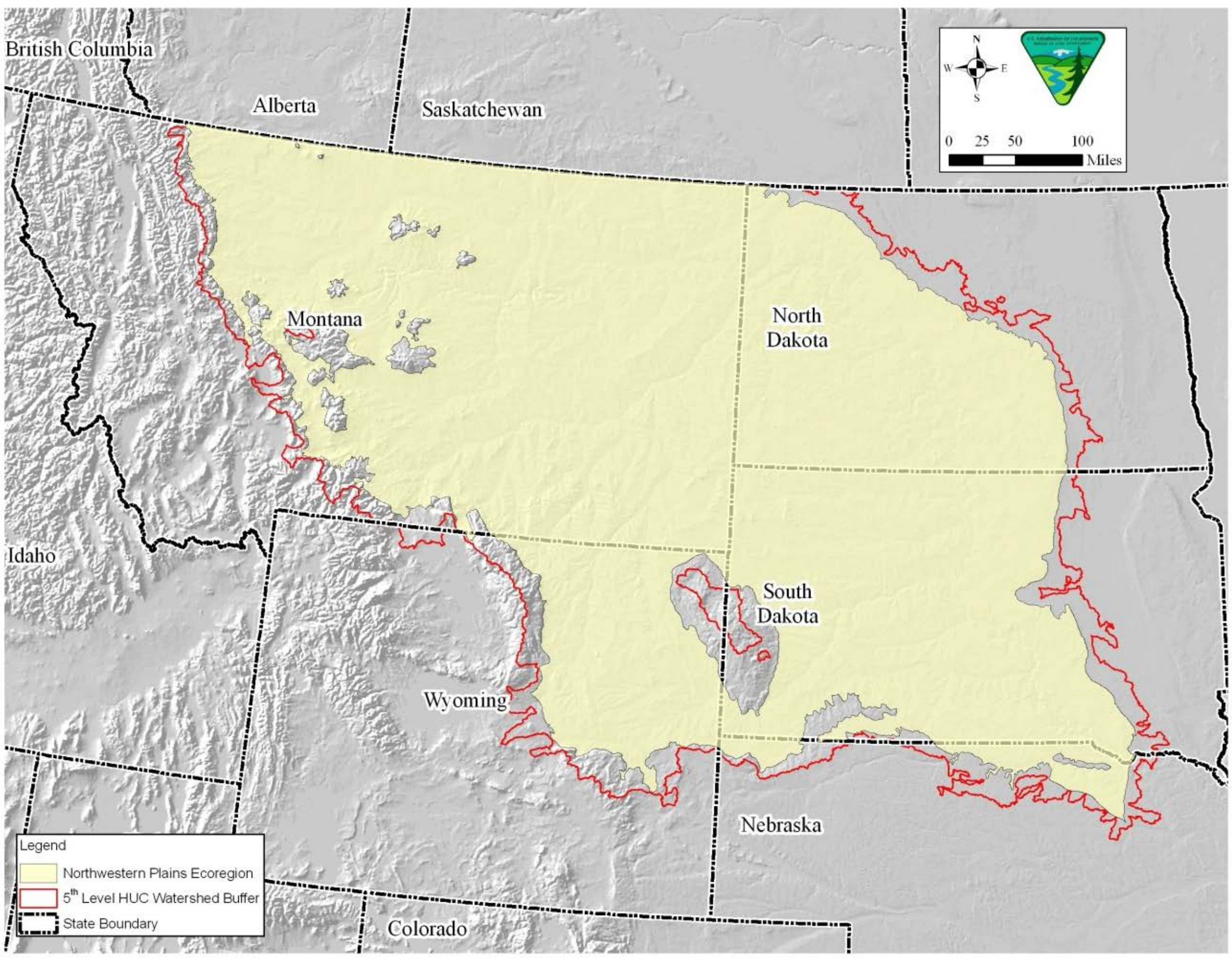

Figure 2-1. Extent of the Northwestern Plains Ecoregion

The intent of the REA was to provide products that are useful at the landscape scale. Therefore, a uniform support unit or landscape unit that provided a regional view, rather than a local, specific view was selected. The primary landscape unit for the analysis and final reporting products was defined as the 6th level HUC for all CEs and CAs and the 5th level HUC for the ecological intactness analyses (BLM 2010). However, in some cases, the analysis unit was as small as the 30-meter (m) pixel. The smallest 6th level HUC is approximately 3,300 acres and the largest is well over 250,000 acres in the Northwestern Plains ecoregion.

2.2.2 Time Horizons

The purpose of the REA is to provide a current status of the landscapes within the ecoregion. 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. For the climate change CA, the current condition was defined as 2010 (BLM 2010); however, data for the period between 2000 and 2010 were not available for the REA analysis. Current climate data were based on models for the period of 1980 to 1999.

Many of the MQs identified for this REA involve questions related to potential for change over time. For all of the CAs except climate change, datasets were evaluated for two future timeframes. The near-term timeframe is a 15-year outlook through the year 2025, and the long-term timeframe is a 50-year outlook through the year 2060. Specifically for the climate change CA, the future condition was assessed as the year 2060.

2.2.3 Uncertainty

Because REAs solely rely on existing data that applies to large multi-state areas and the use of such data may not be consistent with the original intent of those that collected or developed the data, the issue of uncertainty is important to address. The uncertainty inherent in any type of 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 and compounding 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 CEs and CAs and the natural processes that occur every day. The climate change analysis for example is one where a high level of uncertainty was recognized because our understanding is based on historical data that may or may not be consistent with what happens in the future.

Determining how much uncertainty and/or the confidence level associated with every dataset would be impossible in the rapid timeframe that this analysis occurred. 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.

2.3 RAPID ECOREGIONAL ASSESSMENT TEAM

A wide variety of individuals and agencies supported the development of this REA. The AMT (Table 2-2) was composed of a variety of BLM personnel from each of the state offices and the National Operations Center (NOC) in Denver along with other state and federal agency representatives. The AMT provided overall direction and guidance and oversaw the work of Science Applications International Corporation (SAIC) as the contractor who performed the technical data management and analysis tasks required by the REA. SAIC was supported by a variety of subcontractors through the process. The Missouri Resource Assessment Partnership (MoRAP) supported SAIC with aquatic resource mapping and analysis. The Heinz Center provided support with the development of conceptual models, Dr. Peter Lesica provided support with the coarse filters and Mr. Don Childress provided support with some of the fine filters. Dr. Cameron Aldridge provided an initial review of the analysis approach to the GRSG. Dr. Dennis Ojima and Dr. Jim Graham provided assistance with the identification of data sources and the evaluation of the initial conceptual models.

During the pre-assessment phase (Phase I), partnerships were developed with additional federal, state, and local agency managers and technical specialists from within the ecoregion to review work and provide additional input into the REA. For this REA, the current partners include the U.S. Geological Survey (USGS); the National Park Service (NPS); U.S. Bureau of Reclamation; U.S. Fish and Wildlife Service (USFWS); U.S. Bureau of Indian Affairs; and the Montana Fish, Wildlife, and Parks. The USGS served as a peer reviewer throughout the REA process.

Table 2-2. Rapid Ecoregional Assessment Team Members

Agency	Names
BLM	Sandy Brooks, David Wood, Bob Means, Mike DeArmond, Jon Foster, John Carlson, Frank Quamen, Tim Bottomley, Marty Griffith, Tyler Abbott and George Soehn
USGS	Natasha Carr, Dan Manier, Jeff Kirshner
USFS	Jim Morrison
Montana Fish, Wildlife, and Parks	Janet Hess-Herbert

During the assessment phase, the BLM recognized that CE subject matter experts would be the best resources to evaluate individual CE analyses results. To accommodate this approach, rolling review teams (RRTs) for each CE were established. These RRTs met several times to establish evaluation metrics and review geospatial results for each of the CEs. The RRT members are named in Table 2-3. In addition to the names listed in this section, there were many other individuals, both BLM and non-BLM, who provided valuable contributions to this REA. Some of these individuals were from state and other federal agencies and participated in many of the workshops. This REA benefited from their attendance at the workshops and the information and assistance that they provided throughout the process.

Table 2-3. Rolling Review Team Members

Conservation Element	BLM Lead	Names
Grassland Bird Assemblage	John Carlson	Frank Quamen, Bob Means
Prairie Fish Assemblage	Melissa Dickard	John Carlson, Dennis Saville
Black-Tailed Prairie Dog (BTPD) Assemblage	Frank Quamen	John Carlson, Dennis Saville, Bob Means
Golden Eagle	David Wood	Dennis Saville
Prairie Potholes	Mike Philbin	Frank Quamen, Bob Means
Greater Sage-Grouse (GRSG)	David Wood	Frank Quamen, Chris Keefe, Paul Makela
Mule Deer	Paul Makela	Dennis Saville, John Carlson, Linda Cardenas
Evergreen Forest and Woodland	Tim Bottomley	Bob Means, Bill Hensley
Deciduous Forest and Woodland	Tim Bottomley	Bob Means, Bill Hensley
Shrubland	John Simons	Wendy Velman, Floyd Thompson, Sherm Karl
Grassland	John Simons	Wendy Velman, Floyd Thompson, Sherm Karl
Riparian	John Simons	Bob Means
Sparse Vegetation	Wendy Velman	John Simons

3.0 ECOREGION DESCRIPTION

The Northwestern Plains ecoregion is located primarily in Montana, Wyoming, North Dakota, and South Dakota, with small extensions into Nebraska. The assessment area of the Northwestern Plains ecoregion, includes the area within the boundaries of the Northwestern Glaciated Plains (9.3.1) and the Northwestern Great Plains (9.3.3) Level 3 Ecoregions (Commission for Environmental Cooperation 2006) plus a buffer area (Figure 2-1). The extent of the assessment area, including the buffer area for this REA, is 236,249 square miles (611,885 square kilometers [km^2]).

3.1 ECOSYSTEM CHARACTERISITCS

This ecoregion is dominated by a mixed-grass prairie ecosystem. Much of this ecoregion receives less than 16 inches of precipitation a year. Variable precipitation combined with prolonged drought and periodic wildfire has created an environment where native prairie species have adapted, but also prevents major forest establishment, with the exception of moister upland areas. However, woodlands do occur throughout the ecoregion and consist mainly of ponderosa pine, Rocky Mountain juniper, and in Montana in particular, limber pine. Riparian forests and hardwood-dominated draws also are located throughout the ecoregion. Extensive areas of shrub-steppe occur throughout Wyoming and areas of Montana, and substantial wetlands are located throughout the northern and eastern portions of this ecoregion study area (the Northwestern Glaciated Plains, which corresponds to the western portion of the Prairie Pothole Region in the United States).

The Missouri River and associated tributaries, coupled with the prairie pothole wetlands, comprise the dominant aquatic features throughout the upper portion of the ecoregion. The Northwestern Plains and bordering mountains form the primary watershed for the upper Missouri River. Many bird and mammal species breed only on the Western Great Plains of the ecoregion. Much of this area has been converted to agriculture and therefore the remaining intact grasslands provide specific habitat for Great Plains endemics (Samson and Knopf 1996). The region supports extensive livestock grazing and dryland farming and has high value for recreation and public enjoyment. The region also contains major reserves of oil, gas, and coal, as well as areas of high potential for wind and geothermal energy development.

Large tracts of land within the ecoregion are managed by a variety of federal, state, local, and tribal agencies. Figure 3-1 identifies the land areas managed by various agencies including the BLM.

3.2 MANAGEMENT QUESTIONS

The REA process began with a list of MQs identifying management issues and concerns that were of regional importance and that could not be resolved by individual offices alone. Development of these MQs was an iterative process with the goal of developing a clear understanding of the resources in need of assessment and what specific impacts were of particular concern for the region.

During Phase I of the REA, a draft list of MQs was screened by the AMT. Because of the diversity of interests involved in every ecoregion, MQ screening criteria were developed to ensure that the MQs were not only focused, but could be answered by the Phase II analysis. The six screening criteria follow:

1. Is the MQ clear, focused, and relevant to the ecoregion?
2. Can the MQ be answered if data are available?
3. Does the MQ address regional-scale issues?
4. Does the MQ help to answer the following; what do we have, what is its condition, and what is happening or likely to happen to what we have?
5. Do the conceptual models respond to the MQs?
6. Is the MQ amenable to geospatial analysis (This would apply to all questions except the overarching general questions at the top of the list)?

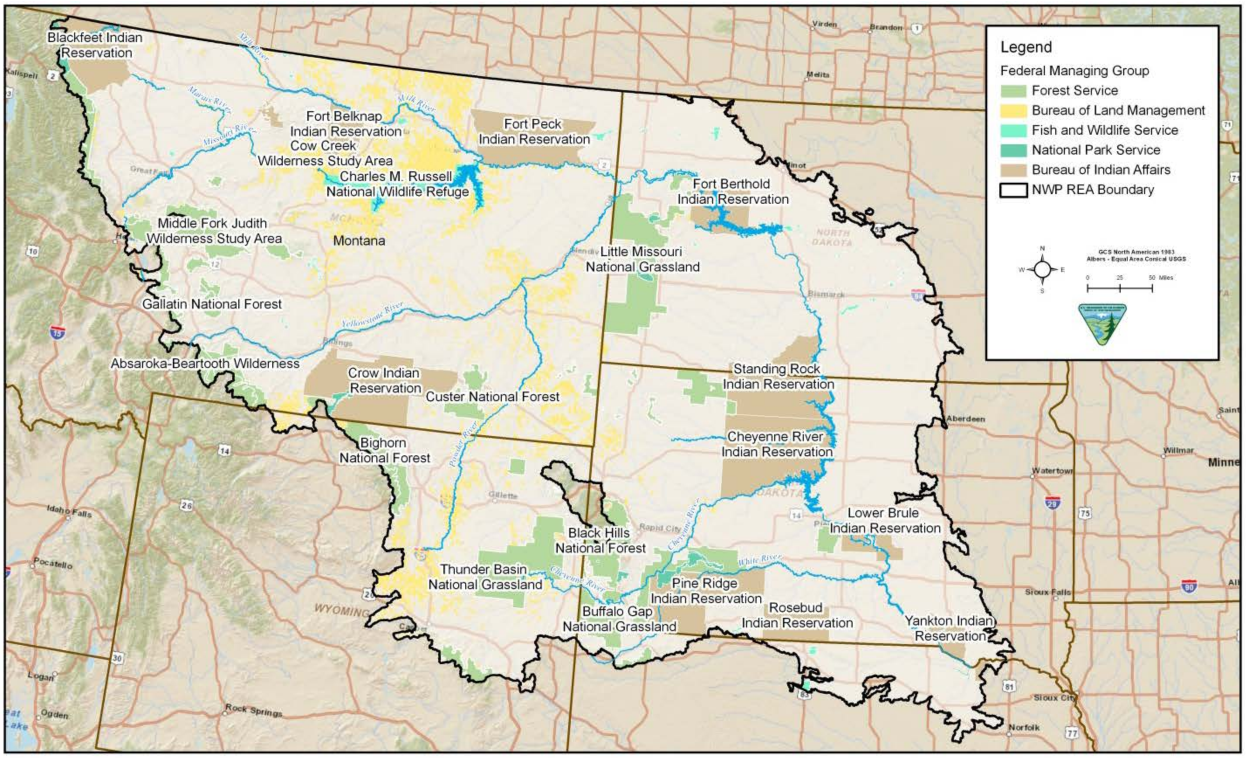

Figure 3-1. Federal and Tribal Managed Lands within the Northwestern Plains Ecoregion

The AMT Team met in November, 2010, and feedback, comments, and recommendations received at this workshop were used to modify the MQs. Approximately 70 MQs or applications of MQs grouped into seven categories resulted from the screening and are presented in Table A-1 of Appendix A. The seven MQs categories are presented in Table 3-1 along with an example of an application of the MQ that would be used by BLM for conservation planning.

Table 3-1. Management Question Categories and Examples

MQ Category for Resource Value or CA	Example of the Application of this MQ
Terrestrial Biotic Resources Where are the important regionally significant terrestrial features, functions, and services across the ecoregional landscape? [a]	What are the regionally significant vegetation types? How are they distributed over the landscape (extent/pattern)? Where will current regionally significant vegetation types be at greatest risk from CAs?
Aquatic/Riparian Biotic Resources Where are the important regionally significant aquatic/riparian biotic features, functions, and services across the ecoregional landscape? [a]	Where are current riparian or aquatic areas currently at risk of fragmentation impoundment, diversion, and lowered water tables due to development, mineral extraction, and agricultural and residential development?
Landscape Species/Species Richness Where are the key habitat types (seasonal, refuges, corridors/connectivity, migration routes, concentrations of regionally significant species, etc.) for landscape species, keystone species, regionally significant species, and regionally significant suites of species? [a]	Where are areas that have potential for restoring regionally significant species habitat or habitat connectivity for regionally significant species?

Table 3-1. Management Question Categories and Examples (Continued)

MQ Category for Resource Value or CA	Example of the Application of this MQ
Wildland Fire Where could core regionally significant values be negatively and positively affected from altered wildland fire regimes (frequency, severity, and seasonality change from historic to present to future)?[a]	Where are current areas with high fire frequency such that they burn on a regular basis?
Invasive or Undesired Non-native Species, Insect and Disease Where will regionally significant values be affected through changes in the spatial distribution and abundance of invasive, (undesired) non-native species?[a]	What habitats have been, or have the potential to be, most severely affected by exotic invasions, and where are they?
Urban, Agricultural, Industrial, and Water Development Where will core regionally significant values be affected through development?[a]	Where are areas of existing, planned, and future renewable and non-renewable energy development (based on existing geospatial databases), including locations of existing leases, relative to areas of high conservation and restoration potential?
Climate Change Where will regionally significant values be affected by climate change?[a]	Where are species habitats most vulnerable to climate change?

[a] Regionally Significant – A native plant, wildlife, or fish resource or community that has a range of distribution and affects management concerns across two or more BLM field office boundaries and is more than locally important. Being more than locally important could include having qualities that give the resource special worth, meaning, or value.

3.3 CHANGE AGENTS

This section describes the basic process used to identify and evaluate the CAs for this REA. The details of the CAs are included in Appendix C.

The identification of the CAs formed the starting point to evaluate the current status and future threats to the key resources of the ecoregion. CAs are natural or anthropogenic disturbances that influence the current and future status of CEs. Each BLM state office has a sense of the known or anticipated CAs to the ecosystems in their REA; however, the goal of the REA was to identify any patterns of environmental change that may be more evident when evaluating the CA across the ecoregion. Historically, a variety of CAs in the Northwestern Plains ecoregion included natural fire cycles, mining, hydrologic alteration, and conversion of natural land to agricultural uses. More recently, the suppression of fire, urban and utility corridor development, energy production, non-native species invasions, and changes in climate patterns have played larger roles.

Several CAs for this REA were initially recommended by the AMT and additional CAs were added based on a thorough evaluation of ecoregion-specific literature. State wildlife action plans (SWAPs) that identified threats to the resources in this ecoregion were also evaluated. The CAs listed in Table 3-2 are depicted as affecting all of the resources within the ecosystem: fire, development, invasive species, insect outbreaks/diseases, and climate change. Several of these categories were subsequently divided into subcategories as shown in Table 3-2. A description of each CA and the current understanding of its effects are presented in Appendix C along with the summary of the REA analysis conducted for each CA to the CEs. Where possible, the cumulative effect of CAs was evaluated. However, the evaluation of the cumulative effect of CAs is difficult to ascertain at an ecoregional level. The analysis of the cumulative effects of CAs would be better suited for a more detailed step-down analysis on specific areas within the ecoregion.

Table 3-2. Change Agents Selected for the Northwestern Plains

Change Agents	Description	CA Package Appendix
Development Urban and Exurban Agricultural Hydrological Energy	Development is the direct modification of the landscape through activities including urbanization, road development, agricultural, hydrological, and industrial development, including the extraction of traditional energy and mineral resources, and the establishment of renewable energy production areas. Development can lead to habitat loss and degradation and effects at a species population level (behavioral disturbance and direct mortality) may also result.	C-1
Wildfire	Historic fire disturbance has shaped ecosystem processes in this ecosystem. Human-influenced changes have affected and altered fire regimes including fire frequency, severity, and seasonality.	C-2
Invasive Species Terrestrial Aquatic	Expansion of invasive species is associated with human activity that results in disturbances to native habitat. The introduction of invasive species can lead to alterations of plant and animal communities or ecological processes that native species and other desirable plants and animals depend on for survival.	C-3
Insect Outbreaks and Diseases	Diseases and exotic pests have had, and continue to have, the potential to exert severe effects on populations of important species and ecosystems including destruction of large areas of natural and/or planted forests and loss or reduction of vital forest ecosystem functions.	C-4
Climate Change	Climate change is thought to be caused by various factors that include human-induced alterations such as global warming. Global climate change has the potential to directly and indirectly affect organisms and communities by changing the locations where species and communities can exist. Climate change can also cause secondary effects by changing the frequency and distribution of fire and threats from invasive species, disease, and insect outbreaks.	C-5

3.4 CONSERVATION ELEMENTS

The approach to selecting CEs was based on identifying ecosystems, species assemblages, and individual species that adequately represent the key resources of the ecoregion and that might best represent the effects of CAs across the ecoregion. In order to facilitate this, a coarse-filter/fine-filter approach was taken. This approach is one of the basic tenets used in regional conservation planning and focuses on ecosystem representation (coarse-filter) complemented by a limited subset of focal species assemblages and individual species (fine-filter). Fine-filters include protected, keystone, or wide ranging species that are considered important resources. The objective of this dual approach is to include the ecosystems and ecological functions (coarse-filter) that are required for biotic integrity, while also providing for biodiversity and species of concern (fine-filter).

The selection of CEs included species, ecosystems and landscapes, and scenery/special values recognized as warranting conservation/protection in consideration of the following core ecological values:

- Native fish, wildlife, or plants of regional conservation concern (e.g., populations, species, or communities identified in SWAPs; species listed under the Endangered Species Act (ESA); species and communities identified through other agency/non-governmental organization assessments; etc.).
- 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.).
- 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).

3.4.1 Coarse-Filter Conservation Elements

Coarse-filter CEs include all of the major ecosystem vegetation types that occur within the ecoregion and represent all of the predominant natural ecosystem functions and services in the ecoregion. The coarse-filter approach requires that standard classifications of the major ecosystem types (both terrestrial and aquatic) that occur within the assessment area be identified. Additionally, using a common classification (U.S. National Vegetation Classification System [NVCS]) of the ecosystems provides the framework for the assessment and forms the basis for consistent maps, descriptions, and models of each ecological unit and broader landscapes where they occur (Unnasch et al. 2009). The desired outcome of coarse-filter selection is to provide coverage for the vast majority of species that occur in the ecoregion.

3.4.1.1 Geospatial Data Sources

In order to identify the coarse-filter CEs, the definitions of all of the vegetation types in the Northwestern Plains ecoregion were obtained from the North Central Gap Analysis Program (GAP). GAP uses the NVCS, which is a standard classification system that was developed to classify both wetlands and uplands and identify types based on vegetation composition and structure and associated ecological factors. The NVCS includes several levels of detail (Level 1, Level 2, Level 3, etc.) that can be used to characterize and map vegetation cover (USGS 2010). The GAP Level 1 (Land Cover) is the most generalized level of vegetation type and includes the broad categories of vegetation structure such as forest, grassland, and shrubland. The Level 3 systems were determined to be the most appropriate level for this REA. Figure 3-2 shows the distribution of land cover across the ecoregion. Some examples of the Level 3 ecological systems include Western Great Plains Sandhill Steppe, Northwestern Great Plains Riparian, Southwestern Great Plains Canyon, and the Northwestern Great Plains Shrubland.

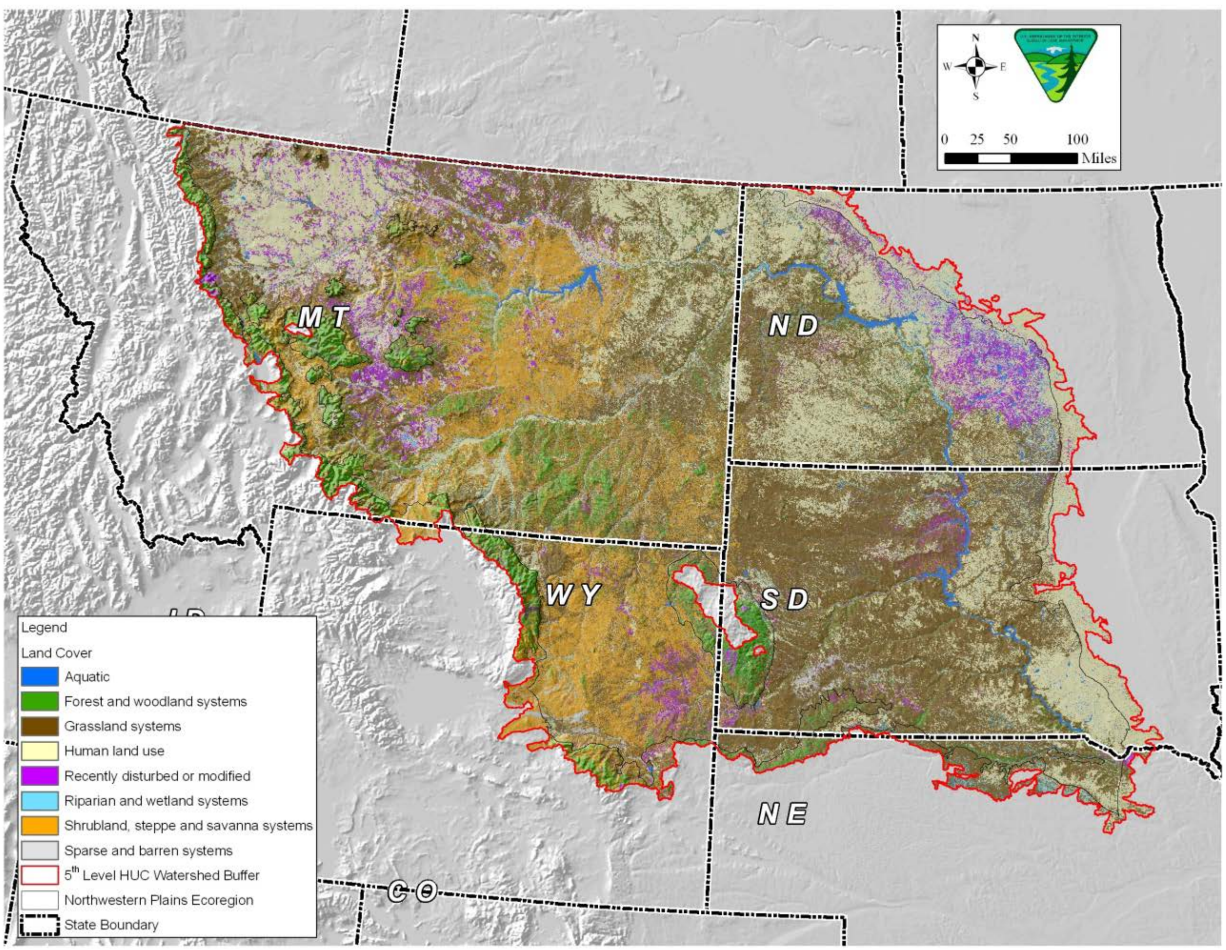

Figure 3-2. Major Land Cover Types (GAP Level 1) of the Northwestern Plains Ecoregion

The North Central region contains states that have not been covered by a Regional Gap Analysis Program (ReGAP) project. For these areas, the National GAP layer used data from the Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) to create a seamless layer. The datasets were merged together to form a continuous layer of vegetation data across the five states. The continuous data layer was then clipped to the Northwestern Plains ecoregion at which point the Level 3 systems were extracted for evaluation. The GAP and LANDFIRE were also the primary datasets for the aquatic and wetland ecosystems.

The identification of the coarse-filter CEs included an aggregation and crosswalk process of the GAP vegetation systems which allowed for a reduced number of coarse-filter CEs to be evaluated in the REA. The process allowed selection of coarse-filter CEs at the formation class level (Level 1) while retaining the capability to evaluate nested geospatial data on every formation or Level 3 mapping unit within or across divisions. The GAP Level 3 ecological systems were first cross walked by the BLM to the Idaho Land Cover Classification System (LCCS) at the Division level, which was cross walked to a comparable category in the NVCS (Foster 2010, personal communication). Most of the GAP Level 3 systems that occur in the Northwestern Plains ecoregion are included in the Idaho LCCS Divisions, effectively linking the GAP Level 3 systems to NVCS. Additional NVCS crosswalk efforts in other states such as the Montana Crucial Areas Planning System (CAPS) (Vance 2010, personal communication) and (Comer et al. 2003b) and professional judgment were used to associate the remaining Level 3 systems to Idaho LCCS Divisions. Appendix B contains a listing of Level 3 Ecosystems organized by Division, Formation, and Class in an adaptation of the BLM Idaho LCCS.

Although the GAP data will serve as the primary source for vegetation data, it is recognized that the GAP data may not be completely accurate for various ecological systems. For example, it is widely known that the GAP system does not provide accurate classifications for xeric uplands. In addition, GAP does not provide a classification for whitebark or limber pine. These inaccuracies were addressed through all phases of the REA.

3.4.1.2 Identification of Coarse-Filter Ecosystems

Table 3-3 presents the Level 1 vegetation types in the Northwestern Plains ecoregion and the percent coverage for each vegetation type. Within this ecoregion, approximately 63 percent of the ecoregion are terrestrial systems, approximately 6 percent are aquatic systems (riparian, wetlands, or open water), approximately 26 percent are under human land use, and approximately 5 percent are recently disturbed areas.

Table 3-3. Gap Analysis Program Level 1 Ecosystems

Level 1 Ecosystem Class	Percent of Ecoregion
Forest and Woodland (evergreen and deciduous)	6.92
Shrubland and Savanna	15.03
Grassland	39.62
Sparsely Vegetated/Barren	2.57
Riparian and Wetlands	4.09
Open Water	1.55
Human Land Use	25.76
Recently Disturbed or Modified	4.52
No Data	0.00

Classes adapted from US Geological Survey, 2010.

3.4.1.3 Coarse-Filter Selection

At AMT Workshop 4, all of the GAP Level 3 systems were evaluated and segregated into the Level 1 divisions to be analyzed. All of the Level 3 system data were retained through the aggregation to division process, and therefore, the ability to re-aggregate any number of Level 3 systems as needed for the REA analysis was maintained.

Table 3-4 lists the six Level 1 divisions and associated Level 3 systems that were selected as coarse-filter CEs for the REA. All Level 3 systems were retained as coarse filters except those defined as Level 1 Human Land Use systems (e.g., developed, pasture/hay, cropland, mines, oil wells), or areas for which there was no GAP data. Collectively, these systems, along with the "no data" category account for 25.76 percent of the ecoregion (Table 3-2). Although the human land use data or areas with no data were evaluated, this data was utilized in the REA, in particular with regard to the role those systems play relative to CAs such as urbanization and agricultural conversion. Cropland and other disturbed areas also provide habitat value for some species of conservation concern (e.g., pronghorn). Thus, the data for all mapped ecological systems and cover types in the ecoregion were retained and used when required by conceptual models for fine-filter CEs. A complete discussion of these ecological systems is provided in Appendix D.

Table 3-4. Ecological Systems Selected as Coarse Filters for the Northwestern Plains Ecoregion

Appendix	Coarse-Filter System	GAP Level 3 Systems
D-1	Evergreen Forest and Woodland	Northwestern Great Plains Black Hills Ponderosa Pine Woodland and Savannah
		Southern Rocky Mountain Ponderosa Pine Woodland
		Northern Rocky Mountain Foothill Conifer Wooded Steppe
		Rocky Mountain Foothill Limber Pine – Juniper Woodland
		Northwestern Great Plains Black Hills Ponderosa Pine Woodland and Savannah
D-2	Deciduous Forest and Woodland	Rocky Mountain Aspen Forest and Woodland
		Western Great Plains Dry Bur Oak Forest and Woodland
		Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland
D-3	Grasslands	Northwestern Great Plains Mixedgrass Prairie
		Western Great Plains Sand Prairie
		Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland
D-4	Shrubland	Inter-Mountain Basins Big Sagebrush Steppe
D-5	Sparse Vegetation	Southwestern Great Plains Canyon (Badlands)
		Western Great Plains Badland
D-6	Riparian	Western Great Plains Wooded Draw and Ravine
		Western Great Plains Floodplains
		Northwestern Great Plains Riparian,
		Western Great Plains Riparian Woodland and Shrubland
		Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland

It is important to note that at abrupt elevation gradients where prairies adjoin mountains, both at the western margin of the Northwestern Plains ecoregion and in the mountain ranges that form "ecological islands" in the western part of the Northwestern Plains, there are substantial differences in the Level 3 ecological systems within the ecoregion boundaries depending on whether the 5th level HUC watershed buffer is included or not. This is because the watersheds within the buffer extend into the mountains toward the headwaters, causing some montane and subalpine ecosystems to be included within the buffered ecoregion boundaries. Although important ecotonal areas occur between the prairie and montane systems, these are represented in Level 3 ecosystems that occur within the Northwestern Plains outside of the buffers, as well as extending into the buffers and beyond. Examples are Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna, Rocky Mountain Foothill Limber Pine-Juniper Woodland, and Northern Rocky Mountain Foothill Conifer Wooded Steppe. These were included in the Evergreen Forest and Woodland category and were retained in the coarse-filter analysis for the Northwestern Plains ecoregion.

Higher montane and subalpine systems included in the buffers are not necessarily representative of major systems within the Northwestern Plains ecoregion but are extensively represented in the adjacent Middle Rockies ecoregion. In particular, for example, these systems include Rocky Mountain Lodgepole Pine Forest, Rocky Mountain Subalpine Dry Mesic Spruce-fir, and Middle Rocky Mountain Montane Douglas-fir. The locations of these montane and subalpine systems, predominantly in the buffer zone of this ecoregion, are shown on Figure 3-2. These were not carried forward in the coarse-filter analysis for Northwestern Plains. The aerial extent of these systems within the ecoregion, including buffer, is very small and therefore not representative of the ecoregion and were also not carried forward as coarse-filter CEs in the analysis for Northwestern Plains. These systems are listed in footnotes of the Table B-2 in Appendix B.

This suite of coarse-filter CEs encompasses the habitat requirements of most characteristic native species, ecological functions, and services in the Northwestern Plains ecoregion. A detailed description of each ecological system selected as a coarse-filter CE is presented in Appendix D.

3.4.2 Fine-Filter Conservation Elements

It cannot be generally assumed that by focusing solely on characteristic ecosystems or habitat types, the ecological requirements of all species will be adequately addressed. Some species may require focused attention as part of a species assemblage (e.g., migratory birds, native fish, etc.). Other species require individual attention because they play critical ecological roles, have significant spatial requirements, or are known to be rare, imperiled, or narrowly endemic (Unnasch et al. 2009). Therefore, identifying species and species assemblages as fine-filter CEs was also a critical component of the REA.

3.4.2.1 Selection Process

The goal of the fine-filter selection process was to produce a list of 25 to 30 candidate species and then to carry 7 to 12 species through the REA process. The identification process started with the development of a database that included species identified by the BLM; species contained in the SWAPs; species that are listed as federally endangered, threatened, or candidate by the USFWS; species listed as G1-G3 by NatureServe; and those contained on the BLM sensitive species lists for Montana, Wyoming, North Dakota, South Dakota, and Nebraska. This initial list was supplemented with some landscape species that have been identified in the literature and species that are representative of habitat that may be inadequately represented by the coarse-filter ecological systems. Additional species identified as regionally significant were also included. Regionally significant species, communities, or assemblages were also evaluated as a fine-filter CE if the species was determined to have qualities that give the resource special worth, meaning, or value and have a range of distribution and affects management concerns across two or more BLM field office boundaries (BLM 2010).

At Workshop 1, the AMT recommended that the selection criteria for CEs be modified to reduce the number of candidate species and species assemblages. The following criteria were also used as rationale for reducing the list of candidate species:

- Strong association with one or more coarse-filter CEs (such as a specific GAP level 3 ecological system).
- Association with a keystone or umbrella species identified as a CE (examples include species typically associated with black-tailed prairie dog [BTPD] colonies).
- Association with a species group or assemblage being carried forward as a CE (e.g., prairie fish species, grassland breeding bird species, forest carnivores, big river fish species).
- Lack of consensus among the AMT to carry the species forward as a fine-filter CE. Discussion points for not carrying a species forward included:
    - insufficient ecological knowledge or lack of data
    - not of regional significance or strong agency concern throughout the ecoregion.

After the initial screening, a draft list of species was further evaluated and some species were grouped into assemblages. The evaluation resulted in five species and four species assemblages as presented in Table 3-5. These species, assemblages, and communities that comprised the fine-filter CEs evaluated in this REA. A detailed description of each species, assemblage, or community selected as a fine-filter CE is presented in the CE package in Appendix E.

Table 3-5. Fine-Filter Conservation Elements for the Northwestern Plains Ecoregion

Species or Species Assemblage	Rationale	CE Package Appendix
Mule Deer (Winter Habitat/ Parturition Areas)	Landscape Species of Regional Significance	E-1
GRSG	Landscape Species of Regional Significance	E-2
Golden Eagle	Landscape Species of Regional Significance	E-3
Grassland Bird Assemblage (includes Swift Fox)	Regional Significance	E-4
BTPD Assemblage	Umbrella or Keystone Species	E-5
Wetland/Riparian Areas (Prairie Potholes)	Key Habitat Types that May Be Incompletely Represented in GAP Coarse-Filter Data	E-6
Prairie Fish Assemblage	Species Assemblage	E-7
Big River Fish Assemblage	Species Assemblage	E-8 [a]
Plains Sharp-Tailed Grouse (PSTG)	Landscape Species of Regional Significance	E-9 [a]
Pronghorn (Migration Corridors/Winter Habitat Assemblage)	Landscape Species of Regional Significance	E-10 [a]

[a] Substantial data gaps were identified for this CE and therefore it was dropped from CA analysis (see noted Appendix).

For three of the proposed CE species, the pronghorn and plains sharp-tailed grouse (PSTG), and for the big river fish assemblage, appropriate data (e.g., occurrence, range) were not available. Based on recommendation from the RRT, these CEs were dropped from further analysis in this REA.

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4.0 ECOLOGICAL MODELS AND INDICATORS

In order to answer the MQs, three types of conceptual models were developed for the Northwestern Plains ecoregion: an ecoregion model, ecological process models, and system-level models. Conceptual models represent the current understanding of the underlying natural processes controlling a system or CE. 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.

Development of the conceptual models included an extensive review of current scientific literature of the ecological requirements for each CE as well as any information on the current or potential impacts of CAs. If ecological process models for the species or species assemblage CEs were previously developed by state partners, agencies or other entities, this information was also evaluated for use. It is important to note that a variety of assumptions were required to develop the models and to the extent practicable, these assumptions were based on the literature relevant to the CEs. System-level models were designed to incorporate ecologically relevant information, regardless of whether this information could inform the final analysis or be presented in a map format. The conceptual models were used to identify indicators necessary to develop the KEA tables that were used to evaluate the MQ for the REA analysis. At each step of the process, REA products were reviewed by subject matter experts (SMEs) participating in the RRT process.

A summary of the tools and data used to conduct the REA is presented below using the golden eagle as an example. For each of the coarse-filter and fine-filter CEs, a detailed description of each species or species assemblage, the ecological models, data sources, KEAs, and metrics that were selected for use in the REA are included in the CE-specific packages presented in Appendices D and E.

4.1 CONCEPTUAL ECOLOGICAL MODELS

In order to answer the question regarding current status and potential for future risk, the development of standardized conceptual ecological models for all of the CEs were developed. A conceptual ecological model is a map of concepts and their relationships. Conceptual models help to organize existing knowledge and create assumptions about a particular system, articulate the known relationships between CEs and associated CAs and thus aid in defining the scope and scale of the analysis.

Three types of conceptual ecological models were developed to support the REA analysis; an ecoregional conceptual model, ecological process models, and system-level models. The ecoregional conceptual model and the MQs served as the initial basis for identifying the data that would be required to complete the REA. The ecological process model diagrammatically illustrates the ecological requirements of the CEs while the system-level model illustrates how the CAs would interact upon the CE and its associated habitat.

Conceptual models are generally constructed as diagrams with shapes that represent the main components of the system, and arrows that identify relationships. Because conceptual models are used to communicate complex issues, a consistent notation and diagrammatical layout was used to ensure that they convey the essential information quickly while requiring minimal specialized knowledge or familiarity with the particular CE.

The relationships identified in conceptual models formed the basis for the development of MQs, provided a filtering device to decide what information is relevant and appropriate, and aided in the selection of associated data layers and analyses for the REA. A hierarchical approach of using nested conceptual models was adopted for the REA and ranged from an ecosystem-wide, comprehensive view of the ecological processes to a detailed depiction of how geospatial information is processed to provide the input metrics for determining regional significance for completion of the assessment.

Appendix E contains the CE packages. These include the conceptual models and attempt to illustrate the ecological requirements and how they may be affected by the CAs in the ecoregion. Also included are the KEAs and narrative describing why the attributes were chosen.

4.1.1 Ecoregion Conceptual Model

A generalized ecoregion conceptual model was developed to depict the relationships among the functional components of the ecosystem resources (e.g., vegetation resources, wildlife) and functions and the major environmental influences, such as climate and development, on a landscape (ecoregional) scale. Figure 4-1 presents the conceptual model developed for the Northwestern Plains ecoregion. The model's simplification suggest events or processes that impact ecosystem attributes, focusing on the major forces of change with large-scale influence, and include CAs that are influenced by both natural and human forces. This ecoregional conceptual model does not include uncertainty or indicate spatial scale, relative magnitude or intensity of effects, or the time-frame of processes.

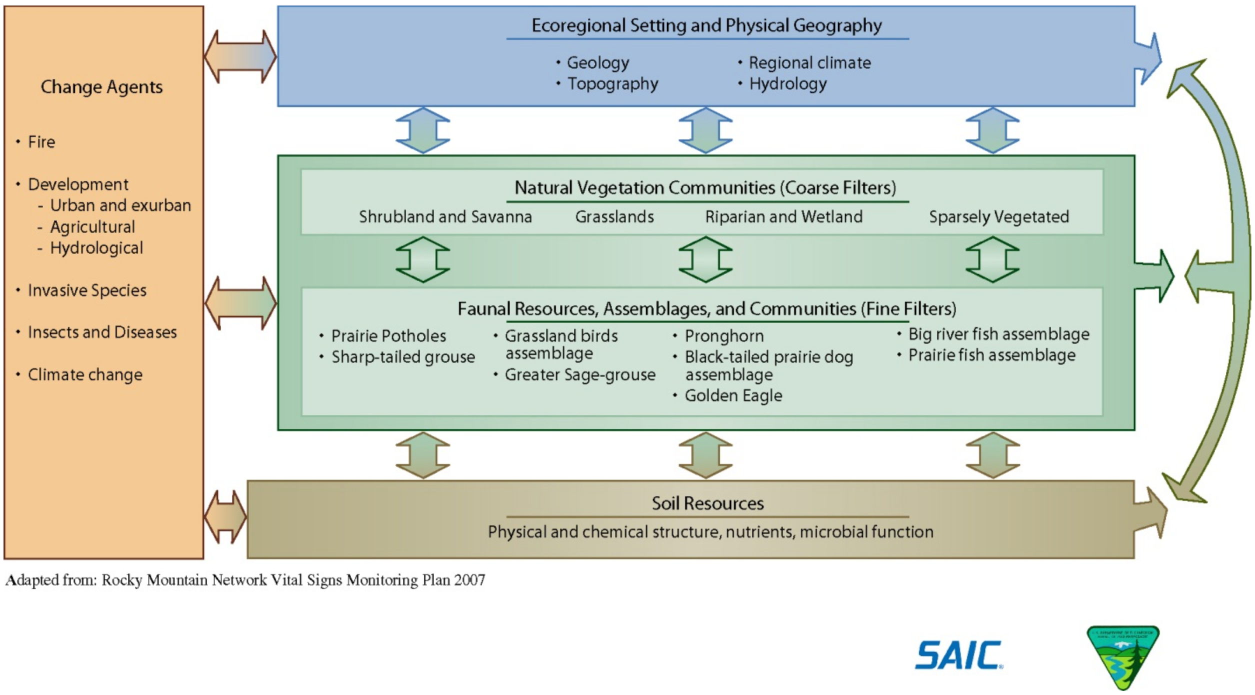


Figure 4-1. Ecoregional Conceptual Model for the Northwestern Plains Ecoregion

On Figure 4-1, the natural features that form the basis for the setting of this ecoregion are identified in the blue box. These include geology, topography, regional climate and hydrology. The natural vegetation communities, both terrestrial and aquatic, that dominate this specific ecoregion are presented in the green box. The natural vegetation communities provide the habitat necessary for the sustainment of the faunal resources. The natural vegetation communities are identified using the Level 1 GAP classifications. Listed below the vegetation communities on the figure are the faunal and wildlife community resources that were defined as CEs. These CEs include the mule deer, greater sage-grouse (GRSG), golden eagle, the grassland bird assemblage, the BTPD assemblage, prairie potholes, the prairie fish assemblage, the big river fish assemblage, the PSTG, and pronghorn. The soil resources (e.g., physical and chemical structure, nutrients) upon which the ecoregional resources are based and sustained are depicted in the brown box. The identified CAs for the ecoregion are shown in the left-hand box in the figure to depict their relationship or effect on all of the natural resources of the ecoregion. Not all of the possible specific effects (e.g., insect infestations, erosion, drought) of the CAs are depicted in the model.

The conceptual model shown on Figure 4-1 is intended to be descriptive of landscape scale functions while remaining simple and generic. Detailed conceptual models specific to each of the CEs were developed to evaluate specific effects relative to the CAs.

4.1.2 Ecological Process Models

Ecological process models were developed for each fine-filter CE to define the ecological requirements of the species or species assemblages during key life cycle periods. The main function of the ecological process model in the REA is as a tool to discern what attributes are important to map and to guide and direct the eventual in-depth analysis of management options and their ecological implications across the landscape. The ecological process models may also be used to: a) explore indirect pathways for ecological effects; b) identify sensitive linkages which may be critical to assessing EI; and c) identify important data gaps. It is important to note that the models are not designed to show ranges of variability or uncertainty for species, communities, or ecosystems.

Development of the ecological process models included a thorough literature review of CE ecological requirements and the CAs that have the potential to affect the CE. If a model for a particular CE was previously developed by state partners, agencies or other entities, this information was evaluated for inclusion.

Figure 4-2 presents an example of the ecological process model developed for the golden eagle, a fine-filter CE for the Northwestern Plains ecoregion. The key ecological processes for the golden eagle are identified in the model as the green boxes and the KEAs are identified by key factor (size, condition and landscape context) and shown in the model as blue diamonds. With regard to the KEAs in the area of landscape context, there is some intentional overlap among the attributes listed in (extent and continuity, patch size, fragmentation, connectivity).

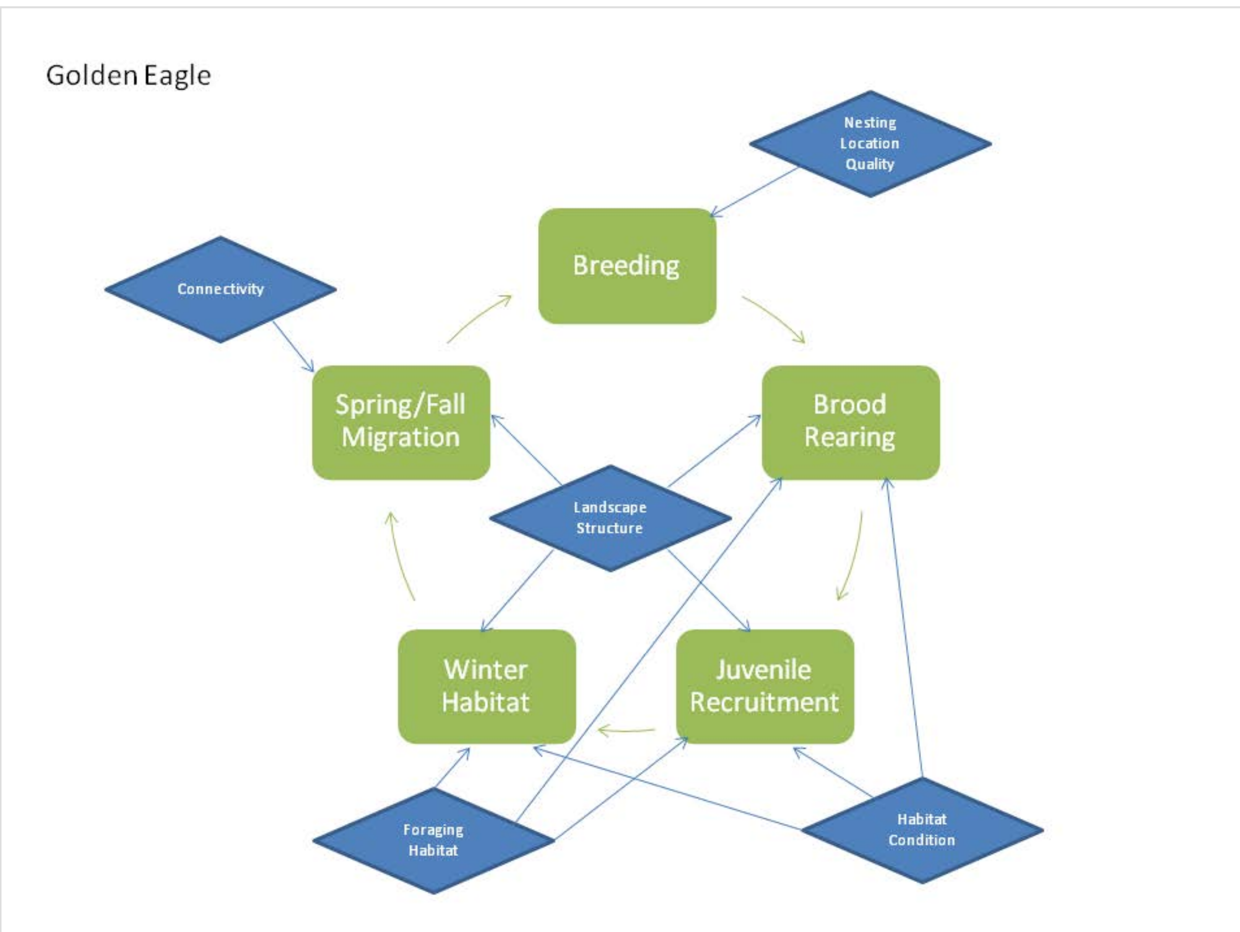


Figure 4-2. Ecological Process Model for the Golden Eagle

The ecological process model indicates that the status of the golden eagle in this ecoregion is defined by five key ecological processes; breeding, broad reading, juvenile recruitment, winter habitat, and spring/fall migration. The associated KEAs therefore target attributes such as nesting location quality, habitat condition, foraging habitat, connectivity during spring/fall migration and landscape structure available to the golden eagle during these critical periods. Any agent of change that positively or negatively influences these factors has the potential to influence golden eagle population levels in the region.

Ecological process models were developed for each fine-filter CE and are presented in the CE specific packages in Appendix E. An extensive narrative for each CE is also presented to document the scientific basis for each conceptual model.

4.1.3 System-Level Models

The system-level conceptual models developed for each coarse- and fine-filter CE are essentially "stressor" models, which depict the effects that environmental stress (i.e., CAs) impose on key ecological components. The system-level conceptual model is used for identifying indicators and metrics with high ecological and management relevance for use in the REA which will guide the evaluation of potential responses to perceived impacts (Noon 2003; Faber-Langendoen et al. 2009a).

Figure 4-3 presents the system-level conceptual model for the golden eagle in the Northwestern Plains. The KEAs for the golden eagle (vegetation, prey abundance and availability, nest locations) are presented as blue boxes on Figure 4-3. The ecosystem characteristic or attribute that most significantly affects the distribution of the golden eagle is habitat condition (vegetation). Vegetation drives the breeding and feeding requirements for the species, specifically the availability of prey species, and available nesting sites.

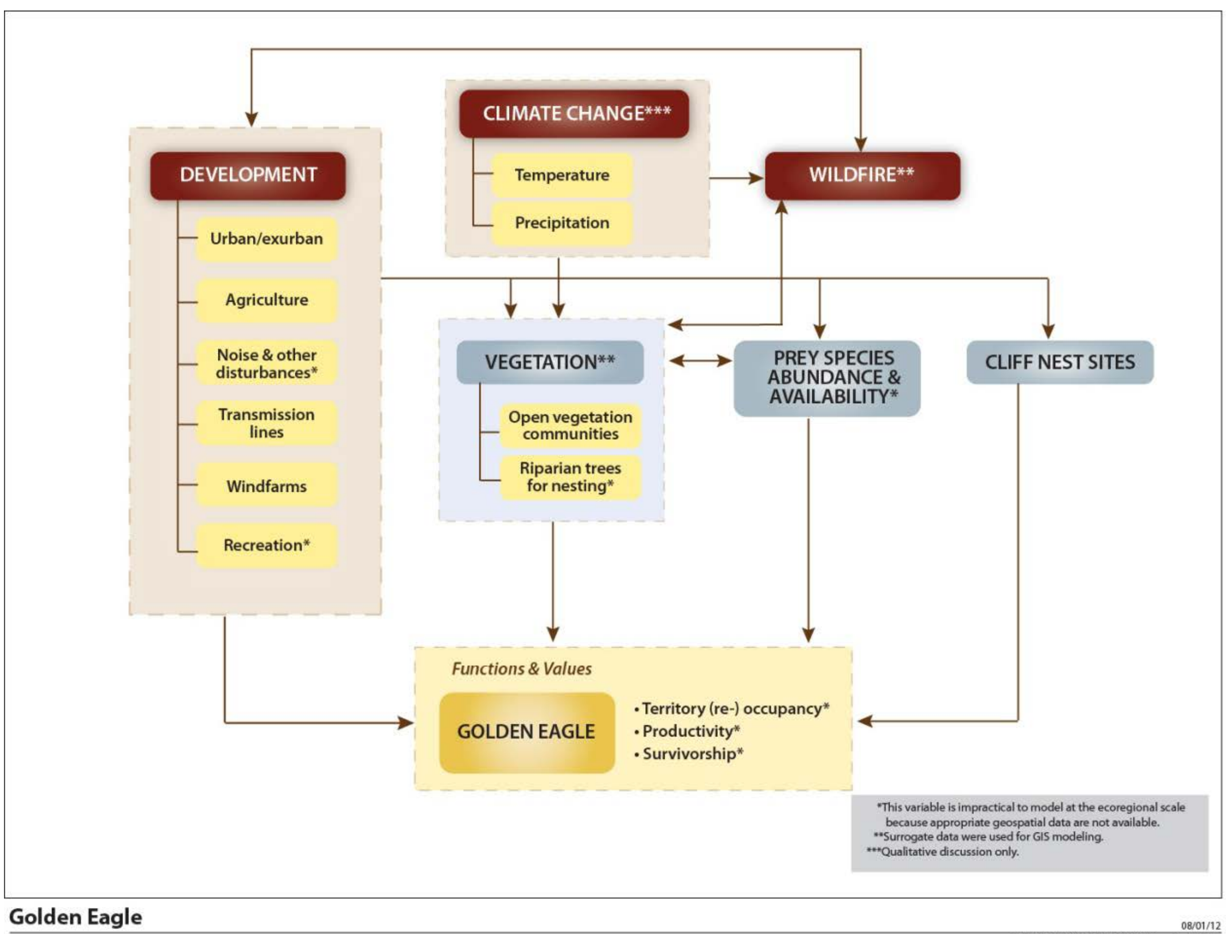


Figure 4-3. Golden Eagle System-Level Conceptual Model

The primary CAs that were identified through literature review are development, climate change, and wildfire which are identified across the top of the figure in red. The specific stressors are identified on Figure 4-3 as yellow boxes. The arrows shown in the system-level conceptual model are used to describe the predicted relationships between KEAs and CAs. As shown in the model, prey species abundance and availability for the golden eagle is threatened by development on a variety of levels including agriculture, transmission lines, and wind farms.

System-level conceptual models were developed for each coarse- and fine-filter CE and are presented in Appendices D and E, respectively. An extensive narrative for each CE is also presented to document the scientific basis for each conceptual model. Future updates of these models will include refined or new scientific information and could involve the introduction of additional components.

4.2 ECOLOGICAL ATTRIBUTES, INDICATORS AND METRICS

Upon completion of the system models, the conceptual ecological models were examined to identify the attributes (structure, composition and ecological processes) for each CE which are considered primary drivers or are the most valuable measurements for assessing relative status or condition. Every species, biological community, or ecological system has distinct characteristics. The dominant and critical characteristics that contribute to the persistence of the resource are defined as the KEAs. It was critically important to identify the KEAs for each CE that can be spatially represented and ranked that provide the basis for the current status analysis in this REA. In some cases, KEAs were initially identified as being important, but uniform comprehensive ecoregion-wide data might not have been available to complete the analysis. In these cases, some KEAs were dropped. Measurable indicators and scoring metrics for each KEA were identified to represent the current status and were used to create geospatial datasets and maps.

4.2.1 Key Ecological Attributes

Ecological attributes should reflect size, condition, and landscape context, and may include biological characteristics, ecological processes, environmental regimes, and aspects of landscape structure that sustain the CE. For some species, the KEAs are well known from historical and recent research. For others, KEAs may still be in question depending on the geographic location of the CE on the landscape.

The principles defined in Parrish et al. (2003) and Unnasch et al. (2009) were used for the selection of the KEAs. Specifically, "KEAs of a resources include:

- Critical or dominant characteristics of the resource, such as specific characteristics of (a) demographic or taxonomic composition; (b) functional composition; (c) spatial structure; (d) range or extent; and
- 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" (Parrish et al. 2003 and Unnasch et al. 2009).

Unnasch et al. (2009) also recommended that three factors be considered when selecting attributes; size, condition, and landscape context.

- **"Size** refers to attributes related to the numerical size and/or geographic extent of the focal ecological resource" (CE 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."

The spatial structure (spatial patterning and connectivity) of the landscape within which the CE occurs is defined as landscape context. Many studies have documented evidence of the importance of surrounding landscape and human activities to the overall ecosystem status (Allen 2004). Human actions at the landscape scale are a principal threat to river ecosystems, impacting habitat, water quality, and the biota via numerous and complex pathways and frequently result in habitat that is both degraded and less heterogeneous (Allen 2004). KEAs defined to assess landscape context evaluate the quality of the landscape immediately surrounding an ecological system in order to provide an assessment of the potential threats to the ecosystem.

As an example, Table 4-1 identifies KEAs (foraging habitat and landscape structure) that were defined for the golden eagle. As presented in the example system-level model for the golden eagle (Figure 4-3), vegetation drives the feeding and breeding/nesting requirements for the species, specifically the availability of prey species, and available nesting sites. It is important to note that some attributes and indicators that could affect this CE as noted on Figure 4-3 are not presented in Table 4-1. These indicators were not used because they were either not suitable for a landscape level analysis or data were not available to support the analysis. However, for indicators where spatial data may not be available, surrogate measurements were sometimes used, if available. Where possible, data gaps were identified for future data gathering efforts.

Table 4-1. Key Ecological Attributes, Indicators, and Metrics for the Golden Eagle

Category	Key Ecological Attribute	Indicator / Unit of Measure	Metric			Data Source	Citation	Weight
			Poor = 3	Fair = 2	Good = 1			
Size	Foraging Habitat	Extent of suitable habitat (percent of HUC [a])	0- 32 [a]	33 - 69 [a]	70 - 100 [a]	GAP	Marzluff et al. 1997; Beecham and Kocher 1975; Smith and Murphy 1973; McGahan 1968	0.700
Landscape Context	Landscape Structure	Road Density (roads/km^2)	>10	5 - 9	<5	Linear Feature	Steenhof et al. 1993 and Professional Judgment	0.075
		Distance to Transmission Lines (km)	<1	1 - 5	>5	Transmission Line Locations/ BLM	Delong 2004; Professional Judgment	0.075
		Distance to Wind Turbines (miles)	<10	10 – 16	> 16	Wind Turbine Towers	Hunt et al. 1998; USFWS Eagle Conservation Plan Guidelines	0.150

[a] Based on Natural Breaks for the GAP vegetation range
km – kilometer(s)

4.2.2 Indicators and Metrics

The REA analysis required the identification and evaluation of indicator data from various sources that would be useful to address the MQs related to the CEs and CAs. Indicators are components that can be used to assess the condition of KEAs and were selected with a specific emphasis on the ability to measure the KEA using existing geospatial data. Scoring metrics were used to represent the current status for each KEA. The current status was illustrated using the geospatial data, which provide the basis for the current status analysis in this REA.

On Figure 4-3, indicators are presented in green boxes. Foraging habitat and nesting location quality are considered KEAs for the golden eagle. The indicators that have been defined for use in assessing the available foraging habitat of the golden eagle are the extent of suitable habitat within the Northwestern Plains ecoregion. Breeding and nesting habitat can be assessed using surrogate indicators; road density, distance to transmission lines, and distance to wind turbines, as measures of landscape structure.

In order to provide a standard for measurement for each indicator, appropriate scoring metrics were established. Scoring metrics are a type of rating scale that is appropriate for each indicator and these include values or estimates of the ecologically acceptable range of variation for each indicator (good) as well as thresholds of unacceptable change (fair or poor). Each indicator is rated by comparing measured values with values expected under relatively unimpaired (reference standard) conditions. In most cases the metrics used to identify attribute quality were based on available publications, coupled with expert analysis and professional judgment in association with data-driven metrics. This process was carried out by the RRT comprised of BLM resource managers, SAIC subject matter experts, and state and federal agency experts. The RRT met periodically to contribute information and to analyze input attributes and outputs that were derived from various forms of spatial analyses. This process enabled the RRT to determine the efficacy of attributes, indicators, and metrics as well as to ascertain the accuracy of each step of the modeling process. To address the differences in magnitude of metric values, the values were standardized (e.g., range between 1 and 3) before compiling. For each KEA, values of 1, 2, or 3 were assigned. Areas of the ecoregion receiving a score of 1 were considered good or within the acceptable range of variation. Areas assigned a 2 were considered fair, and those assigned a value of 3 were considered poor. As noted in Table 4-1, if the extent of suitable habitat for the golden eagle (measured as a percentage of modeled habitat within the HUC) is between 33 to 69 percent, then a metric value of 2 would be used to describe the modeled habitat as fair.

Using this approach, spatial layers were completed for each of the KEAs, and then metric values were summarized and averaged at the 6th level HUC to provide an overall current status for the CE. For some CEs, the KEAs were weighted relative to their importance, so that the resulting metric value was multiplied by the weighting factor and then averaged. The overall threat score for each HUC that intersected the model habitat was assigned a rating of good, fair, or poor based on the natural breaks method to produce a current status data layer for the CE modeled habitat across the ecoregion. A higher overall current status score would result in a rating of poor for the HUC indicating that there are existing threats to the eagle modeled habitat based on the KEA metrics.

4.3 DATA CLASSIFICATION

In the context of this REA it is important to provide an explanation of the classification of data for many of the maps included in this report. Because one of the overall goals of the REA was to rate both the 5th and 6th level HUCs of the ecoregion it was necessary to classify the data in some manner from low to high or poor to good. Any time maps of ordered data are developed, it is necessary to determine how data values will be classified. In other words, which units should be in the lowest class, which units should be in the highest class and how the rest of the units should be distributed among the remaining classes. Although it was determined early on in the REA process that the three classes of good, fair and poor would be used in the analysis, there was no determination of what the value ranges of those classes should be and in fact this could not be determined until the data were evaluated. As is evident in our analysis, very slight adjustments to the “breaks” in the value ranges of ordered data, for example, can alter the map and reveal trends that were not previously detected or in fact are not representative of the data.

There are a variety of different methods for classifying data. Each method has strengths and weaknesses depending on the distribution of the data being analyzed and the end users understanding and use of the maps that result from the classifications. The different methods of classifying data are listed below.

Natural Breaks: This classification method (also variously known as Optimal Breaks and Jenks' Method), assigns the data to classes based upon their position of the data along the data distribution relative to all other data values. This classification uses an iterative algorithm to optimally assign data to classes such that the variances within all classes are minimized, while the variances among classes are maximized. In this manner, the data distribution is explicitly considered for determining class breaks which is the major advantage of this method. The major disadvantage is that the concept behind the classification may not be easily understood by all map users, and the legend values for the class breaks (e.g., the data ranges) may not be intuitive.

Quantiles: In quantile classifications, an equal number of data observations are placed in each class. For example, if there are 50 observations, 10 observations would be placed in each class of a five-class (quintile) quantile map. The data are first rank-ordered, and then the appropriate observations are assigned to each class (class 1, class 2, class 3, etc.). The number of classes also determines the specific type of quantile map (three classes = tertile; four classes = quartile; five classes = quintile). Two advantages of the quantile classification are that it is useful for ordinal data (because the data are rank-ordered) and it can help facilitate map comparisons (as long as the same number of classifications is used for all maps). The disadvantage of the quantile classification is that it does not consider how the data are distributed. Therefore, if the data have a highly skewed distribution (e.g., many outliers) this classification will force data observations into the same class (either the lowest or highest, in this case) where they may not be appropriate; as a result, the quantile classification may give a false impression that there is a relatively normal data distribution.

Equal-interval: In equal-interval classifications, the data ranges for all classes are the same. In other words, the range of the entire dataset is divided by the desired number of data classes, such that each class occupies an equal interval along the range of data values. The advantage of the equal-interval classification is that the resulting equal intervals may be easy for many map users to interpret. The disadvantage of the equal-interval classification is that the data distribution is not considered when determining class breaks for the intervals (only the lower and upper data values are used

Standard Deviations: In standard deviations classifications, the data are assigned to classes based on where they fall relative to the mean and standard deviations of the data distribution. The advantage of this classification method is that by using the mean as a dividing point, a contrast of values above and below the mean is readily seen. This method only works well for a dataset that is normally distributed. An even number of classes should be used, such that the mean of the data serve as the dividing point between an even number of classes above and below the mean. The disadvantage of the standard deviations classification is that it requires a basic understanding of statistical concepts, and hence may be difficult for some map users to interpret.

4.3.1 Current Status Analysis and Data Classification

The current status analysis that was completed for each of the CEs used different key ecological attributes (KEAs) depending on what the conceptual models identified as being important and the availability of data. In some cases, the results of the completed KEA analysis were summed to provide one score for each pixel and in some cases for each watershed. If pixels were assigned scores, the pixels were averaged by watershed to obtain a single classification for that watershed. For some KEAs, weights were used to show importance to particular KEAs over others but in most cases, equal weights were used across all KEAs. These instances varied relative to RRT requests and comments. The resulting summation of the pixels produced a range of values of all pixels across the ecoregion. Once this range of values was produced, it was then necessary to determine how to classify the data. In most cases, the natural breaks method was selected to classify the data because this classification provides the best representation of data distribution among the dataset being evaluated. Because the three units of good, fair and poor were selected as the three classes for the analysis, it was determined that 1 would represent good, 2 would represent fair and 3 would represent poor.

It is important to note that because a different number of KEAs were used for each CE, the total score values from every KEA analysis are different. Because the scores would always be different, the natural break points of the three classifications are represented on the figures in Appendix E as a percent. Figure 4-4 illustrates the histogram of one of the datasets and shows how natural breaks classified the data into the three classifications.

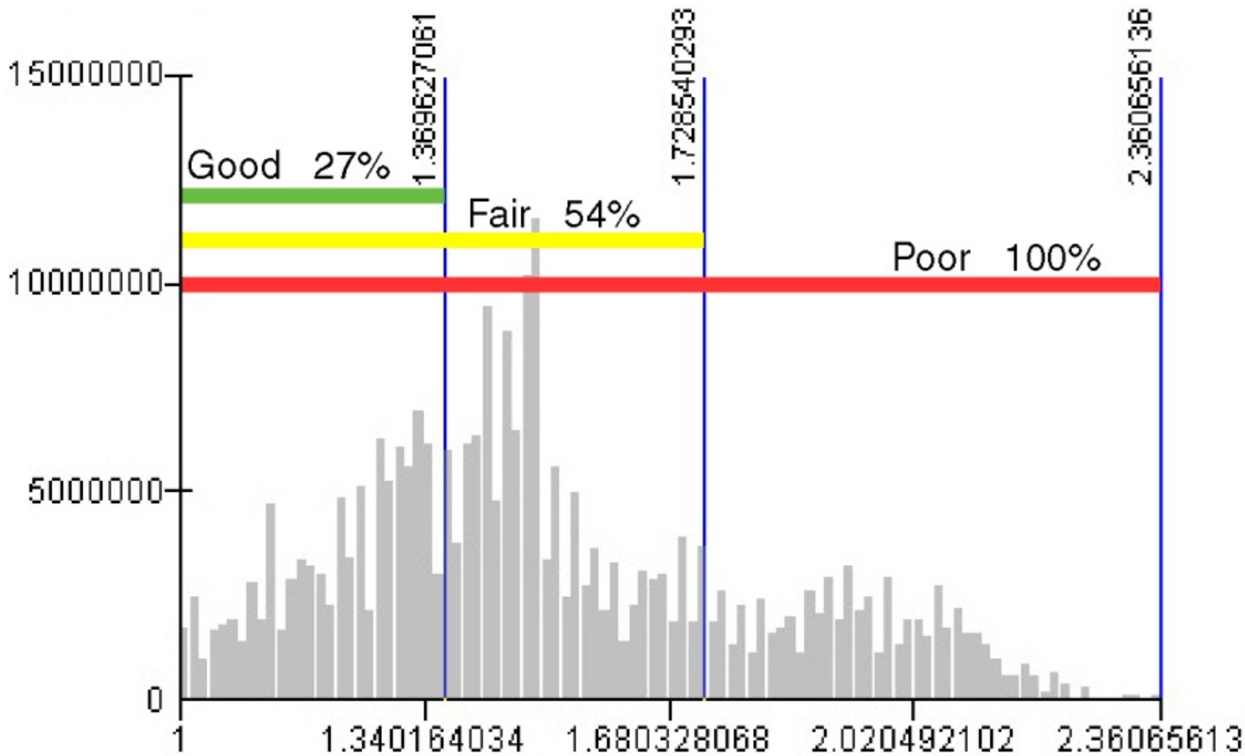


Figure 4-4. Example Histogram Showing Natural Breaks as Percentages

This figure represents the range of the data and the percentages of the data represented by each of the three classifications. Because the KEA analyses for every CE used integer ratings of 1, 2 or 3 for every KEA and not continuous data, there will never be any values less than 1. This factor alone prohibits the classification of 1 as good, 2 as fair, and 3 as poor when completing the final step of "rolling up" to the HUC reporting unit. Figure 4-4 also illustrates that the range of data does not extend to 3 because the maximum value resulting from this KEA analysis is 2.36. This figure further illustrates how the "break values" for good, fair and poor can be represented as percentages (the lower the percentage the better the overall status of the HUC). In this example the "break value" of 1.36 is representative of the best 27 percent of the scores based on the range of the data. The "break value" 1.72 is represented as 27-54 percent and would be assigned a fair rating. All watersheds with a higher score than 1.72, which would be the worst 46 percent, are illustrated as 54-100 percent. These watersheds would be assigned a rating of poor.

Figure 4-5 is a graphic representation of how the geospatial data are scored using natural breaks at the 30-m pixel level then rolled up to the 6th level HUC reporting unit. All of the 30-m pixel data in the HUC watershed ranging in values from 1-3 are averaged together and scored. In this example the scores were then classified by using natural breaks. The result of averaging the data together is that the watershed is characterized as fair.

This example illustrates the point that the intermediate (pixel based) maps provide an indicator of how the watershed received its final rating.

4.4 GEOSPATIAL DATA SOURCES

The ecoregional conceptual model and the MQs served as the initial basis for identifying the data that would be required to complete the REA. REAs are intended as relatively short (18-month) processes that are updated frequently (e.g., every 5 years) to maximize flexibility. The REA process does not include the collection of new information. It was acknowledged from the start that successful completion of the REAs would be dependent upon the availability and the quality of the geospatial data necessary to complete the REA.

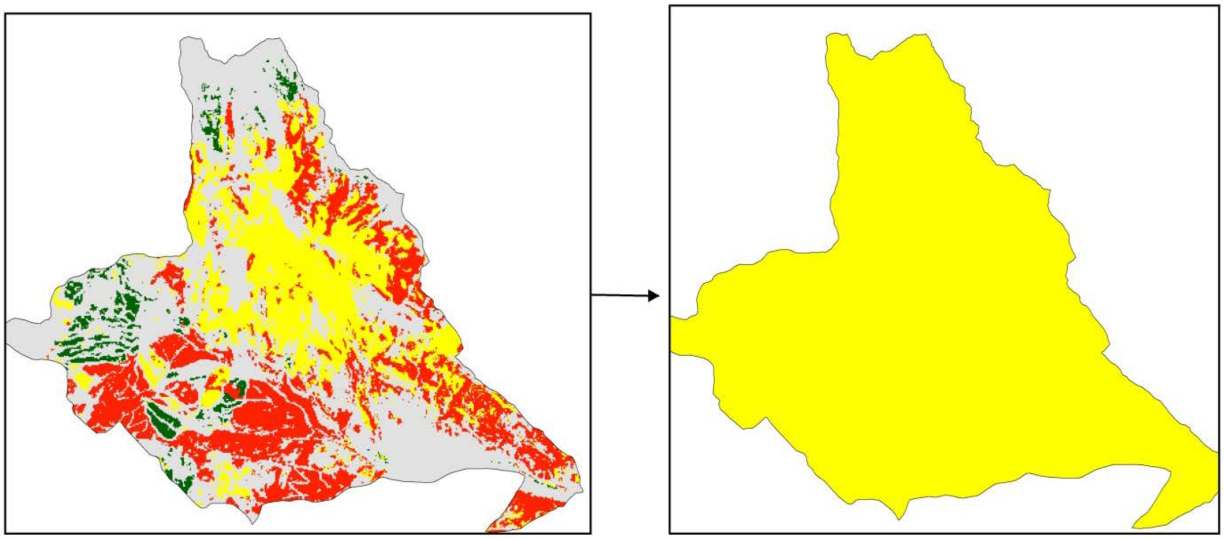


Figure 4-5. Analysis Unit Roll Up to Hydrologic Unit Code Example

The identification of datasets that define the distribution of the CE and represent the KEAs and the application of the scoring/ranking metrics assist with determining the range of variability across the ecoregion. The geospatial modeling that was completed is based solely on the availability and quality of geospatial data for the states included in the ecoregion. In some cases, the data are based primarily on the CAs or, in some cases, proxies for CAs. The source of the datasets used for geospatial modeling is also listed in each KEA table in Appendices D and E (e.g., Table 4-1).

4.4.1 Data Availability

Data availability with regard to species, as opposed to spatial reference, was a factor that affected dataset quality and availability. Species of significant importance (i.e., endangered species) often merit greater monitoring and therefore greater data quality, but not necessarily availability. Big game species and upland birds often are the recipients of better funding and more active management than non-game species, allowing improved dataset quality. Raptor species are actively monitored by a variety of non-governmental organizations (NGOs), offering an abundance of data, but these data are often of varying quality and difficult to obtain. The most difficult CE dataset category to access and evaluate was the aquatic CE species category. Although sport fishing is popular, fisheries data were difficult to locate. Large scale stream data also affected the quality of spatial fisheries datasets.

The primary goal of Task 2 of Phase I was to identify, obtain and evaluate datasets that could be used to answer the MQs. As part of Phase I Task 2, it was determined that additional datasets would need to be created to help to answer the MQs related to "where these resources occur throughout the ecoregion." For example, it was determined that maximum entropy (Maxent) modeling would be required for most of the species or species assemblage but a boosted regression tree model would be developed for the fish assemblages. Early on in the REA process, it was determined that an inductive approach to modeling habitat would be implemented. In other words, the development of KEAs to identify suitable habitat for a species would be more of a deductive modeling approach and because Maxent was determined to be used, the KEAs were developed to show current status versus identify suitable habitat.

Input parameters for Maxent models can vary. In order to develop Maxent models consistent with what had already been completed in the ecoregion and publicly available on existing decision support systems such as the Montana CAPS, a workshop was held to review input parameters. The primary input data for the Maxent models are species point occurrence data that were provided by BLM and obtained from state Natural Heritage Programs (NHPs). These data were very difficult to obtain. As is the case with all point occurrence data, these points do not necessarily represent where the CE is located across the landscape but where the observer identified the CE in the ecoregion at the time of occurrence.

In addition to the identification, acquisition and evaluation of data, the identification of data gaps was also important to the REA process. In addition to the 500 datasets, a multitude of other datasets were evaluated that either did not cover the entire ecoregion or lacked the metadata or other necessary information to be included as part of the REA process. An example of this was the county-level invasive weed data from county weed administrators in South Dakota and Nebraska. These data were at too fine of a scale for use in the REA and not available in similar scales from the other states.

4.4.2 Dataset Selection

More than 500 datasets from more than 50 data sources were obtained. The primary data sources used for this REA were BLM, USFS, state partners, NHPs, USGS, USFWS, ReGAP, GAP, and LANDFIRE. GIS analysts and ecologists identified and obtained several BLM datasets as well as publicly available spatial data which were evaluated to determine which data would provide the coverage required for the current and future analyses. Some datasets obtained contained multiple features and attributes that were important to more than one CE or CA (e.g., elevation, vegetation, water, etc.).

The BLM recognized that various state and federal agencies, partner organizations, LCCs, and stakeholders have dedicated valuable resources to the identification and collection, of many datasets that apply to the REA process. Many of the datasets contain sensitive information regarding the occurrence of specific fine-filter CEs, and therefore in some cases, these datasets were difficult to obtain. This situation resulted in data sharing agreements with NHPs and state and federal agencies for receipt of point occurrence data. It is acknowledged that in some cases, the datasets were more detailed (finer scale) than what is necessary for a landscape level analysis. To the extent practical, the datasets that were obtained were utilized in this REA effort, particularly for individual species. If data could not be obtained or were not suitable for the analysis, a data gap was identified and therefore, the BLM recommended dropping the CE from further analysis in the REA.

4.4.2.1 Coarse-Filter Conservation Element Data Sources

For the terrestrial coarse-filter CEs, vegetation systems data from the Northwest ReGAP and North Central GAP were used as the base layer data. Although ReGAP data were used as the primary source for vegetation data, data from the LANDFIRE project were used for states that were not included in the North Central GAP. For aquatic/riparian/floodplain and wetland systems coarse-filter CEs, a combination of data sources including the Northwest ReGAP and GAP were used as the primary data sources, and where data were available and appropriate, National Wetlands Inventory (NWI) and National Hydrography Dataset (NHD) were also used. The coarse-filter CEs were identified using the GAP Level 3 Systems as discussed in Section 3.4.1 and as noted in Table 3-3.

Modeling current location, distribution, patch size, corridors and potential corridors of terrestrial features was conducted through GIS mapping, overlay analysis, and implementation of spatial analytical tools. These are the analyses that were used to answer the “what and where” MQs. Other MQs concerning status and future conditions involve a more complex approach.

Using the GAP and LANDFIRE sources, spatial data were extracted for each terrestrial coarse-filter CEs by creating a “definition query” using ArcGIS to determine the distribution or current status for the CE. The output uses a 30-m grid for displaying the distribution of each of the terrestrial coarse-filter CEs. The resulting output map was compared to existing distribution sources or imagery and any necessary refinements were made. After the current status layer was created, applicable CA analyses were completed and compared with the CE distribution layer to view areas of current status and predicted future conditions. As a final step, the KEAs were applied to provide the appropriate raster grid output for each coarse-filter CE.

4.4.2.2 Fine-Filter Conservation Element Data Sources

Table 4-2 lists the data sources for the fine-filter CE distribution maps. Although the term "distribution" is used throughout this document, this term is loosely used to define the data output from Maxent modeling (modeled habitat) or adopted range data for other species. Data sources included existing data layers from USFS, Western Association of Fish and Wildlife Agencies (WAFWA), Rocky Mountain Elk Foundation (RMEF), or World Conservation Society (WCS). The species occurrence data will naturally contain some uncertainty in the accuracy of the positions. For the golden eagle, existing distribution models did not exist, and therefore point occurrence data from NHPs and state agencies were used to develop Maxent distribution models. Maxent is a widely accepted method for modeling distribution in instances where species occurrence data are limited. The Maxent model combines species occurrence data with input overlay layers to determine a probability of suitability. For the prairie fish and big river fish assemblages, point occurrence data were limited and therefore probability models were developed.

Table 4-2. Data Source for Distribution Mapping of the Fine-Filter Conservation Elements for the Northwestern Plains Ecoregion

Conservation Element	Notes
Mule Deer (Winter Habitat/Parturition Areas)	WAWFA and Rocky Mountain Elk Foundation
GRSG	Breeding Bird Density Layers
Golden Eagle	State Natural Heritage data were used.
Grassland Bird Assemblage (includes Swift Fox)	State Natural Heritage data were used.
BTPD Assemblage	State Natural Heritage data were used.
Wetland/Riparian Areas (Prairie Potholes)	NWI, NHD and other datasets were used.
Prairie Fish Assemblage	Combination of data from the following sources were used StreamNET, Montana Fisheries Information System (MFish) and Wyoming Game and Fish Department
Big River Fish Assemblage	Combination of data from the following sources were used: StreamNET, MFish and Wyoming Game and Fish Department
PSTG	State Natural Heritage data were attempted to be used. This CE was identified as a data gap. Additional information is included in Appendix E-9.
Pronghorn (Migration Corridors/Winter Habitat Assemblage)	This CE was identified as a data gap. Additional information is included in Appendix E-10.

For other CEs, uses of surrogate data were necessary where adequate occurrence data were not available. For example, the GRSG breeding bird density data and Schroeder range map served as a surrogate for the distribution of this species in the Northwestern Plains ecoregion. Specific details regarding the distribution data sources for each fine-filter CE are provided in the CE packages (Appendix E).

4.4.3 Data Quality Evaluation

The purpose of the data quality evaluation (DQE) was to ensure that the acquired data met or exceeded the DQE criteria outlined in the 2008 U.S. Department of the Interior (USDOI) Data Quality Management Guide (DMG) (USDOI 2008) and that it was appropriate to use in the modeling that was completed for this REA. As part of the DQE process, each dataset and its associated metadata was evaluated and verified for quality and usability against the 11 BLM criteria identified from the 2008 DMG. The DQE is provided in Appendix F. In addition to the DQE findings and recommendations, the AMT provided direction on which data were best suited for analysis to meet the REA objectives.

5.0 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 (MCE). The use of GIS and MCE applications allows the integration of a variety of geographic datasets to produce an output map for a specific purpose. MCE 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 MCE approach was to provide a product that can be easily used by BLM staff without a high 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. The evaluation and selection of the spatial analytical tools and methods were conducted as part of the Phase I pre-assessment.

5.1 ArcGIS

The geospatial analysis was completed using Environmental Systems Research Inst. Inc. (ESRI) ArcGIS 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 provides a range of tools and capabilities for performing spatial modeling and analysis intended for the MCE modeling approach needed to perform this REA.

5.2 DECISION SUPPORT TOOLS

A GIS-based MCE model incorporated within the Decision Support System (DSS) module of ArcGIS Version 10.0 was selected because this approach has been well documented in land use planning, landscape ecosystem analysis, and regional and urban planning. MCE 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 MCE 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 MCE module in the ArcGIS software.

5.3 GEOSPATIAL PROCESS MODELS

The GIS process models are diagrammatic illustrations of the geospatial instructions and workflow processes that were conducted to answer the MQs. The GIS process models function to identify how the KEA information and data sources (datasets) were used to depict the geographic information and how the information was modeled and manipulated in the geospatial analysis. The GIS process models were created by examining the system-level models for each CE and defining which key attributes could be spatially represented. Then, the datasets were used to create a series of intermediate data layers that were combined to produce final analysis products or the maps.

An example of the GIS process model created for each CE is provided on Figure 5-1. The GIS process model outlines the series of data transformations and intermediate datasets (layers) that ultimately result in the "final layer" or final analysis product. The blue ovals on the far left represent data sources such as the BLM linear features dataset. The yellow squares represent the type of indicator data extracted from the data source for each KEA. In this example, the yellow box shows that the data selected are the location of roads extracted from the TIGER data. The white boxes are GIS spatial operations that will be administered to the appropriate layers. These are usually union (overlay all data into one layer) or intersects (overlay all data only keeping data where common overlaps exists between the datasets). The green ovals represent the intermediate datasets or layers. In this example, the development layer for each polygon area is combined (unioned) together to form one intermediate layer representing areas influenced by development. Another intermediate output layer would result after combining datasets to show the potential areas susceptible to change (Figure 5-1). The orange ovals are output products or final layers. In some instances the final layers can also be used as an input layer to another final layer, such as a layer showing areas susceptible to change based on CAs and climate scenarios.

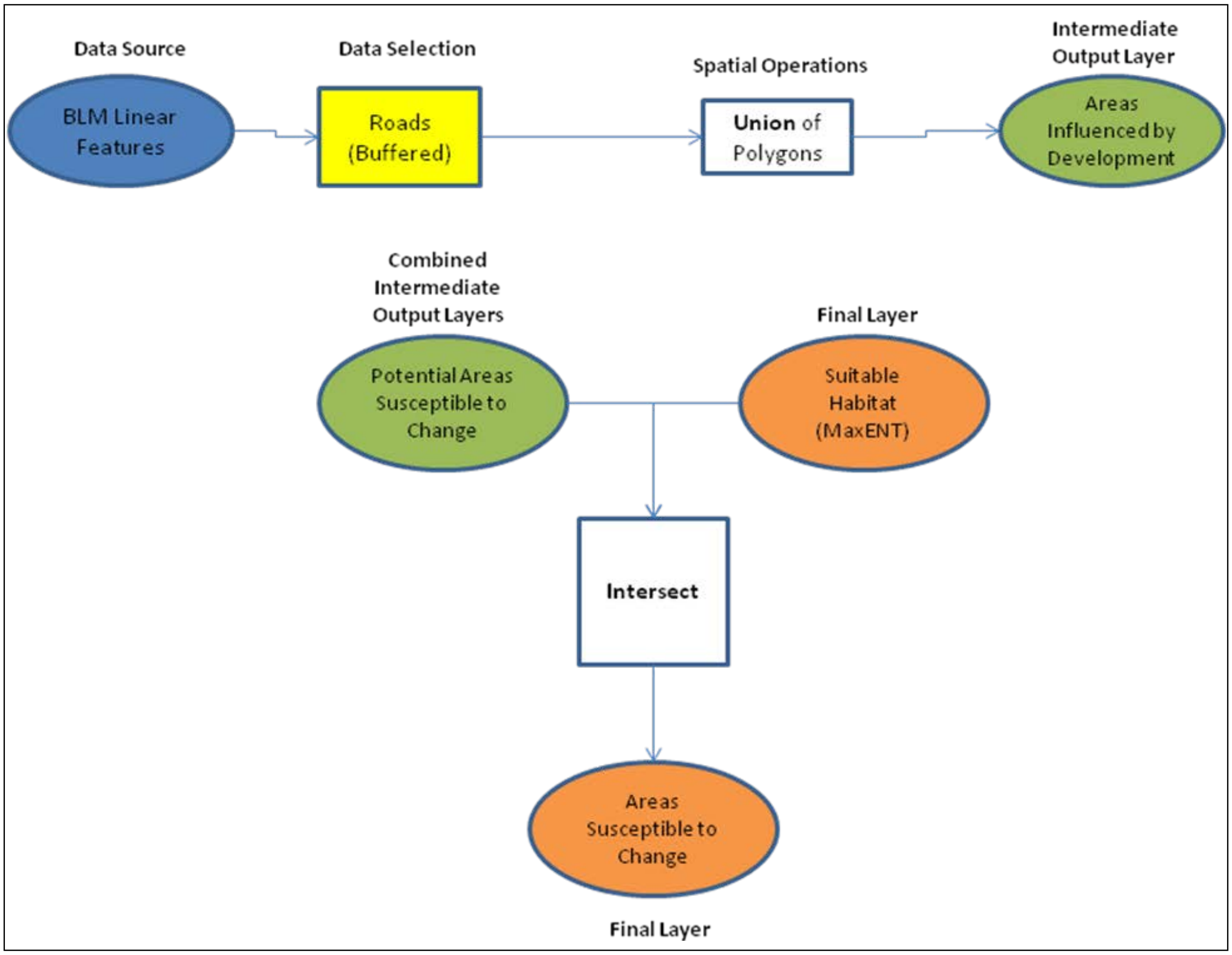


Figure 5-1. Example GIS Process Model

GIS process models were created for each CE and are included as part of the data deliverables for this ecoregion. These models are primarily used to show how the geospatial analyses were conducted and how the relationships between the CAs and the CEs were developed. The GIS process models also have the utility of allowing BLM geospatial analysts to induce various scenarios on the process model to complete "what if" scenarios for future analysis.

5.4 CONSERVATION ELEMENT SPECIFIC MODELING TOOLS

For some fine-filter CEs, existing distribution models did not exist, and therefore point occurrence data or other surrogate data from NHPs and state and federal agencies were used to develop distribution models. The most appropriate modeling tools were selected based on the available species data and environmental predictors.

5.4.1 Maxent Distribution Modeling

Maxent is a self-contained Java application for modeling species geographic distributions using the Maximum Entropy Method developed by Phillips et al. (2004). 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. The process used to create the Maxent distribution models is illustrated on Figure 5-2. The occurrence data for the CE species or species within the assemblage are used as sample points, the ecoregion is the space on which this distribution is defined, and the features are the environmental variables (or functions thereof). During a model run, the species occurrence data are compared to the individual values within the environmental raster layers to evaluate the commonality among observations (training the model). The target distribution is estimated by finding the probability distribution of maximum entropy (i.e., that is closest to uniform) subject to a set of constraints that represent the incomplete information about the target distribution. (Phillips et al. 2006).

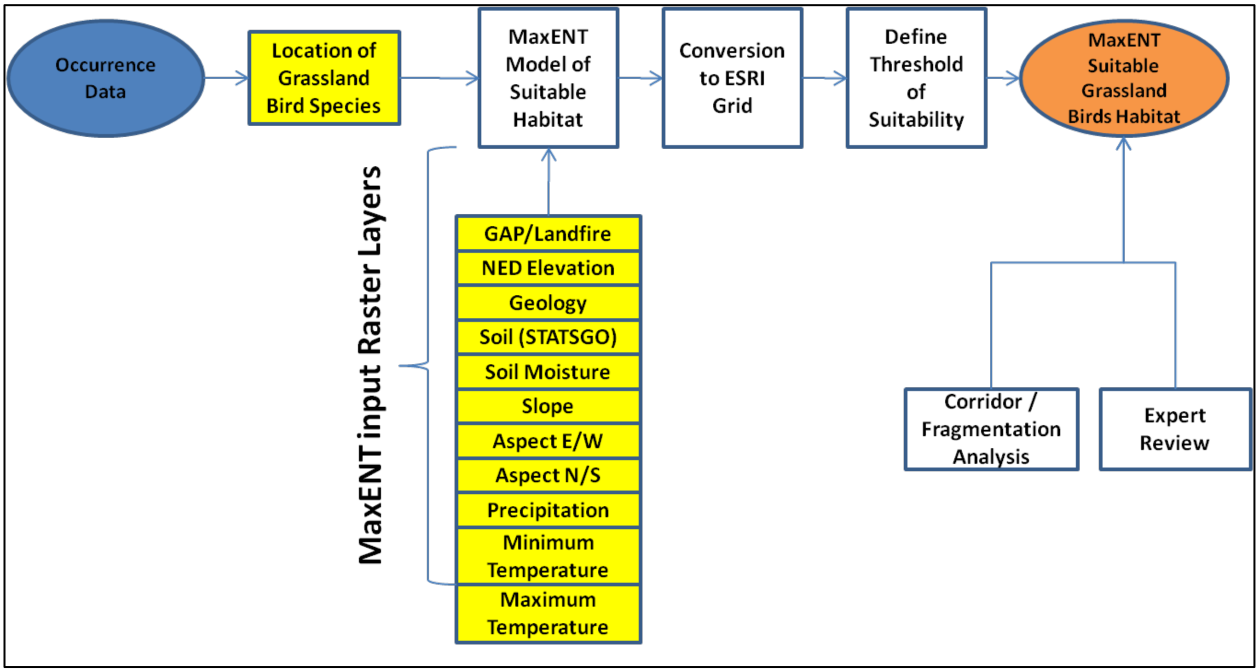


Figure 5-2. Process of Creating the Maxent CE Distribution Model

Once these commonalities are established it can expand beyond locations of occurrences to find suitable locations based on the commonalities between data. Maxent also allows for testing the model to validate the accuracy of the predictions based on occurrence data and also provides various validation measures. 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 and also convert them back to a GIS format for additional processing.

The distribution model output image uses colors to indicate predicted probability that conditions are suitable. Once the distribution models were completed, a model validation was conducted along with expert review of the Maxent habitat model by the RRT to ensure that the model results were reasonable.

Some of the advantages of using Maxent to conduct distribution modeling is that Maxent only requires presence data (occurrences) although it can also modified to use presence/absence data using a conditional model, it can utilize both continuous and categorical data, incorporates interactions between different variables, and the models generated by the software have a natural probabilistic interpretation, giving a smooth gradation from most to least suitable conditions, and therefore are easily interpreted (Phillips et al. 2004 and 2006).

5.4.2 Non-Maxent Distribution Modeling

Distribution modeling for the remaining fine-filter terrestrial species was accomplished through the adoption of existing data sources or through the use of surrogate data. For example, the 75 percent lek locations and Schroeder range data were used as a surrogate for distribution of the GRSG in the Northwestern Plains ecoregion. For aquatic analysis, fish presence date from the Missouri River data were used for the species in the prairie fish assemblage in the Northwestern Plains.

5.5 CHANGE AGENT SPECIFIC MODELS

Upon completion of the distribution modeling, the current status and potential future threat analysis for each CE species and/or assemblage was conducted. The current status analyses included the use of CE-specific KEAs or surrogate indicators to assess the CAs. CA-specific indicators for each CE are documented in the respective CE package in Appendix D or E and are summarized below.

In contrast, the datasets or models available to complete the future threat analysis were developed based on an ecoregional approach and then analyzed in a qualitative manner for each CE. CA-specific analysis for future threats are documented in the respective CA package in Appendix C but summarized below. For a few of the coarse-filter CEs, the future threat analysis was CE-specific, and therefore future threat KEAs were developed and included in the respective CE package (Appendix D or E).

5.5.1 Development

Data regarding development activities including energy development, agriculture and hydrological were obtained from existing datasets. These datasets were primarily used to assess current habitat status through the use of the KEA tables and metric specific to each CE. Future threats were assessed using data to model predicted future conditions on an ecoregion-wide basis or for CE-specific future threat KEAs. Detailed information regarding the data sources are provided in Appendix C-1.

5.5.1.1 Current Status

The USDA National Agricultural Statistics Service (NASS) crop land data layer for 2010 was used for the agricultural-related landscape context or habitat KEAs. Fence layers were sought for the identification of areas creating hazards or impeding migration, however this layer was unavailable at the ecoregion level.

Spatial data related to the location of urban areas and future development plans are important for the REA process. The Integrated Climate and Land Use System (ICLUS) project provides information and data related to population growth scenarios by county. In addition, the Montana CAPS contains data layers on projected housing densities from 1970 through 2020. In addition, some 2010 census data were used. Depending on the census attributes being analyzed, census data from 2000, 2005, or 2010 were selected.

For some CEs (e.g., sparse vegetation), proximity to roadways was used to assess the potential impacts associated with off road vehicle use.

A variety of data related to energy resources and transportation were provided by BLM. Renewable energy projects across the ecoregion include, biomass, wind, ethanol and geothermal. The National Renewable Energy Laboratory (NREL) currently shows no biomass power plants in this ecoregion, but there could be proposed developments seeking permitting. The NREL has information about wind and geothermal power capacity; however, data were not available across the ecoregion, and in some cases were limited greatly in quality and scale

BLM maintains extensive databases on potential oil and gas resources, leases, and the locations of current energy projects. BLM also has data on proposed energy corridors that overlap with other agency jurisdictions. Argonne National laboratory has mapped potential oil and gas and strata unit areas which were obtained. Oil and gas pads were sought in addition to point locations because of their spatial influence on some CEs, however, data were unavailable. Buffered well locations were used as a surrogate for oil and gas well pads.

Data for transmission lines and pipelines were important for many fine-filter CEs. Although some GIS data related to electric transmission lines were provided, other data were obtained through Sagemap. Data on low-voltage distribution lines were difficult to obtain.

The U.S. Army Corps of Engineers (USACE)-maintained National Inventory of Dams (NID) dataset was obtained to locate impediments for migratory fish.

5.5.1.2 Future Threat

Since no future agricultural models exist for use within this ecoregion, a model was created using STATSGO land capability classifications to derive potential future agricultural areas. Although this information can be portrayed spatially, there is no way to temporally show this future threat. This analysis considered the maximum potential for future agricultural areas within this ecoregion.

With regard to urban growth, there was existing models that predict patterns of growth. Integrated Climate and Land-Use Scenarios (ICLUS) SERGoM data provide different time scenarios based on current and future scenarios. The ICLUS future urban extent for the year 2060 was used in this analysis. This corresponds more closely to the data and scenarios used to perform the wind turbine analyses than a near term time period. For CAs that did not have predicted models, proximity analysis was used as a basis for future risk.

The future analysis for oil and gas production characterized potential oil and gas production areas rather than actual well locations. These larger production extents were used to qualitatively assess the potential effect of future production activities. Although these areas are based on oil or gas density data, the application of this data to future potential well site activity is unknown. Therefore, the constraints of this approach were considered in evaluating the effect of potential oil and gas production areas on the ecoregion.

This future potential solar analysis characterized the future potential for solar development based on the solar potential maps developed by NREL. Although these maps are very crude, they were used to assess areas across the ecoregion that had a low, moderate, and high potential for the establishment of solar energy development, and thus a corresponding low, moderate, and high risk to CEs.

The USFWS wind turbine data contained attribute information for current and future wind turbine locations. However, the future turbine locations dataset was very limited in number as most are presumably going to be erected in the very near future. Therefore, an alternative dataset was used to determine the potential areas where wind speeds are conducive to erecting wind turbines over a long-term period. Data characterized by the NREL were used to create a potential future wind energy development data layer. The future wind energy development areas were based on the availability of suitable wind speeds.

Although these CA maps used the future potential for the CA to be developed, the results of these are shown in terms of risk to the CEs. In other words, high future potential equals high risk.

5.5.2 Wildfire

The wildfire CA analysis attempted to evaluate vegetation condition departure, topography and fuel loads to determine potential fire risk across the ecoregion. Based on existing information areas were assigned values of low, moderate and high risk to potential fire.

A fire regime condition class (FRCC) (Barrett et al. 2010) characterizes the degree of departure from the historical fire regime, mostly due to human intervention in natural fire regimes. Low departure is considered to be within the natural (historical) range of variability, while moderate and high departures are outside of that range. Characteristic vegetation and fuel conditions are considered to be those that occurred within the natural (historical) fire regime. Uncharacteristic conditions include invasive weeds, insects, diseases, selectively harvested forest composition and structure, or repeated annual grazing (Barrett et al. 2010).

LANDFIRE provides coarse-scale reference condition for vegetation communities from its Vegetation Condition Class (VCC) data. VCC data, formerly known as FRCC, provide a categorized measure of the difference between current vegetation and structure and estimated vegetation structure and composition from the time just prior to European settlement. VCC data were used to show an estimate of change in vegetation and fuels from their historical condition.

The 13 Anderson Fire Behavior Fuel Model (Anderson 1982) data from the LANDFIRE 2008 refresh (http://www.landfire.gov/NationalProductDescriptions1.php) were used to assign fuel risk. The 13 Anderson Fire Behavior Fuel Model (FBFM13) layer represents distinct distributions of fuel loading found among surface fuel components (live and dead), size classes, and fuel types. The fuel models are described by the most common fire-carrying fuel type (grass, brush, timber, litter, or slash).

Topography influences wildfire behavior largely by affecting fuel moisture (solar exposure) and air/ oxygen movement. On slopes, warm air rises along the slope causing a draft which will cause wildfires to usually burn up-slope. The steeper the slope, the more rapidly the fire will burn up-slope (and more intensely). Steepness of the slope also results in more preheating of fuel in front of the fire and faster igniting of the fuel. Elevation affects the type of vegetation and the length of the season. A summary of the CA analysis for wildfire is provided in Appendix C-2.

5.5.3 Invasive Species Model

One of the primary goals of the REA was to identify areas of the ecoregion where invasives are known to occur and also identify areas where they could potentially occur in the future. A variety of local, state, and federal agencies collect data and information related to invasive species. Species-specific data sources for species such as leafy spurge, knapweed, cheatgrass, Russian-olive, and tamarisk were identified, but much of the data were limited in scale, quality, and number of occurrences or not properly georeferenced.

Due to the lack of data and any existing ecoregion-wide models, the status of this CA within the ecoregion was analyzed based on a determination of the bioclimatic factors associated with ten invasive plant species. The ten species selected for the bioclimatic model were determined based on the species most commonly reported among the states represented in the ecoregion (Appendix C-3). The bioclimatic modeling effort was intended to show where (on the ground) there is a high likelihood of occurrence of the terrestrial invasive plant species based on preferred environmental attributes of the species and a high likelihood of effects (on the ground) to conservation elements in the future, attributable to the future presence of these terrestrial invasive plant species.

The abiotic factors selected affect invasive plant growth and development and included elevation, soil conditions, and climatic factors (temperature and precipitation). Additionally, land classification and roadways were selected as attributes to indicate the habitats commonly associated with the specific invasive species or those most prevalent in the ecoregion. For each attribute, a literature search was conducted to determine the vegetation systems that are most vulnerable based on the preferred habitat of the invasive species (Velman 2012). Using the specific attributes for each of the ten species, maps were produced to represent the most susceptible areas for intrusion. The analysis used the weighted sum tool in GIS (equally weighted for this analysis) to depict the areas of the ecoregion where the bioclimatic factors selected for each invasive species overlapped. Further details on the methods used for the invasive species CA models are described in Appendix C-3.

5.5.4 Insect Outbreak and Disease

The combination of the mountain pine beetle (MPB) and other beetle species pose substantial threats to evergreen forests. Insect infestation was analyzed using aerial detection survey (ADS) from by the U.S. Forest Service. Three insects were identified for analysis; MPB, spruce budworm, and an "other beetles" category which included Douglas-fir beetle, Douglas-fir engraver beetle, pine engraver beetle, and spruce beetle. Each beetle dataset was then converted to raster for spatial analysis.

West Nile Virus is prevalent in various species of birds. Although it is recognized that disease plays an important role in the ecology of the Northwestern Plains and collection of data for this disease is becoming more common, ecoregion, no comprehensive dataset was identified that could be used for the ecoregion to illustrate this CA.

Chronic wasting disease (CWD) affects North American cervids. The known natural hosts of CWD are mule deer, white-tailed deer, elk, and moose. Although the collection of nationwide data for this disease is becoming more common, no comprehensive dataset was identified that could be used for the ecoregion.

A summary of the CA analysis for insect outbreak and disease is provided in Appendix C-4.

5.5.5 Climate Change Model

Various factors were considered in determining the appropriate climate models and data sources to use when considering current climate status and future climate change. Observational data are available to support research over the historical record; however, quantitative estimates of past or future climate must be obtained from simulations of global climate with general circulation models (also commonly referred to as global climate models [GCMs]).

For this REA, high-resolution simulations of present and future climate over the ecoregion were completed by dynamically downscaling global climate simulations from GCMs to a regional level using USGS's Regional Climate Model (REGional Climate Model Version 3 [RegCM3]). The output data from three specific GCMs (ECH5, GENMOM, and GFDL CM2.0) for regional climate simulations using RegCM3 (Hostetler et al. 2011) were provided by the USGS for use in this REA. Climate data for the Northern Rocky Mountains (NRM) and the Southern Rocky Mountains (SRM) were used to create a spatial data subset for this REA. This data subset was further aggregated and coupled for regional climate simulation (current and future) by seasonal time period.

Current climate data were based on RegCM3 models for the period of 1980 to 1999. Data for the period between 2000 and 2010 were not available for the REA analysis. The current RegCM3 data were stored as decadal climate data (i.e., 1980 to 1989 and 1990 to 1999). Therefore these data were merged and averaged across all three GCMs to create an output data layer for the current period of 1980 to 1999. Datasets are 15-kilometer (km) cell spatial resolution output monthly mean data for five parameters; temperature, precipitation, snow water equivalent (SWE), surface soil moistures, and rooting zone soil moisture.

Future climate data were based on the models for the period of 2050 to 2069. The target date for this REA was 2060. Because the RegCM3 models were based on decadal periods, a date range encompassing this date was used in the analysis. The future RegCM3 data were stored as decadal climate data (i.e., 2050 to 2059 and 2060 to 2069). Therefore, these data were merged and averaged across all three GCMs to create an output dataset for the future period of 2050 to 2069.

For both the current and future climate simulations, climate change was evaluated based on seasonal periods. Initially, quarterly seasonal periods were proposed. Based on preliminary evaluation of the climate data and in consideration of the characteristics of temperature and precipitation that are important for the CEs and other CAs, the time periods were revised. These time periods represented four bimonthly seasonal periods within a year as well as a four-month winter snow season and an annual period to supply a context for between seasonal changes.

The accuracy of a climate model's forecasts (i.e., RegCM3) was tested by running the model with data from a known historic period and comparing the results against observed data for that time period. The current climate model was bias corrected using the U.S. Department of Agriculture's (USDA's) PRISM 15 x 15 km. Further details on the methods used for the climate change analysis are presented in Appendix C-5.

NatureServe's Climate Change Vulnerability Index (NSCCVI) was used to determine the vulnerability of each fine-filter CE to climate change. This Microsoft Excel-based tool facilitates a fairly rapid assessment of the vulnerability of a plant or animal species to climate change in a defined geographic area. The NSCCVI process uses a range of attributes for each species that when assessed with the forecasted magnitude of climatic change determines a species' vulnerability. Species are scored as extremely vulnerable, highly vulnerable, moderately vulnerable, not vulnerable/presumed stable, not vulnerable/increase likely, and insufficient evidence (NatureServe 2011). Further details on the methods used for the NSCCVI are presented in Appendix C-5.The results of the NSCCVI analysis are presented for each fine-filter terrestrial species CE in Appendix E. The attributes used for each analysis were taken from various literature sources as summarized in Appendix H.

6.0 ECOREGIONAL FINDINGS

The key purpose of this REA is to identify and understand the ecoregional influences of widespread CAs on a limited number of CEs that represent the key resources of the ecoregion. CAs were selected based on the potential to affect the size, condition and landscape context of the CEs. The REA is intended to provide information that estimates the current status (baseline) and future condition of the natural resources in the ecoregion by examining the relationships between the CEs and CAs. The current status is the existing state or cumulative conditions that results from all past changes imposed upon historical conditions. Future condition is the potential future state of a CE that may occur based on the potential impacts of the CAs. Future conditions are defined in two timeframes; potential for short-term change in 5 to 15 years or long-term change in 50 years. A case study of the ecoregional findings for the golden eagle is provided as Example 1.

6.1 CHANGE AGENTS

The methodology used to evaluate each CA is presented in Appendix C. A summary of the results for the current status and future conditions of the CA in the ecoregion is summarized by CA. The current status of the ecoregion relative to the CEs is described in detail in each of the CE packages contained in Appendices D and E. Where data were available, each of the CEs was evaluated against a set of KEAs to determine current status. In addition, an EI assessment was completed to determine the current intactness of landscapes across this ecoregion.

6.1.1 Development

Development is probably the most predominant CA in this ecoregion. Development is included as a CA for this REA because parts of the Northwestern Plains are experiencing an expansion of urban and exurban development, an increase in infrastructure, oil and gas exploration, and wind farms, along with modification of the landscape by agricultural and hydrological development. Human development activities often have a more significant effect on landscape than natural disturbances because they alter the availability of energy, water, and nutrients to ecosystems; increase the spread of exotic species; accelerate natural processes of ecosystem change; and adversely affect the structure and functioning of ecosystems.

Broad categories of the development CA were initially identified during Task 1. Specific subcategories were added or refined based on the results of the literature review of the potential impacts of CAs on CEs for this ecoregion as well as the evaluation of relevant and available data for the analysis. Development includes urban, exurban, and rural (industrial) development, energy development and exploration, agricultural development, surface water diversion, and groundwater extraction. Some human activities including livestock grazing and logging are agents of change in native ecological systems in this ecoregion, but are not included in the REA. Data collection related to livestock grazing on BLM managed lands has been a locally driven process focused on vegetation response. Livestock grazing data collected by the BLM are useful for analysis at the local scale but are not centralized. Due to differences in data collection techniques and only recent efforts toward data standardization, BLM data have uncertain potential to be useful at the ecoregional scale (http://pubs.usgs.gov/of/2011/1263/). Even with this effort, the available data do not cover all lands. In order to cross the entire ecoregion we need a data source that is collected in a standardized manner and considers grazing across all lands of the ecoregion, hence the reliance on remotely sensed data for much of the REA data. Unfortunately, grazing impacts cannot be accurately assessed and separated from other disturbances with available remotely sensed data.

Ultimately, impacts from grazing should be reflected to some extent by condition measurements and trends in our CE current status assessments (through representations of conifer expansion, fire regimes, riparian habitat quality, etc.). The impact of disturbances in general will be reflected in vegetation communities, although direct ties (such as actual livestock utilization) cannot be made at the large ecoregional scale. Based on this information and consideration of grazing as a change agent, the AMT identified it as a data gap in the process (actual vs. authorized use, consistent data collection, etc.). So at

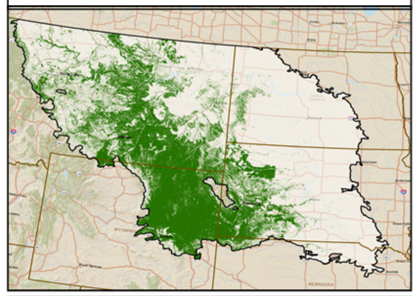
Golden Eagle *Aquila chrysaetos*

Conservation Element for the Northwestern Plains Ecoregion

SUMMARY: In order to identify and understand the ecoregional influences of development on the golden eagle, several key ecological attributes (KEAs) were identified to provide an estimate of overall habitat conditions within the Northwestern Plains. A species distribution model was used to define the existing areas within the ecoregion currently used or available for use based on species preferences. The reporting unit for this assessment was the 6th level Hydrological Unit Code (HUC).

SPECIES DISTRIBUTION: A modeled distribution layer was used in the golden eagle assessment (Figure 1). Data sources for this model were obtained from state wildlife agencies and natural heritage programs (NHPs) and limited to recently active (1990-present) nest site locations. These locations were used to develop Maxent distribution models (Phillips et al. 2004). The Maxent model combines species occurrence data with input overlay layers to determine a probability of suitability.

Figure 1. Golden Eagle Distribution Based on Probable Habitat Suitability

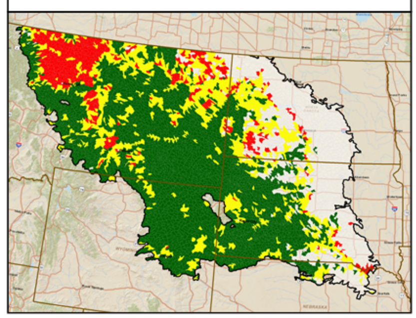


METHODS: KEAs, or indicators representing a KEA, were selected based on important life cycle stages of the golden eagle, known stressors, and existing, available geospatial data (Table 1). The four indicators included: extent of suitable foraging habitat, road density, distance to transmission lines, and distance to wind turbines. For each of the indictors, metrics were used to assess the relative habitat conditions based on available publications, federal and state wildlife experts' judgment, or using data-driven (natural breaks) methods.

Table 1: Key Ecological Attributes and Indicator Description

PREY AVAILABILITY	Golden eagle foraging habitat was selected because reliable prey distribution data was not available.
MORTALITY/ NESTING SUITABILITY	Road density was selected to represent increased human activity which is related to increases in eagle mortality and lower nesting suitability.
LANDSCAPE STRUCTURE	Distance to transmission lines was used as an indicator associated with higher mortality and poor landscape structure.
LANDSCAPE STRUCTURE	Distance to wind turbines was used as an indicator associated with higher mortality and poor landscape structure.

Figure 2. Current Habitat Conditions Based on Selected Indicators



SCORING: In order to provide an overall current status rating for each 6th level HUC, each KEA indicator rating was assigned a score (1=good, 2=fair, 3=poor) and averaged. In some cases, KEAs were weighted before averaging based on expert decision. A final overall rating (good, fair, or poor) for each HUC was determined by the natural breaks method, resulting in a current status rating relative to other areas of the ecoregion. A summary of the ecoregion conditions by overall rating is provided in Table 2.

Table 2: Current Status of Golden Eagle Habitat

Overall Rating	Square Miles	Percentage of HUCs
Good	118,288	64.0
Fair	46,129	25.0
Poor	20,469	11.1

Northwestern Plains Ecoregion
Rapid Ecoregional Assessment;
Bureau of Land Management 10/10/2012.

CURRENT STATUS: Figure 2 shows that the majority of the ecoregion maintains suitable habitat for golden eagles, while areas in western North Dakota, southeastern South Dakota, west-central Montana, and the Golden Triangle (MT) indicate potential habitat loss. The effect of roads on golden eagles ecoregion-wide is minimal; however, locations receiving the lowest score were those areas in close proximity to urban areas and areas of substantial agricultural activity. As noted in Table 2, the overall current status indicates that approximately 64 percent of the 6th level HUC watersheds that intersect the golden eagle distribution received an overall good rating.

FUTURE THREATS: Wind turbines represent a substantial threat to the golden eagles. Because the Nebraska area of golden eagle habitat is fairly small, the threat of wind turbines is probably greatest in this state. Most of the golden eagle habitat will likely remain unaffected by future potential fossil fuels development in this ecoregion; however, localized populations in northeastern Wyoming may be affected. Temperature increases over time resulting from climate change will most likely result in increases in wildfire potential, which will directly affect golden eagle prey availability.

Example 1. Case Study for the Golden Eagle in the Northwestern Plains Ecoregion

this time, because of data limitations, grazing was not included as a specific CA in this landscape assessment. As part of the step-down process, focal areas can be evaluated with localized information and finer scale data supplementing the regional context to determine the potential impacts from grazing (from and outside the assessment) and management objectives can then be adjusted as necessary at the localized scale to meet local and regional objectives. All of the different types of development are explained in Appendix C-1.

6.1.1.1 Current Conditions in the Ecoregion

Although there are certain areas of this ecoregion that have not been affected by change agents in the past, the majority of the ecoregion has been subjected to some type of development, most predominant of which is agricultural practices. As stated in many of the CE packages, current agricultural development is common throughout the Northwestern Plains and is a predominant CA in many of the watersheds across this ecoregion. Figure 6-1 displays the extent of current agricultural development in the Northwestern Plains ecoregion. As described in Section 5.5.1.1, the 2010 NASS cropland data were used to display the current agriculture development status.

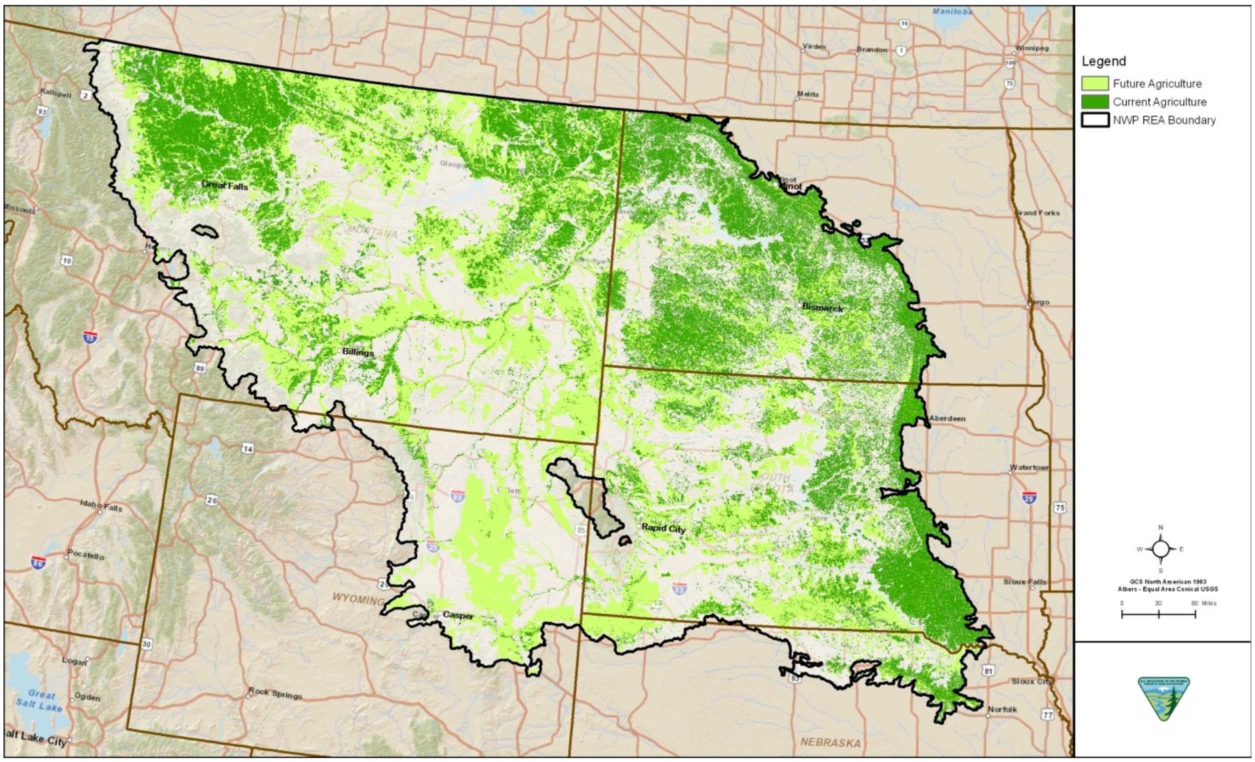


Figure 6-1. Current Agricultural Development and Future Agricultural Potential

6.1.1.2 Future Conditions in the Ecoregion

As part of the REA process, SAIC was tasked with the analysis of the future risk of change agents on various CEs. In order to perform this function, future CAs (i.e., wind, gas, oil, etc.) were subjected to analysis in areas where CAs overlapped CEs distributions. For the most part this task was difficult because of a lack of data. However, in some cases suitable datasets were used to complete the analysis with reasonable outputs. For the most part, the future CA evaluation was a qualitative analysis due to the inherent limitations of the future datasets. The future conditions datasets were all developed from large-scale data that covers broad areas. Although these data are appropriate for use at the ecoregion level, attempts to use them at a finer scale would not be appropriate. These datasets can be used to identify areas or subregions within the ecoregion where more detailed analysis could be completed. As mentioned above, agriculture is the most predominant CA in the Northwestern Plains. Figure 6-1 also displays the soils suitable for future potential conversion to agricultural development. Land capability classification types 1-4 from the State Soil Geographic (STATSGO) database were used to generate this map.

6.1.2 Wildfire

6.1.2.1 Current Conditions in the Ecoregion

The resources of this ecoregion are well adapted to periodic fire. However, as anthropogenic development has spread throughout the west, so has the suppression of wildfire. The risk of wildfire suppression to resources across this ecoregion has had greater consequences to these resources than has wildfire itself (Ingalsbee 2004). Wildfire suppression alters the historical fire regimes of fire-adapted vegetation systems through the buildup of fuel causing them to burn at higher temperatures than more frequent fires. These types of wildfires have the potential to damage vegetation that has evolved under frequent fire regimes. This decrease in native vegetation causes a chain reaction of events that eventually leads to degraded habitats, invasive species and potential loss of other species such as the GRSG. Appendix C-2 contains the results of the current fire analysis for this ecoregion.

6.1.2.2 Future Conditions in the Ecoregion

The future potential fire risk model was developed through the use of a variety of available GIS data. The precision and accuracy of the future fire analysis is unknown and the output maps should not be used to make management decisions at a field unit level. However, these maps can provide managers with information about potential wildfire risk in the Northwestern Plains ecoregion.

6.1.3 Invasive Species

Invasives species are those organisms 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 a site if their future establishment and growth is not actively controlled by management interventions (BLM 2008). Common traits of invasive species include fast growth, rapid reproduction, high dispersal ability, and a tolerance of a wide range of environmental conditions. The expansion of terrestrial invasives is strongly associated with anthropogenic activity with disturbance of native habitat through development of roads, pipelines and transmission lines, and other activities being one of the primary drivers. In addition, wildfire and climate change have the potential to reduce or eliminate native vegetation creating favorable conditions for invasive species.

As part of the pre-assessment for this CA, a wide variety of invasive species were originally evaluated for inclusion into the REA. These included terrestrial invasive plant and animal species and aquatic plant, fish, and invertebrate species. The terrestrial invasive plant species included a variety of invasive weed species including skeleton weed, dalmation toadflax, leafy spurge, Russian olive, tamarisk and many others. The terrestrial animal species included European starlings. The aquatic invertebrates and fish included the quagga mussel, Asian clam, zebra mussel, New Zealand mudsnail, brook trout, brown trout, northern pike and others. The aquatic plant species included didymo and Eurasian watermilfoil.

In order to evaluate the invasive species CA, attempts were made to gather available invasive plant data from the National Invasive Species Management System (NISMS), and various sources from state and county noxious weed programs. In addition, multiple herbariums were contacted to attempt to locate data that could be used to develop ecoregion-wide maps of the invasive species in this ecoregion. Species-specific data sources for terrestrial plant species were identified, but much of the data was limited in scale, quality, and number of occurrences, or not georeferenced. After a substantial amount of research, it was determined that consistent ecoregion-wide invasive species data were not available to create an ecoregional distribution map. Data source for other terrestrial and aquatic invasives (e.g., didymo, mudsnail) was also significantly limited in coverage across the ecoregion and therefore evaluation of other types of invasives as part of this CA was not conducted.

Due to the lack of data and existing ecoregion-wide models, the current status of invasives within the ecoregion was addressed by focusing the assessment on terrestrial plant invasives through the use of bioclimatic modeling. Five bioclimatic factors were used to predict the potential distribution of ten plant species to represent areas where these invasives are most likely to be present or invade based on the combination of optimal conditions. Future threats to the ecoregion from the invasive CA were not assessed.

6.1.3.1 Current Conditions

Five bioclimatic factors (vegetation, elevation, soil factors, precipitation, and temperature) were defined to graphically represent the affinities of the ten most common terrestrial invasive species throughout the ecoregion. The bioclimatic factors were used as surrogate indicators along with the presence of roadways due to the lack of actual presence/absence data on these species in the region. The ten species selected for modeling were the most commonly reported species among the states represented in the ecoregion and included Russian knapweed, hoary cress, Diffuse knapweed, Spotted Knapweed, Canada thistle, Leafy spurge, Dalmatian toadflax, Yellow toadflax, Houndstongue, and Saltcedar (Tamarisk). The bioclimatic data for each species were obtained from the literature sources contained in the U.S. Forest Service (USFS) Fire Effects Information System (FEIS). Figure 6-2 provides an example of the combined bioclimatic factors for Spotted Knapweed. The remaining figures are included in Appendix C-3.

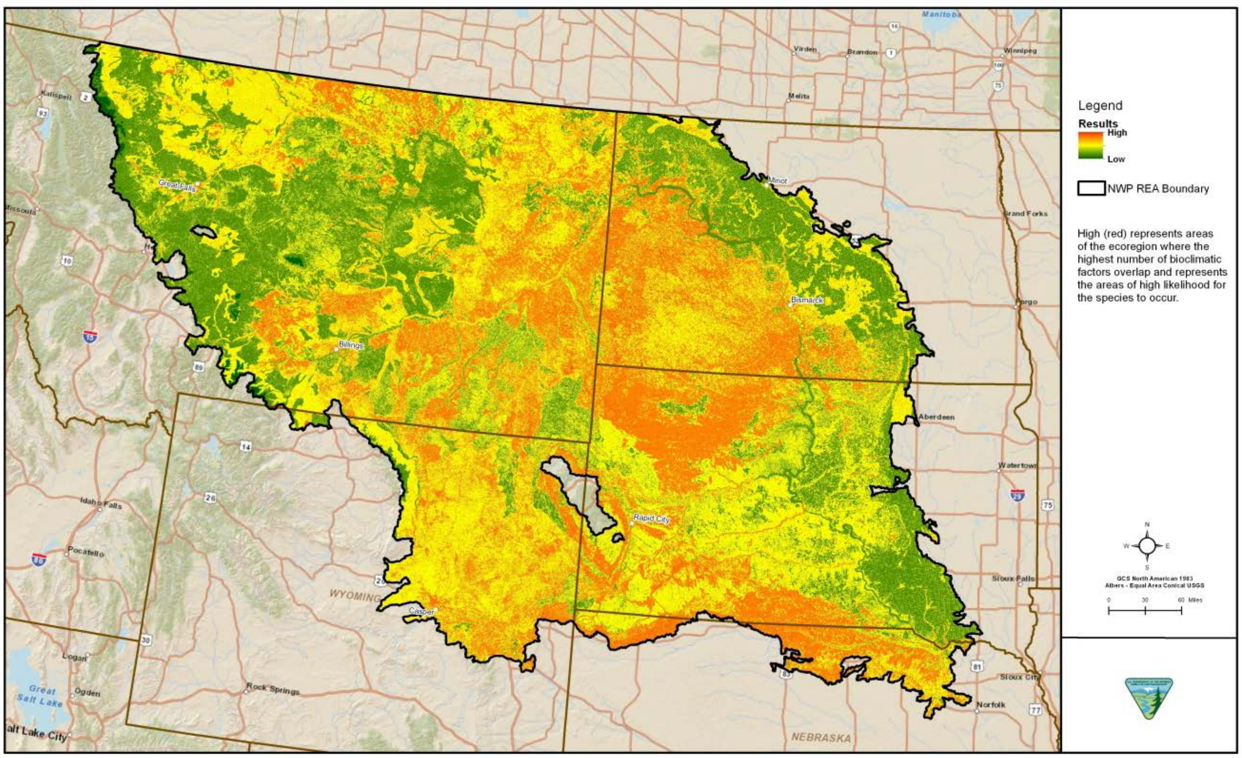


Figure 6-2. Spotted Knapweed Combined Bioclimatic Factors

Each of the ten terrestrial invasive plant species were evaluated relative to their affinities to the bioclimatic factors identified in the FEIS as being important for the propagation of each species. Many of the invasives showed the potential for wide-spread invasion throughout the ecoregion while others appear limited in their potential to spread due to the lack of appropriate bioclimatic factors in certain parts of the ecoregion (See Appendix C-3). For example, Tamarisk is an invasive species associated with riparian habitat and the bioclimatic factors did not differentiate any areas of the ecoregion as being more at risk than others. In addition, Canada thistle also appears to have the potential to spread throughout the ecoregion. However, annual precipitation appears to limit the extent of diffuse knapweed in the southeastern portion of the ecoregion. As noted, some of the species are more generalists and have the potential for wide-spread invasion while others may be limited to the areas noted in Table C-3-3.

The resulting effort to identify current CA conditions within the ecoregion using bioclimatic approach was problematic. For many of the selected species (e.g., diffuse knapweed, Canada thistle), the range of values for the specific bioclimatic values taken from the literature was often too great and therefore, encompassed most of the ecoregion. 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. Additionally, it was difficult to evaluate the impacts of this CA on the coarse-filter CEs since many of the invasives were documented to occur in a variety of ecosystems. Instead of a species approach to evaluating this CA, an ecosystem approach utilizing bioclimatic factors of a few, highly aggressive, species may improve the analysis. However, attempting to evaluate this CA using bioclimatic factors only may still prove difficult to answer the MQs for this CA. The USFWS (2009) notes that researchers have attempted to identify general site attributes and conditions that make some ecological communities more susceptible to invasion than others (Stohlgren et al. 2002; Endress et al. 2006) however, these studies depend on accompanying invasive species point occurrence data to develop predictor models.

Future studies that provide point occurrence data along with bioclimatic factors could be used with spatial models to estimate the actual and potential distribution of non-native species richness, cover, and the probability of occurrence. These models could also provide an indication of how environmental variables contribute to these distributions, and can also be useful for directing control and assessing impact to natural resource assets and management objectives (Barnett et al. 2006).

6.1.3.2 Future Conditions in the Ecoregion

Future threats to the ecoregion from the invasive CA were not assessed because of lack of existing invasive data. Additional data on invasive species distribution is necessary to evaluate the potential current and future impacts of this CA on the key resources of the ecoregion. However, the existing data collection efforts are probably biased based on weed control program priorities or the accessibility of an area which likely leaves a considerable portion of the ecosystems and ecoregion unsampled (Barnett et al. 2006, Barnett et al. 2007). It is recommended that future invasive species data collection efforts be designed to cover more of the landscape and include randomly distributed points to improve representativeness of habitats across the ecoregion. This effort may require that the scope and scale of an invasive species assessment be conducted in phases by focusing on a particular ecosystem and a few highly aggressive invasive species.

6.1.4 Insect Outbreak and Disease

Insect outbreaks and disease have the potential to substantially affect, not only the CEs, but many other resources throughout this ecoregion. Insect outbreaks and diseases are very difficult and costly to track but recent efforts have provided valuable insight to the spread of this CA.

Animal diseases such as sylvatic plague, canine distemper, chronic wasting disease, and West Nile virus have had, and continue to have the potential to exert severe effects on populations of species such as prairie dogs, black-footed ferrets, important game ungulates, swift fox, and a wide variety of birds, including GRSG.

A wide variety of insect outbreaks occur throughout this ecoregion. Pests, such as mountain pine beetle and emerald ash borer, and exotic diseases, such as White Pine Blister Rust, have the potential to spread through portions of the ecoregion, causing severe ecological damage to woodland and forest ecosystems. Because of the lack of data, forest insects were the only components of this CA that could be evaluated using existing GIS data. Overall, there is a general lack of data for diseases (West Nile virus, chronic wasting disease, and sylvatic plague). The current status analysis of the forests relative to the risk of the forest insects returned good results across the ecoregion. Appendix C-4 describes the insect outbreaks and disease analysis that was completed for the Northwestern Plains ecoregion.

6.1.5 Climate Change

Appendix C-5 presents the results of the climate change analysis for this ecoregion. The analysis is presented as a series of figures for each time period analyzed which consists of three subfigures generated using the RegCM3 15-km pixel regional climate change model data. The three subfigures that are included in each figure call-out depict the:

1. Current or baseline period (1980 to 1999),
2. Predicted future climate period, (2050 to 2069) and,
3. Predicted change (delta output).

The figures for the RegCM3 current period for precipitation and temperature (Figure C-5-1 and Figure C-5-7) were visually compared to the PRISM climate maps for the 1971 to 2000 period. RegCM3 appears to produce patterns similar to the PRISM maps across the ecoregion. However, the patterns depicted in the figures generated using the RegCM3 appeared to be shifted approximately 30 km to the southeast for the Northwestern Plains ecoregion.

6.1.5.1 Precipitation Current Status

The general precipitation pattern is presented on Figure C-5-1. The general annual average precipitation pattern for the Northwestern Plains ecoregion is a trend of increasing precipitation from the northwest to the southeast (Figure 6-3). This trend is not present in the November to February period and is less apparent during the warm rainy season in May and June. The Powder River Basin southwest of the Black Hills is another exception as it is relatively drier than the southeastern area of the ecoregion.

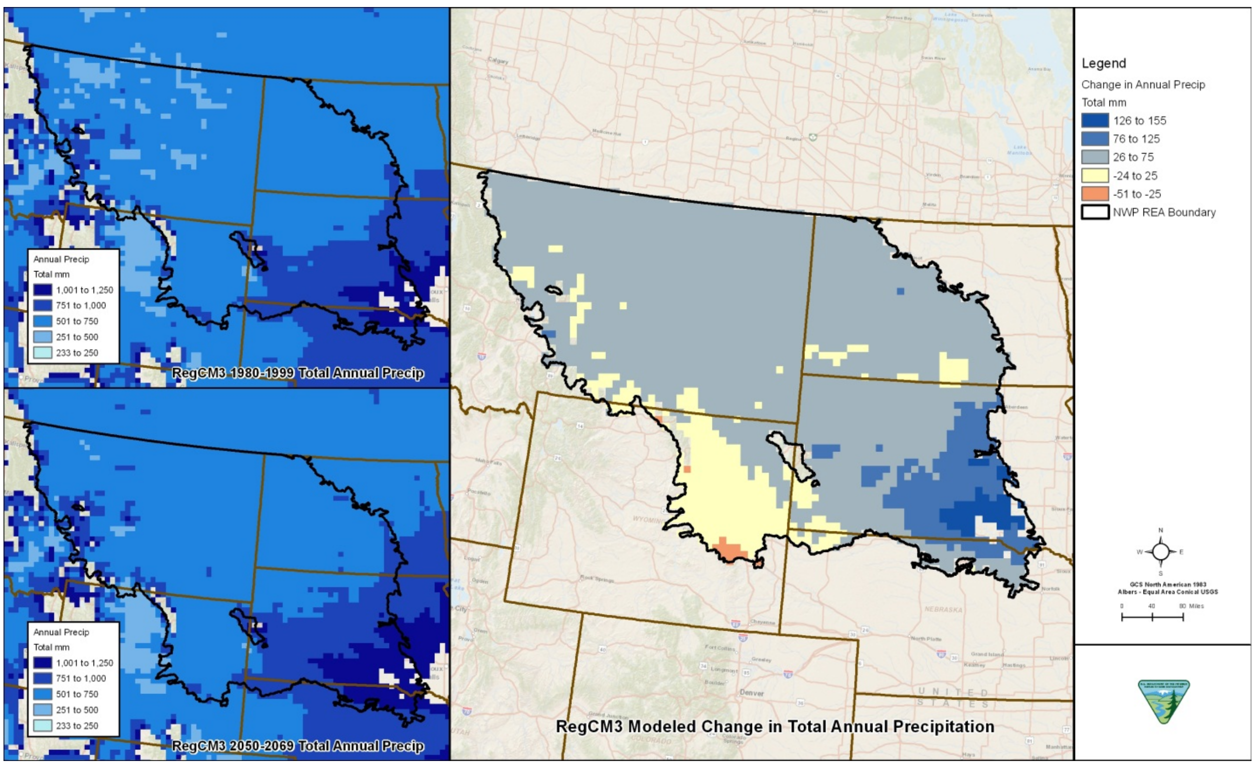


Figure 6-3. Current (1980-1999) and Future (2050-2069) Total Annual Precipitation

6.1.5.2 Precipitation Future Model

In general, the RegCM3 model for the annual precipitation data (Figure 6-3) indicates the general total annual precipitation trend for the Power River Basin to remain unchanged. The data show a large annual precipitation increase in the southeastern area of the ecoregion, and a moderate increase across the rest of the ecoregion. For the March and April timeframe, the model indicates that precipitation across the ecoregion could increase slight to moderately (Figure C-5-2). In May and June, the model indicate that precipitation could slightly increase along the western border of the ecoregion, potentially decrease slightly in western North Dakota, and potentially moderately increase in southern South Dakota and Nebraska (Figure C-5-3).

In July and August, the model indicates that precipitation could decrease moderately in the Power River Basin and in southern South Dakota and Nebraska. The areas of northwestern Montana, northeastern Montana, and northern North Dakota could receive slightly more precipitation (Figure C-5-4).

During September and October, the output presented on Figure C-5-5 indicates that, in general, the southeast area of the Northwestern Plains could be moderately wetter, the area along the border of the Dakotas to also be moderately wetter, and the rest of the ecoregion to be relatively unchanged.

During November to February, the model indicates shows a slight to moderate increase in precipitation along the southern and eastern borders of the Northwestern Plains and a slight decrease along the western border. Data for the remainder of the ecoregion show precipitation generally remaining unchanged (Figure C-5-6).

6.1.5.3 Temperature Current Status

The mean annual temperature for existing climate pattern in the Northwestern Plains is presented on Figure 6-4. The climate change model indicates that the southeastern corner of the Northwestern Plains could be is generally warmer than the rest of the ecoregion. The model shows an exception as an area in south central Montana that is slightly warmer than the surrounding areas during the November to February season.

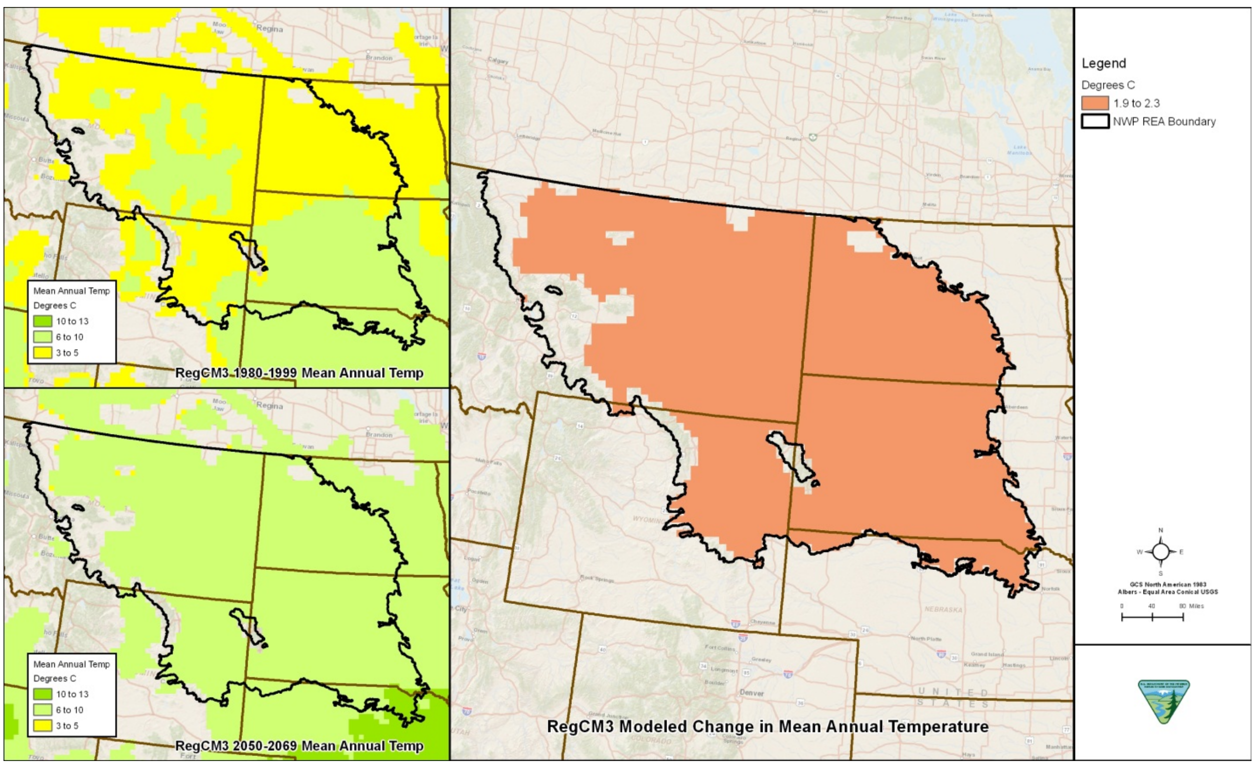


Figure 6-4. Current (1980-1999) and Future (2050-2069) Mean Annual Temperatures

6.1.5.4 Temperature Future Model

As presented on Figure 6-4, the RegCM3 data show that the Northwestern Plains could experience a temperature increase between 1.9 to 2.3 degrees Celsius (°C).

During the March and April timeframes across the Northwestern Plains, the model results predict a potential increase between 1.1 to 3°C except for the areas adjacent to mountains where the model projects that temperature will remain unchanged (Figure C-5-8.).

During May and June, the model predicts that most of the Northwestern Plains could experience a slight increase in temperature while areas along the western and southern borders could increase between 1.1 to 2.3°C. These increases are small but they could have a significant effect on evapotranspiration rates in the relatively dry Powder River Basin (Figure C-5-9).

The model projects that future temperature patterns for July and August across most of the Northwestern Plains could increase between 1.1 to 2.3°C (Figure C-5-10). Areas of the Powder River Basin and the southeastern corner of the ecoregion could increase between 3.1 to 4.2°C. As mentioned, these temperature increases could have a significant effect evapotranspiration rates in the Powder River Basin and reduce the water content of dead vegetation and litter. Both conditions would likely increase water stress in plants and provide more flammable materials for wildfires.

The RegCM3 data for September to October indicate that temperatures across the ecoregion could increase between 1.1 to 3.1 °C, except for the areas adjacent to mountains where the model predicts that temperature could remain unchanged (Figure C-5-11).

For the November to February timeframe, the model indicates that temperatures across the Northwestern Plains could increase between 1.1 to 3°C except for a broad diagonal band from northern Montana to South Dakota where the model shows the temperature increasing between 3.1 to 5.4 °C. This is a very significant change as the actual mean temperature for the northern diagonal band could increase from below zero to zero degrees Celsius, likely resulting in more frequent freeze thaw cycles. (Figure C-5-12).

6.2 CONSERVATION ELEMENTS

The individual KEA analysis provides the basis for the compilation of an overarching data layer that defines the current status of the CE for each HUC across this ecoregion. Future spatial data for development were limited to potential energy development, modeled urban growth, and potential agricultural development as discussed in the development CA analysis presented in Appendix C-1.

Climate change models are highly variable and often difficult to predict. For this REA, the resolution of the spatial data is an important factor to consider. Because of the 15-km resolution of the model, the discussions regarding potential future conditions for each CEs based on climate change are limited to very broad qualitative statements.

6.2.1 Coarse-Filter Conservation Elements

6.2.1.1 Evergreen Forest

The evergreen forest woodlands vegetation system encompasses approximately 3.5 percent of the Northwestern Plains ecoregion. The evergreen forest woodland category is composed of the following GAP Level 3 systems: Northwestern Great Plains - Black Hills Ponderosa Pine Woodland and Savannah, Northern Rocky Mountain Ponderosa Pine Woodland and Savanna, Southern Rocky Mountain Ponderosa Pine Woodland, and Rocky Mountain Foothill Limber Pine - Juniper Woodland. The analysis completed for the evergreen forest woodland is presented in Appendix D-1.

6.2.1.1.1 Current Status in the Ecoregion

Figure 6-5 presents the distribution map for the evergreen forest, which was used to conduct the CA analyses. The results of the current status analysis for the evergreen forest are presented on Figure 6-6.

The results of the current status analysis based on the 6th level HUC for the ecoregion are presented on Figure D-1-8. The overall current status results indicate predominately good to fair scores across the range of evergreen forest woodlands within this ecoregion. Areas that appear most susceptible to current threats occur in the southern portion of the Black Hills and the areas near the Bitterroot Mountains. The overall status of evergreen forest woodlands is also characterized by distribution rather than by HUC on Figure D-1-7. This provides a detailed look at the threat scores on a cell by cell basis. The results of this detailed analysis indicate similar results to those of the HUC level analysis. The results of the VCC

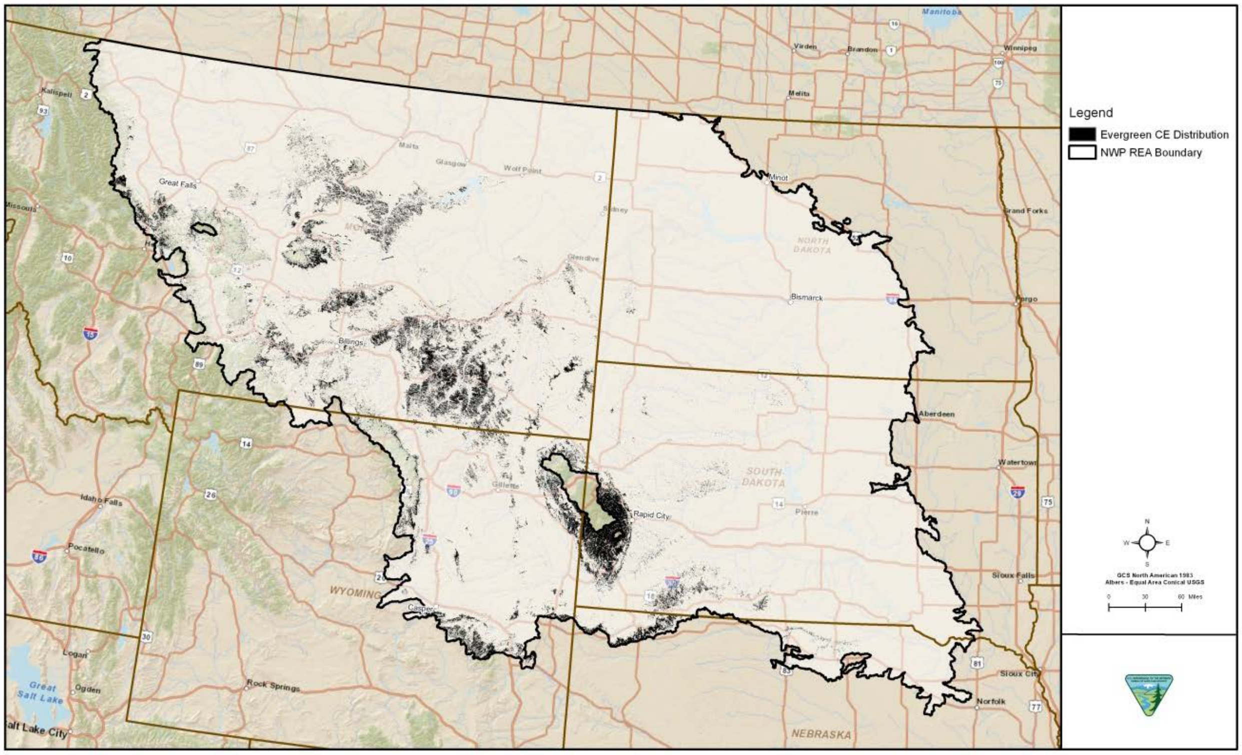


Figure 6-5. Evergreen Forest Distribution in the Northwestern Plains

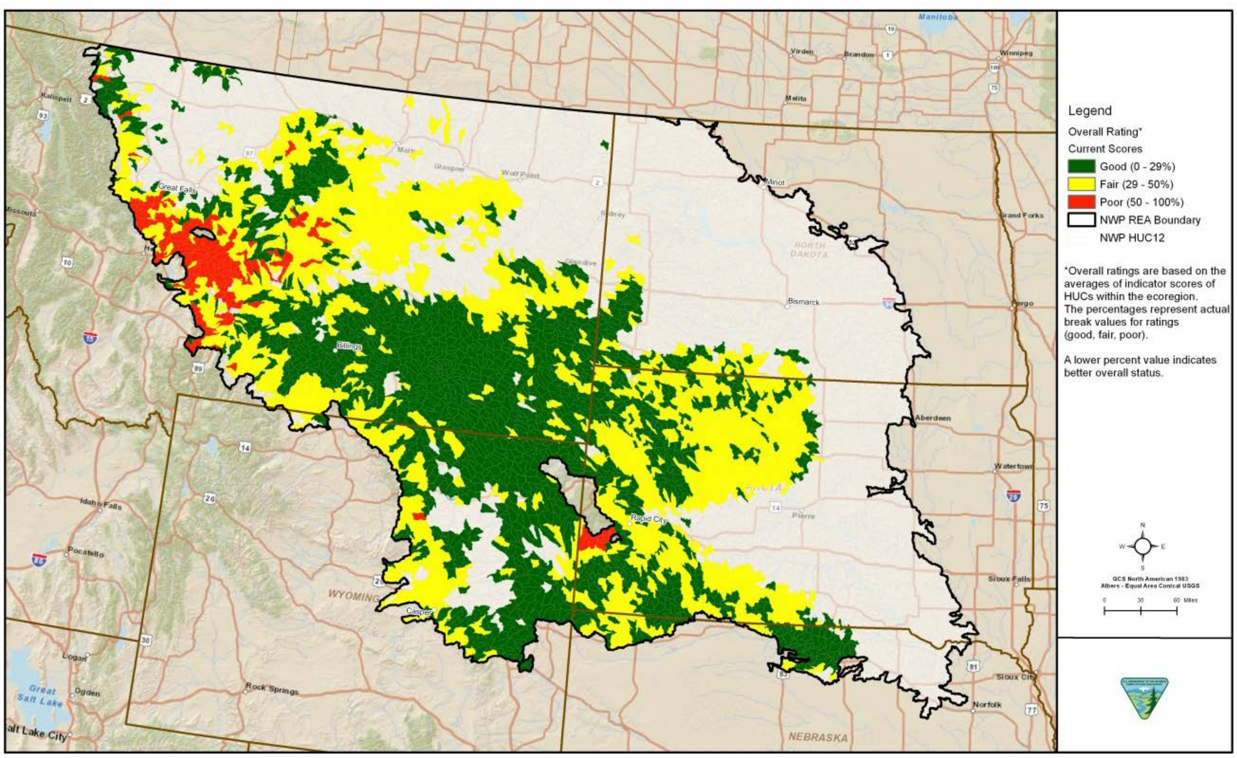


Figure 6-6. Evergreen Forest Overall Current Status in the Northwestern Plains

analysis (Figure D-1-3) suggest that these same areas have undergone a partial departure from natural forest ecosystems, as indicated by a fair score. Evergreen forests within the central portion of Montana appear more susceptible to this departure. Figure D-1-4 illustrates the effects of Mountain Pine Beetle on evergreen forests within the ecoregion. Other beetle infestations are limited to the Black Hills region (Figure D-1-5). Beetle infestations appear to be centralized around the same areas as the other threats. Western Spruce Budworm infestation appear limited to the Bitterroot Mountains with other small evergreen forest stands experiencing significant levels of infestation in southwestern Montana. However, these areas (Figure 3-1) only occur in the buffer area of this ecoregion and are actually in the Middle Rockies ecoregion.

6.2.1.1.2 Future Conditions in the Ecoregion

Development

The ecoregion-wide future threat analysis was conducted as presented in Appendix C-1. The results of the fragmentation potential analysis (Figure D-1-9) indicate a fairly high potential of future fragmentation resulting from proximity to roads and urban areas. Southern areas of the Black Hills show up as being at higher risk for fragmentation. Though many of these areas are located in a national forest and are protected, it could be used to highlight areas of declining connectivity and a reduction in forest interior. There are many definitions of forest interior because the amount of forest interior habitat needed varies for different species. However generally it refers to large tracts of continuous forest cover. Fragmentation diminishes habitat for interior forest dwelling species, In general, habitat quality declines in response to the size of the forest patch.

For the broad CA assessment, future development was limited to potential energy development and climate change as this coarse filter appears to be at low risk from the threats from modeled urban growth and agriculture based on the modeled growth for the ecoregion (Figure C-1-8) and potential agricultural development in forested areas.

Most of the evergreen forest woodlands in the ecoregion will likely remain unaffected by fossil fuels production in the Northwestern Plains. The majority of the evergreen forests in this ecoregion are considered to be at a low risk with regard to the threat of renewable energy production.

Insect Outbreak and Disease

The overall future threat map indicates predominately fair to poor habitat conditions based on potential development and insect outbreaks in middle portions of the Northwestern Great Plains for the evergreen forest woodlands. Areas in the north central portion of the ecoregion also scored poor. However, areas to the north of the Black Hills and areas in the northwest of the ecoregion scored good. It should be noted that the majority of these areas fall in the 5th level HUC ecoregion buffer and in actuality, occur in the Middle Rockies ecoregion.

The insect proximity analysis (Figure D-1-10) indicates that forests in the central and northwest portions of the ecoregion at higher risk for insect infestation. Areas around the Black Hills are scored good and fair future risk of infestation. Based on recent insect outbreaks and the predicted increase in temperatures, it is likely that the continued trend of severe bark beetle outbreaks will occur.

Climate Change

Increasing temperatures due to climate change allow more time for the MBP to complete its life cycle which allow populations to grow more quickly than in the past (Bentz et al. 2008). Increases in the mean annual temperature in this ecoregion are predicted to range from 1.9 to 2.4^{0}C. The threshold for temperature for the shift to univoltine to outbreak multivoltine life cycles is 3^{0}C. The temperature data output indicates that the high elevation southern ranges could experience the greatest increases in temperature. The SWE data indicate substantial decrease of SWE in these same ranges which would result in less soil moisture during the growing season resulting in increased tree water stress and increased susceptibility to mountain pine beetle outbreaks.

Based on the current trends of increased outbreaks associated with increased temperatures, it is assumed there will be a higher population of MPB in the evergreen forest woodland and thus also likely increasing mortality.

In addition, the climate change model for predicted precipitation change to 2060 indicate changes ranging from an increase to 99 mm to a decrease in to 75 mm. This minimal change coupled with the predicted increase in temperatures and altered fire regimes could result in more frequent and severe fires.

6.2.1.2 Deciduous Forest and Woodland

The deciduous forest and woodland vegetation system encompasses less than one half (0.47) percent of the Northwestern Plains ecoregion. The deciduous forest and woodland category is composed of the following GAP Level 3 systems: Rocky Mountain Aspen Forest and Woodland, Western Great Plains Dry Bur Oak Forest and Woodland and Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland. The analysis completed for the deciduous woodland is presented in Appendix D-2.

6.2.1.2.1 Current Conditions in the Ecoregion

Figure 6-7 presents the distribution map for the deciduous forest and woodland, which was used to conduct the CA analyses. The results of the current status analysis for the deciduous forest and woodland are presented on Figure 6-8.

The results of the current status analysis based on the 6th level HUC for the ecoregion are presented on Figure D-2-6. The deciduous forests of the national forests, those in Nebraska, those around the Black Hills, and those along the western border of this ecoregion generally returned good results for the overall current status analysis. The deciduous forests in North Dakota generally returned poor results for the overall current status analysis, primarily due to fragmentation.

6.2.1.2.2 Future Conditions in the Ecoregion

Development

Future threat analysis for development was limited to potential energy development as threats from modeled urban growth and potential agricultural development are not anticipated to affect this coarse-filter CE.

With the exception of areas in northeastern Wyoming, northwestern North Dakota, and northeastern Montana, the majority of the deciduous forests are at a moderate risk to the potential for fossil fuel development. The majority of the deciduous forests in the Northwestern Plains ecoregion are considered to be at low risk with regard to the threat of renewable energy production.

Climate Change

Based on the analysis conducted for the ecoregion as presented in Appendix C-5, temperature and precipitation changes appear to be minor in the deciduous forest areas of the Northwestern Plains. The Sudden Aspen Decline (SAD) has been linked to drought and therefore stands located at lower elevations and on south/southwest facing aspects with localized higher temperatures are the most susceptible (USFS 2009).

6.2.1.3 Grasslands

The grassland vegetation system encompasses nearly 40 percent of the Northwestern Plains ecoregion. The Northwestern Great Plains Mixedgrass Prairie, Western Great Plains Sand Prairie and the Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland Level 3 systems dominate the grasslands of the Northwestern Plains ecoregion. The analysis completed for the grassland system is presented in Appendix D-3.

6.2.1.3.1 Current Status in the Ecoregion

Figure 6-9 presents the distribution map for the grasslands, which was used to conduct the CA analyses. The results of the current status analysis for the grasslands are presented on Figure 6-10.

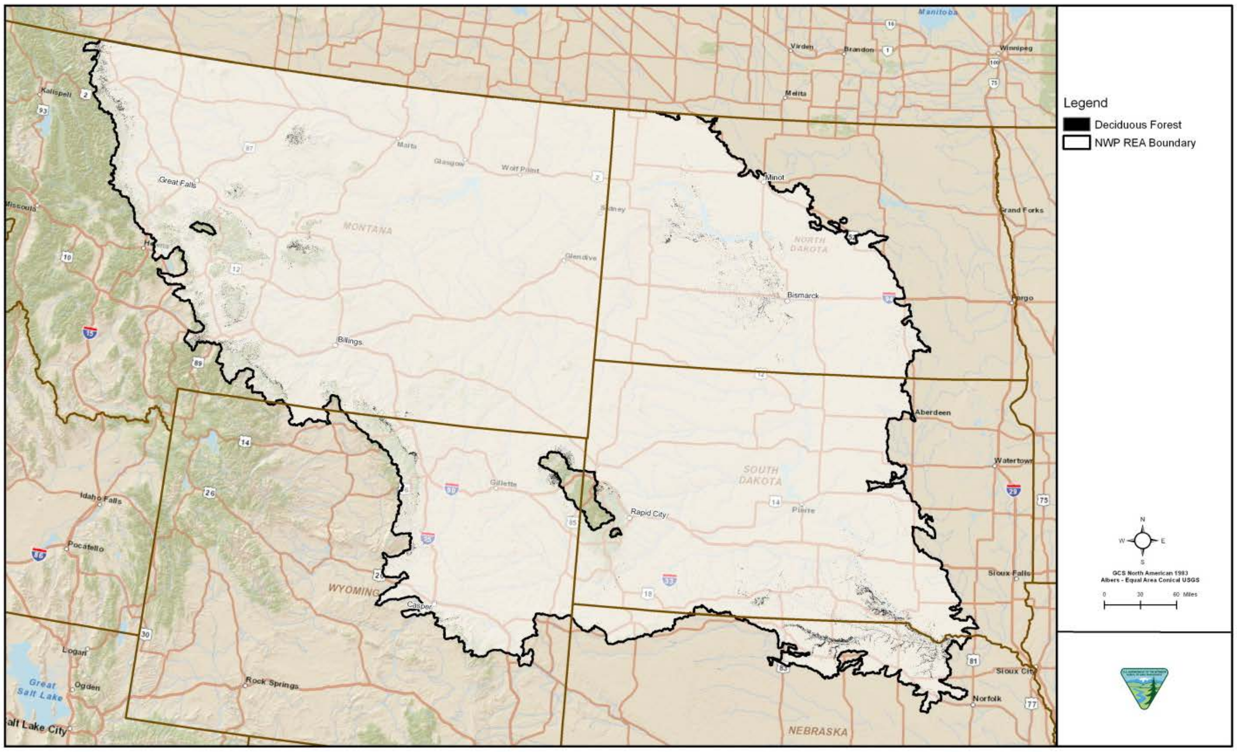


Figure 6-7. Deciduous Forest and Woodlands Distribution in the Northwestern Plains

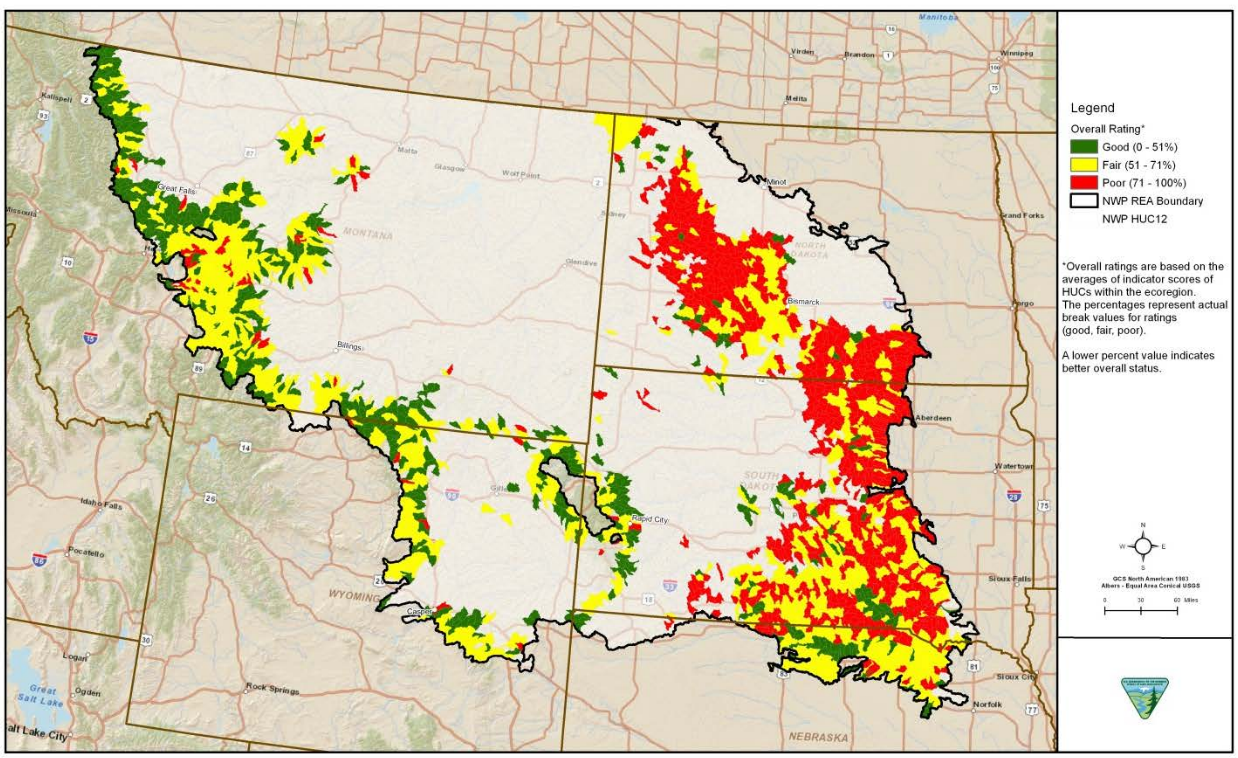


Figure 6-8. Deciduous Forest and Woodlands Overall Current Status in the Northwestern Plains

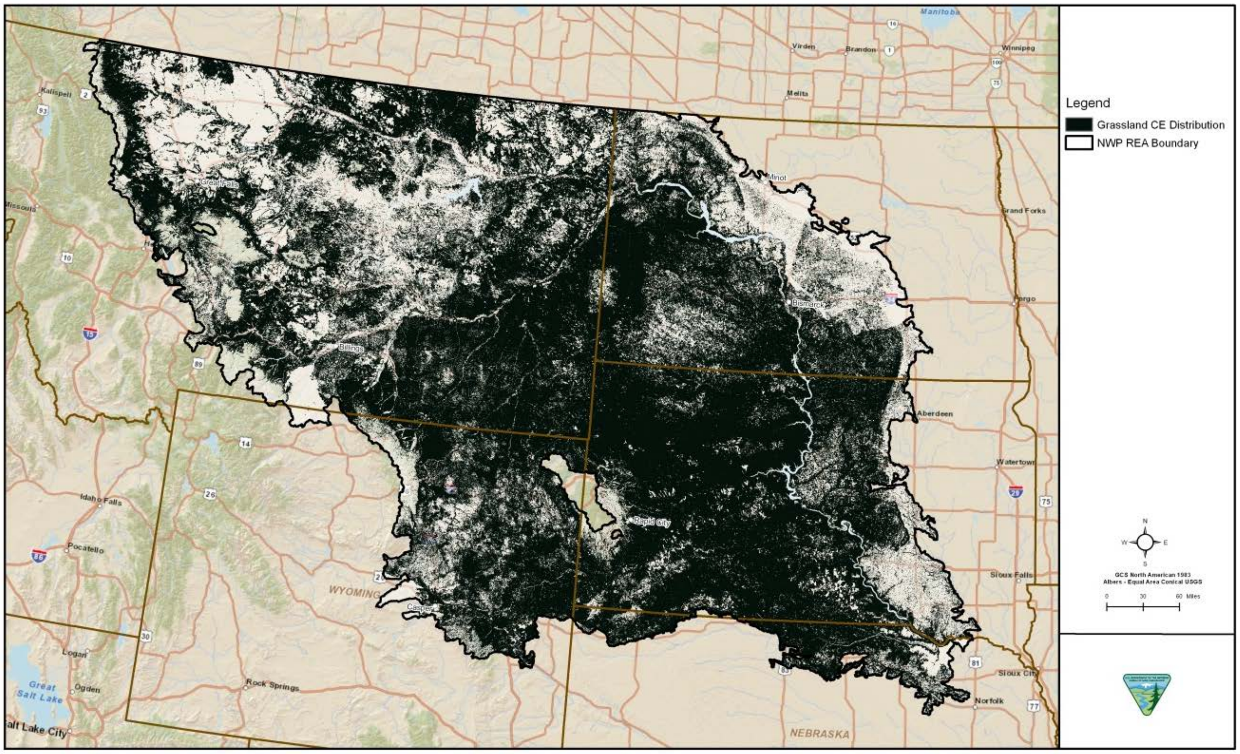


Figure 6-9. Grassland Distribution in the Northwestern Plains

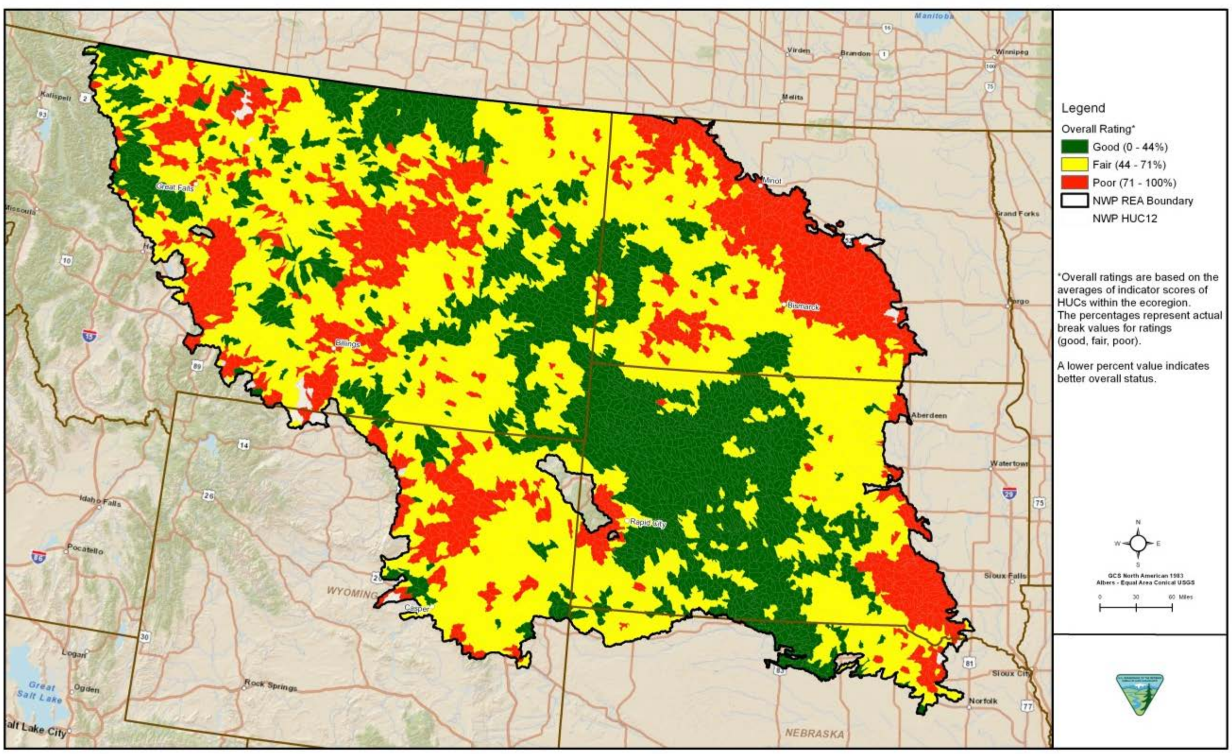


Figure 6-10. Grassland Overall Current Status in the Northwestern Plains

The results of the current status analysis based on the 6th level HUC for the ecoregion are presented on Figure D-3-8. As would be expected, the current status analysis returned good results for the largest patches of grasslands located in northwest and north central South Dakota around the areas near the Cheyenne and Standing Rock Indian Reservations and the Black Hills. The remainder of the grassland areas in this ecoregion returned fair to poor results for the overall risk to the CAs.

6.2.1.3.2 Future Conditions in the Ecoregion

Development

The conversion of grasslands to agriculture is probably the most predominant current and future CA for grasslands. Grain prices will increase commensurate with world population levels and the production of crops will need to equally increase. Figure E-3-12 shows the results of the analysis indicating the potential risk due to potential future agricultural land development. As would be expected, in the Northwestern Plains ecoregion, most of the agricultural areas (current and future) are located throughout the grasslands distribution layer. Thus, the agriculture CA presents risk to grasslands in the future.

It does not appear that urban growth needs to be considered as much of a threat to this CE as agriculture. A small area around Havre, Montana (Figure C-1-2) is expected to become developed but this does not appear to threaten grasslands on a landscape scale.

Most of the grasslands in the ecoregion will likely remain unaffected by fossil fuels production in the Northwestern Plains. The majority of potential fossil fuels production is limited to northeastern Wyoming.

Because of the intricacies involved in the assessment of renewable energy production with regard to grasslands, a limited approach must be taken in this analysis. The majority of the grasslands in the Northwestern Plains ecoregion are considered to not be at risk from future renewable energy production development. It does not appear that future solar development will negatively affect grasslands. The highest potential for solar development is shown to occur in northeast Wyoming and southeast Montana in areas outside of the grasslands distribution area.

Higher elevations within the Northwestern Plains ecoregion are more susceptible to the threat of wind turbine development due to the higher wind speed levels within these areas. However, limited accessibility to these areas could affect the development of wind turbines at higher elevations, limiting the range of wind turbine development to lower elevation mountainous regions. Although the grasslands of north central Montana do not appear to be at risk from wind turbine development, various areas of grasslands in North and South Dakota do appear to be at risk for the development of wind turbines. Although this assessment is primarily qualitative, the spatial distribution of grasslands and mid-level elevation wind turbine potential overlap is apparent. In certain areas, there is potential for negative effects on grasslands within the eastern portion of the ecoregion if wind turbine development increases in these areas.

Climate Change

Climate change presents many different issues relating to grasslands. However, it remains difficult to draw conclusions from the data presented in this REA. Climate change models are highly variable and often difficult to predict. In this case the resolution of the spatial data is an important factor to consider.

Based on the analysis conducted for the ecoregion as presented in Appendix C-5, it does not appear that temperature or precipitation changes will negatively affect the distribution of grasslands in the Northwestern Plains. However, the combined impacts of increased temperatures, localized drought, and conversion of lands to agricultural uses could negatively affect grasslands in the future.

6.2.1.4 Shrubland and Savanna

Shrubland and savanna vegetation systems encompass nearly 15 percent of the Northwestern Plains ecoregion. This coarse-filter analysis focused on one GAP Level 3 System; Inter-Mountain Basins Big Sagebrush Steppe. The analysis completed for this shrubland system is presented in Appendix D-4.

6.2.1.4.1 Current Status in the Ecoregion

Figure 6-11 presents the distribution map for the shrubland and savanna systems, which was used to conduct the CA analyses. The results of the current status analysis for the shrubland and savanna systems are presented on Figure 6-12.

The results of the current status analysis based on the 6th level HUC for the ecoregion are presented on Figure D-4-8. In general, this analysis indicates a poor current status of the majority of the shrubland savanna systems of this ecoregion. In areas where shrubland savanna systems are concentrated from the patch size analysis, the overall score predominantly returned good results. Additionally, review of the results of the overall current status analysis is interesting in that many small areas of shrub savanna in western North Dakota return poor current status scores. These very small patches of shrubland and savanna tend to skew the results of the current status analysis and make it appear worse than it actually is. This is one of the inherent problems with rolling the analysis up to the watershed level. Figure D-4-7 shows that pixel-based results provides a clearer picture into the results of the analysis as compared to illustrating the results being rolled up to an HUC level.

6.2.1.4.2 Future Conditions in the Ecoregion

<u>*Development*</u>

In the Northwestern Plains ecoregion, most of the agricultural areas (current and future) are located throughout the Missouri River Valley. Thus, the shrubland and savanna systems are at risk to agriculture in the future. Only minor portions of shrubland and savanna are currently in close proximity to urban/suburban populations and therefore urban growth is considered a low threat.

Shrubland and savanna systems within northeastern Wyoming are at the highest risk to fossil fuel development. The majority of the shrubland and savanna systems in this ecoregion are not considered to be at risk with regard to the threat of renewable energy production.

<u>*Climate Change*</u>

Modeled temperature and precipitation changes appear to be minor in the areas where shrublands occur in the Northwestern Plains. However, the combined risks of increased temperatures, localized drought and conversion of lands to agricultural uses could negatively affect shrubland and savanna systems in the future.

6.2.1.5 Sparse Vegetation

Sparse vegetation and natural barren areas encompass approximately 2 percent of the entire Northwestern Plains ecoregion, making it one of the smallest vegetation systems in the ecoregion. The coarse-filter analysis for sparse vegetation and natural barren areas focused on two GAP Level 3 systems, the Southwestern Great Plains Canyon (Badlands) and the Western Great Plains Badlands. The analysis completed for the sparse vegetation systems is presented in Appendix D-5.

6.2.1.5.1 Current Status in the Ecoregion

Figure 6-13 presents the distribution map for the sparse vegetation and natural barren areas, which was used to conduct the CA analyses. The results of the current status analysis for the sparse vegetation and natural barren areas are presented on Figure 6-14.

No KEAs were initially developed for this coarse filter. As a proxy to illustrate the potential impacts of off road vehicles, roads were used to complete a proximity analysis. The road density proximity analysis is presented on Figure D-5-3. It appears that there is a low risk associated with roadways in the sparse vegetation habitats of this ecoregion.

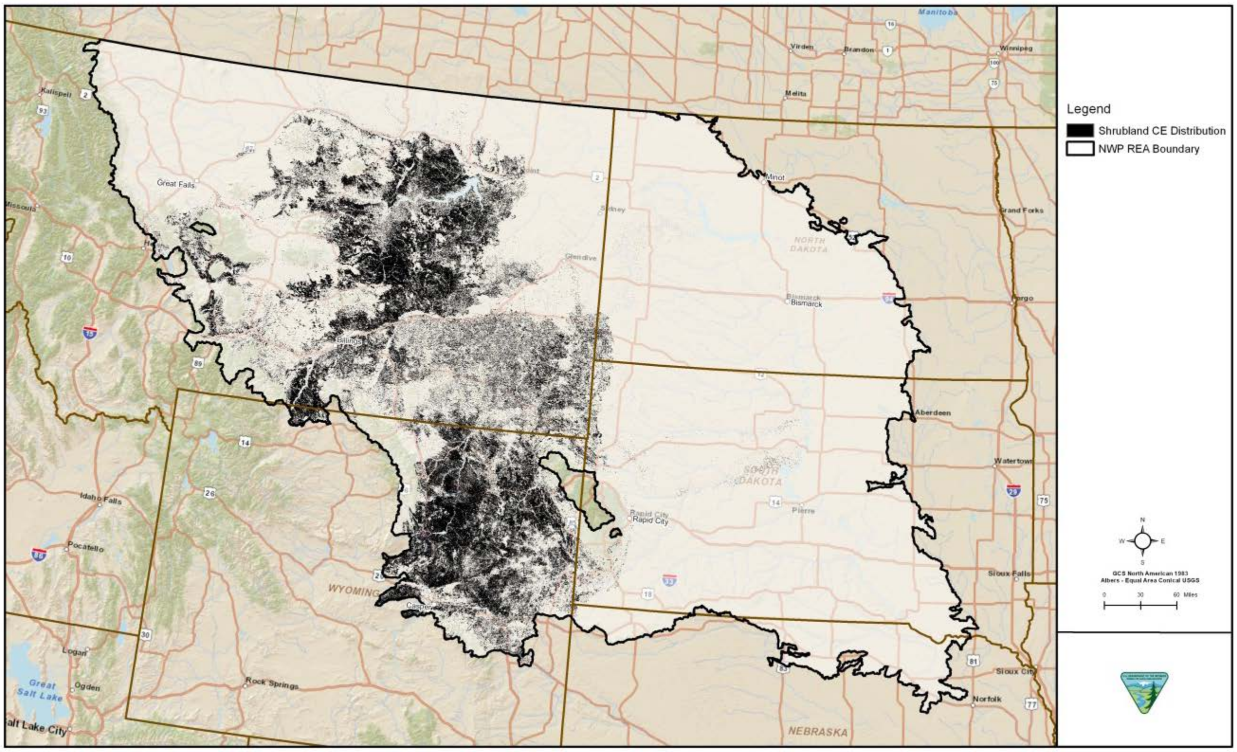


Figure 6-11. Shrubland and Savanna Distribution in the Northwestern Plains

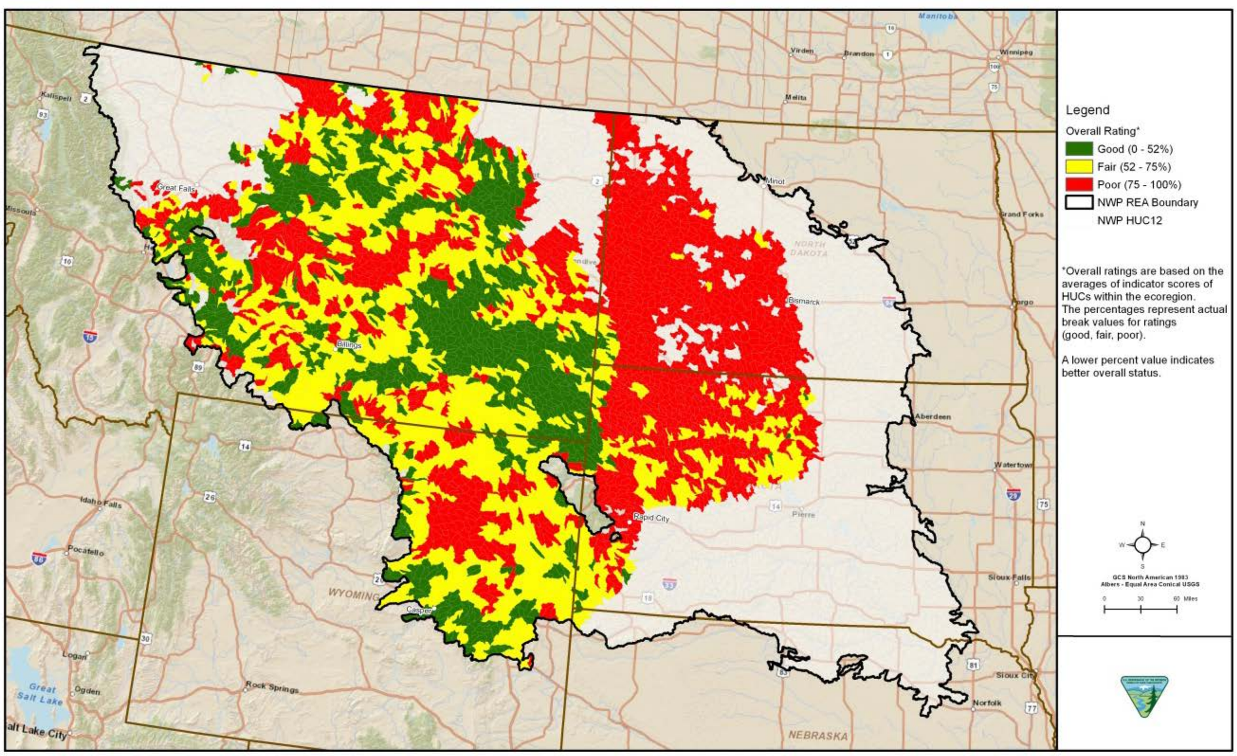


Figure 6-12. Shrubland and Savanna Overall Current Status in the Northwestern Plains

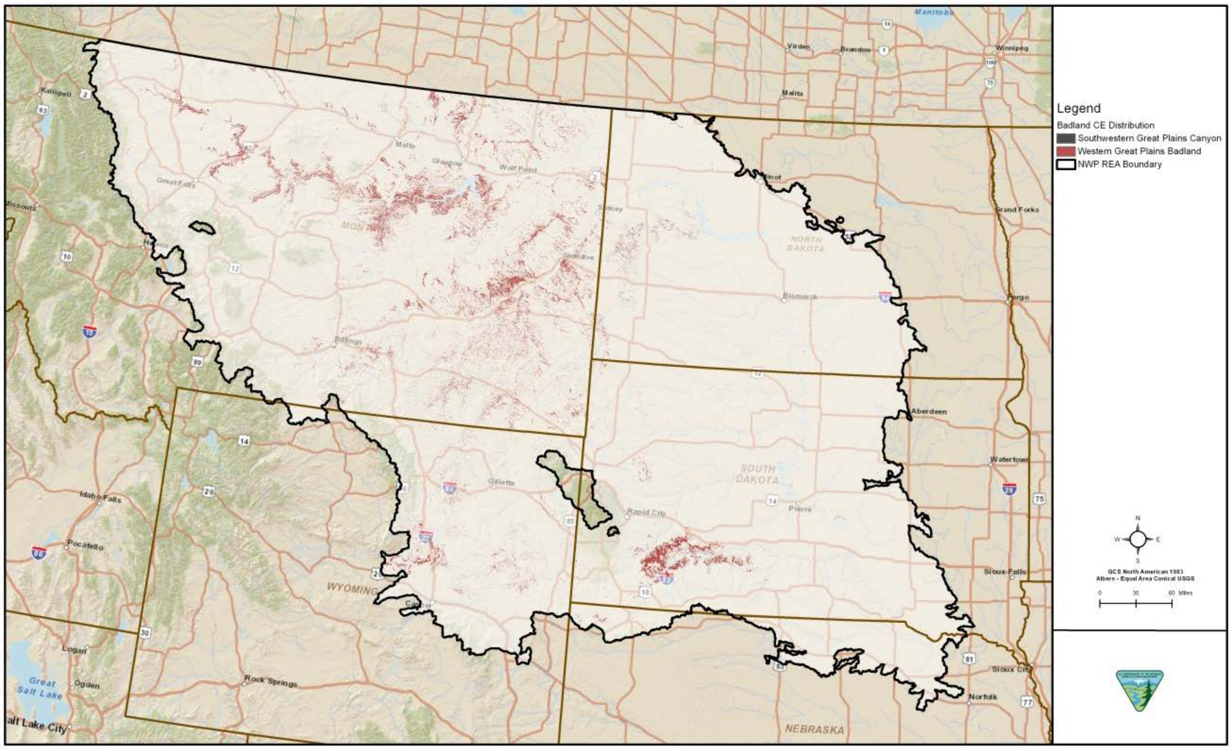


Figure 6-13. Sparse Vegetation Distribution in the Northwestern Plains

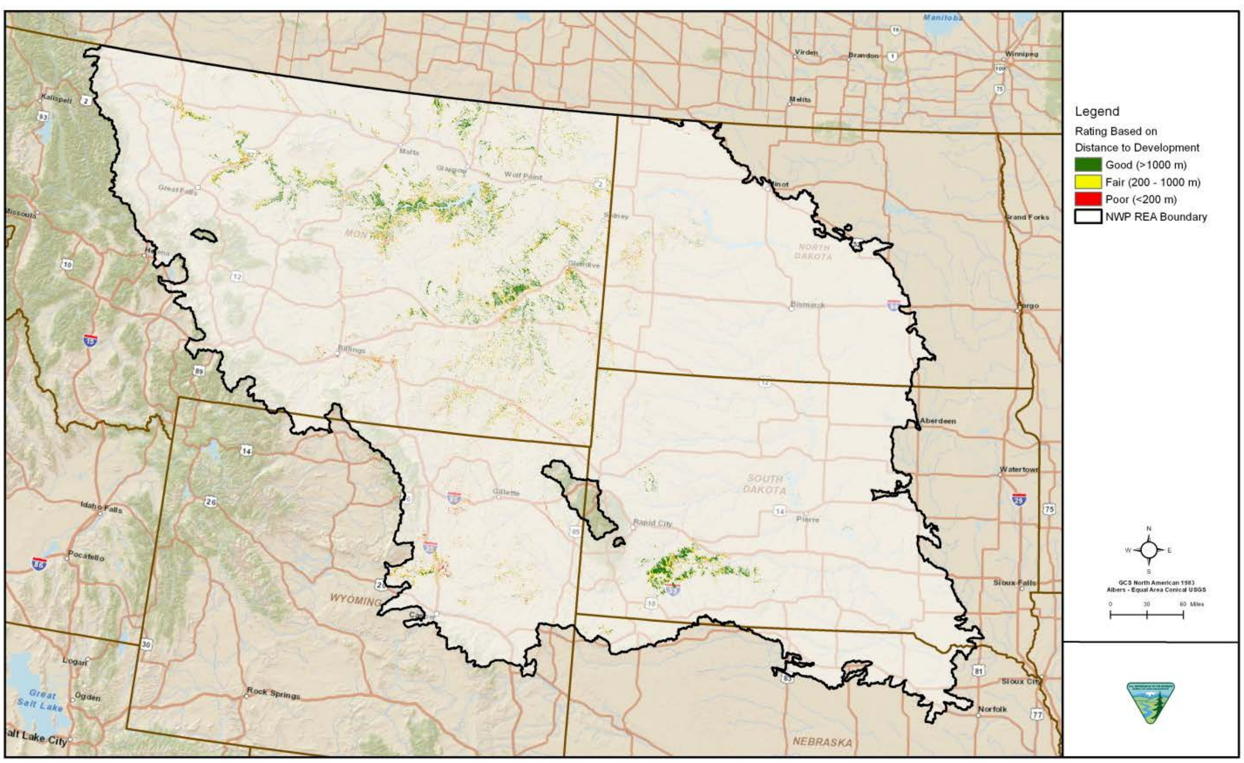


Figure 6-14. Sparse Vegetation Distance to Development in the Northwestern Plains

6.2.1.5.2 Future Conditions in the Ecoregion

Development

Future threat analysis for development was limited to potential energy development as threats from modeled urban growth and potential agricultural development are not anticipated to affect this coarse-filter CE.

From an ecoregional scale, it does not appear that sparse vegetation habitats are at risk from future oil or gas development (Figures C-1-5). The majority of potential gas production is limited to northeastern Wyoming and western North Dakota. Additionally, future renewable energy potential (Figure C-1-8) also appears to present a low risk to sparse vegetation habitats.

Climate Change

Predicted temperature increases of 1.9 to 2.3^{o}C may result in more extreme environmental conditions including temperature increases, which could accelerate erosion processes and restrict vegetation growth or recovery.

6.2.1.6 Riparian Forest Woodlands

The riparian forest woodland vegetation system encompasses approximately 3 percent of the Northwestern Plains ecoregion. The Northwestern Plains riparian coarse filter is mainly comprised of deciduous forest woodland areas along streams and rivers, but also includes shrublands and flats throughout the ecoregion. The riparian forest woodland category was composed of the following GAP Level 3 systems: Western Great Plains Wooded Draw and Ravine, Western Great Plains Floodplains, Northwestern Great Plains Riparian, Western Great Plains Riparian Woodland and Shrubland and Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland. The analysis completed for the riparian system is presented in Appendix D-6.

6.2.1.6.1 Current Status in the Ecoregion

Figure 6-15 presents the distribution map for the riparian forest woodlands, which was used to conduct the CA analyses. The results of the current status analysis for the riparian forest woodlands are presented on Figure 6-16.

The analysis of the current status for the riparian forest is presented on Figure C-6-5. Based on the KEAs selected for this analysis, most of the riparian forest and woodlands found in the ecoregion is located in areas with greater than 60 percent of the riparian corridor in agricultural use. The output from this KEA also indicates that most of the riparian areas within the watersheds of agricultural areas are some of the most fragmented areas in the ecoregion. Urban land use represented by percentage of impervious cover was not found to be a substantial risk for this CE.

6.2.1.6.2 Future Conditions in the Ecoregion

Development

The future threat analysis considered the maximum potential for future agricultural use within this ecoregion based on presence of soils suitable for agricultural use. Most of the land located throughout the Missouri River valley has been converted to agriculture, and so the impact to riparian forests in the Missouri River valley is anticipated to be minimal. However, there are large areas of riparian forests located along the other major tributaries in this ecoregion that have the same soil types and could be at a future risk of conversion to agriculture.

A fossil fuel energy output layer was created to address the management questions associated with future fossil fuels production (Figure C-1-5). With the exception of areas in northeastern Wyoming, northwestern North Dakota, and northeastern Montana, the majority of the riparian areas do not appear to be at a high risk to fossil fuel development.

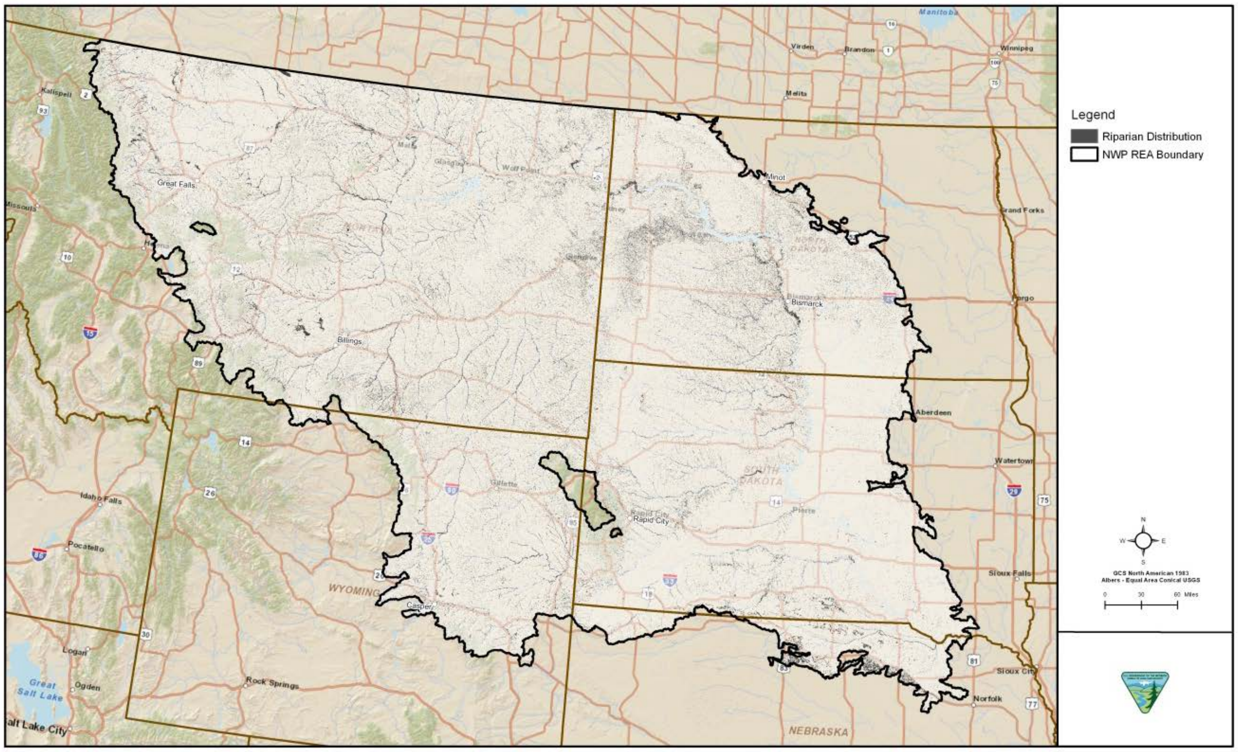


Figure 6-15. Riparian Forest Woodlands Distribution in the Northwestern Plains

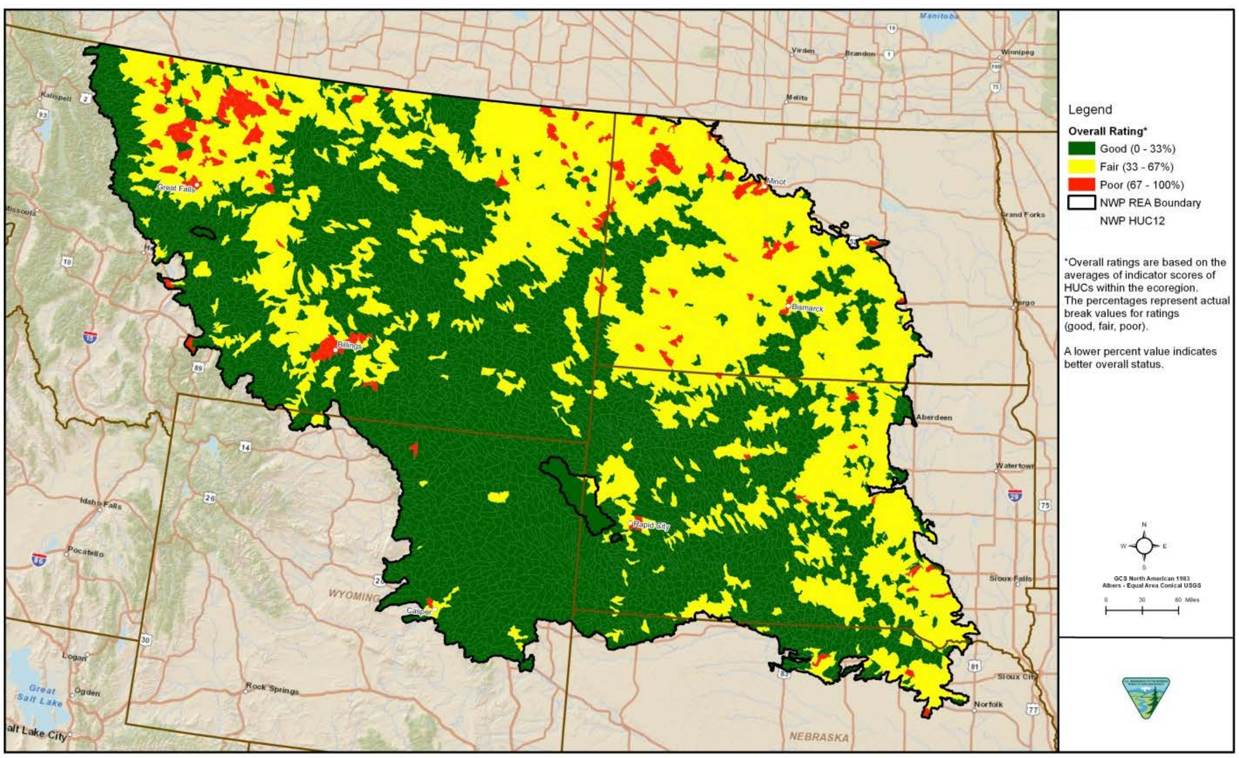


Figure 6-16. Riparian Forest Woodlands Overall Current Status in the Northwestern Plains

A renewable energy output layer was created to address the management questions associated with future renewable energy production (Figure C-1-8). There are numerous factors that are involved in the determination to construct renewable energy facilities. These include the price of oil, government incentives, etc. Therefore, a limited approach must be taken in this analysis. The majority of the riparian areas in the Northwestern Plains ecoregion do not appear to be at a high risk of development from renewable energy production.

Climate Change

Climate change presents many different issues relating to riparian areas. However, it remains difficult to draw conclusions from the data as presented in this REA. Climate change models are highly variable and often difficult to understand. In this case, the resolution of the spatial data was an important factor.

Spring temperatures and precipitation levels are the factors that would most likely threaten the vegetation of riparian areas. Riparian habitats may become stressed under the combined impacts of increased temperatures, localized drought and conversion of lands to agricultural uses in the future.

6.2.2 Fine-Filter Conservation Elements

The individual KEA analyses provide the basis for the compilation of an overarching data layer that defines the current status of habitat for each of the CEs and HUCs across the ecoregion and attempts to assess the current impacts from CAs. In most cases, the current landscape status analysis evaluated the development and wildfire CA.

Future spatial data for development were limited to the potential for energy development, modeled urban growth, and potential agricultural development as discussed in the development CA analysis presented in Appendix C-1. Future climate change was analyzed in a qualitative manner for each CE.

6.2.2.1 Mule Deer

Over the past century, mule deer (*Odocoileus hemionus*) populations throughout their range have fluctuated widely; however, recent trends indicate that populations are declining throughout the West. Much of this decline can be attributed to direct habitat loss (mainly winter range), a loss of browse species and deteriorating forage base, and weather extremes including large-scale droughts and severe winters (Heffelfinger and Messmer 2003). Mule deer were included as a fine-filter CE to ensure that crucial winter range and parturition areas were evaluated as part of the REA process. The analysis completed for the mule deer is presented in Appendix E-1.

6.2.2.1.1 Current Status in the Ecoregion

Figure 6-17 presents the distribution map for the mule deer, which was used to conduct the CA analyses. The results of the current status analysis for the mule deer are presented on Figure 6-18.

The core habitat patch model (Figure E-1-4) indicates that the poorest density of mule deer habitat occurs throughout the northeastern boundary of the ecoregion as well as some smaller clusters of in the southeast and southwest. The overall current status analysis indicates that mule deer habitat is primarily at risk from roads (Figure E-1-6) in the northeast and southeast, and existing oil and gas wells in the southwest (Figure E-1-7).

6.2.2.1.2 Future Conditions in the Ecoregion

Development

The future threats to the mule deer from development are most notable in the southwestern portion of the ecoregion. Future agricultural development (Figure C-1-1) activities in the southwestern portion of the ecoregion may impact mule deer through loss of habitat, especially in potential migration corridors. However, agricultural activities can also benefit mule deer. The southwestern portion of the ecoregion is also a critical area for future oil and gas potential, as well as having the highest potential for solar energy development (Figures C-1-3 through C-1-8).

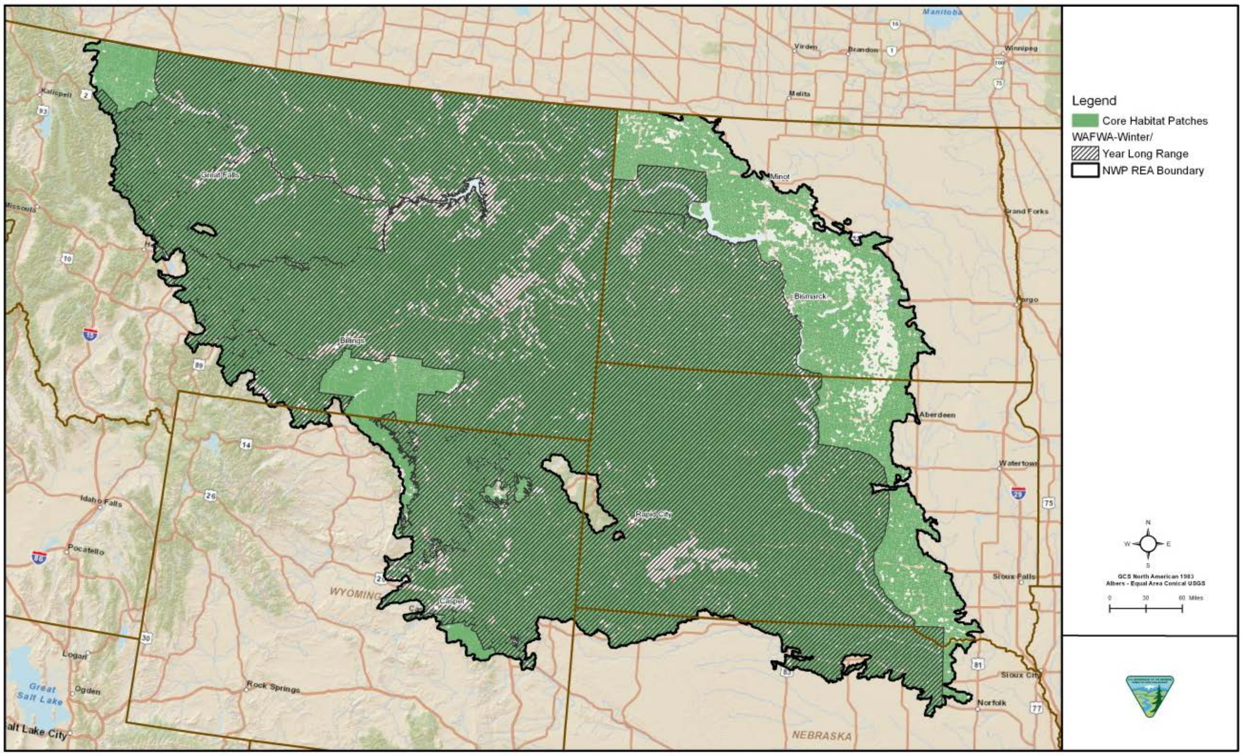


Figure 6-17. Mule Deer Distribution in the Northwestern Plains

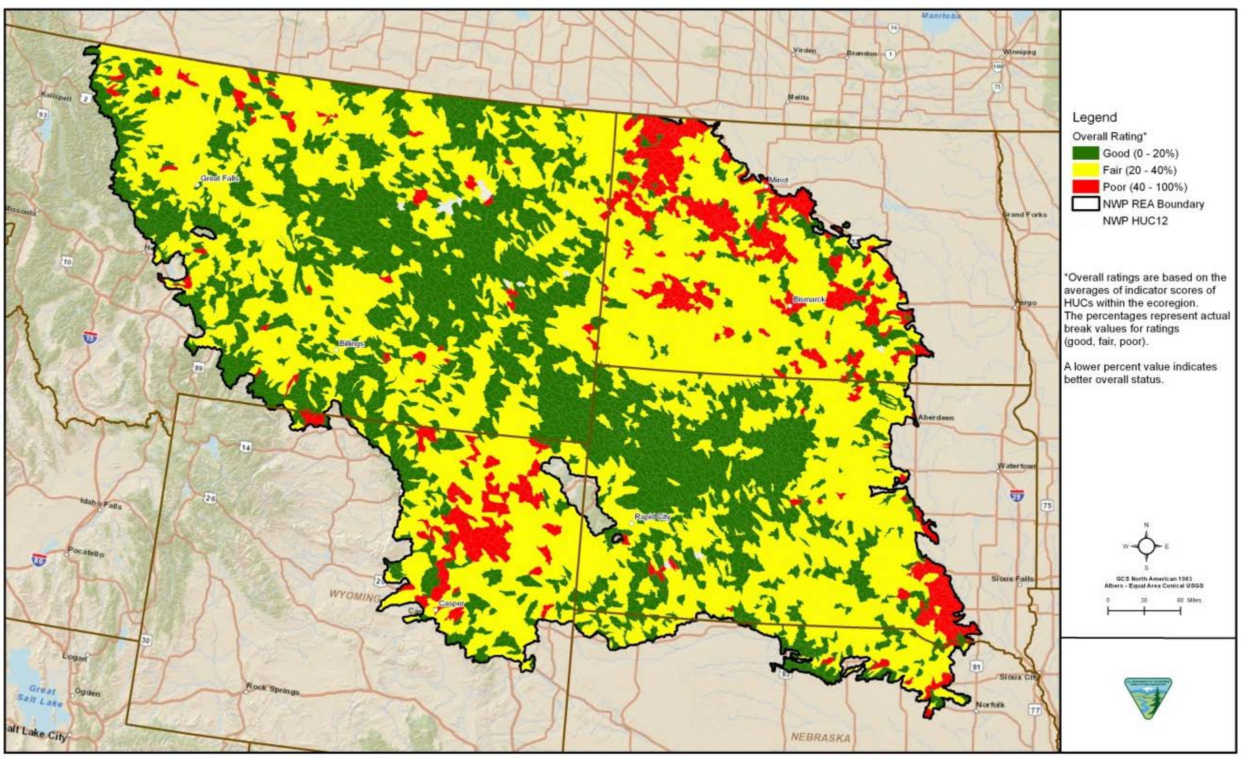


Figure 6-18. Mule Deer Overall Current Status in the Northwestern Plains

Climate Change

With temperature increases expected across North America, lower snowfall is also projected to occur in the ecoregion. Changes in traditional summer/winter ranges may lead to a short-term positive effect on the abundance and distribution of mule deer in this ecoregion. Increases in populations or ranges of mule deer within the region will depend on forage availability and quality with a likely increase in competition for available resources.

The NSCCVI tool was utilized to assess mule deer vulnerability to the effects of climate change. The NSCCVI calculator produced an index score of not vulnerable/increase likely for the mule deer. The assessment rating was largely based on a majority of "neutral" and "somewhat decrease vulnerability" scores calculated when assessing the factors that influence vulnerability. These factors included dispersal and movements, sensitivity to temperature and moisture changes (historical thermal/hydrological niche), dependence on ice or snow-cover habitats, reliance on interspecific interactions to generate habitat, and dietary versatility.

6.2.2.2 Greater Sage-Grouse

The GRSG is considered an umbrella species for sagebrush-associated vertebrates (Rowland et al. 2006). Indirect effects of sagebrush habitat loss, fragmentation, and degradation are thought to have caused the extirpation of the GRSG from approximately 50 percent of its original range (Connelly and Braun 1997; Connelly et al. 2004; Schroeder et al. 2004), leading to its declaration as a candidate species for listing under the Endangered Species Act. The analysis completed for the GRSG is presented in Appendix E-2.

6.2.2.2.1 Current Status in the Ecoregion

Figure 6-19 presents the distribution map for the GRSG, which was used to conduct the CA analyses. The BLM recommended using a combination of the existing breeding bird density (BBD) (Doherty et al. 2010) and GRSG range maps, as developed by Schroeder (2004) and updated by BLM in 2006. The combination of these maps were used, because they were determined to be the best representation of all seasonal habitat usage for this species, and because these maps represent the areas of management concern that are relevant at the scale of the REA. The results of the current status analysis for the GRSG are presented on Figure 6-20.

The current status analysis indicates that the lek and range areas located in central Montana are at the lowest risk from all of the CAs. The patch size analysis indicates that, with the exception of some areas in central Montana and northeastern Wyoming, the majority of the distribution does not contain large contiguous patches of sagebrush (Figure E-2-6). The anthropogenic features that contribute most to the ecoregion as a whole are the distances from highways (Figure E-2-10) and power infrastructure (Figure E-2-11).

6.2.2.2.2 Future Conditions in the Ecoregion

Development

The GRSG habitats in the southernmost portions of this ecoregion appear to be at risk from future agricultural conversion and energy development (Figures C-1-1 and C-1-5). These areas may become critical resources for the species in the ecoregion because the current sagebrush cover and patch size are rated higher (good to fair) than other areas to the north. GRSG habitats do appear to be at risk from future energy development, especially those development activities that will occur in GRSG habitat.

Climate Change

The general precipitation pattern for the Northwestern Plains ecoregion shows a large annual precipitation increase in the southeastern area of the ecoregion, and a slight increase across the rest of the ecoregion (Figure C-5-1). A modeled shift in precipitation to earlier in the season (March and April) combined with increased temperatures during the May and June and July and August seasons suggests that the sagebrush habitat in areas such as the Powder River Basin may experience more frequent wildfires. Associated changes in fire regime which currently pose significant threats to GRSG and the sagebrush ecosystem would increase.

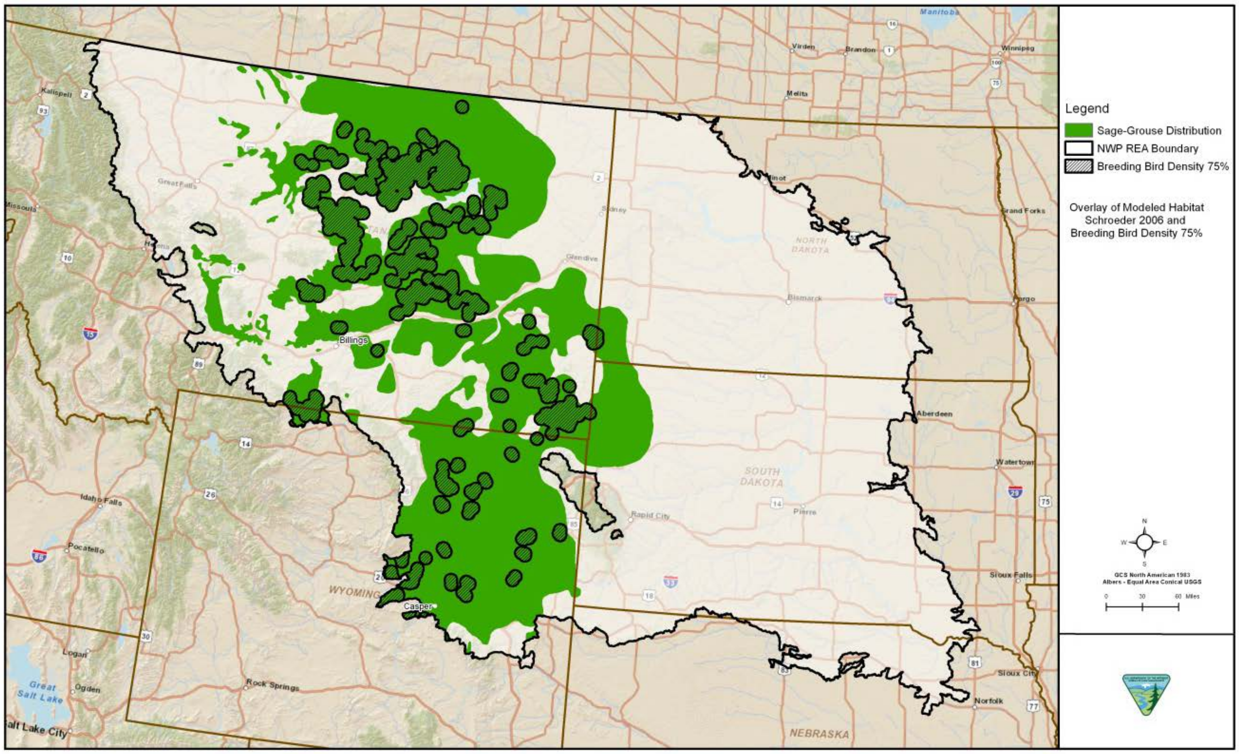


Figure 6-19. Greater Sage-Grouse Distribution in the Northwestern Plains

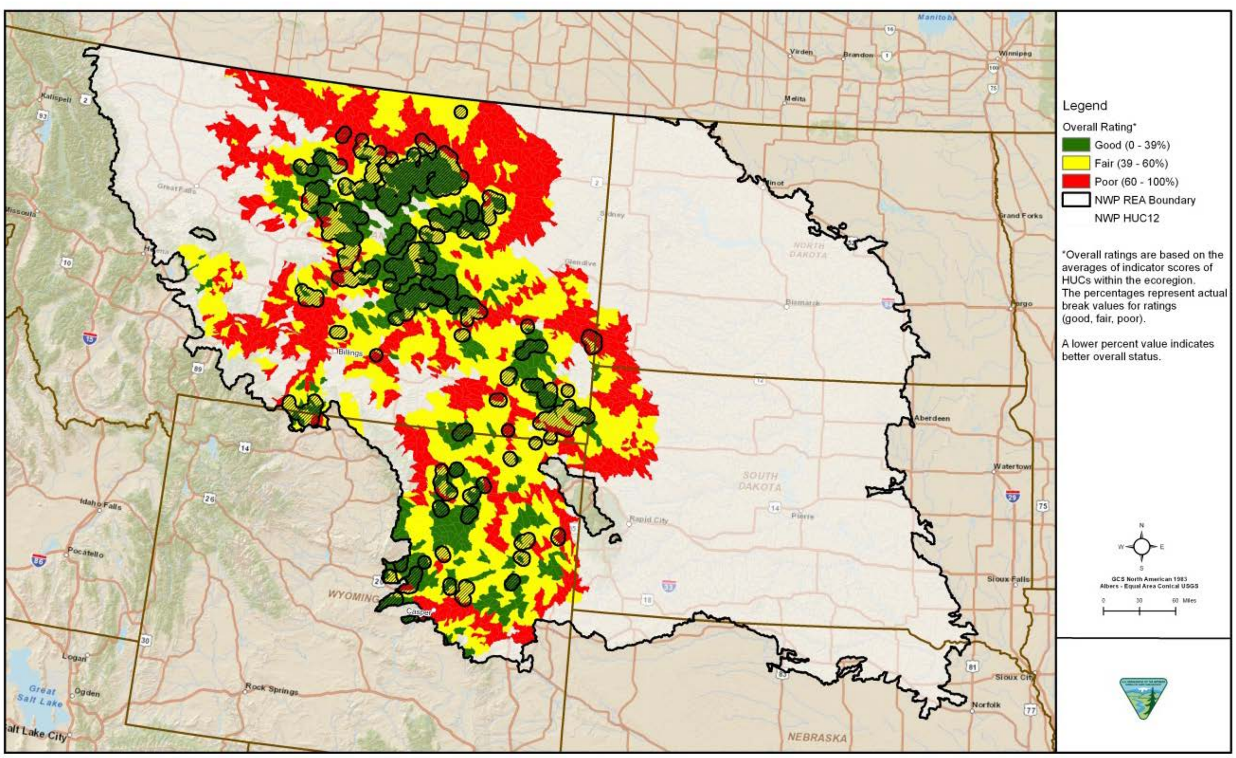


Figure 6-20. Greater Sage-Grouse Overall Current Status in the Northwestern Plains

The NSCCVI tool was utilized to assess GRSG vulnerability to the effects of climate change and produced an index score of moderately vulnerable. The NSCCVI tool indicated that available evidence suggests the abundance and/or range extent of this species within the geographical area assessed is likely to decrease by 2050. The assessment rating was largely based on a majority of neutral and somewhat increase vulnerability scores calculated when assessing factors that influence vulnerability. These factors included distribution to relative barriers, dispersal and movements, reliance on interspecific interactions, and genetic factors.

6.2.2.3 Golden Eagle

The golden eagle (*Aquila chrysaetos*) occurs year-round in the Northwestern Plains (Kochert et al. 2002). Its status in the ecoregion likely reflects the status of the species on a larger scale, due in part to the dispersal of immature and non-breeding adults from outside the region to and throughout the Northwestern Plains. Due to management concerns and potential declining numbers, the golden eagle was defined as a CE for this REA. The analysis completed for the golden eagle is presented in Appendix E-3.

6.2.2.3.1 Current Status in the Ecoregion

Figure 6-21 presents the distribution map for the golden eagle, which was used to conduct the CA analyses. The results of the current status analysis for the golden eagle are presented on Figure 6-22.

The current landscape analysis indicates that the majority of the ecoregion maintains suitable habitat for golden eagles with large areas in western North Dakota, southeastern South Dakota, west-central Montana and the Golden Triangle (Montana) indicating potential habitat loss (Figure E-3-7). The effect of roads on golden eagles in the Northwestern Plains is minimal and generally localized around larger population centers and does not pose a current substantial threat to golden eagles across the ecoregion (Figure E-3-8). Transmission lines exist throughout large portions of the Northwestern Plains, and Figure E-3-9 shows a significant extent of the ecoregion as fair with regard to these lines. However, because the transmission lines do not occupy large areas (spatially) relative to the overall size of the ecoregion, it is likely that the effect from transmission lines on golden eagles will have less of an effect than that which is displayed in this figure. Only a small portion of the ecoregion exists in areas where proximity to transmission lines poses a substantial threat.

The threat of wind energy development in this ecoregion is a concern for localized golden eagle populations (Figure E-3-10). Wind turbine threats represent a substantial portion of the Northwestern Plains and are a current threat to golden eagles in western Montana, northeastern Wyoming, northern Nebraska, western and central North Dakota, and western and central South Dakota. Because the Nebraska area of golden eagle habitat is fairly small, the threat of wind turbines is probably greatest in this state. The overall current status of the golden eagle in the ecoregion in the context of this assessment is good to fair (Figure E-3-11). It is important to note that the locations receiving the lowest score in this assessment are those areas in close proximity to urban areas and areas of substantial agricultural activity (e.g., Golden Triangle). The majority of the western portion of this ecoregion is inhabited by golden eagles and provides suitable habitat for the species.

6.2.2.3.2 Future Conditions in the Ecoregion

<u>Development</u>

Agricultural activities are detrimental to golden eagle distribution, and as human populations increase, it is expected that the demands of a larger human population will require additional agriculture. In this ecoregion, most of the agricultural areas (current and future) occur beyond the golden eagle distribution layer. There is potential for small changes in the distribution of breeding eagles in some areas, but overall golden eagle habitat is likely to remain unaffected.

Golden eagle habitat areas in this ecoregion are mainly affected by urban growth near the major urban areas (e.g., Rapid City, South Dakota; Sheridan, Wyoming; Bozeman, Montana; etc.). However, these areas are minimal in size relative to the distribution extent of the golden eagle and are unlikely to greatly

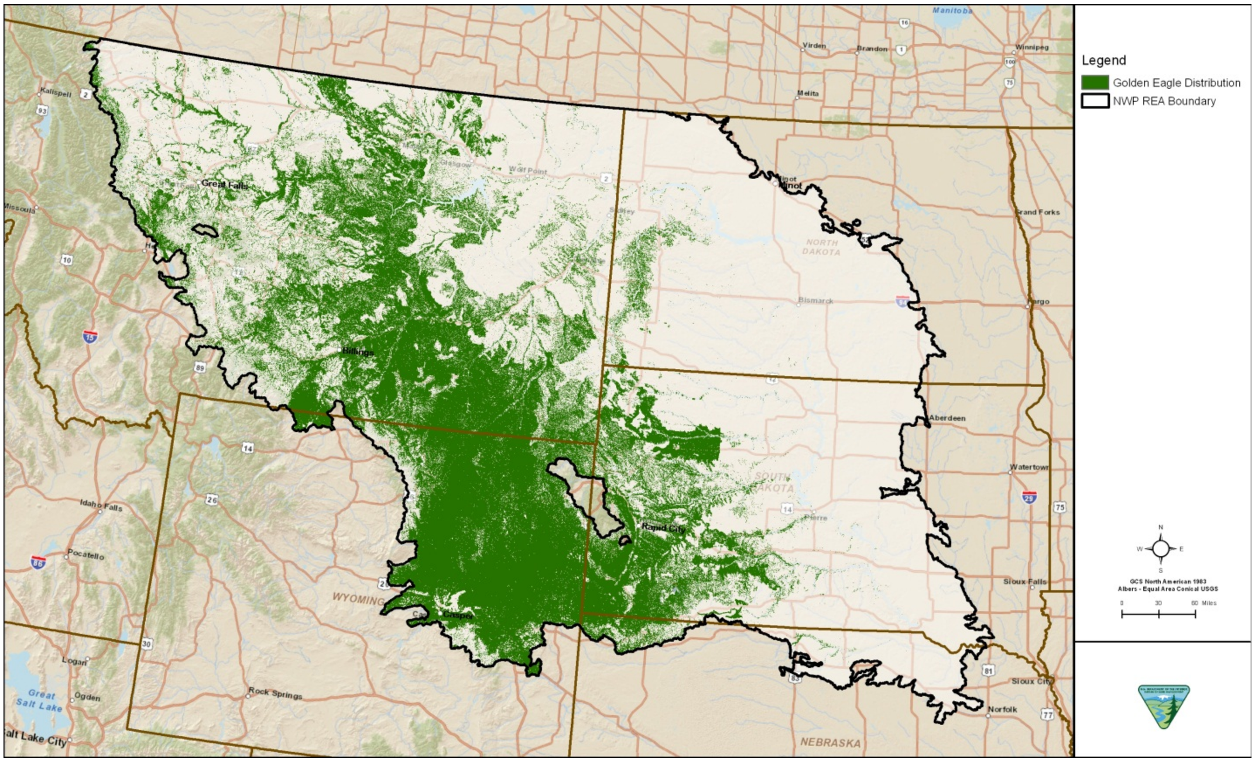


Figure 6-21. Golden Eagle Distribution in the Northwestern Plains

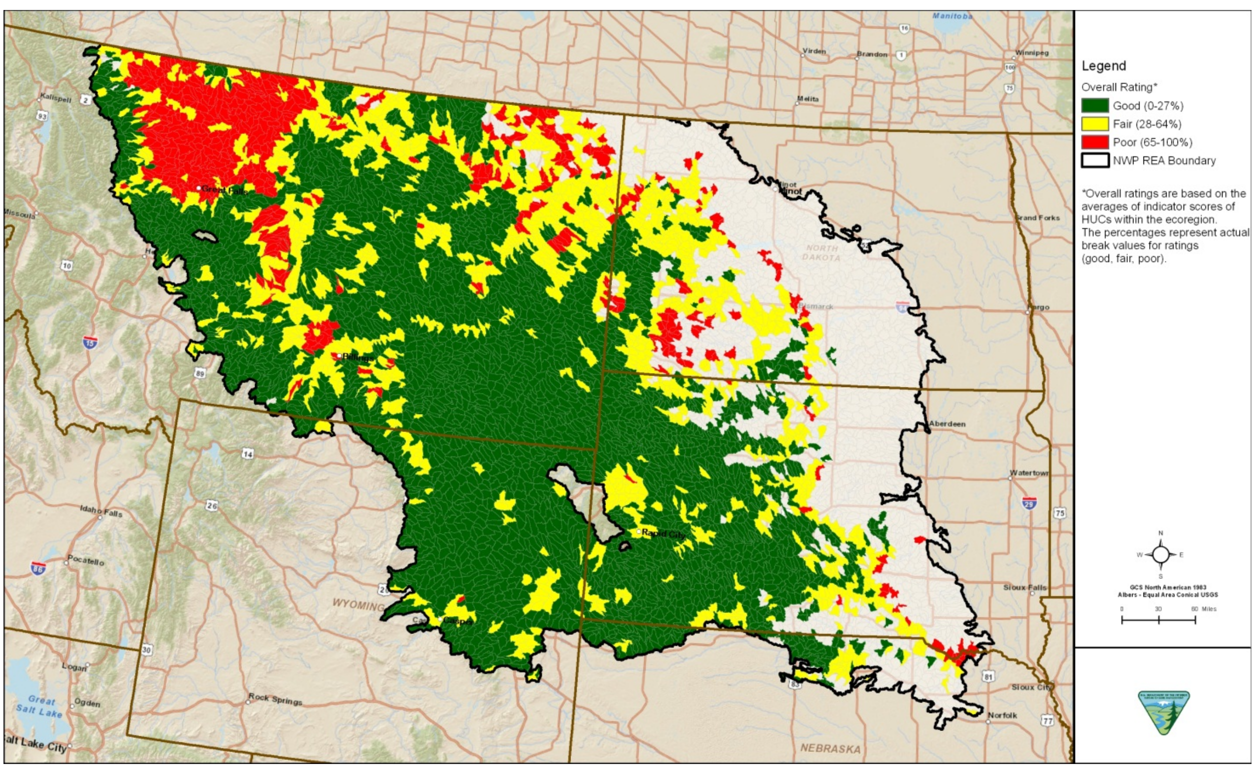


Figure 6-22. Golden Eagle Overall Current Status in the Northwestern Plains

affect golden eagles in this ecoregion. The possible exception to this would be small areas of habitat within the immediate vicinity of these urban areas.

Most of the golden eagle habitats in the ecoregion will likely remain unaffected by oil and gas development in this ecoregion. However, the majority of potential oil and gas development within the ecoregion is limited to northeastern Wyoming which represents a large part of state that is characterized as golden eagle habitat. Additionally, the overall South Dakota golden eagle habitat is limited to the western part of the state, and from a state perspective, is potentially at risk from oil development. Montana also has the potential for a more localized effect on golden eagles as a result of natural gas development.

The majority of the golden eagle habitat does not appear to be at high risk from future potential renewable energy development (Figure C-1-8). Higher elevations within this ecoregion are more susceptible to the threat of wind development do to the higher wind speed levels within these areas. However, limited accessibility affects the construction of wind turbines at higher elevations, limiting the range of wind development to lower elevation mountainous regions. Throughout the mountainous regions of this ecoregion, many of these areas are inhabited by nesting golden eagles. There is potential for a substantial negative effect on golden eagle populations within the western portion of this ecoregion if wind energy development increases in these areas. The southeastern most range of the golden eagle distribution layer is at high risk to potential wind energy development. This area is currently on the fringe of suitable golden eagle habitat and wind energy development in this area could result in a substantial disturbance to golden eagles.

In the Northwestern Plains, the slope and elevations of the western portion of the ecoregion are likely to limit substantial areas from solar energy development. Similarly, golden eagles utilize the more rugged areas of the ecoregion as habitat. This, coupled with the golden eagle distribution across the ecoregion, increases the potential for limited interactions. However, in areas where foothills and less-rugged mountainous terrain exist there is potential for habitat displacement. In this ecoregion, the high-risk areas for potential effect from solar energy development are Northeastern Wyoming, northwestern Nebraska, and the Black Hills and surrounding areas in South Dakota.

Climate Change

A constant overall increase in temperature is expected across the golden eagle range within the Northwestern Plains (1.9 to 2.3°C). Increased fire potential is the most likely result of temperature increase that would directly affect golden eagle prey availability.

Most of the region is expected to experience a mild increase (25 to 75 mm) in annual precipitation or no annual change in precipitation. Increased annual precipitation is expected in the southeast corner of the ecoregion along the Missouri River (76 to 155 mm) and on the eastern edge of the Black Hills. The annual variation in the areas adjacent to the Black Hills is not substantial with regard to its effect on overall prey availability. However, small population shifts in black-tailed jackrabbits are likely to occur.

The golden eagle is a highly mobile species that is uninhibited by most man-made and geographical features. Like all raptor species they are highly adaptable and often able to compensate for climatic variation.

The NSCCVI tool was utilized to assess golden eagle vulnerability to the effects of climate change and produced an index score of not vulnerable/increase likely. The NSCCVI tool indicated that available evidence suggests the abundance and/or range extent of this species within geographical area assessed is likely to increase by 2050. The assessment rating was largely based on a majority of neutral and somewhat decrease vulnerability scores calculated when assessing factors that influence vulnerability. These factors included dispersal and movements, sensitivity to changes in historical thermal niche, dependence on ice or snow-cover habitats, reliance on interspecific interactions to generate habitat, and dietary versatility.

6.2.2.4 Grassland Bird Assemblage

Grassland birds and in particular, endemic grassland birds, have shown steeper, more consistent, and more geographically widespread population declines than many other species (Knopf 1996). The focal species selected to represent this assemblage includes the Baird's sparrow (*Ammodramus bairdii*), McCown's longspur (*Calcarius mccowni*), chestnut-collared longspur (*Calcarius ornatus*) and Sprague's pipit (*Anthus spragueii*). The species that comprise this assemblage were selected because their habitats range from short grass to tall grass prairies. The swift fox (*Vulpes velox*) was included as part of this assemblage because of the species' strong association with short-structured grasslands. The analysis completed for the grassland bird assemblage is presented in Appendix E-4.

6.2.2.4.1 Current Status in the Ecoregion

Figure 6-23 presents the distribution map for the grassland bird assemblage, which was used to conduct the CA analyses. The results of the current status analysis for the grassland bird assemblage are presented on Figure 6-24.

The results of the analysis for current status for the grassland bird assemblage indicate that the majority of the modeled grassland bird habitat is in the fair category. The assessment of fragmentation of habitat based on distance from anthropogenic features did show a risk from fragmentation (Figure E-5-17). In contrast, the assessment of connectivity, based percentage of anthropogenic features within the HUC was good overall (Figure E-5-18). Fire return interval was good throughout the region where grassland bird habitat is present based on Maxent distribution (Figure E-5-16).

6.2.2.4.2 Future Conditions in the Ecoregion

Development

In the Northwestern Plains ecoregion, most of the agricultural areas (current and future) are located within the heart of where the Maxent models predict this assemblage to occur. The majority of Maxent output that intersects with current and future agricultural areas are located in northern Montana and northwestern North Dakota. Areas along the Missouri River in South Dakota and Nebraska are suitable for agricultural development but these areas did not appear to provide suitable habitat for the grassland bird assemblage.

Although the urban areas around Rapid City, South Dakota, and Sheridan, Wyoming, are projected to increase, it is not anticipated that this would adversely affect this assemblage as a whole. A small area around Havre, Montana, is expected to increase in development but again, this does not appear to threaten grassland birds on a landscape scale.

Most of the potential future impacts to the grassland bird assemblage modeled habitat in the ecoregion would potentially result from the development of fossil fuels. Grassland bird assemblage habitat located in northeastern Wyoming and northeastern Montana/northwestern North Dakota appears to be at high risk from potential oil and gas development.

The highest potential risk for solar development in this ecoregion occurs in northeastern Wyoming and southeastern Montana (Figure C-1-6). Although the Maxent models for this assemblage did indicate some modeled habitat in southeastern Montana, the majority of the modeled habitat in northern Montana and North Dakota does not appear to be at risk from solar development.

The potential threats to modeled grassland bird assemblage habitat relative to future wind energy development are presented on Figure C-1-7. Although wind energy development is known to adversely affect grassland birds (Leddy et al. 1999), much of the grassland bird distribution area does not appear to be at high risk from wind energy development.

Climate Change

From a climate change perspective, the relationship between temperature, precipitation, and the re-distribution of vegetation communities through agricultural conversion, changes to historic wildfire regimes and invasive species across the landscape are the factors that will have the greatest impact on this assemblage.

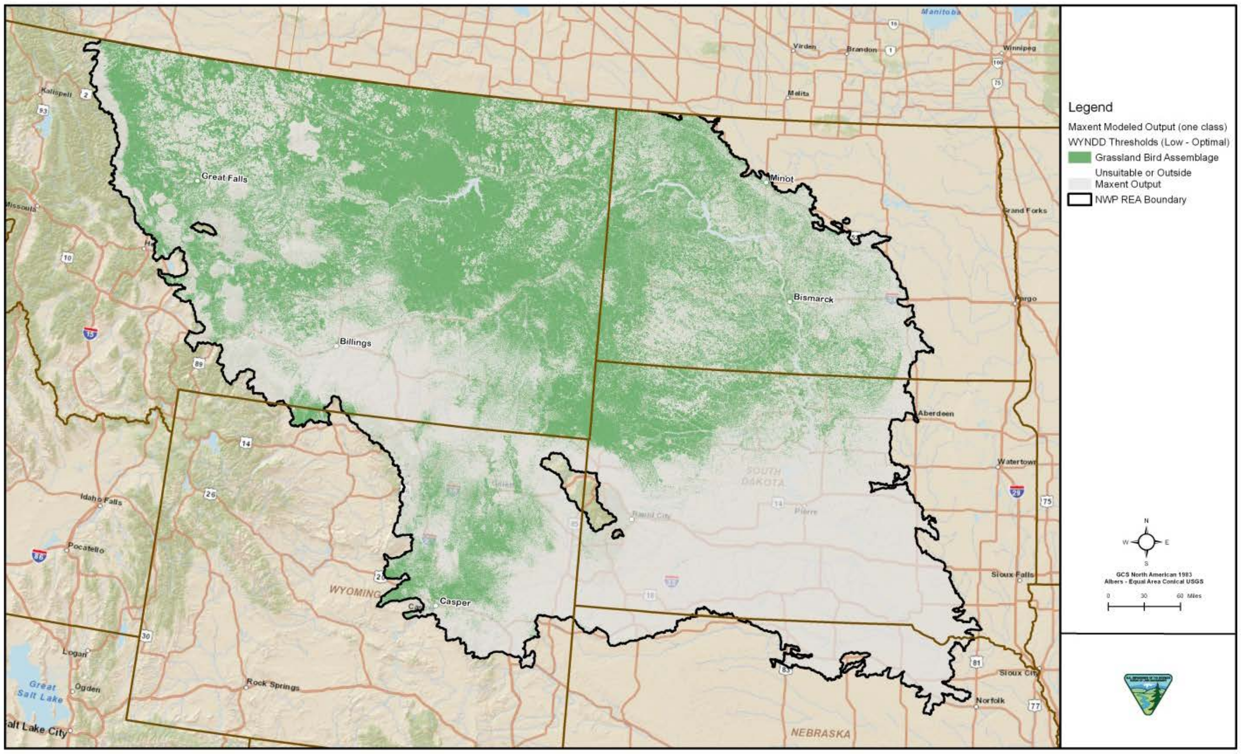


Figure 6-23. Grassland Bird Assemblage Distribution in the Northwestern Plains

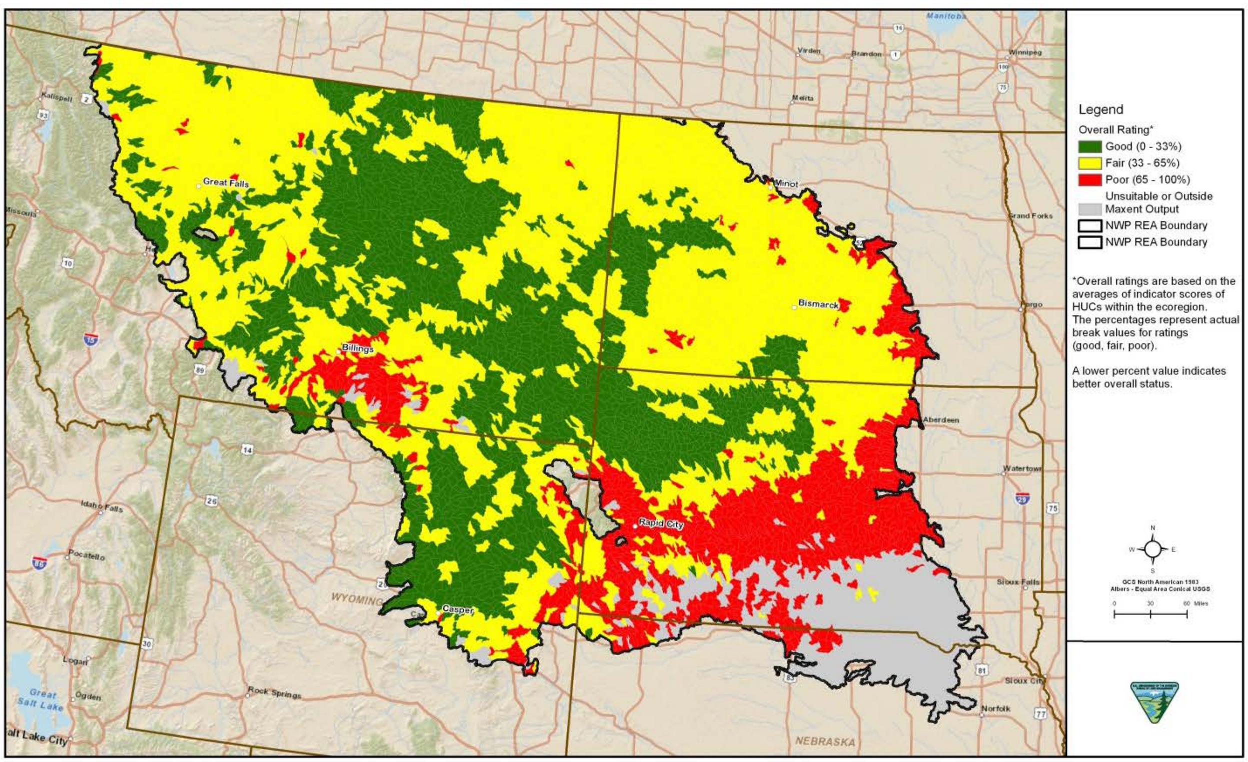


Figure 6-24. Grassland Bird Assemblage Current Status in the Northwestern Plains

All of the species in the assemblage rely on intact grasslands as habitat. If vegetation communities substantially change as a result of increased temperatures and decreased precipitation, it is likely that fire regimes will change and invasive species will negatively affect this assemblage. However, illustrating these potential impacts in a geospatial format was not possible.

The NSCCVI tool was utilized to assess Baird's Sparrow as a representative to the overall vulnerability of the grassland bird assemblage to future climate change and produced an index score of insufficient evidence. The NSCCVI tool indicated that the available information (within the geographical area assessed) about the species' vulnerability is inadequate to calculate an index score. Data gaps for Baird's sparrows specific response to climate change were identified. The assessment rating was largely based on "unknown" scores calculated when assessing factors that influence vulnerability such as; distribution to barriers, dispersal and movements, sensitivity to temperature and moisture changes (historical thermal/hydrological niche), reliance on interspecific interactions to generate habitat, and dietary versatility.

6.2.2.5 Black-Tailed Prairie Dog Assemblage (Prairie Dog, Ferruginous Hawk, Burrowing Owl, Mountain Plover, Black-footed Ferret)

The BTPD Assemblage is representative of large intact landscapes across the Northwestern Plains ecoregion. Although there are many prairie dog colonies throughout the western U.S., the focus of this analysis was on those larger prairie dog colonies that have the potential to provide habitat for not only the associated assemblage species but also many other species. This assemblage is comprised of the following five species; BTPD (*Cynomys ludovicianus*), the Ferruginous Hawk (*Buteo regalis*), the Burrowing Owl (*Athene cunicularia*), the mountain plover (*Charadrius montanus*) and the black-footed ferret (BFF) (*Mustela nigripes*). The analysis completed for this assemblage is presented in Appendix E-5.

6.2.2.5.1 Current Status in the Ecoregion

Figure 6-25 presents the distribution map for the BTPD assemblage, which was used to conduct the CA analyses. The results of the current status analysis for the BTPD assemblage are presented on Figure 6-26.

Based on the results of the current status analysis, it appears that the majority of the Maxent output for this assemblage in South Dakota is not currently at risk from the CAs used for this analysis. However much of the assemblage Maxent output for Wyoming and Montana is rated as fair with moderate risk to the CAs used for this analysis. Assemblage Maxent output in the Golden Triangle area of northwestern Montana does appear to be at risk from anthropogenic features. Alternatively, the proportion of protected lands (Figure E-5-14) and the proportion of prairie (Figure E-5-15) both scored poorly across most of the ecoregion. Good scores for protected lands were limited to central Montana and northeastern Wyoming with scattered areas throughout the rest of the ecoregion. The proportion of Maxent output that scored as good was limited to the southeastern section of the ecoregion. The proportion of land use (Figure E-5-13) results are much more heterogeneous than the other attributes. The majority of the Maxent output is characterized as fair to good. Notable exception occur in the Golden Triangle, eastern Montana and in southern and central North Dakota.

6.2.2.5.2 Future Conditions in the Ecoregion

<u>Development</u>

Most of the agricultural areas (current and future) are located outside of the Maxent output for the BTPD assemblage. With the exception of a few areas in north central South Dakota, there is potential for slight risk from agriculture to the habitat of this assemblage, but in general, the majority of the modeled habitat is likely to remain unaffected.

The BTPD assemblage modeled habitat in northeastern Wyoming and southwestern North Dakota appears to be at high risk from future energy development. The large areas of modeled habitat in South Dakota appear to be at low risk from by oil and gas development. Recent development of energy resources from the Bakken shale formations in eastern Montana and western North Dakota has substantially increased the rate of development in these areas. Although some colonies exist in this area, large concentrations of colonies such as those in northern South Dakota and Wyoming are not known from these areas.

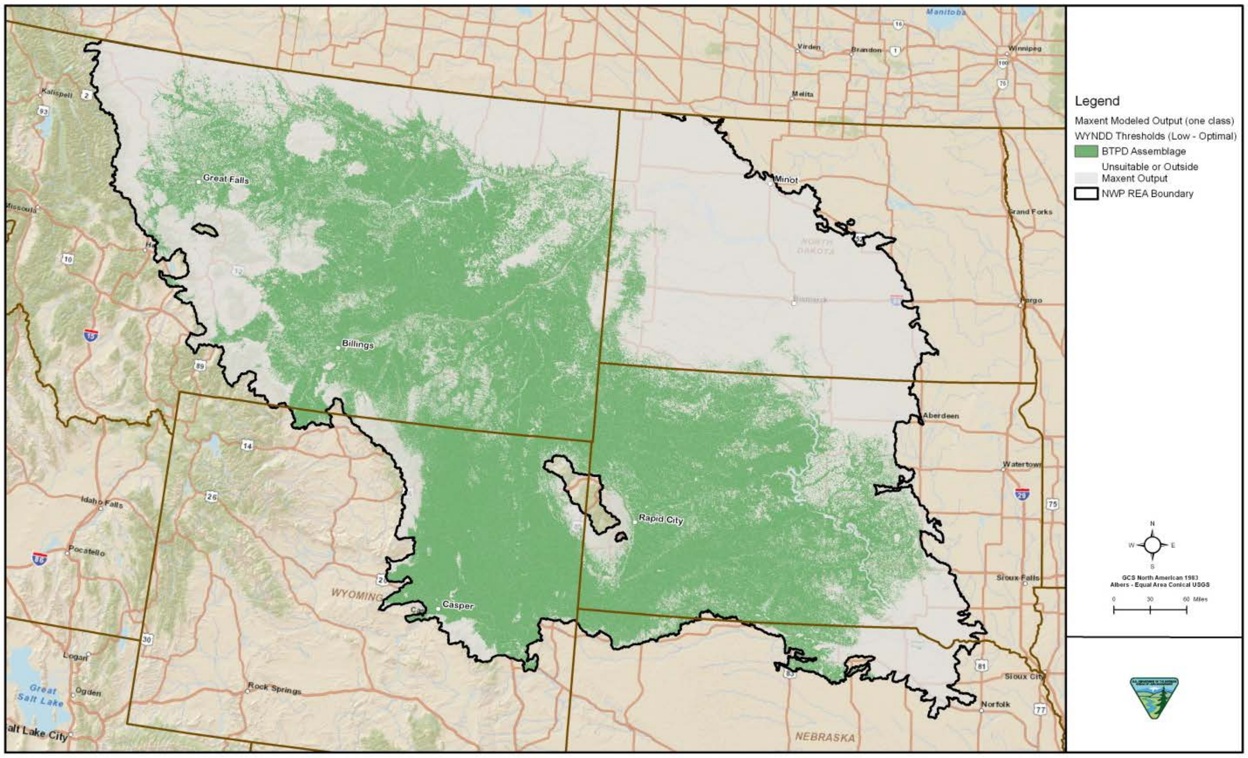


Figure 6-25. Black-Tailed Prairie Dog Assemblage Distribution in the Northwestern Plains

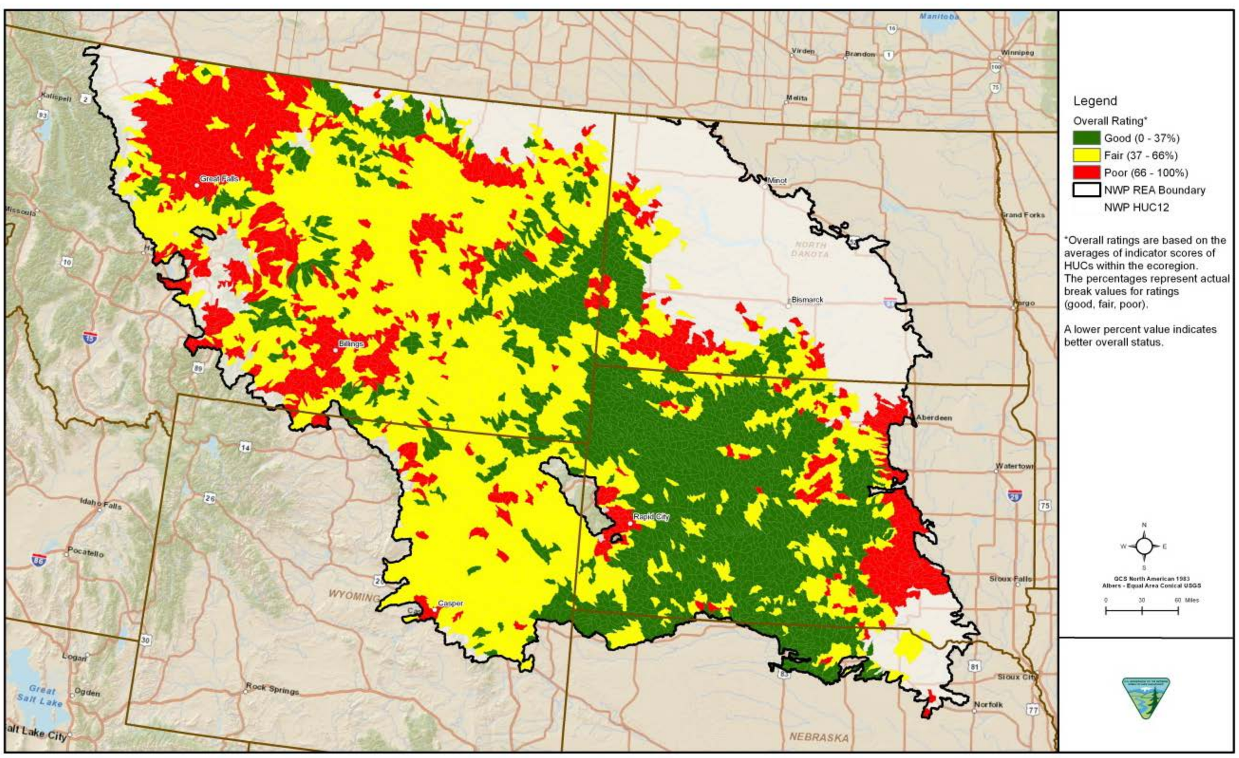


Figure 6-26. Black-Tailed Prairie Dog Assemblage Overall Current Status in the Northwestern Plains

The potential risk to modeled BTPD assemblage habitat relative to future wind energy development is presented on Figure C-1-7. The majority of BTPD assemblage habitat throughout the Northwestern Plains appears to be at moderate risk from future renewable energy development.

<u>*Climate Change*</u>

A constant overall increase in temperature is expected across the assemblage modeled habitat within the Northwestern Plains (1.9°C to 2.3°C). Increased fire potential is the most likely result of temperature increase that would directly affect assemblage habitat quality. All of the species in the assemblage rely on the prairie dog to continue to provide habitat. If vegetation communities substantially change as a result of increased temperatures and decreased precipitation, it is likely that fire regimes will change and invasive species will negatively affect this assemblage. However, attempting to illustrate these potential impacts in a geospatial format is very difficult.

The NSCCVI tool was utilized to assess burrowing owl as a representative to the overall vulnerability of the BTPD assemblage to future effects of climate change and produced an index score of insufficient evidence. The NSCCVI tool indicated that the available information (within the geographical area assessed) about the species' vulnerability is inadequate to calculate an index score. Data gaps for burrowing owl's specific response to climate change were identified. The assessment rating was largely based on "unknown" scores calculated when assessing factors that influence vulnerability. These factors included distribution to barriers, dispersal and movements, sensitivity to temperature and moisture changes (historical thermal/hydrological niche), reliance on interspecific interactions to generate habitat, and dietary versatility.

6.2.2.6 Prairie Potholes

Prairie potholes encompass millions of depressional wetlands of glacial origin that constitute one of the richest wetland systems in the world and occur over 300,000 square miles of prairies in the north central United States and south-central Canada. Prairie potholes in the formerly glaciated terrain in the northern and eastern part of the ecoregion are essential for waterfowl and shorebird breeding and migratory stopovers along the North American Central Flyway. These potholes form part of a system of international importance but comprise such a small percentage of the ecoregion area. Because of the importance of these resources in the ecoregion there was concern that they would be underrepresented in the coarse-filter analysis and therefore were included as a CE. The analysis completed for the prairie potholes is presented in Appendix E-6.

6.2.2.6.1 Current Status in the Ecoregion

Figure 6-27 presents the distribution map for the prairie potholes, which was used to conduct the CA analyses. The results of the current status analysis for the prairie potholes are presented on Figure 6-28.

The current status assessment evaluated the relative risk of potholes from agricultural conversion (Figure E-6-11) and development (Figures E-6-9 and E-6-10). Other analyses that were completed included an evaluation of the perimeter to area ratio (Figure E-6-7) to determine the value of potholes to wildlife, an evaluation of the size of potholes (Figure E-6-4), and an evaluation of the amount of potholes in protected areas (Figure E-6-6) such as national wildlife refuges.

The combined overall current status analysis (Figure E-6-12) resulted in the large majority of the watersheds being rated as fair for all of the analysis. However, the analysis completed to determine the potential for agricultural conversion resulted in the majority of the watersheds being at high or moderate (fair) risk of agricultural conversion.

6.2.2.6.2 Future Conditions in the Ecoregion

<u>Development</u>

Figure E-3-12 shows that the majority of potholes are at risk from potential future agricultural development. Most agricultural areas are located throughout the potholes area of the Northwestern Plains.

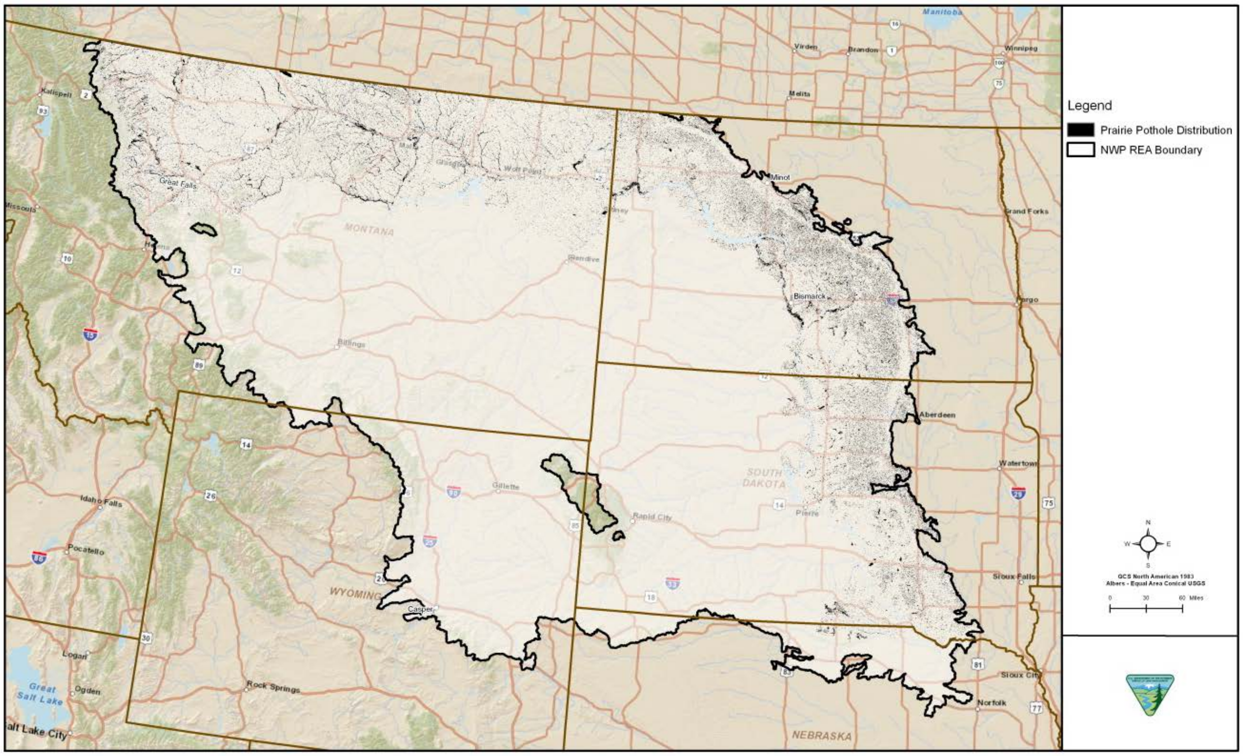


Figure 6-27. Prairie Potholes Distribution in the Northwestern Plains

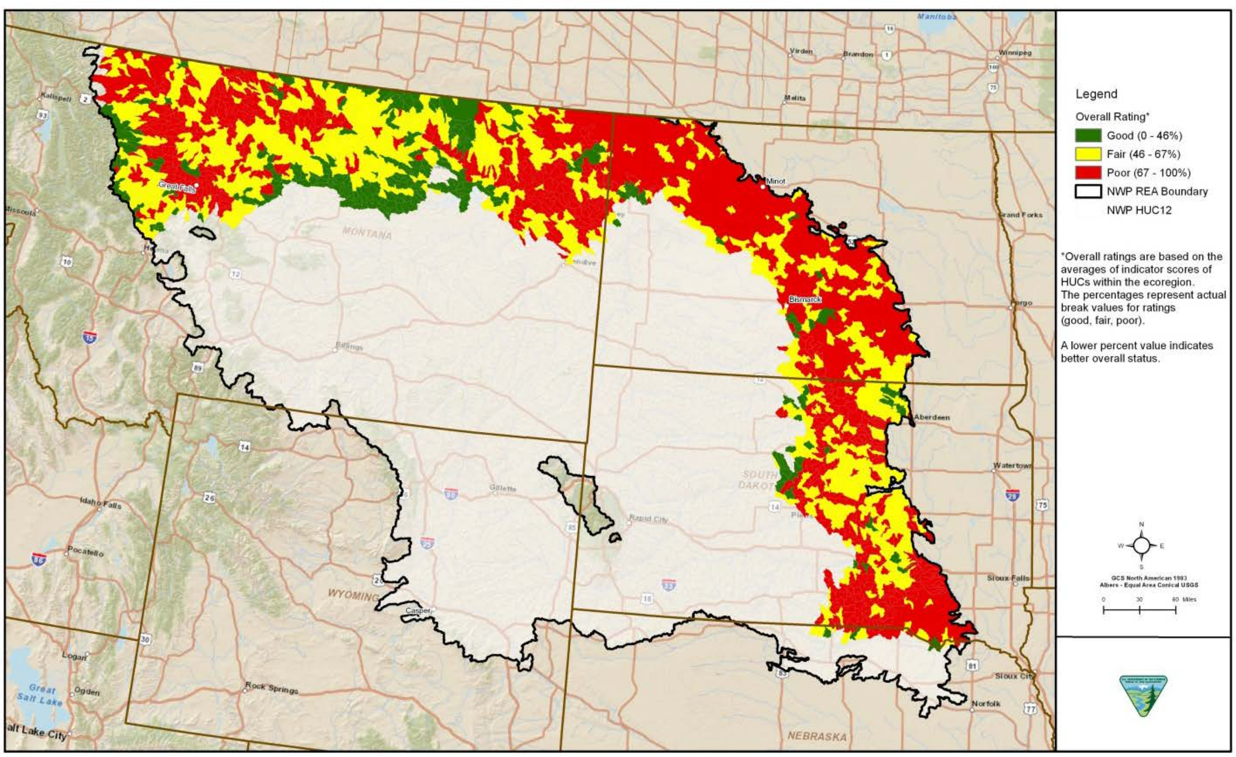


Figure 6-28. Prairie Potholes Overall Current Status in the Northwestern Plains

Thus, potholes are at risk from potential agriculture growth in the future. Urban growth is a low risk to this CE. Most of the potholes in the ecoregion will likely remain unaffected by fossil fuels development in the Northwestern Plains. The majority of potential fossil fuels development is limited to northeastern Wyoming. The majority of the potholes in the Northwestern Plains ecoregion are considered to be at low risk with regard to the threat of renewable energy development. The potholes of north central Montana do not appear to be at risk from future wind turbine development, but various areas of potholes in North and South Dakota appear to be at risk for the development of wind energy.

Climate Change

Climate change presents many different issues relating to potholes. However, it remains difficult to draw conclusions from the data presented in this REA. Climate change models are highly variable and often difficult to predict. In this case, the resolution of the spatial data is an important factor to consider.

Although the analysis completed for this REA does not indicate substantial changes could result from climate change, other recent research indicates otherwise. Johnson et al. (2005) developed a series of wetland simulation models for the prairie pothole region. The model runs that simulated increased temperature and decreased precipitation had the greatest modeled effect on wetland conditions. Under this scenario, the model wetland at five of the six locations became completely dominated by dry marsh conditions because of more frequent and longer drought. The results of their research suggest that climate change could diminish the benefits of wetland conservation in the prairie potholes area of the Northwestern Plains. In addition, the combined impacts of increased temperatures, localized drought and conversion of lands to agricultural uses could negatively affect potholes in the future.

6.2.2.7 Prairie Fish Assemblage

The prairie fish assemblage is represented by two focal species; the pearl dace (*Margariscus margarita*) and the northern redbelly dace x finescale dace hybrid (*Chrosomus eos x Chrosomus neogaeus*). These two species are usually associated with a fairly small but distinctive assemblage of other native species that are also adapted to similar habitat requirements. Very little data for the hybrid species were available and only from Montana and Nebraska. As a surrogate for additional data, species collection data for the northern redbelly dace, finescale dace (*Phoxinus neogaeus*), and northern redbelly x finescale dace hybrid were combined. These species utilize the same basic habitats as the hybrid species. This assemblage is found in small headwater streams, cool ponds, and small spring-fed lakes. Distribution modeling for this assemblage was completed using a series of boosted regression tree (BRT) models in R adjusting the model parameters following Elith et al. 2008. The analysis completed for the prairie fish assemblage is presented in Appendix E-7.

6.2.2.7.1 Current Status in the Ecoregion

Figures 6-29 and 6-30 present the distribution maps for pearl dace and northern redbelly dace x finescale dace hybrid, respectively, which were used to conduct the CA analyses. The results of the current status analysis for the prairie fish assemblage are presented on Figure 6-31.

Figure C-7-18 illustrates the current habitat status by 6th level HUC watershed for this CE based on the KEA overall score which was compared to the occurrence probability figures (Figures C-7-1 and C-7-2) to assess current status conditions. Overall, fragmentation of habitat from dams is low for most of the ecoregion. There are areas in the south-central portion of South Dakota and into Nebraska that seem to correspond to the northern extent of the probability maps for these species. The biggest factor in the overall status assessment seems to be the designation of GAP 3 (multiple use lands that may support extractive uses) and 4 (no known mandate for permanent protection) over most of the ecoregion (Figures E-7-6 and E-7-7). Lands that are not designated as 1 or 2 (permanent biodiversity protection) result in the rating of poor, which is indicated over most of the ecoregion. The only exception is the waters of Fort Peck Lake in Montana and a few smaller watersheds likely representing state or private natural areas.

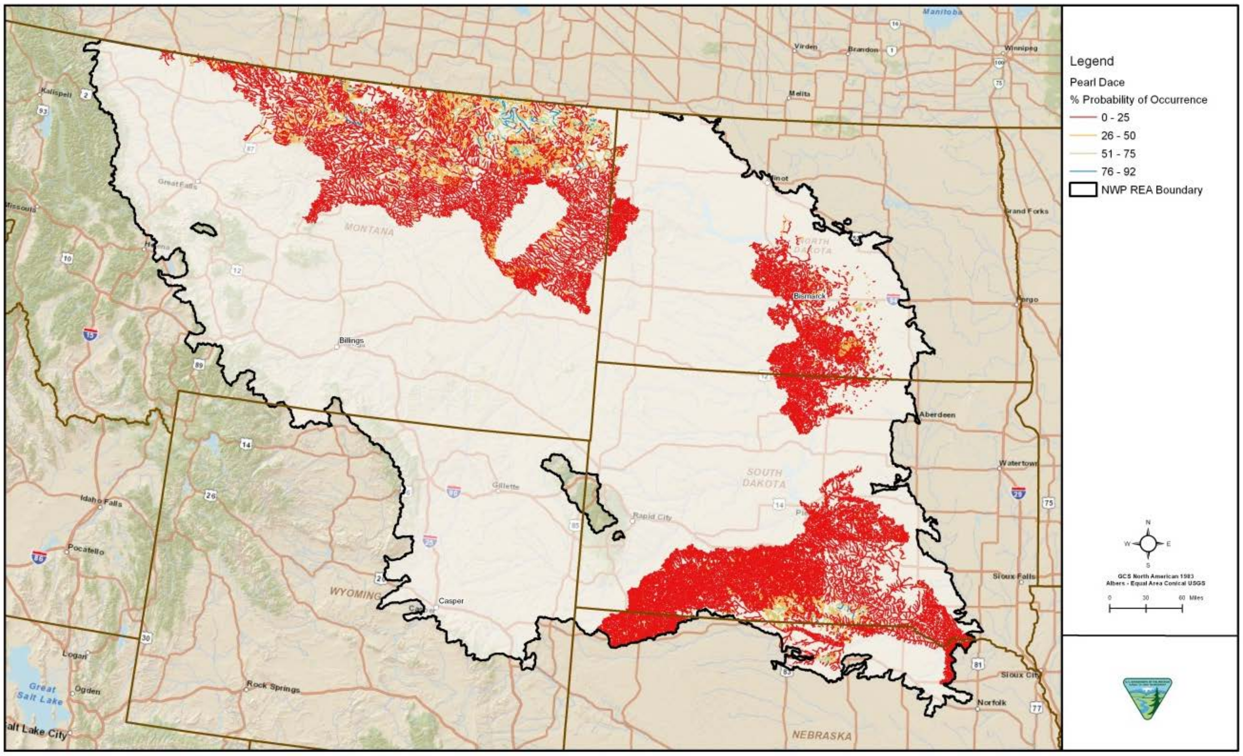


Figure 6-29. Pearl Dace Occurrence Probability in the Northwestern Plains

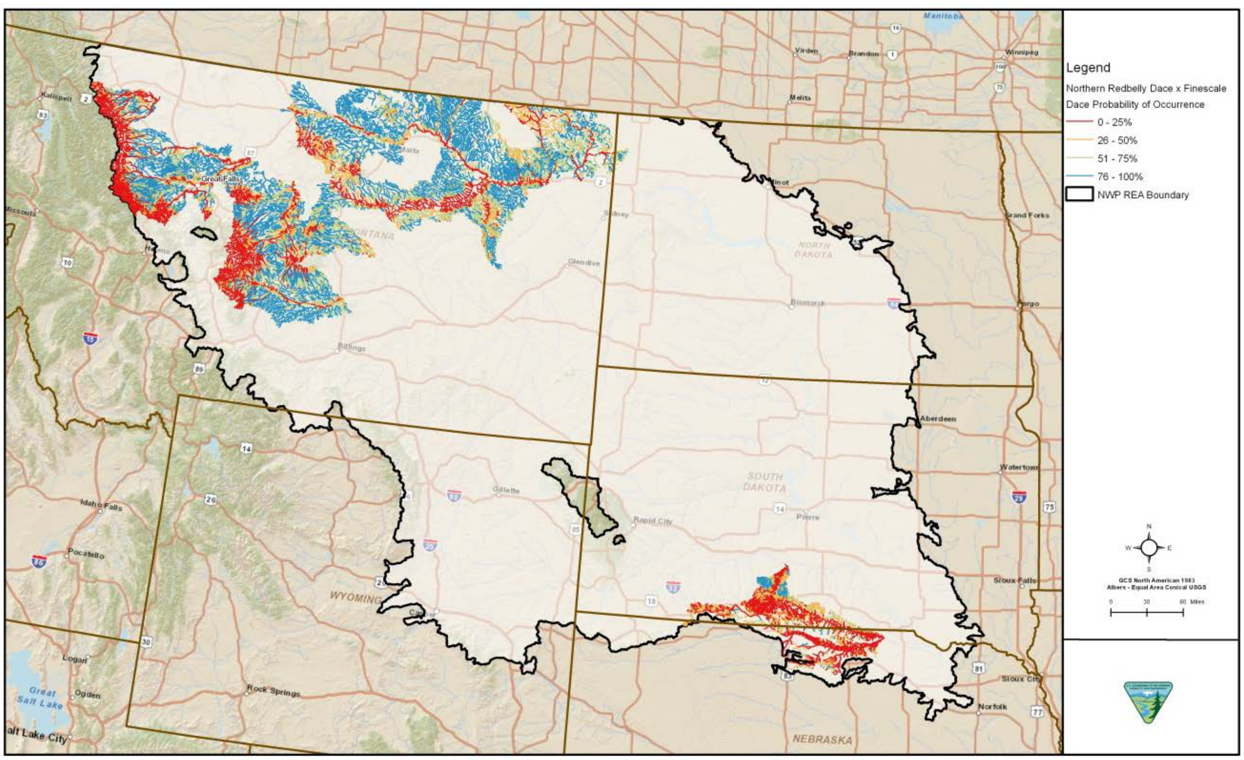


Figure 6-30. Northern Redbelly Dace X Finescale Dace Hybrid Occurrence Probability in the Northwestern Plains

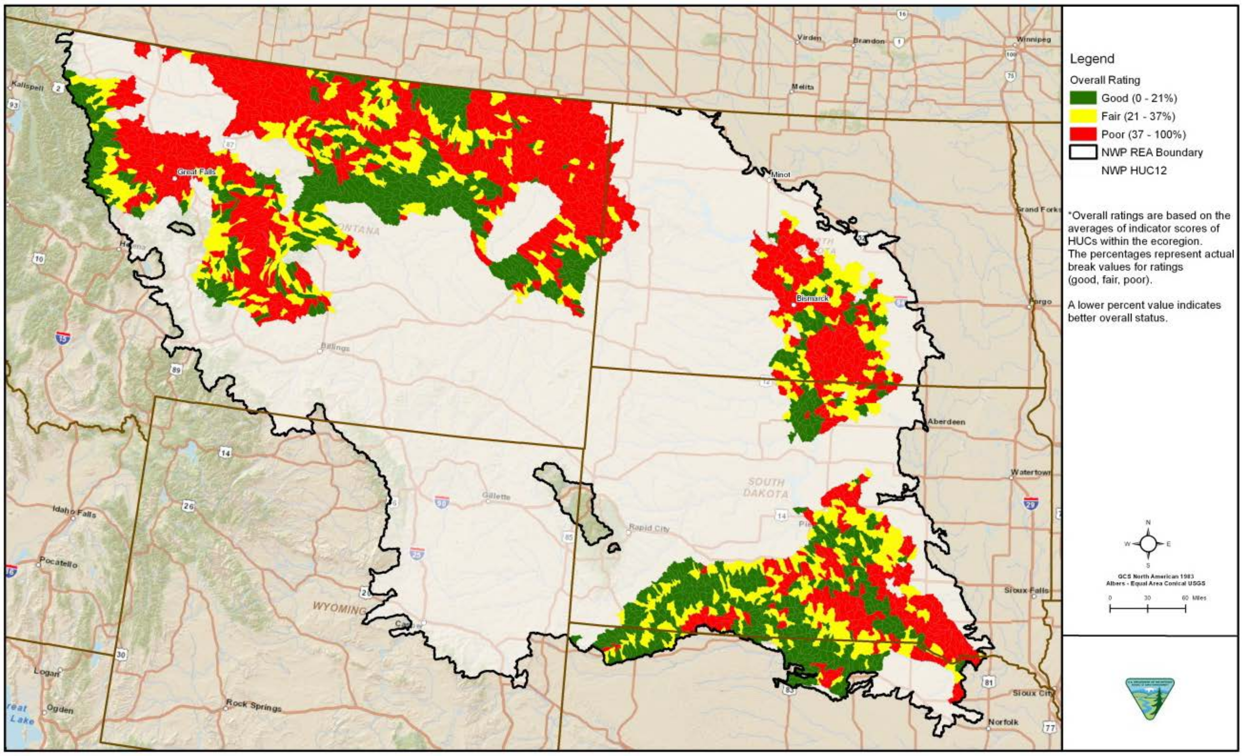


Figure 6-31. Prairie Fish Assemblage Overall Current Status in the Northwestern Plains

Other concerns regarding the overall habitat condition is the locations of 303d listed streams which are present throughout the range of occurrence of the focal species, and roadways and agricultural areas within close proximity to prairie fish streams.

6.2.2.7.2 Future Conditions in the Ecoregion

Development

Based on a review of the distribution maps created for this assemblage (Figures E-7-1 and E-7-2) relative to the future development, it appears that the species of this assemblage are at risk from future agricultural development in Montana and South Dakota. The portions of the species distributions in western North Dakota and Montana that appear to be at risk from future fossil fuel development do not appear to be at a high risk from future renewable energy development in these areas.

Climate Change

Prairie fish species in the Northwestern Plains are particularly susceptible to the microhabitat changes caused by climate change. Some of these could include low base flows, high water temperatures in late summer and larger and more frequent winter flood events. Based on the analysis conducted for the ecoregion as presented in Appendix C-5, predicted temperature increases may lead to increased instances of localized drought. This may have a dramatic effect on the prairie fish assemblage. Pools that serve as refuges for fish in small streams may also be lost and stream reaches may become fragmented. Reduced flow from cool-water springs may result in increases in water temperatures and lower dissolved-oxygen levels which may directly impact populations within these streams.

6.2.2.8 Big Fish Assemblage

The big river fish assemblage is represented by the pallid sturgeon (*Scaphirhynchus albus*), paddlefish (*Polyodon spathula*), sauger (*Sander Canadensis*), sicklefin chubs (*Macrhybopsis meeki*) and sturgeon chubs (*Macrhybopsis gelida*), and the smooth softshell turtle (*Apalone mutica*) and the spiny softshell turtle (*Apalone spinifera*). The species represented by this assemblage depend on large river systems (inclusive of major tributaries) in the West, whether occurring as residents or migrants, and have experienced substantial declines in abundance, distribution, and the availability of suitable habitats since the turn of the twentieth century. Their distributions have been affected by a variety of factors including human development such as the creation of dams, impoundments, migration barriers, elimination of riparian zones and conversion of natural landscapes to agriculture.

In order to conduct the analysis for this assemblage, species occurrence data were solicited from several sources for the purposes of developing an occurrence model using a boosted regression tree (BRT) model in R. Because of the lack of data, a probability of occurrence model for the sauger was the only model that was able to be developed (Figure E-8-1). The paddlefish and pallid sturgeon did not have enough collection data to produce a BRT model and therefore, only presence models were developed (Figures E-8-2 and E-8-3). Additionally, four other species were also initially selected as part of this CE assemblage; the sturgeon chub, the sicklefin chub, and two sub-species of softshell turtles, smooth and spiny; however, species collection data and predictor variables were also not adequate to produce distribution models for these species.

Because of the fish and turtle species data gaps, the RRT for the big river fish assemblage determined that, with only the sauger model, the MQs for this assemblage would not be able to be answered and therefore recommended dropping this assemblage from the analysis. The AMT agreed with this recommendation and the big river fish assemblage was dropped from further analysis. A detailed discussion of the models developed for the fish assemblage is presented in Appendix E-8.

6.2.2.9 Plains Sharp-Tailed Grouse

The PSTG (*Tympanuchus phasianellus jamesii*) is one of six subspecies of sharp-tailed grouse found in North America and the only one that exists within the boundaries of the Northwestern Plains ecoregion. The PSTG inhabit a broad range of plant communities dominated by grasses and shrubs and require expansive and often complex habitat, thus making them excellent indicators of ecosystem function at landscape scale.

In order to conduct the analysis for this species, important data would include occurrences, habitat and range, leks, nesting, brood-rearing, and winter habitat. As a result of the data evaluation conducted for this REA, several data gaps were identified regarding information on this species. Species occurrence data were difficult to obtain as they are generally not available for download from agency websites. Because of the lack of appropriate data for modeling, the AMT determined that current distribution and status of this species throughout the ecoregion could not be mapped or modeled and therefore recommended dropping this CE from further analysis as part of the REA. A detailed discussion of the efforts conducted for this species is presented in Appendix E-9.

6.2.2.10 Pronghorn

Pronghorn (*Antilocapra americana*) are considered a regionally significant species within the Northwestern Plains ecoregion and occupying much of the mixed grassland ecosystem. The core pronghorn area is Wyoming, Montana, Colorado, and South Dakota. More than 80 percent of the continents pronghorn can be found in these four states, with population estimates becoming smaller as we move to the edges of continental pronghorn range (Morton et al. 2008).

The most important datasets required for pronghorn are migration corridors. Migration corridors are areas of habitat connecting wildlife populations or seasonal ranges (Rosenberg et al. 1997). Because the species is considered to be common, occurrences are not recorded by NHPs. Although there were localized datasets and some multi-state migration corridor datasets, no comprehensive ecoregion-wide data could be acquired that was uniform enough for the entire ecoregion. As a result of the lack of adequate geospatial data to define the distribution of the pronghorn, the AMT determined that current distribution and status of this species throughout the ecoregion could not be mapped or modeled and therefore this CE was dropped from further analysis as part of the REA.

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7.0 SUMMARY AND KEY FINDINGS

Ecological integrity is defined as “the ability of ecological systems to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to those of natural habitats within a region” (Parrish et al. 2003). Functional organization refers to the dominant ecological characteristics and processes that “occur within their natural (or acceptable) ranges of variation and can withstand and recover from most perturbations” (Parrish et al. 2003). An ecosystem with ecological integrity should be relatively unimpaired across a range of ecological attributes and spatial and temporal scales (De Leo and Levin 1997). In this REA, the term ecological intactness (EI) is used to describe the ecological integrity at the ecoregion scale.

The purpose of the ecological intactness analysis (EIA) was to summarize the overall current conditions of the ecoregion based on the overall “intact” areas found within the region. The EIA is different from the coarse-filter/fine-filter CE approach in that intactness is not based on MQs, but rather on the intactness of the ecosystem regardless of the importance to managers. A coarse-filter/fine-filter CE approach is inherent in the implementation of EIA (Unnasch et al. 2009); however, through a series of discussions with the AMT, BLM, and USGS EIA team, it was determined that the EIA would assess two generalized land cover classes; terrestrial systems and aquatic/riparian/wetland systems.

The EI analysis provides an opportunity to evaluate current conditions of terrestrial and aquatic ecosystems across the ecoregion. This analysis compares the relative intactness of habitats at the 5th level HUC. Using a direct comparison of HUCs, the watersheds that are of the highest intactness within the ecoregion can be identified. Additionally, CE richness was calculated based on the distribution of the fine-filter CEs throughout the ecoregion. This analysis identifies specific areas of the ecoregion that are most widely used by the CEs. A comparison between the areas of high intactness to the areas of high CE richness provides important information for step-down analysis. A detailed discussion of the EIA and the GIS output results are provided in Appendix G.

7.1 METHODS

The EIA was conducted using methods developed by Faber-Langendoen et al. 2006 and Faber-Langendoen et al. 2009. An index of ecological intactness was determined based on metrics of biotic and abiotic condition, size, and landscape context. Each metric was rated by comparing measured values with the expected values under relatively unimpaired conditions (i.e., operating within the natural range of variation). A rating or score for individual metrics, as well as an overall index of EI was generated to provide a large-scale assessment of ecoregion conditions. The EIA was conducted using ESRI ArcGIS Spatial Analyst tool following a similar spatial analysis approach used by the State of Montana (Vance 2009). The EIA focused primarily on three main components used in the EI spatial analysis: vegetation cover, hydrology, and anthropogenic effect.

The EI analysis for terrestrial systems required identification of native or natural areas throughout the Northwestern Plains to create geospatial data displaying relative “naturalness or native areas” of existing vegetation. The terrestrial habitat modeling for EI focused on use of land cover data sets (NLCD) to extract relevant information regarding large intact “natural or native” vegetation within each 5th level HUC. This factor was important in determining the overall terrestrial EI score for each watershed and was used to account for the departure of each watershed from its “natural” state. The next step of the terrestrial EI was to apply a set of KEAs to the selected natural areas in order to obtain a score or relative ranking of the natural areas located throughout the ecoregion. Metrics developed for other regions such as those used in the state of Washington (WHCWG 2010) to assess patch quality and connectivity were also adapted to the EIA to the extent practicable.

The attributes and indicators associated with aquatic EI were categorized by size, landscape context, and condition following Unnasch et al. (2009). The EI metrics from several wetland assessments developed by the Montana NHP, the USFS and others (Vance 2005; Vance 2009; Wang et al. 2008; Joubert and

Loomis 2005; Potyondy and Geier 2011) were used to the extent practicable given the ecoregion scale and the diverse and non-overlapping data sources.

The data and scoring methods used in the terrestrial EI analyses focused on the 5th Level HUC as the reporting unit. Because the data used in the aquatic EIA was at a finer scale, the initial analysis was completed at the 6th level HUC and then rolled up to the 5th level HUC as the reporting unit.

A CE richness value (total number of fine-filter CEs) for each 5th level HUC was calculated using the distribution overlays created for the fine-filter CEs analyses for each land cover class. The results from this analysis were compared to the results from the EI analysis.

7.2 ECOLOGICAL INTACTNESS OF TERRESTRIAL SYSTEMS

The results of the terrestrial EI analysis indicated some clear patterns are consistent with the quality of habitat within the ecoregion. The agricultural areas throughout the Missouri River Basin in eastern Montana and the Dakotas received predominantly poor terrestrial intactness scores as well as basins of the Marias and Milk Rivers in west-central Montana (Figure 7-1). These ratings were driven primarily by poor ratings for habitat size (Figure G-2) and poor ratings for habitat connectivity (Figure G-4).

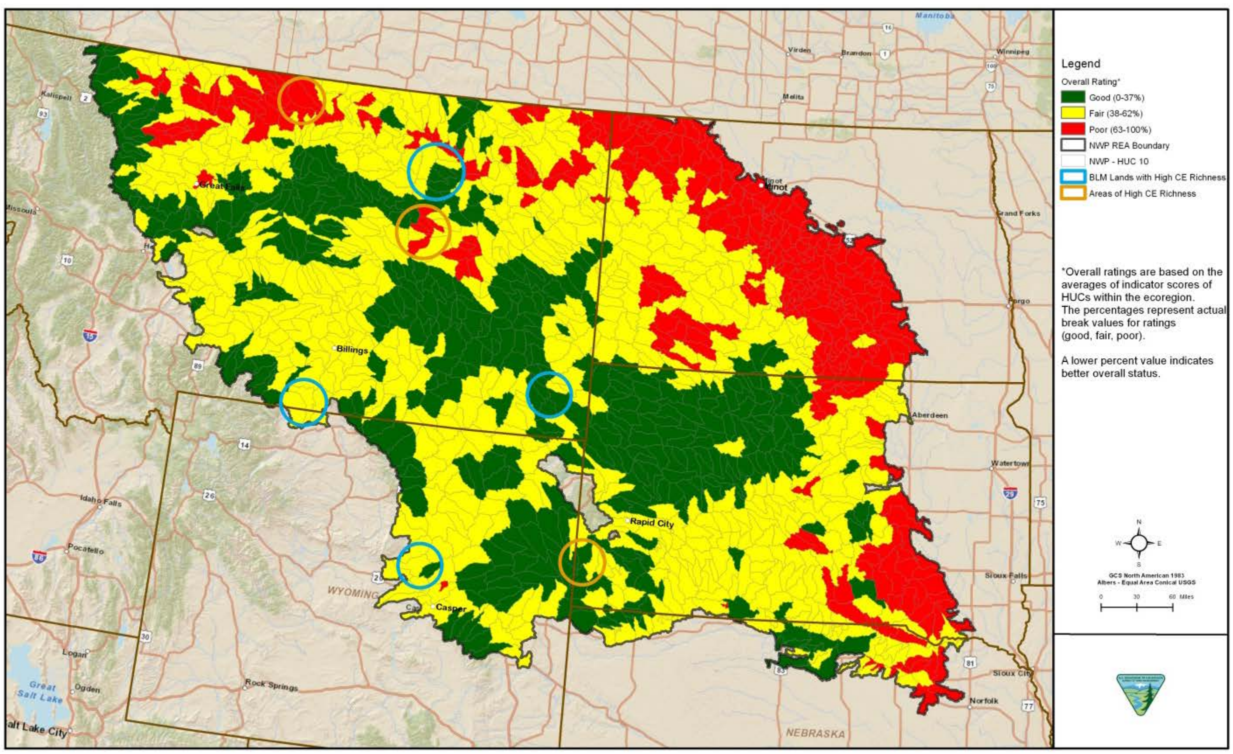

Figure 7-1. Terrestrial Ecological Intactness CE Richness Concentration Analysis with Overall EI Score

The foothill grasslands of western Montana, the central grasslands of Montana along the Yellowstone River, the grasslands within the Powder River basin of eastern Wyoming, and sagebrush steppe habitats south of Casper, Wyoming, were rated as good for terrestrial EI (Figure 7-1). The sagebrush steppe and prairie grasslands in northwest and north central South Dakota also received good intactness scores, predominantly due to the size of intact landscapes. Certain geographical areas within the ecoregion consistently received good scores. Custer National Forest (Montana), Lewis and Clark National Forest (Montana), and Flathead National Forests (Montana) are indicative of fair to good with regard to connectivity, development and size (Figures 7-1 and 7-3).

CE richness was calculated for the fine-filter CEs within the ecoregion using the distribution outputs developed for the fine-filter CE analyses. CE richness was high throughout most of the Montana's Central Grasslands and Glaciated Northern Grasslands and the Powder River Basin in Wyoming as expected based on the selection and distribution of the fine-filter CEs (Figure 7-2). Three general areas, as noted by the orange circles on Figures 7-1 and 7-2, were identified based on high CE richness but resulted in poor or fair EI ratings. Most notable is the Marais and Milk River basins in west-central Montana. These areas are impacted by both low connectivity and low habitat size however, the VCC rating for fire return departure substantially contributed to the poor EI rating (Figure G-3). Similar conditions also resulted in a poor EI rating south of Fort Peck Lake, Montana.

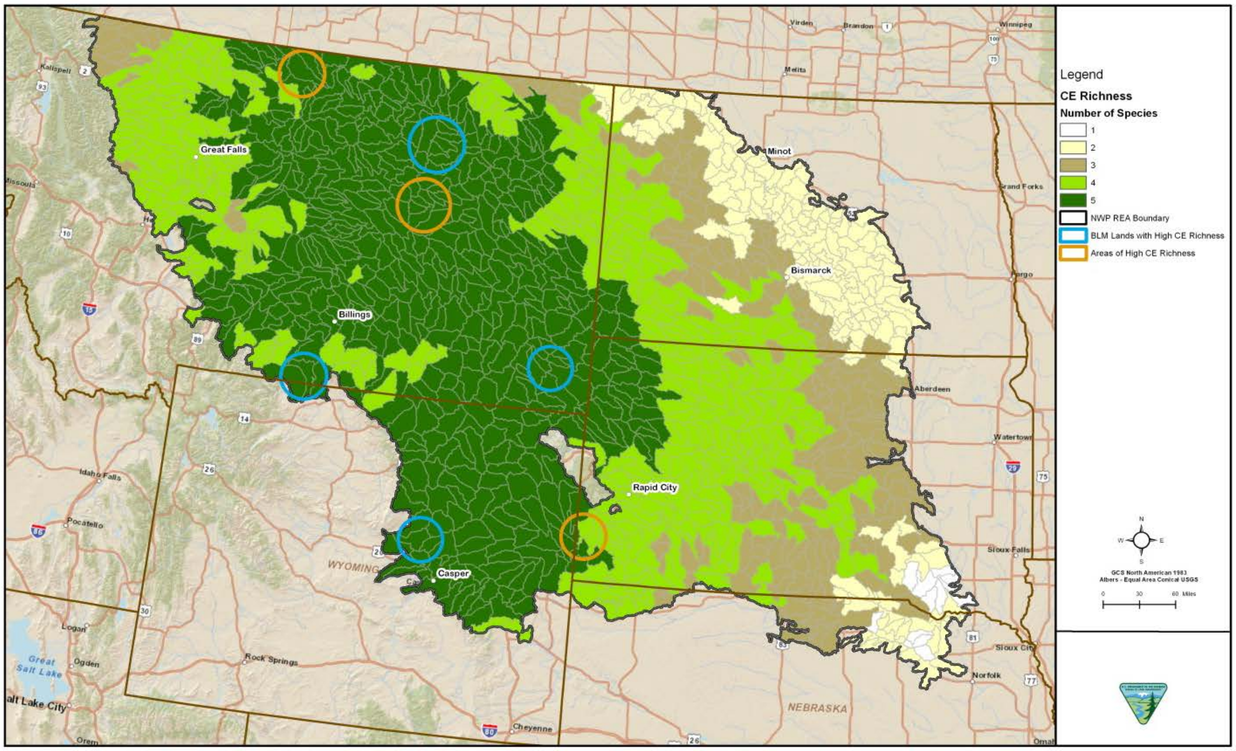

Figure 7-2. Terrestrial Ecological Intactness CE Richness Concentration Analysis by HUC

Several national forests and grasslands are located in the south-central area of the ecoregion and include the Black Hills National Forest, the Thunder Basin National Grassland and the Buffalo Gap National Grassland (Figure 7-3). The terrestrial EI ratings across most of these federal lands are rated as good; however areas immediately surrounding these federal lands within southwestern South Dakota received poor ratings for habitat size (Figure 7-1).

Terrestrial EI was also evaluated for large tracts of BLM lands within the ecoregion. Four of the largest BLM lands across the ecoregion were compared to CE species richness. Areas with the highest CE richness within these large tracts are noted by the blue circles on Figures 7-1 through 7-3. The EI analysis for two of the four areas indicates that EI is rated as fair which would suggest areas of possible interest for more detailed step-down analysis. The BLM lands east of Custer National Forest and extending up the Yellowstone River valley to the Little Missouri National Grassland (Figure 7-3) are within a larger area of the ecoregion that received a good EI rating. Also, the BLM lands north of Fort Peck Lake, Montana, were rated with terrestrial EI ratings from good to fair. These areas are recommended for step-down analysis.

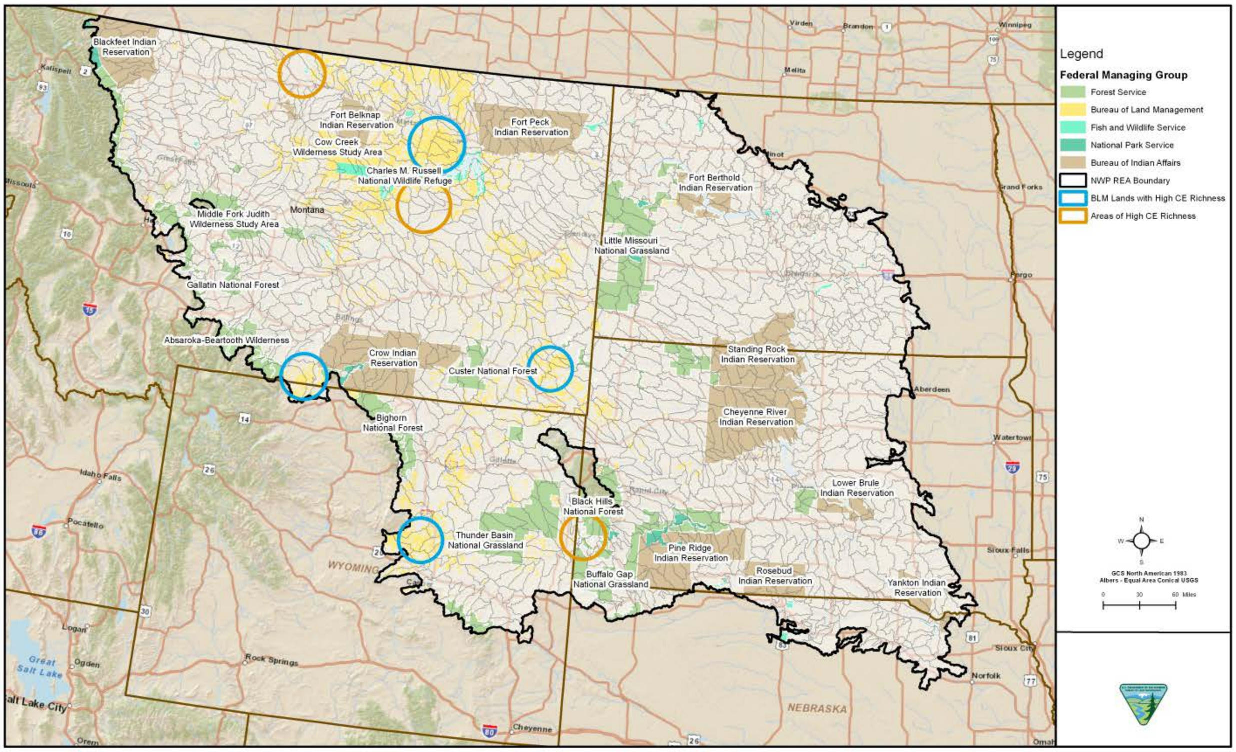

Figure 7-3. Terrestrial Ecological Intactness CE Richness Concentration Analysis with Federally Managed Lands

7.3 ECOLOGICAL INTACTNESS OF AQUATIC SYSTEMS

Aquatic EI results varied substantially across the ecoregion and generally showed lower EI overall (Figure 7-4) for the aquatic habitats as compared to the terrestrial habitats of the ecoregion. The impact of agricultural areas associated with the Missouri River system in the ecoregion was substantial in the aquatic EI results. In Montana, the aquatic habitats of the Marias and Milk Rivers are threatened by potential impacts associated with oil and gas wells and roadways. These areas also lack natural land cover and agricultural use is common within the riparian corridors (Figures G-10, G-11, G-15, G-16, and G-17). In North Dakota, and in particular, the Missouri River basin, a greater percentage of aquatic habitats were rated as poor with the exception of only a few watersheds within the south-central part of the state. Other stream segments in Montana and North Dakota were rated as poor due to their inclusion on the EPA 303d listing (Figure G-12).

In Wyoming, the aquatic EI was influenced by energy-related development. The aquatic EI resulted in a majority of the HUCs rated as fair with impacts associated with the number of mines, number of oil and gas wells, and roadways as major concerns. In contrast to the other states within the ecoregion, a greater percentage of good ratings for the aquatic EI resulted for HUCs in South Dakota, primarily along the Cheyenne and White Rivers (Figure 7-4). This result is offset however, by the presence of poor and fair watersheds associated with the Missouri River.

CE richness was calculated for the fine-filter CEs within the ecoregion using the distribution outputs developed for the CE analyses. CE richness was highest along Missouri River basin in central and eastern Montana based on the distribution of the big river fish and the prairie fish species (Figure 7-5). Most of the Missouri River Basin in eastern Montana, however, received a poor aquatic EI rating and are likely threatened by agricultural impacts (Figure G-17). This area would benefit from step-down analysis to better understand and estimate risks to aquatic habitats.

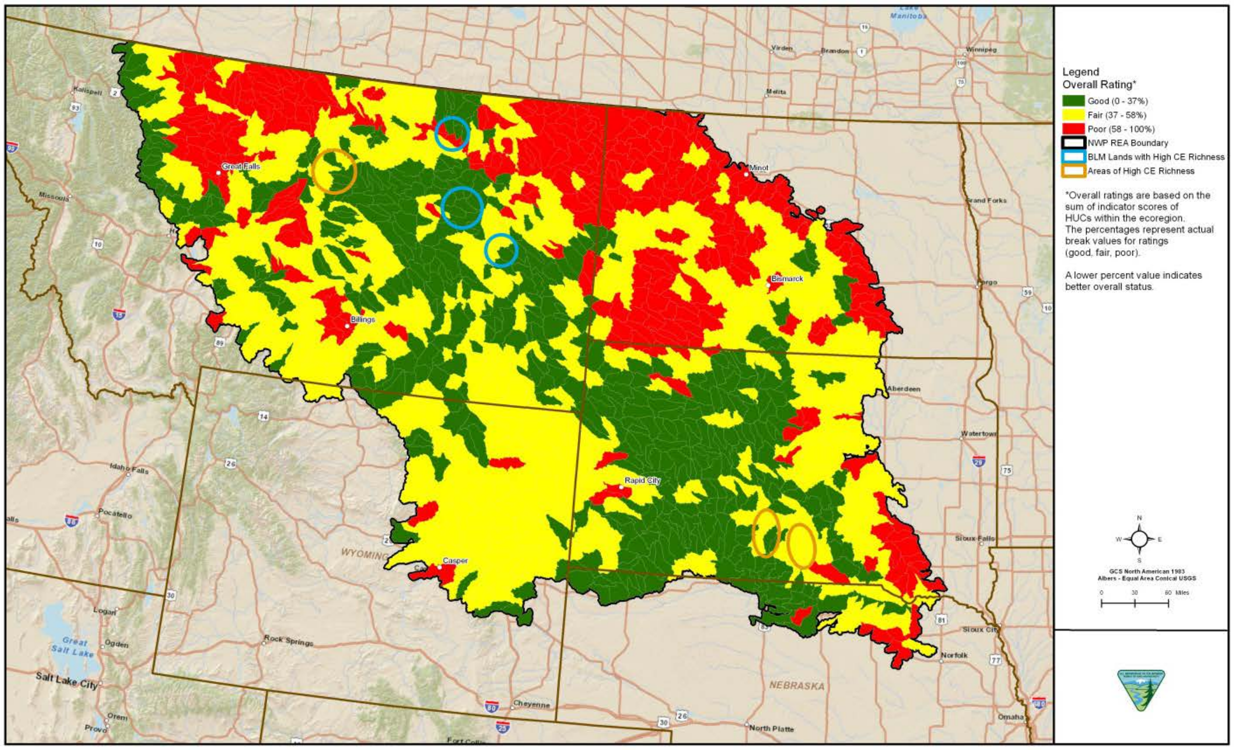

Figure 7-4. Aquatic Ecological Intactness CE Richness Concentration Analysis with Overall EI Score

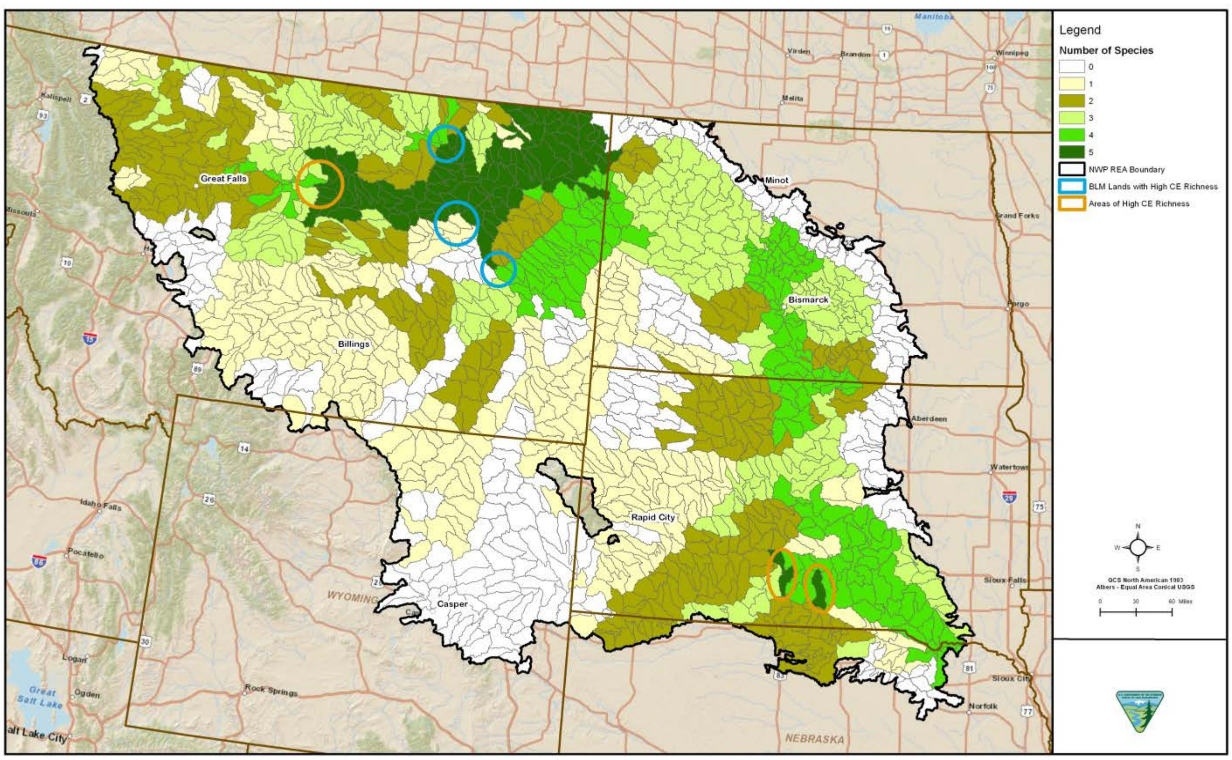

Figure 7-5. Aquatic Ecological Intactness CE Richness Concentration Analysis by HUC

Two other areas of high CE richness as noted by the orange circles on Figure 7-5 were identified in South Dakota's White River region. The aquatic EI ratings for these areas were rated as fair (Figure 7-4).

The aquatic EI was also evaluated for large tracts of BLM managed lands within the ecoregion. Three BLM managed areas with high CE richness as noted by the blue circles on Figures 7-4 through 7-6 were compared the aquatic EI ratings. The EI analysis on two of the three areas indicates that the EI is rated as good. The aquatic habitats within BLM-managed lands north of Fort Peck Lake, Montana, and associated with the Milk River were rated as poor. These areas would also be good candidates for step-down analysis.

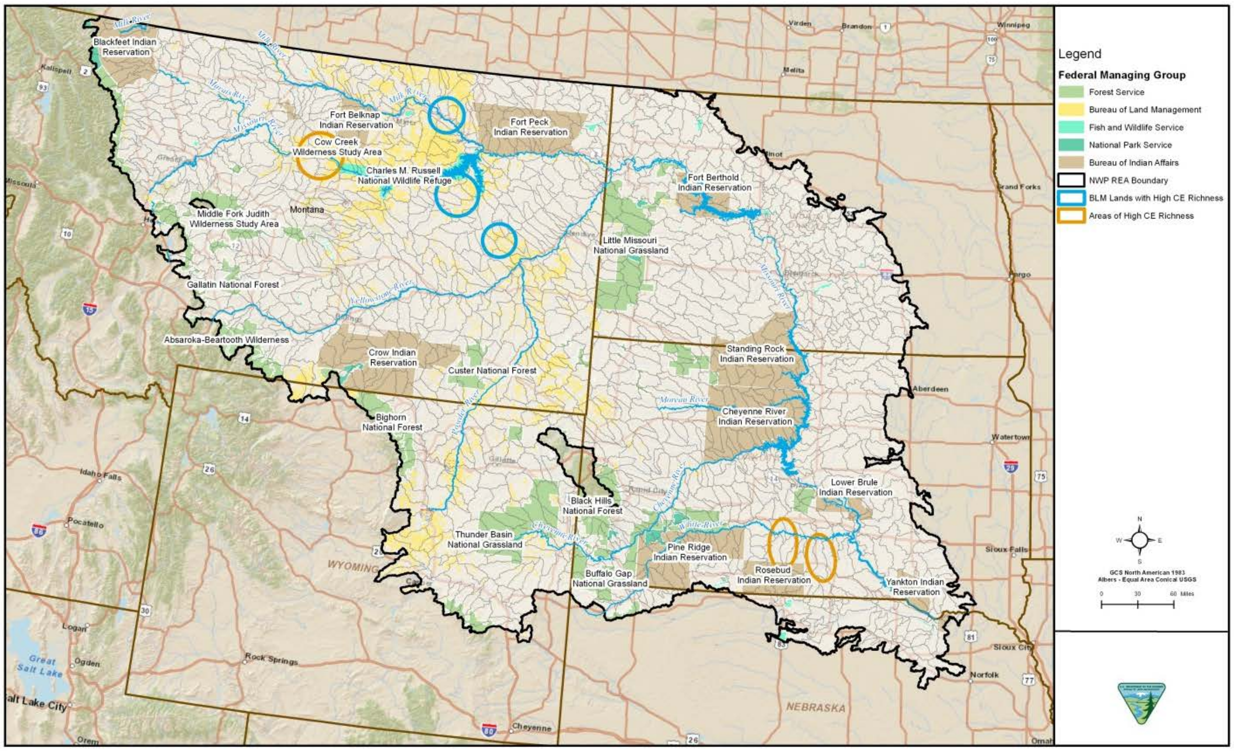

Figure 7-6. Aquatic Ecological Intactness CE Richness Concentration Analysis with Federally Managed Lands

8.0 LESSONS LEARNED

In the past, landscape scale assessments have proven to be very challenging for a number of different reasons. Some of these reasons include the wide variety of resources that are being evaluated, the relative 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.

As mentioned above, evaluating resources at a landscape scale is very challenging. Some of the lessons learned are lessons that should be used to enhance the quality of future REA processes and documents. The majority of the lessons learned relate to the acquisition and manipulation of geospatial data. Unfortunately, many of the multi-state datasets that were required for this REA were not previously assembled and available for use for this ecoregion. Many of the datasets that were used for this ecoregion required some form of edge-matching or re-classification before they could be used. The initial direction for this REA was that the reporting unit for the final output would be rolled up to the 6th level HUC. However, the original and modeled datasets were maintained in their native resolution where possible.

The process of "rolling" datasets up to the HUC level forces the analysis to average up from small scale to large scale. The 6th level HUC watersheds in this ecoregion range between 10,000 and 40,000 acres, whereas one pixel can equate to approximately 0.22 acres. For a more specific example, the current status analysis was completed only on the distribution are of each CE. If the CE distribution area only included one 30-m pixel in a 6th level HUC, the entire HUC would be characterized as CE distribution area and the entire HUC would also be rated the same good, fair, or poor status as that one 30-m pixel.

The KEA process that was used for the REA was based off of Unnasch et al. (2009) and Parrish et al. (2003). This process was not completely conducive to the completion of a current status analysis because some of the KEAs that were developed were not actual threats to the CE but were more along the lines of deductive modeling where the KEA attempted to describe the size of something (colony size, patch size, etc.) and then rate those sizes as good, fair or poor. A specific example of this was in the Northwestern Plains where the Rolling Review Team developed a KEA to evaluate prairie dog colony sizes with the largest sized colonies being rated as good, the medium sized colonies being fair and the small colonies being poor. One of the peer reviewers commented on this approach and indicated that small colonies are just as important as large colonies and that colony size should not be mixed with other KEAs such as the density of roads to develop an overall current status ranking for the assemblage. As a result, the metric for the colony size KEA was changed to large, medium and small and this KEA was not included in the "roll up" of all of the KEAs but kept as a separate analysis.

In addition to CA or threat KEAs being mixed with size KEAs, some KEAs were developed using the watershed as the analysis unit while others were developed using the pixel as the analysis unit. This is problematic because if one KEA analysis is completed at the HUC level then all of the KEA analyses would be required to be completed at the HUC level. The reason for this is because if the data is not standardized to a single analysis unit from the beginning, the results will be biased to the larger analysis unit. One example would be if some of the KEAs in a CE current status analysis use a pixel based Euclidean distance analysis to determine proximity from anthropogenic development and other KEAs in the same analysis use the number of wells per HUC.

In this example, because the analysis units are different, the pixels from the Euclidean distance analysis would need to be rolled up by averaging to the HUC level. This averaging increases the scale of the analysis from the 30-m pixel to the HUC level thereby increasing the coarseness of the analysis.

Throughout the REA process, information on new datasets that could potentially be utilized to enhance maps, models or other REA products was provided. In order to be able to complete this ecological assessment in a "rapid" manner, a deadline for receipt of data that would be used in the REA was established. Unfortunately, data continued to be provided after this deadline. New and perceived "better" data can create a variety of problems throughout the REA process including the requiring re-completion of analysis. This was a substantial issue for this REA and should be considered for future REAs. If data are not available at the time of need, it should be considered a data gap, and approaches, models, surrogates, or other attempts to fill these gaps without actual data should be discouraged, as these are not conducive to completing a "rapid" assessment.

Lastly, the KEA analysis extent area was determined to only be the CE distribution area of the ecoregion and not the entire ecoregion. Limiting the KEA analysis to the CE distribution extent has the potential to create artificial barriers in the KEA analysis. For example, if a moving window analysis is required to complete one of the KEA analyses, limiting the analysis to only the distribution area could artificially bias the analysis near the edges of the distribution depending on what the analysis is evaluating. Initiating new REAs with the knowledge of how to deal with the lessons described above will improve the output of future REAs.

8.1 SUMMARY OF ANALYSIS

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 CEs (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 CA analyses provides answers to the MQs. Summaries of the results of the analysis are located in the main body of this report with the appendices containing the detailed information on the models, methods, tools and summaries of the CEs and CAs.

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 KEAs that were developed.

8.2 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. Although data were not assessed for accuracy, a data quality evaluation was completed as part of the initial phase. Because misclassification of data could substantially 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-m by 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 foot 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 a species' abilities are known and can be related to environmental data and therefore reasonably modeled. Upon review of all of the figures in this appendix, it must be recognized that there is a mixture of data quality throughout the process. 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.
- 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.
- The natural breaks method of distributing the data between the good, fair, and poor categories has the potential to dilute the data.
- Rolling the analysis up to the watershed level also dilutes the original data.

8.3 SIGNIFICANT DATA GAPS

Several issues relevant to the assessment of CAs in the ecoregion were not addressed in sufficient detail to include in this REA, primarily originating from incomplete or lacking data on both biological patterns and processes for the CEs and the CAs. Each of the documents provided in Appendices C, D and E provides information on CE or CA-specific data gaps. Other ecoregion-wide data gaps are also apparent. Further analysis or data gathering is suggested in order to address the MQs developed for the ecoregion. These issues include:

- The identification of appropriate winter ranges across state lines,
- For certain big game species there was an apparent lack of corridor mapping,
- Data on some game species were not as readily available as that of protected species, and
- Data on invasive species.

Invasive species were identified as one of the primary CAs for this REA. Although some localized data exist for some of the invasive species, no comprehensive national or ecoregion-wide data sources were identified for any of these species. For the terrestrial invasive species county level herbariums were contacted for occurrence information. Occurrence information at this level seemed to be generally available but the collection of that information was outside the scope of this analysis. The BLM should focus resources on the identification and collection of data and information to fill these gaps.

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9.0 GLOSSARY

Accuracy	The closeness by which a set of measurements approaches the true value
Assessment Management Team (AMT)	BLM's team that provides overall direction and guidance to the REA and makes decisions regarding ecoregional goals, resources of concern, conservation elements, change agents, management questions, tools, methodologies, models, and output work products. The team generally consists of State Resources Branch Managers from the ecoregion, a POC, and possibly agency partners.
Area Sensitive	Species that respond negatively to decreasing habitat patch size. Area-sensitive species exhibit an increase in either population density or probability of occurrence with increasing size of a habitat patch.
Attribute	A defined characteristic of a geographic feature or entity.
Change Agent	An environmental phenomenon or human activity that can alter/influence the future status of resource condition. Some change agents (e.g., roads) are the result of direct human actions or influence. Others (e.g., climate change, wildland fire, invasive species) may involve natural phenomena or be partially or indirectly related to human activities.
Coarse filter	A focus of ecoregional analysis that is based upon conserving resource elements that occur at coarse scales, such as ecosystems, rather than upon finer scale elements, such as specific species. The concept behind a coarse filter approach is that preserving coarse-scale conservation elements will preserve elements occurring at finer spatial scales.
Community	Interacting assemblage of species that co-occur with some degree of predictability and consistency.
Conceptual Model	A conceptual ecological model delineating linkages between key ecosystem attributes and known stressors or agents of change is a useful tool for identifying and interpreting metrics with high ecological and management relevance (Noon 2003).
Conservation Element	A renewable resource object of high conservation interest often called a conservation target by others. For purposes of this TO, conservation elements will likely be types or categories of areas and/or resources including ecological communities or larger ecological assemblages.
Development	A type of change (change agent) resulting from urbanization, industrialization, transportation, mineral extraction, water development, or other non-agricultural/silvicultural human activities that occupy or fragment the landscape or that develops renewable or non-renewable resources.
Ecological Attributes	Defining characteristics of Conservation Elements that are especially pivotal, influence other characteristics of the Conservation Element, and affect long-term persistence or viability.

Ecological Landscape	Landscape units developed by the WDNR to provide an ecological framework to support natural resource management decisions. The boundaries of Wisconsin's sixteen Ecological Landscapes correspond to ecoregional boundaries from the National Hierarchical Framework of Ecological Units, but sometimes combine subsections to produce a more manageable number of units.
Ecological Integrity	The ability of an ecological system to support and maintain a community of organisms that has a species composition, diversity, and functional organization comparable to those of natural habitats within a region. (Unnasch et al. 2009) An ecological system has integrity, or a species population is viable, when its dominant ecological characteristics (e.g., elements of composition, structure, function, and ecological processes) occur within their natural ranges of variation and can withstand and recover from most variation imposed by natural environmental dynamics or human disruptions" (Parrish, Braun et al. 2003).
Ecoregion	An ecological region or ecoregion is defined as an area with relative homogeneity in ecosystems. Ecoregions depict areas within which the mosaic of ecosystem components (biotic and abiotic as well as terrestrial and aquatic) differs from those of adjacent regions (Omernik and Bailey 1997).
Ecosystem	The interactions of communities of native fish, wildlife, and plants with the abiotic or physical environment.
Element	The basic building blocks of the Natural Heritage Inventory. They include natural communities, rare plants, rare animals, and other selected features such as colonial bird rookeries and mussel beds. In short, an element is any biological or ecological entity upon which we wish to gather information for conservation purposes.
Extent	The total area under consideration for an ecoregional assessment. For the BLM, this is a CEC Level III ecoregion or combination of several such ecoregions plus the buffer area surrounding the ecoregion.
Fine filter	A focus of ecoregional analyses that is based upon conserving resource elements that occur at fine scale, such as specific species. A fine-filter approach is often used in conjunction with a coarse-filter approach (i.e., a coarse filter/fine-filter framework) because coarse filters do not always capture some concerns, such as when a T&E species is a conservation element.
Fire Regime	Description of the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects as well, in a given area or ecosystem. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval.

Hydrologic Unit	An identified area of surface drainage within the U.S. system for cataloging drainage areas, which was developed in the mid-1970s under the sponsorship of the Water Resources Council and includes drainage-basin boundaries, codes, and names. The drainage areas are delineated to nest in a multilevel, hierarchical arrangement. The hydrologic unit hierarchical system has four levels and is the theoretical basis for further subdivisions that form the watershed boundary dataset 5th and 6th levels.
Indicators	Components of a system whose characteristics (e.g., presence or absence, quantity, distribution) are used as an index of an attribute (e.g., land health) that are too difficult, inconvenient, or expensive to measure.
Index of Ecological Integrity	A complementary, integrated suite of Conservation Elements that collectively represent important ecological components of an ecosystem.
Invasive Species	Species that are not part of (if exotic non-natives), or are a minor component of (if native), an original community that have the potential to become a dominant or co-dominant species if their future establishment and growth are not actively controlled by management interventions, or that are classified as exotic or noxious 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 invasives.
Key Ecological Attribute	Critical or dominant characteristics of the resource, such as specific characteristics of: (a) demographic or taxonomic composition; (b) functional composition; (c) spatial structure; (d) range or extent; and 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.
Landscape Connectivity	A measure of the percent of unfragmented landscape within 1 km area (non-riverine), or degree to which the riverine corridor above and below a floodplain area exhibits connectivity with adjacent natural systems (riverine).
Landscape Species	Biological species that use large, ecologically diverse areas and often have significant impacts on the structure and function of natural ecosystems.
Landscape Unit	A set of decisions that establishes management direction for land within an administrative area, as prescribed under the planning provisions of FLPMA; an assimilation of land-use-plan-level decisions developed through the planning process outlined in 43 *Code of Federal Regulations (CFR)* 1600, regardless of the scale at which the decisions were developed. The term includes both resource management plans and management framework plans.

Management Questions	Questions from decision-makers that usually identify problems and request how to fix or solve those problems
Model	Any representation, whether verbal, diagrammatic, or mathematical, of an object or phenomenon. Natural resource models typically characterize resource systems in terms of their status and change through time. Models imbed hypotheses about resource structures and functions, and they generate predictions about the effects of management actions.
Migratory Bird Stopover Site	A site comprised of a set of habitats that birds select during migration. Ideal stopover sites provide accessible water, protection, and food so that birds can not only survive but also regain energy lost during their travels.
National Hierarchical Framework of Ecological Unit	A land unit classification system developed by the U.S. Forest Service and many collaborators.
Native Species	Species that historically occurred or currently occur in a particular ecosystem and were not introduced.
Natural Community	An assemblage of plants and animals, in a particular place at a particular time, interacting with one another, the abiotic environment around them, and subject to primarily natural disturbance regimes. Those assemblages that are repeated across a landscape in an observable pattern constitute a community type. No two assemblages, however, are exactly alike.
Rapid Ecoregional Assessment (REA)	The work plan (scope of services) that guides the Phase II Assessment component of a REA. This document fully establishes the design of the Phase II effort, and is essentially the 'blueprint' for that work effort and resulting products.
Regionally Significant	A native plant, wildlife, or fish resource or community that has a range of distribution and affects management concerns across two or more BLM field office boundaries and is more than locally important. Being more than locally important could include having qualities that give the resource special worth, meaning, or value.
Representative	Native plant species that would be expected to occur in native plant communities influenced primarily by natural disturbance regimes in a given landscape
Resource Value	An ecological value, as opposed to a cultural value. Examples of resource values are those species, habitats, communities, features, functions, or services associated with areas with abundant native species and few non-natives, having intact, connected habitats, and that help maintain landscape hydrologic function. Resource values of concern to the BLM can be classified into three categories: native fish, wildlife, or plants of conservation concern; regionally-important terrestrial ecological features, functions, and services; and regionally-important aquatic ecological features, functions, and services.
Scale	Refers to the characteristic time or length of a process, observation, model, or analysis.

Status	The condition of a criterion (biological or socio-economic resource values or conditions) within a geographic area (e.g., watershed, grid). A rating (e.g., low, medium, or high) or ranking (numeric) is assigned to specific criteria to describe status. The rating or ranking will be relative, either to the historical range of variability for that criterion (e.g., a wildland fire regime criterion) or relative to a time period when the criterion did not exist (e.g., an external partnerships/collaboration criterion)
Step-Down	A step-down is any action related to regionally-defined goals and priorities discussed in the REA that are acted upon through actions by specific State and/or Field Offices. These step-down actions can be additional inventory, a finer-grained analysis, or a specific management activity.
Watershed	A watershed is the 5th or 6th level, 10 or 12-digit unit of the hydrologic unit hierarchy. Fifth level HUCs range in size from 40,000 to 250,000 acres and 6th level HUC range in size from 10,000 to 40,000 acres. Also used as ecoregional term representing a drainage basin or combination of hydrologic units of any size.
Wildland Fire (Fire)	Any non-structure fire that occurs in the wildland.

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APPENDICES

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APPENDIX A
MANAGEMENT QUESTIONS

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Table A-1. Management Questions for the Northwestern Plains Ecoregion Rapid Ecoregional Assessment

MQ for Resource Value or CA	Example of the Application of this MQ
Terrestrial Biotic Resources Where are the important regionally significant terrestrial features, functions, and services across the ecoregional landscape?[1]	1. What is the current location/distribution of sites that have the greatest species richness?
	2. What are the regionally significant vegetation types? How are they distributed over the landscape (extent/pattern)? Where will current regionally significant vegetation types be at greatest risk from CAs?
	3. What regionally significant vegetation types are suitable for potential corridor connectors, and where are areas of potential restoration?
	4. Where are specially designated areas of high ecological value (designated by various agencies or in other work)? What levels of resource management and protection from future development exist in these areas, and where are adjacent areas with potential for restoring connectivity?
	5. What soils are present and what is their current condition?
	6. Which CAs are likely to affect soil fertility and erodibility?
	7. Where are areas of high soil erodibility due to wind or water erosion if existing vegetation cover is removed?
Aquatic/Riparian Biotic Resources Where are the important regionally significant aquatic/riparian biotic features, functions, and services across the ecoregional landscape?[1]	8. Where are the current locations of regionally significant aquatic/riparian habitats, including rivers, streams, lakes, ponds, wetlands, springs, and reservoirs?
	9. Where are current riparian or aquatic areas currently at risk of fragmentation impoundment, diversion, and lowered water tables due to development, mineral extraction, and agricultural and residential development?
	10. What is the current flow regime (hydrograph) of regionally significant stream or river habitats or duration and extent of surface water in regionally significant pond and lake habitats?
	11. What is the condition of aquatic systems, as defined by the Fish Passage Center (FPC)?
	12. How have dominant species changed over time?
	13. Where are exotic species an existing and potential problem?
	14. Where are degraded aquatic systems (water quality) and what are the sources of the degradation (saline discharges, petrochemical discharges, leaching of toxic mineral salts, eutrophication due to concentrated nutrient runoff, other)?
	15. Where will regionally significant aquatic habitats potentially be affected by CAs (duration, magnitude and temperature of flow; duration and extent of surface water presence, if applicable)?
	16. Where will regionally significant aquatic habitats potentially experience the greatest effects of climate change (duration and magnitude of flow, duration and extent of surface water presence, if applicable)?
	17. Where are the most species losses likely to occur due to temperature increases or water reductions?
	18. What/where is the potential for future change in dominant species composition of regionally significant aquatic habitats?
	19. What areas have potential for regionally significant aquatic habitat restoration (based on available geospatial data)?
	20. Where are areas of watershed habitat connectivity?
	21. Where are aquatic habitat strongholds for sensitive species that are intact and provide the best opportunity for protection, restoration, and enhancement?
	22. Where are sensitive aquatic species at risk from stream connectivity or from interbreeding with closely related non-native or exotic species?
	23. Where are areas of watershed habitat connectivity?

Table A-1. Management Questions for the Northwestern Plains Ecoregion Rapid Ecoregional Assessment (Continued)

MQ for Resource Value or CA	Example of the Application of this MQ
Landscape Species/Species Richness Where are the key habitat types (seasonal, refuges, corridors/connectivity, migration routes, concentrations of regionally significant species, etc.) for landscape species, keystone species, regionally significant species, and regionally significant suites of species?[1]	24. Where are areas that have potential for restoring regionally significant species habitat or habitat connectivity for regionally significant species?
	25. Where are the key habitat types (seasonal refuges, corridors/connectivity, migration routes, concentrations of regionally significant species)?
	26. Where are current regionally significant landscape/keystone species and their habitats, including seasonal habitat and movement corridors, at greatest risk from CAs, including climate change (connectivity, small population size)?
Wildland Fire Where could core regionally significant values be negatively and positively affected from altered wildland fire regimes (frequency, severity, and seasonality change from historic to present to future)?[1]	27. Where are areas that have been historically changed by fire suppression?
	28. Where are current areas with high fire frequency such that they burn on a regular basis?
	29. Where are Wildland Urban Interface (WUI) areas that have high potential for frequent fire?
	30. Where will CEs be at risk from altered fire regimes?
	31. Where are areas with potential to show future increases or decreases in wildfire frequency or intensity?
	32. Where do these areas intersect with human development, high conservation and restoration potential?
	33. Where are watersheds with high erosion potential vulnerable to high severity fire?
Invasive or Undesired Non-native Species, Insect and Disease Where will regionally significant values be affected through changes in the spatial distribution and abundance of invasive, (undesired) non-native species, and insect/disease outbreaks?[1]	34. What habitats have been, or have the potential to be, most severely affected by exotic invasions, and where are they?
	35. What areas have the greatest occurrence of invasive species (high, moderate, low effect)?
	36. Where are areas with invasive species that have restoration potential to reverse the infestation (high, moderate, low)?
	37. Which exotics have potential for control and which do not?
	38. Where are areas of potential future introduction and encroachment from invasive species currently known from the region?
	39. Which areas are experiencing the most rapid spread of invasives (may not be supported by existing data) and why?
	40. How might other CAs influence the introduction or spread of non-native species?
	41. Which insects and diseases might pose a significant future problem?
	42. Where will state and federal high-valued resource areas be affected through changes in intensity and range of insects and disease?
	43. What has the change been in frequency and severity of outbreaks (in the last 50 years) and where have they occurred?
	44. How and where are frequency and severity of outbreaks expected to change in response to climate change and to other CAs such as change in fire frequency and intensity?
	45. What is the extent of recent (previous 5 years) forest mortality and what areas are susceptible to mortality over the next 5 years?
	46. Where are the whitebark pine and other pine stands that have been substantially impacted by the mountain pine beetle?
	47. Based on climate change models, what areas could be susceptible to beetle infestation or disease in the future?
	48. Where are the forests that have been substantially impacted by disease?
	49. Where are the stands of ponderosa, lodgepole, and whitebark pine that have not been impacted by the insects or disease?

Table A-1. Management Questions for the Northwestern Plains Ecoregion Rapid Ecoregional Assessment (Continued)

MQ for Resource Value or CA	Example of the Application of this MQ
Urban, Agricultural, Industrial, & Water Development Where will core regionally significant values be affected through development?.[1]	50. Where are areas of existing, planned, and potential future development, including roads (based on existing WUI literature, including Theobald and others)?
	51. Where will the WUI increase as a result of urban/suburban/exurban and second/vacation home development relative to state and federal areas of high conservation and restoration potential?
	52. Which core CEs are threatened by sod-busting, energy development, gravel mining, fragmentation, loss of connectivity, and other development pressures?
	53. Where are areas of existing, planned, and future renewable and non-renewable energy development (based on existing geospatial databases), including locations of existing leases, relative to areas of high conservation and restoration potential?
	54. Where are existing, planned, and potential corridors, including roads, transmission lines, and pipelines, and how do they relate geographically to state and federal high value areas?
	55. Where are likely sources and sinks of discharge from such developments that may diminish quality of receiving waters and habitats (e.g., saline discharges)?
	56. Location of methane extraction ponds located that could serve as breeding sites for mosquitoes carrying West Nile virus and threaten Sage-grouse?
	57. Where are aquifers and their recharge basins? What is the current and projected land use in these areas?
	58. Where are areas in which groundwater extraction has the potential to change surface flow?
	59. Where are areas with high densities of surface water impoundment?
	60. Where do surface water diversions or ground water withdrawals have the potential to create discontinuity between spawning and other habitats (i.e., by creating seasonally dry or impassible stream reaches)?
	61. Where are opportunities to restore continuity in habitats?
	62. Where are existing, planned, and potential areas for development or expansion of recreation areas [e.g., off-highway vehicle (OHV) and snowmobile routes, ski areas, reservoirs) in proximity to areas of high conservation and restoration potential?
	63. Where are existing, planned, and potential visitor serving facilities (food, lodging, etc.) and corridors, including roads and utilities, and how do they relate geographically to high conservation value areas?
	64. On public lands, where are high conservation value resource areas vulnerable to unauthorized use?

Table A-1. Management Questions for the Northwestern Plains Ecoregion Rapid Ecoregional Assessment (Continued)

MQ for Resource Value or CA	Example of the Application of this MQ
Climate Change Where will regionally significant values be affected by climate change?[1]	65. Where are climatic zones located today and what are the potential realistic scenarios for climate (precipitation, temperature, evapotranspiration, storm intensity, flood frequency, etc.) and the impacts to regionally significant ecological values?
	66. Where are species habitats most vulnerable to climate change?
	67. Where are areas of state and federal high conservation value and restoration potential most vulnerable to climate change?
	68. Where are watersheds with the greatest potential for alterations in thermal regime and hydrologic regime? What will these changes be?
	69. Where are surface water and groundwater availability likely to change?
	70. What are predicted changes in the distribution of vegetation types given climate change (including changes to extramural climate)?
	71. Where are CE species' habitats most vulnerable to changing climatic conditions?
	72. What and where are the vegetation types and seral stages that are carbon sinks and carbon sources? What actions in those vegetation types alter the sink/source balance?
	73. Where are the highly vulnerable stands of major tree species susceptible to impacts from climate change over the next 50 years and what is the potential for decreased carbon sequestration on public lands?
	74. Where are potential carbon sequestration areas?

[1] Regionally Significant – A native plant, wildlife, or fish resource or community that has a range of distribution and affects management concerns across two or more BLM field office boundaries and is more than locally important. Being more than locally important could include having qualities that give the resource special worth, meaning, or value.

APPENDIX B

GAP ANALYSIS PROGRAM VEGETATION SYSTEMS

Idaho Land Cover Classification System Cross-Walk with the Northwestern Plains Level 3 Ecological Systems

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APPENDIX C

CHANGE AGENT DESCRIPTIONS AND ANALYSES

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APPENDIX D

COARSE-FILTER CONSERVATION ELEMENT DESCRIPTIONS AND ANALYSES

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APPENDIX E

FINE-FILTER CONSERVATION ELEMENT DESCRIPTIONS AND ANALYSES

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APPENDIX F

DATA QUALITY EVALUATION

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APPENDIX G

ECOLOGICAL INTACTNESS

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APPENDIX H

CLIMATE CHANGE VULNERABILITY INDEX DOCUMENTATION

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Data Request Method

Rapid Ecoregional Assessments (REAs)—National Operations Center, CO

Individual REA data layers and some other products are still available but are no longer being published.

If you would like to obtain more information, including data and model zip files* (containing Esri ModelBuilder files for ArcGIS 10.x and relevant Python scripts), please email **BLM_OC_REA_Data_Portal_Feedback_Team@blm.gov**.
*Note that a few models require software that BLM does not provide such as R, Maxent, and TauDEM.

Models associated with individual REAs may require data links to be updated to function properly. REA reports, technical appendices, and model overviews (for some REAs) contain detailed information to determine what products are available and what datasets are necessary to run a certain model.

Please include the report name and any specific data information that you can provide with your request.

Other BLM data can be found on the Geospatial Business Platform Hub (https://gbp-blm-egis.hub.arcgis.com).