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Wyoming Basin Rapid Ecoregional Assessment

Edited by Natasha B. Carr and Cynthia P. Melcher

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U.S. Department of the Interior
U.S. Geological Survey

Front cover photograph: Area near Little Mountain in southwestern Wyoming. Photo by Timothy J. Assal, U.S. Geological Survey.

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

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Contents

Editors and Contributing Authors....vi

Executive Summary viii

Acknowledgments x

Acronyms Used in this Report....xi

Scientific Names of Species Used in This Report....xiii

Conversion Factors.... xvii

Scientific Notation Used in This Report.... xvii

How to Use the Wyoming Basin Rapid Ecoregional Assessment xviii

Section I. Wyoming Basin Rapid Ecoregional Assessment Overview and Synthesis
Chapter 1—Introduction and Overview.... 1
Chapter 2—Assessment Framework.... 22
Chapter 3—Synthesis of Key Findings for the Wyoming Basin Rapid Ecoregional Assessment.... 63

Section II. Change Agents—Current and Future
Chapter 4—Development 126
Chapter 5—Wildland Fire 141
Chapter 6—Terrestrial Invasive Plant Species 155
Chapter 7—Climate Analysis.... 165

Section III. Assessments of Communities
Chapter 8—Streams and Rivers.... 204
Chapter 9—Wetlands 235
Chapter 10—Riparian Forests and Shrublands.... 261
Chapter 11—Sagebrush Steppe.... 287
Chapter 12—Desert Shrublands.... 315
Chapter 13—Foothill Shrublands and Woodlands.... 339
Chapter 14—Montane and Subalpine Forests and Alpine Zones.... 363

Section IV. Assessments of Species and Species Assemblages
Chapter 15—Aspen Forests and Woodlands 392
Chapter 16—Five-Needle Pine Forests and Woodlands 429
Chapter 17—Juniper Woodlands.... 465
Chapter 18—Cutthroat Trout 492
Chapter 19—Three-Species Fish Assemblage.... 529
Chapter 20—Northern Leatherside Chub 558
Chapter 21—Sauger.... 578

Chapter 22—Spadefoot Assemblage 603
Chapter 23—Greater Sage-Grouse 627
Chapter 24—Golden Eagle 664
Chapter 25—Ferruginous Hawk 691
Chapter 26—Sagebrush-Obligate Songbirds 717
Chapter 27—Pygmy Rabbit 741
Chapter 28—Mule Deer 768

Section V. Landscape Intactness
Chapter 29—Landscape Intactness 803

Appendix 829

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Executive Summary

Rapid Ecoregional Assessments

The overall goals of the Bureau of Land Management (BLM) Rapid Ecoregional Assessments (REAs) are to identify important ecosystems and wildlife habitats at broad spatial scales; identify where these resources are at risk from development, wildfire, invasive species, and climate change; quantify cumulative effects of anthropogenic stressors as required by the National Environmental Policy Act; and assess current levels of risk to ecological resources across a range of spatial scales and jurisdictional boundaries by assessing all lands within an ecoregion. The REAs provide an assessment of (1) baseline conditions for long-term monitoring of broad-scale conditions and trends; (2) landscape-level intactness of ecological communities, habitats for priority species, and the ecoregion overall; and (3) a predictive capacity for evaluating future risks. Ecoregional assessments also can identify data gaps and important ecological attributes, which can inform the development of monitoring strategies for assessing status and trends. The BLM State and field offices and other stakeholders may use this information to facilitate land-use planning and prioritize actions for conservation, restoration, and development, including the development of best-management practices and usage authorizations. By addressing priority management issues identified by multiple Federal and State agencies working collaboratively, REAs also foster interagency collaboration and help to ensure that REA results and products are relevant to multiple stakeholders. Although the REAs are informational tools and not decisionmaking documents, they provide a vehicle for creating stronger, more effective and efficient collaboration and cooperation among all parties interested in regional land and resource management.

Rapid Ecoregional Assessment Components

There are several components of the REAs. Management Questions, developed by the BLM and stakeholders for the ecoregion, identify the regionally significant information needed for addressing land-management responsibilities. Conservation Elements represent regionally significant species and ecological communities that are of management concern. The emphasis on ecological communities is based on the premise that intact and functioning ecological systems are more resistant to both natural and human stressors and are more resilient to these agents of change. Because it is not feasible to manage or monitor all species individually, protection of intact ecological communities may help to serve as a safety net for species not addressed specifically by the REA. Significant species or species assemblages that are of management concern, which may not be adequately addressed at the community level, were specifically addressed as Conservation Elements. The REA identifies and assesses primary factors, or Change Agents, that currently affect or are likely to affect the condition of species and communities in the future.

The Wyoming Basin Rapid Ecoregional Assessment

The Wyoming Basin Ecoregion encompasses approximately 133,656 square kilometers (km^2) (51,604.87 square miles [mi^2]), including portions of Wyoming, Colorado, Utah, Idaho, and Montana. The Wyoming Basin has some of the highest-quality wildlife habitats remaining in the Intermountain West. The wide variety of habitats includes intermountain basins dominated by sagebrush shrublands interspersed with deciduous and conifer woodlands and montane or subalpine forests at higher

elevations. The Wyoming Basin also supports ranching and agricultural operations that are important to the region's economy and vital to conserving habitats for wildlife. The region also contains abundant energy resources, including large natural gas reserves and areas of high wind-energy potential. Combined with increased residential and industrial development, fast-paced energy development is resulting in notable land-use changes, including habitat loss and fragmentation.

We evaluated the following Management Questions for each species and community for the Wyoming Basin REA. Core Management Questions address primary management issues including: (1) Where is the Conservation Element, and what are its key ecological attributes (characteristics of species and communities that may affect their long-term persistence or viability)? (2) What and where are the Change Agents? (3) How do the Change Agents affect the key ecological attributes? Integrated Management Questions synthesize the Core Management Questions: (1) Where are the areas with high landscape-level ecological values (based on key ecological attributes)? (2) Where are the areas with high landscape-level risks (based on Change Agents)? (3) Where are the areas with high conservation potential (highest ecological values, lowest risks)? (4) Where are the potential areas for restoration (highest ecological values, moderate-high risks)? (5) Where are the potential areas for development (lowest ecological values, highest risks)?

Seven major ecological communities were selected as Conservation Elements in the Wyoming Basin. Terrestrial communities include (1) sagebrush steppe, (2) desert shrublands, (3) foothill shrublands and woodlands, and (4) montane/subalpine forests and alpine zone. Aquatic communities include (1) streams and rivers, (2) wetlands, and (3) riparian forests and shrublands. We evaluated a total of 14 species and species assemblages (aspen forests and woodlands, five-needle pine forests and woodlands, juniper woodlands, cutthroat trout, three-fish assemblage, northern leatherside chub, sauger, spadefoot assemblage, greater sage-grouse, golden eagle, ferruginous hawk, sagebrush-obligate birds, pygmy rabbit, mule deer) as Conservation Elements.

We evaluated the four primary Change Agents required for the REA (development, fire, invasive species, and climate change). Additionally, we evaluated insects and disease for particular species and communities. Although grazing and off-highway vehicles were identified as important land uses, we determined that the data were not sufficient to evaluate these factors for the entire ecoregion. Instead, grazing and off-highway vehicles are best addressed with local information.

Assessment Framework

We used a standard assessment framework to evaluate the Management Questions for each species and community. One of the primary goals of the REA is to identify areas that have high conservation potential, also referred to as "large intact areas." At the ecoregion level, the ecological value of large intact areas is based on the assumption that because these areas have not been greatly altered by human activities (such as development), they are more likely to contain a variety of plant and animal communities and to be resilient and resistant to changes resulting from natural disturbances such as fire, insect outbreaks, and disease. Therefore, identifying large, relatively intact areas for species and communities is more likely to incorporate ecological processes that operate across a broad range of spatial and temporal scales, including nest-site or habitat, seasonal movements, and meta-population dynamics (such as dispersal and gene flow), habitat dynamics, and range shifts.

Integrated Management Questions summarize current landscape-level ecological values (based on key ecological attributes) and risks (based on Change Agents). The maps generated to address Core Management Questions for each species and community were ranked to assess values and risks. The combined ranks for landscape-level values and risks were used to rank the conservation potential of

modeled distribution or mapped occurrences of species and communities. This approach summarizes information in a format that can be used as a screening tool for evaluating conservation, restoration, and development potential, but requires local-level datasets to provide finer-scale details on the condition of ecological resources.

Rapid Ecoregional Assessment Products and Results

The results are structured around Management Questions for each Change Agent and Conservation Element. The information needed to address Management Questions is summarized in maps and (or) graphs in individual chapters for each Change Agent and Conservation Element. In addition, the Assessment Synthesis chapter provides a two-page synopsis of each Change Agent and Conservation Element.

Acknowledgments

It is with deep appreciation that we acknowledge the wise leadership provided by Robert "Bob" Means to the Wyoming Basin Rapid Ecoregional Assessment (REA). As the Bureau of Land Management's Project Coordinator for the REA, he worked tirelessly to partner with multiple stakeholders to ensure that the REA met the needs of many land management agencies and organizations. He tirelessly supervised the science activities to make sure that the highest standards were met while also ensuring its relevance to priority management issues, and it was Bob's vision to create a web-based REA data summary and screening tool, which has become a valuable teaching and decision-support tool. He also brought to the Wyoming Basin REA his dedication to the conservation of whitebark and limber pines—indeed, he has been credited with bringing to light the ecological importance and management issues for limber pine, which is now widely recognized as a species of management concern. Bob's recent research and publications on the genetics of ponderosa pine across the western U.S. also helped to inform the REA. Not only did Bob champion the direction and usefulness of the Wyoming Basin REA, he was skilled at bringing people together to solve problems. Overall, Bob's wealth of experience, knowledge, and leadership skills were instrumental to the REA's success. Sadly, Bob passed away suddenly on May 26, 2015. His support for the REA program and guidance ensuring that science is relevant to decisionmakers will be greatly missed.

We also thank the Wyoming Basin Rapid Ecoregional Assessment Management and Technical Teams, and stakeholders for their guidance in the development of this report and other materials. We appreciated reviews of this report and other materials that were provided by Erik A. Beever, Robert G. Bramblet, Ramana Callan, Sean P. Finn, Kimberlee D. Foster, Jill D. Frankforter, Matthew J. Germino, Steven E. Hanser, Steven T. Knick, Michael N. Kochert, Ian I. F. Leinwand, Susan K. McIlroy, Kevin L. Montieth, Beth A. Newingham, Susan L. Phillips, David S. Pilliod, Karen L. Prentice, Dennis F. Saville, Douglas J. Shinneman, George A. Soehn, David D. Susong, Zack Walker, and James K. Wolf. Tammy S. Fancher, Aaron T. Freeman, Daniel J. Manier, and Abra Ziegler provided assistance in developing maps or contributed information for the report.

Acronyms Used in this Report

ADI	Aquatic Development Index
AIM	Assessment, Inventory, and Monitoring program
BCSD	Bias-corrected spatial disaggregation product
BLM	Bureau of Land Management
BP	Before present
CCCM3	Canadian Centre for Climate Modelling and Analysis coupled global model, ver.3
CMIP3	Coupled Model Intercomparison Project, phase 3
COOP	Cooperative Observer Network of the National Oceanic and Atmospheric Administration's National Weather Service
ECHAM5	European Centre Hamburg (climate) Model, ver. 5 (from Max Planck Institute)
ENSO	El Nino-Southern Oscillation
ERC	Energy release component
EVT	Existing Vegetation Types
FAA	Federal Aviation Administration data
FRA	Federal Railroad Administration
GAP	U.S. Geological Survey National Gap Analysis Program
GCM	Global climate model
GFDL2.0	Geophysical Fluid Dynamics Laboratory, ver. 3, coupled climate model
GIS	Geographic information system
GISIN	Global Invasive Species Information Network
GeoMac	Geospatial Multi-Agency Coordination fire dataset
HADCM3	Hadley Centre Coupled (climate) Model, ver. 3, United Kingdom Meteorology Office
IPCC	Intergovernmental Panel on Climate Change
KBDI	Keetch-Byram Drought Index
LANDFIRE	Landscape Fire and Resource Management Planning
MaxEnt	Maximum Entropy modeling software
MAPSS	Mapped Atmosphere-Plant-Soil System Study
MIROC	Model for Interdisciplinary Research On Climate, ver. 3.2, University of Tokyo
MTBS	Monitoring Trends in Burn Severity
NAIP	National Agriculture Inventory Program
NARCCAP	North American Regional Climate Change Assessment Program
NASS	National Agricultural Statistics Service
NED	National Elevation Dataset
NDVI	Normalized difference vegetation index
NHD	U.S. Geological Survey National Hydrography Dataset
NIFMID	National Interagency Fire Management Integrated Database
NLDAS	North American Land Data Assimilation System
NOAA	National Oceanic and Atmospheric Administration
NOAH	National Centers for Environmental Prediction Hydrologic Research Lab Model
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory
NPS	National Park Service
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge

PCM1	Parallel Climate Model, ver. 1, National Center for Atmospheric Research
PDSI	Palmer Drought Severity Index
PPH	Preliminary Priority Habitat
PRISM	Parameter-elevation Regressions on Independent Slopes Model
PPM	Parts per million
REA	Rapid Ecoregional Assessment
reGAP	regional Gap Analysis Program
SAD	Sudden aspen decline
SAGEMAP	Sagebrush and Grassland Ecosystem Map Assessment Project
SGCN	Wyoming Species of Greatest Conservation Need
SOS	Sagebrush obligate songbirds
SM2	Slab Model 2 (Geophysical Fluid Dynamics Laboratory)
SNOTEL	Snowpack telemetry
SRES	Special Report on Emissions Scenarios (by the Intergovernmental Panel on Climate Change)
SWE	Snow water equivalent
TDI	Terrestrial Development Index
TIGER	Topological Integrated Geographic Encoding and Referencing
USGS	U.S. Geological Survey
VIC	Variable Infiltration Capacity
VPD	Vapor pressure deficit
WBD	Watershed Boundary Dataset
WRSD	Western U.S. Stream flow metric dataset
WSCO	Wyoming State Climate Office
WYNDD	Wyoming Natural Diversity Database

Scientific Names of Species Used in This Report

Plants

Alkali cordgrass (*Spartina grascilis*)
Alkali sacaton (*Sporobolus airoides*)
Alkali sagebrush (*Artemisia arbuscula*)
Alkaligrass (*Puccinellia* spp.)
Alpine avens (*Geum rossii*)
Alpine bistort (*Polygonum viviparum*)
Alpine laurel (*Kalmia microphylla*)
Alyssum (*Alyssum alyssoides*)
American pika (*Ochotona princeps*)
Antelope bitterbrush (*Purshia tridentata*)
Aspen (*Populus tremuloides*)
Barneby's clover (*Trifolium barnebyi*)
Basin big sagebrush (*Artemisia tridentata tridentata*)
Big sagebrush (*Artemisia tridentata*)
Birdfoot (*Artemisia pedatifida*)
Bitterbrush (*Purshia* spp., *Purshia tridentata*)
Black alpine sedge (*Carex nigricans*)
Black greasewood (*Sarcobatus vermiculatus*)
Black sagebrush (*Artemisia nova*)
Blue grama (*Bouteloua gracilis*)
Bluebunch wheatgrass (*Peudoroegneria spicata*)
Broadleaf cattail (*Typha latifolia*)
Bud sagewort (*Artemisia spinescens*)
Buffaloberry (*Shepherdia argentea*)
Bunch grass (*Agropyron* and *Poa* spp.)
Canada thistle (*Cirsium arvense*)
Cheatgrass (*Bromus tectorum*)
Chokecherry (*Prunus virginianua*)
Common marestail (*Hippuris vulgaris*)
Common reed (*Phragmites australis*)
Common spikerush (*Eleocharis palustris*),
Crested wheatgrass (*Agropyron cristatum*)
Curly pondweed (*Potamogeton crispus*)
Curveseed butterwort (*Ceratocephala testiculata*)
Desert alyssum (*Alyssum desertorum*)
Douglas-fir (*Pseudotsuga menziesii*)
Duckweed (*Lemna* spp.)
Dyer's woad (*Isatis tinctoria*)
Elk sedge (*Carex garberi*)
Englemann spruce (*Picea engelmanii*)
Fir (*Abies* spp.)
Five-needle white pine (Family *Pinaceae*)
Fringed sagewort (*Artemisia frigida*)
Gambel oak (*Quercus gambelii*)
Gardner saltbush (*Atriplex gardneri*)
Greasewood (*Sarcobatus vermiculatus*)
Green rabbitbrush (*Chrysothamnus viscidiflora*)
Halogeton (*Halogeton glomeratus*)
Hoary cress (*Cardaria draba*)
Idaho fescue (*Festuca idahoensis*)
Juniper (*Juniperus* spp.)
King spikefescue (*Leucopoa kingii*)
Knapweed (*Rhaponticum repens*)
Laramie columbine (*Aquilegia laramiensis*)
Leafy spurge (*Euphorbia esula*)
Limber pine (*Pinus flexilis*)
Limber pine dwarf mistletoe (*Arceuthobium cyanocarpum*)
Lodgepole pine (*Pinus contorta*)
Low sagebrush (*Artemisia arbuscula*)
Mountain big sagebrush (*Artemisia tridentata vaseyana*)
Mountain mahogany (*Cercocarpus* spp.)
Narrow-leafed cottonwood (*Populus angustifolia*)
One-seeded juniper (*Juniperus monosperma)*
Perennial pepperweed (*Lepidium latifolium*)
Pinyon (piñon) pine (*Pinus edulis*)
Plains cottonwood (*Populus deltoides*)
Ponderosa pine (*Pinus ponderosa*)
Prairie junegrass (*Koeleria macrantha*)
Precocious milkvetch (*Astragalus proimanthis*)
Purple loosestrife (*Lythrum salicaria*)
Quaking aspen (*Populus tremuloides*)
Rabbitbrush (*Chrysothamnus* spp.)
Redosier dogwood *(Cornus sericea*)
Rocky Mountain glasswort (*Salicornia rubra*)
Rocky Mountain juniper (*Juniperus scopulorum*)

Russet buffaloberry (*Shepherdia canadensis*)
Russian knapweed (*Rhaponticum repens*)
Russian olive (*Elaeagnus angustifolia*)
Russian thistle (*Salsola* spp.)
Sagebrush (*Artemisia* spp.)
Sago pondweed (*Stuckenia pectinata*),
Saltbush (*Atriplex* spp.)
Saltgrass (*Distichlis spicata*)
Saskatoon serviceberry (*Amelanchier alnifolia*)
Sedge (*Carex* spp.)
Serviceberry (*Amelanchier* spp.)
Shadscale (*Atriplex confertifolia*)
Shrubby cinquefoil (*Dasiphora fruticosa*)
Silver buffaloberry (*Shepherdia argentea*)
Silver sagebrush (*Artemisia cana*)
Skunkbush sumac (*Rhus trilobata*)
Smooth brome (*Bromus inermis*)
Snowberry (*Symphoricarpos* spp.)
Snowbush ceanothus (*Ceanothus velutinus*)
Spruce (*Picea* spp.)
Spurge species (*Euphorbia* spp.)
Starthistle (*Centaurea* spp.)
Stemless beardtongue (*Pentstemon aculis*)
Subalpine fir (*Abies lasiocarpa*)
Tamarisk (T*amarix* spp.)
Timberline bluegrass (*Poa glauca*)
Tumblemustard (*Thelypodiopsis* spp.)
Utah juniper (*Juniperus osteosperma*)
Western wheatgrass (*Pascopyrum smithii*)
Whitebark pine (*Pinus albicaulis*)
Whitetop (*Cardaria draba)*
Willow (*Salix* spp.)
Winterfat (*Ceratoides lanata*)
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)

Birds

American pipit (*Anthus rubescens*)
American white pelican (*Pelecanus erythrorhynchos*)
Ash-throated flycatcher (*Myiarchus cinerascens)*
Bald eagle (*Haliaeetus leucocephalus*)
Bewick's Wren (*Thryomanes bewickii)*
Black tern (*Chlidonias niger*)
Black-throated gray warbler (*Dendroica nigrescens)*
Blue-gray gnatcatcher (*Polioptila caerulea)*
Brewer's sparrow (*Spizella breweri*)
Brown-headed cowbirds (*Molothrus ater)*
Bullock's oriole (*Icterus bullockii)*
Burrowing owl (*Athene cunicularia*)
Clark's nutcracker (*Nucifraga columbiana*)
Common raven (*Corvus corax*)
Cowbird (*Molothrus* spp.)
Crow, raven, jay, magpie, nutcracker (Family Corvidae)
Falcons (*Falco* spp.)
Ferruginous hawk (*Buteo regalis*)
Golden eagle (*Aquila chrysaetos*)
Gray flycatcher (*Empidonax wrightii)*
Great horned owl (*Bubo virginianus*)
Greater sage-grouse (*Centrocercus urophasianus*)
Juniper titmouse (*Baeolophus ridgwayi)*
Lewis's woodpecker (*Melanerpes lewis*)
Loggerhead shrike (*Lanius ludovcianus*)
Long-billed curlew (*Numenius americanus*)
Long-eared owl (*Asio otus*)
Mountain plover (*Charadrius montanus*)
Northern harrier (*Circus cyaneus*)
Piñon (pinyon) jay (*Gymnorhinus cyanocephalus*
Sage thrasher (*Oreoscoptes montanus*)
Sagebrush sparrow (*Artemisiospiza nevadensis*, formerly sage sparrow [*A. belli*])
Townsend's solitaire (*Myadestes townsendi*)
Virginia's warbler (*Oreothlypis virginiae*)
Western scrub-jay (*Aphelocoma coerulescens*)
White-faced ibis (*Plegadis chihi*)
Yellow-billed cuckoo (*Coccyzus americanus*)

Mammals

American bison (*Bison bison*)
American marten (*Martes americana*)
Badger (*Taxidea taxus*)
Bear (*Ursus* spp.)
Beaver (*Castor canadensis*)
Bighorn sheep (*Ovis canadensis*)
Black bear (*Ursus americana*)
Black-tailed jackrabbit (*Lepus californicus*)
Bobcat (*Lynx rufus*)
Burro (*Equus asinus*)
Canada lynx (*Lynx canadensis*)
Canyon mouse (*Peromyscus crinitus*)
Chipmunk (*Tamias* spp.)
Cliff chipmunk (*Tamias dorsalis*)
Cottontail rabbit (*Sylvilagus* spp.)
Coyote (*Canis latrans*)
Deer (*Odocoileus* spp.)
Elk (*Cervus canadensis*)
Fox (*Vulpes* spp.)
Fringed myotis (*Myotis thysanodes*)
Gray wolf (*Canis lupus*)
Grizzly bear (*Ursus asrctos horribilis*)
Ground squirrel (*Spermophilus* spp.)
Great Basin pocket mouse (*Perognathus parvus*)
Jackrabbit (*Lepus* spp.)
Long-tailed weasel (*Mustela frenata*)
Moose (*Alces alces*)
Mountains lion (*Puma concolor*)
Mule deer (*Odocoileus hemionus*)
North American badger (*Taxidea taxus*)
Packrat (*Neotoma* spp.)
Piñon mouse (*Peromyscus truei*)
Piute ground squirrels (*Urocitellus mollus*)
Pronghorn (*Antilocapra americana*)
Pygmy rabbit (*Brachylagus idahoensis*)
Rabbit and hare (Family Leporiddae)
Richardson's ground squirrel (*Urocitellus richardsonii*)
Rocky Mountain mule deer (*Odocoileus hemionus hemionus*)
Swift fox (*Vulpes velox*)
Townsend's ground squirrel (*Urocitellus townsendii*)
Weasel (*Mustela* spp.)
White-tailed deer (*Odocoileus virginianus*)
White-tailed prairie dog (*Cynomys leucurus*)
Wild horse (*Equus caballus*)
Wyoming pocket gopher (*Thomomys clusius*)

Herptiles

Boreal toad (*Anaxyrus boreas boreas*) (formerly *Bufo boreas boreas*)
Bullfrog (*Lithobates catesbeiana*)
Columbia spotted frog (*Rana luteiventris*)
Eastern spadefoot (*Scaphiopus holbrookii*)
Great Basin spadefoot (*Spea intermontana*)
Midget faded rattlesnake (*Crotalus viridus concolor*)
Northern leopard frog (*Lithobates pipiens*)
Northern tree lizard (*Urosaurus ornatus*)
Plains spadefoot (*Spea bombifrons*)
Sagebrush lizard (*Scleroporus graciosus*)

Fish

Bluegill (*Lepomis macrochirus*)
Bluehead sucker (*Catostomus discobolus*)
Bonneville cutthroat trout (*Onchorhynchus clarkii utah*)
Brook trout (*Salvelinus fontinalis*)
Brown trout (*Salmo trutta*)
Burbot (*Lota lota*)
Colorado River cutthroat trout (*Onchorhynchus clarkii pleuricticus*)
Cutthroat trout (*Onchorhynchus clarki* ssp.)
Fathead minnow (*Pimephales promelas*)
Flannelmouth sucker (*Catostomus latipinnis*)
Lake trout (*Salvelinus namaycush)*
Largemouth bass (*Micropterus salmoides*)
Longnose dace (*Rhinichthyes cataractae*)
Longnose sucker (*Catostomus catostomus*)
Mosquito fish (*Gambusia affinis*)
Mountain sucker (*Catostomus platyrhynchus*)
Northern leatherside chub (*Snyderichthys copei*)
Rainbow trout (*Oncorhynchus mykiss*)
Razorback sucker (*Xyrauchen texanus*)
Red shiner (*Cyprinella lutrensis*)
Redside shiner (*Richardsonius balteatus*)
Roundtail chub (*Gila robusta*)
Sauger (*Sander canadensis*)
Smallmouth bass (*Micropterus dolomieu*)
Snake River finespotted cutthroat trout (*Onchorhynchus clarki behnkei*)
Southern leatherside chub (*Lepidomeda aliciae*)
Speckled dace (*Rhinichthys osculus*)
Utah sucker (*Catostomus ardens*)
Walleye (*Sander vitreus)*
White sucker (*Catostomus commersonii*)
Yellowstone cutthroat trout (*Onchorhynchus clarkii bouvieri*)

Other

Asian clam (*Corbicula fluminea*)
Crayfish (Order *Decapoda*)
Mountain pine beetle (*Dendroctonus ponderosae*)
Mudsnail (*Potamopyrgus antipodarum*)
New Zealand mudsnail (*Potamopyrgus antipodarum*)
West Nile virus (*Flavivirus* Japanese encephalitis antigenic complex)
Western spruce budworm (*Choristoneura occidentalis*)
White pine blister rust (*Cronartium ribicola*)
Zebra mussel (*Dreissena polymorpha*)

Conversion Factors

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
kilometer (km)	0.6214	mile (mi)
	Area	
square meter (m^2)	10.76	square foot (ft^2)
hectare (ha)	2.471	acre
square kilometer (km^2)	0.3861	square mile (mi^2)
	Flow rate	
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
	Mass	
	Dissolved Solids (Salinity)	
milligram per liter (mg/L)	0.000008345	pounds per gallon (lb/gal)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
°F=(1.8×°C)+32
Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:
°C=(°F-32)/1.8

Scientific Notation Used in This Report

Symbol	Meaning
<	Less than
≤	Less than or equal to
=	Equals
>	Greater than
≥	Greater than or equal to

How to Use the Wyoming Basin Rapid Ecoregional Assessment

Ecoregional Assessments

The Wyoming Basin REA was a collaborative effort between the U.S. Geological Survey (USGS) and the BLM, with assistance from stakeholders including the National Park Service; U.S. Fish and Wildlife Service; Wyoming Game and Fish Department; Utah Division of Wildlife Resources; Montana Fish, Wildlife and Parks; Wyoming County Commissioners; and Wyoming Natural Diversity Database. The Wyoming Basin REA incorporates multi-scale information to assess the landscape-level condition and trends of ecological resources, including the direct and indirect effects of land use. The overall goal is to provide information that can be used to facilitate land-use planning and prioritize actions for conservation, restoration, and development. In addition, the REAs quantify spatially explicit cumulative effects and provide a broader-scale ecological context for decision-making and planning (such as for Ecological Impact Statements, Resource Management Plans, and strategic planning) at various spatial extents (project, field offices, state, or ecoregion) that cannot be determined using local-level information. Because of the broad spatial extent, the datasets developed by the REAs lack local details and, consequently, REAs ideally will be used in conjunction with local-level information on conditions. Local-level research and monitoring can provide crucial details (such as resource conditions related to soil stability, hydrologic function, and biotic integrity provided by the BLM's Assessment, Inventory and Monitoring [AIM] Strategy [Toevs and others, 2011]); such information is necessary for planning and management activities, and they can be used to validate the predictions of REA models. The conservation potential maps from the REA synthesize the landscape-level information for each species, species assemblage, and ecological community, thereby providing a broad-scale screening tool for identifying potential areas for conservation, restoration, and development.

The Wyoming Basin REA builds on a previous sagebrush ecoregional assessment in the Wyoming Basin Ecoregion (Hanser and others, 2011). There are many similarities between the REA and the sagebrush assessment, particularly in relation to the overall goals, but there are some important distinctions. The REA addressed all vegetation types and associated species in the Wyoming Basin, whereas Hanser and others (2011) focused on the sagebrush ecosystem and associated species. Nevertheless, there were many species in common to both assessments, including greater-sage grouse, Brewer's sparrow, sagebrush sparrow, sage thrasher, and pygmy rabbit. Because of the short time frame allotted for conducting the REAs, we relied on existing regional datasets and used or adapted available models, whereas the sagebrush assessment was a multi-year research project that involved collection of new data and new model development. When appropriate, we incorporated results and models (for example, the greater-sage grouse habitat model) from the sagebrush assessment that addressed the Management Questions for this REA. There were many regional source datasets in common to both the REA and the sagebrush assessment, such as LANDFIRE, but in some cases more recent versions were available for this REA. The sagebrush assessment provides more extensive background information on the Wyoming Basin and summarizes the landscape-level effects of development for several energy fields and over the past hundred years, whereas the REA addresses regional energy effects on current landscape structure and provides projections of the potential for future energy development. As a consequence of these and other differences, the two assessments provide complementary information at the ecoregional level.

Report Organization

Section I

Section I provides background information on REAs and summarizes key findings for the Wyoming Basin REA. Most readers would benefit from reviewing the chapters in Section I, which provide information not duplicated in other sections. Chapter 1—Introduction and Overview provides an overview of the BLM's REA program and the required REA components, and it provides background on the ecological setting and management issues for the Wyoming Basin REA. Chapter 2—Assessment Framework describes the standard methodologies used to assess the landscape-level status of each Conservation Element: seven ecological communities, and 14 species and species assemblages. Chapter 3—Assessment Synthesis summarizes the key findings for the REA overall and for each individual Change Agent and Conservation Element.

Section II

Section II evaluates the four primary Change Agents, both current and projected potential conditions, evaluated for this REA. It provides an overview of the approaches used and summaries of results for the four major Change Agents required in this assessment: Chapter 4—Development, Chapter 5—Wildland Fire, Chapter 6—Terrestrial Invasive Plant Species, and Chapter 7—Climate Analysis. The results summarized in these chapters were used for assessing the potential effects of Change Agents on species and communities, as presented in Sections III and IV.

Sections III and IV

Sections III and IV provide landscape-level assessments for all 21 Conservation Elements evaluated, with the ecological communities in Section III, and the species/species assemblages in Section IV. The chapters in Sections III and IV have a consistent format, which includes a narrative overview for the species or community that highlights ecological information relevant to the REA analyses. The narratives are organized using headings that directly correspond to the key ecological attributes and Change Agents summarized in tables for each chapter. It is important to note that the narratives are not meant to be exhaustive summaries or literature reviews. Rather, we provide a limited number of citations, including major review or synthesis documents when possible, and additional references as appropriate. Each Conservation Element chapter also includes an ecological conceptual model that portrays some of the primary potential interactions and feedbacks among drivers and stressors (Change Agents) evaluated. We used a standard format for all conceptual models so that key ecological attributes and Change Agents that were not addressed (either because available data were insufficient for conducting a regional-scale analysis or because the Change Agent was not expected to be a major issue for a species or community) would be readily apparent. In each chapter, the methods overview provides additional information that pertains specifically to the Conservation Element and is not addressed in Chapter 2—Assessment Framework. The maps, key findings, and summary for each chapter are based on the Management Questions.

The chapters in Section III—Ecological Communities and Section IV—Species and Species Assemblages are as follows. Chapter 8—Streams and Rivers addresses major river systems and perennial, intermittent, and ephemeral streams. Chapter 9—Wetlands addresses both riparian and

depressional wetlands and playas. Chapter 10—Riparian Forests and Shrublands addresses cottonwood and willow communities. Chapter 11—Sagebrush Steppe addresses the basin sagebrush system and associated grasslands. Chapter 12—Desert Shrublands addresses desert shrublands and associated grasslands. Chapter 13—Foothill Shrublands and Woodlands addresses mountain big sagebrush and associated deciduous shrublands (including mountain mahogany) and woodlands (including foothill aspen, juniper, and ponderosa pine, piñon and limber pines). Chapter 14—Montane and Subalpine Forests and Alpine Zones includes all mountain forest types (including mountain slope aspen, Douglas-fir, lodgepole, limber, and whitebark pines, and spruce/fir forests) and alpine areas above tree line.

The chapters in Section IV—Species and Species Assemblages are as follows. Chapter 15—Aspen Forests and Woodlands includes both foothill and mountain slope aspen. Chapter 16—Five-Needle Pine Forests and Woodlands includes limber and whitebark pines. Chapter 17—Juniper Woodlands includes Rocky Mountain and Utah juniper, and limber and piñon pines. Fish species are addressed in four chapters. Chapter 18—Cutthroat Trout covers four subspecies: Bonneville, Colorado River, Yellowstone, and Snake River fine-spotted cutthroat trout. Chapter 19—Three-Species Fish Assemblage addresses bluehead sucker, flannelmouth sucker, and roundtail chub. Chapter 20—Northern Leatherside Chub and Chapter 21—Sauger are single-species chapters. Chapter 22—Spadefoot Assemblage includes the Great Basin and plains spadefoot species. Chapters that cover bird species addressed by the REA include Chapter 23—Greater Sage-Grouse, Chapter 24—Golden Eagle, Chapter 25—Ferruginous Hawk, and Chapter 26—Sagebrush-Obligate Birds, which include Brewer's sparrow, sagebrush sparrow, and sage thrasher. Mammals are addressed in Chapter 27—Pygmy Rabbit and Chapter 28—Mule Deer.

Section V

Section V includes Chapter 29—Landscape Intactness. This chapter describes the ecoregion-level effects of development on landscape structure and identifies relatively undeveloped areas for terrestrial and aquatic communities in the context of the overall ecoregion. This chapter also synthesizes the conservation potential for all species and communities, and evaluates land protection status and land ownership/jurisdiction for the entire ecoregion, providing a broader context for individual chapters.

Appendix

The Appendix includes more details on source data and methods and is written for a technical audience. Supplemental material to the report, including all source and derived datasets, map products, and geographic information systems (GIS) programs (Python scripts) used for analyses are provided to the BLM REA and will be served online by the BLM at http://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas/dataportal.html.

References Cited

Hanser, S.E., Leu, M., Knick, S.T., and Aldridge, C.L., eds., 2011, Sagebrush ecosystem conservation and management—Ecoregional assessment tools and models for the Wyoming Basins: Lawrence, Kans., Allen Press, 409 p.

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