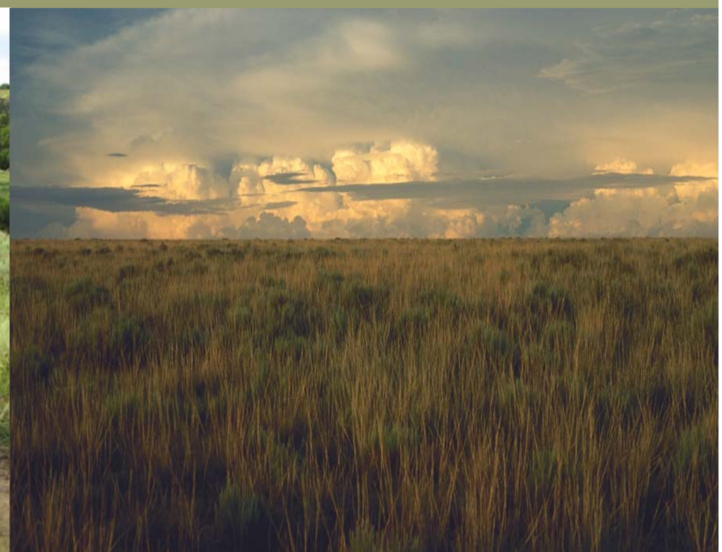
Central Shortgrass Prairie
Ecoregional Assessment and Partnership Initiative

Final Report

November 2006

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I. FORWARD

Nearly two years ago, a group of almost two dozen land managers, landowners, state and federal agency representatives, and scientists came together to develop a scientific/technical assessment of the conservation needs for the Central Shortgrass Prairie ecoregion. The Central Shortgrass Prairie ecoregion encompasses approximately 56 million acres and stretches across all of eastern Colorado, portions of southeastern Wyoming, western Kansas and Nebraska, the Panhandles of Oklahoma and Texas, and northeastern New Mexico. This group evolved into the Shortgrass Prairie Partnership with the vision to promote and support the long-term survival of Central Shortgrass Prairie native species, plant communities, ecological systems, and the ecological processes needed to maintain them.

The conservation of the Central Shortgrass Prairie ecoregion is important because the temperate grasslands are one of the least protected major habitat types on Earth; less than 5% is protected globally. Temperate grasslands also are among the most highly converted habitats on Earth.

Fortunately, much of the Central Shortgrass Prairie is still intact, due in part to a history of use that has not significantly altered the landscape. As this assessment demonstrates, sound land management practices have helped sustain the resources we all want to maintain. Today, more than 50% of the ecoregion's 56 million acres remain as intact native prairie. This represents a tremendous opportunity for conservationists, ranchers, public agencies, farmers, and the inhabitants of the Western Great Plains to maintain a place they consider special, and upon which their livelihoods depend.

In some landscapes, economic pressures have led to the reduction and loss of native shortgrass habitats and resources. The Central Shortgrass Prairie Partnership seeks to conserve what remains and, in some cases, restore what has been lost. During this process we have used state-of-the-art information and techniques to determine that approximately 44% of the ecoregion (24 million acres) is in need of conservation attention to maintain species, communities and ecosystems over the long term.

Long-term conservation success in the ecoregion is inextricably tied to sound management of the region's native prairies and streams by private landowners and water-right holders. Conservation will succeed only if partnerships are established between conservationists and those who make their living on the land, predominantly the ranching community. While public agencies have an important role to play, long-term conservation success lies with private landowners, as nearly 90% of the ecoregion is privately owned. Ranching can be, and in many cases is, compatible with conservation, and conservation is compatible with ranching.

Working with willing landowners to identify and implement conservation solutions that sustain the economies and cultures of the West is a priority of the Central Shortgrass Prairie Partnership. Historically conservationists, private landowners, and resource managers were often perceived to be at odds. More and more we have come to realize that these groups have much in common and their management goals often overlap. The potential to accomplish great things increases as diverse people share knowledge, experience, and effort.

The Shortgrass Prairie Partnership will work with a wide variety of stakeholders on a voluntary basis to accomplish shared goals, engaging in activities that are based on mutual benefit, trust, and respect for the rights of private property ownership. The Partnership will only pursue projects with willing landowners and water-right holders. The challenge is enormous, as 44% of the ecoregion needs to be conserved through conservation activities that sustain native species and ecosystems, and help residents earn a living.

In the coming months, the Partnership will develop a strategy and implementation plan, identify additional organizations and individuals to include in this effort, and prioritize places to channel shared resources. Large expanses of open plains still exist in the Central Shortgrass Prairie where economically productive activities and conservation can work together for the benefit of both. The members of the Central Shortgrass Prairie Partnership believe that these special places should remain intact for present and future generations.

II. EXECUTIVE SUMMARY

Grasslands are one of the most imperiled ecosystems in North America. The Central Shortgrass Prairie ecoregion falls within the globally classified Temperate Grasslands, Savannas, and Shrublands. Grasslands are one of the least protected yet most converted habitat types on Earth. Grassland birds have exhibited the most severe and extensive declines of any other class of North American species. Species complexes of large grazing animals have been greatly altered in almost all temperate grasslands. For example, domestic cattle have replaced bison as the dominant herbivore on the Great Plains. Likewise, populations of several other key prairie species, such as the mountain plover and black-tailed prairie dog, have declined. Increasing human population and associated impacts require a coordinated, proactive approach to conserving the shortgrass prairie. Due in a large part to land-use patterns and past stewardship practices on private and public lands, approximately 50% of the ecoregion remains in a predominantly natural condition. As a result, the ecoregion presents a significant opportunity to conserve remaining examples of intact shortgrass prairie landscapes.

Central Shortgrass Prairie Ecoregion

The Central Shortgrass Prairie ecoregion lies in the western portion of the Great Plains of North America. It encompasses approximately 56 million acres, and includes parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, Texas, and Wyoming. Major rivers within this ecoregion include the Platte, Arkansas, Canadian, Republican, and Cimarron. The majority (92%) of the ecoregion is privately owned; 5% is state-owned, and 3% is in federal ownership.

Collaborative Conservation Assessment

A diverse partnership of federal and state agencies, as well as non-governmental organizations, conducted a collaborative conservation assessment to set priorities within the Central Shortgrass Prairie ecoregion over a two-year period (and revise an earlier assessment completed in 1998). Key partners include: Colorado Association of Conservation Districts, Colorado Natural Heritage Program and other state Natural Heritage Programs, Directorate of Environmental Compliance and Management, Fort Carson, Department of Defense, Colorado Division of Wildlife, Colorado State Land Board, Environmental Protection Agency, Natural Resources Conservation Service, The Nature Conservancy, NatureServe, Playa Lakes Joint Venture, Rocky Mountain Bird Observatory, US Fish and Wildlife Service, USDA Forest Service. This project was funded by the Department of Defense Legacy Resource Management Program, Colorado Division of Wildlife, and The Nature Conservancy. In-kind services were provided by the US Fish and Wildlife Service, Fort Carson (Directorate of Environmental Compliance and Management), state natural heritage programs, universities, and numerous other partners and experts.

The project relies on inter-institutional support through the Partner Steering Group and Core Team. The Partner Steering Group established project goals and objectives, provided strategic direction, and developed initial conservation strategies. This group, now known as the Shortgrass Prairie Partnership, will coordinate implementation and outreach efforts into the future. The Core Team developed technical methods, compiled and analyzed data, developed products, and is responsible for updating key components of the assessment. The team engaged numerous technical experts from across the ecoregion in the development and review of products.

Project Vision and Goals
The vision of the assessment project is to promote the long-term survival of all native species, natural communities, and ecosystems within the ecoregion through the collaborative design and conservation of a network of areas. Project goals are to produce:

- A collaborative ecoregional assessment and conservation implementation strategy;
- A set of conservation areas that best represents the native species, natural communities, ecosystems, and ecological processes to provide a vision of conservation success.
- Critical data, analyses, and tools to support biodiversity conservation;
- Dynamic, flexible, and iterative products that can be easily updated;
- An ecological context to help facilitate effective management at multiple scales; and
- A set of management guidelines to facilitate conservation action for species at risk.

The assessment builds on previous efforts, including the Ecoregion-Based Conservation in the Central Shortgrass Prairie (Central Shortgrass Prairie Planning Team 1998) and the Colorado Division of Wildlife Conservation Plan for Grassland Species in Colorado (CDOW 2003), and lays the groundwork to significantly expand conservation efforts within the region. This report summarizes the work accomplished between July 1, 2004 and July 31, 2006; it is considered a working document that should be periodically updated and improved over time.

Methods
The assessment identifies native species, plant communities, and ecological systems representative of the ecoregion to focus planning and conservation efforts. These ecological features include 146 animal and plant species that are state and/or federally listed, or are considered imperiled, endemic, or declining. Also included are species assemblages (black-tailed prairie dog animal community), shorebird aggregation areas, and 117 natural plant communities, 21 terrestrial ecological systems, 79 aquatic ecological systems that represent common species.

After compiling current data on the distribution of these targets, the team developed conservation goals and measurable objectives for biodiversity representation to guide analyses and evaluate outcomes. Goals serve as hypotheses for evaluating key questions in conservation, including: *How much is enough?* and *How many populations and what distribution is needed for long-term viability or integrity?* The team also evaluated condition to select locations that are most likely to support native species, communities, and systems over the long term. This assessment identifies both terrestrial and aquatic networks of conservation areas for species, communities, and systems that achieve conservation goals while efficiently balancing objectives.

Terrestrial Network of Conservation Areas
Conservation areas are, simply, places in which native species, communities, and ecosystems of the ecoregion are located. These areas are identified as important places that can help to achieve conservation outcomes and to ensure that representative diversity of the ecoregion will persist over time. They provide significant opportunities for conservation partnerships. Conservation of these areas could take many forms, such as fee purchase, easements, financial incentives, or a variety of management agreements, all with willing land owners. Most of these places are working landscapes where existing management is compatible with the conservation of native species and habitats.

The terrestrial network consists of 43 conservation areas encompassing approximately 24 million acres, or 44% of the ecoregion. Areas range from 16,000 to 3.6 million acres in size. If successful, this network would conserve enough area to meet goals for approximately 83% of all targeted ecological features, including 47% of the species, 100% of plant communities, and all terrestrial systems, except the Central Mixed-Grass Prairie, which has undergone extensive conversion. Further inventories and/or restoration efforts are needed to help fill data gaps for other targets, particularly species that did not meet goals (e.g., jeweled blazing star). This assessment also identifies concentrations of playa lakes and reservoirs that serve as important shorebird and water bird aggregation areas.

Eighty-six percent of the land within the network of terrestrial conservation areas is privately owned; 8% is state-owned land, and 5% is federal land. The most widespread threats with the greatest potential impact to biodiversity in the ecoregion include altered hydrologic regime, housing and urban development, invasive species, land conversion to cropland, and commercial wind power generation facilities. Addressing these threats now is critical to avoid further habitat loss and species decline.

Aquatic Network of Conservation Areas

This report also identifies 251 aquatic conservation areas of high importance, stream reaches to meet objectives for conserving freshwater species and ecological systems within each of the five major river basins of the ecoregion within the context of the Eastern Slope of the Rocky Mountains. There are 140 aquatic conservation areas partially or wholly included in the Central Shortgrass Prairie, and another 111 areas outside the ecoregion but within the Eastern Slope river basins. The aquatic network met goals for 42% of systems and 9% of species (26% of fishes, 0% of invertebrates); further inventory and/or restoration is needed to fill gaps for the species and systems not meeting goals. The network includes a total of 32,420 stream miles within the Eastern Slope river basins, including 13,365 stream miles within the Central Shortgrass Prairie. Approximately 24% of the aquatic network overlaps the terrestrial network of conservation areas. Thirty-six of 43 terrestrial conservation areas overlap the aquatic conservation areas.

Current Status of Biodiversity in the Ecoregion

The status of biodiversity of the ecoregion varies. Plant communities, terrestrial ecological systems, and some species assemblages are relatively well studied. Rare and imperiled species and aquatic ecological systems are less well known. Aquatic species, particularly invertebrates, are one of the least known groups, indicating the need for additional inventory and restoration.

Distribution and intensity of threats indicate that the biodiversity of the ecoregion is moderately to highly threatened. The ecological integrity of the Central Shortgrass Prairie is at a moderate to high level because much of it is fragmented and consists of fairly small patch sizes, despite the fact that approximately 50% of the ecoregion remains in natural cover. In addition, distribution of the large patches is uneven, with the largest and most intact landscapes occurring in the southwestern parts of the ecoregion.

Landscape-scale Conservation
Some species that occur on a large scale and in multiple habitats in the Central Shortgrass Prairie are inadequately represented by the ecological system approach. These species are targeted in this report as wide-ranging species. They are often excellent indicators of ecological integrity at a scale above ecological systems. For example, bison use several different ecological systems and very large areas to meet their annual energy requirements. By understanding their conservation requirements, it is possible to gain insight regarding the scale needed for conservation success. Additionally, some species, such as pronghorn, are widespread today, and may not appear to require conservation attention. However, selection of these species is intended to help identify a few areas where the species can approach historical densities and/or ecological function. This can only occur in landscapes where conservation is accomplished in concert with local communities.

Major Accomplishments and Products
Key accomplishments of this collaborative effort include: 1) a vision for conservation success that identifies native species, communities, and ecosystems that merit conservation action; 2) a multi-institutional steering group (Shortgrass Prairie Partnership) to help coordinate conservation efforts within the region now and in the future; 3) a framework to measure conservation success through an adaptive management approach; 4) guidance templates to help coordinate regional land management for selected species-at-risk; and 5) region-wide dynamic products that can be updated as new data and methods become available. The partnership will periodically refine the vision to ensure that it adapts to changes in scientific understanding, evolving economies, threats to native species and ecosystems, local culture, and political realities of the western Great Plains. The Core Team will help keep the assessment dynamic and address priority data gaps.

Uses of the Assessment—Informing Proactive Conservation
This assessment is intended to provide a scientific basis to inform proactive conservation efforts and help shape future conservation activities within the ecoregion. The team integrated extensive data with a sophisticated assessment tool that enabled rapid selection of conservation areas. This should provide a baseline that can be refined as new data become available regarding changes across the region. The 1998 Central Shortgrass Prairie assessment helped drive significant partnership conservation efforts (e.g., advanced mitigation project with the Colorado Department of Transportation to protect key landscapes for species at risk). These proactive conservation efforts, which require the best available scientific information and a commitment by partners and stakeholders to balance growth with the conservation of biodiversity, should be encouraged throughout the ecoregion.

Strategies and Next Steps—Four Key Elements
Several priority strategies will help the Shortgrass Prairie Partnership achieve its ambitious grassland conservation goals. The strategy consists of four key elements: 1) creating a network of effectively conserved working landscapes; 2) addressing public policies and programs, particularly relative to the Farm Bill, that contribute to both the conservation and degradation of native grasslands; 3) working with landowners and managers to identify strategies that conserve the shortgrass prairie while meeting their social and economic objectives over the long term; and 4) raising unprecedented public and private resources to address these key elements.

Conservation Opportunities

Approximately 86% of the network of conservation areas is privately owned and managed. Long-term success depends on continued good management of the native lands and waters of the ecoregion by private landowners and water-right holders. Common conservation and management priorities, abating threats across the ecoregion, and measuring conservation status provide ideal opportunities for partners and stakeholders to work together. The goal of these efforts is to find common ground between conservation objectives and the needs of private landowners, public land managers, and industry. Throughout the Great Plains, partnerships between ranchers, managers, and conservationists are proving that good management results in intact healthy ecosystems. The Shortgrass Prairie Partnership is deeply committed to working with willing collaborators to explore how best to achieve conservation goals within the current and future economic and social needs of local communities.

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Technical Experts Participating in May 2006 Review Workshops
Oakley, Kansas: William Burnidge, Bill Busby, Mike Carter, Jerry Choate, Chris Hise, Kelly Kindscher, Elmer Finck, Steve Kettler, Stan Roth, Roger Tacha, Bill Ulfelder, and Toni Wesley.

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Greeley, Colorado: Dave Anderson, Kirstie Bay, Julie Elliott, Steve Kettler, David Klute, Susan Linner, Brent Lathrop, Steve Mackessy, Eric Odell, Renée Rondeau, Steve Ryder, John Sanderson, Neil Snow, John Sovell, Harvey Sprock, Tim Sullivan, and Chris West.

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North Platte, Nebraska: Mace Hack, Tim Hermansen, Steve Kettler, Brent Lathrop, John Ortmann, Dan Rockford, Rick Schneider, Gerry Steinauer, and T.J. Walker.

Reviewers of Final Report
David Armstrong, Gary Belew, William Burnidge, Bill Busby, Mike Carter, Pat Comer, Mark Eberle, Elmer Finck, Lee Grunau, Barbara Hawke, Chris Hise, Tina Jackson, Tom Johnson, Steve Kettler, Boris Kondratieff, Brent Lathrop, Brian Mihlbachler, Pedro Morales, John Ortmann, Chris Pague, Francie Pusateri, Renée Rondeau, Bruce Rosenlund, D'aun (Deedee) Runner, Rick Schneider, Terri Schulz, Ryan Smith, John Sovell, Tim Sullivan, David Theobald, Bill Ulfelder, and Central Shortgrass Prairie Steering Group members.

Aquatic Expert Reviewers
Beth Bear, Kevin Bestgen, Harry Crockett, Steve Culver, Mark Eberle, Paula Guenther-Gloss, Tom Iseman, Tom Johnson, Ken Keymeier, Doug Krieger, Dirk Miller, Tom Nesler, Chris Pague, Francie Pusateri, Renée Rondeau, Bruce Rosenlund, Jay Skinner, Ryan Smith, and Dave Zafft.

Reviewers of Species Management Guidance Templates
David Armstrong, Gary Belew, Richard Bunn, Bill Busby, Julianne Hoagland, Tass Kelso, Mead Klavetter, Eric Odell, Susan Spackman-Panjabi, Francie Pusateri, and Caron Rifici.

IV. CENTRAL SHORTGRASS PRAIRIE ECOREGIONAL TEAM

A. Central Shortgrass Prairie Partnership Steering Group Members

- Bill Ulfelder, The Nature Conservancy (Facilitator)
- Gary Belew, Directorate of Environmental Compliance and Management, Fort Carson, Department of Defense, Colorado
- Mike Carter, Playa Lakes Joint Venture
- Steve Currey, Pawnee National Grassland, USDA Forest Service
- Herman Garcia, Natural Resources Conservation Service
- David Hanni, Rocky Mountain Bird Observatory
- Tom Johnson, U.S. Environmental Protection Agency
- Steve Kettler, U.S. Fish and Wildlife Service
- Bob McCready, The Nature Conservancy, Prairie Wings Program
- Brian McPeek, The Nature Conservancy of Colorado
- Brian Mihlbachler, U.S. Fish and Wildlife Service
- Tom Peters, Comanche National Grassland, USDA Forest Service
- Francie Pusateri, Colorado Division of Wildlife
- Renée Rondeau, Colorado Natural Heritage Program
- D'aun (Deedee) Runner, U.S. Fish and Wildlife Service
- Britt Weygandt, Colorado State Land Board
- J.D. Wright, Colorado Association of Conservation Districts

B. Central Shortgrass Prairie Core Planning Team Members

- Betsy Neely (Team Leader), Senior Conservation Planner, The Nature Conservancy of Colorado
- David Anderson, Botanist, Colorado Natural Heritage Program
- Gary Belew, Chief, Cooperative Conservation Team, DECAM, Fort Carson
- Patrick Comer, Chief Terrestrial Ecologist, NatureServe
- Lee Grunau, Conservation Planner, Colorado Natural Heritage Program
- Jennifer Horsman, GIS Analyst, The Nature Conservancy of Colorado
- Tina Jackson, Aquatic/Herptile Coordinator, Colorado Division of Wildlife
- Steve Kettler, Biologist, U.S. Fish and Wildlife Service
- Mead Klavetter, Wildlife Biologist, Fort Carson
- Eric Odell, Grassland Species Conservation Coordinator, Colorado Division of Wildlife
- Chris Pague, Senior Conservation Ecologist, The Nature Conservancy of Colorado
- Francie Pusateri, Senior Wildlife Conservation Biologist, Colorado Division of Wildlife
- Renée Rondeau, Director, Colorado Natural Heritage Program
- Bruce Rosenlund, Project Leader, U.S. Fish and Wildlife Service
- D'aun (Deedee) Runner, Ecoteam Coordinator, U.S. Fish and Wildlife Service
- Ryan Smith, Freshwater Ecologist, The Nature Conservancy of Texas
- Kei Sochi, GIS Manager, The Nature Conservancy of Colorado
- John Sovell, Zoologist, Colorado Natural Heritage Program

C. Central Shortgrass Prairie Conservation Target Teams

- ***Amphibians and Reptiles***: Tina Jackson (Team Leader), Geoff Hammerson, Clint Henke, Brad Lambert, Stephen Mackessy, and Bill Turner
- ***Aquatic Ecological Systems:*** Chris Pague/Bruce Rosenlund/Tom Iseman (Team Leaders), John Norman, Michelle Fink, Ryan Smith, and Kei Sochi
- ***Birds:*** John Sovell (Team Leader), Brad Andres, Richard Bunn, Mike Carter, Chris Eberly, Ted Floyd, David Hanni, David Klute, Tony Leukering, Chris Pague, Christopher Rustay, and Ken Strom
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- ***Mammals:*** Chris Pague (Team Leader), Rick Adams, David Armstrong, Bill Busby, Jerry Choate, Carron Meaney, Francie Pusateri, and John Sovell
- ***Plants:*** David Anderson (Team Leader), Dina Clark, Carol Dawson, Craig Freeman, Don Hazlett, Tass Kelso, Nan Lederer, Ellen Mayo, Steve Olson, Caron Rifici, Neil Snow, Gerry Steinauer, Bonnie Heidel, Steven Rolfsmeier, and Bob Sivinski
- ***Fish:*** Bruce Rosenlund (Team Leader), Kevin Bestgen, Brent Bristow, Mark Eberle, Kurt Fausch, Tom Iseman, Tom Nesler, David McNeely, Chris Pague, David Propst, Dane Shuman, Vernon Tabor, Steve Wolff, and David Winters
- ***Terrestrial Ecological System/Plant Communities:*** Steve Kettler/Renée Rondeau (Team Leaders), David Augustine, Bill Busby, Pat Comer, Karin Decker, Herman Garcia, Chris Hise, Bruce Hoagland, George Jones, Brian Mihlbachler, Francie Pusateri, Keith Schulz, and Gerry Steinauer
- ***GIS/Data Management:*** Jennifer Horsman and Kei Sochi (Team Leaders), Vanessa Fields, Michelle Fink, Jon Kindler, Amy Lavender, Bill Martin, Linda Moeder, and David Theobald

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XXIII. TABLES

"Conservation means harmony between men and land. When land does well for its owner, and the owner does well by his land; when both end up better by reason of their partnerships, we have conservation."

Aldo Leopold (The Farmer as Conservationist *In* For the Health of the Land: Previously Unpublished Essays and Other Writings 1999)

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To our children and generations to come, with hope that they will have the opportunity to experience and appreciate the natural diversity of the shortgrass prairie.

V. INTRODUCTION

A. Vision and Goals

The vision of the Central Shortgrass Prairie (CSP) Ecoregional Assessment and Partnership Initiative Project is to promote and support the long-term survival of all native species, plant and animal communities, ecological systems, and the associated ecological processes needed to maintain them, through the collaborative design and conservation of a network of conservation areas. The goals of the CSP assessment are to provide:

1. A collaborative ecoregional assessment and conservation implementation strategy;
2. Critical data, analyses, and tools to support conservation actions;
3. Dynamic, flexible, and iterative products that can easily be updated;
4. Ecological context to help facilitate effective management at multiple scales; and
5. Management guidelines for selected species at risk.

B. Objectives

1. Provide scientific peer-reviewed products to guide collaborative decision-making and conservation efforts;
2. Identify and prioritize a network of conservation areas critical for maintaining biodiversity;
3. Identify critical threats and prioritize actions needed to maintain long-term ecological integrity;
4. Develop a framework to measure change of ecological integrity, threat, and managed area status;
5. Initiate management guidance templates for up to six species at risk; and
6. Identify common conservation goals and partner roles for implementation.

C. Central Shortgrass Prairie Ecoregion

The CSP lies in the western portion of the Great Plains of North America (see Figure A). The ecoregion encompasses approximately 55.7 million acres (22.5 million hectares), and stretches across all of eastern Colorado, portions of southeastern Wyoming, western Kansas and Nebraska, the panhandles of Oklahoma and Texas, and northeastern New Mexico. It is bordered by the Southern Rocky Mountains ecoregion to the west, the Central Mixed-grass Prairie to the east, the Southern Shortgrass Prairie to the south, and the Northern Great Plains Dry Steppe to the north (Bailey 2004).

Major river drainages crossing this region include the Platte, Arkansas, Cimarron and Canadian rivers. The headwaters of the Republican River lie within the CSP (see Figure B). In addition to the diversity of river drainages, the western edge of the ecoregion includes the transition zone between the Great Plains and Rocky Mountains.

Rolling plains and tablelands, dissected by streams, canyons, badlands, and buttes, are dominated by shortgrass prairie with large areas of mixed grass, with sandsage prairie and

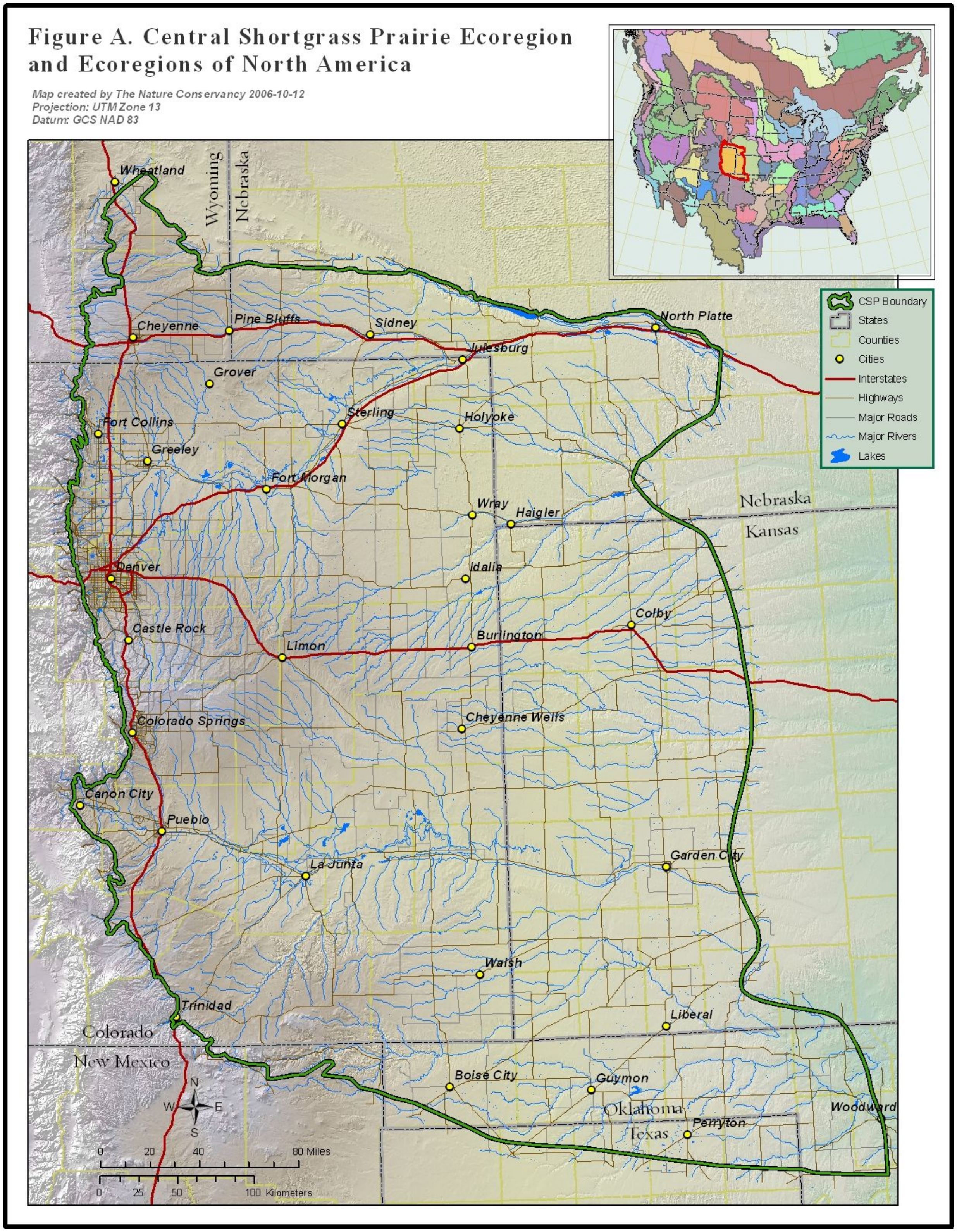


Figure A. Central Shortgrass Prairie Ecoregion and Ecoregions of North America

juniper woodlands on breaks. Surficial geology varies throughout the region, ranging from Quaternary eolian dune sand and loess to tertiary sandstones and basalt flows to Cretaceous shales and limestones. The elevation ranges from approximately 2,500 to 7,000 feet (760-2,130 meters).

D. Aquatic Assessment Area

Terrestrial ecoregions do not effectively encompass the zoogeographic patterns of aquatic species. To more effectively consider aquatic biodiversity in conservation planning efforts, the World Wildlife Fund developed freshwater ecoregions (Abell et al. 2000). These freshwater ecoregions are considered suitable assessment units for freshwater ecoregional planning (Higgins et al. 2005). Therefore, in order to most effectively incorporate aquatic biodiversity and stream-associated communities (e.g., riparian communities), the team independently assessed conservation needs of aquatic and riverine diversity using freshwater ecoregions. Because of the small overlap of the CSP boundary with freshwater ecoregions of the Great Plains (Abell et al. 2000; Figure B), the team decided to assess the aquatic biodiversity within the Eastern Slope drainages of the Rocky Mountains by Ecological Drainage Unit boundaries (EDUs; Higgins et al. 2005). EDUs are groups of sub-basins (i.e. 8-digit Hydrologic Unit Codes, or HUCs) developed by the US Geological Survey. EDUs are composed of sub-basins with similar patterns of zoogeography, physiography, connectivity, climate, and hydrologic characteristics, and are nested within freshwater ecoregions (Higgins 2003, Higgins et al. 2005). EDUs reflect patterns of ecological variation and species composition within freshwater ecoregions, and hence serve as suitable units to assess biodiversity.

The aquatic assessment area includes the Upper Platte River Basin, Middle Platte River Basin, Republican River Headwaters, Arkansas River–West, and Canadian River basins (or EDUS), all of which intersect the CSP terrestrial ecoregion (Figure B). These EDUs were defined by the zoogeographic influences of the three major Western Great Plains river drainages (Cross et al. 1986), and the influence of climate and physiography as captured in the ecoregional section classification of the USDA Forest Service (McNab and Avers 1994). These EDUs did not cover small portions of the easternmost part of the ecoregion, but an adjacent assessment of the Central Mixed-grass Prairie (Steuter et al. 2003) identified areas of aquatic biodiversity significance.

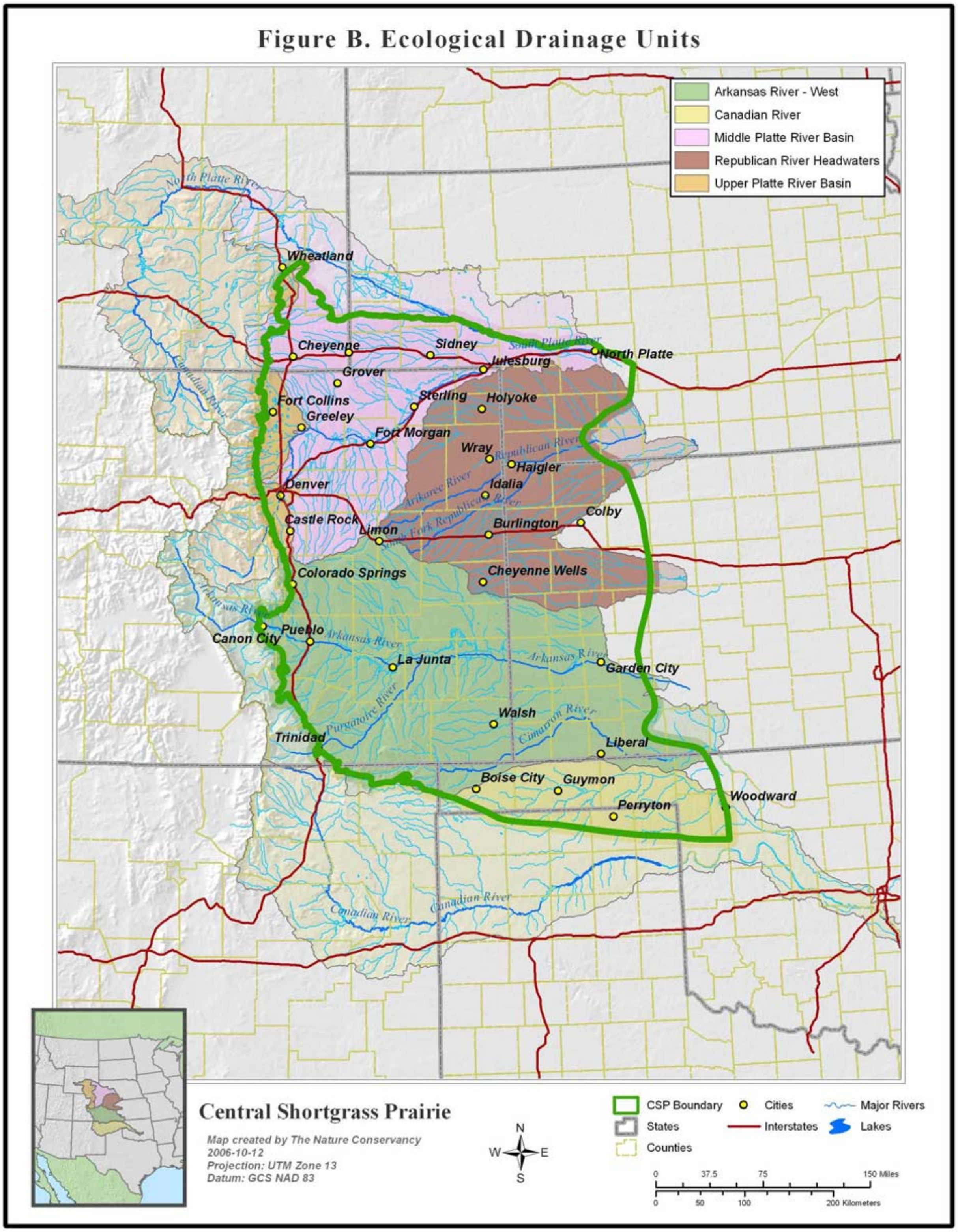


Figure B. Ecological Drainage Units
Arkansas River - West
Canadian River
Middle Platte River Basin
Republican River Headwaters
Upper Platte River Basin
Wheatland
Cheyenne
Sidney
North Platte
Julesburg
Grover
Fort Collins
Greeley
Sterling
Holyoke
Fort Morgan
Wray
Haigler
Denver
Idalia
Colby
Castle Rock
Limon
Burlington
Colorado Springs
Cheyenne Wells
Pueblo
Canon City
La Junta
Garden City
Walsh
Trinidad
Liberal
Boise City
Guymon
Woodward
Perryton
Arkansas River
Republican River
Canadian River
Cimarron River
Purgatoire River
Arikaree River
South Platte River
Central Shortgrass Prairie
Map created by The Nature Conservancy
2006-10-12
Projection: UTM Zone 13
Datum: GCS NAD 83
CSP Boundary
Cities
Major Rivers
States
Interstates
Lakes
Counties
N
S
W
E
0 37.5 75 150 Miles
0 50 100 200 Kilometers

E. Grasslands Overview

The CSP ecoregion lies within the Temperate Grasslands, Savannas, and Shrublands Major Habitat Type (WWF 2005). Grasslands are considered one of the most imperiled ecosystems in North America and worldwide (Knopf and Samson 1997). Less than 5% of grasslands are under legal protection globally, making them one of the least protected and most threatened habitat types on Earth (TNC 2006a; Hoekstra et al. 2005). Approximately half of the CSP land area has been converted for such human uses as tilled agriculture, urban development, and industry. Approximately 80% of mixed-grass prairie and 42% of shortgrass prairie types have been converted within the ecoregion (CNHP and TNC 2006 unpublished data).

Conversion of native grasslands to cultivated cropland and urban development has altered the character of the shortgrass prairie; this has changed the level of wildlife diversity once supported by this landscape (CDOW 2003). American bison (*Bison bison*), American elk (*Cervus canadensis*), and other native herbivores and carnivores have been extirpated or greatly reduced throughout the ecoregion (Choate 1987). Grassland birds, such as the mountain plover (*Charadrius montanus*), have shown steeper and more widespread declines than any other group of North American species (Knopf 1994, Samson and Knopf 1996, Brennan and Kuvlesky 2005). A number of other prairie species, such as the black-tailed prairie dog (*Cynomys ludovicianus*), have experienced declines throughout their ranges (Miller et al. 1990). The decline in the prairie dog population is of particular interest because it possesses many attributes of a keystone species (Kotliar 2000, Kotliar et al. 1999).

While many species have declined precipitously, much of the CSP is still intact, due in great part to a history of use that has not significantly altered the landscape in many places. Sound land management practices have helped sustain the native species, natural communities, and ecosystems. Today, more than 50% of the ecoregion's 56 million acres is still native prairie. This represents a tremendous opportunity for conservationists, ranchers, public agencies, farmers, and the inhabitants of the Western High Plains to maintain a place they consider special, and upon which their livelihoods depend.

Shortgrass prairie dominates the ecoregion, with other vegetation types occurring on atypical soils or topographic features. Dominant grass species of the shortgrass prairie include buffalo grass (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*), and western wheatgrass (*Pascopyrum smithii*). As precipitation increases to the east, mixed-grass prairie communities occur. Dominant grasses of the mixed-grass prairie include needle-and-thread (*Hesperostipa comata*), little bluestem (*Schizachyrium scoparium*), and western wheatgrass. Xeric tallgrass prairie occurs on the western edge along the foothills of the Rocky Mountains and is dominated by big bluestem (*Andropogon gerardii*), little bluestem, and switchgrass (*Panicum virgatum*). Sandhill shrublands occupy major expanses of sandy soils and are dominated by sandsage (*Artemisia filifolia*), sand bluestem (*Andropogon hallii*), and prairie sandreed (*Calamovilfa longifolia*). Along the foothills and in cliffs and canyons, pinyon-juniper *(Pinus edulis-Juniperus monosperma*) woodlands, Gambel oak (*Quercus gambelii*), and mountain mahogany (*Cercocarpus montanus*) shrublands occur. Other vegetation types, such as playa lakes and salt-desert shrublands occur in smaller patches. A variety of riparian shrublands and woodlands dominated by Plains cottonwood (*Populus deltoides*) and willows (*Salix* spp.) occur along streams and rivers.

F. Climate

This region lies in the rain shadow of the Rocky Mountains and receives 10-25 inches (25 to 60+ cm) of annual precipitation, increasing from west to east, mostly in the form of summer rainfall. The climate is semi-arid, with cold, dry winters, and warm to hot summers. Mean annual temperature varies from 44-61° F (7-16° C). Average temperatures increase from north to south, creating another factor that influences plant distribution and abundance; for example, warm-season vs. cool-season grasses (Joyce et al. 2001). Extreme events in the form of hail, blizzards, tornadoes, and dust storms are frequent. Precipitation levels fluctuate greatly from year to year throughout the Great Plains. In 2002, the region experienced a drought that became the worst on record for many municipalities along the western edge of the ecoregion (Pielke et al. 2002). Climate projections for the Great Plains suggest that extreme events might become more commonplace within the next century. Global climate models predict a 7° F (3.9° C) or greater temperature increase in the Great Plains within the next century, and increased weather variability that might result in greater competition for water resources, particularly among farmers and urban communities (McCarthy et al. 2001). A recent analysis of a downscaled global climate model projects a 12° F (6.7° C) warming for the CSP in the next century, along with up to an 8% decrease in average annual precipitation (Zimmerman et al. 2006).

G. Ecological Processes

Climate, grazing (herbivory), and fire are the primary ecological processes driving natural upland systems in the shortgrass prairie (Ostlie et al. 1997). The interaction of these ecological drivers helps maintain landscape heterogeneity and biodiversity in grasslands. Historically, there were large herds of native ungulates such as bison, elk, and pronghorn (*Antilocapra americana*). These large herbivores, along with vast expanses of black-tailed prairie dog complexes, predators, drought, and a natural wildfire regime, maintained a diverse and heterogeneous landscape (Hart 2001, Knopf and Samson 1997). Domestic livestock has replaced the native herbivores on the Great Plains, resulting in dramatic changes in the prairie landscape. Along with grazing regimes, climate, particularly precipitation, determines the regional extent of the shortgrass (as opposed to tallgrass) prairie. Periodic drought may drive many vegetation changes in the shortgrass prairie (Knopf and Samson 1997). Additionally, historic fires were ignited by humans and by lightning during thunderstorms. Native Americans set fires to create fuel-breaks around settlements or to attract herbivores, such as bison and pronghorn, to patches of green grass (Samson and Knopf 1996; Pyne 1997; Jones and Cushman 2004). The role of historic fire in the shortgrass prairie is not well understood (Knopf and Samson 1997).

Primary ecological processes of the ecoregion that support the aquatic systems include precipitation, timing and intensity of snowmelt (some streams), hydrological dynamics, groundwater availability and outputs, nutrient inputs, pH, and aquatic community composition. Human alterations of aquatic ecosystems have greatly affected natural ranges of variability. For example, diversion of flowing water, so necessary to support the region's agriculture and economy, has altered the timing and amount of flows in most rivers and streams of the CSP. Similarly, aquatic fish assemblages have been altered by the additions of non-native sport-fish, often predatory fish, into native streams and rivers.

H. Land Ownership

The majority (92%) of the CSP ecoregion is privately owned. Approximately 5% is state owned (e.g., state land board, state game and fish agencies, state parks), and 3% is managed by federal agencies (2% is National Grasslands managed by the US Forest Service and 0.8% is managed by the Department of Defense). Land ownership patterns within the ecoregion are shown in Figure C. Data for land ownership were obtained from COMaP (Theobald et al. 2005) for Colorado, and the Protected Areas Database (CBI 2006) for the remaining states.

Because the vast majority of land in the CSP ecoregion is privately owned and managed, successful conservation will require engaging willing landowners, and tapping into funding sources that support private land-conservation initiatives and management practices. Implementing conservation activities on a landscape that is primarily privately held most likely will include tools such as conservation easements, restoration and management agreements, and conservation-based incentives for conservation actions. Sound management of the native prairies and streams of the ecoregion by private landowners and water-right holders is inextricably tied to long-term conservation success.

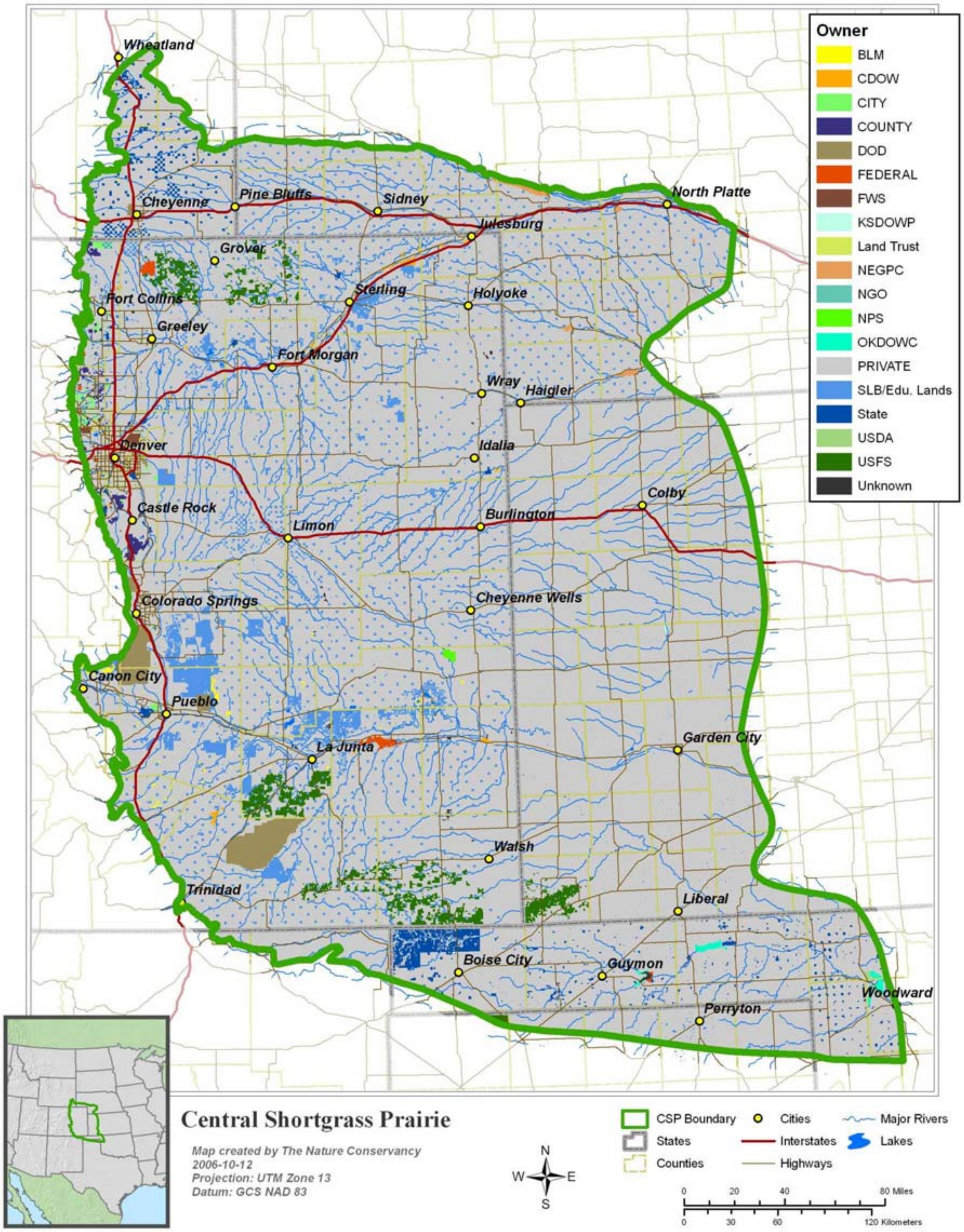
Conservation of the CSP will be successful only if partnerships are established between conservationists and those who make their living on the land, especially the ranching community. While public agencies have an important role to play, long-term conservation success lies with private landowners, as nearly 90% of the ecoregion is privately owned. Ranching and conservation can be compatible. Working with willing landowners to identify and implement conservation solutions that sustain the economies and cultures of the West is a priority of the Shortgrass Prairie Partnership (see ecoregional assessment process in next section).

I. Socioeconomic Trends

The population of the region continues to expand near urban areas, mainly along the western edge of the ecoregion, and declines in the vast rural eastern portion of the ecoregion (Archer and Lonsdale 2003). In 1890, original settlement was predominated by rural and small towns, with less than one-third of the population living in metropolitan areas. By 2000, nearly three-quarters of the region's population lived in metropolitan areas.

A large percentage of land in the ecoregion is cultivated or grazed by domestic livestock, with a human population that continues to be principally dependent on agriculture. Overall population growth for the region lags only slightly behind that of the national average, though this is due to a combination of two divergent trends. First, population in the eastern portion of the ecoregion generally is declining as young people leave agriculture behind. There is some influx into the region, as people seek employment in the meat-packing industry. But this in-migration is far surpassed by out-migration. Secondly, the western edge of the ecoregion, along the Front Range from Cheyenne, Wyoming, to Pueblo, Colorado, is rapidly growing in size and population. As an indicator of trends in the ecoregion, growth along the Colorado Front Range between 1990 and 2000 occurred at a rate of 3%, whereas the eastern plains of Colorado grew at a rate 1.2% (Theobald 2005).

Figure C. Land Ownership



VI. ECOREGIONAL ASSESSMENT PROCESS AND PRODUCTS

This Central Shortgrass Prairie ecoregional assessment is a revision of a previous assessment developed by The Nature Conservancy (TNC) and partners (CSP Planning Team) in 1998. In late 2003, the Conservancy, Colorado Division of Wildlife (CDOW), and Directorate of Environmental Compliance and Management (DECAM), Fort Carson, recognized the need to update the assessment to incorporate current biological data, apply more sophisticated analysis tools, and address new threats to biodiversity. In July 2004, the Conservancy initiated a two-year collaborative effort to revise the assessment by establishing a Core Planning Team and Partner Steering Group.

A. Assessment Steps

The foundation of ecoregional assessments is a comprehensive scientific analysis of existing and new data. Methods largely follow TNC (2004 and 2005), Groves (2003), Groves et al. (2002), Groves et al. (2000), and Higgins et al (2005), and have been tested and revised by TNC and partners throughout the United States, Latin America, the Caribbean, and other countries. Key steps include the following:

1. Identify species, plant communities, terrestrial and aquatic ecological systems to represent the biodiversity of the ecoregion;
2. Develop conservation goals to adequately represent and maintain each target and/or group of targets;
3. Assess the ecological condition of all occurrences to inform the identification of priority areas and conservation strategies, and to measure success;
4. Identify network(s) of conservation areas to meet conservation goals for all targeted species, communities, and ecological systems;
5. Analyze threats across the ecoregion and to targeted species, communities, and ecological systems at conservation areas;
6. Define priorities for conservation action and develop conservation strategies;
7. Develop an ecoregional-scale measures/monitoring framework; and
8. Develop management guidance templates for selected species at risk.

B. Partner Steering Group

The Steering Group was established to provide strategic direction and guidance, ensure that products are useful to partners, and develop conservation strategies. The group, consisting of 17 federal and state agency, and private partner representatives (see CSP ecoregional team section above), is a partnership that will continue to collaborate on conservation priorities and management issues in the ecoregion long after this phase of the assessment is completed. During the second phase of the project, the group (under the new name of Shortgrass Prairie Partnership) will develop implementation and outreach plans. They will also further explore common interests, such as: regional species management, land consolidation, species or mitigation banking, shared conservation priorities, inventory, data gaps and research, conservation incentives for private landowners, Farm Bill programs (reauthorization and directing programs more towards biodiversity priorities), measures and monitoring, invasive species management, and compatible energy development.

C. Core Planning Team

The Core Planning Team (hereafter referred to as Core Team or team) consists of representatives from the CDOW, Colorado Natural Heritage Program (CNHP), DECAM, Fort Carson, Department of Defense (DoD), NatureServe, TNC, and US Fish and Wildlife Service (FWS). See CSP team section above for full list of participants. The team, with considerable help from experts, developed technical methods, compiled and analyzed recent data, documented methods and results, and completed products for use by partners and stakeholders. The team will work with the Shortgrass Prairie Partnership and others to continuously update this assessment to meet the evolving needs of those interested in conserving the shortgrass prairie.

D. Use of this Report

This assessment is designed to guide proactive efforts to conserve natural ecosystems and native species of the shortgrass prairie by identifying a network of sites that support these ecological features. The audience for this report consists of all public and private organizations, as well as individuals, upon whom conservation success depends. No single entity alone can achieve conservation success in the shortgrass prairie. The Shortgrass Prairie Partnership hopes that the assessment products will be used to help land managers and land owners better understand how their lands contribute to broader conservation efforts in the ecoregion, guide conservation efforts by different groups, plan proactively to protect species at risk, and help make land-management decisions regarding fire management, invasive species, grazing, and water management for the benefit of conservation and continued productive activities. This report will serve as a baseline that can be refined as new data become available. See Table 1 for a summary of uses of assessment products.

This report is not intended to provide detailed site-specific information. Boundaries of identified conservation areas should be considered a starting point for refinement; they are only intended to focus on general areas of conservation importance. Conservation actions associated with these areas will depend on further site-specific analysis. Limitations in the identification of conservation areas were due to a variety of reasons, including: incomplete distribution data for species, lack of ecological condition data, and lack of complete land use information to assess threats and aquatic ecological integrity. For these reasons, the products are considered a work in progress; the team encourages experts and others to help to update the information over time.

The 1998 shortgrass prairie assessment has been used in the development of several major conservation initiatives, including: 1) the Shortgrass Prairie Initiative, a multi-million dollar advance mitigation initiative in partnership with the Colorado Department of Transportation (CDOT) and other agencies; 2) development of the Prairie Wings program in collaboration with the US Forest Service (USFS), FWS, and Playa Lakes Joint Venture (PLJV) to assure the conservation of stopover sites for migratory grassland birds throughout their range; 3) assisting with the DoD buffer project to address encroaching residential development adjacent to Fort Carson; and 4) completed conservation easements in priority areas through the Landscapes Legacy Program of Great Outdoors Colorado. The team expects that this collaborative planning effort will build on the important work that has already begun, leading to significantly greater proactive conservation efforts throughout the ecoregion.

Table 1. Summary of uses of assessment products.

Product	Section/ Appendix	Uses
List of identified species, communities, and ecological systems that need conservation attention	Section VII Appendices A-G	▪ Helps focus conservation and management efforts within regional context ▪ Helps set priorities for planning, monitoring, and management
Conservation goals	Section VIII Appendices I, N, Q	▪ Provides context for evaluating projects: how well does an area contribute to overall ecoregional goals?
Viability/integrity guidelines for species, communities, and ecological systems	Section IX Appendices J, K, L	▪ Helps evaluate biological health and assess impacts of management activities ▪ Informs desired biological conditions (goals and objectives) ▪ Informs vegetation management plans, fire management plans, etc.
Interactive database and GIS data layers (ArcReader map)	Section X Appendix M CD	▪ Use data to help answer different questions at multiple scales ▪ Click on a conservation area to see associated targets and threats ▪ Click on a 1:24,000 quad to see Natural Heritage Program elements for both in and outside of conservation areas
Conservation areas, maps, associated ecological features, and threats	Section XII Appendices N, O, Q, R	▪ Provides preliminary information about areas of biodiversity significance (working documents to be improved with new data) ▪ Provides a starting point for developing strategies ▪ Informs land-use decisions ▪ Provides regional context for conservation and management decisions.
Threats and prioritization	Sections XII, XIII Appendices S, T	▪ Identifies priority areas to focus conservation and management actions ▪ Identifies the urgency of needed actions
Measures of success	Section XV Appendix U	▪ Provides a baseline for tracking status of biodiversity, conservation, and threat over time
Species management guidance templates for species at risk	Section XVI Appendices W,X	▪ Facilitate on-the-ground management and conservation projects ▪ Develop partnerships with shared goals
Strategies and opportunities	Section XVII	▪ Preliminary strategies for implementation
Data gaps, inventory, research needs, next steps	Section XVIII	▪ Guide priority inventory and research projects to fill data gaps

VII. CONSERVATION TARGETS

A. Approach

The ultimate goal of the assessment and partnership initiative is to conserve the biodiversity representative of the ecoregion—to keep the common species common, and prevent extinction or decline of rare species. Because it is impractical to plan individually for each native species, the team selected a set of "conservation targets" or features of biodiversity that warrant specific conservation attention. The targets occur at a variety of spatial scales, from local to regional. The team selected three levels of biological organization to represent biological diversity, and focus conservation planning and action (Groves et al. 2002, Groves 2003). These include: 1) terrestrial and aquatic ecological systems, 2) natural plant and animal communities, and 3) species.

The long-term survival of species, plant and animal communities, and ecological systems within the ecoregion requires functional areas with intact ecological patterns and processes. The team adopted a "*coarse-filter/fine-filter*" strategy for this assessment (Groves 2003). This strategy employs a working hypothesis that the conservation of multiple, viable examples of all natural communities and terrestrial and aquatic ecological systems (i.e., "coarse-filter targets") also will conserve the majority of species. In addition to maintaining common species, coarse-filter strategies emphasize the conservation of ecological processes and ecosystem services (e.g., air, water, nutrient cycling). Those species that the coarse-filter approach cannot reliably conserve require individual attention and are referred to as "species targets" or "fine-filter targets" (Groves et al. 2002).

B. Terrestrial Ecological Systems

Terrestrial ecological systems are dynamic assemblages or complexes of plant communities that occur together on the landscape, are tied together by similar ecological processes (e.g., fire, hydrology), underlying environmental features (e.g., soils) or environmental gradients (e.g., elevation), and form repeatable units that serve practical needs for mapping, land management, and monitoring (Groves et al. 2000, Groves 2003, Comer et al. 2003).

Defining ecological systems as targets requires careful consideration of their level of resolution, spatial scale, ability to be mapped, and overall number. For ecological systems to work as coarse filters they must be conserved as part of dynamic, intact landscapes, with some level of connectivity, and they must be sufficiently represented across environmental gradients to account for ecological and genetic variability.

The Core Team identified 21 terrestrial ecological systems, categorized by patch type, and estimated their level of conversion (see Table 2, 3, Appendix A, Figure D). Ecological systems of the CSP were refined from the NatureServe systems database (http://www.natureserve.org/explorer/), GAP and Southwest ReGAP mapping, and the literature.

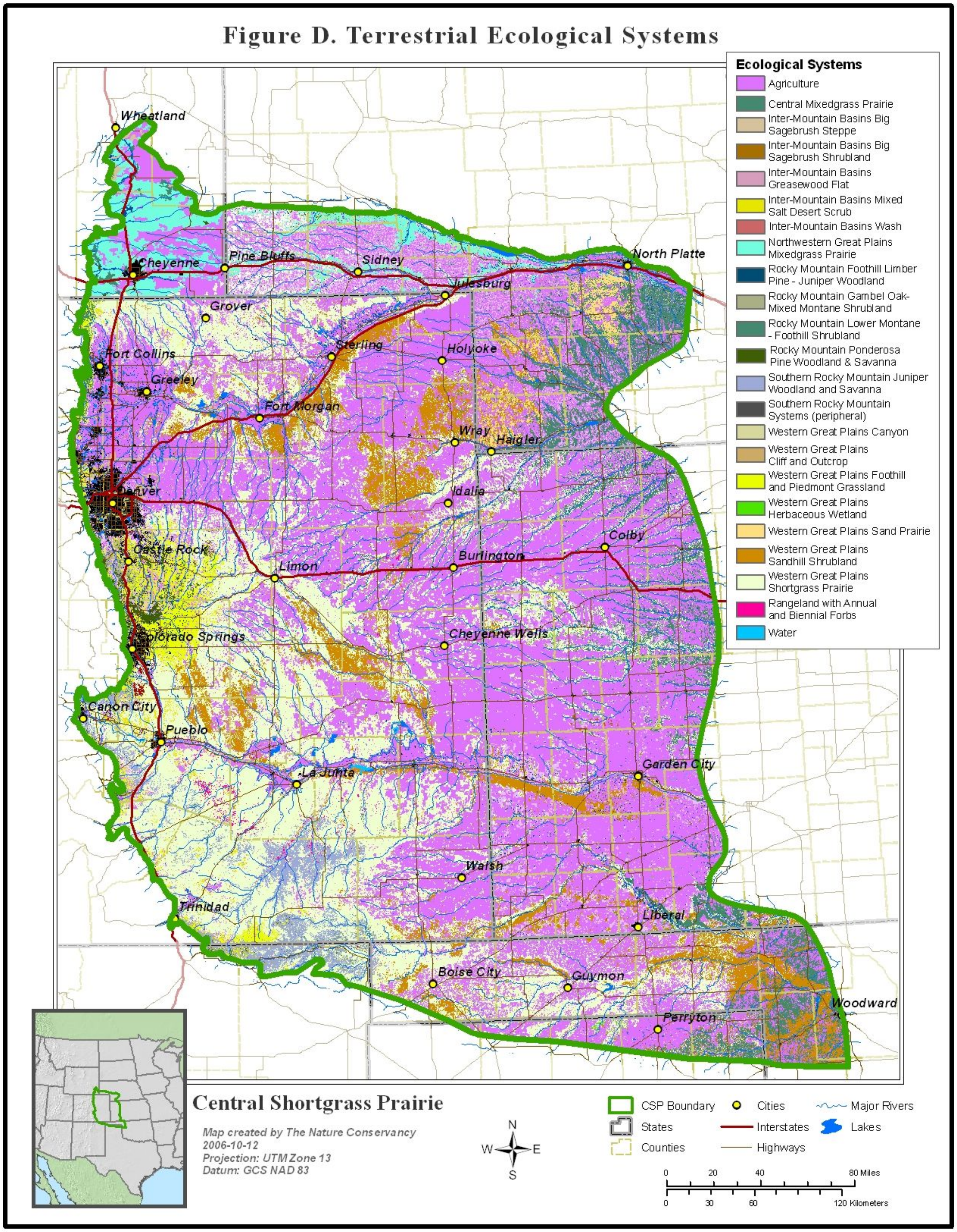


Figure D. Terrestrial Ecological Systems
Ecological Systems
Agriculture
Central Mixedgrass Prairie
Inter-Mountain Basins Big Sagebrush Steppe
Inter-Mountain Basins Big Sagebrush Shrubland
Inter-Mountain Basins Greasewood Flat
Inter-Mountain Basins Mixed Salt Desert Scrub
Inter-Mountain Basins Wash
Northwestern Great Plains Mixedgrass Prairie
Rocky Mountain Foothill Limber Pine - Juniper Woodland
Rocky Mountain Gambel Oak-Mixed Montane Shrubland
Rocky Mountain Lower Montane - Foothill Shrubland
Rocky Mountain Ponderosa Pine Woodland & Savanna
Southern Rocky Mountain Juniper Woodland and Savanna
Southern Rocky Mountain Systems (peripheral)
Western Great Plains Canyon
Western Great Plains Cliff and Outcrop
Western Great Plains Foothill and Piedmont Grassland
Western Great Plains Herbaceous Wetland
Western Great Plains Sand Prairie
Western Great Plains Sandhill Shrubland
Western Great Plains Shortgrass Prairie
Rangeland with Annual and Biennial Forbs
Water
Wheatland
Cheyenne
Pine Bluffs
Sidney
North Platte
Julesburg
Grover
Sterling
Holyoke
Fort Collins
Greeley
Fort Morgan
Wray
Haigler
Denver
Idalia
Colby
Castle Rock
Limon
Burlington
Colorado Springs
Cheyenne Wells
Canon City
Pueblo
La Junta
Garden City
Walsh
Trinidad
Liberal
Boise City
Guymon
Woodward
Perryton
Central Shortgrass Prairie
Map created by The Nature Conservancy
2006-10-12
Projection: UTM Zone 13
Datum: GCS NAD 83
N
W
E
S
CSP Boundary
Cities
Major Rivers
States
Interstates
Lakes
Counties
Highways
0 20 40 80 Miles
0 30 60 120 Kilometers

Table 2. Terrestrial ecological systems of the Central Shortgrass Prairie.

Targeted Systems	Patch Type	Estimated Level of Conversion
Central Mixed-grass Prairie	Large patch	High
Inter-Mountain Basins Big Sagebrush Shrubland	Large patch	Low
Inter-Mountain Basins Big Sagebrush Steppe	Large patch	Low
Inter-Mountain Basins Greasewood Flat	Large patch	High
Inter-Mountain Basins Mixed Salt Desert Scrub	Large patch	High
Inter-Mountain Basins Wash	Linear	Low
Northwestern Great Plains Mixed-grass Prairie	Large patch	Moderate
Rangeland with Annual and Biennial Forbs	Large patch	Low
Rocky Mountain Foothill Limber Pine-Juniper Woodland	Small patch	Low
Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Large patch	Low
Rocky Mountain Lower Montane-Foothill Shrubland	Large patch	Low
Rocky Mountain Ponderosa Pine Woodland and Savanna	Large patch	Moderate
Southern Rocky Mountain Systems (peripheral)	Large patch	Low
Southern Rocky Mountain Juniper Woodland and Savanna	Large patch	Low
Western Great Plains Canyon	Small patch	Low
Western Great Plains Cliff and Outcrop	Small patch	Moderate
Western Great Plains Foothill and Piedmont Grassland	Large patch	Moderate
Western Great Plains Herbaceous Wetland	Small patch	High
Western Great Plains Sand Prairie	Large patch	Moderate
Western Great Plains Sandhill Shrubland	Matrix	Moderate
Western Great Plains Shortgrass Prairie	Matrix	Moderate

Due to mapping issues, the Core Team took a different approach to addressing riparian ecological systems and playa lakes. The team addressed riparian systems by using known occurrences of riparian plant communities and indirectly in the aquatic analysis by identifying areas with higher hydrologic integrity. Playa lakes, shallow depressional wetlands that receive water only from precipitation and runoff (Smith 2003), were treated somewhat differently than ecological systems because they were not well represented in GAP or Southwest ReGAP mapping. The Playa Lakes Joint Venture (PLJV) provided spatial data for playa lakes derived from satellite imagery and soils mapping units.

Table 3. Terrestrial ecological system patch type definitions.

System Patch Type	Definition
Matrix	Form extensive cover (e.g., 75-80 % of the ecoregion), occur on the most widespread landform types, have broad ecological amplitude, and are driven by regional-scale processes
Large-patch	May form extensive cover over some areas, but their boundaries usually correlate with a single dominant process such as hydrology or soils
Small-patch	Have very specific ecological amplitudes and occur where a number of local conditions come together in an unusual way
Linear	Usually are associated with streams and rivers

C. Aquatic Ecological Systems

Regional conservation assessments include aquatic biodiversity because aquatic species and ecosystems are a major component of biodiversity, and are highly threatened worldwide (Master et al. 1998, Abell et al. 2000, Higgins et al. 2005). Because there is a lack of comprehensive biological information for aquatic species and communities, the team used a classification framework developed for aquatic ecological systems that includes biological data, but is based largely on abiotic variables that are known to influence biotic patterns (Higgins et al. 2005, Lammert et al. 1997, Groves et al. 2000). This approach has four spatial levels: aquatic zoogeographic units (e.g., freshwater ecoregions), ecological drainage units, aquatic ecological systems, and macrohabitats (Higgins et al. 2005). This framework, applied widely across the United States and around the world, provides a way to capture representative aquatic biodiversity at the regional level (Higgins 2003).

The team used aquatic ecological systems (Higgins et al. 2005) as coarse-filter targets for the aquatic assessment. Aquatic ecological systems are spatial assemblages of ecological communities that occur together within an aquatic landscape with similar geomorphologic patterns, are tied together by similar ecological processes (e.g., hydrologic and nutrient regimes, access to floodplains) or environmental gradients (e.g., temperature, chemical and habitat volume), and form robust, cohesive, and distinguishable units on a hydrography map (Higgins 2003, Higgins et al. 2005).

Aquatic ecological systems were mapped by using the “bottom-up” approach (Higgins et al. 2005) in which stream reaches called “macrohabitats” are classified, then, aquatic ecological systems are developed by assessing patterns in the distribution of macrohabitats. Macrohabitats are classified by summarizing, at the scale of individual reaches in 1:100,000 scale hydrography (National Hydrography Dataset), the most important physical variables that distinguish natural aquatic communities. In the Eastern Slope drainages, the team identified stream size, elevation, stream gradient, and chemical/permeability characteristics of geologic formations and soil types (as they relate to hydrologic regime and water chemistry) as classification variables. To classify stream reaches into macrohabitats, the team partitioned each variable into classes corresponding to major differences in ecosystem structure and/or function (Table 4). Each reach was then assigned a class for each variable, and the macrohabitat type is the result of a concatenation of the four variables. See Figure E and Appendix B for details.

Figure E. Aquatic Ecological Systems - Stream Sizes

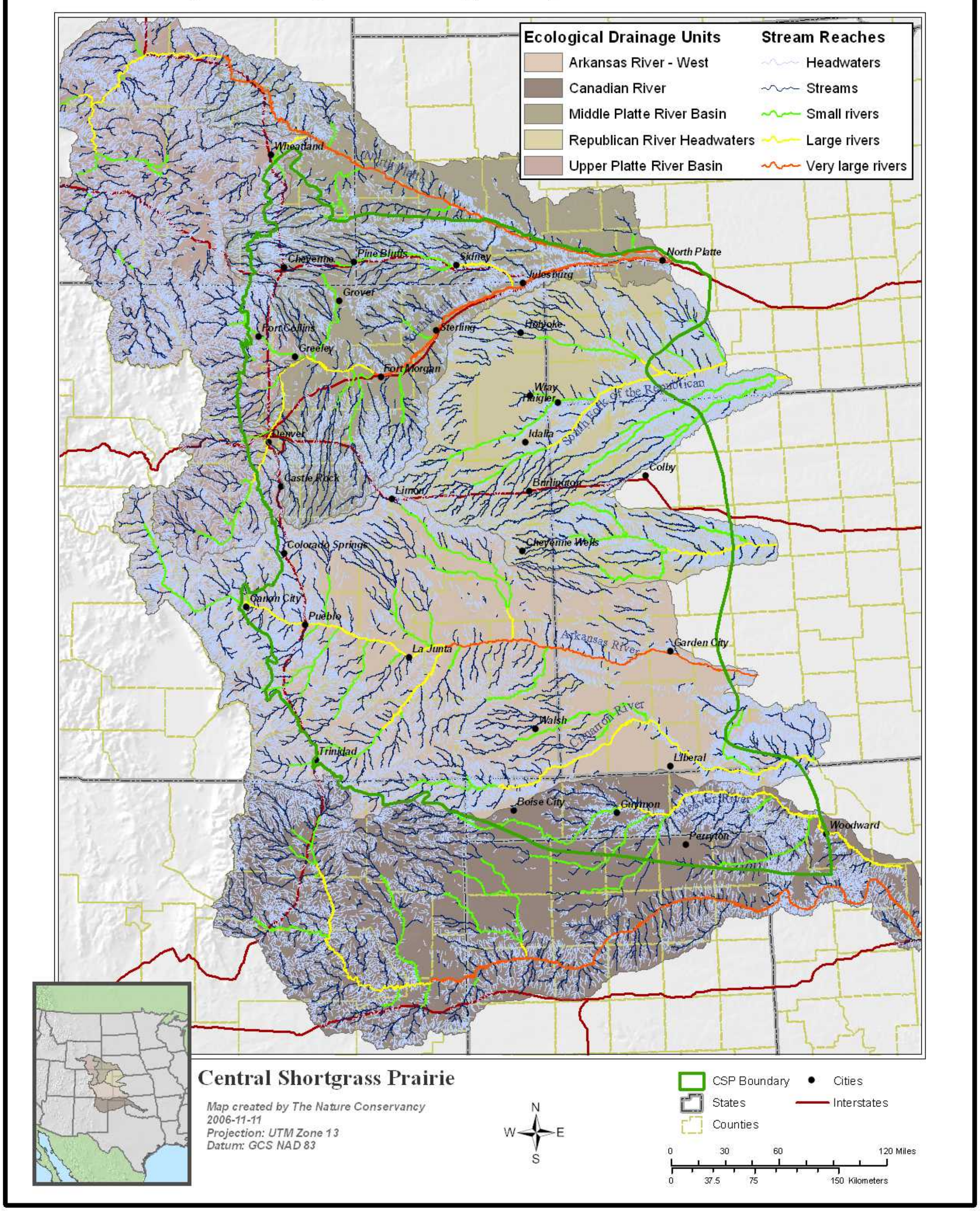


Table 4. Categories of stream size, gradient, elevation, and water chemistry-permeability used in the classification of aquatic macrohabitats for Eastern Slope aquatic systems.

Stream Size (Area km^2)	Gradient (% Slope)	Elevation (m)	Water Chemistry – Permeability
1 – Headwaters (<50)	1 – Flat (<3)	1 – Plains (<1600)	1 – Acid/neutral – High
2 – Stream (50-1000)	2 – Moderate (3-10)	2 – Foothills (1600-2200)	2 – Acid/neutral – Moderate
3 – Small River (1,000-5,000)	3 – Steep (10-20)	3 – Montane (2200-2800)	3 – Acid/neutral – Low
4 – Large River (5,000 - 25,000)	4 – Very Steep (>20)	4 – Subalpine (2800-3500)	4 – Basic – High
5 – Very Large River (>25,000)		5 – Alpine (>3500)	5 – Basic – Moderate
			6 – Basic – Low

The team classified aquatic ecological systems by analyzing patterns of macrohabitat types within watersheds through cluster analysis (Gauch 1982; McCune et al. 2002). The team used GIS to delineate watersheds that encompass the five stream-size classes in the macrohabitat classification model (Table 5). Within the stream and small-river size classes, watersheds that contain similar numbers and types of macrohabitats were grouped into types using PC-ORD V.4 software (McCune and Mefford 1999). Headwaters were included with the classification of streams. Large and very large rivers were classified by a manual process due to the small number of river types and low number of occurrences. Classification of these systems was based primarily on channel location (geologic substrata and ecoregion), location of river headwaters (physiography), and types of nested systems.

Table 5. Number of aquatic ecological systems classified in each stream-size category (see Figure E for map of aquatic systems).

Stream Size	Number of Aquatic Ecological Systems
Stream/Headwater	54
Small River	20
Large River	4
Very Large River	1

D. Terrestrial Plant Communities

The team targeted 117 natural plant communities from state Natural Heritage Programs for conservation in this assessment. In general, these were rare or unusual plant community types, or high quality examples of common plant community types. Other communities were also targeted individually if they were not covered adequately by ecological systems or if they needed special attention (e.g., systems that are under-represented, or plant communities that are heavily impacted, or converted including playa lakes, isolated wetlands, and riparian communities). Otherwise, it was assumed that plant communities were addressed using in the ecological systems analysis. See Figure F for distribution of plant communities within the ecoregion, and Appendix C for a complete list of targeted plant communities.

For plant-community point or polygon occurrence data, various rules were applied to determine which occurrences would be targeted, and, thus, the focus of future conservation efforts (see Table 6 and 7).

Table 6. Criteria used to select plant community occurrences (see Table 7 for definitions). Estimated viability ranks of occurrences, assigned by NatureServe and Natural Heritage Programs are: A=excellent, B=good, C=fair, D=poor, and E=extant.

Global Rank	Occurrences
G1-G2	All occurrences ranked A-C (viable)
G3	All occurrences ranked A-B
G4-G5	A-ranked occurrences for matrix and large patch systems; A & B for small patch, linear, or other cases not well mapped by ecological systems
GU,G?, GNR	A-ranked occurrences for matrix and large patch systems A & B for small patch, linear, or other cases not well mapped by ecological systems; unranked occurrences were treated as C-ranked

Table 7. Global priority ranking definitions assigned by NatureServe/Natural Heritage Programs.

Global Rank	Definition
G1	Globally critically imperiled; typically 5 or fewer occurrences
G2	Globally imperiled; typically 6 to 20 occurrences
G3	Globally vulnerable; typically 21 to 100 occurrences
G4	Apparently secure; usually >100 occurrences
G5	Demonstrably secure, although may be rare in parts of range

E. Species

The Core Team, with assistance from expert reviewers, developed the species target lists for each taxon: amphibians, birds, fish, invertebrates (including crustaceans, mollusks, and insects), mammals, plants, and reptiles, based on the criteria outlined in Table 8.

1. Global Priority Ranks
   The Core Team used the NatureServe/Natural Heritage Program ranking system to assist in selecting the fine-filter targets. This system describes species' rarity with a five-category ranking, where the rarest species are ranked as G1 (Global 1) and the most common are ranked G5 (see Table 7).

Table 8. Criteria used for selecting target species.

Criteria	Definition/Comment
Imperiled species	Critically imperiled or imperiled species that have a global rank of G1-G2 by NatureServe. Regularly reviewed and updated by experts, these ranks take into account number, quality, and condition of occurrences, population size, range of distribution, threats and protection, and IUCN status.
Vulnerable species	Species with a global rank of G3 by NatureServe; declining, endemic, keystone, and/or wide-ranging species.
Federal and state endangered and threatened species	Listed or proposed for listing as Threatened or Endangered by the US Fish and Wildlife Service under the Endangered Species Act, or listed by a state fish and game agency.
Declining species	Species exhibit significant, long-term declines in habitat and/or numbers, are subject to a high degree of threat, or have unique habitat or behavioral requirements that expose them to great risk. Includes species identified by Partners in Flight, Partners for Amphibians and Reptiles Conservation watch list, etc.
Endemic species	Endemic species are restricted to an ecoregion (or a smaller geographic area), depend entirely on a single area for survival, and often are vulnerable.
Keystone species	Species whose impact on a community or ecological system is disproportionately large for their abundance. They contribute to ecosystem function in a unique and significant manner. Their removal initiates changes in ecosystem structure and often a loss of diversity (e.g., bison, prairie dog).
Wide-ranging species	Species with large-scale conservation needs that depend on vast areas (e.g., bison, pronghorn, carnivores); top-level predators (e.g., mountain lion); migratory or nomadic mammals (e.g., elk, bats, birds). Useful in examining linkages among conservation sites.
Species aggregations	Globally significant and critical shorebird migratory stopover sites contain significant numbers of bird species. Unique, irreplaceable examples for the species and/or critical to the conservation of a species or suite of species.
Species assemblages	Major groups of species that share common ecological processes and patterns, and/or have similar conservation requirements and threats (e.g., fish, prairie dog communities).
Other categories	USFS and BLM sensitive species, indicator species, species playing a critical role in ecological processes (pronghorn), disjunct species with populations that are geographically isolated from other populations, and edge-of-range species (peripherals).

2. Other Considerations in Species Target Selection

Birds offer a significant challenge in that they are highly mobile, are often transient, and almost always rely on areas outside the ecoregion to fulfill their ecological requirements (e.g., wintering grounds for neotropical migrants). Due to the migratory nature of most birds, estimates of the percentage of the global population in the Bird Conservation Region 18 (Shortgrass Prairie) portion of the CSP (Rich et al. 2004) were considered when selecting bird targets. In addition to the criteria listed above, bird species were evaluated on the importance of the ecoregion to their conservation, including species that: a) critically depend on the ecoregion; b) are highly characteristic of the ecoregion; and/or c) are in widespread global decline, but well represented within the ecoregion.

3. <u>Species Target List</u>

A total of 148 species were selected as fine-filter or species targets within the ecoregion (see Table 9, Appendix D, and Appendix E for a list of species prioritized by NatureServe global rank, and Appendix F for a description of shorebird aggregation areas). Selected species included those at the edge of their range and that are of concern in one or more states, are declining rangewide, and/or are not reliably captured by the coarse-filter approach. The following is a summary of selected species groups (see Figures F-H for species distribution, modeled prairie dog towns and complexes, and modeled mountain plover):

a. *Federally listed*: 10 species are federally listed under the US Endangered Species Act, such as Colorado butterfly plant (*Gaura neomexicana*), piping plover (*Charadrius melodus*), and Topeka shiner (*Notropis topeka*);
b. *Imperiled:* 31 species are considered imperiled, including Scott riffle beetle (*Optioservus phaeus*), mountain plover (*Charadrius montanus*), Arkansas River shiner (*Notropis girardi*), and round-leaf four o'clock (*Mirabilis rotundifolia*);
c. *Extirpated:* at least eight species are known to have been extirpated from the CSP, including black-footed ferret (*Mustela nigripes*), Rocky Mountain locust (*Caloptenus spretus*), and shovelnose sturgeon (*Scaphirhynchus platorynchus*);
d. *Endemic:* 23 taxa are endemic, or known only from the ecoregion, such as triploid Colorado checkered whiptail (*Aspidoscelis neotesselata*), Botta's pocket gopher (*Thomomys bottae rubidus*), and Arkansas Valley evening primrose (*Oenothera harringtonii*);
e. *Species aggregations and assemblages:* includes both water/shorebirds and prairie dog animal communities (see Appendices F and X for details); and
f. *Wide-Ranging*: includes bison, elk, mountain lion, pronghorn, and bighorn sheep.

Table 9. Summary of the number of species, aggregations, and animal-community targets in the Central Shortgrass Prairie.

Taxonomic Group	Number of Targets
Amphibians	6
Birds	18
Crustaceans	1
Fish	19
Insects	30
Mammals	15
Mollusks	3
Plants	46
Reptiles	9
Shorebird aggregation areas	1
Black-tailed prairie dog animal community	1
Total	149

Figure F. Distribution of Plants, Animals and Plant Communities

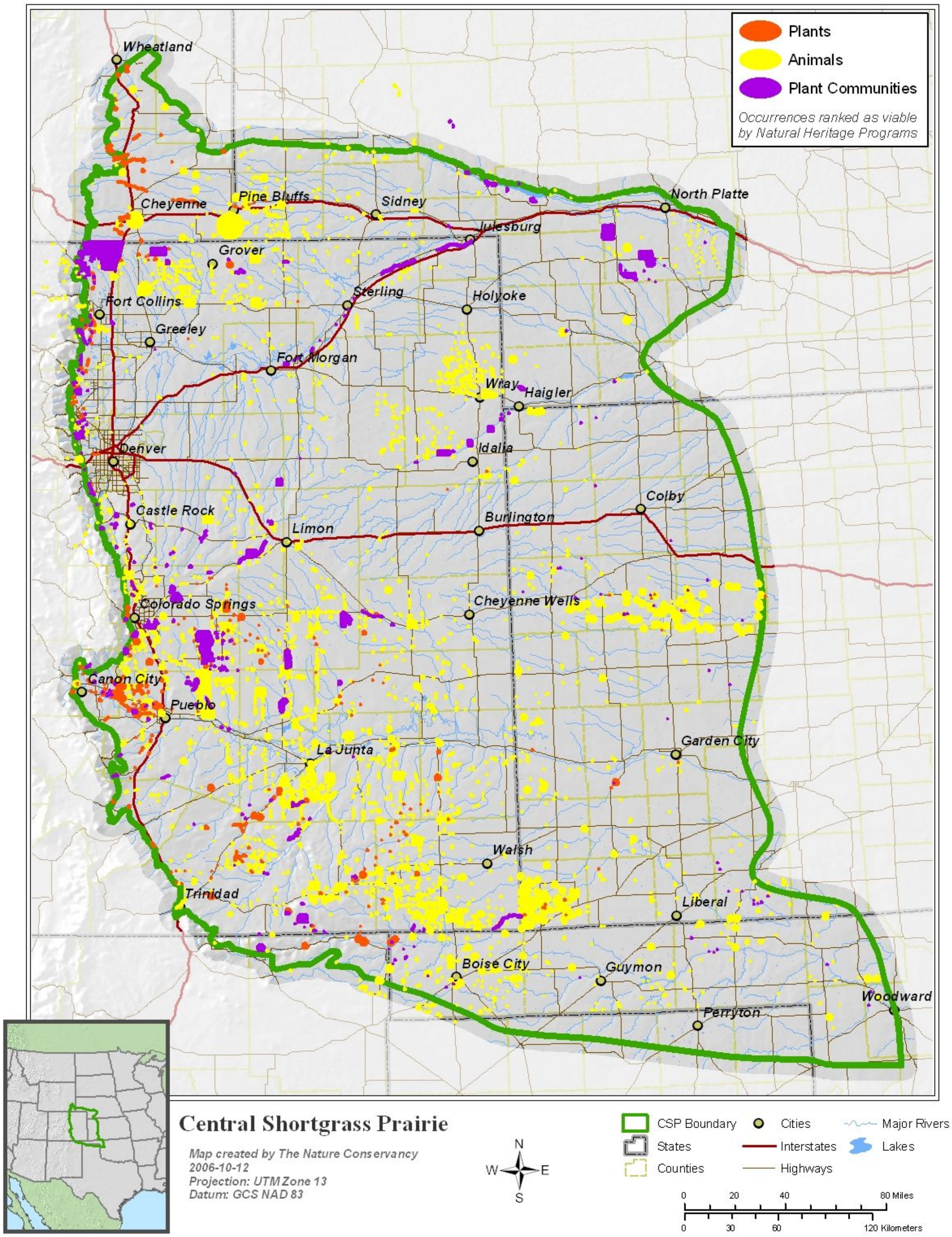
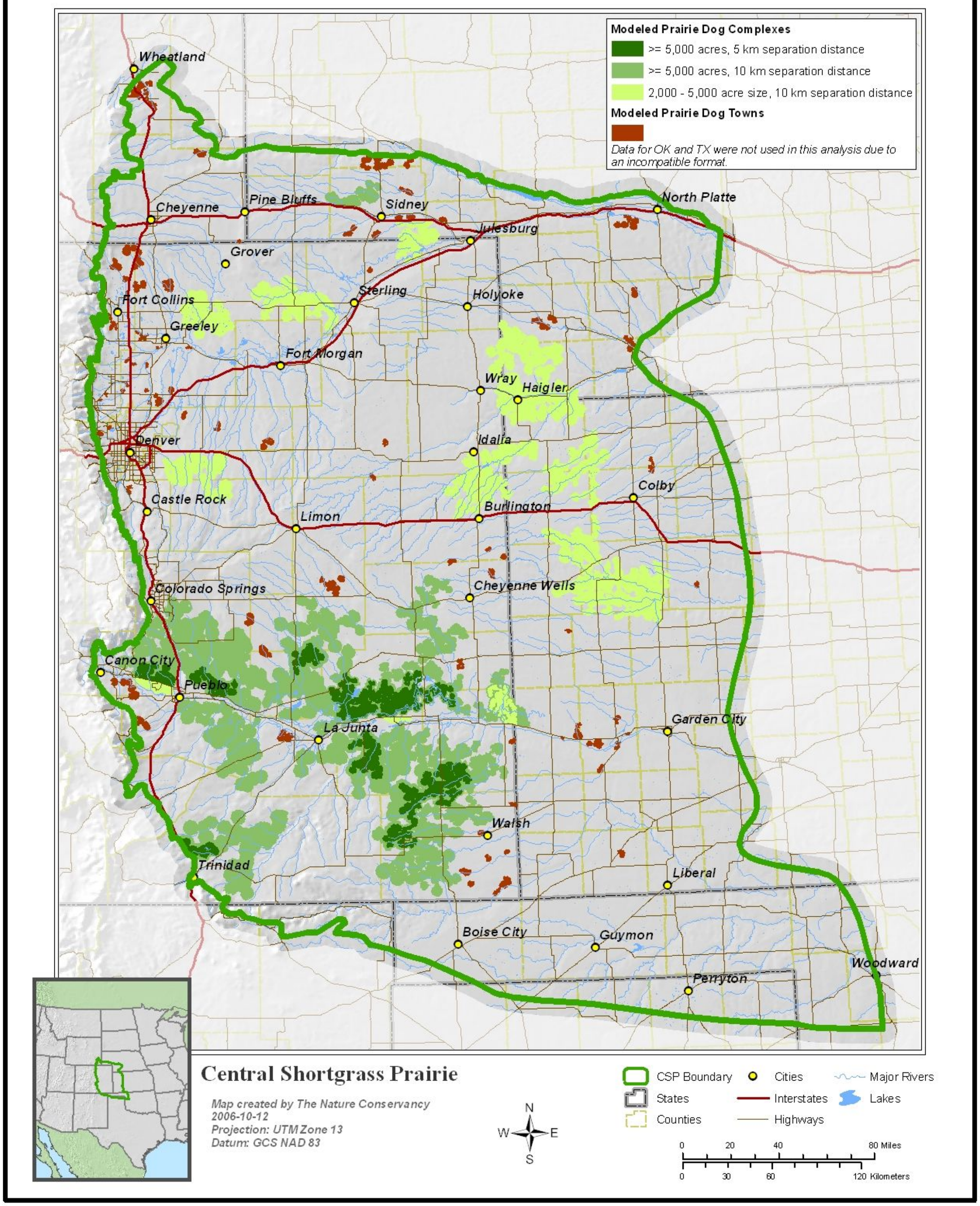


Figure G. Distribution of Black-tailed Prairie Dog



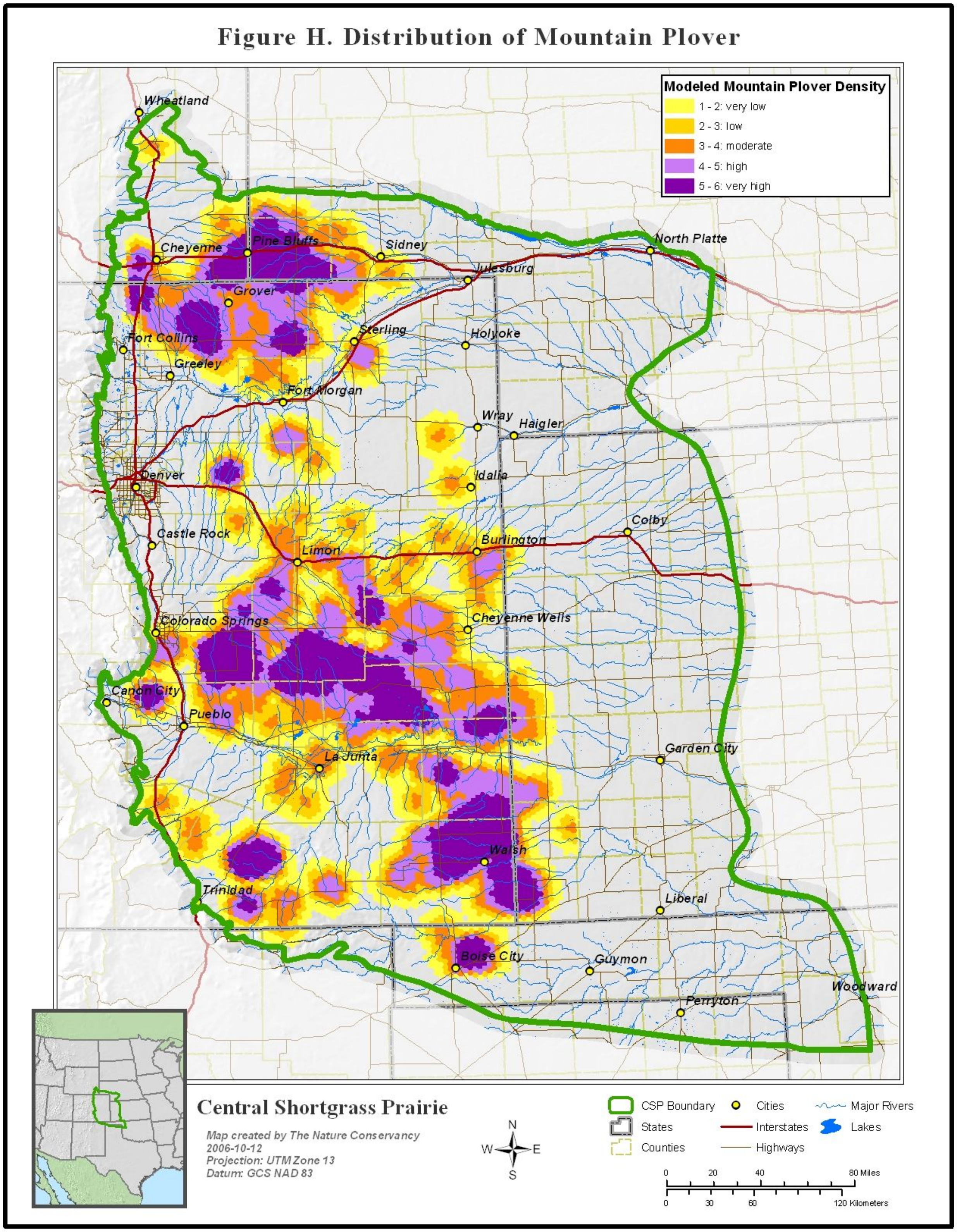


Figure H. Distribution of Mountain Plover
Modeled Mountain Plover Density
1 - 2: very low
2 - 3: low
3 - 4: moderate
4 - 5: high
5 - 6: very high
Wheatland
Cheyenne
Pine Bluffs
Sidney
North Platte
Julesburg
Grover
Sterling
Holyoke
Fort Collins
Greeley
Fort Morgan
Wray
Haigler
Denver
Idalia
Colby
Castle Rock
Limon
Burlington
Colorado Springs
Cheyenne Wells
Canon City
Pueblo
Garden City
La Junta
Walsh
Trinidad
Liberal
Boise City
Guymon
Woodward
Perryton
Central Shortgrass Prairie
Map created by The Nature Conservancy
2006-10-12
Projection: UTM Zone 13
Datum: GCS NAD 83
N
W
E
S
CSP Boundary
Cities
Major Rivers
States
Interstates
Lakes
Counties
Highways
0
20
40
80 Miles
0
30
60
120 Kilometers

4. Species Watch List

An additional 54 species of concern were placed on a Watch List (Appendix G). While these species are of conservation concern in the ecoregion, the team assumed they would be covered through the coarse-filter representation (i.e., ecological systems). Selected Watch List species, such as swift fox (*Vulpes velox*) and grasshopper sparrow (*Ammodramus savannarum*), were evaluated at the end of the project to ensure that they were adequately captured in the network of conservation areas. Other watch-list species may be re-evaluated and included as formal target species in the future, if there are indications of declining conservation status.

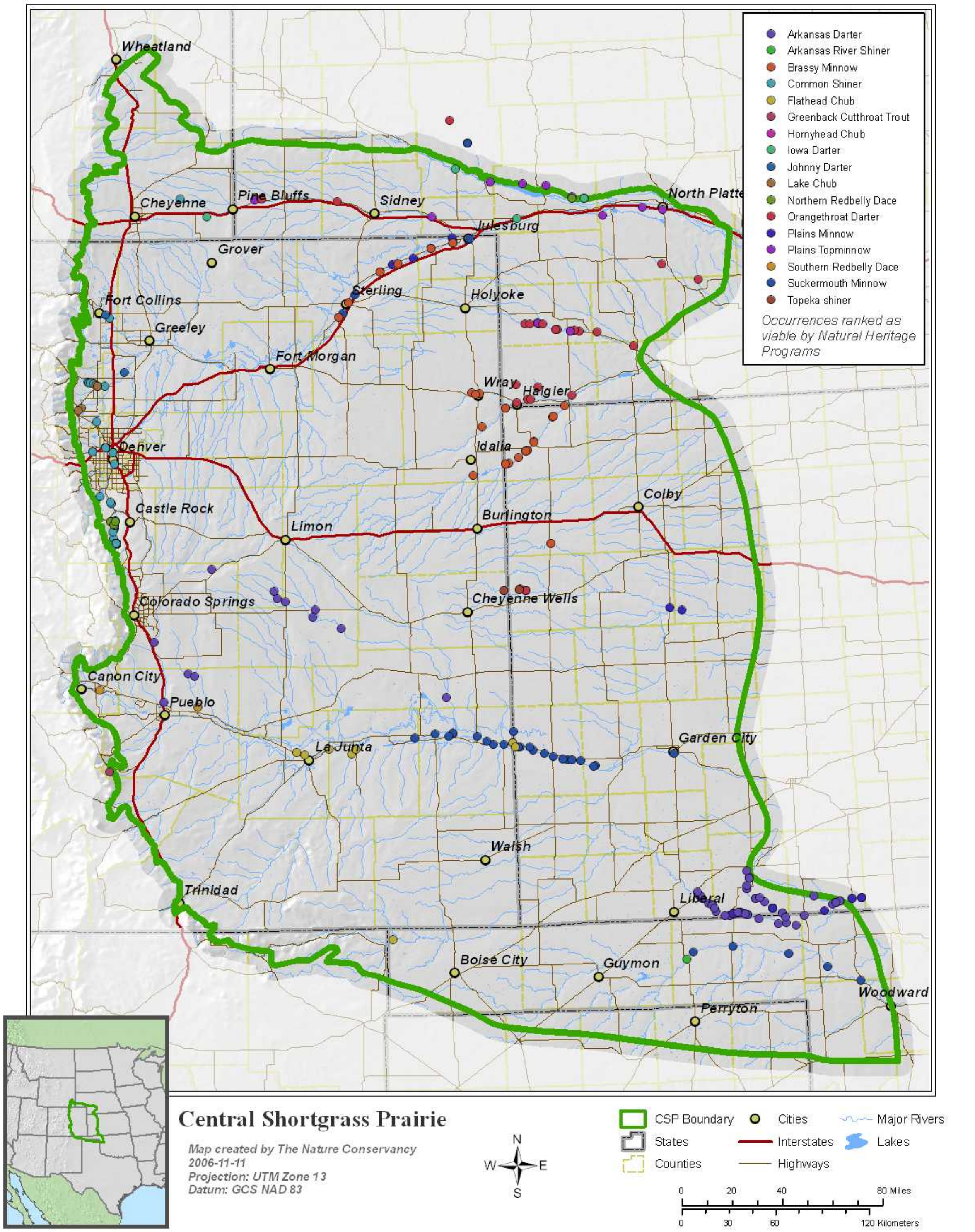
5. Aquatic Species

In addition to aquatic ecological systems, the team selected 55 aquatic species as targets in the aquatic assessment (Table 10) within the Eastern Slope EDU's (36 occur within the CSP). Selection of aquatic species followed the same criteria as for terrestrial species (Table 8). The team generated the aquatic species target list for Eastern Slope drainages that overlap the CSP by selecting all aquatic species from the target lists in all TNC ecoregional assessments that overlap the five EDUs (Table 10). Regional experts reviewed these lists and provided information on additional declining species or newly described species. See Figure I for preliminary distribution of fish targets within the ecoregion (note: this map will be updated in the near future to include expert review information).

Table 10. Summary of species targets in the Eastern Slope aquatic assessment.

	Number of Targets			
Taxonomic Group	**Central Shortgrass Prairie**	**Additions from Southern Rocky Mountains**	**Additions from Southern Shortgrass Prairie**	**TOTAL**
Crustaceans	1	1	1	3
Fish	19	0	0	19
Insects	14	16	0	30
Mollusks	2	1	0	3
Total	36	18	1	55

Figure I. Distribution of Fish Species



VIII. CONSERVATION GOALS

A. Representation Goals

The team adopted a "goal-based" approach to identify and prioritize conservation areas, and to generate various scenarios to address conservation. Using this approach, the team established overall conservation goals, and then developed explicit, numerical objectives for representing targeted species, communities, and ecological systems throughout the ecoregion.

Numerical objectives for target representation are considered a "working hypothesis." Goals are a starting point for conservation and measuring progress. They also reflect varying levels of risk in regard to loss of a species or ecological system. Multiple, alternative conservation scenarios were developed by varying these numerical objectives; lower numerical objectives represent "higher-risk" of extinction scenarios, and higher objectives represent "lower-risk" of extinction scenarios. These alternatives reflect a range of uncertainty and risk associated with making decisions about investments for biodiversity conservation (Tier et al. 2005). A brief description of goals and objectives is below.

1. Goals: Goals describe the desired condition for targeted species, communities, and ecosystems. The goal for species targets is species viability within the planning area, or maintenance of viable populations for at least 100 years.

2. Objectives: Objectives are explicit and quantifiable expressions of broader goals. Objectives address key questions underlying conservation: "*How much? How many? In what spatial distribution?"* These objectives drive conservation scenarios for conservation targets. *(Note: hereafter the term goal is used to mean both goals and objectives throughout this document.)*

B. Terrestrial Ecological Systems

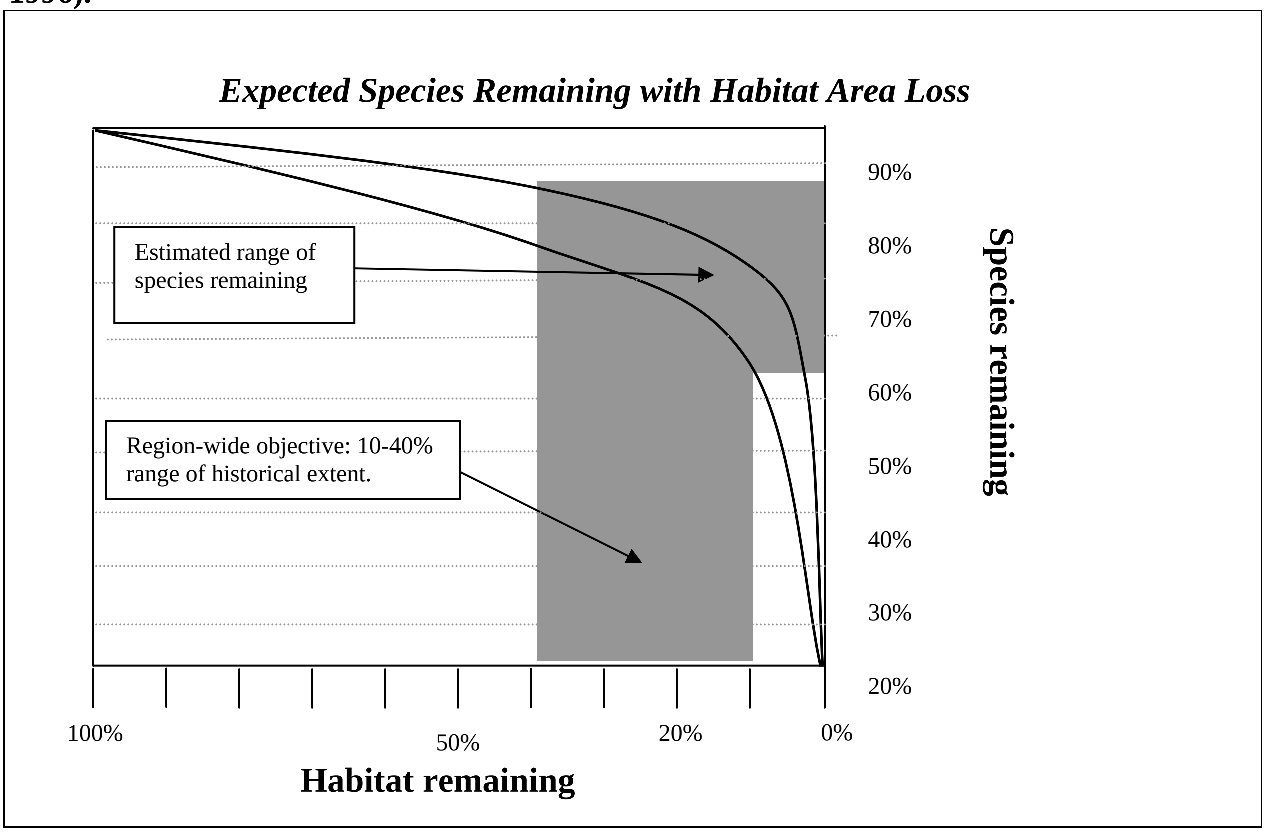
While goals for targeted species emphasize the health and viability of their populations, coarse-filter goals focus on representing ecological variability and environmental gradients. The goal for ecological systems is to conserve enough occurrences to help ensure that "*essential ecosystem services are secure and common species remain viable.*" This coarse-filter approach is used to help ensure that common species remain common.

1. Conservation Scenarios: The Core Team created an analysis of four regional conservation scenarios for the terrestrial network; standard coarse-filter goals were set at 10% (representing very high extinction risk), 20%, 30%, and 40% (representing respectively lower levels of extinction risk) of *historic extent* of each ecological system in the CSP. The decision to use these percentages was based on several assumptions. First, additional habitat for non-targeted species and communities remains outside selected areas. Secondly, non-targeted species tend to occur across multiple ecoregions. Thirdly, published thresholds for vulnerability status provide an initial guide for goal setting. For example, while criteria for establishing degrees of imperilment for species and communities vary (e.g., Mace and Stuart 1994, Master et al. 2002), they generally suggest numbers of discrete locations, or occurrences, ranging from 10 to more than 80 rangewide (see related discussion below for

terrestrial species objectives). For the coarse-filter concept to work, non-target species and communities should be sustained at levels above established thresholds for vulnerable status.

These more common species and communities generally have more than 60 occurrences rangewide. Exploratory analysis previously completed in the region indicated a rough correspondence between percent-area of terrestrial ‘coarse-filter’ representation, and the percentage of terrestrial species ranges likely to be included within these same areas (Tier et al. 2005). These results reflect common assumptions underlying the species area curve (Dobson 1996, Comer 2005a) positing the direct relationship between habitat area and the probability of including additional species (as well as additional populations of the same species). Applying this concept to species conservation, one would expect that with decreasing available area, there will be a gradual decrease in the number of species supported over the long term. Actual percentages needed for non-target species conservation will vary, but should fall within a broad range, from perhaps 10% to 60% of the total ecoregion. The species area curve developed by Dobson (1996) would suggest that coarse-filter representation set as high as 40% and as low as 10% might conserve between 85% and 55% of all native species (both targeted and non-target species), respectively (see Figure 1). Given this, establishing a set of scenarios spanning the range from 10-40% of historical extent provides a reasonable starting point for analysis.

Figure 1. Estimated species loss with percent habitat loss over time (modified from Dobson 1996).



2. Estimating Historical Extent: Several ecological systems, such as the Western Great Plains Shortgrass and Central Mixed-Grass Prairies, have experienced high rates of conversion within the ecoregion. The Core Team developed models of these two systems to generally approximate their historic extent, based on the range of values for elevation and precipitation across the existing extent of the two grassland ecological systems. Ranges of elevation and the two precipitation measures were calculated for shortgrass and mixed grass (information on file at CNHP). The range of values that did not overlap between the two grasslands then was used to determine which areas currently mapped as agriculture or disturbed herbaceous had the highest potential to have originally been shortgrass or mixed grass prairie. Areas with overlap were assumed to be evenly split between the two systems. These values were then extrapolated across existing maps of cultivated land to determine the extent that each grassland system would have occurred had it not been cultivated.

   For parts of the ecoregion, explicit data exists on rates of conversion from natural to non-natural. In several cases, these data were used to estimate historic extent of the ecological systems. Historic data from southwestern Kansas (Robel et al. 2004) provided an indication of the conversion of sandsage prairie (i.e., Western Great Plains Sandhill Shrubland) to human-modified cover. Those figures were used to generate historic extent for the Western Great Plains Sandhill Shrubland and Western Great Plains Sandhill Prairie systems. The team assumed the same level of conversion for southwestern Nebraska Sandhill Shrubland, and estimated the conversion rates for eastern Colorado Sandhill Shrublands to be about one-half the southwestern Kansas rate. Conservation goals were established based on these modeled or documented historic extents. Current extent was assumed to be approximately the same as historic extent for all other ecological systems. See Table 11 for initial objectives for ecological systems used for selecting conservation areas within the ecoregion. See Appendix N for conservation goals in acres for the ecological systems.

   Table 11. Conservation goals for terrestrial ecological systems, expressed as four levels of historic extent for developing various conservation scenarios (see Appendix N for quantitative objectives).

Terrestrial Ecological Systems Extent of Historic Area			
"Very High Risk" Scenario	"Higher Risk" Scenario	"Moderate Risk" Scenario	"Lower Risk" Scenario
10%	20%	30%	40%

3. Playa Lakes: Mapping identified more than 36,000 playa lakes in the ecoregion in both cultivated farmland and native rangeland. Because the team wanted to identify the playa lakes with greatest integrity, the playa lakes within 200 meters of cultivated land were excluded. This left only 1,600 of the original 36,000 playa lakes. Issues with mapping playa lakes precluded using the standard goals (10-40% of all playa lakes); thus the moderate-risk goal was set at 30% of the 1,600 playas identified in native rangelands (= 480). The team recognized that a goal of 480 was obviously inadequate. However, the team expected that many playas would be captured or

"swept in" with other ecological systems in the network and later selected concentrations of playa lakes in tilled areas as potential restoration areas.

C. Aquatic Ecological Systems

The objective for assembling the aquatic network based on aquatic ecological systems was to represent a sufficient number of intact, functioning occurrences of each ecological system target across all EDUs in which they occur. Therefore, representation goals for all ecosystem targets were established at 30% of mapped occurrences in each EDU in which they occur. This percentage corresponds to the moderate risk scenario for terrestrial systems. To ensure a representative and efficient network, the team capped the inclusion of occurrences at a maximum of three for targets with fewer than 75 occurrences, and at five for targets with greater than 75 occurrences.

D. Terrestrial Species

For the majority of species targets, specific knowledge is inadequate to create target-specific objectives. Theoretical work on species viability in Florida suggests that 10 distinct subpopulations of 200 individuals should be sufficient for survival of at least one subpopulation over 10 generations or 100 years (Cox et al. 1994). These numbers were intended to represent minimum-viability estimates for genetic fitness, while the goals for the CSP are broader, and generally more ambitious.

NatureServe and Natural Heritage programs (Master et al. 2002), and the IUCN (Mace et al. 1994) established guidelines for determining the conservation status of species. These guidelines include such criteria as total population size, number of sub-populations or occurrences, condition/occurrence viability, range extent, trends, threats, vulnerability, environmental specificity, and current conservation status. The team used the NatureServe and IUCN systems to define "vulnerable" conservation status for species to inform goal setting.

Table 12 provides a summary of initial goals for groups of targeted species and species assemblages. These numbers were used as a starting point for objectives in the absence of specific information. Targets were grouped according to the proportion of their range-wide distribution within the ecoregion. Objectives decrease as endemism decreases, in rough proportion to the ecoregion's share of the global distribution.

Table 12. Conservation goals for targeted species, expressed as three risk levels for developing various conservation scenarios.

Distribution	High Risk Scenario	Moderate Risk Scenario	Low Risk Scenario
	Number of Viable Occurrences (post 1985)		
G1-G2 Species	All viable	All viable	All viable
G3-G5 Species			
Endemic	21	42	80
Limited	10	21	42
Disjunct	5	10	21
Widespread	5	10	21
Edge of Range	2	5	10

The number of documented occurrences for many species is a limiting factor in generating scenarios. Limitations may be due to limited habitat, incomplete inventories, or past habitat conversions (see Appendix H for targeted species with no occurrence data). Very high risk goals were not developed for species as many species could not meet even the lowest goal levels. In some cases, species goals differed from those in the above table, such as species with naturally low numbers of occurrences, species with existing recovery plans, or species addressed in the CDOW Conservation Plan for Grassland Species for Colorado (2003). Goals were established based on percentage of total occupied habitat for several declining bird species, such as mountain plover (incorporating various levels of density). Goals were established based on modeled habitat for wide-ranging species (see Appendix I). For more detail regarding goals and viability/integrity analyses for the CSP, see Comer (2005b).

E. Aquatic Species

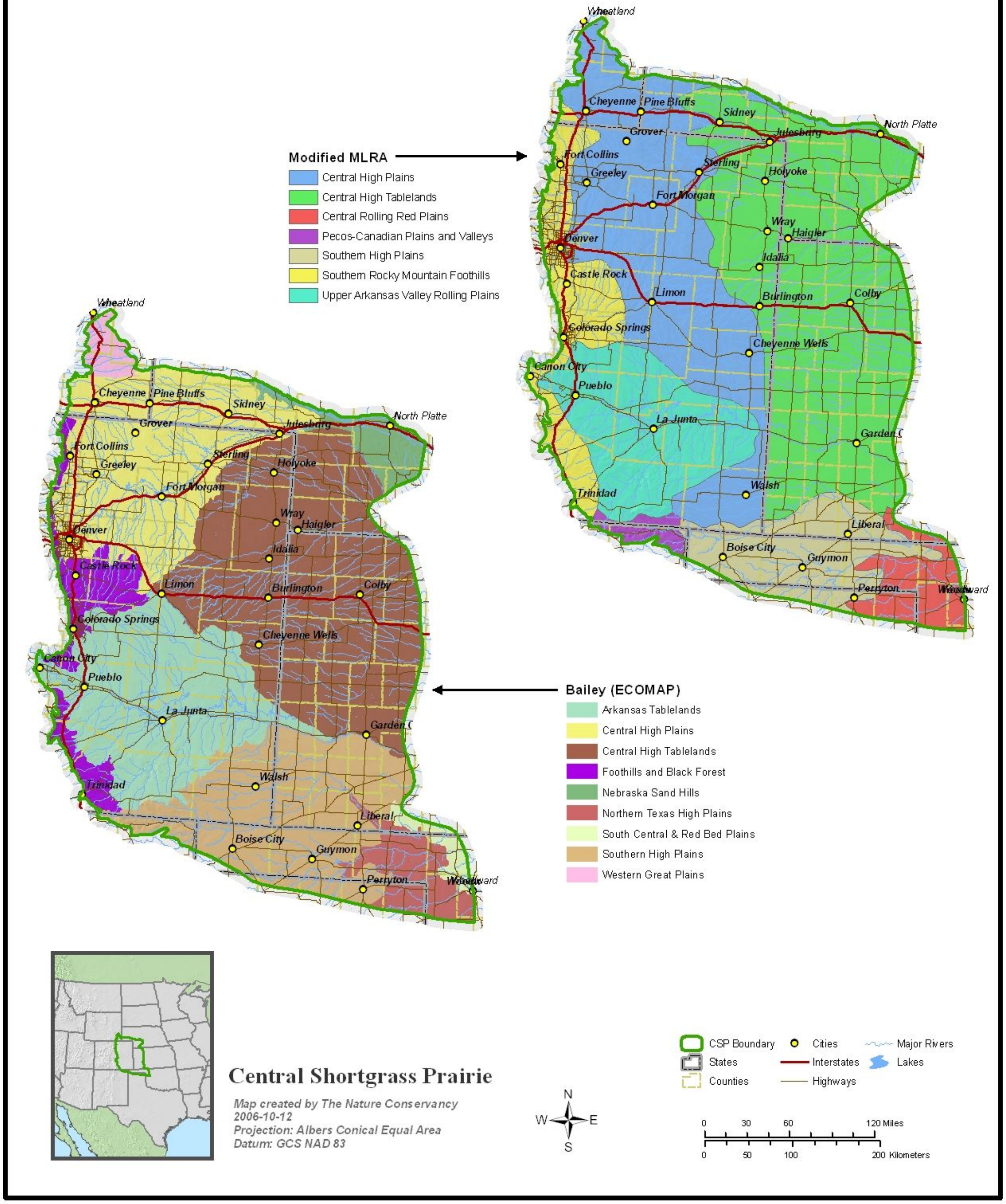
The team set representation goals for species targets in the aquatic assessment within the context of contribution to conservation in the EDUs relative to overall range-wide conservation of the species. The team decided that freshwater ecoregions provide the best context for representation goals, rather than terrestrial boundaries of the CSP.

The team determined goals for aquatic species by first setting an overall goal for freshwater ecoregions, then dividing the freshwater ecoregion goal into the nested EDUs. Ecoregion goals were set for each freshwater ecoregion in which the EDUs of this assessment are nested. The overall ecoregion goal was set based on distribution of the species, following the moderate risk scenario (Table 12). The ecoregion goal was partitioned into EDU goals according to the proportion of the species' ecoregion distribution that the EDU represents. For example, if a species' ecoregional goal was 10 and the species occurs in five EDUs in the ecoregion, the representation goal for each EDU is 2. A minimum goal of two was set for all EDU goals.

F. Representation

Representation of targeted species, communities, and ecological systems stratified across the ecoregion is necessary to capture variability and to provide replication, which ensures persistence in the face of environmental stochasticity, and the likely effects of climate change. The Core Team experimented with two stratification schemes for the assessment (Figure J). The team used the ECOMAP (2004 draft) sections: 1) to perform test runs of SPOT (explained in the network section below); 2) to stratify playa lakes and sandsage prairie system; and 3) to verify expert additions when modifying the network. The team used the NRCS Major Land Resource Area (MLRA) stratification scheme (slightly modified to combine small areas) to analyze results, as it more closely represented the variability within the distribution of terrestrial systems across the ecoregion.

Figure J. Stratification (Bailey 2004) and Major Land Resource Areas (NRCS)



IX. VIABILITY/INTEGRITY ASSESSMENT

A. Methods

A key objective of the assessment is to select conservation areas that capture occurrences of species, communities and ecosystems that will persist for at least the next 100 years, as well as intact, functional areas for conservation. For species, the Core Team assessed factors that affect the *viability* of an occurrence or subpopulation. A viable population is one that maintains its vigor and its potential for evolutionary adaptation (Soule 1987). To evaluate a plant community or ecological system occurrence, the team assessed the current status of composition, structure, and dynamic ecological processes, indicating overall *ecological integrity* of the occurrence. The relative viability or ecological integrity of occurrences was addressed in the following ways:

1. Element Occurrence Ranks: Where occurrence viability/ecological integrity criteria have been developed and applied according to NatureServe standards, *element occurrence ranks* are used to reflect occurrence viability/integrity (Groves et al. 2000); and
2. Landscape Integrity: Where occurrence ranks were unavailable, occurrences are evaluated using the *landscape integrity* or ecological integrity layers to provide an indirect measure of occurrence viability or ecological integrity (Comer 2005b).

B. Element Occurrence Ranking

To rate ecological integrity of targeted species, communities, and ecological systems, the team identified the primary ecological factors (natural disturbance regimes, keystone species, composition or structure, etc.) that drive the *size*, *condition*, and *landscape context* for each target. Following are the criteria used to rank occurrences:

1. Size: a quantitative measure of the area and/or abundance of an occurrence;
2. Condition: an integrated measure of the quality of biotic and abiotic factors and processes within the occurrence; and
3. Landscape Context: an integrated measure of the quality of structures, processes, and biotic/abiotic factors surrounding the occurrence (Groves 2003).

The team obtained species viability information from Natural Heritage Program element occurrence records. CNHP drafted new species viability guidelines with ranking criteria to evaluate size, condition, and landscape context for 11 animal species (e.g., burrowing owl) and for all terrestrial ecological systems to help screen occurrences for selection (see Appendices J and K). The team used the guidelines to rank the estimated viability of target occurrences (A=excellent, B=good, C=fair, and D=poor, E=extant, and NR=not ranked). The guidelines were useful to: 1) select among numerous occurrences; 2) develop desired conditions; and 3) identify targets/areas that need restoration. Occurrence ranks of A, B, C, E, and NR with a last-observed date more recent than 1985 were considered viable. Only viable occurrences were considered in delineation of conservation areas.

C. Terrestrial Ecological Integrity

Ecological integrity describes the capacity to support and maintain a functional ecological system that contains its full range of expected species, communities, and ecological processes. A system with high integrity can withstand and recover from most disturbances. Because information was not available to rank integrity for all ecological systems, the team developed a surrogate to assess ecological systems by using a measure known as *landscape integrity*.

Landscape integrity is defined as an integrated measure of key ecological attributes that support a suite of targeted species or communities, and the degree to which these attributes occur within expected ranges of natural variation. The landscape integrity index (also called suitability index or cost layer) is a GIS-derived map that integrates land-use factors for a given geographic area. A relative score is derived for each area and provides an indication of conditions on the landscape, based upon land-use factors (road density, industrial uses including oil and gas development, coal mines, and gravel mines, agriculture, and development; see Appendix L and Figures K-L). While it is not a direct measure of ecological integrity, this index provides a useful way to prioritize areas that might be most suitable for meeting conservation goals when limited field data are available. This was incorporated into the Suitability Index/Cost Layer described below in Section XI (see Figure M).

Figure K. Industrial Uses and Agricultural Lands

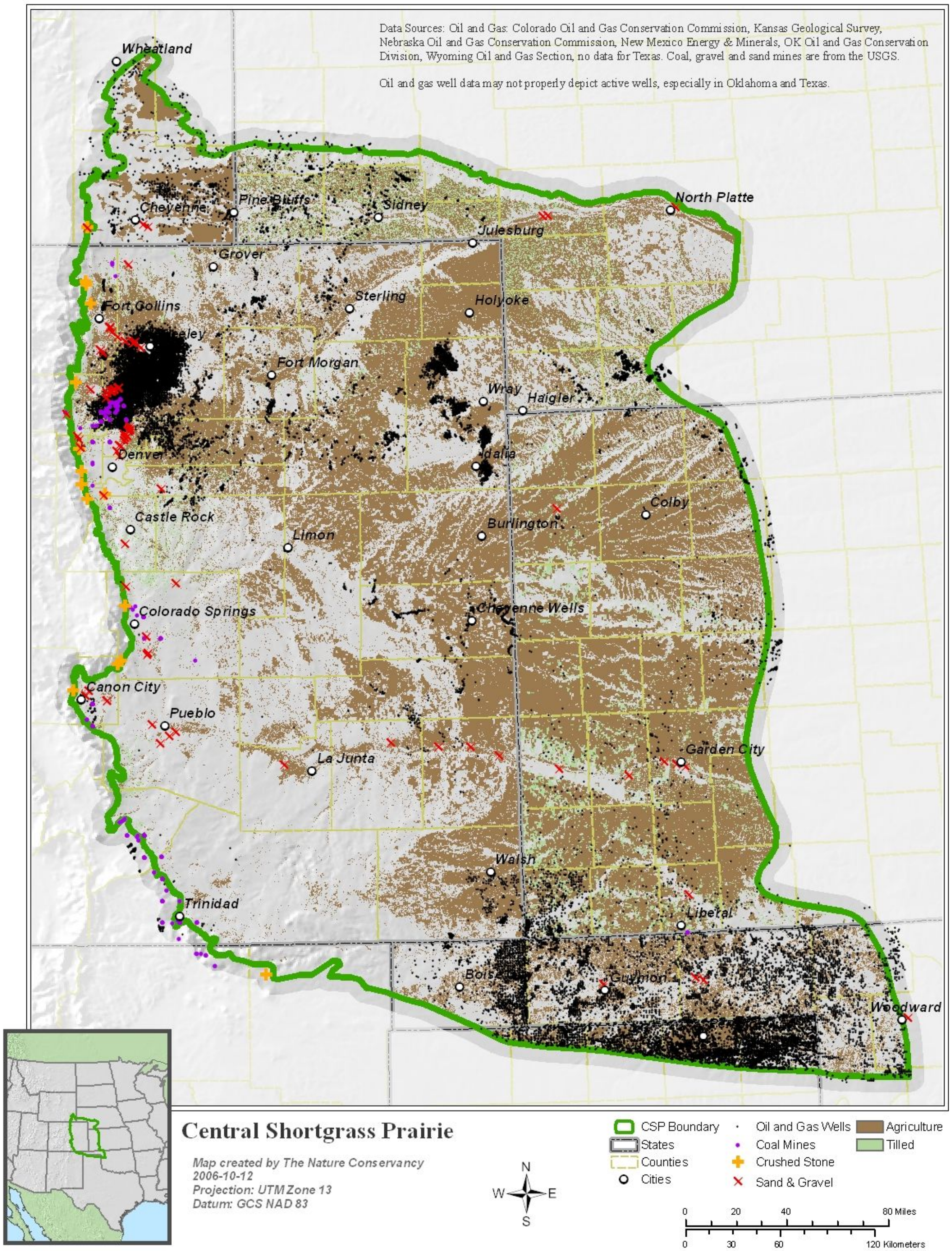
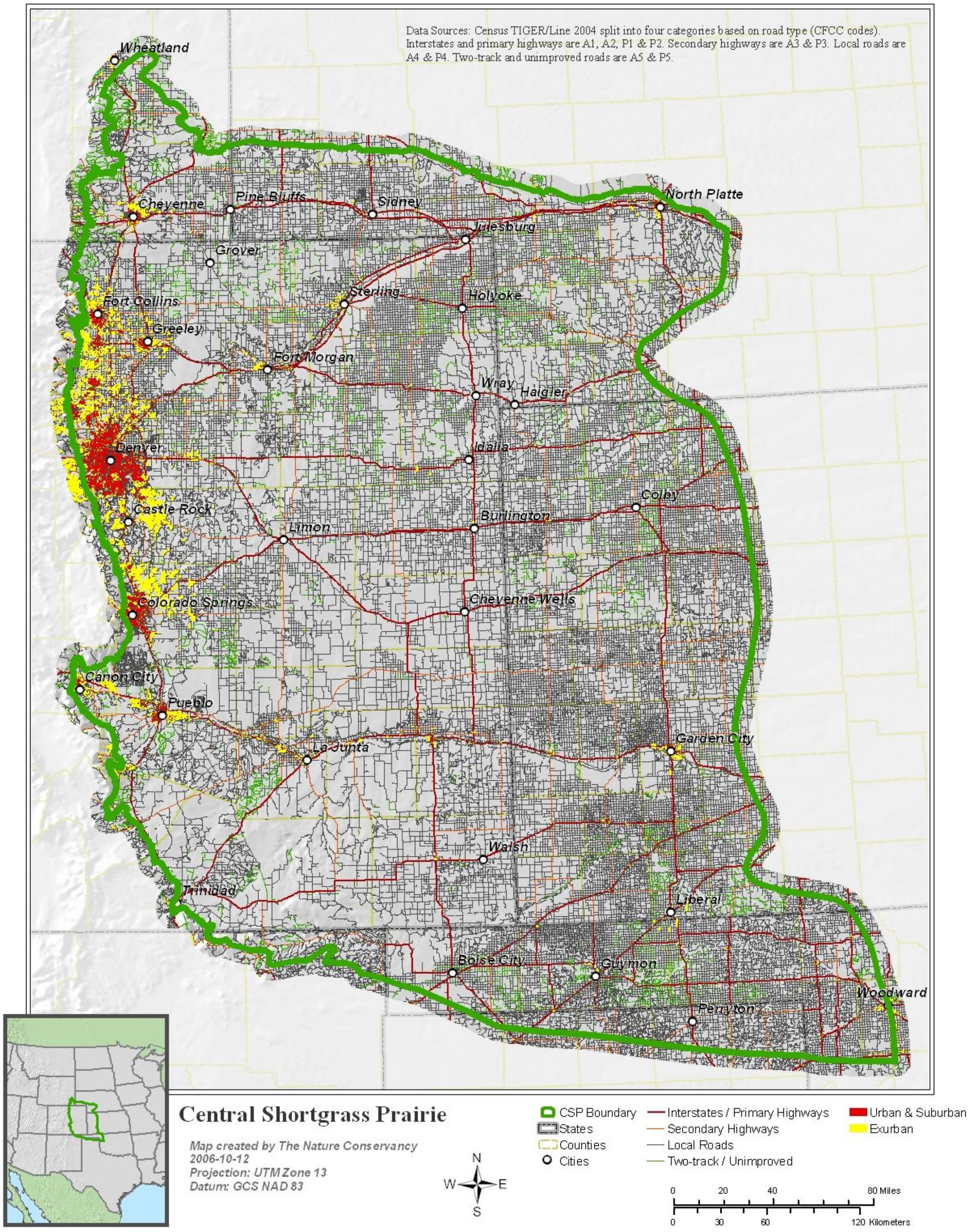


Figure L. Roads and Development



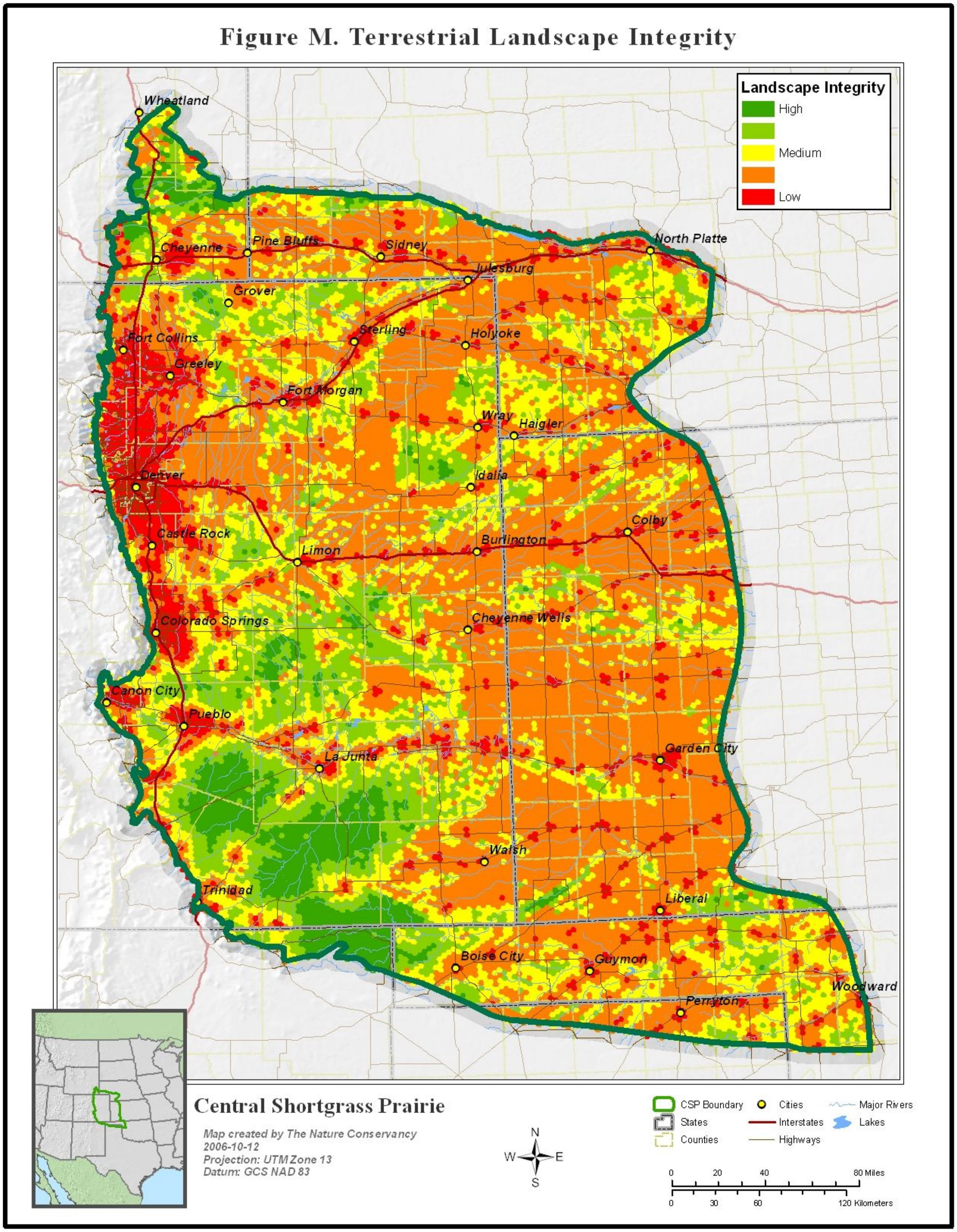


Figure M. Terrestrial Landscape Integrity
Landscape Integrity
High
Medium
Low
Wheatland
Cheyenne
Pine Bluffs
Sidney
North Platte
Julesburg
Grover
Sterling
Holyoke
Fort Collins
Greeley
Fort Morgan
Wray
Haigler
Denver
Idalia
Colby
Castle Rock
Burlington
Limon
Cheyenne Wells
Colorado Springs
Canon City
Pueblo
Garden City
La Junta
Walsh
Trinidad
Liberal
Boise City
Guymon
Woodward
Perryton
Central Shortgrass Prairie
Map created by The Nature Conservancy
2006-10-12
Projection: UTM Zone 13
Datum: GCS NAD 83
CSP Boundary
Cities
Major Rivers
States
Interstates
Lakes
Counties
Highways
N
W
E
S
0
20
40
80 Miles
0
30
60
120 Kilometers

D. Aquatic Ecological Integrity

The Core Team developed an index of aquatic ecological integrity to assess occurrences of aquatic ecological systems for potential inclusion within the network of conservation areas. Similar to the terrestrial portion of the assessment, where there are many choices, it is most efficient to select aquatic locations or units that occur in areas of highest ecological integrity. Therefore, an aquatic integrity index was developed to identify the higher-quality occurrences of each system in each EDU. With this goal in mind, the team used a relative index, which compares the integrity of a given occurrence to others.

This index is based on five variables that constitute indicators of aquatic ecological integrity. The variables used were limited to those for which GIS data were consistent and available across the full extent of the assessment area and hence allow comparison across all system occurrences. These variables include: 1) dam-storage volume density; 2) road density; 3) density of point sources of pollution; 4) watershed land use (percent of watershed in natural vegetative cover); and 5) riparian land use (percent of riparian buffer in natural vegetative cover; see Appendix L and Figure N). Riparian land use was assessed in a buffer of increasing width based on size class; buffer widths of 30m, 90m, 200m, 300m, and 500m were used for the headwater, stream, small river, large river, and very large river classes, respectively.

The five variables were calculated for each aquatic ecological system occurrence. They were then scaled to the "best" occurrence for the aquatic ecological system type within the EDU. The scaled value was calculated as (1 minus the value of the occurrence divided by the value of the best occurrence) for dam density, road density, and point source density and as (value of the occurrence divided by the value of the best occurrence) for watershed and riparian land use. The index was calculated by summing, for each system occurrence, the five scaled variables, resulting in a range of values of 0 (worst ecological integrity) to 5 (best).

The variables used in the integrity analysis are sufficient, but not a complete list of desired indicators. For example, a satisfactory and consistent indicator for the impact of ground and surface water withdrawal was not available across the study area. Data on diversions, water wells, and non-native species were not included because they vary widely across the states in the study area in overall data quality and availability of withdrawal volumes. Also, field-based indicators of biological community integrity (e.g., Index of Biotic Integrity) or water quality also were not available for some areas. When available, such indicators should be considered when reviewing the resulting network, and during implementation.

Species viability for the aquatic site selection followed the methods used for the terrestrial analysis.

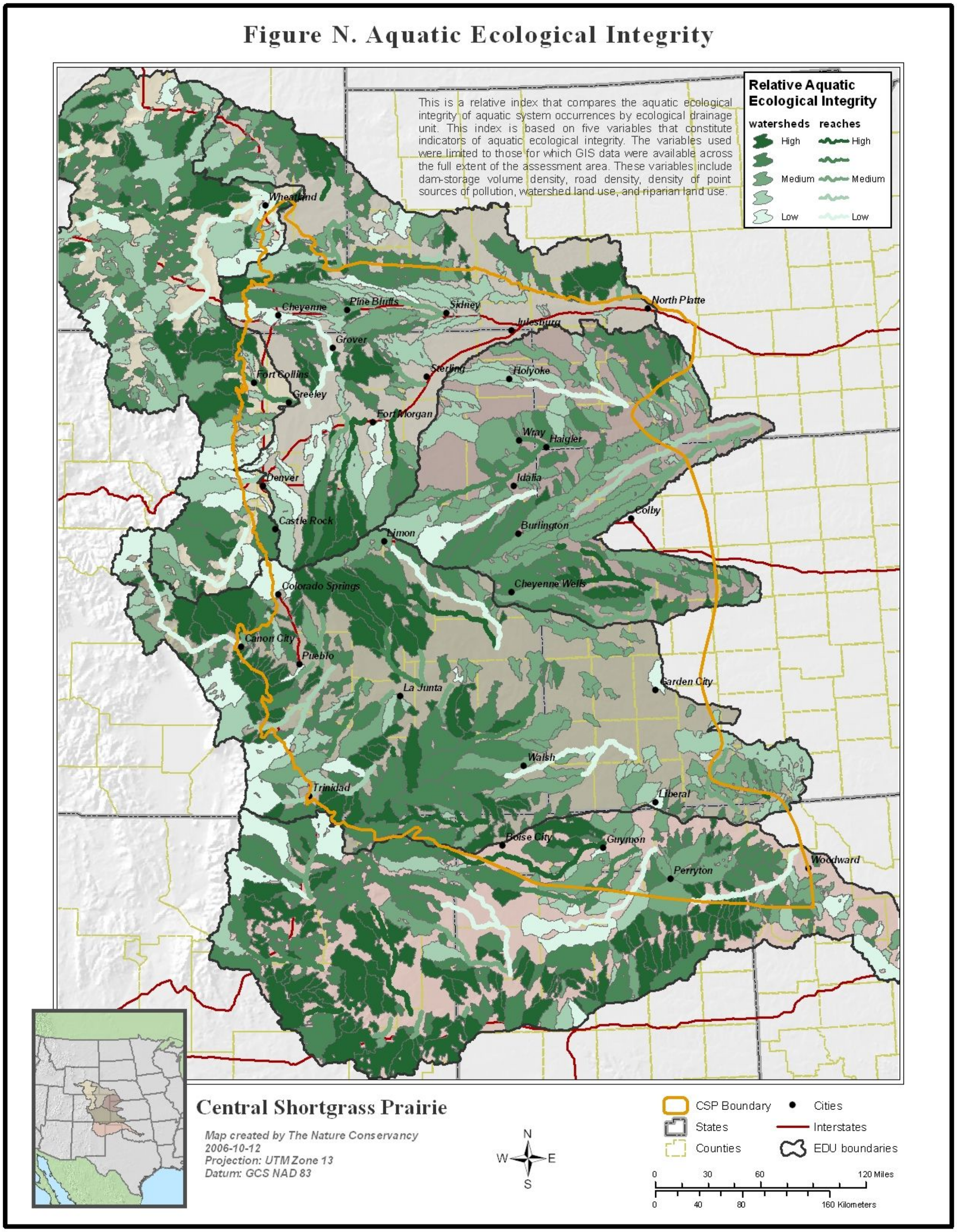


Figure N. Aquatic Ecological Integrity
This is a relative index that compares the aquatic ecological integrity of aquatic system occurrences by ecological drainage unit. This index is based on five variables that constitute indicators of aquatic ecological integrity. The variables used were limited to those for which GIS data were available across the full extent of the assessment area. These variables include dam-storage volume density, road density, density of point sources of pollution, watershed land use, and riparian land use.
Relative Aquatic Ecological Integrity
watersheds
reaches
High
Medium
Low
Wheatland
Cheyenne
Pine Bluffs
Sidney
North Platte
Julesburg
Grover
Sterling
Holyoke
Fort Collins
Greeley
Fort Morgan
Wray
Haigler
Denver
Idalia
Colby
Castle Rock
Burlington
Limon
Colorado Springs
Cheyenne Wells
Canon City
Pueblo
Garden City
La Junta
Walsh
Trinidad
Liberal
Boise City
Guymon
Woodward
Perryton
Central Shortgrass Prairie
Map created by The Nature Conservancy
2006-10-12
Projection: UTM Zone 13
Datum: GCS NAD 83
N
W
E
S
CSP Boundary
Cities
States
Interstates
Counties
EDU boundaries
0
30
60
120 Miles
0
40
80
160 Kilometers

X. DATA PREPARATION AND SOURCES

A. Data Sources and Management

TNC of Colorado, with support from the CNHP and the GIS/Data Management Team, managed tabular and spatial data for the CSP ecoregional assessment by using Microsoft Access in conjunction with ESRI ArcGIS 9.0 and Arc View 3.3 products. All data, except Natural Heritage Program element occurrence records, are archived in a manner consistent with the Conservancy's published guidelines for ecoregional information management (TNC 2000 and 2006b).

The project incorporated numerous data layers from a variety of sources. Examples of basic data sets include transportation, hydrography, digital elevation models, ecoregional and political boundaries, land ownership, and geology. Biodiversity information layers include conservation target locations and ranks, vegetation coverage, and habitat models. Data collected regarding threats or impacts to biodiversity include: commercial wind power generation facilities, development, oil and gas development, dams and diversions, land conservation status, and climate change. See Appendix M for data collected and sources.

The CNHP provided information on location and quality of conservation target occurrences, gathered from Heritage Programs from all seven states in the ecoregion. A total of 5,273 occurrence records (e.g., 1,753 records for birds, 697 records for plant communities) were included in this assessment. The team also compiled ecoregional base-data layers (e.g., rivers, land cover), threats, managed areas, and vegetation, etc. Playa Lakes Joint Venture provided playa lakes data for the ecoregion. The playa dataset was developed using two main sources: NRCS soils data (SSURGO) and LANDSAT imagery (PLJV 2005, 2006).

B. Terrestrial Ecological Systems

Data for terrestrial ecological systems at the ecoregional scale was based on individual GAP Analysis Program maps from Wyoming, Nebraska, Kansas, Oklahoma (draft), and Texas, and other existing maps (Comer et al. 2003). A more recent and consistent map from Southwest ReGAP data (Lowry et al. 2005) was used for the Colorado and New Mexico portions of the ecoregion. These data are derived from Landsat satellite imagery analysis (1999-2001) and DEM (elevation) data with varying levels of field verification. General problems with mapping accuracy were identified and evaluated. Where available, other mapped information was used to overlay and refine GAP and ReGAP map units. TNC, experts, and natural heritage programs in each state reviewed these maps. The terrestrial ecological systems data were used in conjunction with land-cover data to develop the natural/human-modified spatial data layers.

C. Aquatic Ecological Systems

The primary sources of data for the aquatic classification were existing GIS data layers that characterize general physical type and stream network connectivity: 1) USGS National Hydrography Dataset (NHD); 2) USGS National Elevation Dataset (DEM; USGS EROS 1999); 3) geology (Southwest ReGAP); and 4) soils (STATSGO). All classification attributes were generated from these base datasets.

D. Data Limitations

The best possible scenario for any planning process is based on information that is consistent across the ecoregion. As is typical of any multi-state plan, this was not the case in the CSP. Most of the data that were compiled for the planning process was collected in different ways, at different scales, and/or at different intensities. To exclude this information would have meant a nearly complete absence of data for analysis, and the loss of critical information. It is important to recognize how data limitations affect results. Because the analysis program (SPOT-see Section XI below) builds on existing data, gaps and differences across the geographic area undoubtedly influence which areas are selected and which are excluded. Areas in which limited data exist are less likely to be selected, as the SPOT program clusters conservation target occurrences to maximize efficiency by identifying the smallest land area with the greatest number of conservation targets.

These results must be interpreted while recognizing the limitations of existing information. Areas identified in this plan are not considered the only solution for biodiversity conservation. Conservation actions in these areas should protect viable examples of the biodiversity representative of the CSP. This does not mean that areas outside of those identified are unworthy of conservation activity. This plan will be adapted as new information is gathered, and planned conservation actions will pass through the common-sense filter prior to implementation.

As significant conservation actions occur or information changes, the team recommends periodic review (at minimum) and/or reanalysis of the data and an adjustment, as necessary, of targeted species, communities and ecological systems, as well as conservation areas.

Some important data sources and related limitations or issues include the following:

1. Ecological Systems: Mapping inaccuracies exist, especially with small-patch ecological systems, riparian, wetland systems, and the Central Mixed-grass Prairie ecological system. As a result, some classification differences across state borders could not be resolved.

2. Species and Plant Community Data: Data availability often varies from state-to-state and species-to-species, mainly based on past levels of survey efforts, which can vary greatly. Additionally, data are not available for the entire ecoregion, e.g., when a species is common in one state, but is rare or a species of concern in adjacent states.

3. Threat Information: Unequal geographic representation and ability to attend workshops to gather expert input may have resulted in over or under-estimation of expert-derived threat ratings for particular areas.

4. Geographic Bias: The planning team was based in Colorado, resulting in a bias towards Colorado issues, data, and information.

XI. IDENTIFICATION OF CONSERVATION AREAS

A key objective of this assessment was to design an ecoregional network of conservation areas that best achieves conservation goals for all targeted species, communities, and ecological systems by using principles of efficiency, representation, irreplaceability (i.e., relative contribution of areas to target goals) and functionality. This network is more than a collection of independent conservation areas (or portfolio), and includes concepts of linkages, the relationship of one area to another, and the intervening matrix of lands and waters between conservation areas (Groves 2003). The team's methods and tools emphasized transparency and repeatability of the overall process.

The team used two different approaches to identify conservation areas for terrestrial and aquatic ecological features (i.e., a computer program called SPOT was used for selecting terrestrial but not aquatic conservation areas). The team used a combination of both computer-assisted and manual processes that analyzed and evaluated various data sets, including point locations and polygons for all ecological features, spatial data sets of hydrography, land use/land cover, terrestrial and aquatic ecological system maps, land management status, and an index to assess landscape integrity.

A. Terrestrial Network Design

The team used a systematic and replicable site-selection tool known as SPOT (Spatial Portfolio Optimization Tool; Shoutis 2003) for developing the network of terrestrial conservation areas. The program was adapted from Australian applications (Possingham et al. 2000) for use in North America in a tool called SITES, developed by the National Center for Ecological Analysis and Synthesis, University of California at Santa Barbara (Andelman et al. 1999). SPOT incorporates mapped information on target occurrences, allowing the establishment of conservation goals as numbers of point occurrences, area and/or linear distances. The selection process involves selecting and comparing entire portfolios, or collections of sites in an iterative fashion (>1,000,000 iterations). This contrasts with procedures that select individual areas and eventually builds an entire portfolio. The capability of the program to integrate many spatial data sets enables rapid evaluation of alternative network configurations. The program selects areas to meet conservation goals while balancing objectives of efficiency (i.e., the greatest number of goals met for the lowest "cost" or least amount of land or water). For more details about how the SPOT program works, see Shoutis (2003). The following equation summarizes the program's algorithm (Andelman et al. 1999; Shoutis 2003; Marshall et al. 2004):

Total Portfolio Cost =	***Σ Cost of Selected Area*** **+**	***Σ Target Penalty*** **+**	***Σ Boundary Length***
Minimized by selecting a set of conservation areas that captures as many targets as possible as cheaply as possible in a set of areas as compact as possible.	Total score of all units selected for the network from an index based on parameters that reflect likely "cost" of conservation effort (road density, development, industrial uses, and agriculture).	Cost of not meeting conservation goals for each target.	Cost of spatial dispersion of selected areas as measured by the total boundary length of the portfolio.

1. Units of Analysis: A 3,118-acre (1262 hectare or 4.7 square miles) sized hexagon for the unit of analysis was selected for attributing data and running SPOT. The division of the ecoregion into hexagons resulted in approximately 18,000 analysis units in the CSP ecoregion. Hexagons are attributed by intersecting GIS data with points and polygon information for targeted species, terrestrial systems, and the suitability index.

2. Suitability Index/Cost Surface: The representative cost of conserving an area was derived through a suitability index that integrated major land use factors, including: a) road-class density, b) industrial uses including oil and gas wells, coal mines, and gravel mines, c) agricultural lands, and d) urban-suburban development (Figure M). This index, also used for assessing landscape integrity, provides an indirect measure of ecological conditions on the landscape. Index values were assigned different weights depending on the assumed impact the factor might have on conservation targets (e.g., primary roads have greater impact than one-lane dirt roads, and are thus assigned higher values). A base land cost also was assigned to each hexagon to recognize the fact that all land has some inherent cost associated with conservation (see Appendix L for more detail).

3. Target Penalty: Each conservation target was assigned a quantitative goal (number of occurrences, area, or linear distance) for the ecoregion. Failure to meet a target goal resulted in a 1,000-point penalty per target.

4. Spatial Configuration–Minimum Size and Boundary Length Modifier: A minimum size was established to represent the minimum dynamic area necessary for maintaining viability and integrity for terrestrial ecological systems. This requires SPOT to identify contiguous hexagons that contain sufficient area for each target in order to meet the conservation objective of a target. A boundary-length modifier (factor multiplied by total perimeter of the network) of 0.01 was used to increase conservation-area clustering and reduce network fragmentation.

5. Identifying Conservation Areas using SPOT: The team used the SPOT program to create four alternative scenarios for coarse-filter terrestrial ecological systems where conservation goals based on various extinction risk levels may be met (very high, high, moderate, and low-risk scenarios) and three different risk levels for species (high, moderate and low-risk scenarios). Very high risk goals were not developed for species as many species could not even meet the lowest goal levels with available data. The four scenarios, based on various extinction risk levels, are summarized as follows:

    a. Low risk: low risk goals for terrestrial ecological systems and species;
    b. Moderate risk: moderate risk goals for terrestrial ecological systems and species;
    c. High risk: high risk goals for terrestrial ecological systems and species; and
    d. Very high risk: very high risk goals for systems and high risk goals for species.

These four goal-based scenarios reflect a range of uncertainty about how much area would be sufficient for coarse-filter conservation. Hexagons identified in at least 2 of the 4 scenarios were chosen to be in the initial portfolio; these groups of hexagons represent high priority areas given a broad range of uncertainty regarding coarse-filter goals. This initial portfolio achieved the greatest number of conservation goals and closely met the moderate-risk goals for key ecological system types (such as shortgrass prairie), correlated well with Natural Heritage Program priority sites, and captured 41% (23.3 million acres) of the total area within the ecoregion. Thus this initial portfolio served as a starting or preliminary network for further analysis and refinement.

6. Stratification: The team evaluated several additional inputs, including use of stratification units, ecological land units, and various cost layer weightings, before selecting a final solution. After experimenting with multiple runs incorporating fine and coarse stratifications, the team determined that the stratification forced unnatural breaks of ecological systems across the ecoregion, and, thus, decided not to use it in the site-selection process, with the exception of playa lakes (to help capture representation across the ecoregion). Known species locations were limited or unevenly distributed across all states, so stratification of distribution would have excluded good occurrences. Also, for many targets, most locations are necessary to achieve ecoregional goals. The team used the stratification system to manually modify the network in the expert review process, and to validate how well systems were captured across the ecoregion (see below).

7. Evaluation and Refinement of the Network: The Core Team then held a series of review workshops with regional and local experts to evaluate/refine the preliminary ecoregional network of conservation areas, obtain updated data on threats to species, communities and ecosystems at conservation areas, and lay the groundwork for prioritizing areas and developing strategies. The team made the following changes:

   a. Identified a network of concentrations of playa lakes on tilled lands to serve as connectors or linkages between intact landscapes, potential restoration areas, and to maintain a range of habitats and environmental conditions for migratory birds;
   b. Refined the terrestrial ecological system results reclassifying shortgrass prairie that was incorrectly classified as mixed grass prairie in the eastern CSP, documenting results into the conservation area summaries.
   c. Incorporated site and threats results of the recent Nebraska Natural Legacy Project (Schneider et al. 2005);
   d. Added high-quality areas containing mixed-grass and sandsage prairie ecological systems, and additional occurrences for species, communities and shorebird aggregation areas, increasing the area of the preliminary network by only 2-3%;
   e. Used the results of the SPOT run incorporating stratification units to enhance representation of ecological systems across the ecoregion; and
   f. Identified key information needs to help fill data gaps and issues of uneven data across the ecoregion (see next steps section below).

B. Aquatic Network Design

The first step in the assembly of the aquatic conservation areas network was to identify the higher-quality occurrences of aquatic ecological system targets that would fulfill representation and design goals. The team identified the higher-quality occurrences of the systems by using the index of aquatic ecological integrity. To create a network with the maximum degree of hydrological connectivity, the team selected system occurrences starting with the largest system types and progressing to smaller ones. This process helped maximize connectivity among the network of conservation areas by selecting occurrences that connect downstream with previously selected occurrences of larger-sized systems.

For each system target, occurrences with the highest ecological integrity index values were selected for the network, unless other substitute occurrences with lower index values: 1) contained viable occurrences of species targets; 2) connected downstream to previously selected occurrences; and/or 3) had a high amount of perennial flow. With few exceptions, the network does not capture system occurrences that connect downstream to a reservoir or other impoundment, have greater than 15% developed land use, or greater than 50% agricultural land use in their watershed.

To the extent possible, the team avoided selecting ecological systems with lower-integrity scores. However, a subset of network areas representing system occurrences were selected, even though they may have had ecological integrity index scores below the desired thresholds. Such conservation areas are identified as “provisional conservation areas.” These areas contain the best available examples of system targets, as indicated by the integrity index, but have potentially severe impacts from dams, roads, or point-source pollution. These areas also may have low perennial flow or are hydrologically disconnected from other conservation areas. The team included these areas in the network results, but noted the need for field verification of their conservation potential.

The second step in the aquatic network assembly was to assess how well species targets were captured in areas selected for system targets, and to add areas that represent the additional viable occurrences required to progress toward representation goals. Conservation areas from the Southern Shortgrass Prairie aquatic portfolio also were considered in the addition of areas for species targets in Southern Shortgrass Prairie portions of the Canadian River EDU.

A team of experts reviewed the preliminary network, and added several areas to represent additional populations of species targets. Expert review was particularly important in the Southern Rocky Mountains, Wyoming Basins, and Northern Great Plains Steppe portions of the EDUs. Experts confirmed inclusion of some provisional conservation areas and eliminated others.

XII. NETWORK OF CONSERVATION AREAS

Conservation areas are, simply, places in which native species, communities, and ecosystems of the ecoregion are located. These areas are identified as important places to achieve conservation outcomes and to ensure that representative diversity of the ecoregion will persist over time. Conservation of these areas could take many forms including fee purchase, conservation easements, financial incentives, or management agreements, all with willing land owners. In most places, these are working landscapes where attention is paid to conservation of native species and habitats in the context of local communities that depend on the area for their livelihood. Boundaries of conservation areas are preliminary and do not represent the final boundaries needed for conservation success; more detailed analysis is needed to refine boundaries, threats and develop appropriate strategies.

A. Terrestrial Network Results

The final terrestrial network consists of 43 conservation areas encompassing approximately 24.3 million acres (9.7 million hectares), or about 44% of the ecoregion (Figure O). Areas range from 15,592 acres (6,308 hectares) to 3.6 million acres (1.5 million hectares); nine areas are more than one million acres. Individual conservation areas (i.e., identified land area that encompasses or represents the variation and/or targets) contain from three to 70 conservation targets. See Table 13 for a summary of targets per conservation area, and Appendix N for more detailed results. See Appendix O for preliminary summaries of each conservation area; these are working documents that should be improved over time as needed.

The final network of conservation areas achieved goals for 83% of the targets, including 47% of species, 100% of plant communities, and 95% of ecological systems. The Central Mixed-grass Prairie, where extensive cultivation has taken place, is the only ecological system that did not achieve the conservation goal. Fifteen targeted species were over goal: further analyses need to be conducted to determine critical occurrences to meet goal. Conservation goals for several species were unmet; this is likely due to: 1) a lack of distributional data for little-known species; 2) lack of tracking by all heritage programs (e.g., edge of range species); and/or 3) only a few populations are known to occur. Further inventory and/or restoration are needed for these species. See Table 14 for a summary of how well species, communities and ecological systems met conservation goals in the network.

1. Terrestrial Species: The network achieved the goal of 21 occurrences out of a total of 27 modeled black-tailed prairie dog animal complexes, including 82% of the total modeled habitat. Note that this is not a measure of the entire occupied habitat for the prairie dog, but the percent of larger patches of the highest quality suitable habitat for dispersal of prairie dog. Modeled complexes were selected to support the natural growth and retraction of the prairie dog animal community. Similarly, the network included 55% of the modeled habitat area for the mountain plover. The model incorporated known occurrences, densities, and adjacent habitat that are projected to be suitable for mountain plover.

The network contains at least 100% of the habitat goals for targeted wide-ranging mammal species, including elk, bison, and mountain lion, bighorn sheep, and pronghorn (i.e., four occurrences consisting of grassland/shrubland landscapes >250,000 acres). Such large areas act as coarse filters, and protect many other species that need or prefer the same ecological systems. The selected areas are assumed to contain enough habitats to support these species as well as key ecological processes.

After completing the initial analysis, further analyses of species were conducted using data sets that were difficult to integrate into the SPOT program, not available for use for the entire ecoregion, or assumed to be captured by the coarse-filter approach of ecological systems. These included distribution maps for several species, such as the burrowing owl (*Athene cunicularia*), swift fox (*Vulpes velox*), grasshopper sparrow (*Ammodramus savannarum*), lark bunting (*Calmospiza melanocorys*), and riparian systems. The purpose was to determine how well these other species and systems were captured in the final network. Where applicable, the team included these species under expert review comments for each conservation area (see Appendix O).

The network included 66% of the known occurrences of burrowing owl, and 92% of the known occurrences of the swift fox. Habitat for the majority of the watch listed bird species were captured in the terrestrial network, with the exception of grasshopper sparrow, which primarily utilizes croplands and CRP lands (David Hanni, personal communication).

2. <u>Playa Lakes and Shorebird Aggregation Areas</u>: The network included at least 22% (8,100 of approximately 36,000) of the total playa lakes mapped in the ecoregion, and exceeded the goal for untilled playas (900 playas; see Appendix N). This assessment focused on playa lakes in native grassland landscapes, but the vast majority of playas occur on lands that have been cultivated. As a result, only a small proportion of the total playa lakes selected are located in conservation areas. Playa lakes in cultivated lands, while considered of limited long-term viability due to sedimentation and other factors, provide short-term biodiversity values for several species. Restoration of playas lakes in cultivated landscapes is important for achievement of long-term conservation goals for many bird species. Ten concentration areas of playa lakes on cultivated lands outside the conservation areas were identified as potential restoration areas and/or "stepping stones" between conservation areas (Figure P).

   The network includes 22 shorebird aggregation areas that provide habitat for migratory bird species (see Figure Q). Based on expert input, the team pre-selected these areas, which largely consist of impounded lakes and reservoirs. While nearly 30 species migrate through the region, notable species include Baird's sandpiper (*Calidris bairdii*), and stilt sandpiper (*C. himantopus*) because the bulk of the world's population of these species migrates through the CSP. These aggregation areas are dispersed, occur in small numbers, and are spatially and temporally unpredictable, depending on rainfall. Ultimately, a network of playa lakes and reservoirs is needed to capture the natural and geographic variability of the area, and to increase the probability that suitable habitat conditions for bird species exists during most years (T. Floyd and B. Andres, personal communication).

3. Terrestrial Ecological Systems: Coarse-filter ecological systems, represented across the ecoregion, help conserve environmental variability and species habitats across their natural range, and provide a buffer against climate change. Ecological gradients on the CSP are generally subtle and recent weather patterns and grazing management often confounds the effects of the other environmental gradients. The results of the SPOT run using ECOMAP sections resulted in clustering overly constrained by the placement of section boundary lines. The team observed that the terrestrial ecological systems seemed to "naturally stratify themselves" across the major environmental gradients (most importantly, precipitation). For these reasons, the team decided not to use the stratification. However, the team used stratification results to systematically verify the expert recommendations**.** A post-site selection analysis indicated good distribution of ecological systems selected across the ecoregion using NRCS Major Land Resource Areas (MLRA) (data on file at TNC of Colorado) with few ecological systems not achieving goals in each MLRA.

   Riparian systems are represented in both terrestrial and aquatic networks. The aquatic network represents the potential for conservation of riparian communities because it incorporates the variability of the region's streams and rivers. The terrestrial network incorporated the majority of rare riparian communities, while the aquatic network captured representative riparian system diversity and hydrologic integrity.

4. Further Analyses: The PLJV evaluated the performance of the terrestrial network of conservation areas in fulfilling continental and regional bird goals for the CSP. With a few exceptions, the network performed well in supporting priority species, as determined by national bird initiatives. For example, the network would support entire waterfowl populations and all three grouse species (e.g., lesser prairie chicken). Further improvements should be made for species that did not perform well in the portfolio (e.g., spring non-breeding waterfowl, wetland-foraging shorebirds, riparian dependent land birds). See Appendix P for the full report. The team recommends future analyses of the aquatic network of conservation areas.

Figure O. Terrestrial Network of Conservation Areas

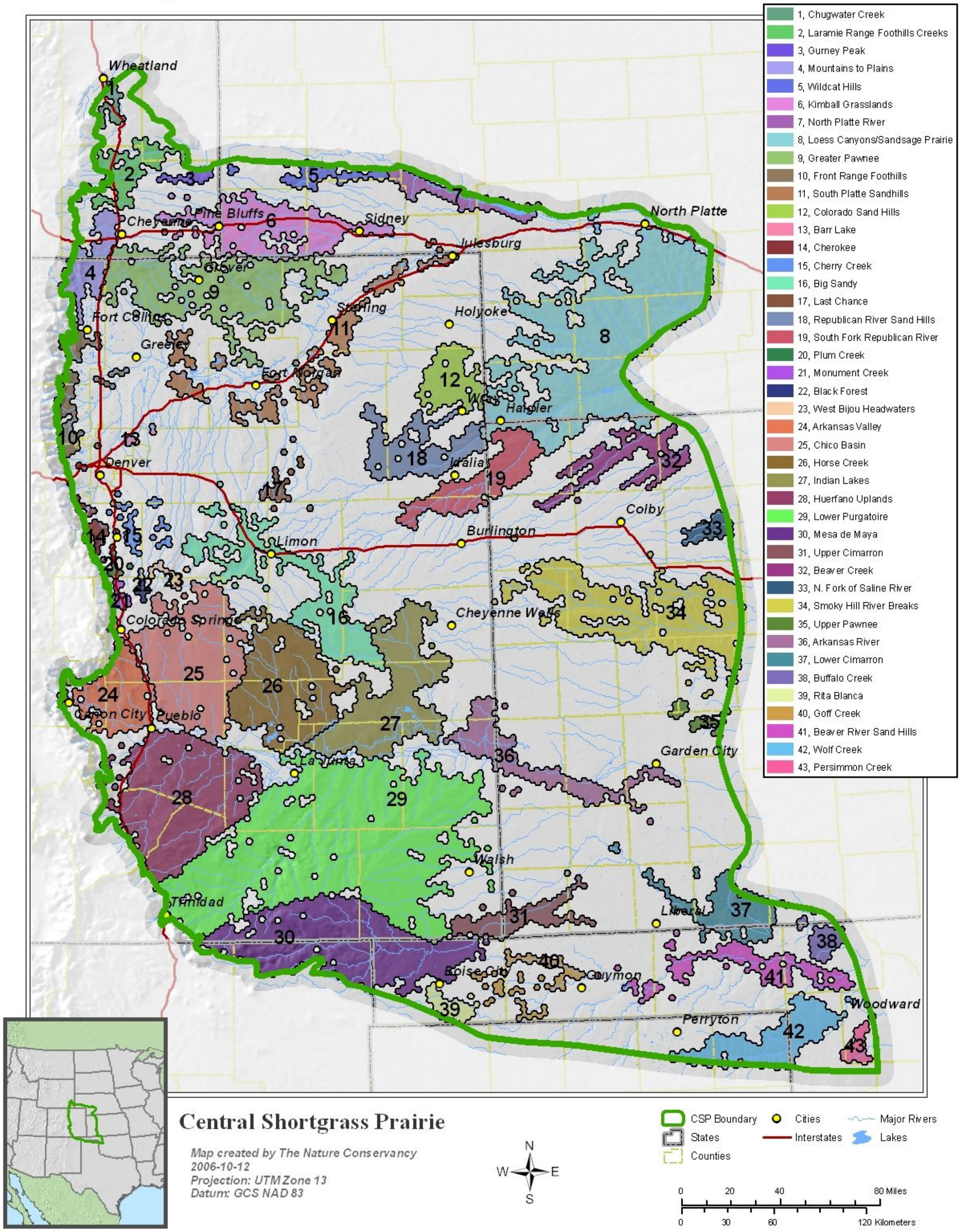


Table 13. Conservation areas, sizes and summary of associated targets (presence/absence only for shorebird aggregations; playa lakes are on untilled land only; number of modeled black-tailed prairie dog complexes).

Conservation Area-#	Acres	Total # of Conservation Targets	Conservation Targets by Major Group						
			Ecological Systems	Plant Comm.	Playa Lakes	Species	Wide Ranging Species	Prairie Dog Community	Shorebird Aggreg.
Arkansas River -36	545,732	16	5	1	13	8		2	
Arkansas Valley-24	517,666	52	12	11	17	25	2	3	
Barr Lake-13	15,592	6	3			1			1
Beaver Creek-32	417,875	8	2	1	2	4			
Beaver River Sand Hills-41	414,756	15	4	5		6			
Big Sandy-16	851,342	41	10	14	80	14	1		
Black Forest-22	24,948	13	6	1		5	1		
Buffalo Creek-38	115,383	8	5		5	2			
Cherokee-14	84,199	27	10	9		7	1		
Cherry Creek-15	112,265	21	8	3	11	8	1		
Chico Basin-25	1,172,545	55	11	20	96	21	2	1	
Chugwater Creek-1	68,606	8	3			5			
Colorado Sand Hills-12	318,084	11	4		1	5			
Front Range Foothills-10	246,359	32	8	13		10		1	
Goff Creek-40	190,227	8	2	1	2	4			
Greater Pawnee-9	1,231,796	42	13	8	11	19		1	1
Gurney Creek-3	53,014	5	2			3			
Horse Creek-26	1,019,740	40	8	2	192	17	1	1	1
Huerfano Uplands-28	1,490,629	42	13	6	47	18	3	1	
Indian Lakes-27	1,057,161	27	9	1	20	14	1	4	1
Kimball Grasslands-6	776,499	23	10	2	79	8	1		
Laramie Range - Foothills Creeks-2	286,899	10	4			6			
Last Chance-17	74,843	9	4	1		4			
Loess Canyons/ Sandsage Prairie-8	2,625,752	29	8	9	216	9	1	1	
Lower Cimarron-37	442,823	14	4	3	33	6			
Lower Purgatoire-29	3,664,202	68	15	12	13	34	5	5	1

Conservation Area-#	Acres	Total # of Conservation Targets	Conservation Targets by Major Group						
			Ecological Systems	Plant Comm.	Playa Lakes	Species	Wide Ranging Species	Prairie Dog Community	Shorebird Aggreg.
Mesa de Maya-30	1,549,880	61	14	18	9	23	4		
Monument Creek-21	34,303	17	5	4	1	6	1		
Mountains to Plains-4	296,255	39	11	15		13			
N. Fork of Saline River-33	99,791	3	2			1			
North Platte River-7	249,478	17	6	6		5			
Persimmon Creek-43	74,843	6	3	3					1
Plum Creek-20	28,066	14	6	2		5	1		
Republican River Sand Hills-18	492,718	22	5	5	3	10			
Rita Blanca-39	109,146	10	2	1	4	6			
Smoky Hill River Breaks-34	1,365,890	22	3	8	15	10		1	
South Fork Republican River-19	502,074	17	5		23	9		1	1
South Platte Sandhills-11	570,680	24	8	7	2	7			
Upper Cimarron-31	302,492	18	5	1	1	11			
Upper Pawnee-35	74,843	4	2		9	1			1
West Bijou Headwaters-23	40,540	15	6	4	8	4			
Wildcat Hills-5	155,923	15	5	2	2	7			
Wolf Creek-42	551,969	12	6	2	5	3			

Table 14. Targeted terrestrial ecological systems, plant communities, and species that met conservation goal in the CSP network of conservation areas.

Target Group	Taxonomic Group	Number of Targets that Meet Goal	Total Number of Targets with Data	Percent of Targets that Meet Goal
Terrestrial Ecological Systems		20	21	95%
Plant Communities		118	118	100%
Playa Lakes		1 (900 on untilled)	1	100%
Species	Amphibians	3	5	60%
	Birds	9	14	64%
	Invertebrates	3	10	30%
	Mammals (small)	3	4	75%
	Plants	21	38	55%
	Reptiles	4	8	50%
	Wide-ranging species	4	4	100%
Species Total		47	84	56%
Animal Assemblage	Black-tailed prairie dog community	1 (22 of 21 communities)	1	100%
Animal Assemblage	Water/Shorebird Aggregation Areas	1 (22 of 22 reservoirs)	1	100%
Target Total		186	225	83%

Note: 30 species were not included in the SPOT run because no data were available (see Appendix H for list of these species). Invertebrates include insects, crustaceans, and mollusks. Also, fish and aquatic insects were included in the aquatic site selection.

Figure P. Potential Restoration Complexes of Playa Lakes

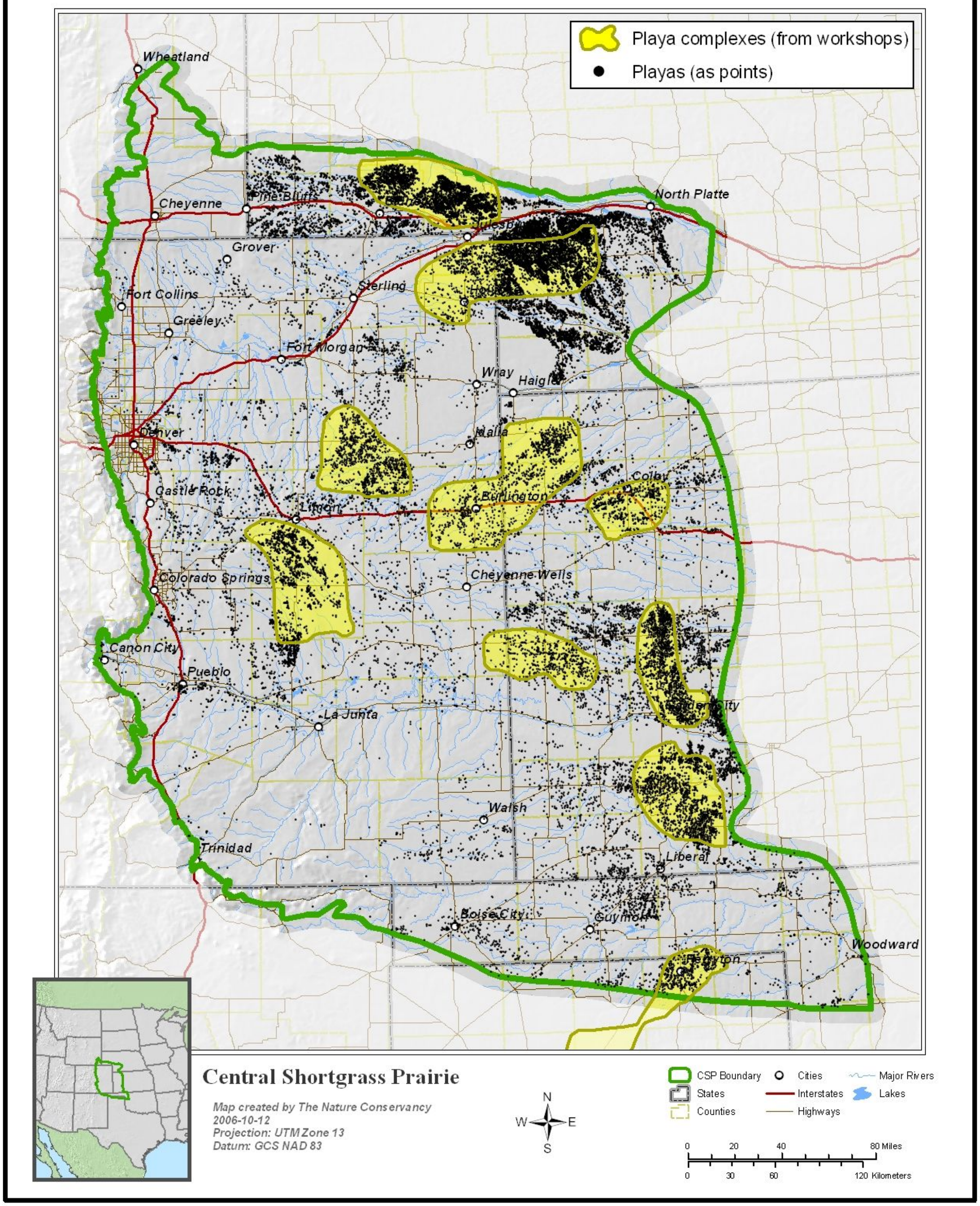
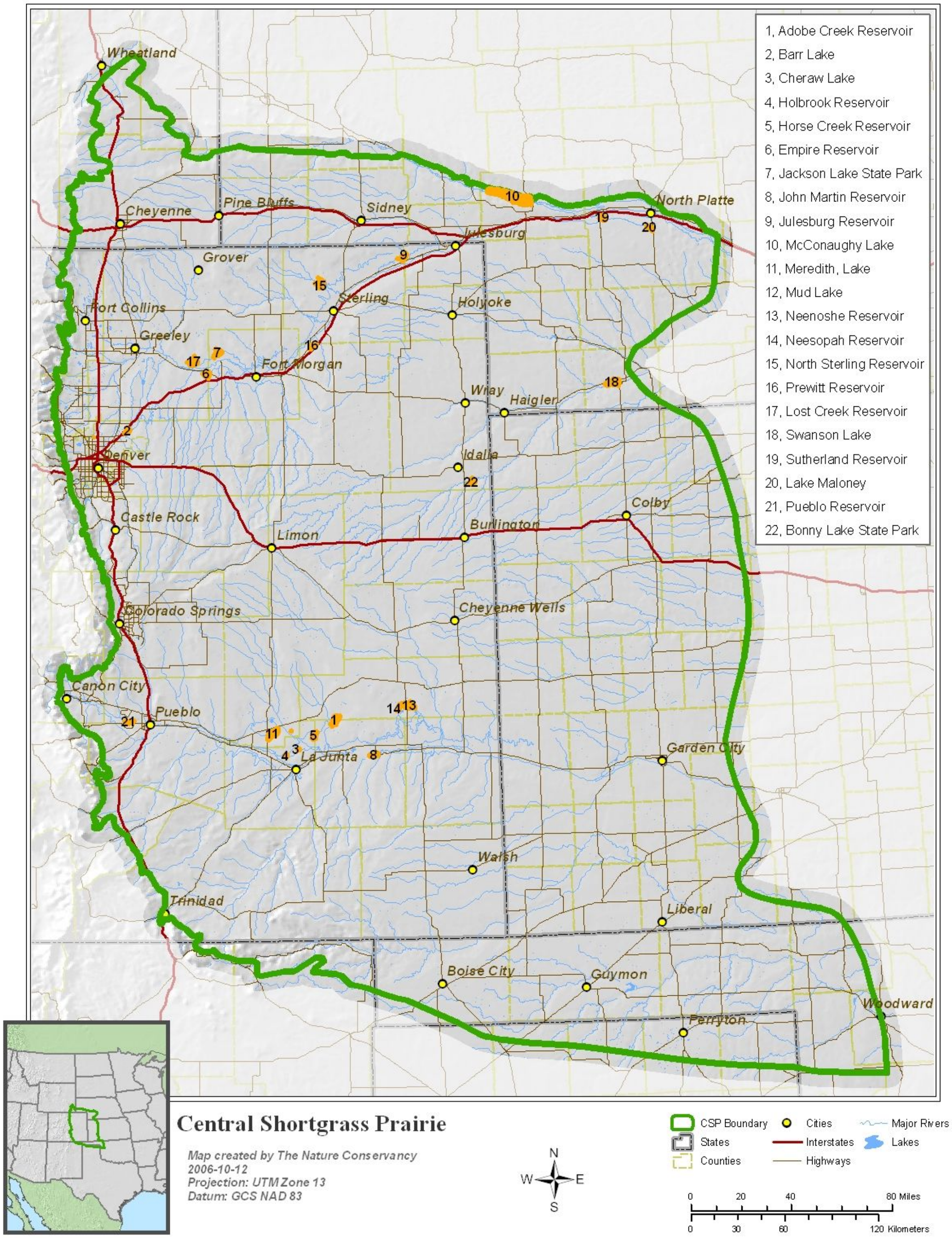


Figure Q. Shorebird Aggregation Areas



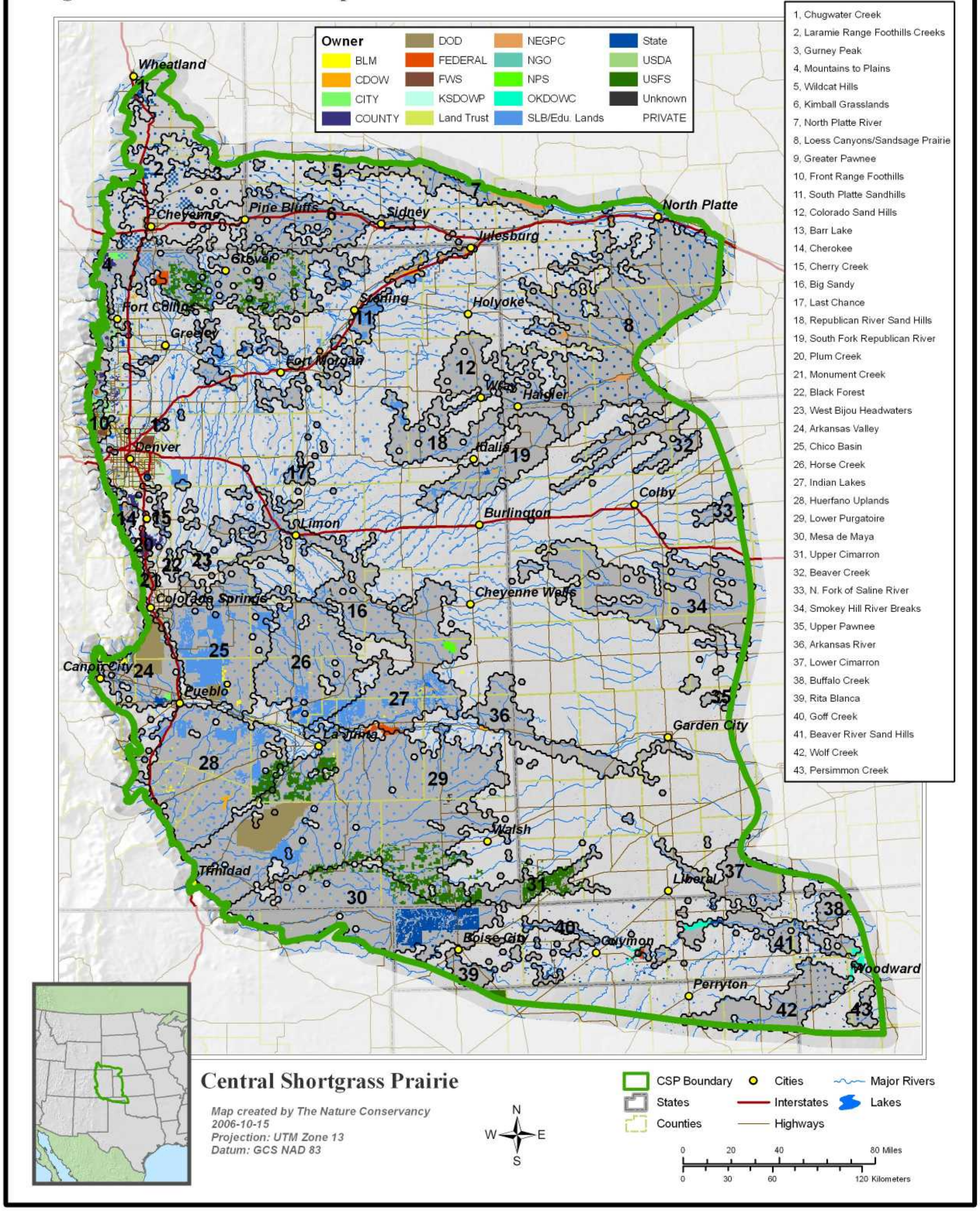
B. Land Management/Ownership

The land ownership status of the network of conservation areas is 86% private, 8% state, 5% federal, and 0.5% local governments. The largest federal holdings within the network of conservation areas are the US Forest Service (approximately 781,500 acres) and Department of Defense (approximately 430,300 acres). Other smaller holdings include local public, Bureau of Land Management, and miscellaneous federal agencies (see Table 15 and Figure R).

Table 15. Land management status summary for conservation areas.

Land Manager/Owner	Total Acres in Ecoregion	Percent of Total Ecoregion	Total Acres in Conservation Areas	Percent of Conservation Areas
Private	51,290,000	92.1%	20,729,200	86.4%
State	2,838,800	5.1%	1,993,600	8.3%
Federal	1,366,800	2.5%	1,163,200	4.8%
Local Government	210,100	0.4%	117,900	0.5%
TOTAL	55,705,700		24,003,900	

Figure R. Land Ownership of the Terrestrial Network of Conservation Areas



C. Aquatic Network Results

The team identified 251 areas of aquatic biodiversity significance within the Eastern Slope drainages. Of the total, 140 conservation areas were partially or wholly included in the CSP. The entire aquatic network is comprised of approximately 32,420 (52,175 km) stream and river miles, with 13,365 miles (21,510 km) in the CSP. The network includes a good representation of all aquatic system sizes (see Table 16; see Appendices Q and R for aquatic conservation areas and associated targets).

Conservation areas are mapped to include: 1) headwaters and streams represented as the entire watershed area; 2) areas capturing small, large, and very large rivers are shown as stream lines buffered to 1 km; and 3) headwater streams with greenback cutthroat trout are shown as stream reaches (see Figure S, Table 17). In some cases, adjacent or connecting reaches were retained as separate conservation areas if the targets exhibited distinct life histories. The team also maintained separation among conservation areas occurring in distinct EDUs.

Table 16. Summary of the representation of five aquatic ecological system categories in the aquatic network within the Eastern Slope drainages.

Size	Number of Initial Conservation Areas	Number of Added Provisional Conservation Areas	Total Conservation Areas
Headwater	15	0	15
Stream	118	53	171
Small River	31	15	46
Large River	14	1	15
Very Large River	4	0	4
TOTAL	182	69	251

1. <u>Aquatic Ecological Systems</u>: The aquatic conservation areas captured sufficient occurrences to meet representation goals in all EDUs for 33 of 79 aquatic systems (Table 18). The inclusion of "provisional conservation areas" to the network and goals analyses resulted in a network in which goals were met for 42 of 79 aquatic systems. The addition of provisional areas increases the risk of selecting highly degraded streams that may be difficult to rehabilitate due to lack of water in the streams, lack of connectivity, and landscape context degradation. These areas are high priorities for field verification prior to on-the-ground conservation action. Overall, most size classes met approximately 50% of their goals; small river systems comprise the lowest proportion of goals met. Attainment of goals was low in some areas due to lack of data, lack of estimated hydrological integrity, and low numbers of occurrences. See Appendix Q for detailed results.

Figure S. Aquatic Network of Conservation Areas

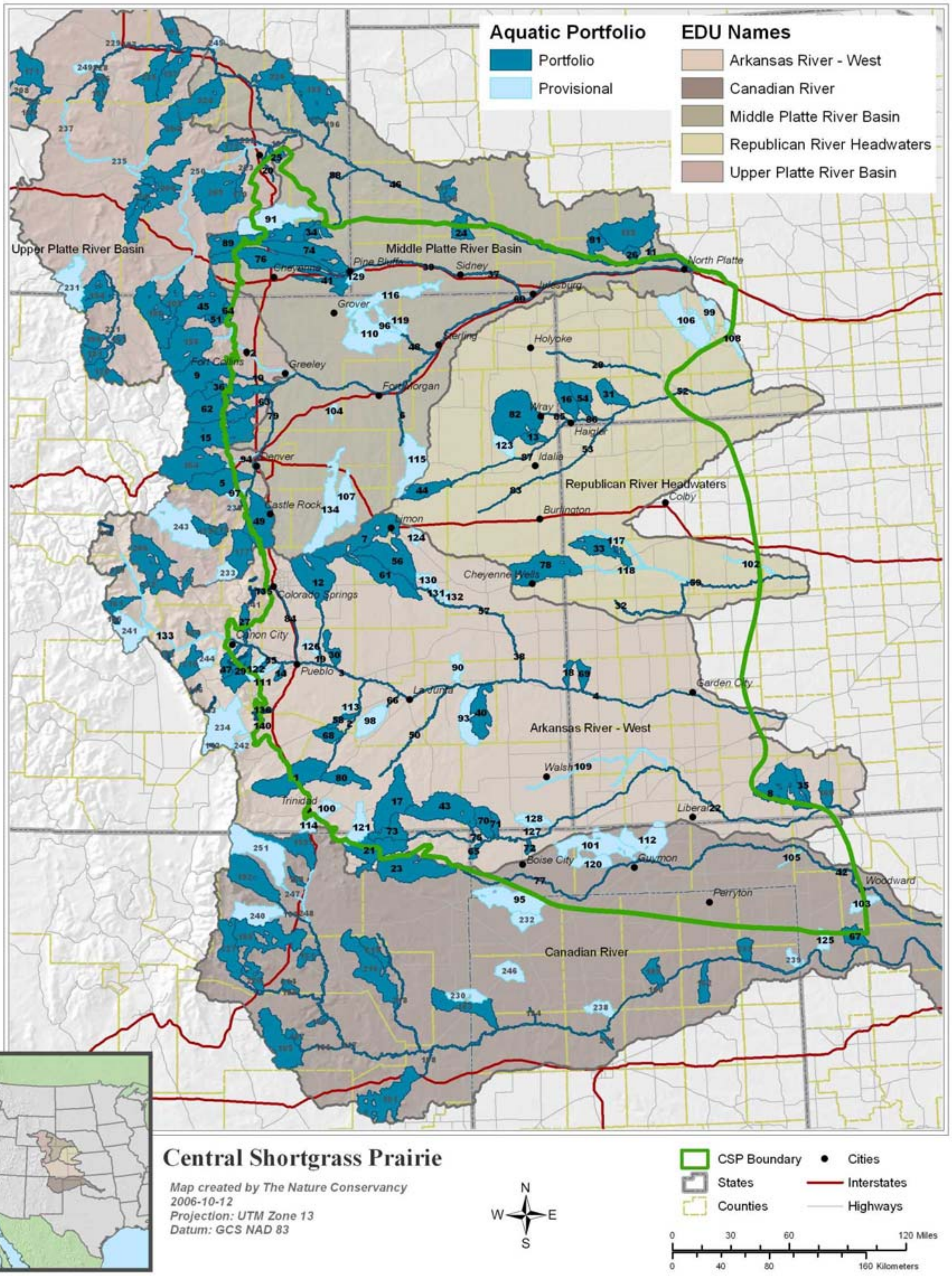


Table 17. Legend to Figure S, the aquatic network of conservation areas.

Area Number	Area Name	Rating	EDU	In or Outside CSP *
1	Apishapa River headwaters	Portfolio	Arkansas River - West	1
2	Apishapa River	Portfolio	Arkansas River - West	1
3	Arkansas River A	Portfolio	Arkansas River - West	1
4	Arkansas River B	Portfolio	Arkansas River - West	1
5	Bear Creek (South Platte River)	Portfolio	Upper Platte River Basin	1
6	Beaver Creek	Portfolio	Middle Platte River Basin	1
7	Big Sandy Creek (CO)	Portfolio	Arkansas River - West	1
8	Big Sandy Creek (KS)	Portfolio	Arkansas River - West	1
9	Big Thompson River headwaters	Portfolio	Upper Platte River Basin	1
10	Big Thompson River	Portfolio	Upper Platte River Basin	1
11	Birdwood Creek B	Portfolio	Middle Platte River Basin	1
12	Black Squirrel Creek	Portfolio	Arkansas River - West	1
13	Black Wolf Creek	Portfolio	Republican River Headwaters	1
14	Boggs Creek	Portfolio	Arkansas River - West	1
15	Boulder Creek	Portfolio	Upper Platte River Basin	1
16	Buffalo Creek	Portfolio	Republican River Headwaters	1
17	Chacuaco Creek	Portfolio	Arkansas River - West	1
18	Cheyenne Creek	Portfolio	Arkansas River - West	1
19	Chico Creek	Portfolio	Arkansas River - West	1
20	Chugwater Creek	Portfolio	Upper Platte River Basin	1
21	Cimarron River headwaters	Portfolio	Arkansas River - West	1
22	Dry Cimarron River	Portfolio	Arkansas River - West	1
23	Corrumpa Creek	Portfolio	Canadian River	1
24	Deep Holes Creek	Portfolio	Middle Platte River Basin	1
25	Deer Creek (Laramie River)	Portfolio	Upper Platte River Basin	1
26	East Clear Creek	Portfolio	Middle Platte River Basin	1
27	Eightmile Creek	Portfolio	Arkansas River - West	1
28	Frenchman Creek	Portfolio	Republican River Headwaters	1
29	Hardscrabble Creek	Portfolio	Arkansas River - West	1
30	Haynes Creek	Portfolio	Arkansas River - West	1
31	Indian Creek (Republican River)	Portfolio	Republican River Headwaters	1
32	Ladder Creek	Portfolio	Republican River Headwaters	1
33	Lake Creek	Portfolio	Republican River Headwaters	1
34	Little Horse Creek	Portfolio	Middle Platte River Basin	1
35	Little Sandy Creek	Portfolio	Arkansas River - West	1
36	Little Thompson River	Portfolio	Upper Platte River Basin	1
37	Lodgepole Creek	Portfolio	Middle Platte River Basin	1
38	Lower Big Sandy Creek	Portfolio	Arkansas River - West	1
39	Middle Lodgepole Creek	Portfolio	Middle Platte River Basin	1
40	Mud Creek	Portfolio	Arkansas River - West	1
41	Muddy Creek	Portfolio	Middle Platte River Basin	1
42	North Canadian River	Portfolio	Canadian River	1
43	North Carrizo Creek	Portfolio	Arkansas River - West	1
44	North Fork Arickaree River	Portfolio	Republican River Headwaters	1
45	North Fork Cache La Poudre River	Portfolio	Upper Platte River Basin	1

Area Number	Area Name	Rating	EDU	In or Outside CSP *
46	North Platte River	Portfolio	Middle Platte River Basin	1
47	Oak Creek	Portfolio	Arkansas River - West	1
48	Pawnee Creek B	Portfolio	Middle Platte River Basin	1
49	Plum Creek	Portfolio	Upper Platte River Basin	1
50	Purgatoire River	Portfolio	Arkansas River - West	1
51	Rabbit Creek	Portfolio	Upper Platte River Basin	1
52	Republican River B	Portfolio	Republican River Headwaters	1
53	South Fork Republican River A	Portfolio	Republican River Headwaters	1
54	Rock Creek (Republican River)	Portfolio	Republican River Headwaters	1
55	Rush Creek (foothills)	Portfolio	Arkansas River - West	1
56	Rush Creek A	Portfolio	Arkansas River - West	1
57	Rush Creek B	Portfolio	Arkansas River - West	1
58	Saunders Arroyo	Portfolio	Arkansas River - West	1
59	Smokey Hill River A	Portfolio	Republican River Headwaters	1
60	South Platte River	Portfolio	Middle Platte River Basin	1
61	South Rush Creek	Portfolio	Arkansas River - West	1
62	St. Vrain Creek A	Portfolio	Upper Platte River Basin	1
63	St. Vrain Creek B	Portfolio	Upper Platte River Basin	1
64	Tenmile Creek	Portfolio	Upper Platte River Basin	1
65	Tesesquite Creek	Portfolio	Arkansas River - West	1
66	Timpas Creek	Portfolio	Arkansas River - West	1
67	Turkey Creek	Portfolio	Canadian River	1
68	UNKNOWN** Apishapa River tributary	Portfolio	Arkansas River - West	1

Area Number	Area Name	Rating	EDU	In or Outside CSP *
69	UNKNOWN Arkansas River tributary	Portfolio	Arkansas River - West	1
70	UNKNOWN Cimarron Creek trib A	Portfolio	Arkansas River - West	1
71	Muddy Creek (Lodgepole Creek)	Portfolio	Arkansas River - West	1
72	UNKNOWN Cimarron Creek trib C	Portfolio	Arkansas River - West	1
73	UNKNOWN Cimarron Creek trib F	Portfolio	Arkansas River - West	1
74	UNKNOWN Lodgepole Creek tributary	Portfolio	Middle Platte River Basin	1
75	Upper Cimarron River/Black Mesa	Portfolio	Arkansas River - West	1
76	Upper Lodgepole Creek	Portfolio	Middle Platte River Basin	1
77	Upper North Canadian River/Corrumpa Creek	Portfolio	Canadian River	1
78	Upper Smokey Hill River	Portfolio	Republican River Headwaters	1
79	Upper South Platte River	Portfolio	Middle Platte River Basin	1
80	Van Bremer Creek	Portfolio	Arkansas River - West	1
81	Whitetail Creek	Portfolio	Middle Platte River Basin	1
82	North Fork Republican River/Chief Creek	Portfolio	Republican River Headwaters	1
83	South Fork Republican River B	Portfolio	Republican River Headwaters	1
84	Fountain Creek	Portfolio	Arkansas River - West	1
85	North Fork Republican River	Portfolio	Republican River Headwaters	1
86	Republican River A	Portfolio	Republican River Headwaters	1
87	Arickaree River	Portfolio	Republican River Headwaters	1
88	Horse Creek B	Portfolio	Middle Platte River Basin	1
89	Horse Creek A	Portfolio	Middle Platte River Basin	1
90	Adobe Creek	Provisional	Arkansas River - West	1

Area Number	Area Name	Rating	EDU	In or Outside CSP *
91	Bear Creek (Horse Creek)	Provisional	Middle Platte River Basin	1
92	Cache La Poudre River	Provisional	Upper Platte River Basin	1
93	Caddoa Creek	Provisional	Arkansas River - West	1
94	Clear Creek B	Provisional	Upper Platte River Basin	1
95	Coldwater Creek	Provisional	Canadian River	1
96	Cottonwood Creek	Provisional	Middle Platte River Basin	1
97	Deer Creek (South Platte River)	Provisional	Upper Platte River Basin	1
98	Dry Creek (Arkansas River)	Provisional	Arkansas River - West	1
99	Fox Creek	Provisional	Republican River Headwaters	1
100	Frijole Creek	Provisional	Arkansas River - West	1
101	Goff Creek	Provisional	Canadian River	1
102	Hackberry Creek	Provisional	Republican River Headwaters	1
103	Indian Creek (North Canadian River)	Provisional	Canadian River	1
104	Jack Rabbit Creek	Provisional	Middle Platte River Basin	1
105	Kiowa Creek	Provisional	Canadian River	1
106	Medicine Creek	Provisional	Republican River Headwaters	1
107	Middle Bijou Creek	Provisional	Middle Platte River Basin	1
108	Mitchell Creek	Provisional	Republican River Headwaters	1
109	North Fork Cimarron River/Sand Arroyo Creek	Provisional	Arkansas River - West	1
110	Pawnee Creek A	Provisional	Middle Platte River Basin	1
111	Peck Creek	Provisional	Arkansas River - West	1
112	Pony Creek	Provisional	Canadian River	1
113	Powell Arroyo	Provisional	Arkansas River - West	1
114	Ranton Creek	Provisional	Arkansas River - West	1
115	Sand Creek (Beaver Creek)	Provisional	Middle Platte River Basin	1
116	Sidney Draw	Provisional	Middle Platte River Basin	1
117	North Fork Smokey Hill River	Provisional	Republican River Headwaters	1
118	Smokey Hill River B	Provisional	Republican River Headwaters	1
119	Spring Creek	Provisional	Middle Platte River Basin	1
120	Tepee Creek	Provisional	Canadian River	1
121	Trinchera Creek	Provisional	Arkansas River - West	1
122	Turkey Creek? (South Red Creek?)	Provisional	Arkansas River - West	1
123	UNKNOWN Arickaree River tributary	Provisional	Republican River Headwaters	1
124	UNKNOWN Big Sandy Creek tributary	Provisional	Arkansas River - West	1
125	UNKNOWN Canadian River trib A	Provisional	Canadian River	1
126	UNKNOWN Chico Creek tributary	Provisional	Arkansas River - West	1
127	UNKNOWN Cimarron Creek trib D	Provisional	Arkansas River - West	1
128	UNKNOWN Cimarron Creek trib E	Provisional	Arkansas River - West	1
129	UNKNOWN Lodgepole Creek trib (Wild Horse Creek?)	Provisional	Middle Platte River Basin	1
130	UNKNOWN Rush Creek tributary A	Provisional	Arkansas River - West	1
131	UNKNOWN Rush Creek tributary B	Provisional	Arkansas River - West	1
132	UNKNOWN Rush Creek tributary C	Provisional	Arkansas River - West	1
133	Upper Arkansas River	Provisional	Arkansas River - West	1
134	West Bijou Creek	Provisional	Middle Platte River Basin	1
135	Bear Creek	Portfolio	Arkansas River - West	1
136	Graneros Creek	Portfolio	Arkansas River - West	1
137	Greenhorn Creek	Portfolio	Arkansas River - West	1

Area Number	Area Name	Rating	EDU	In or Outside CSP *
138	Newlin Creek	Portfolio	Arkansas River - West	1
139	North Apache Creek	Portfolio	Arkansas River - West	1
140	South Apache Creek	Portfolio	Arkansas River - West	1
141	Beaver Creek/Boehmer Reservoir	Portfolio	Arkansas River - West	0
142	Cascade Creek	Portfolio	Arkansas River - West	0
143	Cottonwood Creek (Greenback)	Portfolio	Arkansas River - West	0
144	Lake Fork Arkansas River	Portfolio	Arkansas River - West	0
145	Middle Fork South Arkansas River/Hunt Lake	Portfolio	Arkansas River - West	0
146	North Taylor Creek	Portfolio	Arkansas River - West	0
147	Rock Creek	Portfolio	Arkansas River - West	0
148	Severy Creek	Portfolio	Arkansas River - West	0
149	South Prong Hayden Creek	Portfolio	Arkansas River - West	0
150	Arroyo de Mestejo	Portfolio	Canadian River	0
151	Arroyo Piedra Lumbre	Portfolio	Canadian River	0
152	Bear Creek (North Platte River)	Portfolio	Upper Platte River Basin	0
153	Big Cottonwood Creek	Portfolio	Arkansas River - West	0
154	Big Creek	Portfolio	Upper Platte River Basin	0
155	Birdwood Creek A	Portfolio	Middle Platte River Basin	0
156	Bolton Creek	Portfolio	Upper Platte River Basin	0
157	Box Elder Creek	Portfolio	Upper Platte River Basin	0
158	Cache La Poudre River headwaters	Portfolio	Upper Platte River Basin	0
159	Canadian River headwaters	Portfolio	Canadian River	0
160	Canadian River	Portfolio	Canadian River	0
161	Chalk Creek	Portfolio	Arkansas River - West	0
162	Chicken Creek	Portfolio	Canadian River	0
163	Cimarron River	Portfolio	Canadian River	0
164	Clear Creek A	Portfolio	Upper Platte River Basin	0
165	Conchas River A	Portfolio	Canadian River	0
166	Conchas River B	Portfolio	Canadian River	0
167	Corazon Creek	Portfolio	Canadian River	0
168	Curtis Creek	Portfolio	Canadian River	0
169	Day Creek	Portfolio	Arkansas River - West	0
170	Deadhead Creek	Portfolio	Upper Platte River Basin	0
171	Dry Creek (Sweetwater River)	Portfolio	Upper Platte River Basin	0
172	Dry Laramie River	Portfolio	Upper Platte River Basin	0
173	Dry Rawhide Creek	Portfolio	Middle Platte River Basin	0
174	Foote Creek	Portfolio	Upper Platte River Basin	0
175	Goose Creek	Portfolio	Upper Platte River Basin	0
176	Grizzly Creek	Portfolio	Upper Platte River Basin	0
177	Horse/Trout Creek	Portfolio	Upper Platte River Basin	0
178	Indian Creek (North Platte River)	Portfolio	Middle Platte River Basin	0
179	Lankin Creek	Portfolio	Upper Platte River Basin	0
180	Laramie River headwaters	Portfolio	Upper Platte River Basin	0
181	Little Grizzly Creek	Portfolio	Upper Platte River Basin	0
182	Lower Laramie River	Portfolio	Upper Platte River Basin	0
183	Minneosa Creek	Portfolio	Canadian River	0
184	Monument Creek?	Portfolio	Arkansas River - West	0
185	Moore/Bugby Creek	Portfolio	Canadian River	0
186	Mora River	Portfolio	Canadian River	0
187	North Platte River B	Portfolio	Upper Platte River Basin	0
188	Ocate Creek	Portfolio	Canadian River	0

Area Number	Area Name	Rating	EDU	In or Outside CSP *
189	Pete Creek	Portfolio	Upper Platte River Basin	0
190	Pine Creek	Portfolio	Arkansas River - West	0
191	Plaza Largo Creek	Portfolio	Canadian River	0
192	Ponil Creek	Portfolio	Canadian River	0
193	Potter Creek	Portfolio	Upper Platte River Basin	0
194	Punta de Agua Creek	Portfolio	Canadian River	0
195	Rawhide Creek A	Portfolio	Middle Platte River Basin	0
196	Rawhide Creek B	Portfolio	Middle Platte River Basin	0
197	Red Willow Creek	Portfolio	Middle Platte River Basin	0
198	Revuelto Creek	Portfolio	Canadian River	0
199	Roaring Creek North Platte River	Portfolio	Upper Platte River Basin	0
200	Rock Creek (Medicine Bow River)	Portfolio	Upper Platte River Basin	0
201	Rosita Creek	Portfolio	Canadian River	0
202	Rush Creek (Sweetwater)	Portfolio	Upper Platte River Basin	0
203	Sand Creek (North Platte)	Portfolio	Upper Platte River Basin	0
204	Sheep Creek	Portfolio	Upper Platte River Basin	0
205	Shell Creek	Portfolio	Upper Platte River Basin	0
206	South Fork South Platte River	Portfolio	Upper Platte River Basin	0
207	Sweetwater River A	Portfolio	Upper Platte River Basin	0
208	Sweetwater River B	Portfolio	Upper Platte River Basin	0
209	Sybille Creek A	Portfolio	Upper Platte River Basin	0
210	Texas Creek	Portfolio	Arkansas River - West	0
211	Threemile Creek	Portfolio	Upper Platte River Basin	0
212	Trout Creek	Portfolio	Arkansas River - West	0
213	UNKNOWN Canadian River trib B (Horse Creek?)	Portfolio	Canadian River	0
214	UNKNOWN Mora Creek trib	Portfolio	Canadian River	0
215	UNKNOWN Ute Creek tributary A	Portfolio	Canadian River	0
216	UNKNOWN Ute Creek tributary B	Portfolio	Canadian River	0
217	Upper Canadian River B	Portfolio	Canadian River	0
218	Ute Creek	Portfolio	Canadian River	0
219	Wigwam Creek	Portfolio	Upper Platte River Basin	0
220	Wolf Creek	Portfolio	Canadian River	0
221	Upper North Platte River	Portfolio	Upper Platte River Basin	0
222	North Laramie River	Portfolio	Upper Platte River Basin	0
223	Sybille Creek B	Portfolio	Upper Platte River Basin	0
224	LaBonte Creek	Portfolio	Middle Platte River Basin	0
225	Deer Creek (North Platte River)	Portfolio	Upper Platte River Basin	0
226	Muddy Creek (North Platte River)	Portfolio	Middle Platte River Basin	0
227	Coyote Creek	Portfolio	Canadian River	0
228	Bates Creek	Provisional	Upper Platte River Basin	0
229	Casper Creek	Provisional	Upper Platte River Basin	0
230	Cramer Creek	Provisional	Canadian River	0
231	Encampment River	Provisional	Upper Platte River Basin	0
232	Frisco Creek	Provisional	Canadian River	0
233	Grape Creek	Provisional	Upper Platte River Basin	0
234	Huerfano River headwaters	Provisional	Arkansas River - West	0
235	Medicine Bow River/Little Medicine Bow River	Provisional	Upper Platte River Basin	0
236	North Fork South Platte River	Provisional	Upper Platte River Basin	0
237	North Platte River A	Provisional	Upper Platte River Basin	0

Area Number	Area Name	Rating	EDU	In or Outside CSP *
238	North Plum Creek	Provisional	Canadian River	0
239	Oasis Creek	Provisional	Canadian River	0
240	Rayado Creek	Provisional	Canadian River	0
241	South Arkansas River	Provisional	Arkansas River - West	0
242	South Oak Creek	Provisional	Arkansas River - West	0
243	Tarryall Creek	Provisional	Upper Platte River Basin	0
244	UNKNOWN Grape Creek tributary	Provisional	Arkansas River - West	0
245	UNKNOWN North Platte tributary (Rush Creek?)	Provisional	Middle Platte River Basin	0

Area Number	Area Name	Rating	EDU	In or Outside CSP *
246	UNKNOWN Rita Blanca Creek tributary	Provisional	Canadian River	0
247	Vermejo River B	Provisional	Canadian River	0
248	Upper Canadian River A	Provisional	Canadian River	0
249	Willow Creek	Provisional	Upper Platte River Basin	0
250	Upper Laramie River	Provisional	Upper Platte River Basin	0
251	Vermejo River A	Provisional	Canadian River	0

*1 = in CSP Boundary, 0 = within Eastern Slope but outside CSP
**Unknown areas = stream/river name fields are not populated in the national hydrography data set

Table 18. Aquatic ecological system targets of four size classes that met conservation goals in all Ecological Drainage Units in which they occur.

Table Size	Number of Targets	#(%) Targets that met conservation goals: network without the addition of "provisional conservation areas"	#(%) Targets that met conservation goals in complete network
Stream/Headwater	54	25 (46%)	31 (57%)
Small River	20	5 (25%)	8 (40%)
Large River	4	2 (50%)	2 (50%)
Very Large River	1	1 (100%)	1 (100%)
TOTAL	79	33 (42%)	42 (53%)

Goal attainment for aquatic ecological systems varied across EDUs (Table 19). The Middle Platte River Basin and Arkansas River–West EDUs had the highest proportion of goals achievement, while the Republican River headwaters had the lowest.

Table 19. Number of aquatic ecological system target goals met in the network of conservation areas within five Ecological Drainage Units.

	Number Goals Met / Number Targets					
System Size	**Upper Platte River**	**Middle Platte River**	**Republican River Headwaters**	**Arkansas River-West**	**Canadian River**	**Total**
Stream/headwater	7/20	5/14	0/4	8/24	5/13	25/75
Small River	2/7	2/5	1/2	1/6	1/5	7/25
Large River	0/2	2/2	1/1	2/3	3/3	8/11
Very Large River	NA	1/1	NA	1/1	1/1	3/3
TOTAL	9/29 (31%)	10/22 (45%)	2/7 (29%)	12/34 (35%)	10/22 (45%)	43/114 (37%)

2. Aquatic Species: The initial aquatic network, prior to the addition of "provisional conservation areas," achieved goals in all EDUs for only 5 of 55 species targets (Table 20). The addition of "provisional conservation areas" did not significantly increase attainment of goals. No invertebrate target met goals in all EDUs. The low goal attainment is largely due to a lack of known occurrences. The low number of occurrences is due in part to lack of inventory, declines from historical numbers or range, and natural rarity. See Appendices Q and R for more detailed results. Progress towards goals for species was based on the number of actual populations that the captured viable occurrences represent (note that fish populations, particularly large river fishes, can consist of one or more occurrences).

Table 20. Number of species targets that met conservation goals in all Ecological Drainage Units.

Species	Number Targets	#(%) Targets that met goals: network without the addition of "provisional conservation areas"	#(%) Targets that met goals in complete network
Fishes	19	5 (26%)	5 (26%)
Insects	30	0 (0%)	0 (0%)
Crustaceans	3	0 (0%)	0 (0%)
Mollusks	3	0 (0%)	0 (0%)
TOTAL	55	5 (9%)	5 (9%)

Goal attainment for species varied across all EDUs (see Table 21). The highest proportion of goals was achieved in the Middle Platte River Basin EDU; the lowest proportion occurred within the Republican River headwaters.

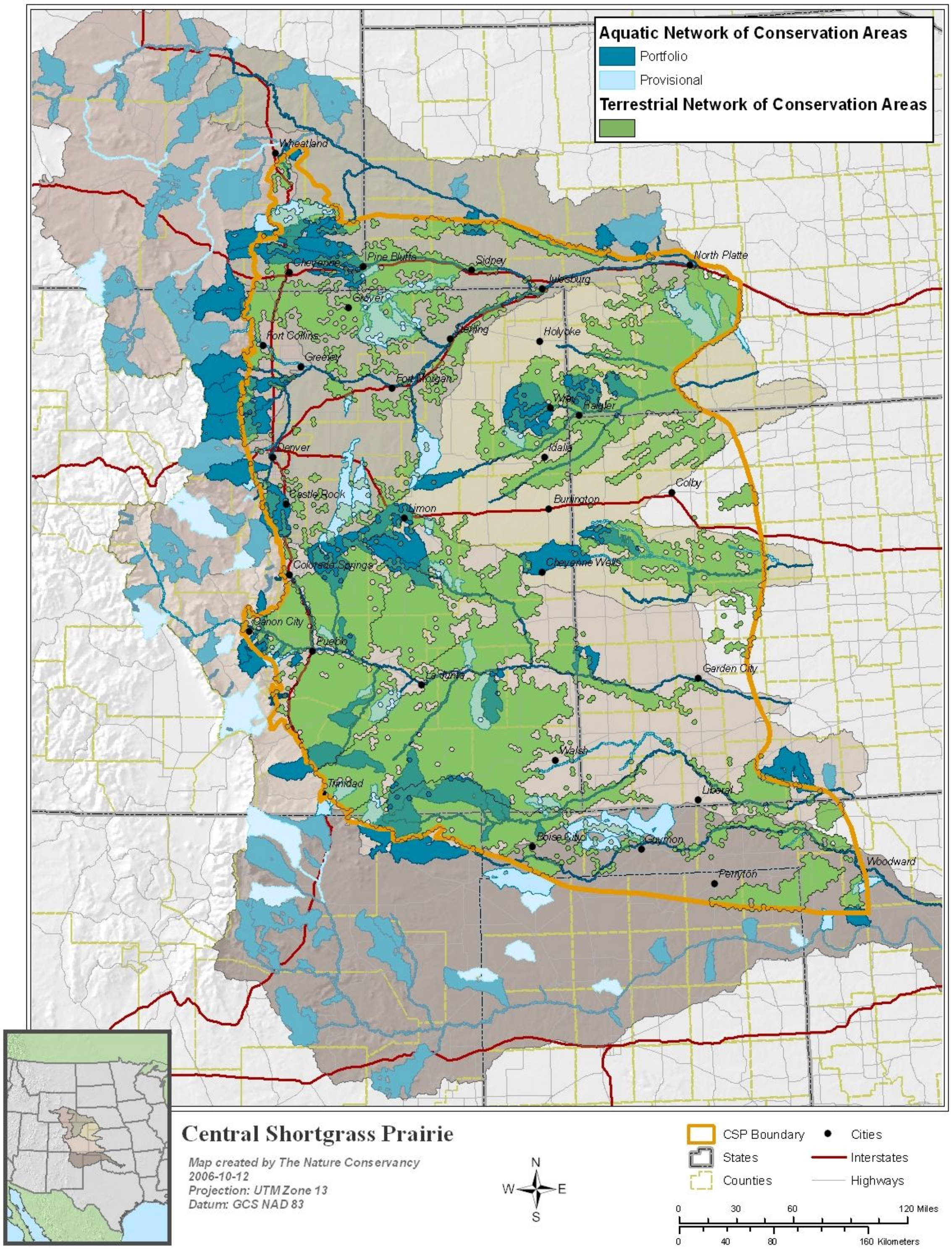
Table 21. Species target goals met in conservation areas (provisional areas excluded) in five Ecological Drainage Units.

Species	Total	Upper Platte River	Middle Platte River	Republican River Headwaters	Arkansas River – West	Canadian River
Fishes	26/50 (52%)	7/13 (54%)	8/11 (73%)	4/10 (40%)	4/9 (56%)	2/7 (43%)
Insects	0/29 (0%)	0/17 (0%)	0/1 (0%)	0/4 (0%)	0/7 (0%)	None
Crustaceans	0/2 (0%)	0/1 (0%)	None	None	None	0/1 (0%)
Mollusks	0/2 (0%)	0/1 (0%)	None	None	0/1 (0%)	None
Total	(%)	7/32 (22%)	8/12 (67%)	4/14 (29%)	4/17 (24%)	2/8 (25%)

D. Integration of Terrestrial and Aquatic Networks

A regional assessment of conservation needs cannot easily separate the aquatic from the terrestrial portions of the region. The team conducted assessments of terrestrial species and ecological systems somewhat independent of the aquatic/riparian species and systems. However, the two assessments should be spatially and strategically integrated wherever possible. The team identified a total of 183 conservation areas within the CSP (43 terrestrial and 140 aquatic areas). Thirty six of the 43 (83%) terrestrial conservation areas include portions of the aquatic conservation areas (e.g., Greater Pawnee, Lower Cimarron, and Horse Creek). Twenty four percent (7,843 miles or 12,630 km) of the entire aquatic network-stream miles overlaps the terrestrial network. The complete network of conservation areas for the CSP includes pieces of the terrestrial assessment and aquatic conservation areas from the Eastern Slope aquatic assessment that occur within or touch the CSP (see Figure T).

Fig T. Overlay of Terrestrial and Aquatic Networks



E. Threats to Targets within Terrestrial Conservation Areas

Identification of threats to biodiversity is a critical step in determining ecoregional priorities and developing conservation strategies. Evaluation of threats helps determine which conservation areas are in greatest need of attention. It also assists in the design of multi-area strategies to address threats across the ecoregion. The Core Team evaluated threats on two levels for this assessment: 1) the conservation area level with expert input and 2) the broad ecoregional level using spatial analyses. Threats are defined as "any human activity or process that has caused, is causing, or may cause the destruction, degradation, and/or impairment of biodiversity and natural processes" by the Conservation Measures Partnership (www.fosonline.org/CMP). This assessment focuses on *direct threats*, also known as *sources of stress*, that immediately affect species, communities, and ecosystems within the terrestrial network.

The framework adopted for the assessment of threats to conservation areas is based on the Conservation Measures Partnership taxonomy (www.fosoline.org/CMP/); it has been slightly modified to accommodate the CSP (see Appendix S for threat taxonomy). Regional and local experts used this framework to identify threats to major systems, communities and/or species at risk occurring within the terrestrial conservation areas. While the emphasis was on terrestrial targets, some experts provided information on threats to aquatic ecosystems. The information provided below is based only on expert knowledge, and should serve only as a starting point for further analyses and planning at the conservation area level. See Appendix O for initial threats by conservation area, and the next section for a general discussion of threats to biodiversity across the ecoregion.

1. <u>Severity</u>: Based on the criteria below, each threat was ranked by experts in terms of severity of the impact to occurrences on the *major ecological systems, communities, and/or species-at-risk* within the conservation area (see Table 22):

    a. Very High: Impact will *destroy* target occurrence of major systems, communities and/or species at risk;
    b. High: Impact will significantly *degrade* target occurrence of major systems, communities and/or species at risk;
    c. Medium: Impact will cause *some degradation* to target occurrence of major systems, communities and/or species at risk; and
    d. Low: Impact will *slightly impact* target occurrence of major systems, communities, and/or species at risk.

Table 22. Threats that present a high or very high severity to targets within conservation areas, as identified by regional and local experts.

Threat Category	Proportion of Areas with Very High or High Threat Severity
Altered hydrologic regime	44%
Housing/urban development	37%
Invasive species	33%
Incompatible grazing management	19%
Oil and gas drilling	16%
Mining	12%
Conversion to cropland	12%
Altered fire regime	9%
Roads	9%
Commercial wind power generation facilities	7%

2. Timeframe: Experts assigned the timeframe of the threats based on the following criteria (this was an attempt to identify urgent threats).

    a. Current: Threats are already taking place (ongoing); and
    b. Future: Threats are likely to begin or continue into the near future (within the next 1-3 years).

3. Scope: Each threat was ranked according to its distribution within conservation areas across the ecoregion using the following system (see Table 23):

    a. Widespread: >50% of areas are affected by threat;
    b. Common: 10-50% of areas affected by threat; and
    c. Limited: <10% of areas are affected by threat.

Table 23. Scope of threats within conservation areas across the ecoregion (proportion of areas affected by threats, as identified by regional and local experts).

Threat	Scope
Widespread (>50% of areas)	
Altered hydrologic regime	72%
Invasive plants	67%
Housing/urban development	58%
Commercial wind power generation facilities	56%
Conversion to cropland	51%
Common (10-50% of areas)	
Oil and gas drilling	40%
Incompatible grazing management	35%
Roads	23%
Altered fire regime	21%
Invasive animals	21%
Commercial/industrial development	12%
Natural systems modification	12%
Limited (<10% of areas)	
Mining	9%
Poisoning prairie dogs	9%
Nutrient loading	9%
Commercial feedlots	7%
Utility lines	7%
Waste materials	7%

The most widespread threats with the greatest impact to biodiversity in the ecoregion include altered hydrologic regime, housing and urban development, invasive species, land conversion to cropland, and commercial wind power generation facilities. Addressing these threats now is critical to avoid further habitat loss and species decline.

Future revisions to the assessment should address the scope of threats to targets within conservation areas, mapped threats (e.g., commercial wind power generation facilities), projected growth, and threats to targets within aquatic conservation areas.

F. Prioritizing Terrestrial Conservation Areas

All conservation areas are important for conserving biodiversity in the ecoregion. However, because so many conservation areas require action, it is necessary to prioritize projects to more effectively conserve biodiversity. Several factors should be considered when setting priorities, including biodiversity value, irreplaceability, contribution towards ecoregional goals, quality or ecological condition, degree to which targets are already conserved, threats, feasibility of achieving conservation, potential management effectiveness for biodiversity (e.g., presence of partners and conservation capacity), leverage opportunities, cost, funding, and potential for success (Groves 2003). Key questions are: *What areas should be conserved first? How should limited resources be allocated?*

To help prioritize terrestrial conservation areas, the team used an Excel tool developed by Goering et al. (2005) to evaluate the relative importance among areas by using criteria that measures conservation contribution, irreplaceability, and vulnerability. This method was first developed by Pressey et al. (1994) and applied by Noss et al. (2002) and others.

Defining the measures of conservation value and vulnerability was the first step. For this analysis, the team used GIS data compiled through the ecoregional assessment process in combination with information provided by experts.

1. **Conservation Value**: For purposes of this assessment, places with the highest conservation value are of critical importance because of their potential to contribute to conservation goals, irreplaceability, and existing protection (Groves et al. 2000, Groves 2003). To summarize the biological contribution of each conservation area, the team assigned values of very high, high, medium, and low for the following factors:

    a. <u>Contribution</u>: Conservation area's contribution towards conservation goals for each target (occurrence amount/total goal and/or acreage amount/total goal);
    b. <u>Irreplaceability</u>: Conservation area's number of G1-G2 species and communities;
    c. <u>GAP Status</u>: Percent of area in GAP 1 or 2 management/protection status to indicate the degree to which an area already is receiving some degree of conservation effort.

2. **Vulnerability:** For the purposes of this analysis, vulnerability is defined as a measure of threat or risk to the biodiversity features within a conservation area being transformed by extractive uses. Practically, this is the percent of area already cleared of native vegetation and thus the area is vulnerable to similar activities in the future (Groves 2003). Spatial data from the landscape integrity analysis were used to calculate vulnerability and repeatability (expert-derived threats were not used as they are not as repeatable as spatial data). Each hexagon was ranked into one of four categories (very high, high, medium or low threat); the value for each hexagon then was averaged over the entire conservation area. This index, considered a relative indicator of impacts, was based on a model of the following land use factors:

    a. <u>Road Density</u> (primary, secondary, local roads, and trails);
    b. <u>Residential and Commercial Development</u>;
    c. <u>Oil and Gas Wells, Sand and Gravel Mines, Coal Mines</u>; and
    d. <u>Tilled Agriculture</u>.

Conservation areas were plotted, according to their scores for each factor, on a scatter plot with conservation value on the y-axis and vulnerability on the x-axis. This exercise allowed conservation areas to be evaluated and sorted according to factors important for biodiversity value, and by level of threats they face (see Figure 2 and Table 24 below). The conservation areas in the upper right have higher conservation value and are more vulnerable (or at a higher risk of loss); areas in the upper left have higher conservation value, but lower vulnerability. Areas of high biodiversity value, whether or not currently threatened, should be the highest priority for conservation action (Groves 2003). Results identified areas that will contribute most to conservation goals. Results of these analyses are presented in Appendix T to facilitate use by various practitioners and to address different questions (see Figure U-V for maps of conservation areas prioritized by conservation value and vulnerability).

All conservation areas are of high biological value, particularly relative to the surrounding landscape; this table is simply an effort to distinguish between them. The lower-value, lower-threat areas also need conservation attention. These results are intended to provide a general guideline to help practitioners make informed decisions regarding conservation areas, and help address various questions. The separation between quadrants is blurry. This is the team's first attempt to prioritize areas for conservation action, and represents a snapshot in time. It should be used in conjunction with on-the-ground knowledge, as vulnerability was modeled using mapped land-use factors. For example, Chico Basin (#25) is currently threatened by residential development and should probably be ranked higher for vulnerability. More comprehensive methods that incorporate new information and other values, such as projected growth, should be completed in the future. In addition, future prioritization efforts should address the aquatic network of conservation areas.

Figure 2. Scatter plot showing relative position of terrestrial conservation areas in the Central Shortgrass Prairie based on conservation value and vulnerability.

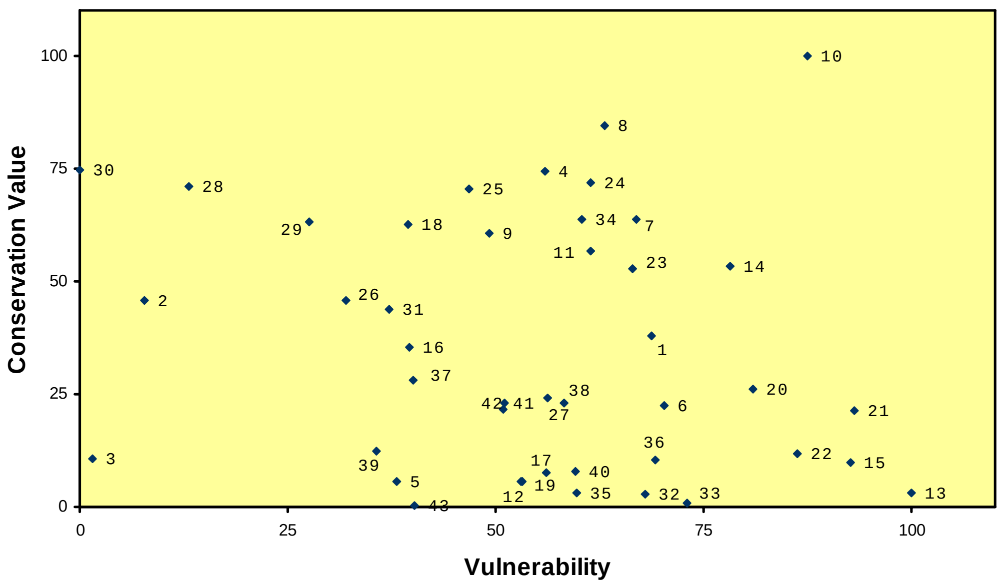


Table 24. Conservation areas plotted by relative scores for conservation value and vulnerability.

Conservation Area	Number
Higher Conservation Value/Higher Vulnerability	
Arkansas Valley	24
Cherokee	14
Chugwater Creek	1
Front Range Foothills	10
Loess Canyons	8
Mountains to Plains	4
North Platte River	7
Smoky Hill River Breaks	34
South Platte Sandhills	11
W. Bijou Headwaters	23
Higher Conservation Value/Lower Vulnerability	
Big Sandy	16
Chico Basin	25
Greater Pawnee	9
Horse Creek	26
Huerfano Uplands	28
Laramie Range Foothills Creeks	2
Lower Cimarron	37
Lower Purgatoire	29
Mesa de Maya	30
Republican River Sand Hills	18
Upper Cimarron	31
Lower Conservation Value/Higher Vulnerability	
Arkansas River	36
Barr Lake	13
Beaver Creek	32
Black Forest	22
Cherry Creek	15
Goff Creek	40
Indian Lakes	27
Kimball Grasslands	6
Last Chance	17
Monument Creek	21
N. Fork of Saline River	33
Upper Pawnee	35
Lower Conservation Value/Lower Vulnerability	
Beaver Creek Sand Hills	41
Colorado Sand Hills	12
Gurney Peak	3
Persimmon Creek	43
Rita Blanca	39
S. Fork Republican River	19
Wildcat Hills	5
Wolf Creek	42

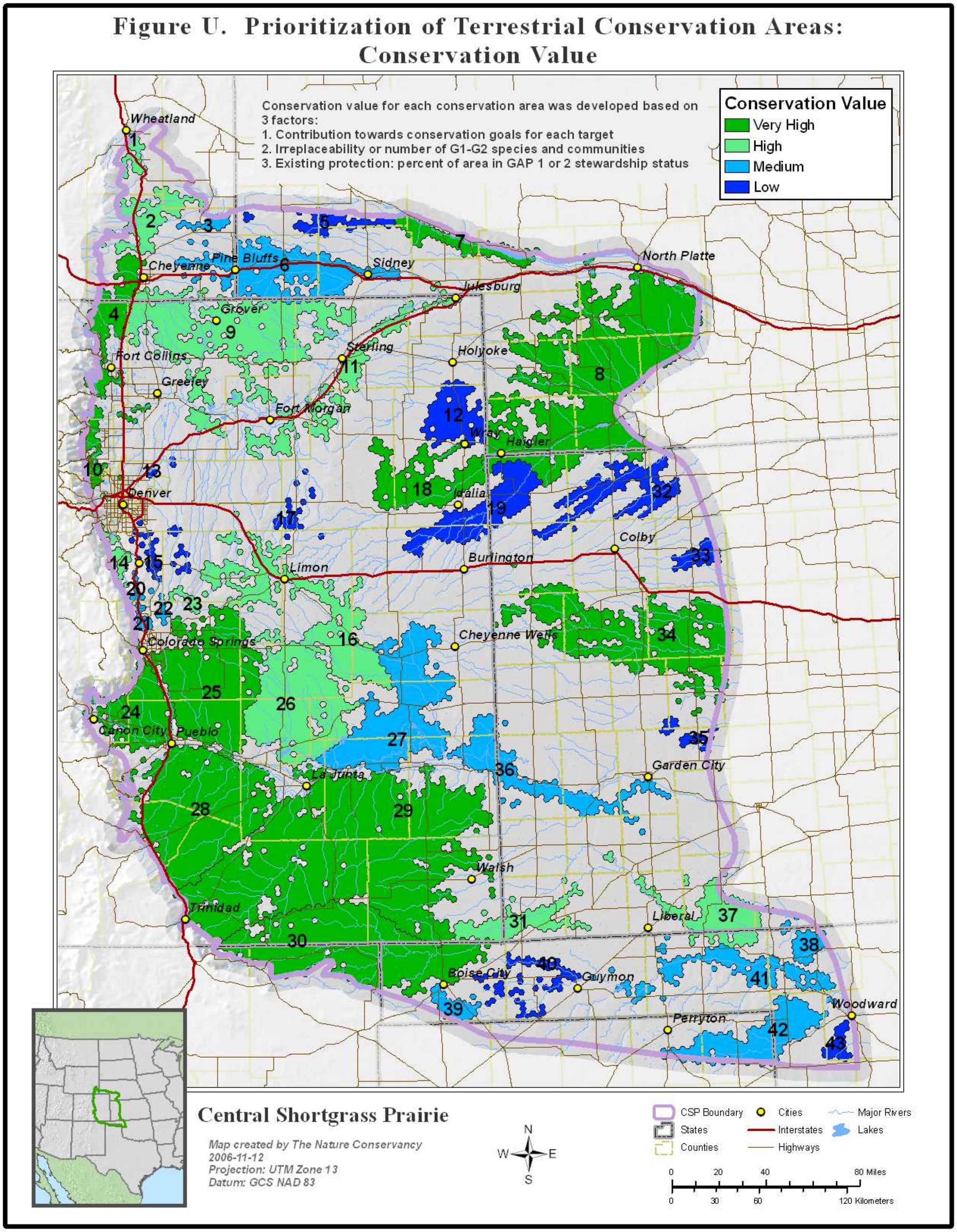
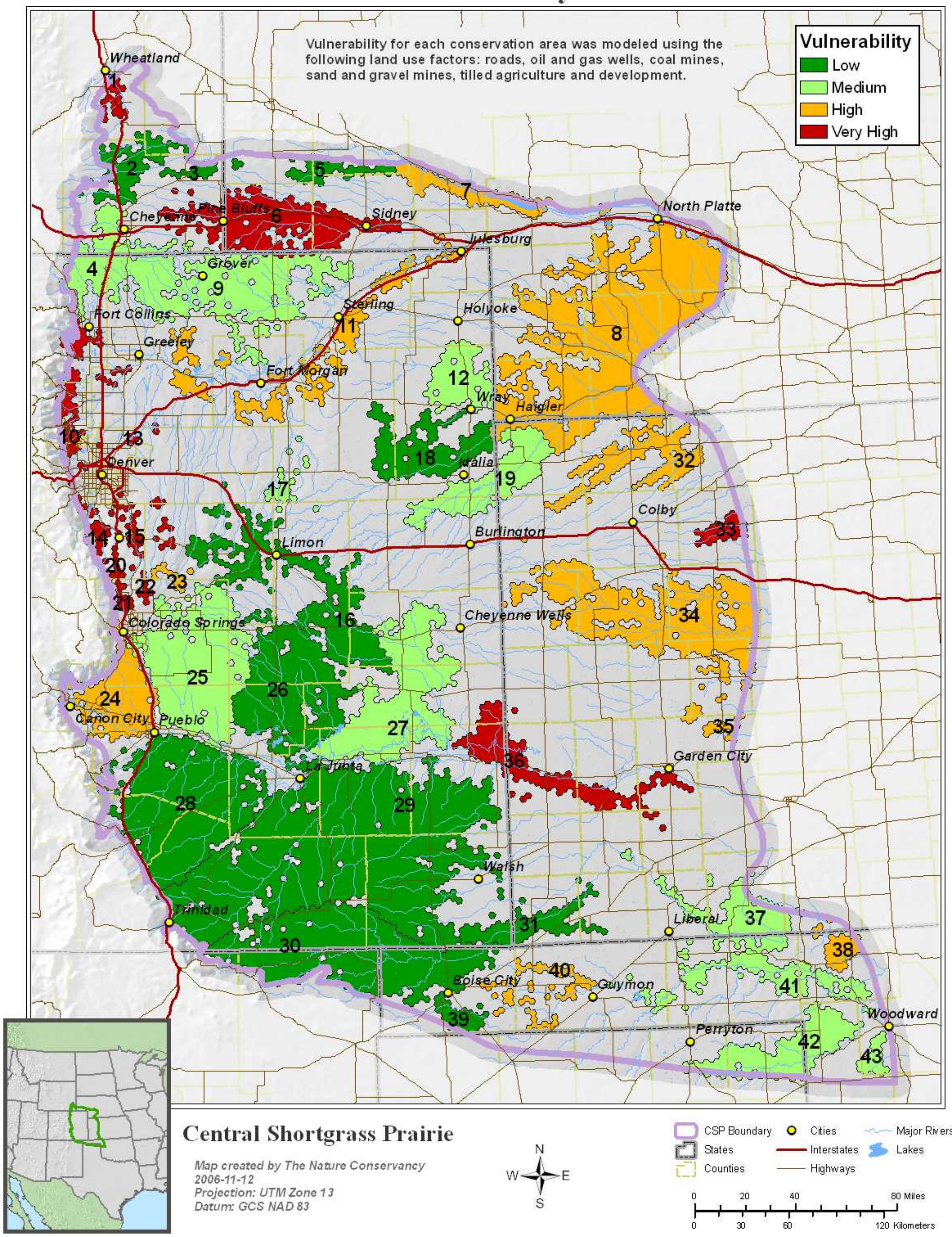


Figure U. Prioritization of Terrestrial Conservation Areas:
Conservation Value
Conservation value for each conservation area was developed based on 3 factors:
1. Contribution towards conservation goals for each target
2. Irreplaceability or number of G1-G2 species and communities
3. Existing protection: percent of area in GAP 1 or 2 stewardship status
Conservation Value
Very High
High
Medium
Low
Wheatland
Cheyenne
Pine Bluffs
Sidney
North Platte
Julesburg
Grover
Sterling
Holyoke
Fort Collins
Greeley
Fort Morgan
Wray
Haigler
Denver
Idalia
Colby
Burlington
Limon
Cheyenne Wells
Colorado Springs
Canon City
Pueblo
La Junta
Garden City
Walsh
Trinidad
Liberal
Boise City
Guymon
Woodward
Perryton
Central Shortgrass Prairie
Map created by The Nature Conservancy
2006-11-12
Projection: UTM Zone 13
Datum: GCS NAD 83
CSP Boundary
Cities
Major Rivers
States
Interstates
Lakes
Counties
Highways
N
S
E
W
0 20 40 80 Miles
0 30 60 120 Kilometers

Figure V. Prioritization of Terrestrial Conservation Areas: Vulnerability



XIII. ECOREGION-WIDE THREATS

Threats to biodiversity are critical considerations in determining ecoregional priorities and developing conservation strategies. Threat assessments provide insights into the urgency of conservation needs and the feasibility for taking action. The Core Team evaluated threats at two levels for this assessment: 1) the conservation area level with expert input and 2) the broad ecoregional level using spatial analyses (landscape integrity/cost layer). With the help of experts and stakeholders, the team identified current and future threats to key ecosystems and species at conservation areas across the ecoregion (see network section above and Appendix O for results of threats to targets at conservation areas). The team also compiled spatial data and conducted GIS analyses, expanding on initial work by Theobald et al. (2004), of key land-use factors across the ecoregion. The combined results of the expert input, data analyses, and literature review indicate that the following ecoregional-scale threats have the greatest current and/or potential impacts on biodiversity in the ecoregion:

- <u>Habitat Conversion and Degradation</u>: housing and urban development, altered fire regime, agricultural conversion, and incompatible grazing management;
- <u>Transportation Infrastructure</u>: road density;
- <u>Energy Development</u>: oil and gas production, mining, and wind energy development;
- <u>Altered Hydrologic Regimes</u>: wells, dams, and diversions;
- <u>Invasive Species/Diseases</u>: plants and animals; and
- <u>Climate Change</u>

A. Habitat Conversion & Degradation

1. <u>Housing and Urban Development</u>

   Conversion of agricultural lands to commercial and residential uses is an important indicator of landscape change and threats to species and natural communities. As property values rise near growing urban and suburban areas, and more rural, exurban (i.e., ranchettes) areas, many farmers and ranchers are selling their land to developers or to large companies (Parton et al. 2003). The conversion rate on the eastern plains of Colorado is 33,000 acres/year, and 58,000 acres/year along the Front Range. Between 1969 and 2002, the rural eastern plains lost 3%, while the Front Range lost 27% of its agricultural land to development, transportation, and reservoirs. (Theobald 2005). This overall trend is similar in rural parts of the other states in the ecoregion.

   Native prairie farmlands and ranchlands are being converted and sold for large-lot residential development. Large-lot, rural development is projected to increase by at least 42% in Colorado, which means close to 3 million acres of rural land may be developed before 2030 (Environment Colorado Research and Policy Center 2006).

   Many economic factors make ranching and farming increasingly challenging today. Grain and beef prices fluctuate, while the cost of labor, fuel, and equipment increases. Land values are soaring in and near urban and some exurban areas. These factors make it difficult for new operators to become farmers and ranchers, and create growing economic pressure for older operators to sell or subdivide their land for development.

Land conversion for residential and urban development and associated land uses is one of the leading causes of species declines and other impacts to biodiversity (Bock et al. 2002; Wilcove et. al 2000; Miller et al. 1990). A major concern is dispersed residential development, or exurban or "ranchette" development (Theobald 2005). Dispersed development can cause shifts in species, from specialists to generalists, increase invasive plant populations and parasites (e.g., brown-headed cowbirds), and support predators (e.g., domestic cats, skunks) associated with human development (Parton et al. 2006; Odell and Knight 2001). Other impacts to native species and ecosystems include habitat fragmentation, habitat loss, decreased water quantity and quality, and increased air pollution (Pague et al. 2006).

2. Agricultural Conversion

Cultivation of grasslands significantly alters species composition and soil structure. The past conversion of prairie lands for cultivated agriculture is a significant problem for many species, particularly grassland birds (Brennan and Kuvlesky 2005). Existing farmland patterns fragment local and regional biodiversity, which leads to increases in invasive species, altered predator patterns, changing natural fire regimes, and limited options for grazing management (Parmar 1997, Garrett-Davis 2004).

Land conversion also affects the hydrology of local and regional watersheds. The amount of cultivated or developed land in a watershed can have significant impacts on hydrologic regime, water quality, and floodplain integrity. Increased extraction of groundwater reduces dry-season water supplies and the amount of surface water available to aquatic and riparian species.

Current conversion rates of native prairie to cultivated agriculture in the ecoregion have slowed significantly in recent years, and other factors, particularly conversion to urban and suburban land uses, have become more significant (Conner et al. 2001; Brown et al. 2005). In addition, the Conservation Reserve Program (CRP) has temporarily retired a large number of cultivated acres in the ecoregion, which currently are planted with grass species. In the Kansas and Colorado portions of the ecoregion alone, more than 3.5 million acres of CRP land currently are under contract (from Farm Services Agency: www.fsausda.gov). Although few CRP fields closely resemble native prairie in species diversity or composition, they do provide benefits for some grassland species (Rodgers and Hoffman 2005). However, the future of these CRP acres is unclear. Nearly 90% of current CRP contracts in the Colorado and Kansas portion of the ecoregion will expire by 2010. Whether Farm Bill policies and appropriations in place at the time of contract expiration will permit re-enrollment of most of these acres is unknown. Many of the currently enrolled acres in the ecoregion rank in the lowest tier of the Environmental Benefits Index, which governs enrollment priorities. If re-enrollment in CRP is not an option, current CRP lands may well revert to cropland.

Many factors influence trends to convert native prairie to cultivated agriculture, including Farm Bill policies, multi-year weather patterns, commodity prices, development of biofuels, and energy costs. The unpredictable way these factors interact and influence land conversion patterns make it difficult for people to proactively address associated impacts on biodiversity.

3. Altered Fire Regime
Fire is a well-documented ecological process in many grassland systems, but the evolutionary role of fire as an ecological process on the shortgrass prairie is not well understood. Fire frequency and size vary greatly depending on recent climate, topography, and historic land use. Fuel production is strongly tied to highly variable precipitation and grazing levels that currently vary across ownership. Fire frequency and size also vary due to fluctuating population levels and movements of large ungulates and prairie dog colonies. Umbanhowar (1996) stated that fire regimes on the Northern Great Plains were highly variable, and reduced productivity during drier periods decreased fuels and made them patchier, which probably resulted in fewer and smaller fires. Higgins (1986) suggested that the demise of the bison herds before 1880 changed the grassland environment more than changes in the fire regime. Effects of greatly increased fuels immediately after the bison slaughter would have been significant (Umbanhowar 1996), especially during the period before European settlers arrived in large numbers, and cattle restocked the plains. In addition to natural wildfires, evidence suggests that fire was an important tool to Native Americans on the western Great Plains. Fire frequency on the Great Plains is estimated to have occurred every 10 years, but most likely varied greatly between 2-35 years.

   Experts suspect that fire, and its interaction with grazing patterns, might have played an important role in creating diverse vegetation structure (heterogeneity) critical for maintaining the range of needs of grassland species (Fuhlendorf and Engle 2001). Research in the western Great Plains has shown that vegetation generally is adapted to fire, and with relatively normal precipitation will recover to pre-burn conditions within 2-5 years.

   Currently, most grassland fires are suppressed, but some land managers in the CSP use prescribed fire to successfully create habitat conditions for specific species (such as Mountain plover), or to limit the invasion of trees and shrubs into open grasslands. Umbanhowar (1996) recommended that managers vary the frequency of prescribed fire, but it is the purview of individual managers to establish the role of fire and its possible uses. Immediate reduction of grazing forage and the uncertainty associated with vegetation recovery and high drought frequency limit the use of prescribed fire on land used for livestock production. Naturally ignited fire also may have undesirable effects, especially if invasive species have affected fuel loads, or when fire threatens property and/or other values (Mike Babler, personal communication). Natural and human-caused fire will continue to occur. With additional research and planning, future fires can be managed to enhance desired conditions.

4. Incompatible Grazing Regime
Grazing is an important ecological process in prairie ecosystems. Historically, an array of herbivores, such as bison, prairie dogs, and even grasshoppers, created a mosaic of disturbance patterns across the landscape that contributed to the diversity of the Great Plains landscape. Since the onset of human settlement, cattle grazing has

become the dominant form of grazing in the ecoregion. Today, ranching helps maintain the relatively large, open spaces that remain in the ecoregion, and often provides the best opportunities for conservation. Grazing as a whole is not a threat to ecosystems in the CSP. Indeed, maintaining grazing as an economic activity is a central conservation strategy. At the same time, certain types of grazing practices are less compatible with maintaining species diversity and can pose a threat to biodiversity.

Traditional measures of range conditions indicate that trends have improved in the past few decades, yet many wildlife species continue to decline in abundance. The plants and animals of the Great Plains have evolved under a wide variety of range conditions. Typically, range management has focused on sustaining livestock production by reducing the variability associated with forage production and grazing. Grazing systems that promote uniform utilization and forage production often tend to homogenize range conditions (Fuhlendorf and Engle 2001). This is often referred to as "managing to the middle." While beneficial to some species, this often is detrimental to others. Under those conditions, less suitable habitat is available to species that require low grass and more bare ground (e.g., mountain plover), or those that rely on patches of taller grass. In some cases, management outside of the middle may be necessary to create or maintain those habitat extremes. In some places, this may require increasing grazing pressure.

There is no one "best" management system. It is essential to provide a variety of conditions to meet the complex needs of grassland ecosystems; management often will be driven by species and/or site specific goals. Utilizing diverse management techniques will help maintain the variety of range conditions required by all grassland species.

B. Transportation Infrastructure

While roads are essential to the economic well-being of the region, they generally have negative effects on the biotic integrity of both aquatic and terrestrial ecosystems, impacting ecological function of natural systems and species. Roads can have major impacts on biodiversity, including increased animal mortality due to road construction and collisions with vehicles, changes in animal behavior (e.g., abandoning nesting areas, or breeding/calving grounds), habitat loss, chemical composition alteration, spread of invasive species, shifts from specialist to generalist species (raptors, some passerines, and plant communities) along roads, increased access by humans, and habitat alteration (Trombulak and Frisell 2000; Forman & Alexander, 1998).

Major variables of roads and their ecological effects include corridor width, connectivity, and usage intensity. A road density of approximately 0.6 km/km^2 (1.0 mi/mi^2) is considered the maximum density in order to maintain a naturally functioning landscape with substantial populations of large predators, such as mountain lions (Forman & Alexander 1998). The distribution and size of remaining prairie patches is a key indicator of the effect of roads on the region's biodiversity.

C. Energy and Mining Development

1. Oil and Gas Production
   Oil and gas currently are primary sources of energy for the United States. Exploration, development, processing, shipment, and utilization of oil and gas have economic implications—they also have potential and existing impacts on biological diversity. Oil and gas development can cause habitat loss and fragmentation. Creation of new wells is typically accompanied by new roads, pipelines, utility lines (Soraghan 2003), and all of the impacts discussed above. Recently, U.S. policy has emphasized the expansion of domestic petroleum exploration and development.

   Approximately 24,000 active, temporarily inactive, and proposed oil and gas wells currently exist within the CSP. Areas with the greatest oil and gas development activity are found in Weld and Yuma counties in Colorado, and the panhandle of Oklahoma. Yuma County alone experienced a 300% growth of permits from 2003 to 2005 (Kerr 2006). New techniques for developing oil and gas likely will increase future development of deposits.

2. Mining
   In the context of the entire ecoregion, the land area impacted by mining is not particularly extensive, but in several cases, plant species are geologically restricted because a large proportion of their habitat is impacted by mining (e.g., for limestone). The impacts of mining are substantial on a local scale, particularly for these range-restricted species.

3. Commercial Wind Power Generation Facilities
   Wind-generated energy generally has been accepted as a sustainable and environmental source of energy because it is renewable. Increasing demand for sources of clean energy likely will lead to significant increases in wind energy facilities on the CSP. The ecological impacts of wind energy vary depending on location and habitat, but documentation exists regarding the affect of wind turbines on the behavior of some birds, including greater and lesser prairie chicken (Robel et al. 2004). Recent research indicates that bats may be at greater risk than birds from flying into wind turbines, especially when turbines are sited along bat-migration corridors.

   Perhaps of greater concern is the cumulative impact of commercial wind power generation facility developments and their associated infrastructure, particularly in terms of habitat fragmentation (Manes et al. 2002). Because windy regions often are located in remote areas, the infrastructure required by these facilities often is created solely for development needs (NREL 2005).
   The CSP ecoregion has significant wind power potential. A comprehensive understanding of site requirements, research on the effects of fragmentation on grassland species, collaborative research, monitoring, and planning are critical components in developing wind power as a truly sustainable source of energy (http://www.nrel.gov/wind/wind_potential.html; Elliott et al. 1997; Elliott and Schwartz 1993).

D. Altered Hydrologic Regimes: Wells, Dams, and Diversions

Human activities such as the construction and operation of dams, reservoirs, water wells, and stream diversions alter both surface water and groundwater functions. Aquatic species can also be significantly compromised by changes in water quality, water quantity, or timing of flows that often are a result of hydrologic alteration. Diversions can create wetlands in places where they would not naturally occur, and can deplete wetlands where they would naturally occur on the landscape. Dams can cause habitat loss directly or through loss of connectivity, and altered flow regime. Wells can alter stream flow and impact aquifers, causing changes in local vegetation, related wetlands, and ecological processes. In short, the harnessing, capture, and changing distribution of water in the arid western Great Plains has been a primary factor in changing land use, along with the quantity, timing, and quality of water. See Figure W for an initial distribution of active water wells, dams and diversions (needs further work).

Surface water is heavily controlled in several major river systems of the CSP including the South Platte, North Platte, Arkansas, Republican, North Canadian, and Upper Cimarron. The majority of existing surface water diversions (canals and ditches) in this region occurs along the South Platte and Arkansas River systems. Several major canals serve agricultural users, while higher up the river systems, large dams and reservoirs serve cities and agriculture.

Groundwater also is a major source of domestic water in the ecoregion. The major aquifer is the High Plains-Ogallala system, one of the world's largest and most rapidly declining aquifers. Farmers pump 6 million acre-feet of water annually from the Ogallala, which recharges at an annual rate of only 185,000 acre-feet. Parts of the High Plains-Ogallala aquifer have experienced significant declines during the 20th Century (from 30-60% declines in saturated thickness across much of western Kansas), and if current practice continues, the aquifer will be unable to support continued irrigated agricultural use (http://www.kgs.ku.edu/Publications/pic18/pic18_1.html).

Water use is expected to intensify over the coming decades, particularly along the urban Front Range in Colorado. For example, Colorado’s Statewide Water Supply Initiative projects increased demand of approximately 630,000 acre-feet for municipal and industrial uses, an increase of approximately 50% over current uses. Of that, 500,000 acre-feet is expected to occur in the Arkansas and South Platte basins. Several trends may affect streams, rivers, and wetlands, including the conversion of agricultural water, and associated farm or ranch lands, to urban use. It also may close management of groundwater use for aquifer sustainability and interstate compact compliance (Tom Iseman, personal communication).

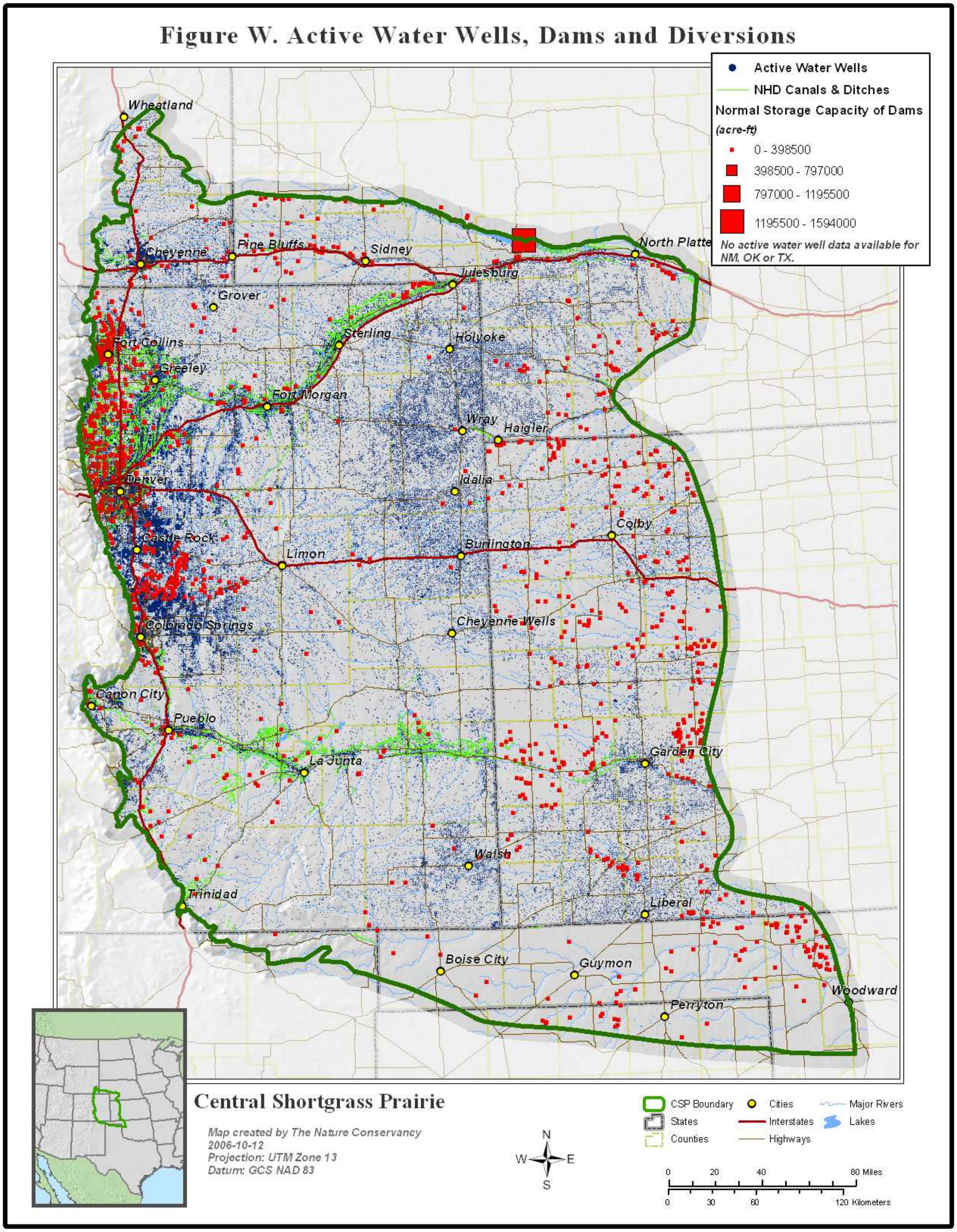


Figure W. Active Water Wells, Dams and Diversions
Active Water Wells
NHD Canals & Ditches
Normal Storage Capacity of Dams
(acre-ft)
0 - 398500
398500 - 797000
797000 - 1195500
1195500 - 1594000
No active water well data available for NM, OK or TX.
Wheatland
Cheyenne
Pine Bluffs
Sidney
North Platte
Julesburg
Grover
Sterling
Holyoke
Fort Collins
Greeley
Fort Morgan
Wray
Haigler
Denver
Idalia
Colby
Castle Rock
Limon
Burlington
Cheyenne Wells
Colorado Springs
Canon City
Pueblo
La Junta
Garden City
Walsh
Trinidad
Liberal
Boise City
Guymon
Woodward
Perryton
Central Shortgrass Prairie
Map created by The Nature Conservancy
2006-10-12
Projection: UTM Zone 13
Datum: GCS NAD 83
CSP Boundary
Cities
Major Rivers
States
Interstates
Lakes
Counties
Highways
80 Miles
120 Kilometers

E. Invasive Species/Diseases

Invasive species are plants or animals that have been introduced to areas where they are not found naturally, and can cause significant economic or environmental harm. Most invasive species are ecological opportunists, taking advantage of natural or unnatural disturbances to invade an area and dominate a community. Some natural disturbances, such as floods, erosion, prairie dog colonies, and drought, provide opportunities for invasive species.

Once invasive species are established, they might change species composition, alter ecosystem functions, and out-compete, hybridize with or prey on native species—seriously threatening native biodiversity. Approximately 49% of all imperiled species in the United States are threatened by extinction due, at least in part, to the influences of invasive species (Wilcove et al. 1998).

1. <u>Invasive Plants</u>

   Impacts of invasive plants on natural systems include altered fire regimes, nutrient cycling, and wildlife forage quality and grazing patterns (Stohlgren et al. 1999). Within the CSP, several important invasive plant species threaten the function of ecological systems and habitat of native species. These include tamarisk (*Tamarix pentandra*), knapweed (*Centaurea* spp.), leafy spurge (*Euphorbia esula*), and Chinese bush clover (*Sericea lespedeza)*. While many invasive species, such as Canada thistle (*Cirsium canadensis*), occupy extensive patches across the ecoregion, the impacts of these four species can be severe.

2. <u>Invasive Animals/Diseases</u>

   The highest extinction rates due to non-native species are found in aquatic ecosystems (Cohen and Carlton 1998). One of the most recent introductions into the streams of the CSP is the New Zealand mud snail (*Potamophyrgus antipodarum*). This small snail discovered in Boulder County, Colorado in 2004, aggressively impacts aquatic habitats by devouring algae that is a fundamental source of food for birds and fish. The snail's impact to aquatic ecosystems should be closely monitored (Richards 2003; McKinney 2005, USGS 2005). Other troublesome invasive animals include the bullfrog (*Rana catesbeiana*) and exotic fish species, which can impact the natural function of aquatic systems (Boydstun et al. 1995; Knopf and Samson 1997). Feral pigs (*Sus scrofa*), recently released into the area around Big Sandy Creek in east central Colorado, can have devastating effects on the prairie ecosystems if not checked. A few areas of the ecoregion are occupied by wild burros (C. Pague, personal communication).

   The spread of sylvatic plague (*Yersinia pestis*) transmitted by fleas is a major threat to the black-tailed prairie dog (Stapp et al. 2003). West Nile Virus, a viral disease transmitted by mosquitoes, also affects animal species in the region, particularly wild birds.

F. Climate Change

Over the past 100 years, temperatures in the northern and central Great Plains have risen more than 2° F (1° C), with increases up to 5.5° F (3° C) in some areas (Joyce et al. 2001). Annual precipitation has decreased during this period. Most climate scenarios project that temperatures will continue to rise throughout the region, and the largest increases will occur in the northern and western Great Plains. Precipitation is likely to decrease in some areas and increase in others; increasing temperatures also will cause evaporation to increase. More intense rainfall events also are expected. These changes likely will have profound consequences for biodiversity, changing life cycles of all species, and ecosystems of the Great Plains and around the world (Joyce et al. 2001). Scientific documentation indicates that climate change is shifting ranges of species and vegetation towards polar regions and up mountain slopes (Gonzalez et al. 2005). Spatial analyses indicate that vegetation could drastically change across half of the United States and Canada if global warming continues at current rates (Gonzalez et al. 2004). Analyses of major vegetation types expected to change between 1990 and 2100 indicate that the most widespread changes are expected to occur in boreal forests, montane grasslands, and temperate grassland habitat types. Arid lands are likely to increase within the temperate grasslands of the central United States (Gonzalez et al. 2004).

Of particular concern is the potential movement of invasive species across the region (Lodge 1993). Other effects include increased fire frequencies, insect/pest outbreaks, decreased water supplies, increased demands for irrigation water, diminished soil fertility and water-holding capacity, and increased intensity of rainfall events, which might increase flooding and soil erosion (Joyce et al. 2001). Changes in the timing and quantity of rainfall could exacerbate water allocation and use conflicts in the region, as well as water management practices (Joyce et al. 2001).

Research conducted in the northern part of the ecoregion indicates that increased minimum spring temperatures correlate with decreased production of blue grama grass (*Bouteloua gracilis*), and increased abundance of invasive and native cool season forbs, making the system potentially more vulnerable to invasion by non-native species, and less tolerant of drought and grazing (Alward et al. 1999).

XIV. MANAGED AREAS AND PROTECTED STATUS ASSESSMENT

A. Purpose

An important step in conservation planning is to determine what biological features currently are managed appropriately within existing conservation lands and waters (Groves 2003). Identifying areas of high biodiversity significance with low protection status can help practitioners prioritize conservation actions (Theobald 2003). Assessing the status of protected and managed areas enables managers to consider where best to focus conservation actions. A managed area assessment assists in answering the following questions:

1. What lands are conserved in perpetuity?
2. To what degree are the biodiversity and necessary ecological processes protected?
3. What lands have management plans?
4. How well have conservation goals and objectives been achieved?

The National GAP Analysis Program classifies lands according to their biodiversity management status (Scott and Jennings 1997; www.gap.uidaho.edu/handbook). The intent of this system is to indicate the level of management focused on biodiversity protection for a land unit. GAP status ranks are based on four criteria:

1. Permanence of protection from conversion of natural to unnatural land cover;
2. Relative amount of the land unit managed for natural cover;
3. Inclusiveness of the management (single species or whole-system focus); and
4. Degree to which management allows maintenance of natural processes.

B. Modifications to GAP Status Ranking

Because this ecoregion consists largely of privately-owned lands, the Core Team augmented the GAP Analysis Program framework for this project to help capture protection status for private lands, such as conservation easements, and less formal kinds of protection. Thus, the team augmented the GAP framework ranking scheme (GAPplus or GAP+) to consider lands not covered by the original GAP framework (See Appendix U for descriptions of GAP categories). The team compiled initial GIS spatial data sets (CBI 2006; Theobald et al. 2005) from each of the seven states with assigned status categories from the GAP Analysis Program. The team applied GAP+ rankings and compiled additional data sets, particularly for private lands.

C. Results

The proportion of the ecoregion and the network within each of the GAP+ rankings is found in Table 25. Protected/managed lands occur in many forms, as indicated in the GAP+ categories, and are spread across the ecoregion (see Appendix U for definitions and Figure X for results). The distribution of conservation lands is uneven, and most of the lands with conservation management occur in Colorado. Lands that are protected or managed for biodiversity in either GAP 1 or GAP 2a and 2b status comprise less than 2% of the ecoregion and network.
Table 25 shows a comparison of the percent of lands in the original GAP categories and the GAP+ categories. Here, one can see the value of the GAP+ classification including non-traditional land protection categories such as the State Land Board Stewardship Trust acres

(4a). Also, the GAP+ categorization illustrates the distinctions made in the GAP+ 4. For example, a larger proportion of private lands under protection (2a and 3a), and private lands in natural cover (4f) are found within the network than are found within the ecoregion as a whole. The results do not imply that lower protected lands under current practices are not managed for biodiversity, but simply that the majority of CSP land is not secure from future conversion to urban development or agriculture.

Table 25. GAP+ categories and definitions, the proportion of the ecoregion, and the network of conservation areas in GAP+ categories (see Appendix U for more detailed descriptions).

GAP+/Level of Protection	Ecoregion–Total			Network of Conservation Areas		
	Hectares	Acres	%	Hectares	Acres	%
1: Public and Private: permanent protection with main biodiversity focus (RNAs)	6,920	17,099	0.0	6,731	16,632	0.1
2a: Public lands in permanent protection, but some management may degrade (National Parks)	18,178	44,920	0.1	9,756	24,107	0.1
2b: Private lands in permanent protection, but some management may degrade (working lands with conservation easements)	6,376	15,754	0.0	4,123	10,188	0.0
3a: Public lands in permanent protection, but subject to extractive uses (National Forest lands)	788,308	1,947,951	3.5	608,189	1,502,869	6.3
3b: Private lands in permanent protection, but subject to extractive uses (conservation easements)	19,744	48,789	0.1	12,382	30,596	0.1
4a: No known mandates or legally recognized easements, some management protections (CO state stewardship trust lands)	69,781	172,432	0.3	59,970	148,189	0.6
4b: No known mandates or legally recognized easements (State Land Board holdings)	878,326	2,170,392	3.9	625,011	1,544,437	6.4
4f: No known mandates or legally recognized easements (most private lands with natural cover)	9,934,408	24,548,459	44.1	6,148,132	15,192,366	63.3
4g: No known mandates or legally recognized easements (private lands in cropland)	10,503,160	25,953,876	46.6	2,179,757	5,386,297	22.4
4h: No known mandates or legally recognized easements (private lands in urban and mining)	310,065	766,188	1.4	61,444	151,832	0.6

GAP+ 4c = private, short-term protection and 4d = private converted lands under restoration with short term protection, such as Conservation Reserve Program lands, did not have accurate maps available.

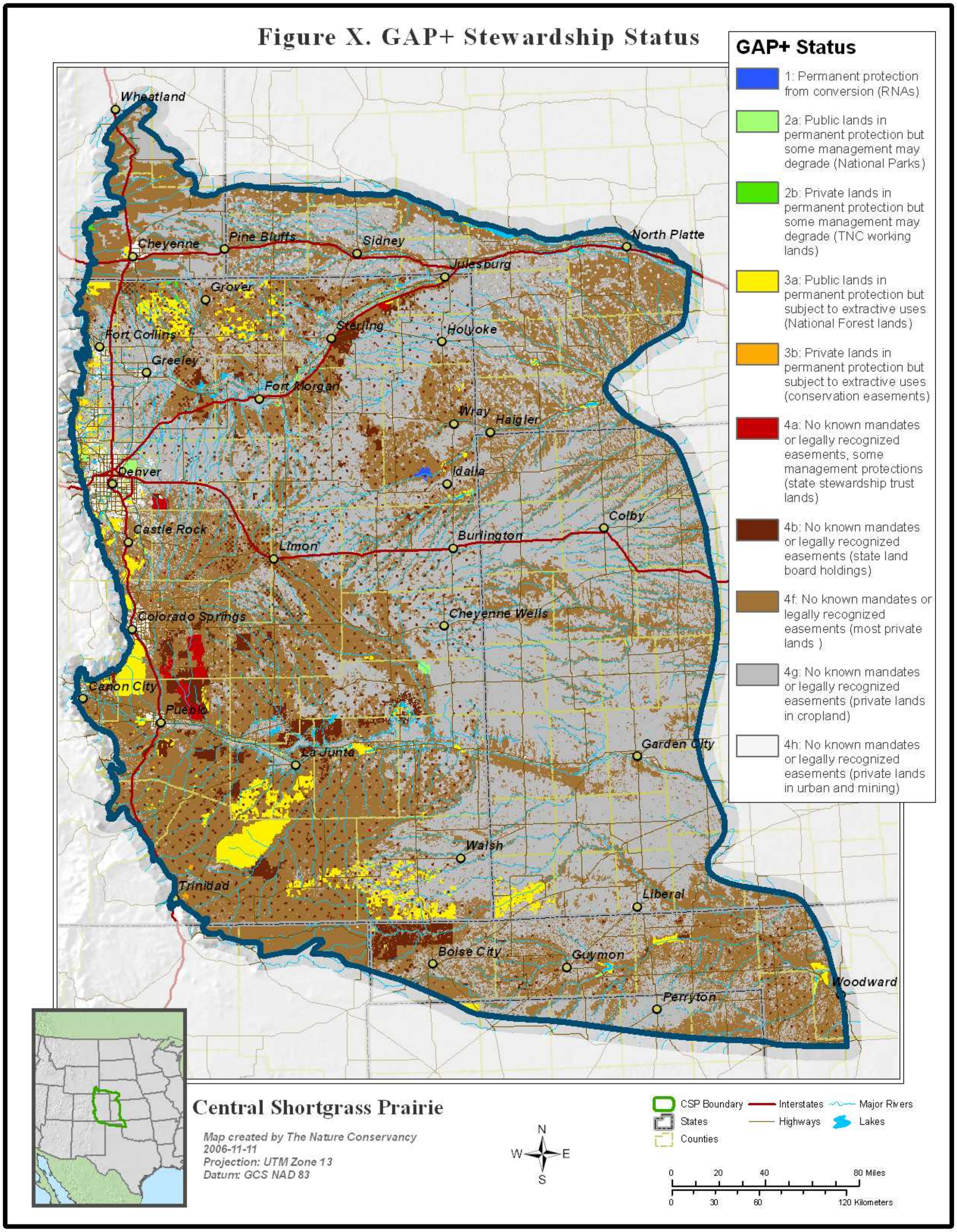


Figure X. GAP+ Stewardship Status
GAP+ Status
1: Permanent protection from conversion (RNAs)
2a: Public lands in permanent protection but some management may degrade (National Parks)
2b: Private lands in permanent protection but some management may degrade (TNC working lands)
3a: Public lands in permanent protection but subject to extractive uses (National Forest lands)
3b: Private lands in permanent protection but subject to extractive uses (conservation easements)
4a: No known mandates or legally recognized easements, some management protections (state stewardship trust lands)
4b: No known mandates or legally recognized easements (state land board holdings)
4f: No known mandates or legally recognized easements (most private lands)
4g: No known mandates or legally recognized easements (private lands in cropland)
4h: No known mandates or legally recognized easements (private lands in urban and mining)
Wheatland
Cheyenne
Pine Bluffs
Sidney
North Platte
Julesburg
Grover
Sterling
Holyoke
Fort Collins
Greeley
Fort Morgan
Wray
Haigler
Idalia
Denver
Colby
Castle Rock
Burlington
Limon
Cheyenne Wells
Colorado Springs
Canon City
Pueblo
La Junta
Garden City
Walsh
Trinidad
Liberal
Boise City
Guymon
Woodward
Perryton
Central Shortgrass Prairie
Map created by The Nature Conservancy
2006-11-11
Projection: UTM Zone 13
Datum: GCS NAD 83
N
W
E
S
CSP Boundary
States
Counties
Interstates
Highways
Major Rivers
Lakes
0
20
40
80 Miles
0
30
60
120 Kilometers

XV. MEASURES/MONITORING FRAMEWORK

A. Purpose

The Core Team developed and applied a preliminary framework to measure and monitor biodiversity health and threats for the ecoregion. The framework is based on guidelines developed by The Nature Conservancy (2005), and refined with feedback from the Core Team and Steering Group. This system will help practitioners refine goals, strategies, and actions through an understanding of the status, timeframe, and scale of action necessary to ensure conservation success.

Developing ecoregional measures helps address several key questions: *How is the ecoregion's biodiversity doing?* and *Are we conserving what we say we are?* This framework is designed to improve the ability to monitor conservation progress. Ecoregional measures serve as a "biodiversity barometer" to highlight how well biodiversity across the ecoregion is doing, the degree to which it is conserved, and whether we can project success in achieving established conservation goals in the CSP (Parrish et al. 2003, TNC of Colorado 2004, TNC 2005). The goal of ecoregional status measures is to develop a set of indicators and measures to establish baselines for understanding the status of biodiversity, to enable the partnership and other users to monitor conservation success over time, and to adapt strategies in response to measures information.

B. Measures

The Core Team selected the following key measures for the CSP ecoregion:

1. Status of Biodiversity;
2. Conservation Status;
3. Threats; and
4. Intactness/Integrity.

See Table 26 below for descriptions of the four key ecoregional measures.

Table 26. Descriptions of four key ecoregional measures.

Measure	What it Measures and Why
Status of Biodiversity	• *Progress towards goals* is the extent to which conservation goals are met in the assessment. Goals are established to estimate the numbers or areas needed to ensure long-term persistence of conservation targets. The goals are designed to be surrogates for viability of targets over the long-term. Progress toward goals is an indicator of *viability or integrity*.
Conservation Status	• *Protected and managed area status* refers to the amount and degree to which lands are legally protected and managed (GAP, GAP+, and/or IUCN systems) and/or in some form of long-term conservation (conservation easements, private reserves, etc.). Measuring the degree to which lands are protected from threats (e.g. oil and gas development) provides an index of conservation progress. • *Potential management effectiveness* indicates the intended management of protected and managed areas, and the degree to which managers can fulfill biodiversity conservation goals. Assesses degree to which conditions facilitate and enable long-term conservation.
Threats	• Threats assessments at the ecoregional scale are important as an *early warning system* for changes in biodiversity status. It is important to know the degree to which the biodiversity is threatened and over what time frame. • Threats are assessed at the target level (threats to targets: degree of threat to targets for both past and future timelines) and the ecoregional level (see below).
Intactness/ Integrity	• *Land use change* is an important factor that can alter the integrity of biodiversity at all scales. The pattern of land use and land cover is the basis for understanding fragmentation, ecological integrity, and needs for reserve or network design. • Land cover is the best indicator of ecoregional integrity (or degree of intactness) and along with roads, it is the best foundation to assess regional fragmentation. • *Past and predicted trends* in land cover help identify where and how fast change is occurring, and help redirect resources to abate threats.

C. Interpretation of Results—Measures of Success and Progress

The following section presents results from a preliminary analysis on key status measures for selected terrestrial systems, species, and where applicable, the ecoregion as a whole and the status of lands within and outside the network of conservation areas. Within the next year, the team will complete full-scale measures assessment of the status of biodiversity, managed and protected lands, and spatially-explicit threats in the ecoregion.

1. <u>Status of Biodiversity (Progress toward Goals):</u> Conservation goals for the CSP assessment were established to ensure adequate representation, and to provide for viability of a target within the ecoregion. Goals are also established to estimate the number of occurrences and/or appropriately sized areas needed to ensure the long-term persistence of these targets. Progress toward achieving these ecoregional goals is an indicator of *viability or integrity*.

   See Table 27 for a summary of the percent of target species meeting goal. For a summary by taxonomic group, refer to Table 14 in Section XII.

Table 27. Progress towards goals.

Conservation Target Group	Percent of Targets Meeting Goal	Biodiversity Status
Terrestrial Species	47%	Medium status
Aquatic Species	9%	Low status
Plant Communities	100%	Very high status
Terrestrial Ecological Systems	95%	Very high status
Aquatic Ecological Systems	53%	Medium status
Species Assemblages	100%	Very high status
Total	83%	Medium status

The results of the assessment on progress towards goals revealed wide variations in the degree to which conservation targets are known or incorporated in the conservation network. Occurrences of natural communities and areas of terrestrial ecological systems available for conservation are 100% and 95%, respectively. Similarly, an adequate number of known occurrences to achieve conservation goals exists for species assemblage targets (100%). This suggests a high degree of opportunity for conservation success relative to these targets.

In contrast, only 53% of the aquatic ecological systems show adequate integrity for potential conservation success. This suggests a high degree of degradation and lack of field assessment for these systems. Only 47% of the terrestrial species met conservation goals, although they are relatively well known compared to aquatic species. This is largely due to inadequately known occurrences, and suggests a need for additional inventory and/or a degree of rarity in the ecoregion that currently is not well understood.

Aquatic species targets revealed the lowest percentage of known occurrences to meet conservation goals. This suggests a lack of knowledge and a high degree of aquatic ecological systems degradation (validated by expert comments on ecoregional threats–see above). This conclusion is supported by CDOW assessments of fish distributions in the Platte and Arkansas rivers (Nesler et al. 1999; Nesler et al. 1997) where large range losses have occurred for many species over the past 100 years.

2. <u>Conservation Status–Protected and Managed Area Status and Management Effectiveness</u>

   a. *Protected and Managed Area Status:* This measure assesses the degree to which land with conservation interest is legally protected and managed, i.e., there is a high degree of confidence in the degree and tenure of that protection. Measuring the degree to which lands are protected from such threats as land conversion, or oil and gas development provides an index of conservation progress. The team used both the GAP and GAP+ classification systems for this measure to identify the relative degree of protection and intended management for biodiversity. For discussion on the two classification systems, please refer to the previous section on Managed Areas and Protected Status Assessment.

The International Union for the Conservation of Nature and Natural Resources (IUCN) has similar but more categories ranging from strict nature reserves to managed resource protected areas (World Conservation Union 1994). Many international organizations and countries outside of the U.S. are using IUCN categories to evaluate the degree to which biodiversity is protected. Although the IUCN system is important for making global comparisons of protection status across ecoregions, the team chose not to use the IUCN classification system for two reasons: 1) IUCN does an inadequate job of capturing protected status for several of the most common conservation tools used in the U.S., in particular, conservation easements, management agreements, and private conservation management tools; and 2) an adequate crosswalk of IUCN categories is not currently available that corresponds with GAP categories.

Protected/managed lands take many forms, as indicated in the GAP+ categories (Tables 25 and 28 and Appendix U), and are spread across the ecoregion (Figure X). The distribution of conservation lands is uneven, and most of the lands with conservation management occur in Colorado. The lands that are considered protected or managed for biodiversity in either GAP 1 or GAP 2 status comprise less than 2% of the ecoregion and network.

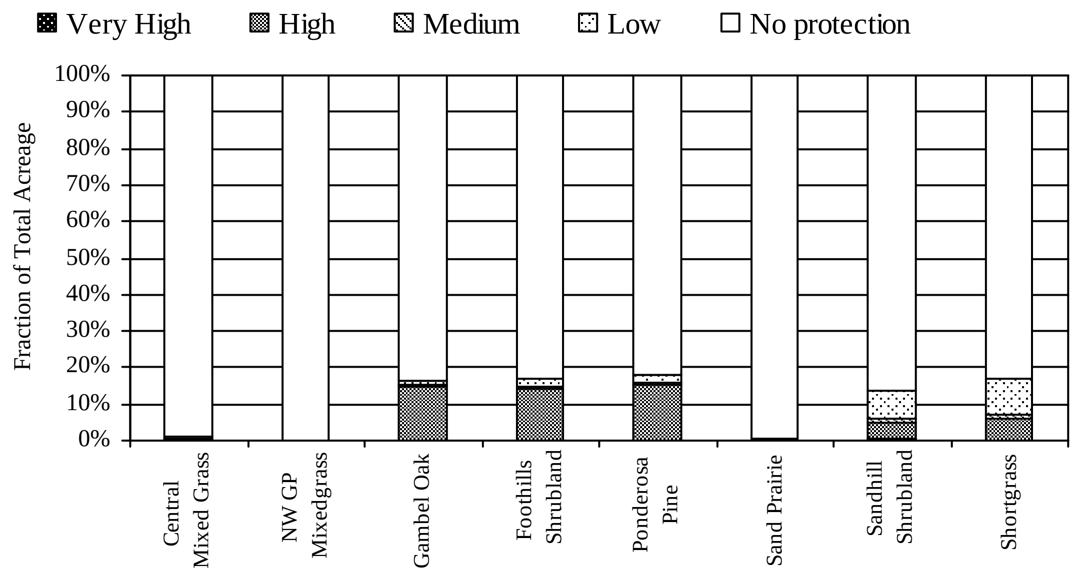
Table 28 shows a comparison of the percent of lands in the original GAP categories and the GAP+ categories. Here, one can get a clearer view of the contributions of non-traditional land protection categories, such as the State Land Board Stewardship Trust acres (4a), which account for 1% of the lands within the network. Also, the GAP+ categorization allowed the team to see that a higher percentage of private lands under natural cover occur within the network compared to lands outside of the network (4f).

Table 28. Percentage of land in original GAP and modified GAP+ categories. The percentage of land within and outside the network of conservation areas is also shown. See Appendix U for definitions of GAP+.

Original GAP Status	Percent of Ecoregion	Percent of Network	Percent Outside the Network	GAP + Status	Percent of Ecoregion	Percent of Network	Percent Outside the Network
1 Permanent protection from conversion	< 1%	< 1%	< 1%	1	< 1%	< 1%	< 1%
2 Permanent protection but some management practices that degrade	<1%	< 1%	< 1%	2a	< 1%	< 1%	< 1%
				2b	< 1%	0	0
3 Permanent protection but subject to extractive uses	6%	6%	1%	3a	4%	6%	1%
				3b	< 1%	< 1%	< 1%
4 No known mandates or legally recognized easements or deed restrictions	92%	92%	99%	4a	< 1%	1%	< 1%
				4b	4%	1%	< 1%
				4f	44%	63%	30%
				4g	47%	22%	65%
				4h	1%	1%	2%

Figure 3 below illustrates the low level of protection of key ecological systems. The team considered only those acres in very high and high protected status to be adequately protected for the purposes of this analysis. The Rocky Mountain foothills types (i.e., Gambel oak, foothills shrublands, and ponderosa pine) have a higher amount of land in adequately protected or managed status, largely because these ecological systems are located primarily where public lands and local government conservation lands exist. In contrast, little or no land with mixed-grass prairie and sand prairie falls into the high or very high protected status category. The team does not consider any ecological system type in the CSP to be adequately protected or managed for biodiversity.

Figure 3. Protected status (GAP+) of the lands covered by selected ecological systems in the Central Shortgrass Prairie Ecoregion. Very high=GAP 1, High=GAP 2-3, and 4a, Medium=GAP+ 4b, c, e, and f) and Low=GAP 4 d, g, and h).



b. *Potential Management Effectiveness:* This measure indicates the degree to which lands and associated species and systems are conserved. It assesses the degree to which the controlling or managing entities are able to implement practices that would fulfill the conservation work intended by their management category. The framework of each GAP+ category assesses the following six elements necessary to achieve effective management of biodiversity:

- Legal status;
- Planning;
- Resources;
- Monitoring;
- Utilization of resources; and
- Implementation of critical management activities.

To assess potential management effectiveness for biodiversity, the team used an assumption-based assessment. Thus, interpretation of management effectiveness will be restricted to assessing the potential for effective management. A description of each element and justification for decisions on the assumed status of potential management effectiveness for biodiversity is shown below:

i. **Legal Status** is based on three indicators: a) permanency of protection; b) disputes regarding land tenure and use rights; and c) the compatibility of biodiversity with other management objectives. Based on this definition, lands permanently protected were given either a high or very high rating (very high when legal status was specific to biodiversity–Gap 1). A high/moderate rating was given to long-term, though not permanent, protection (e.g., SLB stewardship trust lands). Public lands with no permanent protection were rated as moderate, and private lands with no permanent legal protection were rated as low.

ii. **Planning** is based on three indicators: a) planning process is adequate and timely; b) inventory is adequate; and c) stakeholder participation is adequate. Based on this definition, no lands were assumed to be in the very high category. Lands with management plans such as GAP 1, 2 and 4a were ranked as high. Lands without management plans, but under natural cover, were ranked as moderate. Converted and degraded lands were ranked as low.

iii. **Resources** are based on three indicators: a) human resources; b) funding; and c) infrastructure and equipment. Based on this high standard, no lands were given a very high rating. Lands with biodiversity focus (GAP 1 and 2), and some public multi-use lands (GAP 3a, 4a) were ranked high based on certainty of some level of funding and staffing. Lands that are private, natural functioning lands (3b, 4b, and 4c) were ranked as moderate—these lands have some money and resources for conservation activities. All other lands were ranked low.

iv. **Monitoring** is based on three indicators: a) research needs being identified and addressed; b) major biodiversity and threats identified, and trend-data collected; and c) monitoring incorporated into management. Based on this definition and the apparent monitoring deficiencies that exist in most public and private organizations, the highest rank assigned to any lands was moderate (GAP 1, 2, 3, and 4a). All other lands were ranked low.

v. **Compatible utilization of resources** is based on three indicators: a) recreation and visitor use consistent with biodiversity objectives; b) harvesting consistent with biodiversity objectives; and c) land-use zones adequate to protect biodiversity. Based on this definition, lands in GAP 1 were ranked very high. Because GAP 2 and 4a lands possess other resource values, such as recreation, that are as high a priority as conservation, these lands were ranked as high. GAP 3 and 4b, 4c, and 4d lands have a greater utilization of resources and were ranked high/moderate. GAP 4d and 4f were ranked moderate because these lands either are not natural, and/or have intensive uses that are incompatible with the conservation of many species. GAP 4g and 4h were ranked low.

vi. **Implementation of critical management activities** is based on three indicators: a) law enforcement is adequate; b) threat detection, prevention, and mitigation are adequate; and c) critical conservation activities are adequate. Based on this definition, no lands were ranked as very high. Lands managed for natural values and biodiversity (GAP 1 and 2) were ranked high. Lands with more multiple use activities (GAP 3, 4a, 4b, 4c, and 4d) were ranked high/moderate. Private lands with unknown or degraded condition were ranked moderate. Converted lands were ranked low.

Measuring changes in the total area of land that accomplishes conservation is assumed to be an indication of management effectiveness and conservation progress for the ecoregion. For example, an increase in the area that has dedicated planning processes and resources for conservation lands is a positive change for biodiversity.

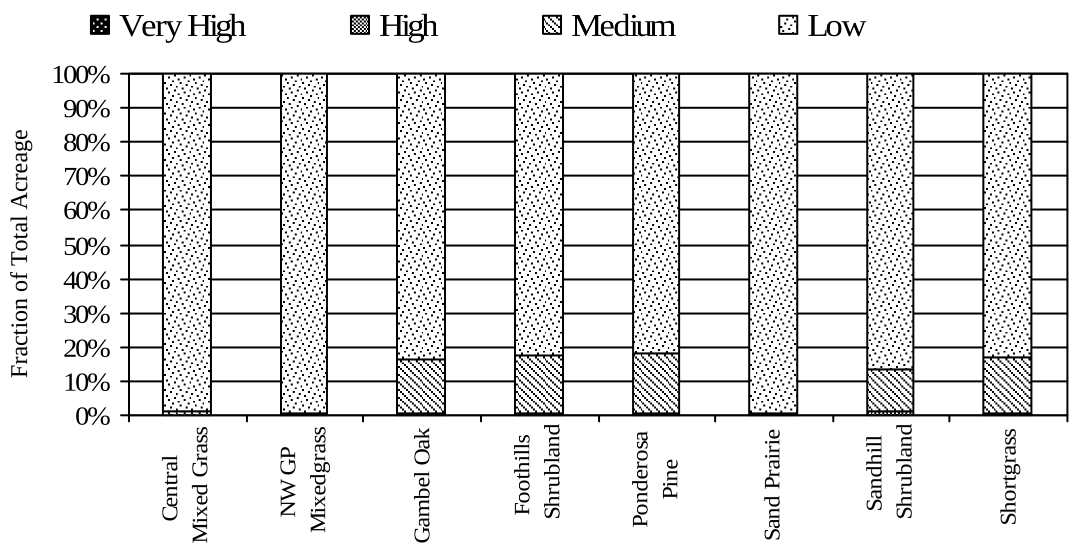
Conservation lands in the CSP ranked low for potential management effectiveness for biodiversity (see Table 29). This highlights the importance, and the inadequacy, of setting aside lands for conservation purposes. Such lands are expected to be managed effectively, and this measure shows that much work needs to be done in this area. Only those lands ranked as very high or high are considered adequately protected, and approximately 6% of CSP conservation areas are categorized as high or very high for potential management effectiveness for biodiversity. Although this does not necessarily imply that large portions of the ecoregion are poorly managed, the measure does indicate that many of the key elements known to support conservation of biodiversity are missing from the practices in this ecoregion.

Table 29. Levels of potential management effectiveness for biodiversity and percentage of lands in each category within and outside the network of conservation areas.

Management Effectiveness Category	Percentage in the Ecoregion	Inside the Network of Conservation Areas	Outside the Network of Conservation Areas
Very High/High	< 1%	< 1%	< 1%
High	< 1%	< 1%	< 1%
High/Moderate	4%	6%	2%
Moderate	4%	6%	2%
Moderate/low	44%	66%	30%
Low	48%	23%	67%

When examining the degree of potential management effectiveness of key ecological system types, the team found that no more than 2% of the total area of any ecological system occurred on lands considered as highly or very highly enabled for conservation (see Figure 4 below). This implies that essentially no formal process or dedicated resources for the protection of biological diversity occurs for any ecological system. The Rocky Mountain foothills system types—Gambel oak, foothills shrublands, and ponderosa pine—have a relatively higher amount of land with some level of potential management effectiveness. This is likely due to the fact that they occur on lands that already are protected.

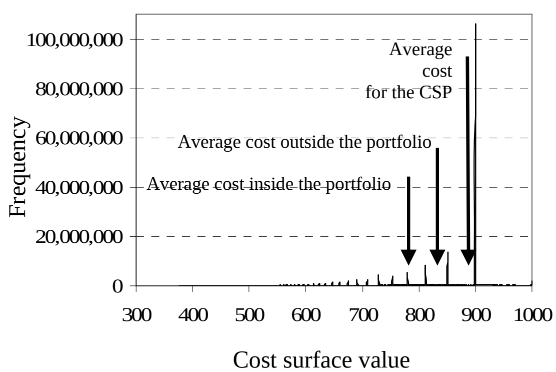
Figure 4. The degree of potential management effectiveness of lands occupied by key ecological systems in the CSP.

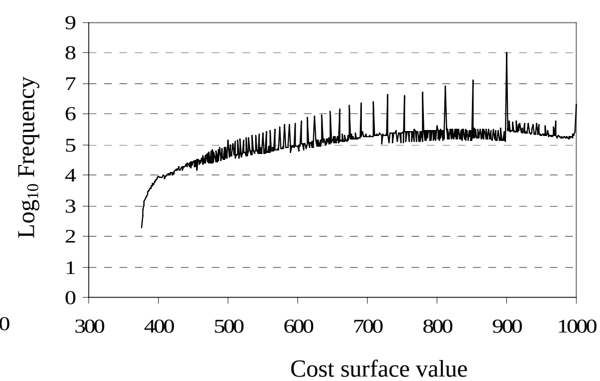


3. Threat Status: Threats assessments at the ecoregional scale are important as an *early warning system* for changes in biodiversity status. The goal of the threat-status measure is to provide baselines for tracking changes and trends in individual threats and, through the use of the landscape integrity (cost surface) analysis (see Appendix L, Figure M), the cumulative threat impacts to the ecoregion's natural values. Because a goal of conservation is to abate the impacts of threats to species and ecological systems, measuring changes in the level of threats to conservation targets also is an indicator of conservation progress. In this report, the team assessed threats at the ecoregional and target levels.

   The assessed threats for the ecoregion are not evenly distributed (see Figure M). Several factors contributed to the skewed distribution. First, many threats were heavily weighted in the calculation of the cost surface. Second, one specific highly-weighted threat, agricultural development, was widespread across the ecoregion. Finally, to capture the widespread agricultural impact more clearly, the team developed the cost surface by choosing the maximum threat value in any cell, rather than calculating the cumulative threat values that overlap in any one area. Consequently, frequency values in the cost surface are highly skewed toward high values (see Figure 5 below). A logarithmic transformation of this frequency distribution more readily illustrates that low-threat values are rare in this ecoregion, and high-threat values are extremely common. This approach may make it difficult to discern differences in average threat status between groups, to detect change over time, and to find occurrences with sufficiently low-threat values to be considered relatively unthreatened. In contrast, the distribution of threats shows that the ecoregion is broadly impacted by the pattern of land uses, including croplands, development patterns, energy infrastructure, and roads.

   Figure 5. Frequency of overall threat values for the ecoregion (left), and Log_{10} frequency of overall threat values for the ecoregion (right).





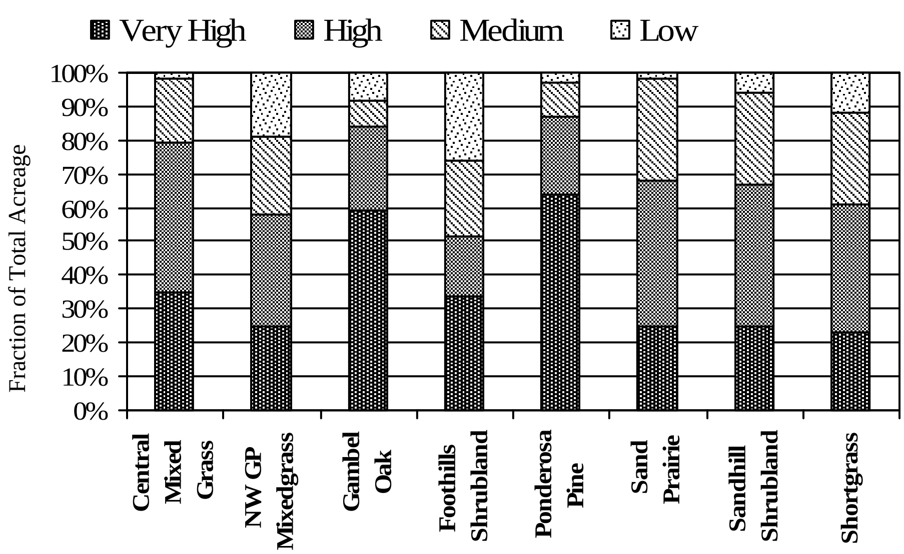
   The average cost value for the entire ecoregion was 832. The average cost for the area included in the network of terrestrial conservation areas was 778. In contrast, the average cost or threat level for the ecoregional area outside of the network was 873 (see Table 30). These numbers provide a baseline for measuring change and progress in the ecoregion as conservation action is taken. While there is hope that ecoregional threats would diminish everywhere, successful implementation of this plan should help maintain, eliminate, or reduce the degree or rate of change of threats in the network of conservation areas.

Table 30. Distribution of overall threat value for the ecoregion, outside and within the network of conservation areas.

Cost Surface Values	Within the Ecoregion	Outside the Network of Conservation Areas	Within the Network of Conservation Areas
Minimum	376	376	378
Maximum	1,000	1,000	1,000
Mean	832	873	778
Median	900	900	800

Some key ecological systems of the CSP are found in areas considered highly or very highly threatened across the ecoregion (Figure 6). The highest degree of threats was observed in the Gambel oak and ponderosa pine ecological systems (>80% of the ecological system is highly threatened). The lowest levels of threat were in Northwestern Great Plains Mixed Grass and Foothills Shrublands (>40% have low to medium levels of threat). In summary, while adequate remaining patches exist on which to implement conservation goals, a relatively high degree of threat to landscape integrity of key ecological systems remains.

Figure 6. Measuring threats to key ecological systems in the Central Shortgrass Prairie Ecoregion.



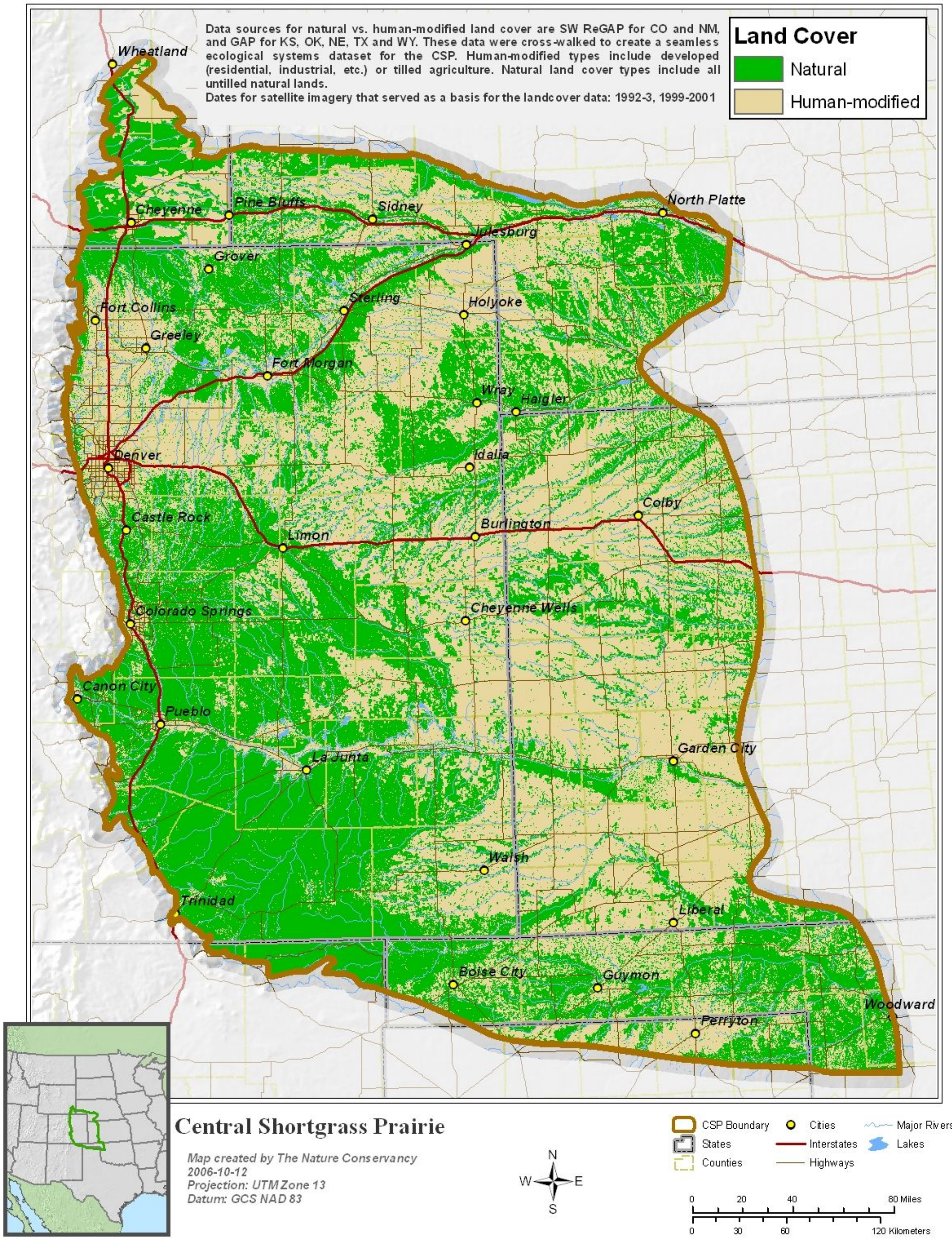
4. Intactness/Integrity: The integrity of an ecoregion or its network of conservation areas is a measure of conservation status and opportunity. The more intact an ecoregion, the more alternative choices and opportunities for conservation success. As such, the pattern of land use change is a basis for understanding progress and status of fragmentation and conservation success. Land cover is an indicator of ecoregional integrity (or degree of intactness). Trends in land cover change will help identify where and how fast changes are occurring, and will help redirect resources to specific areas in order to abate threats.

   Ecoregional intactness was estimated by converting land-cover data, e.g., terrestrial ecological systems data layer from Southwest Regional Gap Analysis Project for NM and CO (1999-2001) and Gap Analysis Project (1992-1998) for other states, into natural vs. human-modified cover. Ecological systems were assigned to one of two classes: human-modified is defined as developed (residential, industrial, etc.) land or tilled agriculture; natural is defined as not tilled (but could be degraded). For example, GAP categories such as Western Great Plains Shortgrass Prairie and Western Great Plains Sandhill Shrubland were classified as natural. Alternatively, GAP categories of agriculture, developed, disturbed, invasive (e.g., woody species only such as tamarisk), and open water were classified as human-modified. This classification did not factor in all forms of land use and some areas invaded by herbaceous invasive species could not be distinguished using satellite imagery. The resulting pattern reveals the amount of native lands remaining, and the degree to which those lands are fragmented or intact (see Figure Y).

   Fifty percent (27.9 million acres) of the CSP area is in natural cover. Highly tillable lands largely have been converted to agriculture, depending to some degree on the availability of water. Lands in and near the northern Colorado Front Range are converted from native cover or agricultural lands to urban areas. Highly-dissected lands (such as canyonlands, bluffs, and sandhills) often remain largely intact, as do the driest areas of the ecoregion (e.g., the shortgrass prairie around the Pawnee National Grassland, and areas south of the Arkansas River). Many small patches of native cover remain throughout the CSP; however, many of those patches do not meet desired size criteria for this assessment. The largest blocks of natural cover occur in the high plains around Cheyenne, Wyoming, and south into northern Colorado, areas east of Colorado Springs, expansive areas south of the Arkansas River in Colorado, the panhandle of Oklahoma, and the dissected lands in the upper Republican River drainage in Nebraska and Kansas (TNC of Colorado 2005).

   The natural/human-modified land cover map (Figure Y) is a baseline for use in measures at the regional scale. The team will compare this baseline to estimate the loss or gain in natural/human modified cover over time (as new land cover/use data layers become available). This measure estimates the degree of conversion in the ecoregion. The integrity analysis using the cost-surface layer offers a finer level of assessment, and is more appropriately used in the evaluation of individual landscapes.

Figure Y. Natural vs. Human-modified Land Cover



D. Conclusion

1. Status of Biodiversity: The team assessed biodiversity on the CSP as very high to low. Plant communities, terrestrial ecological systems, and species assemblages are relatively well known, and occur in adequate numbers, sizes, and condition to conserve. Other target groups, such as rare, imperiled, and focal species, and aquatic ecological systems, are less well known or available for conservation (~ 50% of goals). Aquatic species targets are notably poor in the numbers of occurrences available for conservation. These conclusions illustrate the need for more inventory and/or restoration needs.

2. Conservation Status: The lands, waters, and species that inhabit CSP lands are poorly conserved. This does not imply, however, that the native lands are in poor ecological condition, only that few lands (< 2%) are designated as protected. Approximately 6% is protected from land conversion and managed for multiple uses (e.g., USFS Grasslands). As such, the potential management effectiveness for biodiversity also is poor for the entire ecoregion. Specifically, less than 8% of the conservation areas identified in this assessment have conditions that are adequate enough to achieve conservation goals.

3. Threats: The CSP is moderately to highly threatened, as indicated from the distribution and intensity of individual threats. This conclusion is reflected in the threat assessment for large-scale ecological systems in which high or very high threat values occurred over more than 50% of all systems in the ecoregion.

4. Intactness/Integrity: Integrity in the CSP is at a moderate-high level. Although approximately 50% of the ecoregion remains in natural cover, much of it is fragmented and in fairly small patches. In addition, the distribution of large patches is uneven, and the largest, most intact landscapes occur in the southwestern parts of the ecoregion.

5. Future Work: These ecoregional measures are a starting point for an expanding discussion on the fundamental questions surrounding the issue of how we measure the success of conservation action on the ground. This work will continue into 2007, as the Shortgrass Prairie Partnership continues working to refine these measures in an effort to better reflect changing conditions within the ecoregion. Some future steps include: 1) create occurrences for terrestrial systems, and apply measures with a finer level of detail; 2) create specific measures that address particular agency/partner goals and mandates; 3) devise a means to summarize the effectively conserved status for the ecoregion; and 4) reassess the ecoregional status measures every five years. Because some variables do not change as rapidly as others, devise a schedule that appropriately responds to changes.

XVI. SPECIES MANAGEMENT GUIDANCE TEMPLATES

The purpose of the Species Management Guidance Templates is to serve as a tool that leads to more coordinated and efficient land management for species-at-risk at a regional landscape scale, and involving multiple partners and jurisdictions. The templates are designed to allow for the identification of specific places and actions that encourage willing collaborators to work together to conserve these species in the long-term. The templates were developed with the following criteria in mind:

1. Applicability for guiding management to achieve proactive conservation;
2. Availability of sufficient information (recovery plans, Colorado Division of Wildlife grassland plan, US Forest Service species assessments, CNHP data, etc.);
3. Ability to meet multiple agency goals (partner interests and needs); and
4. Relevance to Fort Carson and/or the Piñon Canyon Maneuver Site.

Management guidelines include:

1. Research information on the species' natural history, distribution, and ecological integrity;
2. Threats and broad goals related to CSP assessment, strategies, partners, land ownership, and management status; and
3. Conservation strategies and associated implementation steps at regional landscape scales.

Priority species and/or species groups selected for development of management guidelines included:

- Rare plants of the Arkansas Valley barrens (see Appendix W for full template); and
- Black-tailed prairie dog animal community (see Appendix X for full template).

A. Rare Plants of the Arkansas Valley Barrens

A Management Guidance Template was prepared to: 1) provide a summary of basic biological information for a suite of rare plants largely occurring within the Arkansas Valley conservation area; and 2) facilitate regional management and conservation. The template is not focused on fine-scale, site-specific management, or the details of species biology, which are well documented in other sources. Rather, the focus is on identifying places and actions that can address the greatest conservation issues facing this suite of rare plants. This template is intended to be a working document that will advance discussions and information collection, and initiate on-the-ground conservation actions.

This template is intended to help conserve a suite of rare plant species occurring in southeastern Colorado by utilizing established partnerships between federal, state, and private entities to work cooperatively on conservation issues. Numerous partner mandates, missions, and goals can be advanced through implementation of relatively few conservation actions. With appropriate planning and actions, partners will contribute significantly to long-term conservation of these vulnerable species, reduce future regulatory and management burdens, and maintain a part of the natural heritage of Colorado and the ecoregion.

The Arkansas Valley barrens are part of the Arkansas Valley Conservation Area. The chalk layer geology that provides habitat for several of the rarest plants is a distinguishing feature of the site. The chalk layer is extremely limited in extent, both geographically and with respect to its relatively shallow depth. It is principally exposed in the Pueblo-Cañon City area; minor patches also occur along the Arkansas River in southeastern Colorado, and southeast along the Arkansas River tributaries and into Las Animas County. The rare plants addressed in this Management Guidance Template include the following:

1. Round-leaf four-o'clock (*Mirabilis rotundifolia*);
2. Golden blazing star (*Mentzelia chrysantha*);
3. Pueblo goldenweed (*Oönopsis puebloensis*);
4. Arkansas Valley evening primrose (*Oenothera harringtonii*); and
5. Arkansas River feverfew (*Parthenium tetraneuris).*

Through the development of this template and interactions of the CSP Steering Group, preliminary discussions have been initiated with key stakeholders and partners responsible for the management of these species and their habitats. These discussions will continue with the purpose of assessing each stakeholder's potential contribution to the conservation of these threatened species. Details of conservation actions will depend on specific analysis, mapping at the site/property level, and the ability of each entity or agency to contribute under the constraints of their mandates, mission, and capacity. Key actions will focus on the following:

1. Meet with current stakeholders to present the results of this template and discuss potential collaborative conservation efforts;
2. Assess current conservation efforts in the context of population goals identified as part of the larger CSP assessment;
3. Pursue formal management and/or conservation agreements to achieve goals; and
4. Document and report progress to stakeholders and appropriate USFWS offices.

B. Black-tailed Prairie Dog Animal Community

The prairie dog animal community Management Guidance Template provides direction for developing future management and conservation goals, identifying significant partners and opportunities to consolidate resources, and setting the stage for on-the-ground implementation among willing collaborators. The information in this template will be applicable to multiple land-management agencies and conservation partners, and may provide a basis for interagency cooperation that contributes to mutual conservation goals.

For the purposes of this assessment, the prairie dog animal community is defined as any active black-tailed prairie dog colony (synonymous with "town") or complex that supports one or more associated species. For the purposes of this template, the team included the following associated species:

1. Burrowing owl (*Athene cunicularia*);
2. Mountain plover (*Charadrius montanus*);
3. Ferruginous hawk (*Buteo regalis*); and
4. Swift fox (*Vulpes velox*).

The template does not directly address the black-footed ferret (*Mustela nigripes*) because no known extant populations of this species remain within the CSP. However, this species is accommodated in the template indirectly, via use of established requirements for black-footed ferret reintroductions to define specific parameters for characterizing prairie dog complexes.

The highest priority areas for conservation of the prairie dog animal community within the ecoregion occur in the Arkansas River drainage of southeastern Colorado. The largest, most well-connected prairie dog complexes, as well as the largest individual prairie dog colonies and some of the highest densities of mountain plover, occur in this area. This distribution is closely aligned with the largest native prairie grasslands remaining in the CSP. Public landowners with the most significant high-priority conservation areas containing prairie dog communities include the Colorado State Land Board, Department of Defense, Comanche and Cimarron National Grasslands, and Pawnee National Grassland.

The most significant threats to the prairie dog animal community are habitat loss, sylvatic plague, chemical control programs, and recreational shooting. Conservation of the prairie dog animal community is a complex endeavor that must address an intricate web of issues, including species viability, private property issues, agricultural production, economics, and deeply rooted cultural values. Success requires a wide range of strategies applied over multiple scales in both space and time. Areas experiencing human population growth will require a different set of conservation strategies than more remote areas, where primary land uses are related to agricultural production. Strategies should be revised in the future, as geographic patterns of impact shift. A full suite of conservation strategies will address the organization of collaborative efforts, land protection, land management, research, and information dissemination. No single set of strategies is sufficient in and of itself, but rather, each will be used in coordination with the others to achieve lasting success.

XVII. CONSERVATION STRATEGIES AND OPPORTUNITIES

During the past two years, a number of public and private institutions and individuals have worked to create a shared vision for terrestrial and aquatic conservation priorities for the 56 million acre CSP ecoregion.

The Steering Group has transitioned into a strategy implementation “Shortgrass Prairie Partnership” (the name has changed from “Steering Group” to “Partnership”). During the coming months, the Partnership, with help from the Core Team, will focus on strategy development and implementation. The group will identify additional institutions and individuals to include in this effort—groups that have not been directly engaged during the past two years, but who are critical for conservation success in the ecoregion. The Partnership wants to engage these entities to gain additional understanding of the context and need for conservation in the ecoregion, and to determine how all can work together to achieve optimal use of resources.

The Partnership will sign a memorandum of understanding to serve as an umbrella to frame the work at project and policy levels in the coming years in order to implement the conservation vision they developed. The Partnership will develop a strategic plan to identify methods for the group and others to make the most progress towards achieving ecoregional conservation objectives. The plan will include a communications and outreach strategy that will help inform elected officials, landowners, and the public about Partnership efforts and cooperative conservation benefits and opportunities.

A. Working with Private Landowners—an Essential Strategy for Success

More than 51 million acres (92%) of the CSP ecoregion is privately owned and managed. Long-term conservation success is inextricably tied to continued good management of the native prairies and streams of the western Great Plains by private landowners and water-rights holders. Conserving the biological resources of the CSP depends on sustaining the agricultural industry of the ecoregion, and requires working with farm organizations and ranching associations throughout the ecoregion. The Shortgrass Prairie Partnership will work with a wide variety of individuals and organizations on a voluntary basis to accomplish shared goals. The Partnership will only engage in activities based on mutual benefit, trust, and respect for the rights of private property ownership. The Partnership will only pursue projects with willing landowners and water-right holders.

Many members of the Partnership have been working with ranchers across the ecoregion for decades to conserve the extraordinary wildlife and natural diversity of the region, while promoting the economic and cultural sustainability of ranching. The Partnership recognizes that its work is bound to future productive activities, particularly ranching, and that the largest and most intact grassland systems are many times those of native prairies managed for cattle production. Combining the knowledge and commitment of the ranching community with land protection tools, scientific expertise, and philanthropic support will create a legacy of grassland conservation that benefits all. Beginning rancher programs exist in many areas in the West present opportunities for young, up-and-coming ranching families to have the opportunity to buy and/or lease ranches, often with low-cost financing and loan guarantees.

These programs should be applied more widely and expand to directly focus training on biodiversity management and benefits.

B. Successful Collaboration and the Department of Defense

This project was supported by the DoD Legacy Program and the CDOW. The DoD actively seeks information to better manage its lands, and the plants and animals that inhabit them. The Partnership is focused on helping the military and others manage their lands for outcomes that benefit conservation. Members of the Partnership have been working with private landowners to place voluntary conservation easements on biologically important lands in the vicinity of Fort Carson, between Pueblo and Colorado Springs. The result is a win-win-win situation—the easements restrict development that can encroach on military training, allow ranchers to realize the value of their development rights while keeping the land in cattle production, and protect important wildlife habitat. In short, the Partnership is working with the DoD and others to preserve the benefits of working ranchlands that support ecologically sustainable land uses, which is a key component of the economy throughout most of the ecoregion.

C. Involving Stakeholders

For this conservation approach to be successful, several stakeholders must play key roles. Most importantly, the Partnership must work with the ranching community and other key landowners and managers. Key stakeholders include, but are not limited to:

- The ranching community, grazing advocacy organizations, Farmer's Union, Farm Bureau, and Colorado Association of Conservation Districts;
- Federal agencies and related entities, including the Natural Resource Conservation Service, Farm Service Agency, land and water conservation districts, watershed associations, Department of Defense, Department of Transportation, US Fish and Wildlife Service, Bureau of Land Management, USDA Forest Service, Bureau of Reclamation, National Park Service, US Army Corps of Engineers;
- Water managers, including conservancy districts, municipal utilities, ditch companies, groundwater management districts, and private water-rights holders;
- State land boards, departments of transportation, wildlife, and agriculture;
- Birders, hunters, local watershed conservation groups, eco-tourists, and recreationists;
- County weed and pest control agencies;
- State and local land trusts; and
- Decision-makers/program administrators/elected officials.

D. Conservation Strategies for the Central Shortgrass Prairie

Several priority strategies will help the Partnership achieve its ambitious grassland conservation goals. The strategies boil down to four basic elements: 1) creating a network of effectively conserved working landscapes; 2) addressing policies and public programs, particularly those in the Farm Bill, that contribute to both the conservation and degradation of native grasslands; 3) helping to sustain ranching as a viable economic activity such that the ecological, social, and economic objectives of conservation and ranching can be achieved over the long term; and 4) raising unprecedented public and private resources to tackle the first three. Specific elements of these strategies are:

1. Purchase and donations of conservation easements. Voluntary land conservation agreements are ideal for privately held lands, as they perpetually protect land while compensating private landowners. Programs that fund conservation easements in ranching landscapes such as the CSP include the Natural Resource Conservation Service (NRCS) Farm and Ranchland Protection Program (FRPP), Grassland Reserve Program (GRP), and Wetlands Reserve Program (WRP). State programs, such as the Colorado Species Conservation Partnership, and the Wyoming Wildlife and Natural Resource Trust also provide funding for conservation easements to protect wildlife habitat. In Colorado, donations of conservation easements are eligible for up to $375,000 in tax credits—an immensely important program that has helped promote the conservation of hundreds of thousands of acres for conservation, and has been used by the Colorado Cattlemen's Agricultural Land Trust, the Legacy Land Trust, and Colorado Open Lands, among others. The National Fish and Wildlife Foundation occasionally funds easements, especially if they are used to support historic ranching families. In addition, local, state and national land trusts are engaged in efforts in all states within the ecoregion to raise funds and work with private landowners to develop conservation easements.

2. Pursue restoration and management agreements with private landowners. Because private landowners might not wish to forego rights by entering into a conservation easement, it is important to promote restoration and management activities across the landscape. NRCS has numerous programs that support restoration and management activities, and benefit wildlife and ecological processes. These programs include Wildlife Habitat Incentives Program (WHIP) and Environmental Quality Incentives Program (EQIP), both of which provide cost-share to landowners to partially cover the cost of land-management changes and habitat improvement projects. The Conservation Reserve Program (CRP), a US Farm Service Agency program, also can be utilized to protect habitat, especially with the special-enrollment programs for riparian areas and playa lakes. It will be critical for the conservation community to provide technical assistance to landowners, and help generate matching dollars to most effectively use these programs. The US Fish and Wildlife Service's Partners for Fish and Wildlife (PFW) is another program that provides funding and technical support to private landowners for restoration and management activities. State game and fish agencies, such as the Colorado Division of Wildlife Wetlands Initiative, also provide funding for certain restoration activities on private land.

3. Address the US Farm Bill incentives programs to reverse agricultural policies that subsidize the conversion of native grasslands to tilled agriculture, increase resources for conservation programs, and streamline their management to facilitate on-the-ground conservation and direct funding to high-priority conservation areas. While the reauthorization of the Farm Bill should be one of the highest priorities in the coming months and years, the Partnership's members will have the opportunity to work with Farm Bill implementers, both public and private, regardless of what changes are made to the bill. Compared to other existing conservation programs, significant funding is available through Farm Bill conservation programs. Improvements could be made in Farm Bill easement programs, FRPP and GRP, the land-retirement Conservation

Reserve Program (CRP), and the Conservation Reserve Enhancement Program (CREP). In addition, the cost-share Environmental Quality Incentives Program (EQIP), and Wildlife Habitat Incentive Program (WHIP) can be used to better foster grasslands conservation. The 2007 reauthorization of the Farm Bill must be one of the highest priorities of a comprehensive grassland conservation strategy. Revisions to the 2007 Farm Bill should eliminate incentives that encourage conversion of ecologically-important lands. Newly converted grasslands should not be eligible for future commodity program support. Grassland conservation interests must broaden and deepen their partnerships with the NRCS, Farm Service Agency (FSA), local conservation districts, and watershed associations to help ensure that the millions of dollars of Farm Bill conservation incentives help promote appropriate land-management practices in priority conservation areas.

4. Work with rural landowners and managers who own and manage private and public grasslands to support land-management practices that promote conservation. The Partnership should seek to work with the ranching community to provide the means for ranchers to succeed, find opportunities for young ranchers and their families who desire to get into the business, and identify economic incentives and rewards for land-management practices that benefit conservation efforts. The success of this grassland vision, goal, and strategy depends on a ranching community that can adapt to changing economies, demographics, social values, and politics of the prairie and a global society. Subsidies and low-interest financing that provides access to land, livestock, and equipment should be identified. Helping ranchers purchase ranches should be a priority, and should utilize access to low-cost financing and loan guarantees offered by agencies such as the Farm Service Association and Colorado Agricultural Development Authority (CADA). In other cases, it will be valuable to provide ranchers with the flexibility of access to grazing leases. Without the participation of current and future ranchers, this vision cannot be fulfilled or sustained. In addition to incentives available through the Farm Bill, new incentives must be provided to property owners for grassland conservation. This includes effective financial rewards, such as tax credits, for those who donate easements (including working easements) on their grasslands. If managing for biodiversity reduces economic returns, then those losses should be addressed through creative and innovative measures.

5. Work with public and private water managers to preserve priority rivers, streams, and wetlands while respecting water rights, sustaining traditional land uses, and meeting future demands. The Partnership should engage the water management community to maintain and restore adequate water supplies in rivers and streams, while sustaining the important cultural and economic water uses of the central prairie. Currently, traditional agricultural water rights are a primary source of new water supplies for growing municipalities on the Colorado Front Range. This pressure will only increase in the coming years (e.g., the recently completed Statewide Water Supply Initiative projects that more than 300,000 acres of irrigated agriculture could be removed from production to meet future municipal demands). The Partnership should work with the state and water-rights holders to implement creative ways for cities and agriculture to

share water, so that cities can firm water supplies, and ranchers and farmers can augment revenues and maintain the economic and habitat values of agricultural lands. In addition, the Partnership should participate in water supply planning forums, including the Inter-Basin Compact roundtables, to seek future water supply solutions that protect priority rivers and streams, while meeting growing demands. By identifying sustainable, multi-purpose water supply solutions, the Partnership can alleviate pressure on agricultural communities and directly protect or enhance rivers, streams, wetlands, and associated species.

6. <u>Develop a groundwater sustainability strategy</u>. Several very large, critical aquifers underlie the CSP ecoregion. The Denver Basin and Ogallala are two of the better-known ones. These aquifers provide critical water for wildlife and human use (both urban and rural). It is essential to develop strategies that help meet current and future water demands, while maintaining the natural systems that depend on the aquifers and other water sources. Collaborating with priority groundwater management districts is essential for long-term success.

7. <u>Consolidate state and federal public grasslands</u>. Public land management is hampered by the disjointed, checkerboard nature of state and USDA Forest Service lands. The Partnership will work with these agencies, and private landowners to consolidate these lands into more manageable blocks through purchases, land swaps and effective land-use planning. Consolidation of these lands should serve to strengthen cooperation between private and public landowners and land managers. The Cimarron and Comanche National Grasslands, Pawnee National Grassland, and state land board landholdings in all Western states are prime examples of why consolidation is essential for management success.

8. <u>Create or utilize innovative tools, such as off-site mitigation or conservation leases, on state and federal lands to facilitate specific management practices among partners in the ranching community</u>. Leases can be subleased to ranchers whose range-management practices are compatible with biodiversity conservation and rangeland management. An example of this arrangement is the Bohart Ranch in Colorado, where the Conservancy holds the grazing lease on state land board lands, and works with a ranching family in the management of the property to ensure that conservation goals are met. These types of projects can also impact land management beyond the boundaries of the leased/deeded land. An excellent example is the Matador Ranch in Montana, where conservation of 35,000 acres of fee land has significantly influenced grazing management, through grass-banking, across approximately 300,000 acres.

9. <u>Pursue innovative water-management partnerships to maintain and restore rivers and streams while providing for traditional consumptive water use</u>. An example of this approach might include the purchase of water rights that allowed the release of water during the spring when snowmelt increased natural flows (before the construction and operation of dams). Releasing pulses of water that mimic the historic, natural timing and volumes of pre-dam flows benefits native species, including plants, fish, amphibians, etc. Looking for ways to restore these flows, while providing additional

water to traditional downstream users, provides a win-win opportunity for local economies and ecosystems.

10. Use an integrated invasive species approach to eradicate new invasive species (particularly in conservation areas identified in this assessment), limit the expansion of established invasive species, and minimize the impacts of prevalent invasive species (e.g., Canada thistle). This approach includes the removal of existing non-native species, and incorporates measures to prevent the introduction and spread of new ones. Through creative partnerships, tamarisk and Russian olive can be removed from key river reaches. Several invasive species initiatives have developed and provided some funding to implement control of invasive species. In addition, it is important to disseminate up-to-date invasive species information with private landowners.

    Such work has already begun along the Purgatoire River, and is aimed at removing tamarisk from the entire extent of the river to restore native, riparian species. This project is expected to last a decade and cost millions of dollars, but it represents the type of ambitious work necessary to maintain native species for the benefit of conservation, as well as landowners and managers.

11. Encourage the use of prescribed fire as one tool for management and restoration. This may include naturally ignited fires if they meet specific criteria. The public should be informed about the positive and negative effects of fire. Suppression agencies should develop programs that reduce the potential for catastrophic fires before fires are ignited, and develop suppression strategies that minimize negative impacts. Training should be provided to reduce risk to firefighters, property, and natural resources. Funding opportunities should be explored that will result in ecologically beneficial use of fire. And, finally, the Partnership should encourage the use of fire on public and private lands, where appropriate.

12. Encourage conservation of important habitat for migratory species, particularly declining bird species, both inside and outside of the ecoregion. Successful conservation for migratory bird species depends on conservation in surrounding and distant ecoregions. For example, mountain plover migrate annually to wintering grounds south and east of the CSP, e.g., Mexico and the Imperial and Central Valleys of California.

XVIII. NEXT STEPS AND RECOMMENDATIONS

It is critical to recognize that the conservation targets (i.e., species, communities, and ecosystems) identified in this assessment, and the priority places and threats, are not static. The Partnership faces the continuous challenge of identifying new data and methods, and incorporating them into its analysis. It also must look at conservation priorities through the eyes of those who will live with on-the-ground results. In summary, while the effort of the past two years helped create a vision for how success should look, that vision needs to be refined continuously to ensure that it adapts to changes in scientific understanding, changing economies, local culture, and political realities of the Great Plains

The DoD Legacy Resource Management Program has approved an additional year of funding for this collaborative conservation effort. This financial support will allow further development of the Shortgrass Prairie Partnership strategic plan, action plan, memorandum of partnership, and outreach plan. It also will enable a field analysis and development of habitat models of several species-at-risk to predict where these species might occur throughout the ecoregion. This work represents the commitment of the Shortgrass Prairie Partnership to constantly improve ecoregional conservation efforts through the collection of new data, and the application of new research, analysis methods, and cooperation.

A. Next Steps for the Shortgrass Prairie Partnership (August 2006 – September 2007)

1. Expand membership of the Shortgrass Prairie Partnership to engage key stakeholders who can best help achieve success at the necessary scale, including conservation districts, cattlemen and ranchers, wind energy and oil/gas corporations, land trusts and conservation organizations, Farm Services Agency, county representatives, and elected officials.
2. Sign a memorandum of partnership that provides a framework for collaboration to conserve the priorities identified in the ecoregional assessment.
3. Develop a strategic plan that outlines the conservation goals and objectives that the Partnership will pursue, and how best to achieve them.
4. Develop a seven-state coordination effort within the CSP to identify opportunities for collaboration.
5. Develop and implement a communication and outreach plan to share results and strategies of the ecoregional assessment with key audiences.
6. Identify opportunities to make progress on shared federal and state agencies' priorities. Pursue conservation opportunities that result in significant short-term progress, including the Colorado Division of Wildlife's $20 million request for proposals to conserve wildlife habitat in the coming years.
7. Begin implementation of recommendations provided in the Species Management Guidance Templates (e.g., fill gaps, determine roles, meet with stakeholders).
8. Present results of the CSP assessment to key stakeholders, including the Inter-Basin Compact roundtables for the Arkansas, South Platte, and Metro-Front Range basins.
9. Develop conservation action plans for priority areas to identify strategies and actions, and refine boundaries for conservation areas.

B. Technical Next Steps for the Shortgrass Prairie Partnership

This assessment was conducted using the most current and best scientific information. However, a number of next steps should be taken in order to keep the assessment alive and useful to practitioners. Also, a variety of gaps still exist, and filling those gaps is an important part of moving forward to conserve the ecoregion's biodiversity, improve scientific understanding of the shortgrass prairie, and maintain a dynamic and adaptive assessment.

1. Data: The Nature Conservancy of Colorado will serve as the official repository for all data from the assessment project and will take the lead on efforts to update, maintain and share assessment data, analyses and products with partners, experts and interested parties. However, due to specific data license agreements, individuals should contact State Natural Heritage Programs for specific occurrence level data.

2. Playa Lakes and Shorebird Aggregation Areas: Mapping playa lakes across a large region with so much natural variation has been challenging; field verification is needed to confirm the presence of individual playas before conservation actions are taken. Valuable efforts by PLJV and RMBO to document playas and associated species in parts of the region are ongoing. It is important to build on these existing efforts and collaborate with other states to conduct further inventories, verify tilled/untilled status, document community types, and assess condition of these important habitats. Additionally, further work is needed to document the role of reservoirs as shorebird aggregation areas, and use by migratory and breeding bird species.

3. Terrestrial Ecological Systems and Targeted Plant Communities: While the most recent coverage for terrestrial ecological systems across the ecoregion was used, the quality of mapping is uneven across the states. The team strongly supports the ongoing updating of ecological systems maps (e.g., through the interagency LANDFIRE effort), and recommends that further efforts refine and increase the accuracy of terrestrial ecological system maps. These data may then be processed using GIS to develop occurrences for systems using NatureServe protocols. Terrestrial systems also need to be cross-walked with the NRCS ecological sites. A comprehensive inventory of targeted plant communities should be conducted, mapped, and documented across the ecoregion.

4. Black-tailed Prairie Dog: Modeling and mapping of prairie dog colonies and complexes was based on data from state fish and game agencies. Future iterations should include data from Oklahoma. We strongly encourage consistent sampling, field-verification, and mapping of prairie dogs across the ecoregion. A combination of consistent aerial surveys, followed by digitizing towns from 1 m resolution Digital Orthophoto Quads, would allow for a more comprehensive survey. A region-wide survey that uses the same approach in all states would allow for consistent monitoring and improve confidence in abundance and distribution estimates. Modeled distribution of suitable habitat should be field-verified; occupied acres are needed and compared with both the CDOW Conservation Plan (2003) and Multi-State Working Group goals (2003).

5. Aquatic Ecological Systems: In developing the ecological integrity index for assessing aquatic ecological systems, the team was unable to obtain consistent ecoregion-wide data sets for water flow, groundwater withdrawals, and indices of hydrological integrity. Future efforts should be focused on obtaining these data sets, addressing threats to aquatic targets, such as invasive species, and refining the aquatic ecological integrity and assessment. Additionally, the aquatic systems should be field-verified through rapid assessment; descriptions should be expanded for the Eastern Slope of the Rocky Mountains. The team also should work with adjacent ecoregions to incorporate aquatic results into their assessments.

6. Aquatic Species: The assessment revealed that many aquatic species, particularly invertebrates, are poorly studied in the ecoregion. The team recommends that systematic surveys of invertebrates, along with integrating data across state boundaries. In the near term, the distribution of fish species needs to be updated to include expert review from this project (Figure I).

7. Threats: The threats information for conservation areas was gathered from local and regional experts, focused largely on targets within the terrestrial conservation areas, and addressed severity, timeline, and scope across the ecoregion. Ecoregion-wide threats were mapped using available data sets. Future threats analyses should:
   a. Include aquatic species and communities at conservation areas;
   b. Continue to refine threats to targeted species and ecosystems within conservation areas and update Appendix O. Consider scope within conservation areas to more accurately capture the full impacts of the threats to the targets;
   c. Analyze the network within the context of projected growth for the ecoregion;
   d. Identify areas with greatest potential for wind energy development by using factors other than wind speed, and obtain accurate wind energy maps;
   e. Analyze opportunities for private land conservation using information on land values;
   f. Conduct comprehensive inventories of invasive plant and animal species, and develop coordinated strategies to address priority species across the ecoregion;
   g. Increase understanding of potential impacts of oil/gas development, given its recent rapid expansion and potential for not-yet-known extraction technologies;
   h. Improve information on locations and trends for energy development; and
   i. Encourage consistent mapping of invasive species across the ecoregion.

8. Climate Change: Additional research is needed to evaluate results of current best-available climate change models on the conservation targets listed for the CSP. The focus of this research should link climate parameters that are predicted to change with ecological processes that support conservation targets. For example, if climate models predict a significant change in flow regimes for major rivers in the southern half of the CSP, it is important to determine which species targets are most likely to be affected, and where. From this research, a series of monitoring stations could be established throughout the ecoregion's conservation areas that detect the most important changes predicted by climate models. Mitigating measures, in terms of new

lands, and connecting corridors may be more effectively identified through this research.

9. Measures: Expand measures to incorporate other spatial and non-spatial data, as well as socioeconomic factors. Future steps include the following:
   a. Create occurrences for terrestrial systems, and applying measures with a finer level of detail;
   b. Create specific measures that address particular agency/partner goals and mandates;
   c. Devise a means to summarize the effectively conserved status for the ecoregion; and
   d. Reassess the ecoregional status measures every five years (i.e., 2011, 2016). Because some variables do not change as rapidly as others, develop a schedule that appropriately responds to rates of change.

10. Fire: A wide variety of information is available on fire histories and fire effects. Specific information for some of the ecological systems in the CSP is better than others. LANDFIRE State and Transition model development is ongoing, but was not incorporated in this assessment (see www.landfire.gov). LANDFIRE Rapid Assessment models for most of the Ecological Systems in the CSP are now available, or will be in the near future. LANDFIRE will continue to refine these models in 2006/2007. Expert input into this process is critical. Scientists and managers should be engaged in future workshops to help review existing models and develop new ones as needed. Based on information used to develop these models, data gaps and research needs can be further identified.

11. Terrestrial Animal and Plant Species: Data for many species of concern are in need of improvement. This is especially true for invertebrates, reptiles, amphibians, mammals and plants. We strongly encourage additional inventory of these species. We need to prioritize and conduct countywide inventories, and inventories in lesser-known parts of the ecoregion, and compile data for species targets with little or no data, particularly invertebrates (see Appendix H). The team will conduct a field analysis of several species at risk, including the whiptail lizard, macro-invertebrates, and rare plants, and develop ecoregion-wide habitat models to help land managers determine where species-at-risk might occur and how best to manage for these species to avoid further declines and federal listings.

12. Goals: Test coarse-filter assumptions to see how well ecological systems capture fine-filters (species and communities), and continue to refine goals as data become available. Conduct further analyses of species that were over-goal in the network of conservation areas (see Appendix N), such as Plains leopard frog, Texas horned lizard, and Cassin’s sparrow, to determine which occurrences are critical to meet goal.

13. Land use and Threat-related Issues: Refine landscape integrity (suitability index/cost-layer) analysis, incorporating other ecoregion-wide spatial data as it becomes available.

14. Network of Conservation Areas: Several next steps are needed to refine the network, including:

    a. Continue to refine the conservation area summaries in Appendix O (e.g., develop descriptions, add photographs, identify critical species occurrences needed to meet goal, contribution towards goal, refine boundaries);
    b. Delineate the greenback cutthroat trout conservation areas for the Platte River basins consistent with those in the Arkansas River basins (as stream reaches).
    c. Analyze the contribution of the aquatic network towards continental and regional bird goals;
    d. Expand summaries for aquatic conservation areas;
    e. Check new datasets to see how well species on the edge of their ranges are captured in the network, particularly from the eastern part of the ecoregion;
    f. Quantify restoration needs for specific targets, such as Central Mixed Grass Prairie system type, and playa lakes; and
    g. Develop more detailed conservation area plans to refine targets, assess threats, and develop strategies.

15. Prioritization of Conservation Areas: Continue to refine the prioritization analysis of conservation areas, integrating new data and methods for the terrestrial conservation areas. Conduct a threats assessment, managed area analysis, and prioritize the aquatic conservation areas to help guide conservation actions for aquatic ecological systems and species.

XIX. CONCLUSION

This assessment, produced in collaboration with a number of key stakeholders and partners, provides a vision for conservation success by identifying 183 key places and waters that merit conservation action, threats to biodiversity at those places, and strategies to mitigate threats in the Central Shortgrass Prairie. It builds on previous efforts (i.e., Ecoregion-based Conservation in the CSP, State Comprehensive Wildlife Conservation Strategies, CDOW Conservation Plan for Grassland Species in Colorado, USFWS Platte/Kansas Ecoregional Plan), and lays the groundwork to significantly expand conservation efforts in the region.

The CSP lies within the Temperate Grasslands major habitat type, one of the most converted yet least protected habitat types in the world. Approximately 50% of the ecoregion already has been converted to non-natural uses. Key impacts on native species, plant and animal communities, and ecological systems in the ecoregion include habitat conversion and degradation, altered hydrologic regime, invasive species, roads, energy development, and climate change. A proactive approach to addressing these threats is needed now to avoid further habitat losses and declines in species. A comprehensive approach also will include the restoration of soils and vegetation, the restoration of hydrologic function, and a means of preventing the worst impacts of noxious weeds and invasive animals, such as non-native fish, feral pigs, and snails.

The majority (86%) of the network of conservation areas is privately owned and managed. Long-term conservation success depends on sound management of the native grasslands and streams by private landowners, many of whom already manage their grassland with care. The Shortgrass Prairie Partnership will work with a wide variety of landowners and organizations on a voluntary basis to accomplish shared goals. The Partnership will engage in activities that are based on mutual benefit, trust, and respect for the rights of private property ownership.

Key accomplishments of this collaborative effort include: 1) a multi-institutional partnership that will coordinate conservation efforts in the region for years to come; 2) terrestrial and aquatic networks of conservation areas that provide a vision to guide conservation for native species, communities, and ecological systems of the ecoregion; 3) a framework for measuring conservation status over time through an adaptive management approach; 4) species management guidance templates to help coordinate land management for species-at-risk among multiple partners; and 5) region-wide dynamic products that inform decision-making, and can be easily updated with new data and methods to guide future conservation efforts. Finally, this assessment provides information that can lead to a future in which grasslands remain intact for current and future generations.

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